Assessing Tightly Bundled, Complete & Technology/
Sector-Specific Policy Mixes to Enable Technology
Development & Adoption to Mitigate Climate Change &
Support a Transition towards a Low-Carbon Energy Future
in Canada

by

Marc R. Wickham

A thesis submitted to the Faculty of Graduate and Postdoctoral
Affairs in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Public Policy

Carleton University
Ottawa, Ontario

© 2021, Marc R. Wickham

Abstract

This thesis examines policy mixes that were designed and implemented to enable technological developments and adoption, to mitigate climate change and support a socio-technical transition to a low carbon energy future. This thesis seeks to assess the early experience with a new experimental policy mix approach, implemented by the Canadian federal Department of Natural Resources since 2016, in which the policy instruments in the policy mix are more ‘tightly bundled’ in terms of design, implementation and evaluation; ‘complete’ in covering the technology innovation chain; and ‘technology/sector-specific’, compared to the traditional, highly siloed policy mix approach.

The thesis’ hypothesis is that the experimental approach is likely to result in hypothesized improvements and benefits, compared with the conventional approach, specifically improvements in consistency of elements, coherence of processes, and comprehensiveness of the policy mix. The thesis uses a comparative case study approach to compare 3 experimental case studies against 3 conventional cases, and seeks to answer 4 research questions directly related to the assessment of the experimental approach, to test the hypothesis and obtain additional insights about the experimental policy approach.

The thesis results in a primary conclusion and six supporting conclusions. The primary conclusion is that the experimental approach shows significant promise, has merit, and results in benefits and improvements, including improvements in the three indicators (confirming the hypothesis), and lower administrative costs, compared to the conventional approach. This is an important conclusion that suggests that the experimental approach has the potential to be a more effective policy mix approach than

the conventional approach. This is sufficient evidence to support further experimentation with and study of the experimental approach in the future. The six supporting conclusions provide additional insights which could be useful in future implementation, including: a preliminary theory of change that provides a causal relationship to explain improvements and benefits; suggestions as to opportunities to further improve the experimental policy mixes, in the future and barriers and constraints that would need to be addressed to reduce implementation risks.

Acknowledgements

I would like to first acknowledge and thank, very much, my Ph.D. Thesis Supervisor, Professor Robert P. Shepherd, as well as my thesis committee members, Professors Stephan Schott and James Meadowcroft, who have been extremely supportive and helpful in providing direction, advice and guidance, to help me complete this thesis. I cannot thank these professors enough – they have been particularly flexible and responsive, during this period of COVID-19 work constraints, and over the past 3 years. Their input has helped to ensure that the research would be relevant and of the highest quality possible. I would like to thank Prof. Meadowcroft for encouraging me to apply to Carleton University’s Ph.D. program, at the outset of my studies, following a meeting over coffee at a conference on Carbon Capture & Storage technologies, for his continuous encouragement, and for providing a number of relevant references. I would like to thank Prof. Schott for many stimulating conversations in his office and at SIGNALS¹, CSERC² and other learning events, such as the Certificate in Energy Programming & Evaluation, which have enriched my studies and this thesis. Finally, I would like to thank Prof. Shepherd, who has provided rigorous, fair and thoughtful comments on my thesis proposals and drafts, and who was always available and responsive, whether online, at the office, or in his beautiful garden. I could not have completed this thesis without Professors Shepherd’s, Meadowcroft’s and Schott’s strong

¹ SIGNALS is a group of ‘Students, Interested parties, and Graduates Networking And Liaising around Sustainability.’ The network stems from the Innovation, Science, and Environment stream of Public Administration Program and the Sustainable Energy (SE) Program, both of Carleton’s School of Public Policy and Administration (SPPA). SIGNALS brings together students, alumni, and professors who are concerned about sustainable development issues. Students, Interested parties, and Graduates Networking And Liaising around Sustainability

² Carleton Sustainable Energy Research Centre

support and encouragement. I would like to thank and acknowledge Prof. David Carment, who acted as Chair for my thesis defence, David Haughton who provided technical support for the video conference, as well as my two external reviewers Prof. Jeremy Rayner and Prof. Scott Bennett. I would like to extend a special thank you to Prof. Rayner for participating in the defence from Victoria, BC, with a very early morning start, as well as for preparing the External Examiners' Report.

I would also like to thank other staff and faculty of Carleton University's School of Public Policy and Administration (SPPA), who have helped facilitate my Ph.D. studies. I am particularly grateful to current and former Directors of the School and Graduate Supervisors of the Ph.D. program, including Professors Graeme Auld, Jose Galdo, Susan Philips, Leslie Pal, and Saul Schwartz. I also benefitted significantly from the support of current and former SPPA staff, who were always extremely friendly and helpful, including Judy Donaldson, Ashley-Dawn McKee, Megan Innes, Mary Giles, Laura Gareau, Mary Au, and Nicki Enouy. I would also like to thank the many SPPA professors whose classes I have taken, and who have provided a rich learning experience that made the Ph.D. studies so worthwhile. In particular, I would like to thank Professors Saul Schwartz, Graeme Auld, Alexandra Mallett, Rob Shepherd, Philip Ryan, Jennifer Stewart, Frances Abele, Manfred Bienefeld, Stephan Schott, Jose Galdo, Donald Swartz, and Steve Montague, for their most interesting courses. Many of the papers and concepts covered in these courses have been referenced in this thesis. I am also grateful for other Carleton University staff, in particular to Joanne Bree, at Faculty of Graduate & Postdoctoral Affairs, as well as Najia Haneefi and Zheren Li at Carleton University's Office of Research Ethics.

As a part-time student who worked full-time outside of the university, my Ph.D. journey was made a little less solitary through interactions with other SPPA students. I would specifically like to thank the following colleagues: Greg Matte, David Pringle, Ian Bron, Harris Berton, Daniel Rosenbloom, Brendan Haley and Matthew Retallack, who have helped make my studies and research so much more interesting and enriching.

I would like to acknowledge and thank public servants at NRCan, especially interviewees, who provided valuable input to this thesis, and to my work supervisors, particularly Yiota Kokkinos and Dean Haslip, for providing me with flexibility and support, to pursue my Ph.D. studies.

On the personal front, I would like to thank my wife, Sandra, and our four children, Adrienne, Alexandre, Charles and Louis-Philippe, who had to put up with me, while I conducted research and worked on the draft of the thesis, typically in the evenings, weekends, on even on family vacations. Completing a Ph.D. degree and thesis requires much time, resources, and personal sacrifices. Their patience, grace and support was much appreciated. As a Christian, I would like to acknowledge God, whose support and awesome creation provides endless motivation to work for the benefit of fellow humans. All good things come from God, including provision, perseverance, fortitude, and insights to complete this thesis. I would like to thank Bach, Mozart, Kendrick Lamar, and my cousin D'Arcy for providing music that was in the background, while I worked on my thesis. Lastly, I would like to thank my parents Arthur and Suzanne, brothers Philip and Guy, as well as my extended family and friends, particularly Phil and Rosie Whelan and Richard Gore, for their unending patience and support.

Table of Contents

Abstract.....	i
Acknowledgements	iii
Table of Contents	vi
List of Abbreviations	x
List of Tables	xii
List of Illustrations.....	xix
Note to Reader	xx
List of Appendices.....	xxiii
Chapter 1: Introduction	1
1.1 <u>Outline</u>	1
1.2 <u>Introduction</u>	1
1.3 <u>Policy Problem</u>	7
1.4 <u>Research Hypothesis</u>	18
1.5 <u>Key Terms & Analytical Framework</u>	19
1.6 <u>Research Approach and Questions</u>	23
1.7 <u>Outline of the Thesis & Summary of Chapters</u>	25
1.8 <u>Relevance of Research, Expected Contributions and Boundaries & Limitations</u>	26
Chapter 2: Literature Review.....	30
2.1 <u>Outline</u>	30
2.2 <u>Introduction</u>	30
2.3 <u>Context: Climate Change, Socio-Technical Transitions & Energy Transitions</u>	33
2.4 <u>Conventional Policy Mixes</u>	38
2.5 <u>Policy Mixes – Evolution and Current State-of-the-Art</u>	45
2.6 <u>Concluding Thoughts – Gaps in the Literature</u>	53

Chapter 3: Methodology.....	56
3.1 <u>Outline</u>	56
3.2 <u>Introduction and General Research Approach</u>	56
3.3 <u>Research Questions</u>	59
3.4 <u>Rationale for Using Case Study Approach and for Selecting Cases</u>	61
3.5 <u>Researcher Background, Potential Bias and Limitations of Case Study Approach</u>	64
3.6 <u>Theoretical Basis to Methodology and Measurement Tools</u>	67
3.7 <u>Methodology – Description of Cases</u>	73
3.8 <u>Methodology – Answering Research Questions</u>	80
3.9 <u>Data Sources</u>	87
3.10 <u>Conclusion – Boundaries & Limitations</u>	90
Chapter 4: Case Studies – Conventional Policy Mixes.....	96
4.1 <u>Outline</u>	96
4.2 <u>Introduction</u>	96
4.3 <u>Background on Conventional Case Studies</u>	97
4.4 <u>Case Study #1 – Technology Early Action Measures (TEAM) (1998-2009)</u>	99
4.5 <u>Case Study #2 – Clean Energy Fund (CEF) (2007-15)</u>	108
4.6 <u>Case Study #3 – GI Ph. 2 - Emerging Renewable Power Program (2018-23)</u>	117
4.7 <u>Conclusion</u>	129
Chapter 5: Case Studies – Experimental Policy Mixes	131
5.1 <u>Outline</u>	131
5.2 <u>Introduction</u>	131
5.3 <u>Background to Experimental Case Studies</u>	132
5.4 <u>Case Study #4 - GI Ph. 1 & 2 - Electric Vehicle & Alternative Fuels (EVAF)</u>	137
5.5 <u>Case Study #5 - GI Ph. 2 - Smart Grids (2018-22)</u>	149

5.6	<u>Case Study #6 - GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC)</u> <u>(2018-24)</u>	162
5.7	<u>Conclusion</u>	179
Chapter 6: Results, Analysis, and Findings.....		181
6.1	<u>Outline</u>	181
6.2	<u>Introduction</u>	181
6.3	<u>Q1 – Are hypothesized improvements & benefits observed in the experimental vs</u> <u>conventional case studies?</u>	184
6.4	<u>Q2 – Are conditions for success observed more in the experimental vs conventional</u> <u>case studies?</u>	199
6.5	<u>Q3 – Differences in observed improvements & benefits among the experimental case</u> <u>studies?</u> 204	
6.6	<u>Q4 – Barriers & Constraints to implementing the experimental policy approach</u>	213
6.7	<u>Conclusion</u>	224
Chapter 7: Conclusions, Alignment with Literature & Next Steps.....		227
7.1	<u>Outline</u>	227
7.2	<u>Introduction</u>	227
7.3	<u>Conclusions & Implications</u>	227
7.4	<u>Contributions of Research to the Literature</u>	240
7.5	<u>Relevance of Rogge & Reichardt Framework</u>	243
7.6	<u>Next steps for research</u>	244
7.7	<u>Final Thoughts</u>	251
<u>Appendices</u>.....		255
Appendix A - Definition of Key Terms.....		255
Appendix B - Interview Guide		262

Appendix C - CUREB-A Certifications	269
Appendix D - Case #1 - TEAM - Supplementary Information	273
Appendix E - Case #2 - CEF - Supplementary Information.....	285
Appendix F - Case #3 - ERPP - Supplementary Information.....	295
Appendix G - Case #4 - EVAF - Supplementary Information	307
Appendix H - Case #5 – Smart Grids - Supplementary Information.....	318
Appendix I - Case #6 – CERRC - Supplementary Information	330
Appendix J - Results, Analysis & Findings – Supplementary Info	346
Bibliography & References	348

List of Abbreviations

APSC	Australian Public Service Commission
ARENA	Australian Renewable Energy Agency
ARPA-E	Advanced Research Program Administration – Energy (a US government STI program)
BDC	Business Development Bank of Canada (a federal agency)
BTO	Buildings Technology Office (an office within the US DOE’s Office of Energy Efficiency & Renewable Energy)
CESD	Commissioner of the Environment and Sustainable Development (of Canada)
CAA	Clean Air Agenda (Canada)
CEF	Clean Energy Fund (an NRCan government STI program)
CE-O	CanmetENERGY-Ottawa (a research lab that is part of NRCan)
CERRC	Clean Energy for Rural & Remote Communities (an NRCan policy mix)
CoP	Conference of Parties to the United Nations Framework Convention on Climate Change
DARPA	Defense Advanced Research Program Administration (US)
DOE	Department of Energy (US)
DSDS	Department Sustainable Development Strategy
EDC	Export Development Canada (a federal agency)
EAP	Economic Action Plan (Canada)
ECCC	Environment & Climate Change Canada (federal department)
ecoERP	ecoENERGY for Renewable Power Program (an NRCan deployment program)
EERE	Energy Efficiency and Renewable Energy (an office within the US DOE)
ERB	Electricity Resources Branch (of NRCan, part of Energy Sector)
ERPP	Emerging Renewables Power Program (an NRCan deployment program)
ES	Energy Sector (of NRCan)
EV	Electric Vehicle
EVAF	Electric Vehicle & Alternative Fuels (an NRCan policy mix)
EVAFIDI	Electric Vehicle & Alternative Fuels Infrastructure Deployment Initiative (an NRCan deployment program)
EVID	Electric Vehicle Infrastructure Demonstration (a government STI program funded by NRCan)
FSDS	Federal Sustainable Development Strategy (Canada)
GHG	Greenhouse gases
GI	Green Infrastructure (Canada)
GSC	Geological Survey of Canada (an organization within NRCan)
IEA	International Energy Agency
INFC	Infrastructure Canada (federal department)
IODI	Indigenous Off-Diesel Initiative (an NRCan government STI program)
IPCC	Intergovernmental Panel on Climate Change
ISED	Innovation Science & Economic Development Canada (a federal dept.)
NASA	National Aeronautic & Space Administration (US)
NCCHPP	<i>National Collaborating Centre for Healthy Public Policy</i>

NRC	National Research Council (of Canada)
NRCan	Natural Resources Canada (federal department of)
OAG	Office of the Auditor General (of Canada)
OECD	Organization for Economic Cooperation and Development
OEE	Office of Energy Efficiency (branch of NRCan, part of Energy Sector)
OERD	Office of Energy Research & Development (a branch of NRCan)
ORER	Offshore Renewable Energy Regulations initiative
ORP	Offshore Renewables Program
PCO	Privy Council Office (Canada)
PCF	Pan-Canadian Framework on Clean Growth and Climate Change
PERD	Program of Energy R&D (a key foundational energy government STI program funded by NRCan and in place since the early 1970's)
PSPC	Public Services & Procurement Canada
R&D	Research & Development + RSA
RD&D	Research, Development and Demonstration + RSA
RDD&D	Research, Development, Demonstration & Deployment + RSA
REED	Renewable Energy & Electricity Division (of NRCan, within ERB)
RSA	Related Science & Technology Activities
SDTC	Sustainable Development Technology Canada
SG	Smart Grids (an NRCan policy mix)
STI	Science, technology and innovation
TEAM	Technology Early Action Measures (an NRCan government STI program that was part of Canada's Climate Change Action Fund and Climate Change Action Plan)
TBS	Treasury Board of Canada Secretariat
ToC	Theory of Change
US DOE	Department of Energy (a federal department of the United States of America)
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNESCO	United Nations Educational, Scientific and Cultural Organization
WoG	Whole-of-government
WPPI	Wind Power Production Incentive (a deployment program funded by NRCan)
ZEV	Zero emission vehicles

List of Tables

Table 1 – Comparison of WoG policy approach with experimental policy approach.....	48
Table 2 – Six case studies examined in this thesis.....	57
Table 3 – Types of policy instruments for climate change mitigation	68
Table 4 – Tool to map policy mixes against the CRI (source: Commonwealth of Australia, 2014).....	71
Table 5 – Conditions necessary for successful implementation of WoG approaches	72
Table 6 – Case studies examined in this thesis – definition and link to key design document.....	74
Table 7 – Tool to describe 21 characteristics of case studies	76
Table 8 – Measurement tool – bundling of policy mixes	78
Table 9 – Tool to map policy mixes along TRL scale.....	79
Table 10 – Tool to map policy mix along CRI scale	79
Table 11 – Tool to describe technology-specificity attribute of policy mix.....	80
Table 12 – Summary of research questions, indicators, data points and data sources	81
Table 13 – Measurement Tool for questions 1a and 1b – Hypothesized improvements and benefits.....	82
Table 14 – Measurement Tool for question 4 – Barriers & Constraints.....	87
Table 15 – Contributions of the 15 participants interviewed to each of the six case studies	89
Table 16 – Three conventional case studies – background information.....	97
Table 17 – TEAM case study - formal and augmented policy mix	102

Table 18 - Summary of consensus view for evaluation criteria and conditions for successful implementation – TEAM.....	105
Table 19 – CEF case study – formal and augmented policy mixes	111
Table 20 - Summary of consensus view for evaluation criteria and conditions for successful implementation – CEF.....	114
Table 21 – 5 Green Infrastructure integrated policy mixes managed by NRCan.....	120
Table 22 – ERPP case study – formal and augmented policy mixes.....	122
Table 23 - Summary of consensus view for evaluation criteria and conditions for successful implementation – ERPP	125
Table 24 - Summary of consensus view for evaluation criteria and conditions for successful implementation – 3 conventional case studies	129
Table 25 – 3 Experimental Case Studies – background information.....	132
Table 26 – EVAF case study – formal and augmented policy mixes.....	139
Table 27 - Summary of consensus view for evaluation criteria and conditions for successful implementation – EVAF.....	144
Table 28 – Smart Grids case study – formal and augmented policy mixes.....	154
Table 29 - Summary of consensus view for evaluation criteria and conditions for successful implementation – Smart Grids.....	158
Table 30 – CERRC case study – formal and augmented policy mixes	169
Table 31 - Summary of consensus view for evaluation criteria and conditions for successful implementation – CERRC.....	174
Table 32 - Summary of consensus view for evaluation criteria and conditions for successful implementation – 3 conventional case studies	180

Table 33 – Summary of findings and results	183
Table 34 – Hypothesized improvements and benefits – experimental versus conventional case studies.....	185
Table 35 – Consistency of elements – comparison of conventional vs experimental case studies	187
Table 36 – Coherence of processes – comparison of conventional vs experimental case studies	190
Table 37 – Comprehensiveness – comparison of conventional vs experimental case studies	192
Table 38 – Administrative Cost Reductions at Design & Implementation Stages	195
Table 39 – Comparison of Administrative costs for audits & evaluations for conventional versus experimental case studies and expected cost savings	199
Table 40 – Conditions for successful implementation – comparison of conventional versus experimental case studies	201
Table 41 - Comparison of experimental case studies – 3 Indicators of Improvement & Benefits	205
Table 42 – Comparison of experimental case studies – Tightness of bundling.....	207
Table 43 - Comparison of experimental case studies – Coverage of Innovation Chain, TRLs, CRIs	208
Table 44 – Selection of 21 Characteristics – highlighting differences	209
Table 45 – Selection of 11 Conditions for successful implementation of WoG approaches – highlighting differences	211

Table 46 – Barriers & constraints for future implementation of the experimental approach	214
Table 47 – Primary Conclusion and 6 Supporting Conclusions	228
Table 48 – Logical relationship between key design features and improvements in 3 evaluation criteria (consistency, coherence, comprehensiveness)	233
Table 49 – Logical relationship between key design attributed and improvements in 7 out of 11 conditions for successful implementation of WoG policy approaches..	233
Table 50 – Contributions to literature	240
Table 51 – TEAM RD&D program phases, Budget and Actual spending	274
Table 52 – TEAM RD&D program information and statistics	277
Table 53 – TEAM case study – documents reviewed	278
Table 54 – TEAM policy mix - tool to determine level of bundling	279
Table 55 – TEAM policy mix - mapping of nine policy instruments against instrument types	279
Table 56 – Mapping of TEAM policy mix against TRL scale	280
Table 57 – Mapping of TEAM policy mix against CRI scale	281
Table 58 – Tool to describe technology-specificity – TEAM policy mix	281
Table 59 – TEAM case study – 21 characteristics of the policy mix	282
Table 60 – TEAM case study – measurement tool with responses to question 1	283
Table 61 – Team case study - measurement tool with responses to question 2	284
Table 62 - CEF case study – documents reviewed	288
Table 63 - CEF policy mix - tool to determine level of bundling	289

Table 64 – CEF policy mix - mapping of four policy instruments against instrument types	289
Table 65 – Mapping of CEF policy mix against TRL scale	290
Table 66 – Mapping of CEF policy mix against CRI scale	291
Table 67 – CEF policy mix – tool to describe technology-specificity	291
Table 68 - CEF case study – 21 characteristics of the policy mix	292
Table 69 - CEF case study – measurement tool with responses to question 1	293
Table 70 - CEF case study - measurement tool with responses to question 2	294
Table 71 – 5 Green Infrastructure integrated policy mixes managed by NRCan	296
Table 72 - ERPP case study – documents reviewed	299
Table 73 - ERPP policy mix - tool to determine level of bundling	300
Table 74 – ERPP policy mix - mapping of four policy instruments against instrument types	300
Table 75 – Mapping of ERPP policy mix against TRL scale	301
Table 76 – Mapping of ERPP policy mix against CRI scale	302
Table 77 – ERPP policy mix – tool to describe technology-specificity	302
Table 78- ERPP case study – 21 characteristics of the policy mix	304
Table 79 - ERPP case study – measurement tool with responses to question 1	305
Table 80 - ERPP case study - measurement tool with responses to question 2	306
Table 81 - EVAF case study – documents reviewed	310
Table 82 - EVAF policy mix - tool to determine level of bundling	311
Table 83 – EVAF policy mix - mapping of policy instruments against instrument types	312

Table 84 – Mapping of EVAF policy mix against TRL scale	313
Table 85 – Mapping of EVAF policy mix against CRI scale	313
Table 86 – EVAF policy mix – tool to describe technology-specificity	314
Table 87- EVAF case study – 21 characteristics of the policy mix.....	315
Table 88 - EVAF case study – measurement tool with responses to question 1	316
Table 89 - EVAF case study - measurement tool with responses to question 2.....	317
Table 90 – Smart Grids case study – documents reviewed	322
Table 91 – Smart Grids policy mix – tool to determine bundling	323
Table 92 – Smart Grids policy mix - mapping of five policy instruments against instrument types	324
Table 93 – Mapping of Smart Grids policy mix against TRL scale	324
Table 94 – Mapping of Smart Grids policy mix against CRI scale	325
Table 95 – Smart Grids policy mix – tool to describe technology-specificity	325
Table 96- Smart Grids case study – 21 characteristics of the policy mix.....	327
Table 97 – Smart Grids case study – measurement tool with responses to question 1A	328
Table 98 – Smart Grids case study - measurement tool with responses to question 2 ...	329
Table 99 - CERRC case study – documents reviewed	337
Table 100 - CERRC policy mix - tool to determine level of bundling.....	338
Table 101 – CERRC policy mix - mapping of eight policy instruments against instrument types	339
Table 102 – Mapping of CERRC policy mix against TRL scale	340
Table 103 – Mapping of CERRC policy mix against CRI scale	341
Table 104 – CERRC policy mix – tool to describe technology-specificity.....	342

Table 105- CERRC case study – 21 characteristics of the policy mix	343
Table 106 - CERRC case study – measurement tool with responses to question 1	344
Table 107 - CERRC case study - measurement tool with responses to question 2	345
Table 108 – Comparison of experimental case studies – 21 characteristics.....	346

List of Illustrations

Illustration 1 – Positioning of government STI programs within the innovation chain ...	15
Illustration 2 - Framework for analysis of policy mixes to enable technology development and adoption for climate change mitigation.....	20
Illustration 3 – Technology and Commercialization Valleys of Death	42
Illustration 4 – Mapping of TRL and CRI scales along the innovation chain	69
Illustration 5 – Technology Readiness Levels (source: Mankin, 2009)	70
Illustration 6 – Tool to map policy mix along innovation chain and example with 3 instruments.....	78
Illustration 7 – Attributes of experimental policy approach along a spectrum.....	235
Illustration 8 – opportunities to improve experimental policy mixes – depth and coverage	236
Illustration 9 – TEAM - Mapping of 9 policy instruments against the innovation chain	280
Illustration 10 – CEF - Mapping of 4 policy instruments against the innovation chain.	290
Illustration 11 – ERPP - Mapping of 4 policy instruments against the innovation chain	301
Illustration 12 – EVAF Mapping of 6 policy instruments against the innovation chain	312
Illustration 13 – Smart Grids - Mapping of 5 policy instruments against the innovation chain.....	324
Illustration 14 – CERRC - Mapping of 8 policy instruments against the innovation chain	340

Note to Reader

The subject of this thesis is the assessment and application of policy mixes, which is a fairly specialized research area, using specialized terminology. Some public servants, who design and implement policy instruments and policy mixes, may not be familiar with this terminology or with the public policy literature related to this topic. They may use different terminology, such as “program”, “initiative”, or “strategy” to describe policy instruments and mixes that they work with on a daily basis. Rogge & Reichardt (2016) argue that the terminology applied to policy mix studies is often ambiguous and inconsistent, and have provided precise definitions of terms in their 2016 article, to help overcome this. In this thesis, I use the terminology defined in Rogge & Reichardt (2016) and have defined other terms in a precise way, also in an attempt to further reduce ambiguity and inconsistency. It is suggested that readers familiarize themselves with the terminology used in this thesis, by referring to the section titled “Definition of Key Terms,” which is in Appendix A, as well as Section 1.5, which further defines key terms. Two specific terms, “programs” and “policy instruments”, are defined below, to help clarify the use of these terms in this thesis, and to avoid confusion.

In the real world of policymaking, Canadian public servants often refer to certain policy instruments, such as instruments to enable research and development (R&D), or technology deployment, as RD&D or deployment “programs.” In addition, government auditors and evaluators commonly use terms such as “program” audits and evaluations, or “program” theory to describe the work that they do. Thus, in practice, the term “program” is often associated with specific types of policy instruments. However, the Treasury Board of Canada Secretariat defines the term “program” more broadly, as:

“individual or groups of services, activities or combinations thereof that are managed together within the department and focus on a specific set of outputs, outcomes or service levels” (TBS 2016). The above TBS definition includes the traditional definition of policy mix used in the academic literature. In this thesis, in order to avoid any confusion, I will only use the term “policy mix,” as defined by Rogge & Reichardt (2016) and avoid using the term “program.”

The term “policy instrument” is defined as the “concrete tools to achieve overarching objectives” (Rogge & Reichardt 2016), and as “tools” (Salamon 2002) or “techniques of governance” (Howlett 2005) “that address policy problems” (Pal 2006). Rogge & Reichardt (2016) mention that alternative terms can be used for “policy instruments”, including implementing measures and programs. Again, to avoid confusion, this thesis will privilege the use of the term “policy instruments” and avoid the use of the term “program.”

The above being said, the term “program” will be retained, in limited circumstances, where (1) it is part of an official name or (2) is commonly used, such as in Emerging Renewable Power Program, one of the three experimental case studies examined; or in commonly used terms such as government science technology & innovation (STI) program, an RD&D program, or program audits and evaluations. The term “program” will also be retained when it is part of a citation from journal or grey literature articles, government websites, etc. Note that, in this thesis, government STI program and RD&D program are considered to be equivalent terms.

This thesis will refer to eight specific types of policy instruments, used in the policy mixes examined, using the typology developed by the Intergovernmental Panel on

Climate Change (IPCC 2007), per Table 3, in section 3.6. The eight types of policy instruments, per the above typology, are: (i) regulations and standards; (ii) taxes and charges; (iii) tradable permits; (iv) voluntary agreements; (v) subsidies and incentives; (vi) information instruments; (vii) government science technology & innovation (STI) programs; and (viii) other.

The “experimental” policy mixes that are assessed in this thesis are new, having been introduced in Canada since 2016. As such, public servants who designed and implemented these policy mixes did not yet name this new policy mix approach. Throughout, this new policy mix approach is referred to as the “experimental policy mix approach.” In the future, it may be useful to assign an actual name to this new approach, in consultation with public servants. Potential candidate names are: (i) integrated policy mix approach for clean technology development and adoption; (ii) whole-of-government policy approach for clean technology development and adoption; or (iii) technology ecosystem policy approach. However, these are still fairly long descriptive names that do not precisely and easily describe it. Ideally, the selected name would be simple and descriptive.

List of Appendices

Appendix A – Definition of Key Terms.....	255
Appendix B – Interview Guide.....	262
Appendix C – CUREB-A Certifications.....	269
Appendix D – Case #1 – TEAM – Supplementary Information.....	273
Appendix E – Case #2 – CEF – Supplementary Information.....	285
Appendix F – Case #3 – ERPP – Supplementary Information.....	295
Appendix G – Case #4 – EVAF – Supplementary Information.....	307
Appendix H – Case #5 – Smart Grids – Supplementary Information.....	318
Appendix I – Case #6 – CERRC – Supplementary Information.....	330
Appendix J – Results, Analysis & Findings – Supplementary Information.....	346

Chapter 1: Introduction

1.1 Outline

- Introduction
- Policy Problem
- Research Hypothesis
- Key Terms & Analytical Framework
- Research Approach
- Outline of Thesis and Summary of Chapters
- Relevance of Research, Expected Contributions and Boundaries & Limitations

1.2 Introduction

This thesis examines policy mixes used by the Canadian federal government to advance and support the development and adoption of new, clean energy technologies to mitigate climate change and to foster a socio-technical transition to a low carbon energy future.

The policy mixes examined aim to develop new technologies used in the production, transportation or utilization of energy that are expected to result in significantly fewer greenhouse gas (GHG) emissions than current technologies, with a longer-term stretch goal of Net-Zero greenhouse gas (GHG) emissions by 2050, as announced by Canada and 65 nations at the UN Climate Action Summit 2019,³ and as further committed by Canada with the introduction of Bill C-12, *Canadian Net-Zero Emissions Accountability Act*,⁴ in November 2020, to legislate Net-Zero GHG emissions by 2050.

Anthropogenic climate change results from the increasing atmospheric accumulation of greenhouse gases, including carbon dioxide (CO₂) and methane,

³ Source: <https://sdg.iisd.org/news/77-countries-100-cities-commit-to-net-zero-carbon-emissions-by-2050-at-climate-summit/> ; <https://www2.liberal.ca/liberals-move-forward-to-legislate-net-zero-emissions-by-2050/?oc-redirect=1> and <https://www.cbc.ca/news/politics/liberals-carbon-net-zero-promise-1.5297364>; accessed 31 July 2020.

⁴ <https://www.canada.ca/en/environment-climate-change/news/2020/11/government-of-canada-charts-course-for-clean-growth-by-introducing-bill-to-legislate-net-zero-emissions-by-2050.html> accessed 1 Jan. 2021.

produced through human activities. The global temperature has been documented to have increased by approximately 0.8°C since 1880 due in large part to an increase in CO₂ in the atmosphere, from 291 parts per million (ppm) in 1880 to 409.8 ppm in 2019⁵ (NOAA 2020). The 2015 *Paris Agreement* seeks to support mitigation measures to slow the increase in average temperature, by 2100, to under 2°C from “pre-industrial levels” (assumed to be roughly levels in 1880).

In order to mitigate climate change and achieve greenhouse gas emission reduction targets made in international agreements, there is a need for a socio-technical and clean energy transition towards low-carbon technologies and solutions across numerous sectors of the economy (IEA 2021). Energy transitions, understood to mean “structural changes in the way energy is supplied, distributed and used” are inherently complex, and there is wide agreement that a variety of policy instruments, combined in a policy mix, are needed to bring about such transitions (Smil 2010, Rosenow, Kern & Rogge 2017). Governments have employed policy mixes to address climate change in the past. However, it is theorized that these policy mixes can be improved by considering factors related to the design, implementation and evaluation of such policy mixes.

The literature on climate change mitigation focuses on energy transitions and energy’s contribution to overall GHG emissions, because in Canada and other countries around the world, 80% or more of GHG emissions are energy-related (NRCan 2017, US EPA 2018).

An important factor influencing energy transitions is the enabling, and ideally

⁵ <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide#:~:text=The%20global%20average%20atmospheric%20carbon,least%20the%20past%20800%2C00%20years>. Accessed Jan. 1, 2021.

acceleration, of technological change (i.e. the development and commercialization of cost-effective low-carbon technologies and solutions) (Rogge & Reichardt 2016).

Government science, technology and innovation (STI) programs⁶ are typically designed and implemented to overcome barriers and enable such technological change – the aim of STI policy. The focus of the thesis research, therefore, is on foundational policy instruments such as governmental STI programs, combined with other policy instruments in policy mixes, to tackle issues such as the development of cost-effective clean energy technologies to reduce GHG emissions in various sectors of the economy.

The general policy problem addressed in this thesis is that there is a desire to improve the overall effectiveness and efficiency of such policy mixes in order that Canada and other countries can better meet their long-term climate change policy goals and commitments. In order to tackle this problem, governments have been experimenting with new policy approaches, to both address problems identified with the conventional approach that has been used to design, implement and evaluate such policy mixes in the past, and take advantage of new insights provided by recent academic research into policy mixes, innovation processes, and transition studies.

The specific policy problem addressed in this thesis is that problems experienced with traditional policy mixes, namely problems related to (1) the policy process, (2) conventional understandings of innovation theory, and (3) technology/sector-specificity.

⁶ Government STI programs provide direct funding for science, technology, and innovation projects, conducted by government scientists and/or by parties external to government such as private sector companies, universities, etc., to advance government objectives and are part of the mix of measures to develop new scientific knowledge, develop new technologies, and foster innovation, for society's benefit. Note that government STI programs can also be referred to as RD&D programs.

These problems are described in more detail below.

The objective of the thesis is to assess the early experience with a specific new experimental policy approach recently introduced by the Canadian federal government to directly address the three problems noted. The assessment permits conclusions to be made as to whether there is early evidence that the experimental policy approach is resulting in improvement and benefits, compared to the conventional policy approach. The experimental policy approach is similar to, and loosely modeled on, an approach introduced by the US Department of Energy in 2010, referred to as an “ecosystem approach,” relating to a collaborative approach amongst organizations working within an innovation ecosystem, and which was applied for a policy mix to support the development and adoption of new low carbon technologies in the area of residential housing and commercial buildings (US DOE 2016).

The thesis compares two types of policy mixes to foster technological development to mitigate climate change, which have been implemented by the Canadian federal government, over the past 23 years:

- (i) Experimental policy mixes which, starting in 2016-17, used a novel policy approach, in which the policy mix is ‘tightly bundled’ in terms of design, implementation and evaluation; ‘complete’ in terms of coverage of the technology innovation chain; and, ‘technology/sector-specific’ (see Definition of Key Terms in the Appendix). The three characteristics of policy mixes, (tightly bundled, complete, and technology/sector-specific) are referred to as the ‘attributes’ of the experimental policy mix in this thesis; and
- (ii) Conventional policy mixes, using the default, traditional policy approach, in

which the different instruments in the mix are/were typically designed, implemented and evaluated separately and independently of one another (i.e., they are loosely bundled and administered in separate “siloes”). Conventional policy mixes are also typically incomplete in terms of coverage of the innovation chain, especially for a specific technological stream. In addition, conventional policy mixes are not typically technology/sector-specific, and target a large number of different technologies, used in a variety of economic sectors, at the same time, as opposed to being targeted to a specific technology or economic sector.

The way in which these three ‘attributes’ are designed in a conventional policy mix leads to in a number of problems, which are the subject of this thesis and spelled out in section 1.3.

It should be noted that ‘real-world’ conventional and experimental policy mixes are rarely pure, in the sense of exactly conforming to the above definitions. In reality, different policy mixes demonstrate a range of attributes, but can be readily identified as either conventional or experimental, based on an overall examination of bundling, coverage of the innovation chain and technology/sector-specificity.

The primary analytical framework used in the assessment of the policy mixes is a framework developed by Rogge & Reichardt (2016). To develop arguments, the thesis draws insights from the literature on policy studies and policy mixes, whole-of-government policy approaches, innovation theory, and socio-technical and energy transitions. It uses a comparative case study approach to conduct the assessment of the experimental approach, as it is well suited to compare the experimental approach versus the conventional approach. Data for the comparative case study analyses is sourced from

a review of government documentary evidence, as well as from semi-structured interviews with federal public servants directly involved in the design, implementation and/or evaluation of the policy mixes examined.

In terms of background, the opportunity to examine and assess this new experimental policy mix approach came about as a result of a series of fortuitous events, which occurred in the 2016-17 and 2017-18 fiscal years. At that time, the Canadian federal Department of Natural Resources (NRCan) was seeking to develop a compelling case in support of an \$882M proposal to access a new source of funding for clean energy technology development, through Infrastructure Canada's Green Infrastructure component of the Investing in Canada infrastructure plan. Because NRCan needed to present a 'united front', different groups within NRCan laid aside their traditional rivalries and developed an integrated proposal, in which different instruments were combined together to present a more complete and compelling series of proposals. As Infrastructure Canada had requested a number of proposals, grouped around different types of 'energy infrastructure', NRCan combined instruments around specific technology and sector groupings that had an infrastructure component, such as smart grids (electricity distribution infrastructure), electric vehicle charging infrastructure, and renewable electricity generation infrastructure. Fortuitously, NRCan policy makers developed and presented proposals that were more 'tightly bundled', more 'complete', and more 'technology/sector-specific', and which were aligned with the latest thinking in terms of innovation theory, and which addressed a greater number of barriers along the innovation chain. In the end, these proposals were indeed compelling and NRCan secured \$882M in new multi-year funding, to support 5 different policy mixes, from a new funding source!

This introductory chapter is structured as follows. First, it describes the policy problem being addressed, specifically providing details about problems related to the conventional policy approach. Second, it states the research hypothesis to be investigated and tested. Third, it provides information about the analytical framework to be used. Next, it outlines the research approach, methodology, and research questions. Fifth, it provides a short overview of the seven chapters. Finally, it examines the relevance of the research, the specific contributions that are made, as well as the boundaries and limitations of the research.

1.3 Policy Problem

The public policy problem is defined in three-parts as follows:

Conventional policy mixes to enable the development of new technologies to reduce greenhouse gas emissions exhibit three attributes and related problems:

- (i) Different instruments (e.g., government RD&D, regulation, incentives) in a conventional policy mix are typically designed, implemented and evaluated independently of one another (i.e. they are loosely bundled, and administered in separate “siloes”). Policy mixes exhibiting this feature can suffer from the well-documented ‘silo problem’ that could result in inconsistencies, such as timing issues; conflicts between instrument goals; and conflicting, non-synergistic or sub-optimal interactions between instruments. In this thesis, these types of conventional policy mixes are referred to as a ‘loosely bundled policy mixes.’
- (ii) The different instruments in a conventional policy mix may not cover the entire innovation chain (a theoretical construct describing the temporal dimension of the innovation process), for the development of a specific technology targeted by

the policy mix. As described in more detail below, innovation theory predicts that such conventional policy mixes are sub-optimal at best in enabling technological development. This problem results from systemic problems in the innovation process and is referred to in this thesis and in the literature as a ‘disconnected science’ problem (Bonvillian & Weiss 2015). In this thesis, these types of policy mixes are referred to as ‘incomplete policy mixes’.

- (iii) The different instruments in a conventional policy mix are typically not technology/sector-specific, and target a large number of different technologies, used in a large variety of economic sectors, at the same time. Thus, the policy instruments are typically not targeted to specific applications or to specific industries or to specific performance targets. This lack of technical/sector specificity and lack of specialization in the policy mix can result in problems such as inconsistencies between instruments, if compared to ‘technology-specific policy mixes’, where there is a conscious effort to ensure instruments in the policy mix are consistent for a specific technology targeted for development, in order to maximize synergies and help reinforce one another, at the design and implementation stages.

Conventional policy mixes may exhibit all three of the above problems, or a subset of the three. It is hypothesized that, as a result of the above problems, conventional policy mixes have lower consistency of elements, coherence of processes, and comprehensiveness than the experimental policy mixes.

The conventional policy approach can be contrasted with the experimental policy approach in which all of the policy instruments are ‘tightly bundled’ (meaning where the

policy instruments in a policy mix are designed, implemented and evaluated together as a group), are ‘complete’ (meaning the policy mix covers the entire innovation chain), and are ‘technology/sector-specific’ (meaning that the policy mix targets a specific technology that is applied to a specific industrial sector, such as buildings, transportation, or electricity generation).

The three-part problem is now described in more detail.

Problem part 1 – Different instruments in a conventional policy mix are typically designed, implemented, and evaluated independently of one another (i.e. they are loosely bundled, and administered in separate ‘siloes’)

One of the problems with conventional policy mixes to foster technological change to support climate change mitigation is that they are/were typically designed, implemented and evaluated, as stand-alone, independent, vertically-delivered, siloed policy measures. This policy approach reflects bureaucratic departmental practices, which traditionally favour vertical accountability and reporting structures, and which are a barrier to the implementation of measures which require more horizontal collaboration between different organizations. This approach favours individual policy measures, as opposed to a group of measures or policy mix. This ‘conventional policy approach’ has been the traditional, default policy approach for decades and results in well-documented ‘silo’ problems.

Silo or stovepipe structures and information flow occur as a result of government departments or organizations specializing and focusing on serving a specialized or vertical segment of society (de Bri & Bannister 2010). Siloed or stovepipe structures emerge as a feature of differentiation and specialization, and are a characteristic of a traditional bureaucracy (de Bri & Bannister 2010; Weber 1948). One of the consequences of siloed structures is that different organizations tend to work in isolation of one another

(Colgan & al 2014), and that coordination between organizations tends to be weak (de Bri & Bannister 2010). Such lack of coordination could result in inconsistencies in the policy mix, such as different policy instruments having different goals and/or conflicting with one another.

Traditionally, organizations have prioritized vertical accountabilities. This quotation from the Canadian publication ‘Lessons Learned from Leading Horizontal Projects’ captures the issue well: “The momentum of a horizontal initiative is not sustained naturally by a system accustomed to operating within vertical silos. When difficulties are faced, many people revert to what they know best and perceive as being safe” (CCMD 2001).

The silo problem, which the experimental policy approach tries to address, is very persistent. According to the literature, operating in silos is the traditional policy process because it is simple, easier to implement than horizontal approaches, and reinforced by two, dominant public administration paradigms, namely Bureaucracy and New Public Management. Bureaucracy, the hierarchy-based model of public administration described by Max Weber, between 1890 and 1920), is characterized by hierarchical accountability and specialization. New Public Management, a market-based model that emerged in the 1980’s, is characterized by a drive to efficiency, which further drives the “disaggregation of departmental structures into service agencies, each responsible for clearly specified products” (Steurer & Berger 2010, Weber 1948). Both of these paradigms have had long lasting influence on public administration and reinforce inertia to operate in “administrative silos.”

The following provides two, clear illustrations of how this problem manifests itself

in their application.

The first illustration is that of Sustainable Development Technology Canada (SDTC), an arms-length, not-for-profit foundation established in 2001 “to develop and demonstrate new technologies to promote sustainable development, including technologies to address issues related to climate change and the quality of air, water and soil” (Justice Canada 2011). The problem with how SDTC has been designed and operates is that it reinforces its status as an independent entity operating in a conventional, siloed fashion, with no or limited designed linkages to other federal government policy measures. As evidence for this, the SDTC Foundation has its own Board, staff, and Investment Committees. It is physically located in offices that are separate from other government organizations. It has its own budget and is evaluated as a separate entity (Justice Canada 2011), not as part of a policy mix. SDTC’s own web site reinforces this point: “SDTC is not a government department and conducts its activities with considerable independence compared with most other federal institutions.”⁷ While there are no explicit restrictions on collaborating with other organizations, its status as an independent, arms-length foundation reinforces the reality that its activities are designed, implemented and evaluated separately from other policy instruments, in the overall climate change policy mix.

The second illustration shows how interpretation of key foundational policy documents, may have reinforced the application of policy processes on an individual policy instrument basis, in the past, rather than at the policy mix level. Up to 2018, the

⁷ <https://www.sdte.ca/en/about/accountability/info-source/> accessed 1 Jan. 2021.

federal department of Natural Resources Canada's (NRCan's) practice has been to evaluate all government STI programs as stand-alone, separate policy measures, independent of other policy measures in the policy mix.. As concrete evidence, it is noted that all evaluations for clean energy government STI programs administered by NRCan's Office of Energy R&D, for the nine year period, from 2010 to 2018, are for those individual government STI programs only. The same can be said for NRCan audits posted on NRCan's website.⁸ It is noted that the *Policy on Evaluation* was rescinded on July 1, 2016, and was replaced with the *Policy on Results* (TBS, 2016), which provides greater flexibility, including the possibility of defining a "program" as an "individual [program] or groups of services, activities or combinations thereof that are managed together within the department and focus on a specific set of outputs, outcomes or service levels" (TBS 2016). This new policy is intended to provide greater flexibility to enable Departments to start evaluating policy mixes, as a whole.

Problem part 2 – The different instruments in a conventional policy mix may not cover the entire innovation chain.

Innovation is a complex, systems-oriented process that occurs along an innovation chain (a theoretical construct describing the temporal dimension of the innovation process), for the development of a specific technology targeted by the policy mix. The International Energy Agency (IEA 2008, IEA 2011) has developed a useful graphic of the innovation system (see illustration 1 on page 14 below) that outlines the five (5) main stages of the *innovation chain*: (i) basic research, (ii) research & development (R&D), (iii) demonstration, (iv) deployment, and (v) commercialization /diffusion. The graphic also

⁸ See NRCan web site for Audit Reports: <https://www.nrcan.gc.ca/audit/reports/944>

includes other important features of the innovation process, including: framework conditions also referred to as systemic factors; government policy interventions or instruments; government and private sector investment; as well as supply and demand factors to foster innovation. Finally, the graphic points to two useful mechanisms in the innovation process: (i) product/technology push and (ii) market/demand pull, and shows that innovation is a non-linear process that includes important feedback loops at various stages of the innovation chain. An important point is that the graphic provides a mechanism to visualize the maturity of a given technology, at a given point in time.

Conventional policy mixes, designed to foster technological development to mitigate climate change, may not cover the five stages listed above in the entire innovation chain, for the development of a specific technology targeted by the policy mix. The following explains why this is a problem and what are the causes of the problem.

Incomplete coverage of the policy mix along the innovation chain causes problems in the technology development and adoption process, because they do not incorporate measures to address barriers that exist at some stages (typically later stages) of the innovation process, and which can only be addressed by government intervention, as documented in current innovation theory. Modern theory states that the innovation process is understood to go well beyond the R&D and demonstration stages, to include a significant amount of effort at the deployment and commercialization stages (Ruttan 2001, IEA 2011 Bonvillian 2019). As explained in chapter 2, the problem with conventional policy mixes is that they were/are designed with an older innovation model in mind, and have not yet been updated to include more modern models of the innovation

process.

Incomplete coverage results in other problems as well. If there is a gap in policy instrument coverage in the policy mix along the innovation chain, for example the absence of one or more policy instruments at the deployment or commercialization / diffusion stage, then this gap will very likely result in a delay, or interruption, of the commercialization process. Incomplete coverage can also result in a lack of, or poor, hand-offs between different instruments along the innovation chain. Innovation theory suggests that there is a need for the policy instruments that address different stages of the innovation chain to work synergistically together, for each technology targeted by the policy mix (IEA 2008, IEA 2011). For example, it would be important, as a given technology matures and reaches certain critical points along the innovation chain, that the key policy instrument acting on the technology be changed. The absence of such ‘hand-offs’ at critical junctures could again result in delays or interruptions in the innovation process, or sub-optimal policy mixes.

The partial coverage provided by government STI programs can be depicted graphically, by areas included within the blue ovals, overlaid on the entire innovation chain model used in this thesis, in illustration 1 below.

Illustration 1 – Positioning of government STI programs within the innovation chain

The above illustration graphically shows where additional policy instruments would be needed to cover stages of the innovation chain not covered by government STI programs, (i.e. at the deployment and commercialization/diffusion stages of the innovation chain), indicated above with red rectangles.

In summary, innovation theory predicts that conventional policy mixes, which are incomplete in terms of coverage of the innovation chain, will be sub-optimal at best in fostering technological development. By contrast, the experimental policy mixes examined in this thesis include policy instruments that cover the entire innovation chain, for a given, specific technology, and thus are likely to be more effective and efficient, in the long run.

Problem part 3 – The different instruments in a conventional policy mix are not technology/sector-specific and target a large number of different technologies, used in a variety of economic sectors, at the same time.

In a conventional policy mix, the different instruments to enable technological development and adoption target many different technologies, used in a variety of economic sectors, at the same time. In other words, the policy instruments may not be

targeted to specific applications or specific industries sectors or specific technology performance targets. In this thesis, this is referred to as a ‘non-technology-specific’ policy mix.

A non-technology/sector-specific policy mix, targeting a number of different technologies used in different sectors, is not problematic per se. However, if a policy field targets a large diversity of technologies and applications, then it is highly unlikely that the policy instruments in the general policy mix will be sufficiently customized or targeted to effectively support technology development and adoption, for all technologies targeted.

Two examples can help illustrate how this problem manifests itself in real life. In the first example, let us assume that the goal of the general policy mix is to support the development and early adoption of electric vehicles (EVs). It can be easily imagined that, in order to be effective, the policy mix would need to target development and early adoption activities that specifically address technical and non-technical barriers that exist for EVs at a particular moment in time. For example, an effective policy mix might need to address barriers related to the absence of electric vehicle charging infrastructure along highways and the need for a consumer purchase incentive to make the price of an EV equivalent to that of a conventional gasoline or diesel powered vehicle. It is apparent that a non-technology/sector-specific policy instrument, such as a general R&D tax credit aimed at manufacturers, may not have the features and flexibility to address the above barriers and that policy instruments that are tailored to the specific barriers of the targeted technology may be more effective.

The second example is for a policy mix whose goal is to support the development

and adoption of energy efficient appliances (e.g. furnace, hot water heater, refrigerator, dishwasher, etc.) used in residential housing. The most effective policy instrument in this case might be a standard or change in appliance regulations, requiring appliance manufacturers to meet a certain technically-feasible energy efficiency performance standard, as of a particular date. One can easily see that a consumer price incentive to support the early adoption of EVs is very different from an energy efficiency standard or regulation targeting the deployment of high efficiency appliances. A non-technology/sector-specific policy instrument (e.g. a general R&D tax credit) is unlikely to be suitable in both of the above examples.

This problem is amplified and exacerbated in the policy field of clean energy for mitigating climate change, which includes hundreds of different technologies and applications. It can be fairly reasonably hypothesized that a technology/sector-specific approach will be more effective in this case.

In contrast to conventional policy mixes, the experimental policy mixes examined in this thesis include policy instruments that are technology/sector-specific, i.e. the instruments are specifically designed and implemented to address barriers related to a specific technology or class of similar technologies, in a particular economic sector.

Cumulative nature of the research problem

Conventional policy mixes may exhibit all three of the above attributes and related problems, or a subset of the three. In cases where a policy mix exhibits two or three attributes, it is readily apparent that the associated problems may be cumulative and reinforcing.

An example helps to show how a cumulative problem manifests itself in reality.

Returning to our example about a policy mix to support the development and adoption of electric vehicles, let us imagine an incomplete policy mix that includes only R&D funding support to improve the technical performance of any clean energy technologies, but that does not include policy measures to support consumer adoption, such as increasing the availability of charging stations along highways, or a purchase incentive to overcome the price difference of electric vehicles compared to conventional vehicles. It can be readily seen that adding adoption measures will only be effective, if they are technology/sector-specific, i.e. if they target electric vehicles. Adoption measures that are designed to help the adoption of a different technology (e.g. home appliances) may not be effective at all in this case. Thus, the addition of policy measures along the innovation chain, that are not specific to the technology/sector being targeted for support, will not have any beneficial effects, and will result in an incomplete technology mix, for that specific technology. Numerous iterations of the above problem can be imagined.

1.4 Research Hypothesis

The key hypothesis investigated is summarized as follows:

As governments experiment with policy approaches to support the development and adoption of new technologies to mitigate climate change, a new experimental policy mix approach, in which the instruments in the policy mix are tightly bundled, complete, and technology-specific, is likely to result in improvements and benefits compared with the conventional policy approach, which has traditionally been used. The specific improvements and benefits are improvements in the consistency of policy mix elements, coherence in policy processes, and comprehensiveness of the policy mix.

A tightly bundled policy mix is a policy mix, whereby the policy instruments are designed, implemented and evaluated as a group, as opposed to individually. A complete policy mix is a policy mix whereby the instruments in the mix cover the entire innovation

chain (i.e., fully cover the 5 stages in the innovation chain, as defined by the IEA (2008), namely basic R&D, applied R&D, demonstration, deployment, and commercialization / diffusion). A technology-specific policy mix is a policy mix, whereby the instruments target specific technologies applied in particular economic and industry sectors, such as buildings, transportation, and electricity generation.

If the above hypothesis is supported by the evidence examined, then this could provide a sufficient basis for further experimentation with, and assessment of, the experimental policy approach, with the ultimate goal of assessing its effectiveness and efficiency in the future.

The counter-argument, or counterfactual to the thesis is that the experimental approach is unnecessary and does not result in any or sufficient improvements and benefits to justify any changes in approach, if compared to the conventional policy approach. This counter-argument assumes that the default, conventional approach has been working just fine, over the past few decades – the idea is that it has rendered sufficient results to warrant few amendments. A second counter-argument is that a strategic or targeted approach to enable technological change along the innovation chain could work just as well as the experimental approach.

1.5 Key Terms & Analytical Framework

Although the study of policy mixes is an active area of academic research, as was mentioned in the Note to Reader in the front matter, Rogge & Reichardt (2016) argue that the terminology applied in these studies is often ambiguous, particularly regarding the characteristics and effects of a policy mix. For this reason, the thesis consistently uses terms and definitions outlined in their 2016 paper, titled *Policy mixes for sustainability*

transitions: an extended concept and framework for analysis. Readers are encouraged to refer to Appendix A, for precise definitions of key terms used in this thesis. This thesis will make use of a policy mix analysis framework outlined in Rogge & Reichardt (2016), which distills decades of academic research in policy studies in the policy process, policy instruments, as well as instrument and policy mixes, to enable technological change to address energy or sustainability transitions. The framework is visually depicted in illustration 2 below. The numbers in the figure indicate each of the components in the framework that could have a distinct effect on technological change.

Illustration 2 - Framework for analysis of policy mixes to enable technology development and adoption for climate change mitigation

Source: Rogge & Reichardt (2016) and Howlett & Giest (2015)

In this analysis framework, the concept of a policy mix is broadened, from earlier more narrow definitions such as “more than just a combination of policy instruments” (Flanagan et. al. 2011) to include:

- (i) dimensions (policy field, governance level, geography, and time);
- (ii) elements (policy strategy including objectives and plans, instruments

- including their goal, type and design, as well as instrument mix);
- (iii) policy processes; and
- (iv) policy characteristics, as supported by the literature (Rosenow Kern & Rogge 2017).

It should be noted that three of the four “characteristics,” referred to as attributes of policy mixes are specifically used as evaluation criteria to measure improvements and benefits (consistency, coherence and comprehensiveness). Howlett & Giest’s 5-step policy process has been used in combination with the analysis framework to provide added detail for the policy process (Howlett & Giest 2015).

The framework defines policy mixes as “a combination of the three building blocks: elements, processes and characteristics”... “delineated by several dimensions, including policy field (i.e., clean energy/sustainability transitions and climate change mitigation), governance level (i.e, federal), geography (i.e, Canada), and time (i.e, 1998-present).” The framework’s expanded definition of policy mixes includes “ultimate objectives of the policy mix,” “interaction” among and between elements, processes and characteristics, as well as the “dynamic nature of the policy mix, referring to it as having ‘evolved’ (Ring and Schroter-Schlaack, 2011) and ‘developed incrementally over many years’ (Kern & Howlett 2009).”

The policy strategy elements include “a combination of interdependent ends (goals) and means (policies, principal plans) to achieve the ends (Andrews 1987, Miles & Snow 1978, Mintzberg 1998, Porter 1980).” This includes “policy objectives associated with sustainability transitions... long-term targets with quantified ambition levels (Rennings & al 2003, Schmidt & al 2012) and may be based on visions of the future (del Rio & al 2010, Kemp & Rotmans 2005).” Principal plans include “framework conventions, guidelines, strategic actions and roadmaps.” The model also includes

instruments, of different types, and with different features or calibrations (e.g., stringency). The analytical framework distinguishes between cornerstone instruments (i.e., government STI programs), and complementary instruments (i.e., other instruments in the mix) and highlights interactions between instruments.

The three key evaluation criteria to assess whether the experimental policy mixes show improvements compared with the conventional mixes are suggested by the framework:

- (i) **Consistency**, which is applied to the policy mix elements, is defined as “how well the elements of the policy mix are aligned with each other.” Rogge & Reichardt propose that consistency can be assessed on different levels, such as time, absence of conflicts, degree of synergies, strategy and objectives, interaction between instruments, and interplay of the instrument mix and policy strategy. All of these applications are included in the assessment approach described in chapter 3.
- (ii) **Coherence**, which is applied to policy processes, is defined as “synergistic and systematic policy making and implementation processes contributing – either directly or indirectly – towards the achievement of policy objectives.” This can be achieved through “procedural mechanisms such as strategic planning, coordinating structures or communications networks,” and can be assessed across “policy fields and governance levels,” “capabilities of policy makers (Jacobsson & Bergek 2011),” and “effect” (e.g., in terms of behaviors of actors and how the process shapes the policy mix). Each of these are applied in the assessment approach described in chapter 3.
- (iii) **Comprehensiveness**, which is applied to a policy mix, is defined as “how

extensive and exhaustive its elements are, and the degree to which its processes are based on extensive decision-making (Atuahene-Gima & Murraray 2004; Miller 2008).” Rogge & Reichardt propose that comprehensiveness can be assessed by: (i) inclusion of “both a policy strategy” (objectives, plans) and “at least one instrument... operationalizing the policy strategy”; (ii) “the degree to which the instrument mix addresses all market, system and institutional failures including barriers and bottlenecks” (Lehmann 2012, Sorrell 2004, Sovacool 2009; Weber & Rohrachner 2012); and, (iii) how the policy mix addresses “all three instrument purposes of technology-push, demand-pull and systemic concerns.” They also define comprehensiveness, applied to policy processes, as being “influenced by their structure, rigor and thoroughness (Atuahene-Gima & Murray 2004)”.

Rogge & Reichardt (2016) state that the above evaluation criteria may be “crucial for assessing the effectiveness” and performance of policy mixes. This view is also supported by other “policy design scholars [who] have been using consistency, coherence and congruence as criteria to assess policy mixes in terms of alignment of instruments and goals” (Kern & Howlett 2009).

1.6 Research Approach and Questions

This section broadly describes how I test the research hypothesis stated in section 1.4, as well as the methodology used to answer each of the four research questions.

This thesis tests the key hypothesis that the experimental policy mixes are likely to result in improvements and benefits compared to conventional policy mixes by assessing the early experience the Canadian federal government has had to date with the experimental approach.

The assessment is based on a comparative case study approach that compares experimental and conventional policy mix approaches. The case study approach is appropriate in the case of this research, because the experimental policy mix approaches examined have only been introduced in the past 3-4 years (in the case of Canada), as a result of recent policy experimentation by both the Canadian and US federal governments. The experimental approach has not yet been assessed in Canada. The case study approach allows for an in-depth examination of this new, experimental policy approach. In addition, a case study approach is helpful in facilitating a comparison of the experimental approach with the conventional policy approach, as well as within cases for the experimental approach.

The unit of analysis is policy mixes, which include government STI programs as a cornerstone policy instrument, combined with other policy instruments, to develop and advance clean energy technologies to reduce GHG emissions, in various industry sectors, in Canada.

The thesis examines and compares six case studies, three of which use an experimental policy approach, and three which use a conventional approach.

The timeframe for the case studies examined is the 23-year time period from 1998 to the present (2020).

To test the hypothesis statement, and compare the case studies, this thesis seeks to answer four research questions, namely:

1. Do each of the three experimental case studies examined result in hypothesized improvements and benefits, as early indicators of success, specifically improvements in consistency of elements, coherence of processes, and comprehensiveness, as suggested by the literature, compared to the conventional case studies? A secondary question is: what are the comparative administrative costs of the experimental versus the conventional policy approach?

2. Are conditions suggested by the literature for successful implementation of whole-of-government policy approaches present to a greater degree in the experimental versus conventional policy approach?
3. Are there any observed differences in the hypothesized improvements and benefits among the different experimental case studies examined, and if yes, what would help explain those differences?
4. Are there barriers and constraints to implementing the experimental policy approach in this policy field?

Together, these questions provide a preliminary assessment of the experimental approach. While the first question directly addresses the hypothesis statement, the three additional questions provide additional information and insights on experimental policy mixes and why the experimental policy approach could result in hypothesized benefits.

1.7 Outline of the Thesis & Summary of Chapters

In terms of outline, the thesis consists of seven (7) chapters, which are organized as follows. This chapter 1 describes the policy problem addressed and the research hypothesis, provides a quick overview of the primary analytical framework used, outlines the research approach, describes the research questions, provides a quick summary of the chapters to come, and outlines the relevance of the research, expected contributions and boundaries & limitations.

Chapter 2 reviews the relevant literature on climate change, socio-technical transitions, innovation theory, policy studies, and whole-of-government policy approaches and links the literature to the problem, hypothesis, research questions, and methodology. Chapter 3 describes the comparative case study approach, comparing three conventional cases against three experimental cases. It also lays out the methodology used to answer each of the research questions.

Chapter 4 describes the 3 conventional case studies examined, while chapter 5

does the same for the 3 experimental case studies. Chapter 6 presents the results, analysis and findings of the research. Finally, chapter 7 discusses the conclusions, implications and contributions of the research, as well as potential future directions for the research.

1.8 Relevance of Research, Expected Contributions and Boundaries & Limitations

The research is relevant and is expected to contribute to the literature, for a number of reasons. First, given that experimentation with tightly bundled, complete and technology-specific policy approaches is new (i.e. introduced in Canada in 2016-17), it has not yet been formally assessed or analyzed, especially in Canada. This research contributes an early assessment of this experimental approach, which can be used to provide advice to public servants as to the merits of further experimentation and assessment with this approach. It also makes a contribution to the definition of the problems related to conventional policy approaches.

Second, this thesis contributes to addressing some gaps in the policy literature. Given that the analytical framework used in this thesis is also relatively new (i.e. published in 2016), there are very few empirical studies that have yet made use of it. This research directly contributes empirical data for these types of studies, using this comprehensive analytical framework, as well as new measurement tools.

Third, in terms of future research on policy mixes for sustainability transitions, the authors of the framework, Rogge & Reichardt, advise policy makers “to work on improving both the consistency of the elements of the policy mix and the coherence of policy processes” and suggest that improvements in these areas are likely to give rise to future improvements in effectiveness. As it is hypothesized that the experimental policy approach examined are likely to result in improvements in three indicators (consistency,

coherence and comprehensiveness), this research makes a direct contribution to this area of suggested research.

Fourth, this thesis seeks to contribute to strengthening the research linkages between policy mix studies and innovation theory, particularly with more current innovation models, such as the extended pipeline model, as well as with new theoretical concepts such as the Commercialization Readiness Index, which has been recently published (in 2014). Again, in terms of suggested topics for future research on policy mixes for sustainability transitions, Rogge & Reichardt (2016) suggest that “the integration of the policy mix concept with other research approaches, such as the technological innovation systems approach, may further sharpen the analytical clarity and policy advice of such approaches in the context of sustainability challenges.”

In summary, the research proposed in this thesis is well aligned with the future research topics recently suggested in the literature.

This thesis limits its investigation to policy mixes to enable technology development and adoption to mitigate climate change in *Canada*, at the *federal* level, in which the core instruments are administered by the Canadian Department of Natural Resources (*NRCan*), the leading federal clean energy technology funding organization. More specifically, this thesis focuses on a selection of *NRCan* policy mixes which include *clean energy government STI* programs, which have as their primary goal to develop clean energy technologies that will lead to greenhouse gas emission reductions in energy production, distribution and end use.

It is reasonable to limit the scope of the thesis to these *energy-related technologies*, to *NRCan*, and to the *energy sector* of the economy because, as mentioned

in section 1.1, in Canada, the US, and many other countries around the world, 80% or more of greenhouse gas emissions are related to *energy-consuming* activities such as transportation, energy, and electricity production, heating and cooling of buildings, operations of appliances and equipment, and production of goods and provision of services (NRCan 2018, US EPA 2018). NRCan is the leading Canadian federal department involved in policy mixes to enable clean energy technology development and deployment, and is the primary funder and performer of research, development, demonstration, deployment and regulatory activities in this area, working, where needed, with other federal, provincial, municipal and private sector collaborators. It is therefore reasonable to limit the selection of cases to those administered by this department.

Because the Canadian government has only recently started experimenting with this policy approach, it is premature to investigate or assess benefits such as improved efficiency or effectiveness, which require the investigation of medium-term and longer-term outcomes achieved by the policy mix, as would be the case under a summative evaluation. Instead, the thesis focuses on assessing shorter term indicators of early success, namely consistency, coherence and comprehensiveness.

The focus of this research is limited to conventional and experimental policy mixes that are/were designed, implemented and evaluated by federal public servants. This public policy and administration focus is a narrow focus that excludes other actors and factors, such as the political dimension or the involvement of industry, private sector finance, and the public. That being said, the design, implementation and evaluation of policy mixes is a function that falls well within the mandate of the public service. Thus, it is reasonable to limit the research to such actors.

Given time constraints, the assessment conducted in this thesis is a preliminary assessment only. As described in section 1.5, the analytical framework used in this thesis is very comprehensive. It is not possible to conduct an assessment that looks at all of the assessment possibilities enabled by this framework. The research carried out in this thesis focuses on assessing only the three key indicators, but as mentioned above, the literature suggests that these are strongly correlated with expected future improvements in effectiveness and are thus appropriate evaluation criteria for a preliminary assessment (Rogge & Reichardt 2016, Kern & Howlett 2009).

The thesis draws insights from policy studies, innovation theory, and whole-of-government policy approaches to support the research and analyses to be conducted. It is hoped that the hypothesis and findings of this thesis could be helpful providing a basis for future assessments of the experimental policy approach, and/or be generalizable to other policy fields, where governments are attempting to address complex problems with policy mixes that include government STI programs.

Chapter 2: Literature Review

2.1 Outline

- Introduction
- Context: Climate Change, Socio-Technical Transitions & Energy Transitions
- Conventional Policy Mixes
 - Silo Problems
 - Innovation Theory – Older & Newer Models of the Innovation Process
 - Innovation Theory – Technology & Commercialization Valleys of Death
 - Innovation Theory – Structural Problems in Large Legacy Sectors
- Policy Mixes for Sustainability Transitions -State-of-the-Art
 - Whole-of-government Policy Approaches
 - Policy Mix Design Principles
- Concluding Thoughts – Gaps in Literature

2.2 Introduction

This chapter links the thesis research with the relevant academic literature. The literature review aims to: (i) provide insights on the problem being addressed; (ii) highlight the literature and theory that are used in this thesis; and, (iii) identify gaps in the literature that are addressed.

This chapter is organized as follows. First, as part of this introduction, I outline what academic literature topics were reviewed, why these topics were selected, and how the research fits at the intersection of these topics. Second, I revisit the context in which the policy mixes are designed, and briefly review specific aspects of the literature on climate change, socio-technical transitions and energy transitions. This review helps to highlight that the problem addressed is very complex, requires a governmental response which is multi-faceted, and incorporates ‘systems’ thinking and approaches, such as those examined and assessed in this thesis. Third, I review the relevant literature related to problems with conventional policy mixes, focusing on two specific issues, namely the silo problem, as well as multiple problems related to the innovation process. This review

is relevant to the research problems highlighted in chapter 1, namely problems associated with loosely bundled, incomplete and non-technology specific policy mixes. Fourth, I review the recent literature on policy mixes for sustainability transitions, which is the nomenclature used to cover the policy mixes examined in the thesis. I show that the current state-of-the-art suggest that there is a need for different approaches to policy mix design. Finally, I conclude by discussing and identifying gaps in the literature and show how the research fills those gaps. For information, I will present literature that informs the research approach and methodology in chapter 3.

The literature topics reviewed are:

- (i) Climate Change Mitigation: is the underlying societal problem being addressed by the policy mixes examined. This literature was reviewed to provide context and insights on the research problem. Climate change, being a super-wicked problem, is very complex and difficult to address. The literature review provides a rationale in support of the relevance of government intervention in this area, including for complete and technology-specific policy mixes.
- (ii) Socio-Technical and Energy Transitions: this literature explains the societal processes by which complex problems such as climate change are, or can be, addressed by society. This literature was reviewed to better understand the context, range of activities, and complexity involved in addressing climate change. This literature is relevant as it discusses one of the goals of policy mixes examined, namely to effect societal transition to a low carbon energy future.
- (iii) Innovation Theory and Technological Development: enabling technological development and innovation is the key objective of the policy mixes examined in

the case studies. Thus, this literature is highly relevant, as it provides insights on how technological change can be enabled and accelerated, especially by government policy mixes. The literature reviewed presents additional theoretical insights into the problems observed with the conventional policy mixes, particularly those related to incomplete and non-technology-specific policy mixes. Finally, the literature is a source of tools and methodologies to both describe the case studies examined and compare them. The concepts and theories explored in this chapter include: the innovation chain; innovation models; disconnected versus connected science; the technology readiness level and commercialization readiness index scales; and ‘valleys of death’ (for more information on these topics, see Definition of Key Terms in Appendix A).

- (iv) Policy Studies and Policy Mixes: policy mixes are the key subject, or object, of study (i.e. the evaluand) being assessed. The literature on policy mixes, and related public policy studies, is highly relevant to this research. As was the case above for innovation theory, this literature is a source of methodological tools to carry out the case study research. This thesis makes use of the analytical framework, proposed by Rogge & Reichardt (2016), which provides the key definitions and some of the tools and methods to describe and characterize the policy mixes being compared. The literature review presents theoretical insights into the problems observed with loosely bundled (conventional) policy mixes, as well as recently developed scholarship in the field of policy mixes for sustainability transitions, which is the subject of this thesis. That being said, the study of such policy mixes is still relatively new and there remain gaps and

limitations in the research.

- (v) Whole-of-government (WoG) Policy Approaches: The experimental policy mix approach examined is very similar to, and can be thought of as a special application of, whole-of-government approaches developed over the past 20 years. Given that there is a substantial literature on WoG policy approaches, it is relevant in providing insights on the experimental policy mixes examined and the evaluation criteria used to understand research question #2.

2.3 Context: Climate Change, Socio-Technical Transitions & Energy Transitions

This section provides context to the policy problem being addressed in section 1.3. It emphasizes the complexity, inter-relatedness, ‘systemic’ and cumulative nature of the problem of climate change. It expands the arguments by discussing the challenges and barriers related to achieving the ultimate goals and objectives of the policy mixes examined. The literature suggests that conventional policy mixes that have traditionally been deployed are likely to be sub-optimal in addressing climate change.

The ultimate objectives of the policy mixes examined are to enable, and ideally accelerate, technology development and adoption to mitigate climate change and support a socio-technical transition to a low carbon energy future. The literature highlights the challenges involved in achieving these goals and outline problems and limitations of loosely bundled, incomplete and non-technology-specific policy mixes. The review of this literature shows that alternative ways of thinking about solutions to the problem are needed.

Climate change – a super-wicked problem

Climate change has been described as a super-wicked problem, because in addition to

being a wicked policy problem, a “particularly complex, persistent and resistant problem,” in which there is a “lack of consensus, as different stakeholders have different goals and values and have differing perspectives as to the nature, severity, and causes of problems” (i.e. solutions are contested) (Rittel & Webber (1973), NCCHPP 2013), it exhibits four features of a super-wicked problem (Levin & al 2012):

1. “Time is running out;
2. Those seeking to solve the problem also contribute to the problem;
3. The central authority needed to address it is weak or non-existent; and,
4. Partly as a result, policy responses discount the future irrationally.”

“Most analysts agree that Canada is not on track to meet its long-term climate commitments,” however, “how we approach the issue can make a big difference.” (Meadowcroft, Layzell & Mousseau, 2019).

The literature suggests that whole-of-government (WoG) policy approaches are thought to be more effective at addressing complex and wicked problems than traditional, vertical policy approaches, by overcoming “incoherence with respect to certain goals by addressing the ‘silo’ problem of ineffectiveness or inefficiencies due to non-cooperation, territoriality, etc.” (Kouri & Gagnon 2007).

The main take-away from this body of literature is that conventional policy mixes that are known to exhibit silo-type solutions have not been, and are unlikely to be, very effective at addressing a super-wicked problem when compared with the experimental policy approach, which share many features with whole-of-government approaches.

Socio-Technical Transitions and Energy Transitions

In Canada, the federal government’s climate change goals are often stated in terms of a

transition to a low carbon economy.⁹ Transitions are thus part of governmental objectives for the policy mixes examined in this thesis. The key points made in this section are that transitions are complex and challenging to address, and that policy mixes that use conventional policy mixes are sub-optimal to meet these challenges.

Transitions are defined as “long-term processes of change that result in major adjustments to societal systems” (Meadowcroft, Layzell & Mousseau, 2019). The literature refers to many types of transitions, including technological transitions (e.g., Geels 2002), socio-technical transitions (e.g., Geels, 2005; Geels & Schott, 2007), sustainability transitions, and energy transitions (e.g., Smil 2010), to name a few. The concept of a socio-technical transition is broader than, but inclusive of, technological transitions. An energy transition can be thought of as one type, or example, of a socio-technical transition.

Socio-technical systems “are characterized by complex patterns of economic, social and technological interdependence. The term ‘socio-technical’ captures the idea that in such systems, technological elements (infrastructure, machinery, knowledge, etc.) are enmeshed with social structures and practices (institutions, behaviour, cultural traditions)” (Meadowcroft, Layzell & Mousseau, 2019). The reference to ‘systems’ relates to the provisioning of important societal products and services, such as food, housing or transportation. When researchers examine socio-technical changes over the long run, most change is incremental. “Periodically, however, there are more dramatic shifts – system changes – brought about by transformations in technologies, social

⁹ See for example: <https://www.canada.ca/en/environment-climate-change/news/2019/06/canadas-plan-for-climate-change-and-clean-growth.html> (accessed July 12, 2020).

practices and business models.” (Ibid). Such periods of “significant reconfiguration” (Ibid), which can affect major aspects of the system, and which result in “major shifts in core systems of societal provisioning, spanning one or more generations” (Meadowcroft 2016, Rotmans, Kemp & Van Ansel 2001), are referred to as socio-technical transitions. Examples include the introduction of refrigeration, which affected “agriculture, food industries, trade patterns, diets and household routines” (Meadowcroft, Layzell & Mousseau, 2019). Another energy-related example is the switch from horse and buggies to cars powered by the internal combustion engine fueled with gasoline or diesel. Socio-technical transitions have many characteristics: they are complex, take time, and they are messy. When speaking about a “low carbon transition... societies will in fact be dealing with multiple transitions across a variety of systems,” requiring multiple responses, or “transition pathways” (Ibid).

Energy transitions, defined as “structural changes in the way energy is supplied, distributed and used” are inherently complex, and there is wide ranging agreement that a variety of policy instruments, combined in a policy mix, are needed to foster such transitions (Smil 2010, Rosenow, Kern & Rogge 2017). Energy transitions can be described in terms of elements including “time, scale, magnitude, direction, drivers, actors and mechanisms,” and are expected to “require shifts not only in technology, but also in political regulations, tariffs and pricing regimes and the behavior of users and adopters” (Sovacool 2016). Transitions are “based on the notion that a single energy source, or group of related sources, dominated the market during a particular period or era, eventually to be challenged and replaced by another major source or sources.” An ‘energy transition’ is deemed to have occurred when a new fuel or technology reaches

between 25 to 50% market share (Sovacool 2016, Smil 2010, Gruber 2012).

Energy transitions occur in phases, following classic diffusion theory, with energy transitions following a typical S-shaped adoption pattern, which occurs over time by adopters who follow a bell curve shaped adoption path based on their propensity for innovation (innovators, early adopters, early majority, late majority, laggards) (Rogers 2005). These energy transition phases result in “large amounts of labour, capital and effort sunk into socio-technical systems that create their own inertia or ‘lock-in’ [and path dependency] which highly resist change” (Unruh 2000, Sovacool 2016). Finally, energy transitions are “multi-actor processes” that “are characterized by radical shifts from one socio-technical configuration to another, and are often long-term processes taking several decades (Rogge, Kern & Howlett 2017).

The literature on climate change mitigation, socio-technical transitions and energy transitions makes the point that “energy transitions face multiple barriers,” including inertia (Walker 2000), technology ‘lock-in, path dependency and resistance to change’ to the development and acceleration of clean energy technologies for climate change mitigation. This is caused by “political, economic, social and technological paradigms” (Bonvillian 2018), “which require significant strategic policy efforts to be overcome” (Rogge, Kern & Howlett 2017, Meadowcroft 2011, Geels 2014). In such cases, experimental policy approaches, including those that are tightly bundled, complete and technology-specific may have a better chance at addressing such complex problems than conventional approaches.

2.4 Conventional Policy Mixes

Silo Problems

The conventional policy approach, in which individual policy instruments are designed, implemented and evaluated independently of one another (i.e., they are loosely bundled) results in “silo” problems, which are negatively reinforced by departmental practices that favour vertical rather than horizontal solutions, accountability and reporting, as well as by policy frameworks that treat policy instruments individually instead of as a group within a silo.

One of the main rationales for applying whole-of-government (WoG) policy approaches is “to eliminate ‘siloes,’ or departments working in isolation from one another, and achieve seamless government” (Colgan & al., 2014). WoG approaches aim to avoid having different policies cut across and undermine each other, and to optimize the impact of government, by using all the instruments at its disposal in an integrated way in support of particular outcomes” (Colgan et al. 2014). The UK form of WoG, called Joined Up Government, was introduced by the Tony Blair government in 1997, and “presented as the opposite of ‘departmentalism’, tunnel vision and ‘vertical silos” (Christensen & Laegrid 2007).

Silo problems occur as a result of government departments or organizations specializing and focusing on serving a specialized or vertical segment of society and are a characteristic of a traditional bureaucracy (de Bri & Bannister 2010; Weber 1948). One of the consequences of silo structures is that different organizations tend to work in isolation of one another (Colgan & al 2014) and that coordination between organizations tends to be poor or nonexistent (de Bri & Bannister 2010).

The WoG literature thus highlights problems with conventional policy mixes, such as inconsistencies in the policy mix elements, as well as a lack of coherence in the policy process. The literature also suggests that WoG-like policy approaches have the potential to overcome such problems (Kouri & Gagnon 2007).

Innovation Theory – Older & Newer Models of the Innovation Process

Conventional policy mixes are typically incomplete (i.e., they do not cover the five stages in the innovation chain), for the development of a specific technology targeted by the policy mix. This results in a failure to address systemic barriers that exist at some of the stages of the innovation process, particularly at the latter stages. Innovation theory predicts that such conventional policy mixes will be sub-optimal at best in enabling technological development.

The problem described in section 1.3 stated that conventional policy approaches are based on the older “pipeline” innovation model, in which the government focuses primarily on early stage research (basic and applied R&D and demo), leaving the later stages of the innovation chain to private industry (Bonvillian & Weiss 2015, Bonvillian 2009). This partial government approach to innovation support, which is typical of incomplete policy mixes, is still popular and being implemented by a number of governments, resulting in problematic ‘disconnected’ innovation models (Bonvillian 2013, Bonvillian 2019, and Bonvillian & Weiss 2015).

The “pipeline or technology push model, associated with Vannevar Bush (1945),” proposes that the five steps in the innovation chain (basic R&D, applied R&D, demonstration, deployment, and commercialization/diffusion), follow a linear process, which was found to be an inaccurate and a simplified view of the process (Bonvillian &

Weiss 2015). The model, also known as a ‘technology push’ or ‘technology supply’ model, results in “disconnected science” (Ibid). The induced innovation model, detailed by Vernon Ruttan (2001), also known as the technology or market pull model, proposes that “the market inspires and pulls technological innovation by firms” (Ibid). This model is thought to favour the development of incremental innovations. Market pull can also occur as a result of government incentives, such as R&D grants, standards (e.g., on energy efficient appliances) and regulations.

The extended pipeline model “is also a technology-push model – but in contrast to the simple pipeline model, it involves governmental action at all stages of innovation” (Bonvillian & Weiss 2015). This model was pioneered by the US Department of Defense (DOD), which not only funded early-stage R&D, but “also funded all the follow-on stages... all the way to the creation of the initial market” (Ibid). One of the most powerful instruments used by the US DOD is procurement and acting as the single largest market for much of US military innovation. “Its most powerful role is in nurturing radical technologies, for example the Internet” (Ibid). Vernon Ruttan documented how “the US DOD has used this model to spur innovation in aviation, electronics, space exploration, nuclear power, and computing (Ruttan 2006).” Other R&D agencies, including the National Aeronautics and Space Administration (NASA), the Defense Advanced Research Projects Agency (DARPA), and the Advanced Research Projects Agency – Energy (ARPA-E) are starting to emulate this “more connected system” (Bonvillian 2013). An important conclusion made by Bonvillian & Weiss (2015), concerning the extended pipeline model is that this model deserves “special notice,” “given its powerful contribution to 20th century technology advance.”

The literature on innovation (e.g., Bonvillian 2009) equates incomplete policy mixes with ‘disconnected science’. Its opposite, a ‘connected science’ approach, is credited for World War II technology breakthroughs such as atomic energy, radar and other technologies that are thought to have contributed to the Allied victory. Unfortunately, after the end of World War II, following the publication of Vannevar Bush’s *Science: The Final Frontier* in 1945, the US government dismantled the connected science approach and substituted it with the pipeline model, focusing on early stage R&D only (Ibid). This led to a ‘disconnected’ innovation model that is widely in place in the US, Canada and other western countries.

In contrast to disconnected science, connected science is defined as an “approach where technology breakthroughs at the science stage are closely connected to the follow-on applied stages of government-supported” activities, all the way to production, “operating under what can be called a ‘technology challenge model’... Not only were the stages of research linked, but the innovation actors were also linked” (Bonvillian 2013).

This discussion on innovation models and disconnected science provides some background, history and context as to why conventional policy mixes to enable technology development and adoption are incomplete. The following discussion of the *valleys of death* concept and other structural barriers specific to the energy sector highlights the rationale for government intervention at all stages of the innovation chain, i.e. for complete policy mixes.

Innovation Theory - Technology and Commercialization Valleys of Death

The theoretical concept of the ‘valleys of death’ outlines additional problems in the innovation process. It highlights the need for government intervention at all stages of the

innovation chain, due to market and other systemic failures.

“The concept of a valley of death is generally understood to be the stage of technological innovation between early-stage development and proof of concept of an invention and its successful commercialization, a stage often avoided by private capital markets and traditionally deemed the most critical moment in technology launch.”

(Bonvillian & Weiss, 2015). Jenkins & Mansur (2011) have proposed that there may be at least two valleys of death: “the early-stage technological valley of death and the later stage commercialization valley of death,” which “block the process of innovation, obstacles that can be addressed only through effective public policy,” and which are shown mapped roughly against the innovation chain in Illustration 3 as follows:

Illustration 3 – Technology and Commercialization Valleys of Death

Source: Jenkins & Mansur 2011

According to Jenkins & Mansur (2011), “the Technological Valley of Death sits between the first and second stages of technological development, as laboratory research seeks further capital to develop a commercial product and prove its basic market viability. The Commercialization Valley of Death occurs later in a technology’s development, after entrepreneurs seek capital to fund demonstration or first-of-a-kind commercial-scale projects or manufacturing facilities. Both valleys of death exist due to a

perception of risk and a scarcity of appropriately matched risk capital in the energy technology market.”

The key points that are relevant to this thesis are that the above valleys of death result from market failures, and that academics suggest complete policy mixes have a higher likelihood of being able to overcome these barriers, by ensuring adequate policy instrument coverage across these ‘valleys’.

Innovation Theory - Structural Problems in Large, Complex Legacy Sectors such as Energy

Another problem mentioned in the literature, which is relevant to this thesis, relates to structural barriers to change in large legacy sector. The policy mixes examined seek to enable the development and adoption of novel low carbon technologies in the energy sector, as energy-related human activity is the source of 80% of GHG emissions.

Bonvillian & Weiss (2015) outline structural obstacles, such as technology lock-in and path dependency, which block disruptive new technologies, such as those required to address climate change, especially in legacy sectors, including in the energy, electricity (generation, smart grid), construction (housing & buildings), and transportation sectors, which are the very sectors targeted by the policy mixes examined in this thesis.

These large and complex legacy sectors are resistant to certain types of new technologies and innovation, especially those that are disruptive, due to the presence of “technological, economic, political and social paradigms that locks-in to existing technology and its supporting business model, protected from innovation by economic, political and social support systems organized around protecting the existing technology” (Ibid). The common features of legacy sectors include “perverse subsidies and price structures to vested interests, financing systems geared to existing technologies, and

existing public habits and expectations” (Bonvillian 2018, Bonvillian & Weiss 2015). In order to address the above structural barriers, Bonvillian and Weiss advocate for the design of policy approaches that use the extended pipeline and connected science innovation models.

Socio-Technical Transitions – need for multi-sectoral approaches

This thesis argues for the need for technology/sector-specific policy approaches. The literature on transitions is relevant in this case, as it describes the need for multiple transitions. For example, Meadowcroft, Layzell & Mousseau (2109) state that when talking about a “low carbon transition... societies will in fact be dealing with multiple transitions across a variety of systems,” requiring multiple responses, or “transition pathways.” Each of the multiple responses, or transition pathways can be equated with a separate policy mix. Such transitions are required to be effected across different socio-technical systems, such as electricity production, transportation, housing, buildings, communities, and different industries.

Summary

The above academic literature suggests that conventional policy mixes, which are loosely bundled, incomplete and non-technology-specific, result in a variety of real problems and limitations. This literature also emphasizes the complexity, inter-relatedness, ‘systemic’ and cumulative nature of the problems outlined. The conclusion is that conventional policy mixes are likely to be sub-optimal in achieving the goals and objectives that have been established.

2.5 Policy Mixes – Evolution and Current State-of-the-Art

The review of the literature has identified an evolution in terms of thinking about policy mixes, which can be characterized as the ‘current state-of-the-art’. The specific literatures referenced in this section are: (a) the literature on whole-of-government policy approaches and (b) the literature on policy mix design principles. These literatures are relevant because there is a parallel between the evolution of thinking on policy mixes and the comparison between the conventional and the experimental policy approaches. The conventional policy approaches can be seen as being based on older design principles, while the experimental policy approach is based on the newer, more evolved design principles.

This section is organized as follows. First, the literature on whole-of-government (WoG) policy approaches is reviewed, as it provides insights on the expected features, benefits and limitations of this relatively new, horizontal policy approach. Similarities between WoG and experimental policy approaches are highlighted. Second, the policy mix design literature is reviewed, as it highlights the latest thinking in terms of the design of such mixes. This literature is relevant as it shows that the design of experimental policy mixes uses updated design principles. Third, the literature related to benefits of whole-of-government and well-designed policy mixes is summarized, to highlight the potential benefits of the experimental policy approach.

Whole-of-government Policy Approaches

The experimental policy mix approach can be thought of as a special case or subset of a whole-of-government policy approach, applied to the policy field of technological development and adoption to mitigate climate change, and applied at a relatively small

scale. Similarities between the two are examined.

In attempting to overcome vertically siloed policy approaches, governments have experimented with new or different policy approaches of various kinds. One class of relatively new experimental policy approaches is referred to as whole-of-government (Colgan et al. 2014), Joined-Up Government (Ling 2002), Collaborative Public Management (Agranoff & McGuire 2003), Horizontal Management (Bakvis & Juillet 2004), or Collective Impact (Kania & Kramer 2011) approaches.

Different terminology is used in different countries to describe WoG policy approaches: whole-of-government is used in Australia and Ireland, Joined-up Government is used in the UK, Collaborative Public Management and Collective Impact are used in the US, and Horizontal Management is used in Canada. For simplicity, I refer to the collection of the above policy approaches as whole-of-government (WoG) approaches.

“Whole-of-government (WoG) is an overarching term for a group of policy responses to the problem of increased fragmentation of the public sector and public services and a desire to increase integration, coordination and capacity. A desire for increased effectiveness and increased efficiency generally drives the adoption of whole-of-government approaches” (Colgan et al 2014, Ling 2002). The benefit of a whole-of-government approach is better coordination of policy aims across departments and agencies and manifested in coordinated programmatic responses.

WoG policy approaches have the following features (Bakvis & Juillet 2004; Colgan et al 2014; Halligan et al, 2011; Kania & Kramer 2011; MAC 2004; Efficacy Unit, 2009):

- “Are joined up to achieve a shared vision. Stakeholders are linked at the policy making (i.e., design) and implementation stages, from the beginning.
- Have a shared understanding of the problem.
- Are boundary-spanning: Work across portfolio boundaries to achieve a shared goal and an integrated response to particular issues.
- Seek to enhance coordination and management of a set of activities between two organizational units that do not have hierarchical control over each other and where the aim is to generate outcomes that cannot be achieved by units working in isolation, or between organizations that have become too disjointed.
- Are supported by a shared measurement system, mutually reinforcing activities and ongoing communication, and are staffed by an independent backbone organization.
- Combine resources.
- Use knowledge and expertise within and outside government more effectively.
- Tackle issues from a systemic perspective.”

The experimental policy approach is similar to the WoG policy approach. In order to demonstrate how similar these approaches actually are, these are mapped from the literature against the features of experimental policy approaches in Table 1 below. The table maps the presence or absence of the above features in the experimental policy approach, using a rating of ‘yes, no, or partially,’ with a comment to justify the rating. There are some differences between the experimental policy approach examined, especially the case studies, and what researchers usually consider as WoG approaches:

- a. Although WoG implies multiple levels of government, the experimental policy

approach is currently limited to the federal level;

- b. Although WoG implies inter-departmental collaboration, most of the instruments in the policy mixes examined are administered within one department, NRCan, and;
- c. Although WoG can imply large policy mixes, the policy mixes examined are fairly small, consisting of less than 10 instruments.

Nonetheless, the experimental policy approach shares a sufficient number of features with WoG approaches, that insights from the WoG literature can be reasonably expected to apply to the experimental approach.

Table 1 – Comparison of WoG policy approach with experimental policy approach

Feature of WoG policy approaches per literature	Present ?	Feature of experimental policy approach examined in Thesis
Are joined up to achieve a shared vision.	Yes	All instruments in policy mix share same vision and high level objectives. Shared vision is documented in Memo to Cabinet (MC) & Treasury Board Submission (TB Sub).
Stakeholders are linked at the policy making (i.e. design) and implementation stages, from the beginning.	Yes	Instruments are designed, implemented and evaluated as a group, as opposed to individually. All implicated stakeholders have input at MC & TB Sub stage, as well as during implementation.
Have a shared understanding of the problem.	Yes	Shared understanding of problem is documented in single MC & TB Sub, covering all instruments in mix.
Work across portfolio boundaries to achieve a shared goal.	Yes	Policy mixes involve different organizations working towards the same goal.
Work across portfolio boundaries to achieve an integrated response to particular issues.	Yes	Policy mixes involve different organizations working towards achieving a common, integrated response.
Seek to enhance coordination and management of a set of activities between two organizational units that do not have hierarchical control over each other.	Yes	Brings together two or more organizations that have no hierarchical control over each other.
The aim is to generate outcomes that cannot be achieved by units working in isolation.	Yes	The goal of policy mixes is greater than can be achieved by one organization alone.
Are supported by a shared measurement system.	Partially	Some common measures are used, and some specific measures.
Are supported by mutually reinforcing activities.	Yes	Activities are designed to be synergistic and reinforcing.
Are supported by ongoing communication.	Yes	Communications between different organizations delivering the policy mixes is encouraged and increased.
Are staffed by an independent backbone organization.	No	This feature is not present in experimental policy mixes examined.
Combine resources.	Partially	The budget for the policy mixes is a single budget, split between policy mix measures. Organizations remain distinct.
Use knowledge and expertise within and outside government more effectively.	Yes	There is more communications between different organizations, as a direct result of the policy mix.
Tackle issues from a systemic perspective.	Yes	The thinking behind the experimental approach is a systems perspective.

A summary of the claimed or expected benefits of WoG policy approaches include: “improving efficiency, information sharing, competitiveness, accountability, and policy coherence; while decreasing costs, duplication of work, conflicting policies, and time needed to complete a task. The benefits are achieved through the ability to combine resources, to tackle problems early and through other practical benefits associated with WoG working, such as more timely information-sharing” (Colgan et al. 2014, Efficacy Unit 2009, OECD 2006).

Policy Mix Design Principles

A second literature that is relevant to the current state-of-the-art thinking on policy mixes is that related to ‘policy mix design.’ Researchers have proposed that there is, or has been, an evolution in terms of thinking or approaches to policy design, ranging from basic/older to more advanced/newer. The more advanced/newer forms of policy design incorporate an increasing number of design considerations, which make policy mixes more suitable for dealing with complex problems, such as enabling technology development and adoption to mitigate climate change and supporting a socio-technical transition to a low-carbon energy future.

Current, updated general policy mix design principles include:

- i. Considering the full range of policy instruments available; and;
- ii. Employing a mix of policy instrument carefully chosen to create positive interactions with each other, and to respond to particular, context-dependent features of the policy sector (Gunningham & al 1998; Howlett & Rayner 2007).

These principles can be used, for example, highlight the argument that modern innovation models should be considered in the design of complete and technology-specific policy

mixes.

According to these updated principles, the goals of a ‘good’ policy mix design include:

- i. How to avoid both ‘over’ and ‘under’ design;
- ii. How to achieve complementarity and avoid ‘redundancy’ or counterproductive mixes;
- iii. How to enhance or layer mixes over time so that they are able to continue to meet old goals and address new ones (Howlett, How & Del Rio 2015).

With respect to the assessment of policy mix designs, Howlett & Rayner (2013) propose that policy designs can be assessed, *ex-ante*, using four ‘ideal types’ of policy mix designs that have been proposed, in a sequential manner over the years. The first ideal type is a policy mix where the number of policy instruments is kept as low as possible, for simplicity, elegance and efficiency. For example, the Tinbergen design rule proposes to use one policy instrument for each policy goal. The second ideal type is a policy mix where the policy instruments chosen move along a continuum from lesser to more coercive type of instruments, over time. For example, at first, less interventionist self-regulation could be used, followed by government regulations with progressively increasing stringency and cost, if and as required. The third ideal type is a policy mix that exhibits desirable criteria such as: consistency, the ability of multiple instruments to reinforce rather than undermine each other in the pursuit of policy goals; coherence, the ability of multiple policy goals to co-exist with each other in a logical fashion; and congruence, the ability of multiple goals and instruments to work together in a uni-directional or mutually supportive fashion. Finally, the fourth ideal type is a policy mix

where there is an attempt to maximize both (i) the complementary effects among policy instruments (e.g. carrot and stick) and (ii) the ‘goodness of fit’ between the policy mix and the governance mode (legal, corporate, market, or network governance forms), while (iii) taking into consideration the ‘degrees of freedom’, or constraints, which designers have in developing policy mixes, taking into consideration policy instruments and mixes which may already be in place and other constraints.

Complementary effects might be achieved through the judicious combination of policy instruments that reinforce one another, for example regulations to produce energy-efficient appliances and incentives for consumers to purchase such. Each governance mode has a different focus, goals, and preferred policy instruments. In the case of policy mixes to advance and accelerate technological development, the governance mode is ‘network governance’ where the goal is to promote inter-actor collaborative research and development activity. In such a case, the preferred policy instruments suggested by the literature are subsidies (grants) and expenditures (on R&D), which, as an aside, is what is actually seen in practice, for example in the case studies examined.

The review of the above literature on policy design demonstrates that there is, or has been, an evolution in thinking about policy design. The experimental policy approach is seen as being based on a more ‘evolved’ view of policy design, especially with regards to the four ideal types of policy design. The experimental policy approach is seen as exhibiting more of the desirable traits of the third and fourth type, than the conventional policy approach, especially with regards to being designed with a view to increase consistency, reinforcement of policy goals, coherence, as well as maximizing complementarity effects.

Benefits of whole-of-government approaches and well-designed policy mixes

The literature on whole-of-government policy approaches, and on well-designed policy mixes, identifies the following benefits:

- Whole-of-government policy approaches are thought to be more effective at addressing super-wicked problems such as climate change than traditional, vertical approaches (Kouri & Gagnon 2007).
- Whole-of-government policy approaches can contribute “to eliminate ‘siloes,’ or departments working in isolation from one another, and achieve seamless government.” They can also optimize the outcomes of government by using all the instruments at the disposal of the state in an integrated way in support of particular outcomes (Colgan et al. 2014, Christensen & Laegrid 2007).
- Well-designed policy mixes and strategic policy efforts are required to overcome the multiple systemic barriers involved in complex socio-technical and energy transitions, including inertia, technology lock-in, path dependency, and resistance to change (Rogge, Kern & Howlett, 2017, Meadowcroft 2011, Geels 2014, Walker 2000).
- Policy mixes, based on the extended pipeline model, and involving governmental action at all stages of innovation (i.e., that are complete), are expected to be more effective at addressing the problem of disconnected science (Bonvillian 2009).
- Policy mixes that have a more complete coverage of the innovation chain, so as to address both the technology and commercialization valleys of death, are more likely to overcome systemic barriers that are not addressed by market forces (Bonvillian & Weiss 2015, Jenkins & Mansur 2011).

2.6 Concluding Thoughts – Gaps in the Literature

This thesis proposes to address and contribute to addressing a number of gaps in the literature.

First, given that the experimental policy approach is new, it has not yet been studied, analyzed or formally assessed, to the best of our knowledge. This thesis contributes an early assessment of this experimental approach, to inform academics, public servants and the public as to its merits and benefits. Second, this thesis makes a contribution to the definition of the problems related to conventional policy approaches and links these problems with the literature on the ‘silo problem’ and innovation theory. Third, given that the analytical framework proposed by Rogge & Reichardt (2016), and used in this thesis, is also relatively new, there are very few empirical studies that have yet made use of it. This research directly contributes empirical data for these types of studies, using this comprehensive analytical framework, as well as new measurement tools.

Fourth, this thesis contributes to addressing some of the forward research agenda proposed in the literature on policy mixes for sustainability transitions. A number of articles, included in the special issue on “Policy Mixes for Energy Transitions” in the journal *Energy Research & Social Science* (Elsevier) (Nov. 2017), and edited by Rogge, Kern and Howlett (2017), pointed to the need for experimentation with ‘comprehensive’ policy mixes that are both complete and technology-specific: “We argue that a well-targeted and comprehensive instrument mix is needed – something that so far has been neglected in existing studies”... “one way of operationalizing comprehensiveness is by determining if the instrument mix includes technology push, demand pull and systemic

instruments” (i.e., a complete policy mix) (ibid, Cantner & al 2016). “We argue that comprehensiveness... should be assessed against technological specificity, instrument types covered, and sectors addressed” (Rosenow Kern & Rogge 2017). All of this being said, there remain gaps which this thesis seeks to address: it is acknowledged that this is a new approach and that research in this area is needed. The authors of the analytical framework, advise policy makers “to work on improving both the consistency of the elements of the policy mix and the coherence of policy processes” and suggest that improvements in these areas are likely to give rise to future improvements in effectiveness (Rogge & Reichardt, 2016).

Fifth, this thesis seeks to contribute to strengthening the research linkages between policy mix studies and innovation theory, particularly with more current innovation models, such as the extended pipeline model, as well as with new theoretical concepts such as the Commercialization Readiness Index, which has been recently published (in 2014). Again, in terms of suggested topics for future research on policy mixes for sustainability transitions, Rogge & Reichardt (2016) suggest that “the integration of the policy mix concept with other research approaches, such as the technological innovation systems approach, may further sharpen the analytical clarity and policy advice of such approaches in the context of sustainability challenges.”

Sixth, the research integrates the literature on policy mixes and innovation theory with the literature on whole-of-government (WoG) policy approaches and looks at the application of WoG approaches to technology development.

In summary, the research attempts to integrate and tie together the literature topics reviewed in this chapter, in order to describe and assess a new, experimental policy

approach that shows promise in addressing problems associated with traditional policy mix approaches.

Chapter 3: Methodology

3.1 Outline

- Introduction and General Research Approach
- Research Questions
- Rationale for Using Case Study Approach and for Selecting Cases
- Researcher Background, Potential Bias and Limitations of Case Study Approach
- Theoretical Basis for Measurement Tools
- Methodology – Description of Cases
- Methodology – Answering Research Questions
- Data Sources
- Conclusion – Boundaries & Limitations

3.2 Introduction and General Research Approach

This chapter describes the methodology to be used to assess the experimental policy mixes and answer the four research questions. The chapter is organized as follows. First, the introduction provides an overview of the research approach, as well as of the case studies selected. The second section lays out the four research questions as well as the general approach used to answer each question. The third section provides the rationale for using the case study approach and for selecting the six cases examined. The fourth section provides background on the researcher and describes sources of potential bias as well as mitigation measures. The fifth section provides the theoretical basis for the overall research approach as well as for select measurement tools. The next two sections provide the methodology to describe the cases and to answer the individual research questions. The next section describes the data sources for the research. Finally, the conclusion provides boundaries and limitations of the research.

This thesis tests the key hypothesis that the experimental policy mixes are likely to result in improvements and benefits compared to conventional policy mixes by assessing the early experience the Canadian federal government has had to date with the

experimental approach. The experimental approach has not yet been assessed in Canada.

The assessment is based on a comparative case study approach that compares experimental and conventional policy mix approaches. The case study approach is appropriate in the case of this research, because the experimental policy mix approaches examined have only been introduced in the past 3-4 years (starting in 2016-17 in the case of Canada), as a result of recent policy experimentation by both the Canadian and US federal governments. The case study approach allows for an in-depth examination of this new, experimental policy approach.

The unit of analysis is policy mixes, which include government STI programs as a cornerstone policy instrument, combined with other policy instruments, to develop and advance clean energy technologies to reduce GHG emissions, in various industry sectors, in Canada. The timeframe for the case studies examined is the 23-year time period from 1998 to the present (2020) following that of the first conventional case study highlighted in Table 2.

The thesis examines and compares six (6) case studies, implemented by the Canadian federal department of Natural Resources (NRCan), supported in some cases by other departments, which are named based on the government STI program included in the policy mix, as shown in Table 2 below.

Table 2 – Six case studies examined in this thesis

Policy approach applied?	Number of Cases	Name of Case Studies Based on Government STI program
Conventional	3	1. Technology Early Action Measures (1998-2009) 2. Clean Energy Fund (2009-15) 3. GI Ph. 2 - Emerging Renewables (2018+)
Experimental	3	1. GI Ph. 2 - Clean Energy for Rural & Remote Communities (2018+) 2. GI Ph. 2 - Smart Grids (2018+) 3. GI Ph. 1 & Ph. 2 - Electric Vehicle & Alt Fuels (2016+)

Three of the case studies have implemented an experimental policy approach and three have implemented a conventional approach.

The thesis utilizes and refers to one primary theoretical analytical framework, detailed by Rogge & Reichardt (2016), which was introduced in section 1.5. This analytical framework is used in several ways. First, it serves as the reference to define key terms. Second, it provides a means to richly describe, characterize and compare the case studies. Third, the framework provides the three evaluation criteria/indicators used to assess whether the experimental policy mixes show hypothesized improvements and benefits compared with the conventional mixes and thus test the hypothesis statement. Each of the three evaluation criteria (consistency of elements, coherence of processes, and comprehensiveness of the policy mix) were described in section 1.5.

In terms of comparative analyses, the detail provided by the analytical framework allows for a number of different comparisons to be made, both comparing the three experimental case studies against the three conventional cases and comparing the three experimental cases amongst themselves.

The thesis makes use of two primary data sources: (i) review of documentary evidence related to the policy instruments and policy mixes examined, and (ii) semi-structured interviews with key government officials directly involved in the design, implementation and/or evaluation of the above policy mixes.

A useful table summarizing the research questions, indicators, expected number of data points and data sources, is provided in Table 12, in section 3.8, which describes the methodology to answer each research question.

3.3 Research Questions

To test the hypothesis statement, and assess the case studies, this thesis seeks to answer four research questions, namely:

1. (a) Do each of the three experimental case studies examined result in hypothesized improvements and benefits, as early indicators of success, specifically improvements in consistency of elements, coherence of processes, and comprehensiveness, as suggested by the literature, compared to the conventional case studies? A secondary question is: (b) what are the comparative administrative costs of the experimental versus the conventional policy approach?
2. Are conditions suggested by the literature for successful implementation of whole-of-government policy approaches present to a greater degree in the experimental versus conventional policy approach?
3. (a) Are there any observed differences in the hypothesized improvements and benefits among the different experimental case studies examined, and if yes, (b) what would help explain those differences?
4. Are there barriers and constraints to implementing the experimental policy approach in this policy field?

Together, these four questions provide a preliminary assessment of the experimental approach. While the first question directly addresses the hypothesis statement, the three additional questions provide additional information and insights on the experimental policy mixes and potential reasons as to why the experimental policy approach could result in hypothesized benefits.

Prior to answering the research questions, the six case studies are defined, described, mapped along the innovation chain, and characterized using features suggested by the analytical framework. This characterization provides the basis for comparison between the cases. Background information is provided to provide context for the reader and situate the policy mix within larger policy frameworks or initiatives. The characterization includes a pictorial mapping of the policy instruments along the

innovation chain, and mapping against the Technology Readiness Level and Commercialization Readiness Index scales, to provide greater detail. The description and characterization of the case studies provides a strong basis for the comparative analyses that is completed to answer the research questions.

The following provides a quick summary of the methodology to answer each of the four research questions:

Question 1 is first answered by comparing the level of consistency, coherence and comprehensiveness (three evaluation criteria) between the experimental and conventional case study groups, to assess whether there are any observed improvements in these three evaluation criteria/indicators, in the experimental case studies. Ratings and commentary provided by interviewees for each of the cases provides a basis for explaining any differences between the groups. The sources of data in this case are the documentary evidence and the semi-structured interviews. The second part of question 1 compares the administrative costs for delivering the experimental versus the conventional case studies. This is an important component of the assessment because any benefits seen above need to be assessed against any potential incremental costs.

Question 2 is answered by first assessing each case study against 11 conditions for successful implementation, which are suggested by the literature on whole-of-government approaches, and then conducting a comparison between experimental and conventional case study groups, to observe any differences. The source of data in this case is the documentary evidence.

Question 3 is answered by first comparing the three experimental cases for differences in the three indicators (consistency, coherence and comprehensiveness) and

second, by conducting four comparative analyses among the three experimental case studies, using data from the description and characterization of case studies, as well as the results from question 2.

Question 4 is answered by obtaining input from federal public servants obtained through the semi-structured interviews, in which they are asked to share their views on barriers and constraints that they have experienced in designing, implementing or evaluating experimental policy mixes.

Table 12 in section 3.8 provides a useful summary of the indicators, number of expected data points, and data sources for each of the research questions.

3.4 Rationale for Using Case Study Approach and for Selecting Cases

This thesis utilizes a qualitative case study approach. A case study is an established research approach that is used extensively in a variety of disciplines, and “is particularly useful to employ when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest, in its natural real-life context (Crowe & al. 2011).” The case study method is characterized by “a smaller number of observations (small N), a qualitative approach to the research, the comprehensiveness of the examination of the subject studied and its context, as well as a naturalistic design, emphasizing the real-life context (Ibid, Gerring 2007)”. According to Yin (2009), case studies can help to understand and explain causal links and pathways resulting from new policy initiatives, which is what the research in this thesis attempts to do, with respect to the new policy mixes examined.

The case study approach is an appropriate research method to use, in this thesis, because: (1) the experimental policy mix approaches examined are new, having been

introduced in the past 3-4 years in Canada; (2) given their newness, there are only a few (i.e. four) cases available for study in Canada (to the best of our knowledge); (3) also given their newness, there is a need for in-depth description and exploration of these new policy mixes, in order to try to answer fundamental ‘how’ and ‘why’ questions, including potential causal linkages, such as those included in the 4 research questions above; and (4) because of the very high cost and complex process to develop, fund and implement actual, new policy mixes in the real world, it was not possible to design an experimental, quantitative research approach.

The research uses a collective, or multiple case, research approach, where $N=6$ cases, divided into two groups, with $N=3$ for the experimental group and $N=3$ for the conventional group. The goal of utilizing a multiple case study approach is to provide a basis for comparison between the two groups to test the hypothesis and to obtain insights as to if and how improvements and benefits are realized in the experimental versus conventional group of cases. An equal number of cases were selected, for each group, in an attempt to provide a balanced assessment of the two groups of cases.

The approach used to select the six cases studies is now described.

In the case of the conventional case studies, an attempt was made to select three “typical” and representative conventional cases of policy mixes, implemented by NRCan, over the 1998-2020 timeframe. These three were selected out of approximately ten policy mixes administered by NRCan over this timeframe. The three case studies were selected because: (1) the policy mixes were designed to enable technology development to mitigate climate change; (2) they exhibited the attributes of conventional policy mixes; (3) the policy mixes are representative, as they were amongst the largest (in \$ terms) and

most important, at the federal level, during their timeframes, over the past 23 years; (4) the policy mixes are spread out over time and sequential, covering a sufficiently long timeframe so as to provide useful historical information; (5) the policy mixes are largely non-overlapping and therefore cover distinct time periods; (6) there is significant, easily accessible documentation on each case study; (7) key personnel that designed, administered, and evaluated the policy mixes were/are available to be interviewed for this thesis; and (8) they exhibited some differences amongst themselves, demonstrating a range of possibilities for such conventional policy mixes.

In the case of the experimental case studies, to the best of our knowledge, there are/were only four cases of experimental policy mixes implemented by NRCan, at the federal level in Canada, during the timeframe of the research (1998 to 2020). Originally, all four cases were selected for study. However, in consultation with the Thesis research committee, the number of cases selected was reduced to three to match the number of conventional case studies examined. The three cases selected are considered sufficiently similar with the fourth case as to be representative. As was the case for the conventional cases, the three experimental case studies were selected because: 1) the policy mixes were designed to enable technology development to mitigate climate change; (2) they exhibited the attributes of experimental policy mixes; (3) there is significant, easily accessible documentation on each case study; and (4) key personnel that designed, administered, and evaluated the policy mixes were/are available to be interviewed.

The general limitations of the case study approach include: errors in defining and selecting cases resulting in lack of theoretical generalization, lack of rigour, and potential difficulties in integrating findings with the theory (Ibid). In this thesis, the above

limitations are mitigated by: (1) focusing on three specific attributes of policy mixes which clearly differentiate the experimental and conventional cases, namely degree of tightness of bundling, coverage of the innovation chain, and technology-specificity and selecting cases on this basis; (2) grounding the research approach and methodology in the recent literature, e.g. innovation theory and the framework for analysis of policy mixes developed by Rogge & Reichardt (2016); and (3) using documentary evidence to supplement semi-structured interviews.

3.5 Researcher Background, Potential Bias and Limitations of Case Study Approach

I, as researcher, am currently employed by the Department of Natural Resources and have worked, since February 2018, as Director of R&D at the CanmetENERGY-Ottawa Research Centre. In my current job, I oversee a group of up to 70 researchers conducting applied clean energy research, in the fields of housing and buildings, renewable energy, energy for northern and remote communities, and the electrification of transportation.

Previously, from 2005 to Feb 2018, I worked at NRCan's Office of Energy R&D (OERD), which is the Government of Canada's primary funder of clean energy research, development and demonstration. I worked as a program manager for 8 years and as Director of Energy Science & Technology Programs for 4 years. As such, during this time, I was involved in the design and implementation of a number of existing and new clean energy government STI programs, whose primary goal was to develop and demonstrate novel, clean energy technologies to reduce GHG emissions in all major economic sectors. My responsibilities included overseeing STI programs, many of which are included in the policy mixes examined in this thesis. I have also been the lead on a number of audits and evaluations, completed to assess the effectiveness of these

government STI programs. I have not been involved in the design or implementation of policy mixes, since leaving OERD in February 2018.

One of my motivations for conducting this research is a genuine desire to improve how policy mixes are designed, implemented and evaluated, in order to benefit society at large. Climate change has been described as one of humanity's greatest challenges in the 21st century. Climate change mitigation and adaptation are expected to be increasingly important to governments around the world, over the next decades. I hope to contribute, in a small way, to addressing this complex problem, by contributing to the research on policy mix studies in an effort to better identify those occasions when an experimental versus conventional approach is warranted.

My prior work experience with the Office of Energy R&D represents a potential source of bias. This source of potential bias is specifically highlighted here, for transparency. One of my reasons for leaving the Office of Energy R&D, in early 2018, was to reduce and partially eliminate the perception of, or real, bias in this research. As mentioned above, I am no longer involved in the delivery of the policy mixes examined, nor are there any linkages between the research presented in this thesis and my current day-to-day job. I sincerely believe that there would be no societal benefit in promoting an experimental policy mix approach that is not genuinely improved, versus the conventional approach, and that the only way to demonstrate this is through sound, unbiased and peer-reviewed evidence. Planned future assessments could provide support and/or contrary views to the findings and conclusions reached in this thesis. In fact, NRCan is planning to conduct internal audits/evaluations of the three experimental policy mixes examined, over the coming few years. These audits and evaluations will be led and

conducted by NRCan's Audit and Evaluation Branch, and may include external, third party auditors and evaluators, who will examine the experimental policy mixes from a fresh and unbiased perspective.

The ontological and epistemological perspective which I bring to this qualitative, case study research is somewhere between a pragmatic and post-positivist perspective (Mertens & Wilson, 2012). This perspective can be summarized as “establishing which variables to study in advance and seeing whether they fit”, as well as focusing “on testing and refining the theory (hypothesis) on the basis of the case study findings (Crowe & al, 2011).” I believe that there may genuinely be a better way to design, implement and audit/evaluate policy mixes, which this thesis seeks to uncover. I believe that it would be useful to find this out as soon as possible, in order to address the urgent, super-wicked problem of climate change. In order to do so, I would like to use as rigorous a methodology as possible, in order to provide high quality, unbiased information to decision makers. Thus, the research approach is based on sound ‘program theories’, such as the policy mix analytical framework, innovation theory, and whole-of-government approaches. That being said, it is acknowledged that the underlying context (climate change, socio-technical transitions), policy mixes examined, and the policy design, implementation and evaluation processes involved are very complex. Thus, the methodological approach is qualitative (as opposed to quantitative in typical post-positivist research), and thus, the conclusions reached in this thesis are expected to be preliminary.

3.6 Theoretical Basis to Methodology and Measurement Tools

This section provides the theoretical basis for some the tools that are used to describe case studies and answer the four research questions. The four topics covered in this section are: the framework for analysis of policy mixes, tools to describe and categorize policy instruments in the policy mixes examined, tools to map policy instruments along the innovation chain, and tools to assess the presence of conditions for success in whole-of-government policy approaches.

Rogge & Reichardt's Framework for the Analysis of Policy Mixes

The primary theoretical framework used in this thesis is Rogge & Reichardt's *Framework for the Analysis of Policy Mixes*, introduced in section 1.5 and visually depicted in Illustration 2 on page 20. This comprehensive framework is used to guide the development of a number of measurement tools to describe and characterize the case studies examined. These descriptions are then used to provide a basis for comparative analyses between conventional and experimental cases, to answer question 1 and 2, as well as between experimental cases, to answer questions 3.

Tool to Describe the Instruments used in the Policy Mixes Examined

The policy instruments used to mitigate climate change are well documented (Borras & Edquist 2013). For example, the Intergovernmental Panel on Climate Change (IPCC 2007) has proposed that instruments, combined in a policy mix, can be categorized using eight (8) major instrument categories (see Table 3 below). This list of eight instrument categories provides a good representation of the breadth and scope of instruments used in such policy mixes and is used to describe policy instruments in this thesis.

Table 3 – Types of policy instruments for climate change mitigation

1	Regulations and Standards	These specify the abatement technologies (technology standard) or minimum requirements for pollution output (performance standard) that are necessary for reducing emissions.
2	Taxes and Charges	A levy imposed on each unit of undesirable activity by a source.
3	Tradable Permits	These are also known as marketable permits or cap-and-trade systems. This instrument establishes a limit on aggregate emissions by specified sources, requires each source to hold permits equal to its actual emissions and allows permits to be traded among sources.
4	Voluntary Agreements	An agreement between a government authority and one or more private parties with the aim of achieving environmental objectives or improving environmental performance beyond compliance to regulated obligations. Not all VAs are truly voluntary; some include rewards and/or penalties associated with participating in the agreement or achieving the commitments.
5	Subsidies and Incentives	Direct payments, tax reductions, price supports or the equivalent thereof from a government to an entity for implementing a practice or performing a specified action.
6	Information Instruments	Required public disclosure of environmentally related information, generally by industry to consumers. These include labelling programmes and rating and certification systems.
7	Research and Development (R&D)	Activities that involve direct government funding and investment aimed at generating innovative approaches to mitigation and/or the physical and social infrastructure to reduce emissions. Examples of these are prizes and incentives for technological advances.
8	Other	Other policies not specifically directed at emissions reduction but which may have significant climate- related effects.

Source: Intergovernmental Panel on Climate Change (IPCC) 2007

Tools to Map Coverage of the Policy Mix along the Innovation Chain, Technology Readiness Levels and the Commercial Readiness Index

The theoretical concept of the innovation chain was described in section 1.3, visually depicted in illustration 1, and is therefore not repeated here. A method to map the policy mix against the innovation chain was developed for use in this thesis, as described in the next section. This mapping uses two theoretical concepts that provide useful refinements to the concept of the innovation chain, namely: (i) Technology Readiness Levels (TRLs), developed by the US National Aeronautics & Space Administration (NASA), and (ii) the Commercial Readiness Index (CRI), developed by the Australian Renewable Energy Agency (ARENA). Together, the TRLs and CRI break down the innovation chain in greater detail, showing the many different steps of the process of innovation.

The TRLs and CRI are relevant for this research for a number of reasons. First, they provide a means to visualize steps in the innovation process, as in illustration 4 below, which shows the TRLs and CRI side-by-side, and shows that the CRI extends across the last three of the five stages of the innovation chain, including demonstration, deployment and diffusion/commercialization (this last stage not shown in the illustration below). Second, they provide insight into the design and implementation of policy mixes, especially with regards to what activities may be required to support a “complete” policy mix that covers the entire innovation chain and that covers all of the activities included in both the TRLs and CRI. Third, the TRLs and CRI provide a credible and well-defined tool to map the policy mixes examined.

Illustration 4 – Mapping of TRL and CRI scales along the innovation chain

Source: Commonwealth of Australia 2014

Technology Readiness Levels (TRLs) are a methodology, developed by NASA in the mid-1970s to measure the maturity of new technologies. TRLs are defined as: “a systematic metric/measurement that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology” (Mankins 1995), or as a “discipline-independent, program figure of merit (FOM) to allow more effective assessment of, and communication regarding, the

maturity of new technologies” (Mankins, 2009). The nine levels on the TRL scale are defined as follows:

Illustration 5 – Technology Readiness Levels (source: Mankin, 2009)

The Commercial Readiness Index (CRI), inspired by the TRLs, was developed by the Australian Renewable Energy Agency (ARENA), an agency of the Australian Government, as “a tool that project proponents may want to use... to measure the commercial readiness of renewable energy solutions” (Commonwealth of Australia 2014). It was developed to highlight that “while the majority of technology risk is retired through the TRL 1-9 framework, there is often significant uncertainty and risk remaining in the demonstration and deployment phase” (Ibid). In other words, as is suggested by innovation theory and the innovation chain, the CRI highlights specific barriers and risks that need to be overcome along the innovation chain. The CRI also highlights the need for a complete policy mix to overcome those barriers and enable the development of new technologies to the point where they are having a significant impact in society, for example in reducing greenhouse gas emissions, at large scale.

The CRI is a tool to help map the stage at which a commercial application of a technology is at, on its journey to become a “bankable asset class”. The CRI has six stages or levels: (i) hypothetical commercial proposition (technically ready but commercially unproven), (ii) commercial trial at small scale, (iii) commercial scale up, (iv) multiple commercial applications, (v) (existence of) market competition, and (vi) bankable asset class. Per the ARENA, there are two main components to the CRI, the six levels and eight indicators, for each level on the index, as shown in Table 4 below. This table is used in this thesis to map the policy instruments in the policy mix to obtain a finer level of detail as to coverage of the innovation chain.

Table 4 – Tool to map policy mixes against the CRI (source: Commonwealth of Australia, 2014)

			Indicators							
			Regulatory Environment	Stakeholder Acceptance	Technical Performance	Financial Performance - Costs	Financial Proposition - Revenue	Industry Supply Chain & Skills	Market Opportunities	Company Maturity
Status Summary Level	'Bankable' Grade Asset Class									6
	Market competition driving widespread deployment									5
	Multiple commercial applications									4
	Commercial scale up									3
	Commercial trial									2
	Hypothetical commercial proposition									1

Tools to Assess Presence of Conditions for Successful Implementation of Policy Approach

As mentioned in chapter 2, the experimental approach can be thought of a special case of a whole-of-government (WoG) policy approach applied to technology development for climate change mitigation. One of the research questions (i.e. question 2) seeks to answer the question as to whether conditions for successful implementation of WoG policy approaches are present to a greater degree in the experimental versus the conventional policy approach. In order to provide a measurement tool to answer this question, a review of the WoG literature was conducted, to determine a consensus view on what these necessary conditions are. This review has resulted in the development of a list of 11 conditions for success, which are summarized in Table 5 below.

Table 5 – Conditions necessary for successful implementation of WoG approaches

1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action.
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources.
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project
7	Costs and benefits	"tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc.
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills.
9	Role of Central Agencies:	Direct involvement to overcome barriers.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes.

Source: Kania et al (2014); Bakvis & Juillet (2004); CES (2014) Centre for Effective Services; APSC (2007) Australian Public Service Commission; Carayannopoulos (2016); Ling (2002) per APSC (2007).

3.7 Methodology – Description of Cases

Before answering the research questions, both the conventional and experimental case studies are described and characterized. The case studies are described in chapter 4, for conventional case studies and in chapter 5, for experimental case studies. This section explains how each case study examined is defined, described, mapped along the innovation chain, and characterized using features suggested by the analytical framework. This characterization of the case studies provides a strong basis for comparative analyses.

Defining Policy Mixes in Cases Studies

The definition of policy mixes in these case studies is not as straightforward as one might expect. As mentioned in the Note to Reader, public servants do not usually discuss their work in terms of policy mixes; rather they discuss the individual measures with which they are involved, typically called a program or programs as part of a broader initiative. To complicate matters, new policy mixes may be layered on top of existing policy mixes. Or, the policy mixes examined may fit within much larger government policy “frameworks,” or existing “policy regimes,” which could include dozens of policy instruments, which are too large to be practically assessed together. The exercise of defining and describing the policy mixes examined demonstrates how complex the design, implementation and evaluation of policy mixes in “real world government” really is when linked with broad policy aims that may have several expected results attached to other policy aims.

The policy mixes to be examined are the formal policy mixes as defined in formal government documentation, such as Memoranda to Cabinet or Treasury Board Submissions. The three experimental policy mixes to be examined are the policy mixes

described in NRCan’s Green Infrastructure Phase 1 and Phase 2 Treasury Board Submissions, which are the formal documents used for final decision making by Canadian federal Treasury Board Ministers. The conventional policy mixes are also formally defined in other Treasury Board Submissions. In sum, the key Treasury Board Submissions defining the policy mixes examined are outlined in Table 6.

Table 6 – Case studies examined in this thesis – definition and link to key design document

No.	Name of Govt STI program in Policy Mix	Phases	Timeframe	Treasury Board Submission
Conventional Case Studies				
1	TEAM program	Ph. 1 Ph. 2 Ph.3	1998-2001 2001-04 2004-09	Climate Change Action Fund (CCAF) CCAF Extension Climate Change Plan for Canada - Technology & Innovation Initiative
2	Clean Energy Fund		2009-15	Clean Energy Fund
3	GI Ph. 2 - Emerging Renewables Power Program		2018-23	Green Infrastructure Phase 2
Experimental Case Studies				
4	GI Ph. 2 - Clean Energy for Rural & Remote Communities		2018-24	Green Infrastructure Phase 2
5	GI Ph. 2 - Smart Grids		2018-22	Green Infrastructure Phase 2
6	GI Ph. 2 - Electric Vehicles & Alternative Fuels		2018-22	Green Infrastructure Phase 1 & Phase 2

All Green Infrastructure policy mixes examined fit within the 12-year \$180B Investing in Canada infrastructure plan,¹⁰ which includes 80 different “programs” and initiatives, and funding for over 15,000 projects. More specifically, they fit within the \$26.9B Green Infrastructure stream of the Investing in Canada plan. Similarly, the other conventional case studies examined fit within larger frameworks, including the Federal Sustainable Development Strategies (FSDS) in force at the time of the policy mix design. The Fourth FSDS (2019-22),¹¹ in place as of 2020, includes 13 different high-level goals and a very large number (over 100) of different “instruments,” delivered by 41 federal departments and agencies. As mentioned above, these much larger policy mixes are much too large and unwieldy to be assessed in this research and were thus excluded. However,

¹⁰ <https://www.infrastructure.gc.ca/plan/placemat-tableausynthese-eng.html> , accessed 20 Aug. 2019.

¹¹ <http://fsds-sfdd.ca/index.html#/en/goals/>

the fact that the formal policy mixes fit within larger policy mixes is kept in mind, in cases where there are informal linkages that could affect the formal policy mixes examined.

The existing policy regime, under which both experimental and conventional case studies were/are designed and delivered, includes some important additional policy instruments, which on an exceptional case-by-case basis, are included in the analyses undertaken. These are defined as an informal or augmented policy mix, which include the formal policy mixes, plus where applicable, additional key existing policy instruments. These additional policy instruments are those that are judged to be highly complementary and understood to be designed and implemented at the same time as the formal policy mixes. For example, for all six cases examined, it is assumed that the Program of Energy R&D (PERD), NRCan's long-standing and permanent federal energy government STI program, in place since the early 1970's, is part of the augmented policy mix. This is supported by the fact that PERD is mentioned in all Treasury Board Submission documents, reviewed as a complementary instrument. Any additional instruments are made explicit in the detailed description of each case study in chapters 4 and 5.

Describing Case Studies

Each case study is described as follows. First, some background information provides the context for the development of the policy mix. This could include, for example, Canada's international climate change commitments, or the existing policy regime in place, at the time the policy mix was being designed. Second, both the formal and augmented policy mixes are defined, per the procedure described above. Third, the three attributes that make each case study either conventional or experimental are described, per the

procedure described below. Fourth, the policy mix is described using 21 characteristics, per Table 7 below, as suggested by the Rogge & Reichardt analytical framework. These characteristics include the following: policy dimension, policy process, strategy elements, instruments, and instrument mixes. The data source that was used to determine the actual nature of each characteristic is the documentation reviewed for each policy mix. Some of the characteristics were measured on a scale of 1 to 5 (Low, medium low, medium, medium high, high), as determined by me as researcher in reviewing the documentary evidence. Fifth, a reference to the documents reviewed is provided.

Table 7 – Tool to describe 21 characteristics of case studies

Policy Mix Characteristics			
Characteristics	Sub-characteristics	# sub-char.	Description/Measure
Policy mix approach		1	Conventional or Experimental
Dimension	Policy Field	1	All technology development for clean energy transition
	Governance level	1	All federal government; all single department or organization
	Geography	1	All Canada
	Time	2	Timeframe; Temporal offset between instruments
Policy process	Type	1	Tightly coupled or loosely coupled
Elements	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)
	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)
Instruments	Number of instruments in policy mix	1	1-10
	Instrument - Type	1	Codes & standards, regulations, taxes & charges, tradable permits, voluntary agreements, subsidies and incentives, information, other
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns
	Instrument - Design Features	4	legal or voluntary; target actors; duration; differentiation
Instrument Mix	Cornerstone instrument	1	Government STI program or other
	Interactions between instruments	1	Degree of interaction (1-5)
	Number of interactions between instruments	1	count 1 for each pair of instruments
	Type of interaction between instruments	1	e.g. feedback loop

Sub-Total - sub-characteristics

21

Describing the three attributes that make each case study either conventional or experimental

Conventional and experimental policy mixes are defined and selected on the basis of three attributes: loose or tight bundling; incomplete or complete coverage of the innovation chain; and technology-specificity. Interested readers can find, in the

Appendices, a section that provides details as to how a formal case study demonstrates attributes of either a conventional or experimental policy mix. This is done by (i) examining the policy process used for each instrument used in the policy mix, in the case of bundling; (ii) mapping the instruments along the innovation chain, to observe actual coverage of the policy mix; and (iii) determining the level of technology specificity from the policy mix documentation. It should be noted that, in the real world, there may be both “ideal cases” of conventional or experimental policy mixes which are tightly/loosely bundled, complete/incomplete and technology-specific/not technology specific, as well as “mixed cases” where 1, 2 or 3 attributes may be fully or partially present. The case studies examined include both ideal and mixed cases.

Attribute #1 - Bundling

To confirm whether the policy mix is loosely or tightly bundled, the policy process used to develop instruments and the policy mix was examined to determine whether different instruments in the mix are/were designed, implemented and evaluated independently of one another (conventional) or as a group (experimental). To describe this, the data measurement grid, developed based on Howlett & Giest (2015), shown in Table 8 is used. Each step in the policy process is characterized as either loose or tight, based on information found in the policy mix documentation. Note that the agenda setting step is skipped, because at the agenda setting stage, discussions of policies are typically at a high level, and do not get down to the level of detail of relatively small policy mixes, which are the subject of study in this thesis.

Table 8 – Measurement tool – bundling of policy mixes

		Design			
	Agenda Setting	Policy Formulation	Decision Making	Implementation	Policy Evaluation
Instrument 1	N/A				
Instrument 2	N/A				
Instrument 3	N/A				
...	N/A				
Instrument n	N/A				

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

To confirm degree of completeness of coverage of the innovation chain, the policy mix is mapped using the measurement tool developed and shown in Illustration 6 below. This tool provides a high-level visualization of coverage along the innovation chain. The illustration shows a filled-in hypothetical example for a policy mix consisting of three policy instruments: (i) a government STI program, (ii) regulations, codes and standards development, and (iii) a deployment or incentive instrument. This hypothetical example shows how this particular example policy mix fully covers the entire innovation chain. It is expected that conventional policy mixes may only cover part of the innovation chain, while experimental policy mixes are expected to have improved or full coverage.

Illustration 6 – Tool to map policy mix along innovation chain and example with 3 instruments

Innovation Chain												
Basic R&D		Applied R&D				Demonstration			Deployment		Commercialization / Diffusion	
Technology Readiness Level (TRL)												
#	1	2	3	4	5	6	7	8	9			
1	Government STI program (R&D and demonstration)									Regulations and Codes & Standards		
2										Subsidies & Incentives (deployment)		
3												

In order to provide a greater level of refinement in the measurement of actual coverage of the policy mix against the innovation chain, the policy mixes is also mapped against both the Technology Readiness Level and Commercialization Readiness Index scales.

The policy mix is mapped for coverage along the Technology Readiness Level

scale, using the measurement tool shown in Table 9. An X is inserted for each TRL covered by the policy mix, to better understand the coverage of the policy mix on the TRL scale. Given that each of the policy mixes examined includes government STI programs, it is expected that coverage along the TRL scale is generally good. However, mapping of the policy mix against the TRL scale helps to confirm this.

Table 9 – Tool to map policy mixes along TRL scale

	Technology Readiness Level								
	1	2	3	4	5	6	7	8	9
Policy Mix									

Finally, the policy mix is mapped for coverage along the Commercialization Readiness Index scale, using the measurement tool shown in Table 10. An X is inserted for each CRI covered by the policy mix, to better understand the coverage of the policy mix on the CRI scale. It is assumed the policy mix is focused at a particular CRI level, given the maturity of the technology being targeted for development. The indicators provide greater granularity of coverage. It is anticipated that this mapping helps to expose gaps in both the conventional and experimental policy mixes.

Table 10 – Tool to map policy mix along CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment								
	CRI 4 - Multiple commercial applications								
	CRI 3 - Commercial scale up								
	CRI 2 - Commercial trial								
	CRI 1 - Hypothetical commercial proposition								

Attribute #3 – Technology specificity

To confirm degree of technology-specificity, the policy mix is characterized using the tool shown in Table 11 below. A technology-specific policy mix is defined as a mix where the instruments target specific technologies applied in specific economic and industry sectors, such as buildings, transportation, and electricity generation.

Documentary evidence is examined for each instrument in the policy mix and a yes/no answer is provided in the data gathering matrix. If the instrument is technology specific, then the technology or sector targeted is also entered. Once all of the policy instruments have been assessed in this way, a conclusion is made about the technology-specificity of the policy mix.

Table 11 – Tool to describe technology-specificity attribute of policy mix

	Technology Specific	
	Yes or No	Technology or Sector Targeted
Instrument 1		
Instrument 2		
Instrument 3		
...		
Instrument n		

3.8 Methodology – Answering Research Questions

This section outlines the methodology to answer each of the research questions. A useful summary of the indicators, number of data points, and data sources is shown in Table 12, for each research question.

Table 12 – Summary of research questions, indicators, data points and data sources

Research Question	Research Questions	Indicators	# Data points / method	Data Source
1A	Do the experimental case studies result in improvements in consistency, coherence and comprehensiveness compared to conventional case studies?	3 indicators: Consistency, coherence, comprehensiveness, per Rogge & Reichardt analytical framework	11 data points for each of the 6 cases studies = 66 data points	Semi-structured interviews; case study document review
1B	What are the comparative administrative costs of the experimental versus the conventional policy approach?	Administrative cost at each of 3 stages of policy process (design, implementation, audit/evaluation)	Qualitative comparison	Semi-structured interviews; case study document review
2	Are conditions suggested by the literature for successful implementation of whole-of-government policy approaches present to a greater degree in the experimental versus conventional policy approach?	11 indicators per review of whole-of-government literature	11 data points for each of the 6 cases studies = 66 data points	Case study document review
3A	Are there any observed differences in the hypothesized improvements and benefits between the different experimental case studies examined?	3 indicators: Consistency, coherence, comprehensiveness	11 data points for each of the 3 experimental cases studies = 33 data points	Semi-structured interviews; case study document review
3B	if yes to question 3A, what would help explain those differences?	4 main indicators: tightness of bundling; coverage of innovation chain; characteristics; and conditions for successful implementation	For 3 experimental cases: 3 data points for tightness of bundling; mapping + 13 data points for coverage of innovation chain; 21 characteristics; and 11 conditions for successful implementation = 144 data points	Semi-structured interviews; case study document review
4	4. Are there barriers and constraints to implementing the experimental policy approach in this policy field?	5 categories: (1) organizational/ structural, (2) leadership, (3) process-related, (4) complexity & scale, (5) other, per review of whole-of-government literature	Number of specific barriers and constraints identified by interviewees	Semi-structured interviews

Method for Question 1

The first research question is formulated as follows and is addressed by answering two sub-questions:

- a. Do each of the three experimental case studies examined result in hypothesized improvements and benefits, as early indicators of success, namely improvements in consistency of elements, coherence of processes, and comprehensiveness, as suggested by the literature, compared to the conventional case studies?
- b. What are the comparative administrative costs of the experimental versus the conventional policy approach?

The following explains the methodology to answer each of the two sub-questions.

Question 1a is answered by comparing the level of consistency, coherence and comprehensiveness (three evaluation criteria) between the experimental and conventional case study groups, to assess whether there are any observed improvements in these three evaluation criteria, in the experimental case studies. Each of the three hypothesized benefits of consistency, coherence and comprehensiveness were defined, in chapter 1, to consist of sub-components, shown in Table 13 below, which could each be measured, using definitions provided in the analytical framework. Each sub-component is measured on a scale of 1 to 5 (Low, medium low, medium, medium high, high), using data from the semi-structured interviews. Interviewees were asked to provide: (1) a rating between 1 and 5, as well as (2) comments to justify the rating. The final assessment of each case study consists of a ‘consensus’ for each hypothesized benefit and sub-component measured, between myself as researcher and interviewees, based on the rating, and mediated using the comments. Commentary provided by interviewees for each of the cases provides a basis for explaining reasons for comparative between the groups.

Table 13 – Measurement Tool for questions 1a and 1b – Hypothesized improvements and benefits

Question	Hoped-for Improvement and benefit	Measure	Indicator
1a. Do each of the three experimental policy mixes result in hoped-for improvements and benefits, namely improvements			
	Consistency of elements	Alignment over time	temporal consistency (1-5)
		Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)
		Overall - strong consistency	Degree of existence of synergies (1-5)
		Policy Strategy	Degree of alignment of policy objectives (1-5)
		Instrument mix	Degree of reinforcement between instruments (1-5)
		Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)
	Coherence of processes	Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)
		Organizational capacity	Degree of engagement between groups (1-5)
		Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)
	Comprehensiveness	Barriers (market, institutional) - Coverage of TRL and CRI	Degree to which the policy mix addresses barriers , i.e. all stages in the TRL and CRI (1-5)
		Barriers (systemic) - Push, pull & systemic concerns	Degree to which the policy mix addresses all barriers - systemic / innovation process (1-5)
1b. What are the comparative costs of the experimental versus the conventional policy approach?			

Once each of the 3 experimental and 3 conventional case studies have been assessed, then these are compared as a group against one another to determine if a pattern of improvement can be observed. The results of this comparison are summarized and analyzed in chapter 6.

Question 1b, on the comparative administrative costs of the experimental versus the conventional policy approach, is answered qualitatively through the semi-structured interviews. In this thesis, the administrative cost is defined as the cost for administering the different policy instruments in the policy mix, which consists primarily of the cost of staff designing, implementing and evaluating the instruments in the policy mixes, as well as a multiplication factor to cover corporate functions associated with the personnel (human resources, finance, training, facilities, information technology, etc.).

The literature review on whole-of-government policy approaches, reviewed in chapter 2, suggests that there could be increases in administrative costs in designing, implementing and evaluating the experimental policy mixes versus the conventional mixes, due to the need for increased coordination and communications, at all stages of the policy process. A counter-argument to the above is that administering a policy mix as a single “group” may yield administrative synergies, if compared to administering instruments individually and separately. This thesis seeks to confirm whether this is the case or not.

Determining the administrative cost of a policy mix is not as straightforward as one would expect. The best source of the planned, or expected, administrative costs of different instruments in the policy mix are the design documents (i.e., Treasury Board Submission documents). However, there could be differences between planned and actual

administrative costs, and it is very difficult to obtain actual administrative costs from public sources of information. Another difficulty in assessing administrative costs is normalizing the cost against the relative amount of funding provided by the government for each policy instruments in the mix. For example, it can be reasonably expected that a larger government STI program may have greater administrative costs, on a dollar basis, than a smaller one. However they may be equivalent on a normalized basis.

Given the above difficulties in obtaining accurate, normalized data on actual administrative costs, the comparative cost of administering experimental versus conventional policy mixes are assessed qualitatively.

Method for Question 2

The second research question is formulated as follows:

2. Are conditions suggested by the literature for successful implementation of Whole-of-government policy approaches present to a greater degree in the experimental versus conventional policy approach?

The conditions for successful implementation were determined through a review of the whole-of-government (WoG) literature, summarized in section 3.6. This review results in 11 conditions required for successful implementation of policy mixes which employ a horizontal, WoG policy approach, summarized in Table 5 found in section 3.6.

Question 2 is answered through the examination of case study documentation carried out by myself, as researcher. Documentation for each of the instruments included in the case studies is examined to see if each of the 11 conditions can be observed, according to the details included under measure, in the table below. The absence of the condition in the case study is indicated with a zero. The positive observation of the condition is indicated on a scale ranging from 1 to 5 (low, medium low, medium, medium high, high). A range from 1 to 5 in this case provides more detail than a single

measurement of observed versus non-observed.

Once each of the 3 experimental and 3 conventional case studies has been assessed for each of the 11 conditions, then these are compared as a group against one another to determine if a pattern of improvement can be observed. The results of this comparison are summarized and analyzed in chapter 6.

Method for Question 3

The third research question continues with the assessment of the experimental policy approach, and is formulated as a two-part question follows:

3. (a) Are there any observed differences in the hypothesized improvements and benefits among the different experimental case studies examined, and if yes, (b) what would help explain those differences?

While questions 1 and 2 compare the experimental versus the conventional case studies, as two groups, question 3 compares and looks to identify differences between the three experimental case studies. Further, the third question also seeks to understand any causes that could help explain any differences observed. A key assumption at the outset of this thesis was that there actually are observed differences between the experimental case studies examined, because of differences in design and implementation of these policy mixes. In trying to uncover the causes for any observed differences, the approach utilizes and leverages the descriptive information provided for each case study, as outlined in section 3.7., including the 21 descriptive characteristics and the 11 conditions for successful implementation.

Question 3 is answered by conducting comparative analyses between the three experimental case studies. First, a comparative analysis is conducted to identify any differences in the amount of improvement in consistency, coherence, and comprehensiveness, between the three experimental cases. Second, four comparative

analyses are conducted to identify potential causes for the differences in the hypothesized improvements and benefits. The four comparative analyses are:

- (i) Differences in the degree of tightness of bundling of the policy mixes;
- (ii) Differences in the coverage along the innovation chain of the policy mixes, as well as mapping of the policy mixes on the TLR and CRI scales;
- (iii) Differences in the 21 characteristics of the three case studies, per Table 7; and
- (iv) Differences in the observed conditions for successful implementation, per Table 5 above.

The results of the above comparative analyses are summarized and discussed in Chapter 6.

Method for Question 4

The fourth research question is forward looking and looks at what might be needed to support additional experimentation with, or adoption of, the experimental policy approach, in the future. The fourth question is formulated as follows:

- 4. Are there barriers and constraints to implementing the experimental policy approach in this policy field?

Question 4 is answered through semi-structured interviews with federal public servants. In addition, my own observations of the barriers and constraints observed in the case studies, are added to the interview responses. Categories of data from the interviews are captured in Table 14 below. The categories or types of expected responses were developed based on insights gained through the literature review, leaving room for “other” barriers and constraints to be captured as well.

Table 14 – Measurement Tool for question 4 – Barriers & Constraints

#	Categories of Barrier or Constraint	Responses from interviewees	Observed or not?
1	Organizational / Structural	Prioritization of vertical accountabilities (vs horizontal)	
		Silo problems	
2	Leadership	Lack of leadership awareness and support	
3	Process-related	Lack of common processes	
		Research collaboration process constraints	
4	Complexity and Scale	# Instruments	
		# Organizations within Departments & Agencies	
		# Departments	
5	Other	Low priority on 'experimentation'	
		Departmental mandate to support multiple instruments	
		Competition between innovative policy approaches	

3.9 Data Sources

The research uses two primary data sources: the review of documentary evidence related to the case studies examined; and semi-structured interviews with key federal government informants who were involved in the design, implementation and evaluation of the case studies examined.

Document Review for each Case Study

For each case study, a number of documents were reviewed including, where available:

(i) policy frameworks providing overall context as well as the existing policy regime (e.g., Investing In Canada Plan, Federal Sustainable Development Strategy); (ii) key design and decision-making documents (e.g., draft or final Memoranda to Cabinet, Treasury Board Submissions); (iii) implementation documents (e.g., guides and descriptions, instructions to applicants, announcements); (iv) departmental evaluation reports; and, (v) other documents such as press releases and media stories. Most of the documents are publicly available. In other cases, the documents were accessed through staff at NRCan.

Semi-structured Interviews with Federal Public Servants

In order to collect qualitative data on the case studies, semi-structured interviews were conducted with participants that were all current and former federal public servants, or evaluation professionals, who worked at Natural Resources Canada, or who are very knowledgeable about the policy mixes examined. Interviewees were government STI program, audit or evaluation staff and professionals directly involved in the design, implementation, and/or audit/evaluation of the policy mixes.

In order to proceed with the semi-structured interviews, I as researcher submitted the necessary documentation required for review by Carleton University's Research Ethics Board (CUREB-A). The research was determined to be research involving very low risk to participants. A certification of Institutional Ethics Clearance was granted on Nov. 26, 2019, which was extended on Dec. 8, 2020, expiring on Dec. 8, 2021, to enable the semi-structured interviews to proceed. The two certifications are included in Appendix C.

Fifteen participants or federal public servants were interviewed during the period specified by the above certifications. The inclusion criteria used for participants was the degree of familiarity with the instruments and policy mixes being studied. In all cases, the federal public servants interviewed were directly involved with the design, implementation and audit and evaluation of the policy mixes examined. Typically, public servants interviewed were at the Policy Analyst, Manager, Director, or Director General level. As I have worked at NRCan since 2005, as recommended by Carleton's Office of Research Ethics, any public servants who work, or who have worked, under my supervision, or under the supervision of my direct reports, were excluded from the list of

participants, to eliminate potential bias.

Participants provided input on one or more of the 6 case studies studied, depending on their familiarity with the case studies. Most of the interviewees were involved with designing or implementing several of the policy mixes and therefore provided input on two or more case studies. Audit and evaluation staff and professionals were also typically involved in evaluating more than one of the cases and therefore provided input on two or more cases. Table 15 below summarizes the contribution of the fifteen participants interviewed to each of the six case studies. It was easier to recruit participants for policy mixes that are more recent and currently being implemented.

Table 15 – Contributions of the 15 participants interviewed to each of the six case studies

Case Study - Policy Mixes	Participant Contributions
<i>Conventional</i>	
Technology Early Action Measures (TEAM)	3
Clean Energy Fund	4
GI Ph. 2 - Emerging Renewables Power Program	5
<i>Experimental</i>	
GI Ph. 1 & 2 - Electric Vehicle & Alternative Fuels	4
GI Ph. 2 - Smart Grids	6
GI Ph. 2 - Clean Energy for Rural & Remote Communities	5
Total	27

Participants were recruited via email. If they agreed to participate, they were provided with the interview questionnaire, included in Appendix B, ahead of time and were asked to sign a consent form. Participants were asked to participate in a single interview lasting 60 to 90 minutes.

Semi-structured interviews were conducted over the phone. Responses to questions were recorded by the researcher, in handwritten note form. As recommended by CUREB, the responses were de-identified, or anonymized, and encrypted so that they

could not be ascribed to any individual participant, and so that the identity of individual participants would not be accidentally disclosed.

As was mentioned in section 3.8, responses from interviewees, for question 1a, which is the key question testing the hypothesis, were recorded using a two-step process: (1) interviewees provided a ranking from 1 to 5, or Low to High, followed by (2) commentary justifying the rankings. To arrive at a ‘consensus’ rating for each of the three indicators and sub-measures, I, as researcher, looked for key terms or justifications, which were aligned with the consensus view of the rating. Thus, the ratings were based on two checks: the first impression of the interviewee as well as content analysis of the comments and justifications provided.

3.10 Conclusion – Boundaries & Limitations

This conclusion summarizes the main limitations to the research that is conducted in this thesis. These limitations can be grouped into three main categories: limitations in perspective, limitations related to the scope and focus of the research, and limitations related to methodological issues. Each of these limitations is described below.

Limitations in perspective

The first category of limitations has to do with the primary disciplinary perspective taken in this thesis.¹² This thesis focuses primarily on a public policy and administration perspective and does not look at the problem and solutions from other perspectives, such as the political science, business management, human behavior, economics, international

¹² This category of limitations referenced was proposed, in a video webinar, by Dr. Jochen Markard, Senior researcher and Lecturer at the Group for Sustainability and Technology within the Department of Management, Technology, and Economics of ETH Zurich. The video referenced is: <https://www.youtube.com/watch?v=WM3YXcamooM> accessed 1 Jan 2021.

diplomacy, or cultural perspectives. Even within the public policy perspective, this thesis takes a fairly narrow perspective, focusing on a policy mix approach implemented by public servants, combined with insights from innovation theory and whole-of-government policy approaches.

Although the thesis references the literature on socio-technical and energy transitions, which provides a broad perspective on the multi-dimensional system-level changes required, on a global scale, to effectively mitigate climate change, the thesis only references selected aspects from this literature, which are specific to the experimental and conventional policy mixes examined. The thesis does not include an examination of wider issues, such as the interconnectedness of climate change within a set of broader issues or societal goals, for example as embodied in the United Nations' 17 Sustainable Development Goals¹³ (UN 2020). Some researchers, such as Meadowcroft & al 2019, argue that “taken on its own, the climate problem cannot today [sufficiently] motivate transformative change across multiple societal systems” and that, therefore, there is a need to “link climate mitigation to other social goals” and to “harness [other] disruptive currents (e.g. the digital information, automation, and Artificial Intelligence / data analytics revolutions) to bring about a better world”. Such a broad perspective is outside of the scope of the research carried in this thesis.

In spite of the above limitations, the research carried out in this thesis is well aligned with, and consistent with, current research trends and recommended directions for future research, in the area of policy mixes in support of sustainability transitions, which is a very active research topic.

¹³ Source: United Nations, Sustainable Development Goals <https://sdgs.un.org/goals>

Limitations related to the scope and focus of the research

The second category of limitations has to do with the limited scope and focus of the research. For ease of reading, limitations are underlined and associated policy dimensions are shown in brackets, below.

As mentioned in Chapter 1, this thesis limits its investigation to policy mixes that enable technology development and adoption to mitigate climate change (policy field) in Canada (geography), at the federal level (governance level), in which the core instruments are administered primarily by NRCan (organizational level). The above limitations are reasonable, because NRCan is the primary federal department that has the mandate to enable the development and deployment of clean energy technologies, and the scope and scale of its activities are sufficiently large to be material, within the Canadian context. In addition to the above, this thesis focuses on a relatively limited number, or subset, of NRCan policy mixes, which have as their primary goal to develop clean energy technologies, which include government STI programs as a cornerstone instrument, and which could lead to greenhouse gas emission reductions in energy production, distribution and end use. This is viewed as a reasonable limitation, because current energy producing and consuming technologies are currently generating 80% or more of greenhouse gas emissions around the world (NRCan 2018, US EPA 2018), and higher performing technologies, at an affordable cost, are needed to substitute existing technologies. As was mentioned in Chapter 1, it is also reasonable to limit the scope of the research to the above, given the urgent need for new, cost effective, low carbon clean energy technologies, across a large number of economic sectors, in Canada and around the world.

In addition to the above, other limitations include that the timeframe is limited to 23 years from 1998 to 2020. In addition, the size and scale of policy mixes examined are on the smaller size, with 10 instruments or less in the mixes examined. It is acknowledged that the policy mixes examined fit within much larger policy mixes and policy regimes, which may include over 100 instruments in the broader mix, but where the instruments are very loosely connected, or bundled, with one another. The above limitations reflects the state-of-the-art for new, experimental policy mixes that are tightly bundled, complete and technology-specific.

The scope of the research in this thesis is also limited to the assessment of short-term indicators of success only, because the experimental policy mixes examined are relatively new, having been introduced only since 2016, at the federal level in Canada. Given the above, it would be premature to assess benefits, such as improved efficiency or effectiveness, which require data on the medium-term and longer-term outcomes achieved by the policy mixes, which are not yet available. Also, given the above, the assessment conducted in this thesis is a preliminary assessment only. As was described in section 1.5, the analytical framework used in this thesis is very comprehensive. It is not possible to conduct an assessment that looks at all of the assessment possibilities enabled by this framework. The research carried out in this thesis focuses on assessing only the three key indicators, but as previously mentioned, the literature suggests that these are strongly correlated with expected future improvements in effectiveness and are thus appropriate evaluation criteria for a preliminary assessment (Rogge & Reichardt 2016, Kern & Howlett 2009).

The research of this thesis was carried out, in part, during the global COVID-19

pandemic. Some authors (e.g., Rosenbloom & Markard 2020) have argued that governments should leverage “COVID-19 recovery programs to simultaneously advance the climate agenda presents a strategic opportunity to transition toward a more sustainable post–COVID-19 world.” Given that the research carried out in this thesis was designed in the years before the start of the COVID-19 pandemic, it was outside of the scope of the research to look at the short, medium and longer term impacts that the COVID-19 pandemic has on the policy mixes examined.

Limitations related to methodological issues

The third series of limitations are related to issues related to the design or implementation of the research method. Two such limitations are outlined below.

The first limitation described has to do with temporal offsets in the analysis of policy mixes. Policy mixes to enable technology development and adoption are typically designed to be implemented over a specific timeframe, and yet are constrained by the time-based nature of the innovation process, the stages of which are represented by the Technology Readiness Levels and Commercial Readiness Index. As this thesis’ research progressed, and after the case studies were drafted, it became clearer that temporal offsets are an important feature of the policy mixes to enable technology development. I have attempted to take this need for temporal offset into consideration, by informally considering the effect of past government STI programs, as well as current government STI programs, where such information was available. However, this was not anticipated at the beginning of the study and is therefore highlighted as a limitation. A more systematic approach to this problem would be recommended for future studies of this kind.

The second limitation related to methodology has to do with unconscious bias on the part of interviewees. As a researcher, I noticed that all interviewees displayed a slight positive bias towards the policy mixes for which they were interviewed. In many cases, this could be anticipated, as many interviewees are or were personally invested in the design, implementation, and /or audit or evaluation of specific policy instruments included in the policy mixes. As such, their responses to the assessment questions tended to accentuate the positive contributions of the instruments that they were personally involved in. As they typically did not have as much knowledge of the other policy mixes being assessed, they had difficulty providing responses that were well calibrated, relative to other policy mixes. In addition, as this is a new, highly specialized research topic, they were not as familiar with the issues for which they were being interviewed on, as one would have hoped. Although they are the public servants that are most knowledgeable about the policy instruments and policy mixes examined, they are not accustomed to analyzing these policy mixes, from a public policy studies perspective. Finally, interviewees appeared reluctant to provide responses that utilized the full range of allowable responses, ranging between 1-5 (low, med-low, med, med-high, high), preferring to provide responses between med-lo and med-high, in the majority of cases. The above limitations are due, in part, to the design of the interview questions, which used a semi-structured interviewing approach. A structured interview questionnaire could not be designed, at the outset of the research, because it was not clear what the range of answers would be to the research questions. Now that this thesis has been completed, a better designed questionnaire, including structured responses that utilize the full range of allowable responses (from low to high), could help reduce these limitations, in the future.

Chapter 4: Case Studies – Conventional Policy Mixes

4.1 Outline

- Introduction
- Background on Conventional Case Studies
- Case Study #1 – Technology Early Action Measures (TEAM)
- Case Study #2 – Clean Energy Fund (CEF)
- Case Study #3 – GI Ph. 2 – Emerging Renewables Power Program
- Conclusion

4.2 Introduction

This chapter presents information and data on the three conventional case studies examined in this thesis. The chapter is organized in a straightforward manner: a background section introduces the three case studies, briefly reviews reasons provided in chapter 3 as to why they were selected and describes them at a high level. Next, each of the three case studies is described and assessed. Finally, the conclusion points to the analysis and comparative work completed in chapter 6, with data from chapters 4 and 5.

Each of the three sections on the individual case studies is organized as follows. First, the case studies are defined, described, and characterized using features suggested by the analytical framework. This includes: (i) presentation of background information, (ii) definition of formal/augmented policy mix, and (iii) characterization of the policy mix. Second, the data, collected through the document review and semi-structured interviews, is presented. This data is used to answer the first two research questions in chapter 6. Additional information, including: additional background information; documentary sources; policy mix attributes; mapping along the innovation chain; and detailed data tables are included in Appendices D, E and F, for each of the three case studies.

4.3 Background on Conventional Case Studies

The three case studies of policy mixes, selected as part of the conventional group of case studies, are shown in Table 16 below. Each case study is named based on the cornerstone instrument. The shorthand names of the three case studies are: TEAM, CEF and ERPP.

Table 16 – Three conventional case studies – background information

Government STI programs as cornerstone instrument in policy mix Case Studies - Conventional Policy Approach	No. of Instruments in Augment. Policy Mix	Federal Budget	Program Timeframe		Cornerstone Instrument Budget/Actual \$M	Formal Case Policy Mix Budget/Actual \$M	Augmented Policy Mix Budget/Actual \$M
			# Years	From/To			
Technology Early Action Measures (TEAM) - Ph. 1	5	B1998	3	1998-2001	56	200	369
TEAM - Phase 2	5	B2000	3	2001-04	35	150	302
TEAM - Phase 3	4	B2003	5	2004-09	60	250	518
	9*		11	1998-2009	151	600	1,188
Clean Energy Fund (CEF)	4	B2009	8	2007-15	306	306	1,011
GI Ph. 2 - Emerging Renewable Power Program (ERPP)**	4	B2017	5	2018-23	200	200	663
Total for 3 case studies	4-9		23***	1998-2023	657	1,106	2,862

* Note: For TEAM, the policy mix included different instruments during the 3 different phases, so that in total, there were 8 different types of instruments over the 3 phases.

** Note: The Emerging Renewables program is an early stage deployment program that targets "emerging" renewable energy technologies. Thus, it is very similar to a demonstration program, and has been included as a government STI programs.

*** Note: 1998 to 2020 = 23 years

The above case studies were selected based on factors outlined in section 3.4, including that they exhibit attributes of a conventional policy mix: (i) the instruments in the policy mix are considered to be “loosely” bundled, (ii) the policy mixes only partially cover the innovation spectrum, and, (iii) the policy mixes were not designed to be technology-specific. Per section 3.4, other reason as to why these three conventional case studies were selected include: (1) the policy mixes are typical and representative, as they were amongst the largest (in terms of dollar budget) and most important, at the federal level, during their timeframes, over the past 23 years (1998 to 2020 inclusive); (2) the policy mixes are sequential, covering a sufficiently long timeframe so as to provide useful historical information; (3) the policy mixes are largely non-overlapping and therefore cover distinct time periods; (4) there is significant, easily accessible documentation on each case study; (5) key personnel that designed, administered, and

evaluated the policy mixes were/are available to be interviewed for this thesis, and (6) they exhibit some differences, demonstrating a range of possibilities for designing and implementing such conventional policy mixes.

Each of the three case studies includes a cornerstone instrument in the policy mix, which is indicated in the left column of Table 16 above. In the case of the TEAM and CEF policy mixes, the cornerstone instrument is a government Science Technology & Innovation (STI) program. In the case of the ERPP policy mix, the cornerstone instrument is an early-stage deployment/incentive instrument, which is shown, below, to be very similar to, or essentially the same as, a government STI program.

Each policy mix was administered over a timeframe ranging from 4 to 11 years, which is typical at the federal government level, in Canada. The overall timeframe covered by the three case studies is approximately 23 years, which is sufficiently long, to provide significant historical evidence. The three case studies are listed and presented in chronological order, in order to situate them within their own historical context, and highlight developments and learnings, over the past 2 decades. As can be seen in the above table, the total Budget allocations to the individual policy mixes were quite substantial, ranging from \$200 M to \$1,188 M, over 4-11 years.

In terms of differences, each of the three case studies was designed and implemented during different timeframes and have varying durations. In addition, different case studies demonstrate slightly different levels of technology or sector-specificity. TEAM is the least technology-specific policy mix, amongst the six case studies, as it was designed to provide funding to projects in at least 8 different technology areas.

4.4 Case Study #1 – Technology Early Action Measures (TEAM) (1998-2009)

This case study focuses on the policy mix that includes the TEAM late-stage R&D and demonstration (RD&D) program as its cornerstone instrument. The policy mix timeframe is 1998-2009, or 11 years. Given the 2009 end date, different instruments in the policy mix have been formally evaluated, to assess the medium-term results and effects. The key features of this policy mix are that it included 9 policy instruments, covering 3 instrument types. The policy mix is a typical, conventional policy mix, because each instrument is delivered by a separate organization (loosely bundled), the instruments as a group provide only partial coverage of the innovation chain (incomplete), and the policy mix as a whole was non-technology specific. This case study is more detailed than others, because it had a relatively long timeframe of 11 years and, as the oldest of the six case studies, there is significant documentary evidence available for review.

This section includes background information derived from interviews, definitions of the formal and augmented policy mixes, as well as characteristics and interview data that are used for the comparative analyses between case studies in chapter 6. Additional details on this case study are provided in Appendix D.

Background on the TEAM policy mix

The TEAM policy mix¹⁴ (1998-2009) was part of a larger suite of measures developed, at the federal level, to meet the challenge of reducing greenhouse gas (GHG) emissions, following the Third Conference of the Parties (CoP3) to the United Nations framework Convention on Climate Change (UNFCCC), held in Kyoto, Japan, and the adoption of

¹⁴ The sources for much of the information in this Background section has been taken from the TEAM Business Plan and Management Framework, June 30, 1998 (see TEAM 1998 in the Bibliography).

the Kyoto Protocol, on December 11, 1997. At that time, Canada and 150 other nations negotiated GHG emission reductions to be realized over the next 10-15 years. In 1997, Canada agreed to reduce domestic GHG emissions by 6% below 1990 levels (from 564 MT/year in 1990 to 531 MT/year), to be achieved by the 2008-12 time period.

The TEAM policy mix was designed to deliver specific aspects of Canada's climate change commitments, under the Kyoto Protocol, namely: technology development and demonstration, public outreach, and further policy development. It was part of the federal government's response to seriously tackle climate change. The formal policy mix evolved over time, was renewed twice, was delivered under 3 phases over 11 years, and had a total budget of \$600M. The expected outcomes included: demonstration of a large suite of new technologies, new methods for measurement and reporting of GHG emissions from projects, as well as policy research and engagement, leading to a suite of additional measures in the future.

It is interesting to note that the policy mix changed substantially over 11 years, shifting from a general policy mix that included policy development, to a policy mix focused primarily on technology development and demonstration. By 2009, the policy development activities funded by the policy mix resulted in a large number of new initiatives, which can be thought of as the "larger climate change policy mix" or "policy regime", with a total budget of at least \$3.8B. In addition to this, other actual achievements included the funding of more than 140 climate change technology demonstration projects funded, with significant co-funding from 450 private sector, academic and other government partners, leveraging over \$1B in private sector funding. An important outcome of the policy mix was the development of GHG emission

measurement and reporting methods, which are used today by Environment & Climate Change Canada (ECCC) to report on Canada's GHG emissions, as well as the development of an international standard to measure GHG emission reductions from individual projects, which is in wide use, internationally, today.

Additional background information on this policy mix is provided in Appendix D, including a listing of the documentary evidence used to describe and characterize the policy mix, as well as mapping of the policy mix along the innovation chain, as well as against the Technology Readiness Level and Commercialization Readiness Index scales.

Defining the formal and augmented policy mixes

The formal policy mix, outlined in design documents including the Treasury Board Submissions, consists of eight (8) instruments, as shown in Table 17 below. A 9th instrument, the Program of Energy R&D (PERD), is added to define the augmented policy mix. Although not formally part of the policy mix, PERD is a complementary instrument that is referred to, in the design documents, and is closely related to the technology demonstration instruments included in the policy mix. The funding reserve was not counted as an instrument as it was used to augment the budget of other instruments.

As mentioned above, the policy mix changed over the course of its 11-year timeframe. The Climate Change Secretariat was an organization that provided oversight of the policy mix, which received approximately 25% of the total funding for the CCAF under Phase 1 (first 3 years from 1998-2001). It was decided that the Secretariat would be discontinued after Phase 1.

Table 17 – TEAM case study - formal and augmented policy mix¹⁵

Case Study - Formal Policy Mix per CCAF/TEAM Program Documentation + PERD						
Climate Change Action Fund (CCAF) 1998-2001 (3 years)		Part of Action Plan 2000 on Climate Change Climate Change Action Fund (CCAF) Extension 2001-04 (3 years)		Part of Climate Change Plan for Canada Technology & Innovation Initiative 2004-08 (4 years) + 2008-09 (1 yr extension for TEAM)		Budget TOTAL
Components of Policy Mix	\$M	Components of Policy Mix	\$M	Components of Policy Mix	\$M	\$M
1 Technology Early Action Measures (TEAM) - Ph. 1	56	Technology Early Action Measures (TEAM) - Ph. 2	35	Technology Early Action Measures (TEAM) - Ph. 3	60	151
2 Foundation Building	34	Building for the Future	60			94
3 Science, Impacts & Adaptation (SIA)	15	Science, Impacts & Adaptation (SIA)	15			30
4 Public Education & Outreach (PEO)	30	Public Education & Outreach (PEO)	20			50
5		International Policy & Related Activities	10			10
6				Technology & Innovation R&D	105	105
7				Hydrogen Economy - Innov. Excel. & Early Adopters	80	80
8 Climate Change Secretariat (CCS)	50			Implementation & Monitoring	5	55
Reserve	15	Reserve	10	Reserve	-	25
Sub-Total -Climate Change Action Fund	200		150		250	600
9 Program of Energy R&D (PERD)	169		152		268	588
Total - Case Study	369		302		518	1,188

The policy and outreach activities, such as Foundation Building; Science, Impacts & Adaptation; Public Education & Outreach, and International Policy were discontinued after Phase 2, as these functions were transferred to ECCC and funded under a different budget envelope (Finance Canada 2003). It is also interesting to note that, under Phase 3, it was decided that the policy mix should be focused exclusively on one instrument type, namely government STI programs, with the addition of Technology & Innovation R&D, and Hydrogen Economy – Innovation Excellence and Early Adopters RD&D programs.

Policy Mix - Coverage of the Innovation Chain

Per data found in Appendix D, the TEAM policy mix was found to have good coverage of the basic R&D, applied R&D, and demonstration stages of the innovation, and of the 7 levels of the Technology Readiness Level scale, but no coverage of the deployment and commercialization stages of the innovation chain. In terms of coverage of the

¹⁵ Source: Climate Change Action Fund (CCAF), and of the TEAM RD&D program, namely the CCAF Treasury Board Submissions and reporting documents, as well as the TEAM Business Plan and Management Frameworks, for the 3 phases of the TEAM policy mix.

Commercialization Readiness Index, the policy mix covers only the first 2 levels, out of 6, further confirming partial coverage of the later stages of the innovation chain.

Characteristics of Policy Mix in Case Study

The TEAM policy mix is described using the 21 characteristics suggested by the Rogge & Reichardt analytical framework, per Table 7 in section 3.7. The data to complete Table 59, which can be found in Appendix D, was derived from the documentary evidence. This table is used as a starting point for comparative analyses, and includes information on the policy elements, instruments, instrument mix, policy process and policy domain.

Some highlights of the features and characteristics of this policy mix that were not previously mentioned include the following.

At the policy element level, which looks at the degree of existence of objectives and plans at the policy mix level, the rating for both measures was determined to be med-low. This is because the suite of measures, included in the policy mix, is more of a loose grouping than a synergistic whole. Each of the instruments were delivered by separate organizations, were not designed to interact with one another, and had their own objectives and plans. There were only very loose objectives and plans at the policy mix level, resulting in a med-low rating.

At the policy instrument level, using the instrument typically outlined in section 3.6, there were three types of instruments, government STI programs, information instruments, and other, which included policy development and engagement, both domestically and internationally. The degree of alignment of goals was rated to be low, because there were few apparent synergies between instruments, at the design stage.

Different instruments targeted different actors, limiting synergistic effects. The duration or timeframe of different instruments were different, resulting in limiting opportunities for synergies. The instruments' design was highly differentiated, resulting in a more diffuse impact.

At the instrument mix level, the amount of interaction between instruments was limited, at all three of the design, implementation and audit/evaluation stages.

At the policy dimension level, there was no planned temporal offset between R&D activities supported by PERD and the rest of the instruments. This means that R&D activities supported by PERD, during the timeframe of the policy mix, were unlikely to interact in a meaningful way with later stage technology demonstration instruments during this timeframe. The impact of R&D funded by PERD is likely to occur during a future timeframe. Note that this is a normal issue with policy mixes that include instruments that operate at different stages of the innovation chain and that this observation applies to all conventional and experimental policy mixes examined. To overcome this issue, the researcher needs to consider PERD activities from a timeframe that precedes the policy mix.

Data collected to answer research questions

The information provided in this sub-section presents the data collected through the semi-structured interviews and document review to directly answer research questions 1A and 2. The data tables presented below are used in the comparative analyses conducted in chapter 6. A high-level summary is shown in Table 18. The rest of this section unpacks these results.

Table 18 - Summary of consensus view for evaluation criteria and conditions for successful implementation – TEAM

	TEAM
Q1A - Measurement of Evaluation Criteria - overall	Med-Low
(i) Consistency of element	Med-Low
(ii) Coherence of processes	Med-Low
(iii) Comprehensiveness of the policy mix	Med-Low
Q2 - Degree of presence of conditions for successful implementation	Med-Low to Med

Question 1A – Assessment of consistency, coherence & comprehensiveness

Detailed data collected to answer the research question #1A, which is concerned about the three evaluation criteria, including consistency of elements, coherence of processes, and comprehensiveness of the policy mix, are found in Table 60, in Appendix D, and are summarized below. In summary, the TEAM policy mix was found to have a medium-low rating, overall, and for each of the above three evaluation criteria.

The policy mix was rated med-low on consistency of elements because (i) different instruments had different impact timeframes and therefore had low temporal consistency; (ii) there were few synergies between instruments because different instruments targeted different actors and activities, where any reinforcement was not apparent; (iii) the instruments goals were common only at a high level but not at the instrument level, and (iv) the degree of reinforcement between instruments was seen as being relatively low.

The policy mix was rated med-low on coherence of processes because: (i) although a Secretariat was established early on to attempt to coordinate reinforcing activities, the Secretariat was dissolved after phase 1, and afterwards different organization implementing instruments acted completely independently of one another; (ii) there was low engagement between groups administering different instruments in the policy mix; and (iii) the perceived effectiveness was based on individual instruments strengths as opposed to being the result of policy mix synergies.

The policy mix was rated med-low on comprehensiveness because, although there was good coverage of the TRL scale, there was no coverage of the later stages of the innovation chain, and many barriers related to deployment and commercialization were left unaddressed by the policy mix.

Question 2 – Degree of presence of conditions for successful implementation

Detailed data developed to answer the research question #2, which is concerned about the 11 conditions suggested by the literature for successful implementation of Whole-of-government policy approaches, are found in Table 61, in Appendix D, and summarized below. The data to complete this table was derived from the documentary evidence. In summary, the degree to which these conditions were perceived to be in place was rated as med-low to medium, with the rationale for the ratings provided in the comments column.

Highlights supporting the overall and individual ratings are:

- (i) Common goals and understanding of the problem were at a high level only, relating to reducing GHG emissions at the national level; the joint approach to solving the problem was also at a high level only.
- (ii) There was no shared measurement of results for activities at the policy mix level, again except for the high-level reduction of GHG emission. The TEAM RD&D program developed a method for calculating the GHG emission reductions on a project basis, which is / was widely applicable and was the basis for an ISO standard. However, this was developed later on in the policy mix timeframe.
- (iii) While the activities of the different instruments in the policy mix were designed to be mutually reinforcing, at a high level, there was not active coordination to ensure that these would actually be reinforcing, at the implementation stage.

- (iv) Communications, amongst the organization delivering the different instruments in the policy mix, were limited to sharing information on individual reporting as opposed to shared implementation.
- (v) Champions advocated for their own instruments and not necessarily for the policy mix as a whole. In fact, there was occasional rivalry between organizations to obtain additional resources, kept in reserve.
- (vi) Central agencies were primarily involved at the policy formulation and program review stages, but not at the implementation stage to help overcome barriers.
- (vii) There was no explicit common accountability framework for the policy mix, particularly for phase 2 & 3, although there was some shared accountability during phase 1, reporting to the Secretariat.
- (viii) Central agencies provided some details on the expected mandate and outcomes for the individual instruments, but less so for the policy mix as a whole.

Concluding Observations

The TEAM policy mix exhibits the features and characteristics that are typical of a conventional policy mix approach. The assessment of the three evaluation criteria for question 1 resulted in a medium-low rating, overall and for each of the three assessment criterion. This was in alignment with expectations for a conventional policy mix, which is loosely bundled, incomplete and not technology specific. The degree of presence of conditions for successful implementation of a Whole-of-government policy mix approach was rated med-low to medium, which was also as expected for a conventional policy mix that is designed, delivered and evaluated using a loosely bundled approach. The above ratings confirm some of the relative disadvantages of a conventional policy mix

approach. The data presented in this section is used in the comparative analyses presented in chapter 6.

4.5 Case Study #2 – Clean Energy Fund (CEF) (2007-15)

This case study focuses on the policy mix that includes the Clean Energy Fund (CEF) government STI program as its cornerstone policy instrument. The policy mix timeframe is 2007-15, or 8 years. The key features of this policy mix are described as follows.

Formally, the CEF was designed as a single, stand-alone instrument, as defined by its own Memorandum to Cabinet (MC). The CEF was administered by one organization, NRCan's Office of Energy R&D, which also administered or monitored other policy instruments, which are considered loosely bundled with the CEF. Thus, the informal, augmented policy mix includes three other policy instruments, described further below, which were mentioned as complementary instruments in the MC and Treasury Board Submission. The policy mix objectives were to advance the development of new technologies to reduce GHG emissions. Taken together, the policy mix had two sub-components, applied R&D and demonstration, and thus partially covered the innovation chain. The CEF policy mix was not technology specific, because its mandate covered a number of different technologies. However, it did have a significant focus on carbon capture and storage (CCS) as well as renewable heat and electricity generation technologies. Because of this, the CEF is a typical, conventional policy mix.

This section includes background information derived from interviews, definitions of the formal and augmented policy mixes, as well as characteristics and interview data that are used for the comparative analyses between case studies in chapter 6. Additional details on this case study are provided in Appendix E.

Background on the CEF policy mix

As mentioned above, the Clean Energy Fund (CEF) was originally designed, per the federal Budget 2009, as a time-limited, stand-alone, \$1B government STI program. The CEF was part of the government's broader suite of measures to address climate change and other environmental issues, under a policy framework referred to as the Clean Air Agenda (CAA). Under the CAA, the government's stated climate change goal was to reduce GHG emissions by 17% from 2005 levels by 2020,¹⁶ which is Canada's commitment in the Copenhagen Accord (Dec. 2009). The CEF policy mix was designed to contribute new technologies in support of this objective.

The CEF was originally designed with funding allocations of \$150M for R&D in at least 8 technology areas, \$200M for small scale demonstration of clean and renewable energy technologies, and \$650M for demonstration of large-scale CCS projects in real world settings.¹⁷ In Budget 2010, the government cut the CEF funding by \$205M, transferring the funds to another initiative.¹⁸ Given the focus on reducing the federal government deficit, in subsequent years, the CEF's funding was further reduced. In the end, the total actual RD&D program spending was approximately \$306M, with \$27.8M of actual expenditures on the R&D component, \$111M spent on the small-scale demonstration component and \$147M spent on the large-scale CCS demonstration component.¹⁹

The results achieved to date by the policy mix have been quite impressive,

¹⁶ Source: OERD CEF files: NRCAN CEF web site, archived page for 25 Feb. 2011.

¹⁷ Source: OERD CEF files: NRCAN CEF web site, archived page for 23 April 2009.

¹⁸ Canada Budget 2010. <https://www.budget.gc.ca/2010/home-accueil-eng.html> accessed 23 May 2020.

¹⁹ Source: for R&D: Evaluation of the CEF; for demo: Auditor General of Canada http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201710_03_e_42491.html accessed 23 May 2020.

especially for the CCS component of the mix: 3 large-scale CCS demonstration projects have been implemented and are operational in Canada, resulting in the annual capture and sequestration of up to 3.8 million tons of CO₂ per year, which is close to the original target of 3-5 projects reducing up to 5 million tons per year. The projects achieved significant leverage of \$3.67B on a federal investment of \$595M.

Additional background information on this policy mix is provided in Appendix E, including a listing of the documentary evidence used to describe and characterize the policy mix, , as well as mapping of the policy mix along the innovation chain, as well as against the Technology Readiness Level and Commercialization Readiness Index scales.

Defining the formal and augmented policy mixes

The formal policy mix, outlined in its Memorandum to Cabinet (MC) and Treasury Board Submission, consists of a single, stand-alone government STI program, which had 3 components: (i) R&D, (ii) small-scale renewable energy demonstration, and (iii) large-scale CCUS demonstration.

The informal augmented policy mix is defined as the CEF, along with three other government STI programs, namely: (i) the Program of Energy R&D, which as mentioned in the TEAM case study, is NRCan's long-standing and permanent R&D program in place since the early 1970s, (ii) the ecoENERGY Technology Initiative, and (iii) the \$250M CCS RD&D program announced in Budget 2008, as shown in Table 19 below. In total, the timeframe for the policy mix was 8 fiscal years from 2007-08 to 2014-15.

Table 19 – CEF case study – formal and augmented policy mixes

Key Programs and other instruments in Policy Mix Examined	No. of Instruments in policy mix	Delivered by Organization	Approx. Actual Spending \$M
Clean Energy Fund (2009-15)	1	NRCan/OERD	305.6
Sub-Total - Formal Case Study	1		305.6
<i>Other Instruments in policy mix</i>			
ecoENERGY Technology Initiative (2007-13)	1	NRCan/OERD	179.4
Budget 2008 (2008-09)	1	Dept of Finance & OERD	250.0
Program of Energy R&D (2009-15)	1	NRCan/OERD	276.3
TOTAL - Augmented Case	4		1,011.3

The rationale for including the above three instruments in the informal augmented policy mix is as follows: (i) the ecoENERGY Technology Initiative (ecoETI) and PERD were both mentioned as complementary RD&D programs to the CEF program, in the CEF Treasury Board Submission; (ii) NRCan's Office of Energy R&D (OERD) administered the CEF, ecoETI and PERD, as well as \$10M of the \$250M budgeted in the Budget 2008 RD&D program; (iii) NRCan's OERD also officially monitored the technical reporting of the SaskPower Boundary Dam 3 large-scale CCS demonstration project, which received the remaining \$240M in funding through Budget 2008, through the federal the Department of Finance. The SaskPower CCS demonstration project was closely related, and complementary, to the two CCS demonstration projects funded by the CEF.

Although not included in the above informal augmented policy mix, as the case study analysis in this thesis is limited to federal instruments only, it should be stated that the above instruments were administered closely with policy instruments administered by the Government of Alberta, namely the \$2B Alberta CCS Fund, as well as regulations that were developed by the province of Alberta, to facilitate the delivery of large-scale CCS demonstration projects in the province, which were co-funded by the CEF and Alberta CCS Fund.

Policy Mix - Coverage of the Innovation Chain

Per data found in Appendix E, the CEF policy mix was found to have good coverage of the basic R&D, applied R&D, and demonstration stages of the innovation, and of the 7 levels of the Technology Readiness Level scale. However, it was found to have little to no coverage of the deployment and commercialization stages of the innovation chain. In terms of coverage of the Commercialization Readiness Index, the policy mix covers only the first 3 levels, out of 6, further confirming partial coverage of the later stages of the innovation chain.

Characteristics of Policy Mix in Case Study

The CEF policy mix is described using the 21 characteristics suggested by the Rogge & Reichardt analytical framework, outlined in chapter 3. The data to complete Table 68, which can be found in Appendix E, was derived from the documentary evidence. This table is used as a starting point for comparative analyses, and includes information on the policy elements, instruments, instrument mix, policy process, and policy domain.

Some highlights of the features and characteristics of this policy mix that were not previously mentioned include the following.

At the policy element level, which looks at the degree of existence of objectives and plans at the policy mix level, the rating for both measures was determined to be Medium. This is relatively higher (than the TEAM case for example), because, although for non-CCS technologies, there are only weak joint objectives and plans, for CCS technologies, there is a fairly strong strategy linking the instruments.

At the policy instrument level, using the policy instrument typology outlined in section 3.6, there was only one type of instrument used in the policy mix, namely

government STI programs. The degree of alignment of goals for the different instruments was medium, which is a combination of low for non-CCS technologies and high for CCS technologies. In terms of design features, the CCS components of the different instruments targeted very similar actors, while the non-CCS components targeted a large variety of actors; the overall differentiation was medium being a combination of wide focus for non-CCS technologies and a narrow focus for CCS technologies.

At the instrument mix level, the interactions between instruments was considered med-high as there was interaction between PERD, CEF and ecoETI on non-CCS R&D and interaction between all research, development and demonstration activities on CCS technologies.

At the policy dimension level, as was the case with the TEAM case study, there is a temporal offset between R&D activities supported by PERD and the rest of the instruments. This means that R&D activities supported by PERD during the timeframe of the policy mix are unlikely to interact in a meaningful way with other instruments during this timeframe.

Data collected to answer research questions

The information provided in this sub-section presents the data collected through the semi-structured interviews and document review to directly answer research questions 1A and 2. The data tables presented below are used in the comparative analyses conducted in chapter 6. A high-level summary is shown in Table 20 below. The rest of this section unpacks these results.

Table 20 - Summary of consensus view for evaluation criteria and conditions for successful implementation – CEF

	CEF
Q1A - Measurement of Evaluation Criteria - overall	Med
(i) Consistency of element	Med
(ii) Coherence of processes	Med
(iii) Comprehensiveness of the policy mix	Med
Q2 - Degree of presence of conditions for successful implementation	Med

Question 1A – Assessment of consistency, coherence & comprehensiveness

Detailed data collected to answer the research question #1A, which is concerned about the three evaluation criteria, including consistency of elements, coherence of processes, and comprehensiveness of the policy mix, are found in Table 69 in Appendix E, and summarized below. In summary, the CEF policy mix was found to have a medium rating, overall, and for each of the above three evaluation criteria.

The policy mix was rated medium on consistency of elements because, while the consistency of elements, absence of conflicts, degree of synergies and reinforcement was lower for non-CCS technologies, it was relatively high for CCS technologies. So, a rating of medium was deemed appropriate, for the policy mix as a whole. This observation and medium rating also applied to temporal consistency as well as goals.

The policy mix was rated medium on coherence of processes for the same reasons as above. For non-CCS technologies, there was relatively low engagement between different instruments in the policy mix, but for CCS technologies, engagement was relatively high. In addition, for non-CCS technologies, the perceived effectiveness was based on individual instruments strengths as opposed to being the result of policy mix synergies, but for CCS technologies, the perceived effectiveness was based on both the individual instruments and some interactions between the instruments.

The policy mix was rated medium on comprehensiveness. This is because, for

non-CCS technologies, there was low coverage of the later stages of the innovation chain and many barriers, related to deployment and commercialization, were left unaddressed by the policy mix. However, for CCS technologies, the policy mix was perceived as having much better coverage of the innovation chain and of barriers.

Some of the reasons for this perception of better coverage are the very large, ‘industrial’ scale of the CCS demonstration projects funded by the CEF, as well as the very large investment of private sector and government funds actually allocated to funding projects (more than \$1B per project). These factors resulted in projects that were implemented in real-world, commercial settings, and which were designed to be operated over many decades (20-50 years). This is very different than for other, more typical technology demonstration projects, which are comparatively much smaller and whose trial period might be short (e.g., piloting a new type of energy-efficient technology in a test home for 6 months). This means that the CEF large-scale demonstration component had some features that closely resembled those of deployment and commercialization subsidy/incentive instruments. Additional information on this matter is available in Appendix E.

Question 2 – Degree of presence of conditions for successful implementation

Detailed data developed to answer research question #2, which is concerned about the 11 conditions suggested by the literature for successful implementation of Whole-of-government policy approaches, are found in Table 70 in Appendix E, and summarized below. The data to complete this table was derived from the documentary evidence. In summary, the degree to which these conditions were perceived to be in place was rated as medium.

Highlights supporting the overall and individual rating are as follows.

Overall, while conditions for successful implementation of Whole-of-government approaches were low for the non-CCS components of the policy mix, they were relatively higher, across the board, for the CCS components of the policy mix. A medium rating was selected to reflect this mixed view, which was observed for many of the 11 conditions. An important factor justifying the medium rating is the absence of formal and explicit goals and reinforcing actions, at the policy mix level.

In practice, there was evidence of shared measurement, mutually reinforcing activities, and a good degree of communications for the CCS technologies supported by the policy mix, but much less so for the other technologies targeted. NRCan's Office of Energy R&D (OERD) acted as a de-facto backbone organization, catalyst and champion, providing support to guide the policy mix's vision and strategy, particularly in the case of CCS technologies, where a small, dedicated team administered most aspects of the policy mix. However, for other technologies supported, OERD was not as effective, possibly because of the need to support a large number of different, unrelated technologies, in a much less focused way. Central agencies were primarily involved at the policy formulation stages, but not at the implementation or evaluation stages, to help overcome barriers. During the later stages of the policy mix timeframe, central agencies appeared to be more interested in cutting funding to the policy mix, in order to achieve deficit reduction targets, than in providing help to achieve the goals of the policy mix. Central agencies provided details as to mandate and expected outcome, for CCS technologies, specifying the number of projects to be supported and the specific GHG emission reduction targets to be met. However, central agencies did not provide any equivalent

details as to mandate and expected outcomes for non-CCS technologies. In summary, the above observations support an overall rating of Medium on the presence of 11 conditions for successful implementation of Whole-of-government policy approaches.

Concluding Observations

Overall, the CEF policy mix exhibits the features and characteristics that are typical of a conventional policy mix approach, but with one notable difference. The policy mix exhibits conventional policy mix features prominently for most technologies supported. However, for CCS technologies, the policy mix exhibits features that have some similarities to an experimental policy mix. The assessment of the three evaluation criteria for question 1 resulted in a medium rating, overall and for each of the three assessment criterion. This was in alignment with expectations for a conventional policy mix, which is loosely bundled, incomplete and not technology specific, in general. The degree of presence of conditions for successful implementation of a Whole-of-government policy mix approach was also rated as medium, which was also as expected for a conventional policy mix that is designed, delivered and evaluated using a loosely bundled approach. It is interesting to note that the ratings were higher than for the TEAM policy mix, primarily because of the CCS technology component.

4.6 Case Study #3 – GI Ph. 2 - Emerging Renewable Power Program (2018-23)

This case study focuses on the policy mix that includes the Emerging Renewable Power Program (ERPP) as its cornerstone instrument. The policy mix timeframe is 5-years, from 2018-19 to 2022-23. The key features of this policy mix are as follows. The formal policy mix only includes a single instrument, a \$200M standalone deployment incentive instrument, which focuses on new renewable energy technologies and thus has features

that resemble a late-stage government STI program. The informal, augmented policy mix has been defined to include three other instruments, which are loosely bundled with the ERPP, detailed below.

This case study is an interesting case to examine because, while it was designed as part of the suite of the Green Infrastructure (GI) initiative, from which the three experimental case studies were selected, this policy mix is clearly a conventional policy mix and case study. It is therefore interesting to compare it with the three experimental case studies described in chapter 5.

This policy mix is conventional because, as formally defined: (i) it includes only a single instrument that is not tightly bundled with other policy instruments; (ii) it only partially covers the innovation chain (i.e., it is not complete); and (iii) it is not strictly technology-specific, as it focuses on a number of “emerging” renewable electricity generation technologies, some of which are quite different from one another. At best, it could be considered partially technology-specific. Thus, on the whole, the policy mix is conventional.

The ERPP defines “emerging” as technologies that: (i) have been successfully deployed at the utility scale in other countries but not yet in Canada; or (ii) have been successfully demonstrated in Canada but not yet commercially deployed.²⁰ The emerging renewable technologies targeted by the ERPP include: offshore wind, geothermal, instream tidal, concentrated solar photovoltaic technologies, wave, river hydrokinetic,

²⁰ <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/RFP-ApplicantGuide-En-Mar13.pdf> accessed Oct. 10, 2020.

next-generation biomass, or other emerging renewables.²¹

This section includes background information derived from interviews, definitions of the formal and augmented policy mixes, as well as characteristics and interview data that are used for the comparative analyses between case studies in chapter 6. Additional details on this case study are provided in Appendix F.

Background on the ERPP policy mix

As was referenced above, the 5-year, \$200M ERPP is part of a suite of five policy mixes administered by NRCan, under the Budget 2016 and Budget 2017, GI Phase 1 & 2 initiatives, and is closely related to the three experimental case studies to be described in chapter 5. A brief introduction to the GI initiative is provided here, with more detail provided in chapter 5, section 5.3.

This conventional case study is part the Government of Canada's \$180B 12-year Investing In Canada Plan,²² the federal government's primary infrastructure initiative. While much of the Investing In Canada Plan is administered and delivered by Infrastructure Canada, some components of the plan are delivered by other federal departments, including NRCan.²³

Green Infrastructure (GI) is one of five major components of the Investing In Canada Plan, and received \$26.9B in Budget 2016 and Budget 2017.²⁴ The goals of the GI component are to support infrastructure projects that support Canada's ongoing

²¹ Ibid.

²² Infrastructure Canada, Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/about-invest-apropos-eng.html> . Accessed 16 Feb. 2019.

²³ Infrastructure Canada: Funding Delivered under the Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/funding-financement-eng.html> . Accessed 16 Feb. 2019.

²⁴ Infrastructure Canada: Green Infrastructure. <https://www.infrastructure.gc.ca/plan/gi-iv-eng.html> . Accessed 16 Feb. 2019.

transition to a clean growth economy, including initiatives that support the implementation of the Pan-Canadian Framework on Clean Growth and Climate Change.²⁵ NRCan administers 10 GI initiatives, which have a budget of \$967.5M over up to 12 years.²⁶

Of the 10 GI initiatives administered by NRCan above, five were packaged together in two Treasury Board Submissions, GI Phase 1 and 2, per Table 21 below. Note that the Electric Vehicle & Alternative Fuels initiative has two phases and started a little earlier than the others. Of the five initiatives below, four are assessed in this thesis.

Table 21 – 5 Green Infrastructure integrated policy mixes managed by NRCan

	No. of Instruments in Formal Policy Mix	GI Ph.	Federal Budget	Program Timeframe		Funding \$M	Treasury Board Submission Date
				# Years	From/To		
GI Ph. 1 & 2 policy mixes							
GI Ph. 2 - Emerging Renewables Power (ERPP)	1	2	B2017	4	2018-23	200.0	07 Dec. 2017
GI Ph. 2 - Energy Efficient Buildings	8	2	B2017	8	2018-26	182.0	07 Dec. 2017
GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC)	5	2	B2017	6	2018-14	217.8	07 Dec. 2017
GI Ph. 2 - Smart Grids	2	2	B2017	4	2018-22	100.0	07 Dec. 2017
GI Ph. 1 & Ph. 2 - Electric Vehicle & Alt Fuels (EVAF)	3	1	B2016	2	2016-18	62.5	14 Dec. 2016
		2	B2017	4	2018-22	120.0	07 Dec. 2017
				6	2016-22	182.5	
Total Funding						882.3	

As discussed above, the ERPP was designed differently, i.e. as a conventional mix, if compared to the other four, experimental policy mixes in the suite. The reader may wonder why the ERPP was designed differently than the others. The response provided by interviewees, and inferred by the researcher, is that the funding provided to the ERPP was relatively small, at \$200M, relative to the size of funding support expected to be provided to projects (up to \$50M per project). Therefore, because the number of

²⁵ Infrastructure Canada: Green Infrastructure. <https://www.infrastructure.gc.ca/plan/gi-iv-eng.html>. Accessed 16 Feb. 2019.

²⁶ Infrastructure Canada: Funding Delivered under the Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/funding-finance-eng.html>. Accessed 16 Feb. 2019.

projects supported was expected to be small, it was decided to keep the number of delivery instruments to a minimal number, i.e. one, recognizing that this one ‘instrument’ might actually have to provide the functions of multiple instruments.

As of June 2021, the ERPP had announced \$165.1M in funding towards 6 projects: 3 geothermal, 2 instream tidal and 1 bi-facial solar photovoltaic projects.²⁷ On the ERPP’s website, there is a special note that specifically states that: “Demonstration projects are not eligible under this program.”²⁸ This statement confirms that the ERPP does not include any formal linkages to government STI programs and is focused exclusively on deployment. A knowledgeable observer might argue that the types of technologies and projects actually supported are, in fact, similar to demonstration projects. Nevertheless, the formal design is as a single, standalone deployment instrument.

Additional background information on this policy mix is provided in Appendix F, including a listing of the documentary evidence used to describe and characterize the policy mix, , as well as mapping of the policy mix along the innovation chain, as well as against the Technology Readiness Level and Commercialization Readiness Index scales.

Defining the formal and augmented policy mixes

The formal policy mix associated with this case study, as defined within the design documents including the GI Phase 2 Treasury Board Submission, consists of a single instrument, the ERPP.

The augmented policy mix is defined as the ERPP, along with three other

²⁷ Ibid.

²⁸ Ibid.

instruments, namely: (i) the Program of Energy R&D, which is NRCan’s long-standing and permanent R&D program in place since the early 1970s, (ii) the Energy Innovation Program, and (iii) the \$5M Offshore Renewables Program, as shown in Table 22 below.

Table 22 – ERPP case study – formal and augmented policy mixes

Key Programs and other instruments in Policy Mix Examined	No. of Instruments in policy mix	Delivered by Organization	Approx. Budget \$M
Emerging Renewables Power Program (2018-23)	1	NRCan / LCES / REED	200.0
Sub-Total - Formal Case Study			200.0
<i>Other Instruments in policy mix</i>			
Offshore Renewables Program (2018-23)	1	NRCan / LCES / REED	5.0
Energy Innovation Program (~2018-23)	1	NRCan / ETS / OERD	262.5
Program of Energy R&D (~2018-23)	1	NRCan / ETS / OERD	187.8
TOTAL - Augmented Case	4		655.3

Note that in the augmented policy mix, two instruments are administered by NRCan’s Renewable Energy & Electricity Division (REED) and two by NRCan’s Office of Energy R&D (OERD). The Offshore Renewables Program (ORP), administered by REED, has a 5-year timeframe, which is similar to the ERPP, namely 2018-23. The ORP administers the Offshore Renewable Energy Regulations (ORER) Initiative, whose goal is to “develop modern safety and environmental protection regulations that will apply to exploration, construction, operation and decommissioning activities related to renewable energy projects and power lines in Canada’s offshore areas.”²⁹ The focus on the ORER is on offshore wind and power lines. The regulations are expected to be published in the fall 2023.³⁰ The two RD&D programs administered by OERD, PERD and the Energy

²⁹ https://www.rncanengagenrcan.ca/en/collections/offshore-renewable-energy-regulations-initiative?utm_medium=email&utm_source=email&utm_campaign=gwcc_2020&utm_content=regulations_group4_en accessed October 12, 2020.

³⁰ Ibid.

Innovation Program³¹ (EIP), are permanent RD&D programs. It should be noted that the EIP was made a permanent RD&D program, in Budget 2017 (2017-18), as a program to supplement PERD. Together PERD and EIP are now co-managed as NRCan's foundational clean energy RD&D programs. I have selected the same 2018-23, 5-year timeframe, for these instruments, to match the timeframe of the ERPP, however it is understood that funding for these two RD&D programs is over a much longer timeframe than this.

The rationale for including the above three instruments in the augmented policy mix is as follows: (i) the Offshore Renewables Program (ORP) is complementary to the ERPP that seeks to develop a regulatory framework for offshore wind projects in Canada. The ORP is administered by REED, so there is close communication between REED staff administering the two instruments; (ii) the two permanent RD&D programs, PERD & EIP, provide funding for NRCan's long-term RD&D program. The EIP, or its predecessors, provided funding to several projects that are directly related to some of the projects supported by the ERPP, for example the DEEP geothermal project and the Fundy Ocean Research Centre for Energy project, which provides infrastructure for tidal projects in the Minas Passage of the Bay of Fundy. It can therefore be stated that the PERD, EIP and ERPP work synergistically to move projects along the innovation chain, for emerging renewable technologies. It should be noted that both PERD and EIP are diversified RD&D funds that fund a large number of different technologies, i.e. they are not technology-specific.

³¹ <https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/18876>

Policy Mix - Coverage of the Innovation Chain

Per data found in Appendix F, the ERPP policy mix was found to have good coverage of the basic R&D, applied R&D, demonstration and deployment stages of the innovation, and of the 7 levels of the Technology Readiness Level scale, but no coverage of the commercialization stage of the innovation chain. In terms of coverage of the Commercialization Readiness Index, the policy mix covers only the first 3 levels, out of 6, further confirming partial coverage of the last stage of the innovation chain.

Characteristics of Policy Mix in Case Studies

The ERPP policy mix is described using the 21 characteristics suggested by the Rogge & Reichardt analytical framework, per Table 7 in chapter 3. The data to complete Table 78, which can be found in Appendix F, was derived from the documentary evidence. This table is used as a starting point for comparative analyses, and includes information on the policy elements, instruments, instrument mix, policy process, and policy domain.

Some highlights of the features and characteristics of this policy mix that were not previously mentioned include the following.

At the policy element level, which looks at the degree of existence of objectives and plans at the policy mix level, the rating for both measures was determined to be medium. This is because there are no formal or explicit objectives or plans, at the policy mix level, even if informally, there were high level objectives and loose plans to support the development of emerging renewable energy technologies.

At the policy instrument level, using the instrument typically outlined in section 3.6, there are three types of instruments in the informal, augmented policy mix: government STI programs, subsidies and incentives (deployment), and regulatory

activities. The goals at the instrument level were quite well aligned, even if only informally, scoring a med-high rating. There were instruments at the technology push and pull levels, and one addressing systemic concerns (i.e. regulations), so this measure was rated as med-high.

At the instrument mix level, different instruments targeted fairly similar actors which is favorable; the duration of the instruments was very similar, maximizing opportunities synergies; but the degree of interaction was rated as med-low, as interactions between instruments was not planned, at the design stage, and occurred on an informal basis only.

Data collected to answer research questions

The information provided in this sub-section presents the data collected through the semi-structured interviews and document review to directly answer research questions 1A and 2. The data tables presented below are used in the comparative analyses conducted in chapter 6. A high-level summary is shown in Table 23 below. The rest of this section unpacks these results.

Table 23 - Summary of consensus view for evaluation criteria and conditions for successful implementation – ERPP

	ERPP
Q1A - Measurement of Evaluation Criteria - overall	Med-Low to Med
(i) Consistency of element	Med
(ii) Coherence of processes	Med-Low
(iii) Comprehensiveness of the policy mix	Med
Q2 - Degree of presence of conditions for successful implementation	Med

Question 1A – Assessment of consistency, coherence & comprehensiveness

Detailed data collected to answer the research question #1A, which is concerned about the three evaluation criteria, including consistency of elements, coherence of processes, and comprehensiveness of the policy mix, are found in Table 79 in Appendix F, and

summarized below. In summary, the ERPP policy mix was found to have a med-low to medium rating, overall, and a mix between med-low and medium for each of the above three evaluation criteria.

The policy mix was rated medium on consistency of elements because (i) different instruments had similar timeframes and therefore had high temporal consistency; (ii) the design of the ERPP as a deployment “only” instrument resulted in some, informal conflicting or contradictory factors, as some observers might consider the ERPP to be a demonstration instrument while others might consider it as a deployment instrument. Nevertheless, the impacts of these contradictory factors are relatively low. (iii) There were some synergies between the ERPP, ORP and the renewable energy component of the EIP; (iv) the degree of alignment of individual instruments objectives and reinforcement between instruments was informal only and therefore rated as med-low; (v) overall the degree of reinforcement of the strategy and instrument mix was also informal and thus rated as med-low.

The policy mix was rated med-low on coherence of processes because: (i) there was no formal coordination between different instruments, and there was only a bit of informal coordination; (ii) there was low engagement between groups administering different instruments in the policy mix; and (iii) the perceived effectiveness of the ERPP or policy mix was based on individual instruments strengths as opposed to being the result of policy mix synergies.

The policy mix was rated medium on comprehensiveness because, although there was good coverage of the TRL scale, and some coverage of the CRI scale, barriers related to the adoption of key emerging renewable technologies targeted by the ERPP,

such as offshore wind, were only partially addressed. As evidence, as of June 2021, no offshore wind projects had been selected for support by the ERPP and no offshore wind projects were under construction or operational in Canada.

Question 2 – Degree of presence of conditions for successful implementation

Detailed data developed to answer the research question #2, which is concerned about the 11 conditions suggested by the literature for successful implementation of Whole-of-government policy approaches, are found in Table 80 in Appendix F, and summarized below. The data to complete this table was derived from the documentary evidence. In summary, the degree to which these conditions were perceived to be in place, for the policy mix, are considered to be medium, with the rationale for the ratings provided in the comments column.

Highlights supporting the overall and individual ratings are as follows.

- (i) There were common goals at a high level, to support emerging renewable energy technologies. However, as there was only one policy instrument in the formal policy mix, there were no formal common goals at the policy mix level.
- (ii) There was no shared measurement of results at the policy mix level, however individual instruments focused on measuring similar results, related to electricity generating technologies.
- (iii) There were some, mutually reinforcing activities between the ERPP and the Offshore Renewable Program (ORP), as these were delivered by the same organization, i.e. REED. There was more limited communications between the ERPP and EIP in cases where there were common projects only.
- (iv) There was no backbone support organization.

- (v) Champions primarily advocated for their own instruments, except in the case of ERPP and ORP, which had objectives in common.
- (vi) Central agencies were primarily involved at the policy formulation stage, and not at the implementation stage to help overcome barriers.
- (vii) There was no common accountability framework set up for the policy mix as a whole.
- (viii) Mandates and expected outcomes from central agencies were a little more detailed, but at the individual instrument level, not at the policy mix level.

Concluding Observations

The ERPP case study exhibits the features and characteristics of a conventional policy mix. The assessment of the three evaluation criteria for question 1 resulted in a med-low to medium rating, overall and for each of the three assessment criteria. This is in alignment with expectations for a conventional policy mix, which is loosely bundled, incomplete and only partially technology-specific. The lowest rating (med-low) was on coherence of processes, reflecting the fact that all instruments were administered in a loosely bundled fashion. Synergies and complementarities that could have been improved, had the policy mix been administered using the experimental approach.

The degree of presence of conditions for successful implementation of a Whole-of-government policy mix approach was rated as medium, which was also as expected for a conventional policy mix that is designed, delivered and evaluated using a loosely bundled approach. The above ratings highlight some of the relative disadvantages of a conventional policy mix approach.

4.7 Conclusion

This chapter presented information and data on the three conventional case studies examined in this thesis, with policy mixes that are loosely bundled, incomplete, and not technology-specific. The three conventional cases have many similarities, but also some differences, which reflect the range of design and implementation options available to policymakers.

The TEAM case study provides an example of a typical conventional policy mix, with relatively low ratings (med-low) on evaluation criteria and medium degree of presence of conditions for successful implementation of Whole-of-government approaches, as show in Table 24 below.

Table 24 - Summary of consensus view for evaluation criteria and conditions for successful implementation – 3 conventional case studies

	TEAM	CEF	ERPP	Group
Q1A - Measurement of Evaluation Criteria - overall				
(i) Consistency of element	Med-Low	Med	Med	Med
(ii) Coherence of processes	Med-Low	Med	Med-Low	Med-Low
(iii) Comprehensiveness of the policy mix	Med-Low	Med	Med	Med
Q2 - Degree of presence of conditions for successful implementation	Med	Med	Med	Med

The CEF case study is an example of a conventional policy mix with better assessment ratings on the criteria evaluated and based on improvements seen in one of its components, which had a significant focus on a specific technology, namely Carbon Capture & Storage (CCS) technology. Finally, the ERPP case study had rating results that were in between the other two cases, reflecting the fact that although it had a narrower technology focus on emerging technologies, the degree of bundling of the instruments in the policy mix was not as strong as in the CEF case study.

At the group level, the group average ratings are in the med-low to medium range for the three evaluation criteria (consistency, coherence, comprehensiveness).

For consistency of elements, the rating was medium to reflect the fact that common objectives/strategy and integrated plans were not observed to be significantly aligned, and there were only a medium level of synergies between the instruments.

The rating was lowest (med-low) for coherence of processes because, for all conventional cases, the instruments in the policy mix were designed, delivered and evaluated independently of one another, in a loosely bundled policy mix.

For comprehensiveness of the policy mix, policy mixes in the experimental group of cases were observed to have greater coverage of barriers, as well as of the steps in the innovation process, resulting in a higher rating, than the conventional group of case studies.

The data presented in this chapter provides a strong basis for comparative analyses to be conducted in chapter 6.

Chapter 5: Case Studies – Experimental Policy Mixes

5.1 Outline

- Introduction
- Background on Experimental Case Studies
- Case Study #6 - GI Ph. 1 & 2 – Electric Vehicles & Alternative Fuels (EVAF)
- Case Study #5 - GI Ph. 2 - Smart Grids
- Case Study #4 - GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC)
- Conclusion

5.2 Introduction

This chapter presents information and data on the three experimental case studies examined in this thesis, mirroring chapter 4, which covered the conventional case studies.

The chapter is organized in the same way as in chapter 4: a background section introduces the three case studies, briefly reviews reasons provided in chapter 3 as to why they were selected, and describes them at a high level. Next, each of the three case studies is described and assessed. Finally, the conclusion points to the analysis and comparative work to be completed in chapter 6, with the data from chapters 4 and 5.

The background section is a little more detailed than in chapter 4, to present information that is common to the three case studies, as these experimental cases were designed together, are being implemented at approximately the same time, and have many features in common. Note that the third conventional case study described in chapter 4, the ERPP policy mix, is related to these three experimental case studies. The background section in this chapter therefore builds on some of the points already made in chapter 4, section 4.6.

Each of the three sections on the individual case studies is organized in the same way as in chapter 4. First, the case studies are defined, described, and characterized using features suggested by the analytical framework. This includes: (i) presentation of

background information, (ii) definition of formal/augmented policy mix, and (iii) characterization of the policy mix. Second, the data collected through the document review and semi-structured interviews is presented, which are used to answer the research questions 1 and 2, in chapter 6. Data for research question 1b, on the perceived incremental cost of the experimental approach, and for research question 4, on barriers to the future implementation of the experimental approach, which did not apply for conventional case studies, are also included.

Additional information, including: additional background; documentary sources; policy mix attributes; mapping along the innovation chain; and detailed data tables are included in Appendices G, H and I, for each of the three case studies. . In terms of order of presentation, I start with the Electric Vehicle & Alternative Fuels case study first, as it was initiated two fiscal years prior, and served as a model, to the other two experimental case studies.

5.3 Background to Experimental Case Studies

The three case studies of policy mixes, selected as part of the experimental group of case studies, are shown in Table 25 below. Each case study is named based on the name of the policy mix used in the design documents, i.e. the Treasury Board Submissions. The shorthand names of the three case studies are: EVAF, Smart Grids, and CERRC.

Table 25 – 3 Experimental Case Studies – background information

Case Studies - Experimental	No. of Instruments in Formal Policy Mix	G.I. Phase	Federal Budget	Program Timeframe		Budget Funding \$M	Treasury Board Submission Date
				# Years	From/To		
GI Ph. 1 & Ph. 2 - Electric Vehicle & Alt Fuel (EVAF)	3	1	B2016	2	2016-18	62.5	14 Dec. 2016
		2	B2017	4	2018-22	120.0	07 Dec. 2017
		1 & 2		6	2016-22	182.5	
GI Ph. 2 - Smart Grids	2	2	B2017	4	2018-22	100.0	07 Dec. 2017
GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC)	5	2	B2017	6	2018-14	217.8	07 Dec. 2017
Total Funding						500.3	

The above case studies were selected based on a number of factors outlined in section 3.4, which include that: (1) to the best of the researcher's knowledge, there are/were only four cases of experimental policy mixes implemented by NRCan, at the federal level in Canada, during the timeframe of the research (1998 to 2020) including the three selected; (2) the policy mixes were/are designed to enable technology development to mitigate climate change; (3) they exhibit the attributes of experimental policy mixes (tightly bundled, complete and technology-specific); (4) there is significant, easily accessible documentation on each case study; (5) key personnel that designed, administered, and evaluated the policy mixes were/are available to be interviewed; and (6) they exhibit some differences, demonstrating the range of possibilities for designing and implementing such experimental policy mixes.

Each of the three case studies includes a government STI program, as the cornerstone instrument in the policy mix. As can be seen in Table 34 above, these policy mixes are fairly large and significant, in terms of dollars budgeted, ranging from \$100-218 M. Each policy mix is currently at the implementation stage, and has a timeframe ranging from 4 to 6 years, which is typical for "fixed term" policy mix at the federal government level, in Canada.

The experimental policy mixes are part of the federal government's climate change plans to meet commitments made in Paris, on 12 Dec 2015, at the UNFCCC³² Conference of Parties 21. Canada ratified the Paris Agreement on October 4, 2016 and reiterated Canada's commitment to reduce GHG emissions by 30% from 2005 levels by 2030, a reduction of 226M Tons, from 749M tons of greenhouse gas (GHG) emissions, to

³² UNFCCC is the United Nations Framework Convention on Climate Change

523M tons, by 2030.³³ Also in 2016, the federal government released the Pan-Canadian Framework on Clean Growth and Climate Change³⁴ (PCF), a federal-provincial strategy to address climate change, with most provinces and territories signing on (Saskatchewan and Manitoba did not originally sign on to the PCF. Manitoba has since joined).³⁵ The three experimental case studies and the ERPP conventional case study fall under the PCF, which can be considered the larger policy framework or policy regime.

Following the release of the PCF, the government announced that it was setting a more ambitious, longer-term, stretch goal of Net Zero GHG emissions by 2050, and introduced Bill C-12, the *Canadian Net-Zero Emissions Accountability Act*,³⁶ in November 2020, to legislate Net-Zero emissions by 2050. On April 22, 2021, the federal government announced that Canada's shorter-term climate change mitigation target would be increased from the Paris target of 30% reduction from 2005 levels by 2030, to a 40-45% reduction from 2005 levels by 2030, a very significant increase.³⁷

As is the case for the conventional case studies, the three experimental case studies also fit within other larger policy frameworks, including the large and long-term federal infrastructure funding plan, referenced below, the Canadian Energy Strategy,³⁸ as well as the Federal Sustainable Development Strategies (FSDS) in force at the time of the

³³ Source: GI Ph. 2 Treasury Board Submission, NRCan.

³⁴ <https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html>

³⁵ <https://www.canada.ca/en/environment-climate-change/services/climate-change/pan-canadian-framework-reports/second-annual-report/section-1.html>

³⁶ <https://www.canada.ca/en/environment-climate-change/news/2020/11/government-of-canada-charts-course-for-clean-growth-by-introducing-bill-to-legislate-net-zero-emissions-by-2050.html> accessed 1 Jan. 2021.

³⁷ <https://globalnews.ca/news/7779596/climate-change-emissions-targets-canada-2030-trudeau/> and <https://www.theglobeandmail.com/politics/article-canada-to-cut-greenhouse-gas-emissions-by-up-to-45-per-cent-by-2030/>

³⁸ <https://www.canadapremiers.ca/canadian-energy-strategy/>

policy mix design. The current Fourth FSDS (2019-22),³⁹ in place as of 2020, includes 13 different high level goals and a very large number (over 100) of instruments, delivered by 41 federal departments and agencies.

As was mentioned in section 4.6 on the ERPP case study, the three experimental case studies and the ERPP are part of the Government of Canada's Green Infrastructure (GI) component of the \$180B 12-year Investing In Canada Plan.⁴⁰ While much of the Investing in Canada Plan is administered and delivered by Infrastructure Canada, some components of the plan are delivered by other federal departments, including NRCan.⁴¹

It is interesting to note that, starting with Budget 2016, NRCan started receiving a significant amount of funding from a new source of funding, i.e. Infrastructure Canada, to enable the development of new technologies to address climate change. According to interviewees, NRCan public servants developed and proposed the new experimental policy approach to Infrastructure Canada, as they believed an integrated, whole-of-government-type of policy approach would be perceived by Infrastructure Canada as being more complete and compelling than the traditional policy approach, and would help secure significant new funding. This turned out to be correct, as in total, Infrastructure Canada approved the proposal and provided NRCan with \$882.3M to deliver the four GI-related policy mixes examined in this thesis (ERPP, EVAF, Smart Grids, and CERRC) as well as the \$182M GI Energy Efficient Buildings policy mix, which is the one case study that was not examined.

³⁹ <http://fsds-sfdd.ca/index.html#/en/goals/>

⁴⁰ Infrastructure Canada, Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/about-invest-apropos-eng.html> . Accessed 16 Feb. 2019.

⁴¹ Infrastructure Canada: Funding Delivered under the Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/funding-financement-eng.html>. Accessed 16 Feb. 2019.

The three experimental case studies are similar to one another in several ways. First, they are all part of the Green Infrastructure initiative, with funding in Budget 2016 and Budget 2017, and administered by NRCan. Second, they incorporate the same experimental “design” concept and were brought forward via two Treasury Board Submissions in 2016 and 2017. Third, they all have close start dates for the start of implementation. Fourth, each policy mix includes a number of policy instruments, including: a government STI program as a cornerstone instrument, as well as other technology pull instruments, such as deployment instruments, which provide incentives for market adoption of new, higher performing technologies, and codes and standards, which provide a basis for the creation of a mass market for the new technologies developed by the government STI programs. In this case, the number of instruments in the formal policy mix ranges from 2 (Smart Grids), to 3 (EVAF), to 5 (CERRC). Finally, for all three case studies, the core technology-specific government STI program is a demonstration instrument, delivered by NRCan’s Office of Energy R&D.

There are several differences between the three experimental case studies. First, the focus of each of the three policy mixes is on a different technology sector, i.e. clean transportation, smart grids, and clean energy for rural and remote communities. Second, the specific goals and objectives of the case studies are different, as they are specific to each technology. For example, the primary goal of the CERRC policy mix is to reduce the dependence on diesel fuel to produce electricity and heat in northern and remote communities, while one of the goals of the EVAF policy mix is to establish a coast-to-coast electric vehicle charging network. Third, the organizations delivering some of the technology pull instruments are different. For example, NRCan’s Office of Energy

Efficiency's Transportation & Alternative Fuels (TAF) division delivers the deployment and codes & standards components of the EVAF policy mix, while the Renewable Energy & Electricity Division (REED) delivers the deployment component of the CERRC and Smart Grid policy mixes. Fourth, each of the three case studies was designed and implemented with differing numbers and types of instruments in the policy mix. Fifth, it is expected that the degree to which the different instruments in the policy mix are tightly bundled may vary between case studies. One of the objectives of this thesis is to identify causes and reasons for this variability. Finally, the policy mixes have varying durations. These differences are further described in the write up on each case study below.

5.4 Case Study #4 - GI Ph. 1 & 2 - Electric Vehicle & Alternative Fuels (EVAF)

This experimental case study focuses on the Electric Vehicle & Alternative Fuels (EVAF) policy mix, which was originally formally designed, as part of Budget 2106, as a 2-year, \$62.5M policy mix, with two policy instruments: (i) a government STI program called the EV Infrastructure Demonstration (EVID), and (ii) a deployment instrument called the EV and Alternative Fuels Infrastructure Deployment Initiative (EVAFIDI). Originally, the policy mix timeframe was two fiscal years (2016-18). The policy mix was subsequently augmented by an additional \$120M, extended for an extra 4 fiscal years from 2018-22, and expanded to include a third policy instrument, a Codes & Standards development component. In summary, the key features of this experimental policy mix are as follows. The EVAF, as formally designed, has 3 instruments, a budget of \$182.5M, and a timeframe of 6 years (2016-22). As an experimental policy mix, it is tightly bundled, complete and technology specific.

This section includes background information derived from interviews, definitions of the formal and augmented policy mixes, as well as characteristics and interview data that are used for the comparative analyses between case studies in chapter 6. Additional details on this case study are provided in Appendix G.

Background on the EVAF Policy Mix

This policy mix was developed to address GHG emissions from the transportation sector, which accounts for approximately a quarter of Canada's total emissions (24% in 2017).⁴² While lower-carbon vehicles and fuels, specifically electric vehicles (EVs), natural gas (NG) and hydrogen (H₂), are commercially available, uptake of these vehicles and fuels is limited due to financial and other barriers, including higher costs, consumer awareness and confidence, and lack of recharging infrastructure. As there is a need to reduce costs and improve the performance, functionality and availability of charging and alternative fuels refueling infrastructure, the federal government developed a policy mix to specifically address technical, costs and other barriers.

Additional background information on this policy mix is provided in Appendix G, including a listing of the documentary evidence used to describe and characterize the policy mix, , as well as mapping of the policy mix along the innovation chain, as well as against the Technology Readiness Level and Commercialization Readiness Index scales.

Defining the formal and augmented policy mixes

The formal policy mix, outlined in design documents including the Treasury Board Submissions, consists of three instruments, as shown in Table 26 below. The three

⁴² <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/electric-vehicle-infrastructure-demonstration-evid-program/20467>

instruments are: a government STI program (EVID), an incentive instrument (EVAFIDI), and a regulations/standards instrument (Codes & Standards).

Table 26 – EVAF case study – formal and augmented policy mixes

Key Programs and other instruments in Policy Mix Examined	Phase	Timeframe	No. of Fiscal Years	No. of Instruments in policy mix	Delivered by Organization	Approx. Budget \$M
GI PH. 1 & 2 - Electric Vehicle & Alternative Fuels (EVAF)						
Government STI program (Demonstration) - EVID	1&2	2016-22	6	1	NRCan/OERD	76.4
Deployment program - EVAFIDI	1&2	2016-22	6	1	NRCan/OEE/TAFD	96.1
Codes & Standards	1&2	2016-22	4	1	NRCan/OEE/TAFD	10.0
Sub-Total - Formal Case Study	1&2	2016-22	4-6	3		182.5
Other Instruments in policy mix						
Zero Emission Vehicle Infrastructure (ZEV) program		2019-24	5	1	NRCan/OEE/TAFD	130.0
Government STI program -ecoENERGY Innovation Initiative		2011-16	6	1	NRCan/OERD	281.0
Government STI program - Program of Energy R&D		2018-22	6	1	NRCan/OERD	225.4
TOTAL - Augmented Case		2016-24	4-8	6		818.9

The \$76M EVID (demonstration) component of the policy mix was designed⁴³ to address technical and non-technical barriers such as costs and improved technical performance, and support the demonstration of EV charging and H₂ refueling technologies for a variety of applications and settings, such as for multi-unit residential buildings or townhouse developments, and for EV owners who do not have garages (with individual owners' charging equipment). Other EV recharging infrastructure applications targeted include freight transportation, vehicle fleets including taxis, public transit (eBuses), autonomous vehicles, bi-directional charging equipment, and solutions to minimize the impact of charging on the electricity grid. The hydrogen refueling applications targets medium and heavy duty vehicles, i.e. trucks, only. The EVID RD&D program is administered by NRCan's Office of ENERGY R&D. As of October 2020, the EVID had announced \$35M in funding to 16 projects.⁴⁴ Some notable projects supported

⁴³ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/electric-vehicle-infrastructure-demonstrations-evid/green-infrastructure-phase-ii-electric-vehicle-infrastructure-demonstration-program-request/22157>

⁴⁴ <https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/current-investments/21146#investmnet>

are: several electric bus demonstration projects in the cities of Newmarket and Brampton, in Ontario, and Vancouver and Burnaby, in BC.; a project to demonstrate fast charging EV charging stations along the Trans-Canada Highway in rural and remote areas addressing recharging in locations where the limited supply of electricity is partially compensated for with the use of electricity storage and local electricity generation using solar panels.⁴⁵

The \$96M EVAFIDI (deployment) component of the policy mix was designed⁴⁶ to support the deployment of a coast-to-coast EV recharging network along Canada's major highways, to improve consumer confidence that there would be sufficient charging infrastructure to support consumer adoption. The EVAFIDI deployment incentive instrument also targeted natural gas and hydrogen refueling infrastructure along specific transportation corridors and regions. The EVAFIDI's goals are the installation of 900 EV recharging stations along the Trans-Canada Highway and other key commercial routes from Vancouver to Halifax, 15 natural gas refueling stations along major freight routes, and 12 H₂ refueling stations in large metropolitan areas. As of March 2020, according to NRCan, the EVAFIDI had selected projects enabling the installation of 837 EV fast chargers, 23 natural gas refueling stations along freight routes, and 8 hydrogen refueling stations for funding.⁴⁷ The EVAFIDI is administered by NRCan's Clean Fuels Branch.

The \$10M Codes and Standards component of the EVAF policy mix has, as objective 'to research, develop, adapt and update codes and standards for electric and

⁴⁵ <http://www.ecamion.com/fast-charging-stations-for-electric-vehicles-coming-to-trans-canada-highway/>

⁴⁶ <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/electric-alternative-fuel-infras/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352>

⁴⁷ <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/electric-alternative-fuel-infras/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352>

alternative fuel vehicles and infrastructure... to address key barriers to the uptake of these vehicles in Canada'. The new codes and standards are planned to be harmonized with those of the US, and published as binational standards, where possible. This component is administered by NRCan's Clean Fuels Branch.

The augmented policy mix is defined as the EVAF, along with three other instruments, namely: (i) the Zero Emission Vehicle Infrastructure (ZEVI), a new \$130M 5-year deployment instrument announced in Budget 2019 to extend and supplement the EVAFIDI program over the 2019-24 timeframe, (ii) the Program of Energy R&D, which is NRCan's long-standing and permanent government STI program in place since the early 1970s, and (iii) the ecoENERGY Innovation Initiative (ecoEII), another government STI program administered over the 2011-16 timeframe.

The ZEVI deployment incentive instrument was designed⁴⁸ to deploy a network of zero-emission vehicle charging and refueling stations in more localized areas where Canadians live, work and play. Note that this is complementary to the EVAFIDI which focused on major highways and transportation corridors. Support is also available for strategic projects for electric vehicle and/or hydrogen infrastructure for corporate fleets, last-mile delivery fleets, and mass transit. This is complementary to the demonstration projects supported by the EVID instrument. Zero Emission Vehicles (ZEVs) are defined as plug-in hybrid electric vehicles, battery electric vehicles, and hydrogen fuel cell vehicles. The ZEVI is administered by NRCan's Clean Fuels Branch.

Note that there is a temporal offset between the ecoEII and the remainder of the

⁴⁸ <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/zero-emission-vehicle-infrastructure-program/21876>

policy mix. The ecoEII is the predecessor RD&D program to the Energy Innovation Program (EIP), which was made a permanent RD&D program in Budget 2017, to supplement PERD. I have selected the same 2016-22, 6-year timeframe, for PERD, to match the timeframe of the EVAP, however it is understood that funding for this RD&D program is over a much longer timeframe than this.

The rationale for including the above three, additional instruments in the augmented policy mix is as follows: (i) the ZEFI was designed as a complementary incentive instrument to the EVAFIDI, to provide coverage of additional segments of the national EV and alternative fuel charging infrastructure; (ii) the two permanent RD&D programs, PERD and ecoEII, provide funding for NRCan's long-term RD&D and (iii) the ecoENERGY Innovation Initiative (ecoEII), provided funding to several projects that are related to the projects selected for funding by the EVAF, for example the AddÉnergie and BC Hydro electric vehicle charging infrastructure projects, which together started to contribute to the national network of electric vehicle charging stations. The ecoEII was specifically mentioned in the EVAF Phase 1 Treasury Board Submission as a complementary, predecessor government STI program. It can therefore be stated that the ZEFI, PERD, EIP and EVAF work synergistically to move projects along the innovation chain, for electric vehicle and alternative transportation fuel technologies. It should be noted that both PERD and EIP are not technology-specific.

Policy Mix - Coverage of the Innovation Chain

Per data found in Appendix G, the EVAF policy mix was found to have good coverage of all 5 stages of the innovation, and of the 7 levels of the Technology Readiness Level scale, In terms of coverage of the Commercialization Readiness Index, the policy mix

was found to cover up to 5 levels, out of 6, further confirming very good coverage of the later stages of the innovation chain. Note that this good coverage is as expected, for an experimental policy mix.

Characteristics of Policy Mix in Case Studies

The EVAF policy mix is described using the 21 characteristics suggested by the Rogge & Reichardt analytical framework, per Table 7 in section 3.7. The data to complete Table 87, which can be found in Appendix G, was derived from the documentary evidence. This table is used as a starting point for comparative analyses, and includes information on the policy elements, instruments, instrument mix, policy process, and policy domain.

Some highlights of the features and characteristics of this policy mix that were not previously mentioned include the following.

At the policy element level, which looks at the degree of existence of objectives and plans at the policy mix level, the ratings are medium-high and medium, respectively. There are high level objectives and plans at the policy mix level. However, for strategy, each of the demonstration, deployment and codes & standards components of the formal policy mix have objectives, which are quite different from one another. That being said, the objectives are complementary and enable technology development and adoption. For plans, each of the demonstration, deployment and codes & standards components of the formal policy mix were implemented separately.

At the policy instrument level, using the instrument typically outlined in section 3.6, there are three types of instruments in the informal, augmented policy mix: government STI programs, incentive instruments, and regulatory/standards instruments. Goals at the instrument level are aligned to a significant degree, formally in the Treasury

Board Submission. Goals are very aligned given that they are technology-specific, targeting different aspects of EV recharging and natural gas and H2 refueling infrastructure.

At the instrument mix level, different instruments targeted very similar actors. Although at the design stage, the interaction between instruments was anticipated as high, at the implementation stage, interaction was limited, relative to other policy mixes in the GI suite. There was good interaction between the EVAFIDI and ZEVI, as well as between the EVAFIDI and codes and standards instrument.

At the policy dimension level, there is a temporal offset between PERD (R&D) and ecoEII (2011-16) and the formal EVAF policy mix. The ZEVI also has 2 year temporal offset with formal EVAF policy mix.

Data collected to answer research questions

The information provided in this sub-section presents the data collected through the semi-structured interviews and document review to directly answer research questions 1 and 2.

The data tables presented below are used in the comparative analyses conducted in chapter 6. A high level summary is shown in Table 27. The rest of this section unpacks these results.

Table 27 - Summary of consensus view for evaluation criteria and conditions for successful implementation – EVAF

	EVAF
Q1A - Measurement of Evaluation Criteria - overall	Med to Med-High
(i) Consistency of element	Med to Med-High
(ii) Coherence of processes	Medium
(iii) Comprehensiveness of the policy mix	Med-High
Q1B - Administration cost compared to conventional approach	Slightly better or same
Q2 - Degree of presence of conditions for successful implementation	Med

Question 1A – Assessment of consistency, coherence & comprehensiveness

Detailed data collected to answer research question #1A, which is concerned about the three evaluation criteria, including consistency of elements, coherence of processes, and comprehensiveness of the policy mix, are found in Table 88 in Appendix G, and are summarized below. In summary, the EVAF policy mix was found to have medium to medium-high ratings, overall, and a mix between medium and med-high for each of the above three evaluation criteria.

The policy mix was rated medium to med-high on consistency of elements because (i) there was a relative absence of conflicting elements (med-high); (ii) the degree of alignment of the policy objectives was good at the policy mix level (med-high); (iii) there was some reinforcement (med-high) between instruments, particularly between the RD&D components, and between the deployment components, but less so between RD&D and deployment components. However, other aspects of consistency, such as existence of synergies and degree of reinforcement between strategy and instrument mix, were rated medium because (iv) implementation of the RD&D and deployment components of the policy mix were conducted in a separate manner by OERD and TAFD, which limited synergies and reinforcement at the policy mix level. In addition, (v) there were temporal inconsistencies, namely lack of offset between demonstration and deployment components, which limited the possibility for reinforcement between these elements, over the timeframe of the policy mix.

The policy mix was rated medium on coherence of processes because: (i) there was good reinforcement of planning and communications at the design stage, but less so at the implementation and evaluation stages, as there was some separate administration at

these stages; (ii) there was some engagement between OERD and the Clean Fuels Branch at the design stage, but less so at implementation and the evaluation stage; and (iii) the reduced engagement at the implementation and evaluation stages resulted in a reduction of impact of coherence on perceived effectiveness of the EVAF policy mix; and (iv) there were/are separate audits and evaluations planned for the demonstration, deployment and codes & standards components of the formal policy mix.

The policy mix was rated medium-high on comprehensiveness of the policy mix because of the number of barriers that were addressed by the augmented policy mix, as reflected in the coverage of the TRL and CRI scales, particularly for EV recharging technologies. Comprehensiveness was not as strong for natural gas and hydrogen refueling infrastructure.

Question 1B – comparative cost of experimental vs conventional approach

For the EVAF policy mix, the comparative administrative costs to deliver this experimental policy approach was considered equivalent or slightly better than the administrative costs to deliver this policy mix using a conventional approach, due to the fact that, for the most part, the EVAF policy mix was implemented and evaluated in the traditional manner, as a conventional policy mix. Cost savings are perceived to have been realized at the design stage, given that the additional costs related to increased coordination and communications required to develop an integrated proposal, were more than offset by savings of implementing a single set of Memoranda to Cabinet, Treasury Board Submissions and other planning documentation and processes, at the design stage.

Question 2 – Degree of presence of conditions for successful implementation

Detailed data developed to answer the research question #2, which is concerned about the

11 conditions suggested by the literature for successful implementation of Whole-of-government policy approaches, are found in Table 89 in Appendix G and summarized below. Data to complete this table was derived from the documentary evidence. In summary, the degree to which these conditions were perceived to be in place, for the policy mix, are considered to be medium, with the rationale for the ratings provided in the comments column.

Highlights supporting the overall and individual ratings are as follows.

- (i) The EVAF policy mix scored med-high on common goals, as the two organizations that delivered the policy mix, OERD and the Clean Fuels Branch, share a vision for change that includes a common understanding of the problem and have developed a joint approach that is complementary.
- (ii) The policy mix scored medium on most other conditions primarily because of the fact that at the implementation and evaluation phase, the policy mix was administered in a more conventional manner. For example, mutually reinforcing activities, as well as communications, were limited between the demonstration and deployment components during the implementation and evaluation stages.
- (iii) As was the case for all experimental policy mixes, there was no dedicated backbone organization for administering the policy mix as a whole.
- (iv) Compared to other experimental policy mixes examined, there was slightly less evidence of champions or catalysts advocating for the policy mix as a whole, as opposed to for their own instruments.
- (v) There was no need for tolerance for incremental costs, per question 1B, because costs were lower or the same as for conventional policy mixes.

- (vi) There were no new tools or new capacities developed in support of the policy mix as a whole.
- (vii) As for other case studies examined, while central agencies were active at the design stage and provided more detail as to expected mandate and outcomes for the policy mix, there was less involvement afterwards.
- (viii) There was only moderate evidence that the accountability framework was adjusted to account for the dual nature (organizational vs horizontal accountabilities) of accountabilities, given that only the design stage was tightly bundled.

Concluding Observations

The EVAF policy mix exhibits the features and characteristics that are typical of an experimental policy mix approach. However, the policy mix also demonstrates slight variations compared to an “ideal case” of an experimental policy mix. Although it was designed as a tightly bundled mix, had very good coverage of the innovation chain, and was technology-specific, it was not delivered as a tightly bundled policy mix at the implementation and evaluation stages. Because of this, the policy mix scored relatively weaker, compared to other experimental case studies, on coherence of processes.

The assessment of the three evaluation criteria for question 1 resulted in a medium to medium-high rating, overall, and for each of the above evaluation criteria. This is in alignment with expectations for an experimental policy mix. The degree of presence of conditions for successful implementation of a whole-of-government policy mix approach was rated as medium, which was as expected for an experimental policy mix, but also slightly lower than for the other experimental case studies. The data presented in this section is used in the comparative analyses presented in chapter 6.

5.5 Case Study #5 - GI Ph. 2 - Smart Grids (2018-22)

This experimental case study focuses on the 4-year \$100M Smart Grids policy mix that includes the Smart Grids demonstration component as its cornerstone instrument. The key features of this policy mix are as follows. It is the smallest (at \$100M) and simplest policy mix of the three experimental case studies, consisting of only 2 policy instruments in the formal mix, namely a demonstration and a deployment component. It is also the policy mix with the shortest timeframe, i.e. 4 years, from 2018-19 to 2021-22. The stated reason for the relatively short timeframe is to “reflect the government’s interest in moving quickly to advance this initiative”, in order to reap the societal benefits, including GHG emission reductions, more quickly (GOC 2017).

This section includes background information derived from interviews, definitions of the formal and augmented policy mixes, as well as characteristics and interview data that are used for the comparative analyses between case studies in chapter 6. Additional details on this case study are provided in Appendix H.

Background on the Smart Grids policy mix

In terms of background, smart grids refer to both a desired state of electricity transmission and distribution networks, and to a class of clean energy technologies, which “modernize the safe and secure delivery of electricity, provide foundations for new market structures and a higher quality of service for customers. They are a key enabler for GHG mitigation, as they increase the hosting capacity of renewable [electricity] generation, leverage more from the electricity infrastructure we have, and increase

resiliency”.⁴⁹ In practice, smart grids are achieved through the installation of different technologies throughout the electricity transmission and distribution network. This can include equipment that is owned by, or located on premises of, electricity distribution companies and/or electricity consumers, whether residential or commercial clients. Examples of smart grid technologies include: (i) demand-response technology that allows electricity companies to control the timing of use of end use appliances such as residential electric hot water tanks, by switching them on or off at specific times, to manage peak electricity demand throughout the day, week, month and/or year; (ii) utility-scale battery-based electricity storage technology along with a distributed energy resource management system (DERMS), located in the electricity distribution network, that enable an electricity company to utilize battery power, at peak electricity demand times, to reduce peak electricity demand, in a specific distribution zone or for a particular electricity customer; (iii) enhanced communications and control equipment that would enable electricity companies to bi-directionally route electricity produced on a distribution network, for example a new small solar farm located in a downtown park, to wherever the electricity was needed in the service area close to the park, and (iv) equipment that enable a distribution area to operate as a micro grid, that can be operated as an isolated “island”, in the case of a power failure or under other conditions when such a state would be desirable. The above examples were taken from actual projects funded by the Smart Grids policy mix, per NRCan’s web site.⁵⁰

In terms of it being part of the federal government’s Green “Infrastructure”

⁴⁹ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793>

⁵⁰ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793>

initiative, it should be noted that the electricity grid or network is considered to be infrastructure of national importance, interconnected between provinces, owned by a mix of provincial, municipal and private utilities, and operated for public benefit and use. Electricity is considered an essential service. The reliability and cost of delivering electricity is considered a key economic factor in economic competitiveness and growth (GOC 2017).

There is a perceived need for the Smart Grids policy mix because electric utilities have specifically highlighted the unique challenges they face in pursuing smart grid technologies, due to regulatory constraints on spending, and the nature of smart grids providing benefits to the entire system or to all users of the electricity system, while utilities can only recoup costs from their own ratepayers. In addition, utilities are reluctant to invest in smart grid technologies because these technologies are perceived as being too risky (Ibid).

The objectives of the Smart Grids policy mix are to accelerate the transition to a clean growth economy, by better utilizing the existing capacity of electricity assets, increasing the penetration of renewable electricity generation, and increasing the reliability, resiliency, and flexibility of the electricity system, while maintaining cyber security.⁵¹ At the design phase, the policy mix was expected to contribute to the further decarbonizing of the Canadian electricity network, which in 2018 was 80% non-emitting, and to contribute to GHG emission reductions in the electricity sector and to job growth, by 2030.

The Smart Grids policy mix is delivered jointly by NRCan's Office of Energy

⁵¹ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793>

R&D (OERD) and Renewable Energy & Electricity Division (REED), through a “one-window” or “no wrong door” process for applicants. “One-window” is a Whole-of-government concept that is meant to streamline the delivery of government services, for users, by using a single point of contact, to be used by applicants and other users of the policy mix. The “no wrong door” approach means that stakeholders can interact with anyone administering the policy mix, or apply to any of the different components, and be directed to the proper staff or policy mix component. An example of a single point of contact would be for the proposal application process – in this case, there would be a single application process for applicants, for both demonstration and deployments components.

The Smart Grids policy mix was clearly developed with the “one-window” and “no wrong door” concept in mind, from inception. The targeted end users in this case are electrical utilities, electrical system operators, and transmission system owners and operators only, as these are the entities that are most likely to adopt and implement smart grid technologies.

In addition to having a single call for proposals, there was a single process for every facet of the administration of the policy mix, from documentation of funding application requirements to communications with the public. According to interviewed staff, this integrated delivery has resulted in significant cost savings, even if it requires a higher degree of coordination and communications.

As of October 2020, the policy mix had announced that it had allocated \$73.1 M to support the implementation of 17 new projects, implemented by a variety of utilities in 8 different Provinces and Territories: 5 demonstration, 7 deployment, and 5 hybrid

projects, which include features of both demonstration and deployment projects. Hybrid projects were not anticipated at the start of the policy mix. The fact that approximately 1/3 of projects supported are hybrid projects is a testament to the integrated nature of policy mix implementation.⁵²

Additional background information on this policy mix is provided in Appendix H, including a listing of the documentary evidence used to describe and characterize the policy mix, , as well as mapping of the policy mix along the innovation chain, as well as against the Technology Readiness Level and Commercialization Readiness Index scales.

Defining the formal and augmented policy mixes

The formal policy mix, outlined in design documents including the Treasury Board Submission, consists of two instruments:

- Demonstration component (\$35M) to fund demonstration projects of innovative and emerging smart grid technologies, delivered by NRCan's OERD; and
- Deployment component (\$65M) to fund deployment projects of technologies that are at the commercial stage, delivered by NRCan's REED.

The augmented policy mix is defined as the two instruments in the formal Smart Grids policy mix, along with three other government STI programs, namely: (i) the Impact Canada Initiative (ICI) Power Forward Challenge; (ii) the Energy Innovation Program; and (iii) the Program of Energy R&D, as shown in Table 28 below.

⁵² Ibid.

Table 28 – Smart Grids case study – formal and augmented policy mixes

Key Programs and other instruments in Policy Mix Examined	Timeframe	No. of Fiscal Years	No. of Instruments in policy mix	Delivered by Organization	Approx. Budget \$M
GI Ph. 2 - Smart Grids					
Government STI program - Demonstration component	2018-22	4	1	NRCan/OERD	35.0
Deployment component	2018-22	4	1	NRCan/REED	65.0
Sub-Total - Formal Case Study	2018-22	4	2		100.0
Other Instruments in policy mix					
Government STI program - ICI Power Forward Challenge (Canadian portion of Cda - UK initiative)	2018-22	4	1	NRCan/OERD	11.0
Government STI program - Energy Innovation Program - Smart Grid component	2018-22	4	1	NRCan/OERD	20.0
Government STI program - Program of Energy R&D	2018-22	4	1	NRCan/OERD	8.0
TOTAL - Augmented Case		4	5		139.0

There is a strong rationale for including the above three, additional government STI programs in the augmented policy mix, because they are administered by the same team at NRCan's Office of Energy R&D that administers the demonstration component of the Smart Grids policy mix. Of the three additional policy instruments, PERD and the Energy Innovation Program⁵³ (EIP) are NRCan's permanent RD&D programs.

The estimated amounts of budget funding for PERD and EIP are for the clean electricity and smart grids budgets only. I have selected the same 2018-24, 4-year timeframe, for both PERD and EIP, to match the timeframe of the Smart Grids policy mix, however it is understood that funding for these two RD&D programs is over a much longer timeframe. It should be noted that both PERD and EIP are not technology-specific. The EIP, or its predecessors, provided funding to smart grid R&D and demonstration projects that are similar in nature, or precursors, to the projects supported by the Smart Grids policy mix.

The Impact Canada Initiative – Clean Technology Impact is a \$75M experimental clean technology RD&D program, announced in Budget 2017, and administered by NRCan's OERD, working in close partnership with the Impact and Innovation Unit of

⁵³ <https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/18876>

the Privy Council Office (PCO). According to its web site,⁵⁴ the Impact Canada Initiative (ICI) is a “Whole-of-government effort to accelerate outcomes-based funding approaches to deliver meaningful results to Canadians”. The ICI uses a differentiated approach which includes: (i) “flexible terms & conditions” for government STI programs, providing departments with “authorities to pursue outcomes-based programming”; (ii) an ICI “challenge web platform which provides a vehicle for departments to engage new and diverse problem solvers”; and (iii) “PCO advisory services and knowledge sharing to help departments design high-impact initiatives, measure impact and share ‘what works’”. Since Budget 2017, the ICI model has been used in four major government priority areas: smart cities, clean technology (Clean Tech Impact), responding to the opioid crisis, and improving indigenous outcomes.

The Power Forward Challenge (PFC) is one of five challenges⁵⁵ supported by the \$75M Clean Tech Impact component of the ICI, and administered by NRCan’s OERD. It was structured as a Canada-UK collaborative initiative to design better power grids, i.e. smart grids. Canada, via NRCan’s OERD, and the UK each administer their own parts of the initiative, but share overall goals, vision, and communications. The Canadian budget for the PFC is approximately \$11M. OERD administered the Smart Grid demonstration component of the policy mix, as well as the Power Forward Challenge, and the smart grid components of PERD and EIP, as a group. In January 2019, the PFC announced funding to 10 Canadian semi-finalists out of 70 applicants, and funding to 3 Canadian finalist

⁵⁴ <https://www.canada.ca/en/innovation-hub/services/impact-canada-initiative/info-sheet.html>

⁵⁵ The other four challenges in the ICI Clean Technology Impact are: (1) The Sky’s the Limit (approx. \$14M for green aviation fuels); (2) Women in Clean Tech; (3) Crush It (approx. \$10M for reducing energy use in mining); and (4) Indigenous Off-Diesel Initiative (\$20M).

teams in June 2019.

Policy Mix - Coverage of the Innovation Chain

Per data found in Appendix H, the Smart Grids policy mix was found to have good coverage of 4 out of 5 stages of the innovation, and of the 7 levels of the Technology Readiness Level scale. In terms of coverage of the Commercialization Readiness Index, the policy mix was found to cover up to 4 levels, out of 6, confirming relatively good coverage of the later stages of the innovation chain. Note that this relatively good coverage is as expected, for an experimental policy mix.

Characteristics of Policy Mix in Case Studies

The Smart Grids policy mix is described using the 21 characteristics suggested by the Rogge & Reichardt analytical framework, per Table 7 in section 3.7. The data to complete Table 96, which can be found in Appendix H, was derived from the documentary evidence. This table is used as a starting point for comparative analyses, and includes information on the policy, instruments, instrument mix, policy process, and policy domain.

Some highlights of the features and characteristics of this policy mix that were not previously mentioned include the following.

At the policy element level, which looks at the degree of existence of objectives and plans at the policy mix level, there is an explicit policy strategy at the formal policy mix level. There are also explicit objectives and goals at the policy mix level, as well as at the instrument level. Therefore, this measure was rated high. Also at the policy strategy level, there are explicit plans at the formal policy mix level, as well as at the instrument level. Given that plans need to be typically more detailed than objectives, and that the

plans are not that detailed, the rating is slightly lower on plans than for objectives (med-high).

At the policy instrument level, using the instrument typically outlined in section 3.6, there are two types of instruments in the policy mix: government STI programs and subsidies and incentives (deployment). The goals at the instrument level are significantly aligned, at the formal policy mix level, and only slightly less so for the augmented policy mix scoring a med-high rating. There are instruments at both the technology push and pull levels, but this measure was rated as medium, because the commercialization/diffusion phase of the pull stage was not covered, and there were no instruments covering systemic concerns, such as regulations or standards.

At the instrument mix level, different instruments targeted very similar actors; the duration of the instruments was very similar, covering similar timeframes and offering some opportunities for synergies; and the degree of interaction was rated as “high, because there were/are very significant interactions between the two components of the formal policy mix, and a fair degree of interactions with the other instruments in the augmented policy mix.

At the policy dimension level, there was/is a natural temporal offset between R&D activities supported by PERD, the R&D component of ecoEII and the formal instruments. Ideally, there should also have been a temporal offset between the demonstration and deployment component, to allow sufficient time for demonstration projects to be completed, and then picked up by the deployment component, but this was not possible due to the relatively short (4 years) policy mix timeframe. The same could be said between the Power Forward Challenge and deployment component.

Data collected to answer research questions

The information provided in this sub-section presents the data collected through the semi-structured interviews and document review to directly answer research questions 1 and 2.

The data tables presented below are used in the comparative analyses conducted in chapter 6. A high level summary is shown in Table 29. The rest of this section unpacks these results.

Table 29 - Summary of consensus view for evaluation criteria and conditions for successful implementation – Smart Grids

	Smart Grids
Q1A - Measurement of Evaluation Criteria - overall	Med-High
(i) Consistency of element	Med-High
(ii) Coherence of processes	Med-High
(iii) Comprehensiveness of the policy mix	Medium to Med-High
Q1B - Administration costs compared to conventional approach	Lower
Q2 - Degree of presence of conditions for successful implementation	Med-High

Question 1A – Assessment of consistency, coherence & comprehensiveness

Detailed data collected to answer the research question #1A, which is concerned about the three evaluation criteria, including consistency of elements, coherence of processes, and comprehensiveness of the policy mix, are found in Table 97 in Appendix H, and summarized below. In summary, the Smart Grids policy mix was found to have med-high rating, overall, and for two out of the three evaluation criteria.

The policy mix was rated med-high on consistency of elements because (i) different instruments had similar timeframes; (ii) there were few conflicting or contradictory elements; (iii) there were significant synergies between the demonstration and deployment components of the formal policy mix, evidenced by the fact that one third of projects selected were hybrid projects; (iv) the degree of alignment of policy objectives for the different instruments was high; (v) there was a strong degree of

reinforcement between the demonstration and deployment instruments, and a lower, but still significant amount of reinforcement between the other individual instruments; and (v) overall the degree of reinforcement of the strategy and instrument mix was considered med-high.

The policy mix was rated med-high on coherence of processes because: (i) the two instruments in the formal policy mix were administered in a highly coordinated fashion, at the design, implementation and evaluation stage. At the implementation stage, the two instruments used the same call for proposals process, same review committees to review and select proposals, and same communications process for announcements. (ii) There was frequent and consistent engagement between OERD and REED on the design and delivery of the policy mix. And (iii) the degree of synergistic policymaking and engagement is perceived as having a direct impact on the effectiveness of the policy mix.

The policy mix was rated between medium to med-high on comprehensiveness of the policy mix because, although there was good coverage of the TRL scale, there was only partial coverage of the CRI scale, and not all barriers were addressed. In particular, it was noted that regulatory barriers were not effectively addressed through this policy mix.

Question 1B – comparative cost of experimental vs conventional approach

For the Smart Grids policy mix, the comparative administrative costs to deliver this experimental policy approach was considered to be lower than the administrative costs to deliver this policy mix using a conventional approach. This is partially due to the fact that a “single window” approach was used to interact with proponents. The demonstration and deployment components were effectively delivered as an integrated policy mix, with a

single web site and applicants' guide, a single call for proposals process, a single proposal review and selection process, and a single communications process. Overall, it was felt that this approach resulted in overall savings, even if there was a need for greater coordination and communications. The policy mix's simple design, with only two policy instruments in the formal mix, may have been a contributing factor. Cost savings are also perceived to have been realized at the design stage, given that the additional costs related to increased coordination and communications required to develop an integrated proposal, were more than offset by savings of implementing a single set of Memoranda to Cabinet, Treasury Board Submissions and other planning documentation and processes.

Question 2 – Degree of presence of conditions for successful implementation

Detailed data developed to answer the research question #2, which is concerned about the 11 conditions suggested by the literature for successful implementation of Whole-of-government policy approaches, are found in Table 98 in Appendix H, and summarized below. Data to complete this table was derived from the documentary evidence. In summary, the degree to which these conditions were perceived to be in place, for the policy mix, is considered to be med-high, with the rationale for the ratings provided in the comments column.

Highlights supporting the overall and individual ratings are as follows.

- (i) There was a common understanding of the problem and a joint approach to solving the problem that was identified at the design stage.
- (ii) There were some shared metrics identified for the two components of the policy mix, as well as individual metrics identified for each component.
- (iii) There appears to be some strong reinforcing activities, as some prior R&D and

demonstration activities led to some of the demonstration and deployment projects, under this policy mix.

- (iv) There was very frequent and regular communications between the OERD and REED staff. Staff interacted on common processes, such as the calls for proposals, selection of projects, policy mix communications, reporting, etc.
- (v) There were champions at the Senior Director and Director levels throughout the design and implementation phases.
- (vi) OERD and REED developed common tools to deliver the policy mix, including call for proposals materials, common proposal review and selection processes, processes for hybrid proposals, and will be working on a common evaluation approach.
- (vii) The role of central agencies was higher than for the conventional and the EVAF case studies, because of their involvement in the Impact Canada Initiative Power Forward Challenge, which was included in the augmented policy mix.
- (viii) Given that there will be joint audits and evaluations covering all the instruments in the formal policy mix, the accountability framework is expected to be adjusted to account for the dual nature of accountabilities.
- (ix) Central agencies provided more detail on the mandate and expected outcome, at the policy mix level, than was the case for conventional case studies.

Concluding Observations

The Smart Grids policy mix exhibits the features and characteristics that are typical of an experimental policy mix. The assessment of the three evaluation criteria for questions 1A resulted in a med-high rating, overall, and for two out of the three assessment criteria.

The rating for comprehensiveness is slightly lower, because the policy mix did not address all barriers. Specifically, regulatory barriers were singled out as needing to be addressed by future policy mixes. The overall assessment was in alignment with expectations for an experimental policy mix, which is tightly bundled, complete and technology-specific. The degree of presence of conditions for successful implementation of a Whole-of-government policy mix approach was also rated as med-high, which was as expected for an experimental policy mix. The data presented in this section is used in the comparative analyses presented in chapter 6.

The Smart Grids case study is an interesting case study to examine as part of this thesis, because it represents a near “pure” form of the experimental policy mixes. Looking ahead, it would be likely that, on a comparative basis, this case study would rate relative high, or higher, on the assessment criteria, compared with other experimental case studies, as well as against the conventional case studies, based on the factors outlined above.

5.6 Case Study #6 - GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC) (2018-24)

This third experimental case study focuses on the \$218M Clean Energy for Rural & Remote Communities (CERRC) policy mix that includes the CERRC government STI (demonstration) program as its cornerstone instrument. The key features of this policy mix are as follows. It is the largest and most complex mix of the three experimental case studies examined, consisting of 5 policy instruments, for the formal policy mix, and 8 instruments in the informal, augmented policy mix. The policy mix timeframe is 6 fiscal years, from 2018-19 to 2023-24.

This section includes background information derived from interviews,

definitions of the formal and augmented policy mixes, as well as characteristics and interview data that are used for the comparative analyses between case studies in chapter 6. Additional details on this case study are provided in Appendix I.

Background on the CERRC policy mix

The focus of this policy mix is on approximately “200 remote [off-grid] communities and industrial sites that rely on diesel fuel for electricity generation and heat. Many of these communities, which are not connected to the continental [electricity] grid [or natural gas distribution system], are Indigenous or have significant Indigenous populations. While diesel generation is a well-known reliable source of energy in these communities, it comes with many with many environmental, social and economic disadvantages”,⁵⁶ such as having to import expensive diesel fuel into communities, diesel spills, and GHG and other air pollution.

A map of the 200 rural and remote communities targeted by the policy mix is publicly accessible as part of the national Atlas of Canada maintained by NRCan.⁵⁷ This map provides information on primary fuel use by remote community.

The objectives of the policy mix are to improve resiliency of rural and remote off-grid community’s energy supply, by diversifying electricity generation and heat sources to include renewable energy, such as wind, solar and biomass, supplemented by energy storage, implement energy efficiency measures to reduce the amount of energy required

⁵⁶ <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/reducing-reliance-diesel.html>

⁵⁷ <https://atlas.gc.ca/rced-bdece/en/index.html>

in communities, and build community skills and capacity.⁵⁸ In practical terms, the primary goal of the CERRC policy mix is to reduce reliance on imported diesel to generate electricity and heat in rural, northern and remote communities and replace it with locally produced energy, including wind and solar, or locally harvested biomass.

The CERRC policy mix, which is designed and delivered by NRCan, is part of, and fits within, the federal government's larger policy frameworks to address climate change, energy efficiency, infrastructure, and housing in Canada's Arctic, northern and remote regions. The CERRC policy mix fits within the Pan-Canadian Framework on Clean Growth & Climate Change (PCF), as well as within Infrastructure Canada's Investing in Canada infrastructure plan, which has allocated an additional \$2B over 11 years for the "rural and northern community infrastructure stream", including "roads, food security, broadband communications infrastructure and energy".⁵⁹ This \$2B in infrastructure funding includes \$400M in funding to the Arctic Energy Fund, which is funding provided by the federal government to Canada's three Territorial governments, to help them contribute to resilient and efficient energy systems,⁶⁰ including contributing funding to projects funded by CERRC. The CERRC is also complemented by the \$53.5M Northern REACHE (responsible energy approach for community heat & electricity) initiative, which has been delivered by Crown-Indigenous Relations & Northern Affairs Canada, another federal department, since 2003.⁶¹ Funding provided by the federal First

⁵⁸ <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/reducing-reliance-diesel.html>

⁵⁹ <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar72018.pdf>

⁶⁰ <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar72018.pdf>

⁶¹ <https://www.nrcan.gc.ca/reducingdiesel>

Nations Infrastructure Fund, and administered by Indigenous Services Canada, can be used by indigenous communities to co-fund projects supported by CERRC.⁶² The CERRC policy mix also complements work undertaken by Polar Knowledge Canada, a federal agency reporting to the federal Minister of Northern Affairs, which “is responsible for advancing Canada’s knowledge of the Arctic, strengthening Canadian leadership in polar science and technology, and promoting the development and distribution of knowledge of other circumpolar regions, including Antarctica. POLAR Knowledge operates the Canadian High Arctic Research Station (CHARS) campus, in Cambridge Bay, Nunavut, and conducts world-class, cutting edge Arctic research out of this facility.”⁶³

The CERRC formal policy mix is made up of 5 instruments, delivered by four different organizations within NRCan. The original parameters for each instrument are provided below, as defined in the policy mix documentation shared with the public in 2018.⁶⁴ These parameters have been slightly amended over time, based on input from stakeholders.

1. **Demonstration** – \$60M to demonstrate innovative renewable energy, energy efficiency, energy storage or smart-grid technologies to displace diesel fuel for power and/or heat. Funding of \$2-5M per project is expected to support approximately 15 projects. This instrument is delivered by NRCan’s Office of Energy R&D (OERD).
2. **Deployment** – \$90M million for deployment of commercially available renewable energy technologies for electricity. Heat may also be produced, but the primary output of the project must be electricity. Funding of \$4-8M per project is expected to support approximately 10-20 projects. This instrument is delivered by NRCan’s Renewable Energy & Electricity Division (REED).

⁶² <https://www.nrcan.gc.ca/reducingdiesel>

⁶³ <https://www.canada.ca/en/polar-knowledge.html>

⁶⁴ <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar22018.pdf>

3. **BioHeat** - \$55M for feasibility studies and/or deployment/installation of proven biomass combustion heating systems, district heating and combined heat and power systems that displace diesel or certain other fossil fuels used for heating. Electricity may be produced, but the primary output of the project must be heat. Funding of \$4-8M per project is expected to support approximately 20-40 projects. This instrument is delivered by NRCan's Canadian Forestry Service (CFS).
4. **Capacity Building** – \$10M for the development of energy literacy and local technical expertise through skills training and network participation in rural and remote communities. Funding of \$100-300k per project is expected to support approx. 20 projects. This instrument is delivered by NRCan's REED.
5. **Energy Efficiency** - \$3M for “program” and policy support for the deployment of energy efficiency technologies through complementary “programs” led by federal partners. This instrument is delivered by NRCan's Office of Energy Efficiency's (OEE) Housing Division and Building & Industry Division.

The CERRC policy mix is expected to deliver approximately 80 technology demonstration, deployment and capacity building projects.

As is the case with the Smart Grids case study, the first three instruments above, i.e. demonstration, deployment and BioHeat deployment, are delivered through a “one-window” or “no wrong door” approach. This means that NRCan has a single web page providing information on the three instruments, issues a single call for proposal for all three policy mix components, selects proposals through a single process for all three components using the same team of experts on review committees, and announces funding decisions through a single process. The “no wrong door, one-window” approach allows staff delivering the policy mix to seamlessly re-direct proposals that have been submitted under the wrong stream (e.g. demonstration) to the most appropriate stream (e.g. deployment). This approach is much more convenient and user friendly for applicants. This approach's effectiveness has been enhanced, in this case, by coordinating the timing of call for proposals, such that these occur at the same time, for all three instruments. According to staff, “one-window” integrated delivery has resulted in

significant cost savings, even if it requires a higher degree of upfront coordination and communications. It should be noted that the three policy instruments, using the “one-window” approach, are similar in that they target technology-oriented projects, i.e. demonstration or deployment of technologies.

The capacity building component of the policy mix is administered slightly differently than the above three instruments, because it is not oriented towards technology demonstration or deployment projects. Rather, this policy instrument’s goals are to support “community-level capacity building that will increase clean energy opportunities, including renewables and energy efficiency, and contribute to reducing diesel reliance in rural and/or remote communities”.⁶⁵ Funding allocated to this policy instrument is smaller (\$10M) than for the technology-oriented instruments (\$55-90 M per component), to support projects and activities such as “curriculum development, training, community networking on energy issues, energy planning, and energy literacy”.⁶⁶

The energy efficiency policy instrument is also administered differently than the other four instruments. As can be noted, budgeted funding is quite low, at \$3M over 8 years, being targeted at funding a few federal employees to provide “expert advice, policy and technical support to [other] federal instruments targeting northern and remote communities” (GOC 2017). The “other” federal instruments in this case include government STI programs or deployment incentive instruments providing funding for residential and commercial buildings in northern and remote communities. Such

⁶⁵ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-communities-capacity-building-stream/20477>

⁶⁶ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-communities-capacity-building-stream/20477>

programming is provided through the departments and organizations mentioned above, which are part of the larger policy mix, including Indigenous Services Canada (e.g. Northern REACHE initiative), Infrastructure Canada, Canada Mortgage & Housing Corporation, and Polar Knowledge.

As of November 2020, CERRC had formally announced that it had allocated \$58.5 M, or 29% of budgeted funds, to support the implementation of 28 technology demonstration and deployment projects, which are being implemented by a variety of communities in different Provinces and Territories.⁶⁷ However, staff unofficially reported that the above figures only represented a fraction of actual projects selected, and that up to 88 projects had been selected for support, which is above the overall target of 80 for the policy mix as a whole. According to staff, the main reason that these other projects had not yet been announced was that there was a government-wide slowdown in non-COVID-19 related communications, during the height of the pandemic, during most of 2020-21. In addition to the above, the CERRC had announced that it had allocated \$3.7M, or 37% of budgeted funds, to support 10 capacity building projects.⁶⁸

Additional background information on this policy mix is provided in Appendix I, including a listing of the documentary evidence used to describe and characterize the policy mix, , as well as mapping of the policy mix along the innovation chain, as well as against the Technology Readiness Level and Commercialization Readiness Index scales.

⁶⁷ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-commun/clean-energy-rural-and-remote-communities-funded-projects/22524>

⁶⁸ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-commun/clean-energy-rural-and-remote-communities-funded-projects/22524>

Defining the formal and augmented policy mixes

The formal policy mix, outlined in design documents include the Treasury Board Submission, consists of the five (5) instruments described above, as shown in Table 30 below.

The augmented policy mix is defined as the five instruments in the formal CERRC policy mix, along with three other government STI programs, namely: (i) the Impact Canada Initiative (ICI) Indigenous Off-Diesel Initiative (IODI); (ii) the Energy Innovation Program; and (iii) the Program of Energy R&D, as shown in Table 30 below.

Note that in the augmented policy mix, four instruments are administered by NRCan's Office of Energy R&D (OERD), two by NRCan's Renewable & Electrical Energy Division (REED), and one each by NRCan's Office of Energy Efficiency (OEE) and Canadian Forestry Service (CFS).

Table 30 – CERRC case study – formal and augmented policy mixes

Key Programs and other instruments in Policy Mix Examined	Timeframe	No. of Fiscal Years	No. of Instruments in policy mix	Delivered by Organization	Approx. Budget \$M
GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC)					
CERRC - Demonstration (government STI program)	2018-24	6	1	NRCan/OERD	60.0
CERRC - Deployment	2018-24	6	1	NRCan/REED	90.0
CERRC- BioHeat	2018-24	6	1	NRCan/CFS	55.0
CERRC - Energy Efficiency	2018-24	6	1	NRCan/OEE	3.0
CERRC - Capacity Building	2018-24	6	1	NRCan/REED	10.0
Sub-Total - Formal Case Study	2018-24	6	5		218.0
Other Instruments in policy mix					
ICI - Clean Technology Challenge - Indigenous Off-Diesel Initiative	2018-22	4	1	NRCan/OERD	20.0
Government STI program - Energy Innovation Program	2018-24	6	1	NRCan/OERD	7.0
Government STI program - Program of Energy R&D	2018-24	6	1	NRCan/OERD	6.0
TOTAL - Augmented Case		4-6	8		251.0

There is a strong rationale for including the above three, additional instruments in the augmented policy mix, because they are administered by the same team at NRCan's OERD that administers the demonstration component of the CERRC demonstration component of the policy mix. Of the three additional policy instruments, the Program of

Energy R&D (PERD) and the Energy Innovation Program⁶⁹ (EIP) are NRCan's permanent RD&D funding programs. The estimated amounts of budget funding for PERD and EIP are for the R&D budgets for northern housing and renewable energy only. I have selected the same 2018-24, 6-year timeframe, for both PERD and EIP, to match the timeframe of the CERRC policy mix, however it is understood that funding for these two government STI programs is over a much longer timeframe than this, and that RD&D conducted in a prior period would likely have greater interaction with the policy mix than current R&D. It should be noted that both PERD and EIP are not technology-specific. The EIP, or its predecessors, provided funding to northern energy R&D and demonstration projects that are similar in nature, or precursors, to the projects supported by the CERRC policy mix. For example, the ecoENERGY Innovation Initiative (2011-16) provided \$7.8M in funding for a flagship wind energy and energy storage project at the Glencore Raglan nickel mine in northern Quebec, which resulted in the demonstration of an Arctic-grade 3 MW wind turbine, and a three-stage storage system, in a very harsh environment. This project has laid the groundwork for further renewable energy projects in remote locations, as supported by the CERRC policy mix.

As was mentioned in section on the Smart Grids case study, the Impact Canada Initiative – Clean Technology Impact is a new, \$75M experimental clean technology government STI program, announced in Budget 2017, and administered by NRCan's OERD, working in close partnership with the Impact and Innovation Unit of the Privy Council Office (PCO), which to date has launched five R&D challenges. The \$20M

⁶⁹ <https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/18876>

Indigenous Off-Diesel Initiative (IODI) is one of these five challenges.⁷⁰ It has the largest budget of the five and was structured slightly differently than the other “challenges” as an “initiative”, to “support clean energy champions and their communities with tailored clean energy training, access to expertise and financial resources to develop and start implementing an ambitious diesel reduction plan”.⁷¹ A challenge in this case typically refers to a competitive process resulting in a single winning proposal or team, whereas this initiative is meant to be more collaborative, supporting many winning proposals or clean energy “champions”.

The focus of the IODI is on capacity building and training. Under phase 1,⁷² a selection jury made up of indigenous representatives selected 15 champions, who each received \$40k to participate in the 20/20 Catalyst Program, a hands-on capacity building instrument designed to develop the skills to maximize community social and economic benefits of clean energy initiatives, and to support community engagement activities. Under phase 2, which was under way until March 2021, champions work with their respective communities to develop a community energy plan, identify training requirements to support the plan and develop a detailed project implementation plan. Finally, under phase 3, communities start to develop their first clean energy project, identified through the clean energy planning process. One or more of the leading clean energy projects will be eligible to receive up to \$9M from the CERRC policy mix to implement their projects. Thus, as confirmed by the IODI web site, the IODI and CERRC

⁷⁰ The other four challenges in the ICI Clean Technology Impact are: (1) The Sky’s the Limit (approx. \$14M for green aviation fuels); (2) Women in Clean Tech; (3) Crush It (approx. \$10M for reducing energy use in mining); and (4) Power Forward Challenge (\$11M).

⁷¹ <https://impact.canada.ca/en/challenges/off-diesel>

⁷² Text for the 3 phases sourced on this site: <https://impact.canada.ca/en/challenges/off-diesel/process>

policy mix are quite tightly integrated. As mentioned above, as of November 2020, the IODI had allocated \$600k in funding to 15 champions.

Policy Mix - Coverage of the Innovation Chain

Per data found in Appendix I, the CERRC policy mix was found to have good coverage of 4 out of 5 stages of the innovation, and of the 7 levels of the Technology Readiness Level scale. In terms of coverage of the Commercialization Readiness Index, the policy mix was found to cover up to 4 levels, out of 6, further confirming relatively good coverage of the later stages of the innovation chain. Note that this good coverage is as expected, for an experimental policy mix.

Characteristics of Policy Mix in Case Studies

The CERRC policy mix is described using the 21 characteristics suggested by the Rogge & Reichardt analytical framework, per Table 7 in section 3.7. The data to complete Table 105, which can be found in Appendix I, was derived from the documentary evidence. This table is used as a starting point for comparative analyses, and includes information on the policy elements, instruments, instrument mix, policy processes, and policy domain.

Some highlights of the features and characteristics of this policy mix that were not previously mentioned include the following.

At the policy element level, which looks at the degree of existence of objectives and plans at the policy mix level, there is an explicit policy strategy at the formal policy mix level. There are also explicit objectives and goals at the policy mix level, as well as at the instrument level. However, the strategy needed to be changed, after the launch of the policy mix, from technology and diesel reduction to more community-oriented goals.

Therefore, this measure was rated med-high. Also at the policy strategy level, there are explicit plans at the formal policy mix level, as well as at the instrument level. Given that plans need to be typically more detailed than objectives, and that the plans are not that detailed, the rating is slightly lower on plans than for objectives (med-high).

At the policy instrument level, using the instrument typically outlined in section 3.6, there are three types of instruments in the augmented policy mix, government STI programs, subsidies and incentives (deployment), and other (capacity building & policy support). The goals at the instrument level are significantly aligned, at the formal policy mix level, and only slightly less so for the augmented policy mix, resulting in a rating of med-high. There are instruments at the technology push and pull levels, and some addressing systemic concerns (capacity), but none at the commercialization/diffusion phase, so this measure was rated as med-high.

At the instrument mix level, 4 of 5 instruments in the formal policy mix target exactly the same actors, in this case, rural and remote communities and their clean energy champions. The energy efficiency instrument targets these same actors in an indirect manner, through other deployment incentive instruments delivered through Indigenous Services Canada, the Canada Mortgage & Housing Corporation and other federal departments. The government STI programs added in the augmented policy mix target similar actors, as well as a broader list of actors including technology developers, academia, etc. In addition, the duration of the instruments is very similar, covering similar timeframes and offering some opportunities for synergies. Finally, the degree of interaction was rated as med-high, because although there is a very high degree of interaction between four of the five instruments in the formal policy mix, the interaction

is slightly lower for the energy efficiency component.

At the policy dimension level, there is a natural temporal offset between PERD and EIP and instruments in the formal policy mix. Ideally, there should also have been a temporal offset between the capacity building, demonstration and deployment components, to allow sufficient time for capacity building projects to be first completed, followed by demonstration projects, and then by the deployment component, but this was not possible due to the relatively short (6 years) policy mix timeframe. The same could be said between the Indigenous Off-Diesel Initiative and deployment component.

Data collected to answer research questions

The information provided in this sub-section presents the data collected through the semi-structured interviews and document review to directly answer research questions 1 and 2.

The data tables presented below are used in the comparative analyses conducted in chapter 6. A high level summary is shown in Table 31. The rest of this section unpacks these results.

Table 31 - Summary of consensus view for evaluation criteria and conditions for successful implementation – CERRC

	CERRC
Q1A - Measurement of Evaluation Criteria - overall	Med-High
(i) Consistency of element	Med-High
(ii) Coherence of processes	Med-High
(iii) Comprehensiveness of the policy mix	Med-High
Q1B - Administration cost compared to conventional approach	Lower
Q2 - Degree of presence of conditions for successful implementation	Med-High

Question 1A – Assessment of consistency, coherence & comprehensiveness

Detailed data collected to answer the research question #1A, which is concerned about the three evaluation criteria, including consistency of elements, coherence of processes, and comprehensiveness of the policy mix, are found in Table 106 in Appendix I, and

summarized below. In summary, the Smart Grids policy mix was found to have med-high rating, overall, and for each of the above three evaluation criteria.

The policy mix was rated med-high on consistency of elements because (i) there were few conflicting or contradictory elements, even if the goals had to be adjusted after the launch of the policy mix; (ii) there were significant synergies between the demonstration and two deployment instruments of the formal policy mix; (iii) the degree of alignment of policy objectives for the different instruments was considered strong and explicit; (iv) there was good reinforcement between the demonstration and deployment instruments; and (v) overall the degree of reinforcement of the strategy and instrument mix was considered med-high.

The policy mix was rated med-high on coherence of processes because: (i) the instruments in the formal policy mix were administered in a highly coordinated fashion, at the design, implementation and evaluation stage. At the implementation stage, three out of five instruments (demonstration & two deployment instruments) used the same call for proposals process, same review committees to review and select proposals, and same communications process for announcements. (ii) There was frequent and consistent engagement between OERD, REED, CFS and OEE on the design and delivery of the policy mix. And (iii) the degree of synergistic policymaking and engagement is perceived as having a direct impact on the effectiveness of the policy mix.

The policy mix was rated med-high on comprehensiveness of the policy mix because the degree to which all barriers were addressed was quite high, given that a large number of renewable energy technologies were specifically supported and the policy mix included capacity building and energy efficiency.

Question 1B – comparative cost of experimental vs conventional approach

For the CERRC policy mix, the comparative administrative costs to deliver this experimental policy approach was considered to be lower than the administrative costs to deliver this policy mix using a conventional approach. This is partially due to the fact that a “one-window” approach was used to interact with proponents. In addition, the three demonstration and deployment components were effectively delivered using a single process, with a common web site and applicants’ guide, a single call for proposals process, a single proposal review and selection process, and a single communications process. Overall, it was felt that this approach resulted in overall savings, even if there was a need for greater coordination and communications. Cost savings are also perceived to have been realized at the design stage, given that the additional costs related to increased coordination and communications required to develop an integrated proposal, were more than offset by savings of implementing a single set of Memoranda to Cabinet, Treasury Board Submissions and other planning documentation and processes. There are also cost savings expected to be achieved at the audit and evaluation stage, as instead of auditing and evaluating five separate policy mix components, as would have been done using the conventional approach, a single joint audit and evaluation of the formal policy mix as a whole is planned to be initiated in 2021-22.

Question 2 – Degree of presence of conditions for successful implementation

Detailed data developed to answer the research question #2, which is concerned with the 11 conditions suggested by the literature for successful implementation, are found in Table 107, in Appendix I, and summarized below. The data to complete this table was derived from the documentary evidence. In summary, the degree to which these

conditions were perceived to be in place, for the policy mix, are considered to be medium-high, with rationale for the ratings provided in the comments column.

Highlights supporting the overall and individual ratings are as follows.

- (i) There was a common understanding of the problem and a joint approach to solving the problem that was identified at the design stage. Over time, this common understanding was adjusted to focus more on the needs and interests of the community, based on stakeholder input.
- (ii) There are some shared metrics identified for the five instruments in the policy mix, as well as individual metrics identified for each component.
- (iii) There were strong mutually reinforcing activities, as some prior R&D and demonstration activities led to continuing demonstration and deployment projects, under this policy mix.
- (iv) There was frequent and regular, i.e. weekly, communications between the OERD, REED, CFS and OEE staff delivering each of the instruments. Staff interacted on common processes, such as the calls for proposals, selection of projects, policy mix communications, reporting, etc.
- (v) There were champions at the Senior Director and Director levels throughout the design and implementation phases.
- (vi) OERD, REED and CFS developed common tools to deliver the policy mix, including call for proposals materials, common proposal review and selection processes, processes for hybrid proposals, and will be working on common evaluation approach.
- (vii) The role of central agencies was higher than for the conventional and the EVAF

case studies, because of their involvement in the Impact Canada Initiative Indigenous Off-Diesel Challenge, which was included in the augmented policy mix.

- (viii) Given that there will be joint audits and evaluations covering all the instruments in the formal policy mix, the accountability framework is expected to be adjusted to account for the dual nature of accountabilities.
- (ix) Central agencies provided more detail on the mandate and expected outcome, at the policy mix level, than was the case for conventional case studies.

Concluding Observations

The CERRC policy mix strongly exhibits the features and characteristics that are typical of an experimental policy mix. The assessment of the three evaluation criteria for question 1A resulted in a medium-high rating, overall, and for each of the three criterion. This was in alignment with expectations for an experimental policy mix. The policy mix was clearly designed as a very tightly coupled policy mix, it had good coverage of the innovation chain except at the commercialization/diffusion stage, and was very technology- specific, namely for renewable technologies to reduce diesel use in electricity generation and heat in remote communities. In terms of design, it was designed, from the start, to be an integrated policy mix. Four out of five instruments in the policy mix were implemented in a very synergistic, combined manner. The joint audit and evaluation planned for the policy mix will look at the five components of the policy mix at the same time.

In terms of administrative costs (question 1B), costs were perceived as being lower than if the instruments had delivered using a conventional approach, based on the

implementation of a number of combined processes.

The tightly bundled, complete and technology-specific nature of the policy mix can also be seen in question 2, which measured the degree of presence of conditions for successful implementation of a Whole-of-government policy mix approach. The ratings on this measure was therefore med-high.

The CERRC case study is an interesting case study to examine as part of this thesis, because, like the Smart Grids case study, it represents a near “pure” form of the experimental policy mix. Looking ahead, it is likely that, on a comparative basis, this case study would rate relative high, or higher, on hoped for improvements and benefits, compared with the conventional case studies, based on the factors outlined above.

5.7 Conclusion

This chapter presented information and data on the three experimental case studies examined in this thesis. The three cases were similar in some ways, and different in other ways, providing an indication of the range of design and implementation options, available to policymakers, for experimental policy mixes, to enable clean energy technology development to mitigate climate change. The TEAM case study provides an example of a typical conventional policy mix, with relatively low scores (med-low) on evaluation criteria and degree of presence of conditions for successful implementation, as shown in Table 32 below. The CEF case study is an example of a hybrid policy mix with the attributes of a conventional policy mix (loosely bundled, incomplete, partially non-technology-specific) but with a significant, but partial focus on a specific technology (CCS), which helps explain the higher scores (medium) on evaluation criteria and presence of conditions for successful implementation. Finally, the ERPP case study was

in between the other two, in that although it also had a partial focus on a particular technology, the degree of bundling was not as strong as in the CEF case.

The data provided in this chapter provides a strong basis for comparative analyses to be conducted in chapter 6.

Table 32 - Summary of consensus view for evaluation criteria and conditions for successful implementation – 3 conventional case studies

	EVAF	Smart Grids	CERRC
Q1A - Measurement of Evaluation Criteria - overall	Med to Med-High	Med-High	Med-High
(i) Consistency of element	Med to Med-High	Med-High	Med-High
(ii) Coherence of processes	Medium	Med-High	Med-High
(iii) Comprehensiveness of the policy mix	Med-High	Med to Med-High	Med-High
Q1B - Administration cost compared to conventional approach	Slightly lower or same	Lower	Lower
Q2 - Degree of presence of conditions for successful implementation	Medium	Med-High	Med-High

Chapter 6: Results, Analysis, and Findings

6.1 Outline

- Introduction
- Question 1 - Are hypothesized improvements & benefits observed in experimental vs conventional case studies?
- Question 2 – Are conditions for success observed more in the experimental vs conventional case studies?
- Question 3 – Are there differences in observed improvements & benefits between the experimental case studies?
- Question 4 – Are there barriers & constraints to implementation the experimental policy approach?
- Other Findings
- Conclusion

6.2 Introduction

As a very brief refresher, referring back to the introduction in chapter 1 and the methodology chapter, the key objective of this thesis is to assess the Canadian federal government's early experience with the new experimental policy approach, and to test the hypothesis, in research question 1, that the experimental policy mix approach is likely to result in improvements and benefits compared to the conventional policy approach. The specific improvements and benefits that are mentioned in the hypothesis are improvements in the consistency of policy elements, coherence in the policy processes, and comprehensiveness of the policy mix, which are suggested as early indicators of success for policy mixes, by the analytical framework. The three additional research questions provide additional information and insights about the experimental approach, namely: (ii) whether conditions for successful implementation are observed to a greater extent in experimental versus conventional case studies, (iii) whether there are differences in observed improvements among the three experimental case studies, and if so, what reasons could help explain these differences, and (iv) what are the barriers and

constraints to the future implementation of the experimental approach. Together, these four questions provide a preliminary, multi-pronged assessment of the experimental approach. The assessment uses a comparative case study approach to answer the first three questions. The first two questions compare the two groups of cases studies (experimental vs conventional), while the third question looks at differences among the three experimental case studies.

This chapter is organized around the four research questions and takes as input the data presented in chapters 4 and 5. Following this introduction, there are four sections to cover each of the four research questions in sequence, and a conclusion. Each of the sections covering the research questions dive right into the results, analysis and findings. The findings then form the basis of conclusions that are developed and presented in chapter 7.

Table 33 below presents the key findings and results, which are detailed in the next four sections. In summary, the key finding is that the experimental case studies result in improvements in consistency, coherence and comprehensiveness, compared to the conventional case studies, and that these results are aligned with differences in the design and implementation of experimental versus conventional policy mixes examined. Supporting findings are: (i) that the experimental case studies were observed to be delivered at a lower administrative cost than the conventional case studies, at all stages of the policy process; (ii) that conditions for successful implementation were observed to a greater extent in experimental versus conventional case studies; (iii) that there were observed differences between experimental case studies in consistency, coherence and comprehensiveness, and that there are credible explanations to explain those differences;

and (iv) 11 specific barriers and constraints to the future implementation of the experimental approach were identified. The rest of this chapter unpacks these findings. The reader is referred to section 3.8, which includes a useful summary (in Table 12), for a description of the methodology used to answer each of the questions.

Table 33 – Summary of findings and results

Research Question	Findings	Indicators / data points
1A	Experimental case studies result in improvements in consistency, coherence and comprehensiveness compared to conventional case studies	3 indicators: Consistency, coherence, comprehensiveness, as measured per 11 data points, per case study.
1B	Cost to administer experimental case studies is relatively lower than cost to administer conventional case studies, at all stages of the policy process	Administrative cost at each of 3 stages of policy process (design, implementation, audit/evaluation).
2	Conditions for successful implementation were observed to a greater degree in experimental versus conventional case studies	11 indicators/data points, which are conditions for successful implementation, per case study.
3A	There are observed differences among the 3 experimental cases: (1) Smart Grid & CERRC case studies had higher ratings for consistency & coherence vs EVAF; (2) EVAF & CERRC case studies had higher rating for comprehensiveness vs Smart Grids	3 indicators: Consistency, coherence, comprehensiveness; 11 data points per case study.
3B	Four comparative analyses provide credible explanations for differences: (1) tightness of bundling correlated with consistency and coherence; (2) coverage of innovation chain, TRL and CRI correlated with comprehensiveness; (3) 2 characteristics (# instruments and instrument type) correlated with comprehensiveness; (4) 7 out of 11 conditions correlated with consistency and coherence	4 main indicators: tightness of bundling; coverage of innovation chain; characteristics; and conditions for successful implementation.
4	Five categories of barriers and constraints, resulting in 11 specific barriers and constraints identified through semi-structured interviewees	5 categories: (1) organizational/ structural, (2) leadership, (3) process-related, (4) complexity & scale, (5) other, per review of whole-of-government literature.

6.3 Q1 – Are hypothesized improvements & benefits observed in the experimental vs conventional case studies?

The first research question seeks to directly contribute to the assessment of the experimental approach by looking at the evidence supporting hypothesized improvements and benefits observed in the experimental case studies, compared with the conventional case studies. This part of the assessment is conducted in two parts. First, the case studies are examined, and compared as two groups, to see if there is evidence of improvements in consistency of elements, coherence of processes, and comprehensiveness. Second, the cost of administering the experimental case studies is examined and compared with that of the conventional case studies, to see if such costs are higher, the same or lower. The methodology used to answer question 1A and 1B above was provided in section 3.8, and is not repeated here. As a quick reminder, for question 1A, there are 3 key indicators, as measured by 11 data points for each case study, with data measures ranging from low to high (1-5), based on the semi-structured interviews and document review.

Overall Improvements and Benefits

In summary, the experimental case studies examined did result in improvements and benefits compared with the conventional case studies, with an improvement observed for each of the three indicators, namely consistency of elements, coherence of processes, and comprehensiveness. These results are presented in Table 34 below. The top part of the table shows: (i) that an improvement was observed for each indicator, (ii) the degree of improvement ranging from 1 to 5,⁷³ and (iii) the change in the rating between the two

⁷³ For example a change in the rating from conventional to experimental, from Medium to Medium-High, would correspond to a degree of improvement of 1. A change in the rating from conventional to

groups of case studies, conventional vs experimental. The bottom part of the table shows the corresponding rating detail for each of the three case studies, as well as for the average (shaded area), which is the basis of the comparison between the two groups, summarized in the top part of the table.

Table 34 – Hypothesized improvements and benefits – experimental versus conventional case studies

Indicator	Improvement Observed?	Degree of Improvement	From / To	
			Conventional	Experimental
Consistency of elements	Yes	1	Med	Med-High
Coherence of processes	Yes	2	Med-Low	Med-High
Comprehensiveness	Yes	1	Med	Med-High

Indicator	Conventional				Experimental			
	TEAM	CEF	ERPP	Aver.	EVAF	Smart Grid	CERRC	Aver.
Consistency of elements	Med-Low	Med	Med	Med	Med to Med-High	Med-High	Med-High	Med-High
Coherence of processes	Med-Low	Med	Med-Low	Med-Low	Med	Med-High	Med-High	Med-High
Comprehensiveness	Med-Low	Med	Med	Med	Med-High	Med to Med-High	Med-High	Med-High

The results above represent the most important findings in this thesis, as they provide evidence in support of the hypothesis statement that improvements are ‘likely’ to be observed in the experimental group of case studies, for each of the three indicators. The ratings above are supported on the basis of improvements in 10 out of the 11 data points measured for the three indicators, which in turn are based on input from semi-structured interviews with public servants and document review. These results are in alignment with expectations, and reflect differences in design and implementation of the experimental versus conventional policy mixes.

The results of this comparison demonstrate that the degree of improvements was greatest for coherence of processes, with an improvement from medium-low to medium-

experimental, from Medium-Low to Medium-High would correspond to a degree of improvement of 2, and so on.

high, or 2 degrees of improvement out of 5, between the conventional and experimental group of cases. This result makes sense and reflects the fact that the three experimental policy mixes were designed, implemented and evaluated as tightly bundled policy mixes. This is contrasted with the conventional case studies, which were designed, implemented and evaluated as loosely bundled policy mixes. This major difference in the policy processes implemented in each of the two groups of case studies results in this significant difference in rating.

The results of the comparison for consistency of elements and comprehensiveness result in a degree of improvement of 1 out of 5, from medium to medium-high, for both of these indicators.

For consistency of elements, this result is in line with expectations, because it reflects the fact that common objectives/strategy and integrated plans were observed at the policy mix level, in the case of the experimental case studies. Such common objectives, strategies and plans were not observed to the same degree, in the case of the conventional policy mixes, resulting in a lower rating.

For comprehensiveness of the policy mix, policy mixes in the experimental group of cases were observed to have greater coverage of barriers, as well as of the steps in the innovation process, resulting in a higher rating, than the conventional group of case studies.

The above results and findings are now unpacked for each of the three indicators: consistency, coherence and comprehensiveness.

Consistency of policy elements

From chapter 1, consistency of elements is defined as “how well the elements of the

policy mix are aligned with each other”. Rogge & Reichardt (2016) propose that consistency can be assessed on different levels, for example with regards to temporal consistency, absence of conflicts, degree of synergies, strategy and objectives, interaction between instruments, and interplay of the instrument mix and policy strategy, which are the basis of the 6 data points measured to assess this indicator.

Results of the comparison between the conventional group of case studies and the experimental group are summarized in Table 35 below.

Table 35 – Consistency of elements – comparison of conventional vs experimental case studies

Measure	Indicator	Conventional				Experimental			
		TEAM	CEF	ERPP	Aver.	EVAF	Smart Grid	CERRC	Aver.
Alignment over time	temporal consistency (1-5)	Low	Med	High	Med	Med	Med-High	Med	Med
Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)	Med	Med-High	Med	Med	Med-High	Med-High	Med-High	Med-High
Overall - strong consistency	Degree of existence of synergies (1-5)	Med-Low	Med	Med	Med	Med	Med-High	Med-High	Med-High
Policy Strategy	Degree of alignment of policy objectives (1-5)	Med-Low	Med	Med-Low	Med-Low	Med-High	High	Med-High	Med-High
Instrument mix	Degree of reinforcement between instruments (1-5)	Med-Low	Med	Med-Low	Med-Low	Med-High	Med-High	Med-High	Med-High
Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)	Med-Low	Med	Med-Low	Med-Low	Med	Med-High	Med-High	Med-High
Overall		Med-Low	Med	Med	Med	Med to Med-High	Med-High	Med-High	Med-High

Overall, as can be observed in the above table, and as previously mentioned above, there is an improvement in consistency of elements observed in the experimental group, compared to the conventional, from medium to medium-high (1 degree of improvement over 5), which is reflected in improvements in 5 out of 6 data points measured for the consistency indicator. Note that there is a fairly large improvement, of 2 degrees of improvement over 5, for 3 out of 6 data points. Results are unpacked below.

For weak consistency, or the degree of absence of conflicting or contradictory elements, there is an observed improvement, from medium to medium-high (1 degree of improvement over 5). The experimental policy mixes contained fewer conflicting or contradictory elements, than the conventional, for two reasons. First, they had specific

objectives at the policy mix level, which cascaded down, in a consistent manner, to objectives at the instrument level. Second, given that the policy mixes were technology-specific, the design of the policy instruments were designed specifically for the targeted technologies, which translated into a lower probability of a mismatch or conflict between the instruments in the mix and a technology targeted for development.

For strong consistency, or the degree of existence of synergies, there was an observed improvement in the experimental versus the conventional group of case studies, from medium to medium-high (1 degree of improvement over 5). The conventional policy mixes had less synergies than the experimental, because different policy instruments were only loosely connected with one another and had limited interactions. This was notable for the TEAM policy mix, where after the design phase, different policy instruments were largely administered independently of one another, resulting in a low rating. The degree of synergies was also lower in the case of general versus technology-specific policy mixes, because general instruments are less likely to have synergistic effects than technology/sector-specific elements.

For policy strategy, or the degree of alignment of policy objectives, there was a fairly large observed improvement in the experimental versus the conventional group of case studies, from medium-low to medium-high (2 degrees of improvement over 5). In this case, the difference was due to a greater degree of integration between different instruments in the policy mix, for the experimental group of cases. This high degree of integration was achieved, in part at the design stage, by describing the various aspects of each instrument in the same document (i.e. Treasury Board Submission), highlighting common elements, such as similar stakeholders targeted, and describing objectives with

similar language. For example, different instruments in the CERRC policy mix targeted the same group of northern and remote communities, with different technologies, at different stages of maturity, to match communities' capacities and level of ambition to achieve the overall goal of reducing the use of diesel in electricity and heat production.

For instrument mix, or the degree of reinforcement between instruments, there was also a fairly large observed improvement in the experimental versus the conventional group of case studies, from medium-low to medium-high (2 degrees of improvement over 5). The degree of reinforcement, for all three experimental policy mixes, was relatively higher than for the conventional, because reinforcement was planned as part of the policy mix design. For example, for EVAF policy mix, there was tight coordination between the deployment and codes & standards components, as they are administered by the same group and there was strong feedback between the two. For the CERRC case study, the policy mix supported different communities' renewable energy needs, depending on locally available resources, whether wind, solar, or biomass. And the capacity building, demonstration and two deployment components of CERRC supported communities in different and complementary ways, and were adapted to communities' experience and readiness to implement renewable energy projects.

Finally, for policy mix, or the degree of reinforcement between strategy and instrument mix, there was a fairly large observed improvement in the experimental versus the conventional group of case studies, from medium-low to medium-high (2 degrees of improvement over 5). This is due to the relatively strong linkage between the policy mix strategy and interaction between instruments, especially at the implementation stage.

In summary, tightly bundled, complete and technology/sector-specific (i.e.

experimental) policy mixes displayed improvements in the consistency of elements, resulting in large part from the manner in which they were designed and implemented.

Coherence of processes

From chapter 1, coherence of processes was defined by Rogge & Reichardt (2016) as “synergistic and systematic policy making and implementation processes contributing towards the achievement of policy objectives”, which can be achieved through “procedural mechanisms such as strategic planning, coordinating structures or communications networks”, and can be assessed across “capabilities of policy makers”, and “effect”, for example in terms of behaviors of actors and how the process shapes the policy mix. The above is the basis of 3 data points measured to assess this indicator.

Results of the comparison between the conventional group of case studies and the experimental group are summarized in Table 36 below.

Table 36 – Coherence of processes – comparison of conventional vs experimental case studies

Measure	Indicator	Conventional				Experimental			
		TEAM	CEF	ERPP	Aver.	EVAF	Smart Grid	CERRC	Aver.
Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)	Med	Med	Med-Low	Med	Med	Med-High	Med-High	Med-High
Organizational capacity	Degree of engagement between groups (1-5)	Low	Med	Low	Med-Low	Med	Med-High	Med-High	Med-High
Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)	Low	Med	Med-Low	Med-Low	Med	Med-High	Med-High	Med-High
Overall		Med-Low	Med	Med-Low	Med-Low	Med	Med-High	Med-High	Med-High

Overall, there is a fairly large improvement in coherence of processes observed in the experimental group, compared to the conventional, from medium-low to medium-high (2 degrees of improvement over 5), which is reflected in improvements in 3 out of 3 measures of coherence. This is primarily due to the fact that, for the Smart Grids and CERRC experimental cases, the policy mix was tightly bundled at all three of the design, implementation and audit / evaluation stages of the policy process. In contrast, the

conventional, and EVAF, case studies either exhibited loose bundling only, or tight bundling only at the design stage. Results are unpacked below.

For synergistic policymaking, there was an observed improvement in the experimental versus the conventional group of case studies, from medium to medium-high (1 degree of improvement over 5). The primary differences between the experimental and conventional groups were that: (a) all experimental cases used a single design process that included all instruments in the formal policy mix; (b) there are/were frequent and regular meetings and communications between different organizations delivering the different instruments in the mix, to plan and coordinate joint activities at the design, implementation and (planned) audit / evaluation stages, particularly for the Smart Grids and CERRC cases; (c) a number of activities, that would have normally been delivered separately and independently, i.e. duplicated, were jointly delivered as a single process for two or more instruments in the mix, particularly for the Smart Grids and CERRC cases.

For organizational capacity, or the degree of engagement between groups, there was a large observed improvement in the experimental versus the conventional group of case studies, from medium-low to medium-high (2 degrees of improvement over 5). This difference is due to a significantly greater number of planned and actual meetings and communications observed, in the case of the experimental case studies. These were required to coordinate common processes, such as a joint Treasury Board Submission, or implementation activities, such as a joint announcement and call for proposals process.

For direct effect of coherence, or the degree of impact of coherence on perceived effectiveness, there was a large observed improvement in the experimental versus the

conventional group of case studies, from medium-low to medium-high (2 degrees of improvement over 5). Public servants involved in the delivery of the policy mixes examined perceived that, given that for the experimental cases, there were much more frequent and regular coordination meetings and communications, as well as much greater coordination around common processes, these two factors contributed to improved policy mix delivery. It is acknowledged that these conclusions are preliminary, given that all experimental policy mixes were still in the early years of being implemented. A more definitive conclusion may be possible once implementation has been completed, and a formal evaluation of the policy mix, assessing effectiveness, has been completed.

Comprehensiveness

From chapter 1, comprehensiveness was defined as “how extensive and exhaustive its elements”. Rogge & Reichardt propose that comprehensiveness can be assessed by (i) “the degree to which the instrument mix addresses all market, system and institutional failures including barriers and bottlenecks (Lehmann 2012, Sorrell 2004, Sovacool 2009; Weber & Rohrer 2012); and (ii) how the policy mix addresses “all three instrument purposes of technology-push, demand-pull and systemic concerns”. The above is the basis of 2 data points measured to assess this indicator.

Results of the comparison between the conventional group of case studies and the experimental group are summarized in Table 37 below.

Table 37 – Comprehensiveness – comparison of conventional vs experimental case studies

Measure	Indicator	Conventional				Experimental			
		TEAM	CEF	ERPP	Aver.	EVAF	Smart Grid	CERRC	Aver.
Barriers (Tech development, market)	Degree to which the policy mix addresses all barriers - innovation process, push, pull, TRL, CRI	Med-Low	Med	Med	Med	Med-High	Med to Med-High	Med-High	Med-High
Barriers (systemic) - Other	Degree to which the policy mix addresses all barriers - systemic, regulatory, etc. (1-5)	Med-Low	Med	Med	Med	Med-High	Med to Med-High	Med-High	Med-High
Overall		Med-Low	Med	Med	Med	Med-High	Med to Med-High	Med-High	Med-High

Overall, there is an improvement in comprehensiveness observed in the experimental group, compared to the conventional, from medium to medium-high (1 degree of improvement over 5), which is reflected in improvements in 2 out of 2 measures of comprehensiveness. Comprehensiveness is higher for the experimental group, because: (i) there was greater coverage of the innovation chain, particularly the later stages of the chain; and (ii) the mix of instruments addressed more barriers, particularly those that addressed barriers specific to a particular technology. For example, the EVAF policy mix addressed specific barriers related to the deployment of fast-charging equipment, along Canada's major highways, to address user concerns about the range of electric vehicles, as well as specific barriers related to new applications, in the demonstration component, such as fast charging stations combined with battery storage and solar photovoltaic panels, to address electricity grid issues along more remote regions of Canada's highway systems, where the electricity grid is capacity constrained.

The EVAF case also included a codes and standards instrument, which are considered particularly effective, when combined with government STI programs, in enabling and accelerating the development and adoption of new technologies, because they help support technologies in the later stages of the innovation chain, including the commercialization stage, at a relatively lower cost of delivery, compared to deployment incentive instruments.

In contrast, none of the conventional case studies included any instruments beyond the demonstration stage of the innovation chain, which is the traditional boundary for government STI programs.

Comparative administrative costs of the experimental versus the conventional policy approach

The results and findings for this question were a little unexpected. While the literature on whole-of-government policy approaches suggests that administrative and implementation costs could be both potentially higher or lower, interviewees providing input on the experimental case studies were of the strong opinion that administrative costs to deliver the experimental policy approach were actually lower than for conventional policy mixes. The main argument provided by interviewees is that while there are higher upfront costs in terms of planning, communications, and coordination, these costs are more than offset by administrative cost savings that are achieved by combining processes for two or more instruments, during all three of the design, implementation and audit/evaluation stages. These results are supported by information provided on the three experimental case studies in chapter 5. The rest of this section unpacks these results and findings, and provides specific examples of cost reductions achieved.

In terms of increased upfront administrative costs, interviewees were of the view that increased costs, due to the need for greater planning, coordination and communication, were relatively small and time-limited, occurring over a matter of just a few months, in the early stages of implementation following the design stage. Once this early coordination work had been completed, attention was turned to implementation, where the bulk of the administrative cost savings are achieved, over the full timeframe of the policy mixes, measured in years. This factor helps to provide a cap on any incremental upfront costs of administering the experimental policy mixes.

Interviewees were of the opinion that net administrative cost savings were achieved, for experimental case studies, at all stages of the policy process, namely at the

design, implementation and at the audit/evaluation stages. At the design and implementation stages, the degree and types of administrative cost reductions observed, where interviewees identified cost savings, are shown in Table 38 below.

Table 38 – Administrative Cost Reductions at Design & Implementation Stages

	Formal Policy Mix		
	EVAF	Smart Grids	CERRC
DESIGN			
• Same Memorandum to Cabinet	3/3	2/2	5/5
• Same Treasury Board Submission	3/3	2/2	5/5
• Same program Terms & Conditions			
• Common implementation plan	2/3	2/2	5/5
IMPLEMENTATION			
Announcement & Communications			
• Same web site		2/2	3/5
• Same announcement		2/2	3/5
Shared Personnel			
• Shared personnel		2/2	
Proposal Solicitation			
• Same program Terms & Conditions			
• Same call for proposal process		2/2	3/5
• Same proposal solicitation announcement	some	2/2	3/5
• Same applications guide		2/2	3/5
• Same application template		2/2	3/5
• Same email address for receipt of proposals		2/2	3/5
• No wrong door - proposals redirected	3/3	2/2	5/5
• Same communications w proponents		2/2	3/5
• Hybrid projects accepted		2/2	
Proposal Review & Project Selection			
• Same proposal review committees		2/2	3/5
• Same governance committees			
• Same executive final decision			
• Same announcement of selected projects		2/2	3/5
Project Administration			
• Same administration team			
• Same due diligence processes			
• Same agreement template			
• Same financial management process			
• Same document management system			
• Same weekly coordination meetings	3/3	2/2	5/5
• Same communications w proponents		2/2	3/5
• Same reporting		2/2	3/5
• Same project audit processes			
Reporting			
• Same reporting to public		2/2	3/5
• Same reporting metrics			
• Same lessons learned processes		2/2	

A fraction (e.g. 5/5 or 2/3) indicates that a single, common approach or process was used for 5 out of 5 policy instruments, or 2 out of 3, as the case may be for step in the process, for each case study. This fraction is representative of the savings achieved. For

example 2/2 could translate into actual costs to deliver an experimental mix as being ½ of the costs of delivering a similar mix using a conventional approach, or up 50% cost savings. In a second example, a 5/5 might translate into an actual cost of delivery of 1/5th the cost to deliver the conventional policy mix, or up to 80% in cost savings for that part of the process. Note the variations between cases, which are explained below.

As can be seen from the table, there are clusters of processes where cost savings were achieved. At the design stage, cost savings were achieved by packaging instruments together in policy mixes and documenting these in single Memoranda to Cabinet, Treasury Board Submissions, and implementation plans. This is contrasted in the design approach for conventional policy mixes where individual instruments may be brought forward under separate documents, which adds and duplicates costs.

At the implementation stage, costs savings were primarily achieved in the following areas: (i) announcements and communications, (ii) shared personnel, (iii) proposal solicitation process, (iv) proposal review and selection process, and some aspects of (v) project administration and (vi) reporting.

For example of an implementation stage cost savings, the Smart Grids and CERRC policy mixes each used one common web site to communicate with the public on matters that relate to multiple policy instruments.⁷⁴ In this case, administrative cost reductions are achieved in terms of web page design and developing single announcements, rather than having to duplicate web pages and announcements for each instrument in the policy mix, as is done for a conventional policy mix.

⁷⁴ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793> and <https://www.nrcan.gc.ca/reducingdiesel>

Administrative cost savings were also significantly observed to occur during the proposal solicitation process. In the case of each of the Smart Grids and CERRC policy mixes, many aspects of this process were made common for two or more policy instruments, for example implementing a single call for proposals, with a single application guide and common application template, as well as a single contact for submission of applications, and a single process to answer the public's questions.

The EVAF policy mix achieved relatively fewer administrative cost reductions, compared to the Smart Grids and CERRC cases, primarily because the demonstration and deployment components of the policy mix were administered as separate, distinct instruments. There were some administrative cost reductions relating to the fact that the deployment and codes & standards components were administered by the same organization, but these savings were considered to be more modest.

Although administrative cost savings were observed and described, at the design and implementation stage, these could not be quantified, and are simply described qualitatively, as applicable for different components of the administration process.

The above table is also useful in identifying processes for which cost savings were not achieved. These represent potential opportunities for achieving further integration of processes and cost reductions, in the future. Areas for future consideration for administrative cost savings, include: (i) combined governance processes for executive decision-making; (ii) combined financial management systems; and (iii) combined project administration and project disbursement processes.

At the audit / evaluation stage, there were significant cost savings achieved for two out of three experimental case studies, in the order of 50% or more, because different

instruments in the policy mix were audited and evaluated together, as opposed to separately, which is the case for the conventional case studies.

The amount of cost savings achieved is proportional to the number of policy instruments in the formal policy mix. For example, in the case of the Smart Grids case study, given that there were two policy instruments, and that there is a single joint audit and evaluation planned for the formal policy mix, there is at least a 50% cost reduction, compared to the case where each of the two policy instruments would be audited and evaluated separately. In this particular case, given that the audit and evaluation will be also be combined, there are additional cost savings but these are not counted in this case, as this is part of a broader, more generalized trend towards combining audits and evaluations, as observed in the significant number of ‘joint projects’ in NRCan’s 2019-24 Integrated Audit & Evaluation Plan.⁷⁵

These cost savings, for experimental cases, can be contrasted with the situation for conventional case studies, where according to interviewees, there were separate audits and evaluations for each of the policy instruments in the formal policy mix. A summary comparing the number of audits and evaluations conducted for the conventional versus experimental case studies is shown in Table 39 below. Assuming an average cost of \$125k per audit or evaluation, and a timeframe of 1 year to complete such audits or evaluations, the dollar savings can be estimated in the range of one to several hundreds of thousands of dollars, per policy mix. In addition, more audits and evaluations can be completed in a shorter timeframe.

⁷⁵ <https://www.nrcan.gc.ca/nrcan/transparency/reporting-accountability/plans-performance-reports/audit-evaluation/annual-plans/natural-resources-canada-2019-24-integrated-audit-evaluation-plan/22240>

It is interesting to point out that NRCan's Audit & Evaluation Branch appears to have understood, early on, that there were opportunities for efficiencies and cost reductions. It had initially proposed auditing and evaluating the individual instruments in the policy mixes independently, per conventional practice. However, following discussions with staff delivering the policy mixes, it adjusted its Integrated Audit & Evaluation Plan, to combine audits and evaluations and examine the policy mix as a whole. In doing so, it achieved significant efficiencies and cost savings.

Table 39 – Comparison of Administrative costs for audits & evaluations for conventional versus experimental case studies and expected cost savings

Policy Mix	Conventional or Experimental	Number of Instruments in Formal Policy Mix	Number of Evaluations	Number of Audits	Total Audits & Evaluations	Approx. cost Savings (%) vs Conventional Case Studies	Approx. cost Savings (\$k) vs Conventional Case Studies
TEAM	Conventional	8	8	?	8	N/A	N/A
CEF	Conventional	1	1	1	2	N/A	N/A
ERPP	Conventional	1	1 joint audit / evaluation		1	N/A	N/A
EVAF	Experimental	3	3 joint audits / evaluations		3	0%	-
Smart Grids	Experimental	2	1 joint audit / evaluation		1	50%	125
CERRC	Experimental	5	1 joint audit / evaluation		1	80%	525

6.4 Q2 – Are conditions for success observed more in the experimental vs conventional case studies?

The second research question continues with the assessment of the experimental approach, and with the comparison of the experimental group of case studies versus the conventional group. This time, the comparison looks at the relative presence of 11 conditions, suggested by the literature, required for the successful implementation of horizontal, whole-of-government policy approaches, between the two groups of cases. As was shown in section 2.5, the experimental policy approach shares many features with, and can be thought of as a special case of, a whole-of-government policy approach. Given this point, the 11 conditions can therefore be applied to the experimental case studies.

The goal of this comparison is to gain further insights and explain differences between the experimental and conventional policy approaches, by identifying conditions where the differences are most salient. The data for this comparison is found in the description and analysis of each of the six case studies, in chapters 4 and 5, as well as in the tables included in Appendices D-I. These tables are used to provide a basis for comparing the two groups of case studies, as summarized in Table 40 below. The methodology used to answer question 2 was provided in section 3.8, and is not repeated here.

Overall, conditions for successful implementation were observed more often in the experimental versus conventional case studies, with an overall improvement from medium to medium-high, or 1 degree of improvement over 5, in 9 out of the 11 data points measured.

As seen in the table below, the largest differences(2 degrees of improvement) between the two groups are observed in 2 out of 11 conditions, namely for: shared measurement and accountability framework. A single degree of improvement is observed in the case of 7 out of the 11 conditions for successful implementation, namely for: common goals, mutually-reinforcing activities, continuous communications, catalysts & champions, tools and resources, role of central agencies and mandate/expected outcomes. Finally, 2 out of 11 conditions were not considered relevant, namely: backbone organization and costs and benefits. Only one case study (TEAM) included a backbone organization, and this organization was disbanded partway through implementation; therefore its impact was considered to be relevant. For costs and benefits, there was no perceived need for incremental costs, given the findings in section

6.3, which found that the experimental approach resulted in cost savings, as opposed to incremental costs; therefore, this condition is also considered not relevant.

Table 40 – Conditions for successful implementation – comparison of conventional versus experimental case studies

#	Conditions	Measure	Conventional				Experimental			
			TEAM	CEF	ERPP	Aver.	EVAF	SG	CERRC	Aver.
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	Med-Low	Med	Med	Med	Med-High	Med-High	Med-High	Med-High
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med-Low	Med	Med-Low	Med-Low	Med	Med-High	Med-High	Med-High
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med-Low	Med	Med	Med	Med	Med-High	Med-High	Med-High
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	Med-Low	Med	Med	Med	Med	High	Med-High	Med-High
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	Med-Low	None	None	None	None	None	None	None
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	Med	Med	Med	Med	Med	Med-High	Med-High	Med-High
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	Med	N/A	N/A	N/A	Med-Low	Med-High	Med-High	Med-High
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	Med-Low	Med	N/A	Med	Low	Med-High	Med-High	Med-High
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med	Med	Med	Med	Med	Med-High	Med-High	Med-High
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	Med-Low	N/A	N/A	N/A	Med	Med-High	Med-High	Med-High
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	Med	Med	Med	Med	Med-High	Med-High	Med-High	Med-High
			Med-Low to Med	Med	Med	Med	Med	Med-High	Med-High	Med-High

Selected highlights of key differences between the experimental and conventional group of case studies are briefly described below.

- Shared Measurement: Two out of the three experimental case studies (Smart Grids and CERRC) established some shared measurement metrics between the instruments in the policy mix, which were specific to the technologies/sectors targeted. This is contrasted with the conventional case studies, where the shared metrics were at best, at a high level, such as jobs created or estimated GHG emission reductions.
- Accountability Framework: In the case of the experimental case studies, there were adjustments made to the accountability framework to account for the dual nature of the policy mix, i.e. at both the instrument and at the policy mix level. This is reflected in reporting requirements as well as in the combined audits and/or evaluations that are planned to be conducted for the policy mix as a whole, for the Smart Grids and CERRC cases. This approach was not observed for the conventional case studies or for the EVAF experimental case.
- Common goals: For the experimental group of cases, a common understanding of the problem, vision for addressing the problem, and common goals were articulated at the policy mix level. These were detailed and specific. The goals of the different instruments were also designed to be better aligned with the common goals, and more reinforcing, than was the case for conventional case studies.
- Mutually-reinforcing activities: the experimental group had more mutually-reinforcing activities, because this was an important design consideration.
- Continuous communications: For the three experimental cases, there were regular and frequent meetings and communications to coordinate the design and early

implementation of the policy mixes. In addition, in the case of the Smart Grids and CERRC cases, these regular and frequent communications continued throughout the implementation stage, particularly for joint announcements and call for proposals processes. In contrast, for the conventional group, communications were much more limited between organizations delivering individual instruments.

- Catalysts & Champions: Both the conventional and experimental groups of case studies benefited from certain catalysts, or triggering events, as well as from the actions of certain individuals who acted as champions. However, in the case of the conventional case studies, the champions appeared to be primarily interested in advancing the specific policy instrument or technology component which they represented (e.g. TEAM government STI program within policy mix or CCS component within CEF), as opposed to the policy mix as a whole. For both the Smart Grids and CERRC case studies, certain individuals championed the overall policy mix approach, to both improve the odds of obtaining favorable funding decisions from Infrastructure Canada at the design stage, and to improve effectiveness at the implementation stage.
- Tools, resources and capacity building: For the Smart Grids and CERRC experimental cases, organizations worked together to develop a significant number of new tools and resources. Examples include: a common web site; common proposal solicitation, review and selection processes; common reporting templates; etc.
- Mandate and expected outcomes: It was observed that central agencies provided more detail on expected outcomes, for the policy mix as a whole, for the

experimental group compared to the conventional group. For example, the EVAF case study included specific targets for installations of electric vehicle charging infrastructure along major highways across Canada.

6.5 Q3 – Differences in observed improvements & benefits among the experimental case studies?

The third research question continues with the assessment of the experimental policy approach, and seeks to gain insights on the design and implementation of this new policy approach. In order to do this, the third research question first compares the three experimental case studies against each other, to first observe any differences in the improvements and benefits observed among the three experimental cases, and second to try to understand what could help explain those differences. Four comparative analyses are conducted to identify potential causes for the differences in the improvements and benefits observed, utilizing the data used to describe experimental case studies, in chapter 5, including:

- (i) Differences in the degree of tightness of bundling of the policy mixes;
- (ii) Differences in the coverage along the innovation chain of the policy mixes, as well as mapping of the policy mixes on the TLR and CRI scales;
- (iii) Differences in some of the 21 characteristics of the three case studies; and
- (iv) Differences in the observed conditions for successful implementation, per data from section 6.4 above.

Comparing experimental case studies – improvements and benefits

The first comparison to be examined relates to the differences in the three indicators of improvements observed among the three experimental case studies, shown in Table 41 below. Note that this summarizes the information that was presented in Chapter 5. In

general, there were slight differences among the cases, for each of the three indicators.

The explanations of the differences provide some interesting insights and describe some of the nuances in design and delivery, underlying these differences.

Table 41 - Comparison of experimental case studies – 3 Indicators of Improvement & Benefits

Indicator	Experimental		
	EVAF	Smart Grid	CERRC
Consistency of policy Instruments	Med to Med-High	Med-High	Med-High
Coherence of policy processes	Med	Med-High	Med-High
Comprehensiveness of the policy mix	Med-High	Med to Med-High	Med-High

In terms of consistency of elements, the Smart Grids and CERRC case studies were assessed as having slightly higher ratings than the EVAF case study. It should be noted that elements of the policy mix were designed to be consistent with one another, at the design stage, for all three experimental case studies. However, for Smart Grids and CERRC, consistency of elements was further reinforced through tighter integration during the implementation stage, particularly through integrated delivery between the demonstration and deployment components of the policy mix. This tighter integration was achieved through combined announcements, use of a single web site, combined call for proposals processes, and combined proposal review and selection processes, facilitated by frequent coordination meetings between the different groups implementing the different instruments in the policy mixes. This greater level of integration, at the implementation stage, was not implemented as much in the case of the EVAF policy mix, as there was fewer coordination meetings and no attempt at combining implementation processes between the demonstration and deployment components. However, for EVAF, there was a good degree of integration between the deployment and codes & standards

components, which were administered by the same team. Additional detail, for each of the 6 sub-components for consistency of elements, is provided in Appendix J.

In terms of coherence of processes, both the Smart Grids and CERRC policy mix were rated relatively higher than EVAF on coherence of processes because:

- (i) The instruments in the formal policy mix were administered in a highly coordinated fashion, at the design, implementation and audit / evaluation stages. At the implementation stage, several policy instruments, including the demonstration & deployment components, used the same call for proposals process, same review committees to review and select proposals, and same communications process for announcements, which was not the case for EVAF.
- (ii) There was frequent and consistent engagement between the organizations, namely the Office of Energy R&D and the Renewable Energy & Electricity Division, on the design and delivery of both the Smart Grids and CERRC policy mixes.
- (iii) The degree of synergistic policymaking and engagement is perceived as having a direct impact on the effectiveness of the policy mix, by interviewees.
- (iv) At the audit/evaluation stage, audits and evaluations were planned to assess all policy instruments as a group, instead of individually, for the Smart Grids and CERRC cases. For the EVAF, the different instruments making up the mix will be audited and evaluated individually.

Additional detail, for coherence of processes, is provided in Appendix J.

In terms of comprehensiveness, the EVAF and CERRC case studies were assessed as having slightly higher ratings than the Smart Grids case study because, having a greater number of policy instruments, i.e. 3 and 5 for EVAF and CERRC

respectively, versus 2 for Smart Grids, they were able to address a greater number of barriers in the innovation process. It should be noted that the difference in assessed rating between EVAF / CERRC and Smart Grids was relatively small.

Comparing experimental case studies – potential causes for observed differences

The second set of comparative analyses were conducted to identify potential causes for the differences in the hypothesized improvements and benefits, observed between the three experimental case studies. Five different comparisons were made, using the characteristics and features for each of the case studies, as described in chapter 5.

(a) Differences in the degree of tightness of bundling of the policy mixes:

The first comparison is in the degree of tightness in bundling. Note that this characteristic was measured for the formal policy mix, as all instruments that were added to the augmented policy mix are loosely bundled. As can be seen in Table 42 below, while all of the policy instruments in the Smart Grids and CERRC policy mixes were tightly bundled at all stages of the policy process, instruments for the EVAF policy mix were loosely bundled at the implementation and audit / evaluation stages. As was observed above, this is one of the reasons that the Smart Grids and CERRC policy mixes were assessed higher than EVAF for consistency of elements and coherence of processes.

Therefore, the degree of tightness of bundling appears to be somewhat correlated with the two assessment criteria of consistency of elements and coherence of processes.

Table 42 – Comparison of experimental case studies – Tightness of bundling

Process Steps	EVAF	Smart Grids	CERRC
Design	Tight	Tight	Tight
Implementation	Loose	Tight	Tight
Policy Evaluation	Loose	Tight	Tight

(b) Differences in the coverage along the innovation chain of the policy mixes, as per the mapping of the policy mixes on the TLR and CRI scales:

The second comparison is in the degree of coverage of the innovation chain, as well as coverage of the Technology Readiness Levels (TRLs) and Commercialization Readiness Index (CRI) scales. Note that this characteristic was measured for the augmented policy mixes, for all case studies, and included additional instruments at the R&D stage (e.g. Program of Energy R&D and Energy Innovation Program) and other stages (e.g.. other deployment or regulatory initiatives, where applicable) that were closely related to the formal policy mixes. As can be seen in Table 43 below, the EVAF policy mix had greater coverage of the innovation chain than the Smart Grids or CERRC policy mixes, because it had slightly higher coverage of the CRI scale, if compared to the other two mixes. The coverage of the CRI scale was greater for EVAF because its deployment incentives covered multiple commercial applications (CRI level 4) and supported a very large number of installations (e.g. over 800 electric vehicle charging stations) such that these deployment incentives are starting to drive the development of market competition, which in turn is beginning to support wider deployment of electric vehicle charging stations across Canada (assessed as partially meeting CRI level 5).

Table 43 - Comparison of experimental case studies – Coverage of Innovation Chain, TRLs, CRIs

Coverage Components	EVAF	Smart Grids	CERRC
Coverage of the Innovation Chain	1. Basic R&D to 5. Commercialization / Diffusion	1. Basic R&D to 4. Deployment	1. Basic R&D to 4. Deployment
Coverage of Technology Readiness Levels	1 - 9	1 - 9	1 - 9
Coverage of Commercialization Readiness Index	1 - 4.5	1 - 3.5	1 - 3.5

(c) Differences in the 21 characteristics of the three case studies:

The third comparison is in differences in the 21 characteristics used to describe each policy mix, between experimental case studies examined. Note that these characteristic were used to describe the augmented policy mixes, and included additional instruments at the R&D and other stages of the innovation chain. Table 108 in Appendix J depicts the 21 characteristics for the three experimental policy mixes, side by side. The majority of the characteristics are similar for all three mixes, and/or do not appear to have any correlations with differences in consistency, coherence or comprehensiveness. Focusing on differences, there were two that merit to be highlighted: (i) the number of policy instruments included in each policy mix, and (ii) the types of policy instruments included in each policy mix. These two characteristics are highlighted with shading in Table 44 below.

Table 44 – Selection of 21 Characteristics – highlighting differences

Category	Characteristic	EVAF	Smart Grids	CERRC
Instruments	Number of Instruments in policy mix	3 formal / 6 augmented	2 formal / 5 augmented	5 formal / 8 augmented
	Instrument - Type	3 (1) Regulations & standards; (5) Subsidies & incentives; (7) Government STI programs	2 (5) Subsidies & incentives; (7) Government STI programs	3 (5) Subsidies & incentives; (7) Government STI programs; (8) other

In terms of number of instruments in the policy mix, there was a significant difference between the cases, ranging from 2 instruments (Smart Grids) to 3 instruments (EVAF) to 5 instruments (CERRC), in the formal policy mix, and an additional 3 instruments in each of the mixes for the augmented policy mixes. A smaller number of instruments is easier to integrate and administer, but a larger number provides potentially

greater coverage of the innovation chain and of barriers to innovation, leading to better comprehensiveness. The CERRC case had the highest number of instruments, at 5 and 8, for the formal and augmented policy mixes, respectively. According to interviewees, this relatively high number of instruments in the mix did not appear to present significant issues, from an administration or coordination point of view. It is likely that the number could be increased before there any such administrative or coordination issues would be experienced. As was observed in the CERRC case study, a larger number of instruments, in a well administered experimental policy mix, appears to have a favourable impact on comprehensiveness.

In terms of types of instruments in the policy mix, per Table 44 above, the EVAF case had 3, Smart Grids had 2, and CERRC had 3 different types of instruments in the policy mix. All 3 policy mixes included a government STI and an incentive (deployment) instrument. In terms of differences in types of instruments, the EVAF mix included a third instrument to enable the development of new codes and standards, while CERRC had a third instrument, other, to help build capacity within northern and remote communities. As was previously mentioned, the inclusion of a codes and standards and capacity building instruments to the EVAF and CERRC mixes helped address additional barriers and positively impacted the rating on comprehensiveness. Conversely, interviewees for the Smart Grids case study mentioned that the lack of a codes and standards instrument (a third instrument) in the Smart Grids policy mix was noted and considered a weakness. Interviewees mentioned that a codes and standards instruments should be strongly considered for any future policy mix addressing smart grid technologies. In summary, an increased number of types of policy instruments in the mix

appears to be correlated with improvements in comprehensiveness, as more instruments, if properly designed, can help address more barriers in the innovation process.

(e) Differences in the observed conditions for successful implementation:

The fourth comparison looks at differences in the observed 11 conditions for successful implementation of whole-of-government policy approaches, between the three experimental case studies examined, using the data that was reviewed for question 2, in section 6.4 above. Out of 11 conditions, there were 7 where there are differences among the three case studies, as highlighted in Table 45 below.

Table 45 – Selection of 11 Conditions for successful implementation of WoG approaches – highlighting differences

#	Conditions	Measure	Experimental		
			EVAF	SG	CERRC
1	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med	Med-High	Med-High
2	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med	Med-High	Med-High
3	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	Med	High	Med-High
4	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	Med	Med-High	Med-High
5	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	Low	Med-High	Med-High
6	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med	Med-High	Med-High
7	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	Med	Med-High	Med-High
Summary- Overall			Med	Med-High	Med-High

Overall, the Smart Grids (SG) and CERRC case studies had a higher rating, for the 11 conditions, than the EVAF case, primarily because the policy mixes were more tightly bundled at all three of the design, implementation, and audit / evaluation stages. In contrast, the EVAF policy mix was less tightly bundled at the implementation and audit/evaluation stages.

This difference in degree of bundling translated into higher ratings, for Smart Grids and CERRC, in 7 out of the 11 conditions for successful implementation, compared to the EVAF case. Ratings for the remaining 4 out of 11 conditions were identical for the three experimental case studies. Highlights of the differences among the cases are provided below.

In terms of shared measurement and accountability framework, Smart Grids and CERRC established shared measurement metrics between the instruments in the policy mix, which were specific to the technologies/sectors targeted. In contrast, for EVAF, although there were some shared metrics, there was a relatively greater emphasis on establishing metrics that were specific to each instrument.

In terms of mutually-reinforcing activities, Smart Grids and CERRC had a greater number of synergistic activities at the implementation (e.g. combined announcement, communications, calls for proposals, review processes, etc.) and audit / evaluation (e.g. combined audits and evaluations) stages, compared to the EVAF case. In contrast, the EVAF mix had fewer such combined activities at the implementation stage and separate audits and evaluations planned for each instrument in the policy mix.

In terms of continuous communications, frequent and regular communications were maintained and continued into the implementation and audit / evaluation stages, for

Smart Grids and CERRC, as this was required to implement the mutually-reinforcing activities mentioned above. For EVAP, there was relatively less need for continuous communications, at the implementation and audit / evaluation stages, because at these stages, the demonstration and deployment components of the mix were administered separately.

In terms of catalysts and champions, there was a higher rating for Smart Grids and CERRC, if compared to EVAF, because champions advocated relatively more for greater integration of policy instruments, at all stages of the policy process.

In terms of tools, resources and capacity building, Smart Grids and CERRC developed new tools and capacities needed for the combined delivery instruments, at the implementation and audit / evaluation stage.

In terms of the role of central agencies, both the Smart Grids and CERRC policy mixes had greater involvement of central agencies during the implementation stage, than EVAF, due to the inclusion of a central agency-led initiative, i.e. the Impact Canada Initiatives, in the augmented policy mix. Given that this is a special case that is unlikely to be replicated in the future, this is noted as a ‘special’ difference only.

6.6 Q4 – Barriers & Constraints to implementing the experimental policy approach

The fourth research question is forward looking and looks at the primary barriers and constraints to further experimenting with, and implementing, the experimental approach, in the future.

Responses from interviewees are organized into five (5) categories of responses, summarized in Table 46 below. The categories of expected responses were developed based on insights gained through the literature review, leaving room for new and ‘other’

barriers and constraints to be captured as well. The sub-categories identified below reflect the specific responses, or data, from interviewees, associated with each category. These provide the interesting details as to the real and tangible barriers and constraints to be faced by public servants, who may be interested in continued, future implementation of this policy approach. The rest of this section expands on interviewees' responses for each category.

Table 46 – Barriers & constraints for future implementation of the experimental approach

#	Categories of Barrier or Constraint	Responses from interviewees
1	Organizational / Structural	Prioritization of vertical accountabilities (vs horizontal) Silo problems
2	Leadership	Lack of leadership awareness and support
3	Process-related	Lack of common processes Research collaboration process constraints
4	Complexity and Scale	# Instruments # Organizations within Departments & Agencies # Departments
5	Other	Low priority on 'experimentation' Departmental mandate to support multiple instruments Competition between innovative policy approaches

Organizational / structural barriers and constraints

The first category of barriers and constraints identified include organizational and structural barriers, specifically: (a) prioritization of vertical accountabilities versus horizontal accountabilities and (b) the persistence of silo problems.

Interviewees for the experimental case studies examined, identified the traditional tug of vertical accountabilities, as well as the persistent 'silo problem', as being barriers to the future implementation of the experimental approach. They stated that, in their opinion, the experimental approach was 'fragile', in that it required strong leadership awareness and support, as well as good chemistry between collaborating organizations.

Interviewees were keenly aware that the experimental approach is still new and unproven. They acknowledged that any setbacks or even small, partial failures, such as miscommunications between different organizations, could lead senior management to revert back to ‘tried and true’ traditional vertical approaches. The above findings are well aligned with the literature on whole-of-government policy approaches. These barriers and constraints could potentially be overcome through increased awareness of the benefits of the experimental approach, as well as through additional robust evidence demonstrating the approach’s advantages compared to conventional approach. Such evidence may be available in the near future through planned audits and evaluations of the policy mixes examined.

The prioritization of vertical accountabilities and persistence of silo problems are closely related to leadership-related issues, which are presented next.

Leadership-related barriers and constraints

The second category of barriers and constraints identified include leadership-related issues, specifically: (a) lack of awareness in this approach, and (b) lack of leadership support, leading to lack of adoption and implementation of the experimental approach, at both the design and implementation stages of the policy process.

Interviewees identified that there was relatively low awareness of the experimental policy approach at the senior management level of NRCan (i.e. above the Director General level), namely at the Assistant Deputy Minister, Deputy Minister, and Minister level. There are several reasons for this lack of awareness: (i) the experimental policy approach is relatively new; (ii) there is no accepted “label” or “name” for the experimental policy approach; (iii) the approach can be considered fairly difficult to

explain; and (iv) design and implementation of this policy approach typically occurs at a lower organizational level (i.e. Director General, Director, Manager, working level). In any event, this translates into lack of awareness, as well as lack of understanding of potential benefits, at the senior management level. This can be an important barrier to future implementation, because senior management has a significant role in shaping proposals that go to Cabinet and Treasury Board for ultimate approval. A lack of awareness at this level is likely to result in lower adoption of the experimental approach in the future.

Lack of leadership support, at the design and implementation stages, was also identified as a potential barrier to future adoption and implementation of the experimental approach. According to interviewees, lack of leadership support can result from prioritization of vertical accountabilities and/or a lack of willingness to work horizontally with other groups, due to organizational rivalry for budget resources and policy mandates. This rivalry between horizontal groups could be grounded in the sincere belief that their organization, and/or policy instrument, could be more effective than others' in meeting government goals and objectives. Organizations tend to be most familiar with their own activities, and the policy instruments and approaches for which they are responsible for. They are therefore best able to articulate strong rationales for proposals that use of their organizations' staff and resources, rather than for a combined, integrated proposals involving other organizations. This type of barrier is consistent with the literature, especially Public Choice Theory as it relates to bureaucracy, for example in the work of William Niskanen (e.g. Niskanen, 1971). To be clear, interviewees did not identify that there were cases of lack of leadership support for the experimental policy

approach in the case study examined. Rather, interviewees stated that future successful implementation of the experimental approach would require strong leadership support.

Process-related barriers and constraints

The third category of barriers and constraints identified include process-related issues, specifically: (a) the need to develop additional common processes to facilitate future implementation and (b) process constraints which limit research collaborations between federal researchers and external parties, such as academia and private companies.

Interviewees identified the need to develop additional common processes as a means to gain further support for the experimental approach, by streamlining processes and lowering costs. However, there are barriers to implementing these additional process improvements. As was noted in section 6.3, most of the administrative cost savings achieved by using the experimental approach, to date, were achieved in ‘front-end’ processes, through the use of common announcements, communications, and proposal solicitation and selection processes. Interviewees identified ‘back end’ processes as being potential, future cost reduction and streamlining opportunities. Future opportunities could include: developing common terms & conditions for all policy instruments, developing a single contribution agreement template used for all instruments in the policy mix, creating a single common administrative group processing claims and finances for all instruments in the mix, as well as developing a single set of reporting requirements.

The barriers to achieving the above include: (a) administrative difficulties and time required to develop common terms & conditions and/or common agreement templates that cover organizational and technical requirements of the different policy instruments being combined; (b) administrative difficulties required to change

departmental financial systems, which have been in place for decades and are designed to reinforce vertical accountabilities; and (c) resistance to change, especially outsourcing agreement administration to another group.

Interviewees identified a second process-related barrier, this one related to research collaborations between federal researchers and external parties. This issue appears to be specific to the Canadian federal government, and is the result of the long-standing, fundamental principle of the separation between (a) funding for government operations (i.e. federal researchers) and (b) funding for parties external to the federal government (i.e. private companies, universities, research centres, etc.). Each type of funding is actually “voted” on separately by federal parliamentarians, and reported on separately by departments in their annual reports. Departments, such as NRCan, are prohibited from using vote 10 G&C funding, intended for external parties, for government operations (vote 1), and vice versa. As a result of this policy, NRCan’s legal and compliance groups, who are responsible for ensuring compliance with the above policy, have tended to take a very conservative approach to collaborative S&T research.

This conservative approach to collaborative research has resulted in much fewer, and much less effective, collaborations between federal researchers and external parties than could be the case, than if this barrier did not exist. Recently, NRCan has started experimenting with a potential mechanism to overcome this barrier, called a Science & Technology Assistance for Cleantech (STAC)⁷⁶ project agreement, which formally allows such collaborations to take place. However, STAC projects are still new, are not

⁷⁶ <https://www.nrcan.gc.ca/climate-change/canadas-green-future/clean-growth-programs/applicants-guide-clean-growth-program/20043>

currently allowed for the policy mixes examined in this thesis. According to interviewees, addressing this barrier to collaboration, in the future, would likely lead to much greater collaboration and to much more effective policy mixes.

Complexity / scale-related barriers and constraints

The fourth category of barriers and constraints identified include complexity and scale. As was observed in the experimental case studies examined, implementation of the experimental policy approach was done at a relatively small scale, with a relatively small number of instruments (2-5 in the formal policy mix), and in all cases, within the boundaries of a single, federal department, namely NRCan.

According to interviewees, scaling up the experimental approach to include a larger number of instruments, organizations within departments, and departments would likely involve some “growing pains” and should be approached carefully and incrementally. There are likely constraints, in terms of maximum number of instruments, organizations and departments that can be feasibly included in the effective implementation of the experimental approach, due to the need for substantial coordination and communications amongst organizations delivering the policy mix.

In terms of the experimental case studies examined, the CERRC policy mix was the most complex, with 5 instruments and 4 separate NRCan organizations involved in delivering the formal policy mix, and 8 instruments in the informal augmented policy mix. As observed in the examination of this case study, at this scale, the implementation of the experimental approach was feasible and effective. However, it should be noted that all organizations are within a single department and have a long history of experience in working together.

Based on the case studies examined, it is likely that the maximum of policy instruments that could be included in an effective experimental policy mix would be in the range of 10-20 policy instruments, at most. This estimate is based on the fact that there are 8 instruments in the CERRC augmented policy mix, and that interviewees mentioned that they were looking at expanding this in the future. It is possible that, as experience is gained and operationalized, a greater number of instruments could be combined in a mix in the future. The maximum number of policy instruments that can be accommodated in an effective policy mix is likely a function of the type of instruments added to the mix.

The case studies examined provided some insights as to the types of additional policy instruments that could be added to larger policy mixes in the future. This includes instruments that:

- (i) Add depth of coverage at different stages of the innovation chain, for example additional government STI programs, including those that take a different approach to innovation such as technology challenges;
- (ii) Extend the timeframe of different instruments into the future;
- (iii) Extend the reach of instruments to segments along the innovation chain that are not adequately covered by the existing instruments, such as the later stages of the Commercialization Readiness Index, for example commercialization loans; and
- (iv) Extend the reach of instruments to address systemic issues, such regulations and public education about the benefits of new technologies.

In terms of the maximum number of individual organizations, or departments,

involved in an experimental policy mix, based on the case studies examined, it is difficult to imagine an effective mix involving more than 6-10 organizations, given the need for significant amount of coordination and communications. This estimate is based on the experience of the CERRC policy mix, which currently includes 4 separate organizations. Interviewees shared that they were exploring the possibility of expanding the CERRC policy mix, in the future, to include policy instruments administered by two other organizations, in this case the Northern REACHE administered by the department of Indigenous Services Canada (ISC), as well as other instruments administered by the department of Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). This would add 2 additional organizations, in this case 2 new departments, to the 4 organizations currently administering the CERRC policy mix.

It was generally felt that adding additional instruments delivered by organizations within a particular department would be significantly easier than adding instruments delivered by a separate department.

‘Other’ barriers and constraints

The fifth category of barriers and constraints identified include ‘other’, which captures various other insights provided by interviewees. Three specific barriers and constraints to the further adoption and implementation of the experimental approach were identified: (a) the relatively low priority of policy experimentation within the larger Budget proposal process; (b) organizational mandate constraints; and (c) competition with other experimental approaches.

The first ‘other’ barrier, to be identified, is the relatively low priority of policy experimentation within the Budget proposal process. In shaping, reviewing and

approving Budget proposals and Treasury Board Submissions, Cabinet and Treasury Board Ministers need to consider a wide range of considerations, including policy content (what), stakeholders (who) and policy delivery (how). For example, Cabinet may need to take into consideration and prioritize the immediate needs of society, for example responding to a recession or crisis, such as the COVID-19 pandemic, as was the case in 2020-21. Cabinet may also need to consider new, relatively urgent political priorities that were recently advanced by various stakeholders, or are in response to global developments. In 2020-21, in the area of clean energy, the federal government prioritized the development of two new technological / sectoral strategies: the Hydrogen Strategy for Canada⁷⁷ and the Small Modular Reactor (nuclear) Action Plan,⁷⁸ which were developed in part due to provincial political considerations. Within such a political environment, policy experimentation, which is concerned with optimizing how government operations work, has a relatively lower priority compared to other issues. Under these conditions, the onus then falls to middle management to insert policy experimentation within new initiatives. However it is harder to do so if the government's focus is on other, more pressing issues.

The second 'other' barrier and constraint identified is related to organizational mandates. As it turns out, the experimental approach is best suited to organizations, such as NRCan, who have the mandate to support and implement multiple policy instruments, at any one time. In the years prior to 2016-17, NRCan was already implementing, and

⁷⁷ <https://www.canada.ca/en/natural-resources-canada/news/2020/12/minister-oregan-launches-hydrogen-strategy-for-canada.html>

⁷⁸ <https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/nuclear-energy-uranium/canadas-small-modular-reactor-action-plan/21183>

had significant experience, with a range of policy instruments, such as government STI programs, deployment incentives, regulations, standards, capacity building, etc., before these were combined together into the experimental policy mixes. Organizations with a more narrow focus, such as specialized agencies, may be constrained in the number of policy instruments they can implement. For example, as was mentioned in chapter 1, Sustainable Development Technology Canada (SDTC), a foundation set up “to develop and demonstrate new technologies to promote sustainable development” (Justice Canada 2001), is constrained in its mandate to focus on late-stage technology development and demonstration only. Similarly, the National Research Council (NRC) also has a primary focus on basic and applied research and development, although it does also is involved in codes and standards.⁷⁹ Such organizations may not be able to implement the experimental policy mix approach on their own, or may only be able to partially implement such experimental approaches. Consequently, they may need to partner with other departments, such as NRCan, to do so. It would be up to NRCan and other departments to consider partnering with these specialized agencies to develop integrated policy mixes, but such inter-agency collaboration is not as natural as within a given department. Specialized agencies may be less aware and less interested in the experimental policy approach, given these organizational constraints. The above are barriers to further implementation of the experimental policy approach in the future.

The third ‘other’ barrier or constraint identified has to do with competition between innovative policy approaches. In 2016, when the Liberal government came into power, it signaled an openness to policy experimentation and even set up a new Impact

⁷⁹ <https://nrc.canada.ca/en>

and Innovation Unit within Treasury Board.⁸⁰ As a result, departments started experimenting with a variety of new approaches. For example, NRCan's Office of Energy R&D (OERD), which spearheaded the experimental approach examined in this thesis, also introduced at least two other significant policy innovations: (a) Technology Challenges, two of which were included, and described, in the augmented policy mixes for two case studies (see ERPP and CERRC case studies), as well as (b) a "Consolidated Program" approach, consolidating instrument delivery, previously delivered by three organizations (energy, mining, forestry), into one organization, for NRCan's new Clean Growth Program.⁸¹ Within this context, some policy experimentations may have a higher profile and visibility within government, than others, especially if they are endorsed and sponsored by central agencies. Interviewees stated that Technology Challenges, in particular, appeared to have much greater visibility at the senior management level, partially because these were co-delivered with Treasury Board. Within a competitive context, not all policy experimentation may be retained for future use. This competition may constrain the future implementation of the experimental policy approach examined in this thesis.

6.7 Conclusion

This chapter presented the results, analysis and findings related to the four research questions, and two sub-questions (1B and 3B), addressed in this thesis. These findings provide the foundations for the conclusions outlined in chapter 7, which follows.

In summary, the six key findings that were described in this chapter are that:

⁸⁰ <https://www.canada.ca/en/innovation-hub.html>

⁸¹ <https://www.nrcan.gc.ca/climate-change/canadas-green-future/clean-growth-programs/20254>

- 1) The experimental case studies were observed to result in improvements in the three assessment criteria (consistency of elements, coherence of processes, and comprehensiveness of the policy mix), compared to the conventional case studies. These findings are supported by input from interviews with public servants, which provided ratings and accompanying commentary/rationale, on 11 data points or sub-criteria. The comparative analysis of the interview data showed that there were improvements in 10 out of 11 sub-criteria, with the degree of improvement ranging from 1 to 2 degrees of improvement, out of 5 (ratings from 1-5, low to high). This is the most important finding from the research, in that it supports the hypothesis that the experimental policy approach results in improvements and benefits compared with the conventional policy approach. This finding is associated with question 1A.
- 2) The experimental case studies were observed to be delivered at a lower administrative cost than the conventional case studies, at all stages of the policy process. This finding is supported by a qualitative analysis of the policy mixes' comparative administrative costs, at each step of the policy process, supported by input and commentary from interviewees involved in the design, implementation and audit/evaluation of the policy mixes examined. This finding is also important in that it provides a preliminary indication that the experimental policy approach may have another benefit, in the form of lower administrative costs, which could be confirmed through upcoming audits and evaluations of the experimental policy mixes, expected to be completed over the coming years. This finding is associated with question 1B.
- 3) Conditions for successful implementation of whole-of-government policy approaches were observed to a greater extent in experimental versus conventional

case studies. This finding provides additional insights on the differences between experimental and conventional policy mixes. Improvements were seen in 9 out of 11 data points measured, with a single degree of improvement shown for 7 out of 11 data points, and 2 degrees or more of improvements observed for 2 out of 11 data points. This finding is consistent with expectations, as the experimental policy approach shares many features with whole-of-government approaches. This finding is associated with question 2.

- 4) There were observed differences between the three experimental case studies in consistency, coherence and comprehensiveness. This finding was expected as there were differences in the design, implementation and audit/evaluation phases of the policy process, among the three experimental policy mixes. This finding was supported by comparative analysis of the three evaluation criteria, and the 11 sub-criteria. This finding is associated with question 3A.
- 5) With regards to finding #4 above, there are credible explanations to explain those differences among the three experimental case studies. The findings were supported by four comparative analyses among the three experimental case studies, comparing design features or characteristics. This finding is associated with question 3B.
- 6) Eleven specific barriers and constraints to the future implementation of the experimental approach were identified.

Chapter 7: Conclusions, Alignment with Literature & Next Steps

7.1 Outline

- Introduction
- Conclusions & implications
- Contributions of this research to the literature
- Relevance of Rogge & Reichardt framework
- Next steps for research
- Conclusion – recap

7.2 Introduction

This final chapter is organized into four sections, followed by a recap. The first section discusses the major conclusions and implications of the research, building on the findings and analysis outlined in chapter 6. The second section describes the contributions that this research makes to the literature. The third section reflects on the relevance of the primary analytical framework used in this thesis, while the fourth section looks to the future and presents some ideas as to the next steps for this research. The conclusion provides a short recap of the research conducted.

7.3 Conclusions & Implications

The primary objective of this thesis is to conduct an early assessment of the experimental policy approach to determine if it has merit, compared to the conventional approach, and to uncover other insights on the experimental approach. This objective addresses the general policy problem, outlined in chapter 1, to find means to improve policy mixes, whose goal is to advance and support the development and adoption of new, clean energy technologies, to mitigate climate change. This objective also addresses the specific policy problems associated with conventional policy mixes.

This section presents this thesis' primary conclusion, related to the assessment, as well as six supporting conclusions that result from the findings and analysis. A summary

of these seven conclusions is shown in Table 47 below. The table also outlines implications for each conclusion and shows the linkage between the conclusions and the findings and research questions.

In summary, the primary conclusion is that the experimental approach shows significant promise, has merit, and provides an alternative policy approach, which results in benefits and improvements compared to the conventional approach.

Table 47 – Primary Conclusion and 6 Supporting Conclusions

Primary Conclusion		Questions
The evidence supports the conclusion that the experimental policy shows promise, has merit, and offers improvements and benefits compared to the conventional approach, for this policy field. <u>Implications</u> : potential for greater effectiveness and efficiency; pathways to better design policy mixes.		Q1
Supporting Conclusions		
1	There is a logical relationship between design / implementation of experimental policy mixes and observed improvements & benefits. <u>Implications</u> : preliminary theory of change provides plausible causal relationship; merits of experimental approach could be further supported by theory, to be confirmed by further research.	Q1, Q2 & analysis
2	In the real world, there are several variations of the experimental approach. <u>Implication</u> : Experimental approach is flexible. Awareness of variations provides diagnostic tool to dynamically improve policy mixes.	Analysis
3	There are opportunities for further improving the experimental policy approach. <u>Implication</u> : Experimental policy approach could potentially yield greater improvements and benefits in the future.	Analysis
4	Fuller implementation of the experimental approach results in greater improvements and results. <u>Implication</u> : Strive for fuller implementation.	Q3
5	The number of 'specific' technologies and sectors, around which experimental policy mixes can be designed, is likely limited. <u>Implication</u> : Positive impact on feasibility of technology/sector-specific policy mixes.	Analysis
6	Future implementation of the experimental approach faces barriers and constraints. <u>Implication</u> : Awareness of these could help reduce implementation risk.	Q4

The six supporting conclusions are:

- (i) The analysis conducted in this research has identified a logical relationship between the design and implementation features of the experimental policy mixes and the observed improvements and benefits, which can be thought of as a preliminary theory of change. This preliminary theory of change provides a plausible causal relationship between the design / implementation features and improvements and benefits, which could be further confirmed through future research.

- (ii) There appears to be variations in the design and implementation of the experimental approach, in the real world of policy making. An awareness of these variations provides policy makers with flexibility in terms of implementing the experimental approach. Such awareness could also help policy makers diagnose policy mixes, with a view to improving them.
- (iii) There appear to be opportunities to further improve the experimental policy mixes, for example by integrating additional processes and/or by adding instruments and delivery organizations, to extend the depth and coverage of the policy mix. This implies that additional benefits could potentially be realized in the future.
- (iv) There appears to be greater benefits related to a fuller implementation of the experimental policy approach. This implies that, where possible policy makers should strive towards this fuller implementation.
- (v) The number of ‘specific’ technologies and sectors, around which experimental policy mixes can be designed, is likely limited. In terms of implication, this has a positive impact on the feasibility of implementing technology/sector-specific policy mixes.
- (vi) The research has identified barriers and constraints to the future implementation of this approach. An awareness of these could help reduce implementation risks.

It should be stated that the conclusions apply only for the policy field covered in this thesis, which is clean energy technology development to reduce greenhouse gas emissions, in a variety of economic sectors, to foster a transition to a low-carbon energy future. It should also be noted that these conclusions are preliminary, given that this is a first, early assessment. Conclusions are limited to experimental policy mixes that are similar, in size and features, to the cases examined in this thesis.

The remainder of this section unpacks these seven conclusions.

Primary Conclusion: The experimental policy approach shows promise, has merit, and offers improvements and benefits compared to the conventional approach, for this policy field

The primary conclusion of the research is that the experimental policy approach appears to be a promising new approach, has merit, and offers improvements and benefits compared to the conventional approach. This conclusion is supported by the findings for question 1, which demonstrated that the experimental case studies results in improvements in consistency of elements, coherence of processes and comprehensiveness of the policy mix. In addition to this, the experimental policy approach is observed to: (ii) result in administrative cost savings compared to the conventional policy approach, per findings for question 1; (iii) address the three problems identified with the conventional approach outlined in chapter 1; and (iv) is suited to be implemented as a whole-of-government approach, per the findings for question 2, which are additional benefits.

One of the implications of this conclusion is that NRCan, and the federal government, could consider further experimentation with, and study of, this new approach. Next steps could include: (a) raising awareness of the new approach, including developing an appropriate and recognizable “label” or “name” for the approach; (b) sharing the results of this assessment with public servants currently involved in the design and delivery of policy mixes, as well as with senior management, and with audit & evaluation staff; (c) disseminating the results of this assessment more broadly, to departments outside of NRCan, and to central agencies; as well as (d) identifying opportunities to apply the experimental approach to new policy mix proposals, within NRCan, in the near future. The researcher was recently advised that the experimental policy approach is being very seriously considered for the renewal of one of the policy

mixes examined, starting in 2022-23.

Future experimentation with the new experimental approach could include additional assessments, to assess medium and longer-term effects, including effectiveness and efficiency. The upcoming audits and evaluations of the experimental policy mixes, scheduled to be completed over the next few years, could provide additional, useful information, provided that the planned audits and evaluations are conducted using a ‘policy mix’ lens. It is likely that the audit and evaluations methodologies will need to be amended or adapted, in order to examine aspects related to the policy mix as a whole. This thesis could help inform such methodologies.

This is a significant and important conclusion because the research indicates that the experimental policy approach provides a potential pathway to better design, implement and evaluate policy mixes, in this policy field. This is important because better approaches are urgently needed to tackle climate change. This conclusion suggests this experimental policy approach could help provide part of solution set to address this important, super-wicked societal problem.

One of the benefits of experimental policy approach is that it can be delivered at a lower administrative cost, due to cost savings achieved at each stage of the policy process, as demonstrated in section 6.3. The implications of this conclusion are that this important factor could help improve the case for further experimentation with, and assessments of, the experimental approach. This conclusion is important because the cost-effectiveness of policy approaches is an important consideration in policy decision-making, especially in resource-constrained government budgetary situations.

Another benefit of the experimental policy approach is that it addresses the

specific problems associated with conventional policy mixes. As indicated in chapter 1, these problems are rooted in the fact that the conventional approach is based on older, outdated assumptions and design principles, including: loosely bundled, siloed policy approaches (Colgan & al 2014, de Bri & Bannister 2010); incomplete innovation models (disconnected science, pipeline model) (Bonvillian & Weiss 2015); and older policy mix design approaches (Howlett & Rayner 2013). By contrast, experimental policy mixes are based on updated assumptions and design principles, including a whole-of-government policy approach, updated innovation model (connected science, extended pipeline model) which recommend coverage of all 5 stages of the innovation chain, and which address a greater number of barriers, as well as updated policy mix design principles that seek to increase desirable criteria such as consistency and coherence.

Supporting Conclusion 1: There is a logical relationship between design and implementation of experimental policy mixes and observed improvements & benefits; preliminary theory of change provides a plausible causal relationship

The analysis conducted in this research has identified a logical relationship between the design and implementation features of the experimental policy mixes and the observed improvements and benefits, which can be thought of as a preliminary theory of change. In turn, this preliminary theory of change provides a plausible causal relationship between the key attributes of experimental policy mixes (tightly bundled, compete and technology/sector-specific), selected research observations, and the observed improvements, namely: (i) improvements in consistency, coherence and comprehensiveness, (ii) administrative cost savings, and (iii) improvements in 7 out of the 11 conditions for successful implementation of whole-of-government (WoG) policy approaches. These plausible causal relationships are shown in Table 48 and 49 below.

Table 48 – Logical relationship between key design features and improvements in 3 evaluation criteria (consistency, coherence, comprehensiveness)

Key Attributes	Research Observations	Improvements in Assessment indicators for 3 indicators
Tightly Bundled	More integrated design of instruments & policy mix More integrated implementation Greater communications and coordination Audit/evaluate policy mix for lessons at policy mix level	Improved coherence of processes Improved consistency of elements
Complete	Better coverage of innovation chain Address more barriers to innovation	Improved comprehensiveness of policy mix
Technology/Sector-Specific	Increased specialization of administration staff More customized design of instruments & policy mix	Improved consistency of elements Improved comprehensiveness of policy mix

Table 49 – Logical relationship between key design attributed and improvements in 7 out of 11 conditions for successful implementation of WoG policy approaches

Key Attributes	Research Observations	Improvements in Assessment indicators 11 conditions for successful implementation
Tightly Bundled	More integrated design of instruments & policy mix More integrated implementation Greater communications and coordination Audit/evaluate policy mix for lessons at policy mix level	Common goals Shared measurement Mutually-reinforcing activities Continuous communications
Technology/Sector-Specific	Increased specialization of administration staff More customized design of instruments & policy mix	Tools, resources & capacity building Accountability framework Mandate & expected outcomes

Note that the logical relationships are inferred from research observations that are ‘logically’ associated with each key attributes. For example, integrated implementation of several instruments is linked with the ‘tightness of bundling’, and results in observed improvements in coherence. In the case of the three evaluation criteria, there is a clear relationship between key attributes and improvements in consistency, coherence and comprehensiveness. For example, a more complete policy mix results in improved comprehensiveness.

A similar relationship was shown to exist between the key attributes and the observed administrative cost savings that were observed for the experimental policy approach, as described in section 6.3.

In the case of the presence of 11 conditions for successful implementation of WoG approaches, a relationship can be inferred for 7 out of 11 conditions. The other 4

(e.g., catalysts & champions, role of central agencies, etc.) cannot be logically related to the key attributes, and are therefore independent of, and unrelated to, the key attributes.

The key implications of this are that: (i) this preliminary theory of change suggests that there could be a plausible causal relationship between the key attributes of the experimental policy approach, and observed improvements and benefits, and (ii) if the theory of change is confirmed in the future through further research, this could provide additional support for the merits of the experimental policy approach.

Supporting Conclusion 2: In the real world, there are several variations of the experimental approach

The analysis of the case studies in the thesis supports the conclusion that there are many different ways, or variants, in which the experimental policy approach can be implemented, and that the different variants each have different features, strengths and weaknesses. The three experimental case studies examined were quite different from one another and can be thought of as three such variants. Two of the conventional case studies examined, the CEF and ERPP cases, also exhibited some limited features of the experimental policy approach, in that they were both partially technology/sector-specific.

This conclusion is also based on the observation that in the ‘real-world’, conventional and experimental policy mixes are rarely ‘pure’, in the sense of exhibiting the features expected to be observed in ‘pure’ or ‘ideal’ conventional and experimental policy mixes. The real world is always a little bit more nuanced and complex than that anticipated by theory.

The above observation means that the experimental approach can be thought of as a policy approach that exhibits the three attributes (tightness of bundling, completeness of coverage of the innovation chain, technology specificity), which are implemented along a

spectrum or continuum, from lighter to fuller, as shown in Illustration 7, below. This spectrum or continuum could theoretically go from cases where none of the three attributes are observed, at the left of the illustration, to cases where some of the attributes are partially observed, as in the middle of the illustration, to cases where all of the three attributes are fully observed, as at the right of the illustration i.e. (pure experimental policy mix).

Illustration 7 – Attributes of experimental policy approach along a spectrum

No attributes observed	1 or 2 attributes partially observed	1 attribute fully observed	1 attribute fully observed	2 attributes fully observed	2 attributes fully observed	3 attributes fully observed
(pure conventional policy mix)			1 or 2 other attributes partially observed		3rd attribute partially observed	(pure experimental policy mix)

There are several implications to this conclusion. One implication is that the experimental approach can be thought of as a flexible approach, with different variants available to policymakers, depending on context and circumstances. For example, in the case of the EVAF case study, conditions were such that policymakers decided that the demonstration and deployment instruments should be delivered independently from one another. This was different than in the case of the Smart Grids and CERRC, where these instruments were delivered in a joint, combined manner. This provides policymakers with greater flexibility and options, in terms of implementation, if this flexibility is desired.

A second implication is that awareness of these variations, and of the above spectrum, provides a potential diagnostic tool to dynamically improve policy mixes. For example, a policy mix fully exhibiting two attributes, but only partially exhibiting one attribute, could potentially be improved by addressing the attribute that is partially

exhibited.

Supporting Conclusion 3: There are opportunities for further improving the experimental policy approach

Another conclusion that results from the findings and analysis is that there are opportunities for further improving the experimental approach. Improvements could be effected either through: (i) changes in the process of designing, implementing or evaluating the policy mixes, or (ii) by adding to the number and types of instruments and delivery organizations involved in the policy mixes, to add depth and coverage of policy mix, as shown in illustration 8 below.

Illustration 8 – opportunities to improve experimental policy mixes – depth and coverage

Ideas for improvements in process or depth/coverage are readily supplied by the analysis of case studies, as well as in the findings and results outlined in chapter 6. For a process improvement example, in section 6.3, the analysis of administrative cost savings identified additional process steps, which could be further integrated and combined, to yield additional cost savings and efficiencies, compared to conventional policy mixes. For a depth/coverage improvement example, additional instruments could be added in the commercialization/diffusion stage, to provide increased coverage across the later stages of the innovation chain.

An implication of this conclusion is that the experimental policy approach could potentially yield greater improvements and benefits, in the future, which could help

strengthen the case for its adoption. Another implication is that this also opens up the possibility of dynamic change, in the implementation of the experimental approach, over time, and along the above-mentioned spectrum. For example, it may be possible to change one, two or three attributes of an experimental policy mix, over time, to tighten the bundling, or increase coverage of the innovation chain, or improve comprehensiveness, through the addition of new instruments, and/or amendment of existing instruments. This conclusion ties in nicely with the historical-institutional literature on the processes of change and development of policy mixes (Howlett & Mukherjee 2014; Wellstead, Rayner & Howlett 2016).

Supporting Conclusion 4: Fuller implementation of the experimental approach results in greater improvements and results

The analysis of the case studies, and findings for question 3, which compared the three experimental case studies, supports the conclusion that the improvements and benefits observed are increased in the case of a ‘fuller’ implementation of the experimental approach. For example, indicators for improvements in consistency of elements, coherence of processes, and comprehensiveness were higher, in cases where bundling of the policy instruments in the mix was tighter, and/or coverage of the innovation chain was more complete, and/or the policy mix was more technology/sector-specific.

The implication of this conclusion is that, where possible, policymakers should strive for a fuller implementation of the experimental policy mix, rather than a lighter implementation, and that such fuller implementation is likely to lead to greater improvements and benefits. Again, it should be stated that the improvements and benefits assessed were only early indicators of success. Further research would be recommended to validate these conclusions, and to extend the assessment to medium and longer term

improvements and benefits, including effectiveness and efficiency.

Supporting Conclusion 5: The number of ‘specific’ technologies and sectors, around which experimental policy mixes can be designed, is likely limited

This thesis assessed an experimental policy approach, which includes the feature/attribute of technology/sector-specificity. For example, the specific technologies and sectors included in the three experimental case studies examined are: (i) the transportation sector, specifically focusing on electric vehicle charging and hydrogen refueling infrastructure; (ii) the electricity sector, specifically focusing on smart electric grid technologies, and (iii) renewable electricity and heating technologies for northern and remote communities. It is noted that these technology and sector categories are at the ‘meso’ scale. In other words, the technology specific categories are neither too narrow (e.g. for smart grid technologies: distributed energy resource management systems, a single type of smart grid systems), nor too broad (all technologies to reduce greenhouse gas emissions in the Canadian economy). The scale of technologies and sectors targeted by the experimental policy approach typically incorporate different but related technologies that provide similar functions, for example electricity generation, which are used by similar stakeholders (e.g. electricity generation or production companies).

With regards to the potential future implementation of the experimental policy mix, an interesting question that may need to be answered is: how many different policy mixes would be needed to provide coverage of all clean energy technologies and energy sectors, required to effectively mitigate climate change in Canada? This question could also be posed in terms of degree of technology/sector specificity, or granularity, required for an effective technology/sector-specific policy mix.

Although the above question was not included as part of the formal research

questions in this thesis, interviewees expressed the view that the degree of technology specificity, applied in the experimental policy mixes examined, was sufficiently ‘granular’ to result in improvements and benefits. This insight is helpful in that it suggests that the number of specific technologies or sectors, around which experimental policy mixes would need to be designed, is likely limited to a feasible number, estimated at between 25-50 technologies/sectors. A listing of such ‘specific clean energy technologies/sectors’ could be an interesting future research topic. In order to develop such a list, a good place to start would be to review clean energy technology development plans developed by the IEA or federal government organizations, such as NRCan or the US Department of Energy. The ‘technology/sector’ granularity of such plans has been developed over decades, incorporating insights as to how best to group technologies, from a technology development perspective.

The implication of this conclusion is that there is a limit to the number of policy mixes that may need to be designed and implemented to address all clean energy technologies and sectors, and that the number is likely to be feasible. This in turn means that the wider use of the experimental policy approach is also likely to be feasible.

Supporting Conclusion 6: Future implementation of the experimental approach faces barriers and constraints

The final conclusion of the thesis is related to question 4, which sought to better understand the barriers and constraints to implementing the experimental policy approach in this policy field. The findings in section 6.6 identified 5 categories of barriers and constraints, including: organizational/structural, leaderships-related, process-related, complexity/scale-related, and other. It detailed 11 specific barriers and constraints identified by interviewees.

The implications of this conclusion are that: (i) awareness of these barriers and constraints could help reduce implementation risks; and (ii) effectively addressing these barriers and constraints could help ensure that the potential benefits of the experimental approach are realized.

In order to address these issues, there is a need for a concerted effort to raise awareness of the experimental policy approach and of its benefits. This includes sharing results of this assessment with NRCan staff, including senior management and audit/evaluation staff, and disseminating results of this assessment more broadly, to other federal departments and to central agencies.

7.4 Contributions of Research to the Literature

The research completed in this thesis contributed to the literature, in the following areas:

Table 50 – Contributions to literature

1	First assessment of the experimental approach in Canada.
2	Conclusions that experimental policy approach results in improvements in consistency, coherence and comprehensiveness. Also, contributed a number of supporting conclusions and findings.
3	Developed methodology for assessment of experimental approach.
4	Research experience and empirical data using Rogge & Reichardt (2016) analytical framework for assessment of policy mixes.
5	Addressed forward research agenda item, identified by Rogge & Reichardt (2016) with regards to methods to improve consistency of elements and coherence of processes.
6	Strengthened research linkages between policy mix studies and innovation theory.
7	Strengthened research linkages between policy mix studies and whole-of-government literature.

First, this was the first examination and assessment of the experimental approach, given that it is relatively new, having been introduced in Canada, in 2016-17. This thesis helps to better understand problems with conventional policy mixes, which the new

approach tries to address, as well as the design features of the experimental policy approach, which are shown to be well supported by the literature on policy mixes, whole-of-government policy approaches, and innovation theory.

Second, the thesis contributes findings and conclusions directly related to the early assessment of the experimental approach. As its primary conclusion, the thesis provided evidence that the experimental policy approach resulted improvements in consistency of elements, coherence of processes and comprehensiveness, as well as in administrative costs, compared to the conventional approach. This conclusion, as well as other, supporting findings and conclusions are sufficiently interesting to suggest further research on, and experimentation with, the experimental approach, including on the assessment of the medium and longer-term effectiveness and efficiency of such policy mixes.

Third, this thesis contributes significantly to the methodology for the early comparative assessment of the experimental approach, including several measurement tools, which were based on the analytical framework for policy mixes proposed by Rogge & Reichardt (2016), as well as on the literature on whole-of-government policy approaches and innovation theory.

Fourth, this thesis contributes research experience and empirical data, using the analytical framework referenced. Rogge & Reichardt (2016) had noted that there were few empirical studies making use of the framework and suggested this as part of the forward research agenda for policy mix studies and for their analytical framework. This thesis contributed directly to addressing this forward research agenda topic.

Fifth, also with regards to the future research agenda on the topic of policy mixes

for sustainability transitions, Rogge & Reichardt (2016) advised policymakers “to work on improving both the consistency of the elements of the policy mix and the coherence of policy processes” and suggested that improvements in this area would be likely to give rise to future improvements in effectiveness. This thesis contributes directly to this forward research topic, by providing evidence, in the form of case studies, on how to both improve the consistence of elements and coherence of processes, through the implementation of the experimental policy approach.

Sixth, this thesis contributes to strengthening the research linkages between policy mix studies and innovation theory, by examining the experimental policy approach that references an updated innovation model, specifically the extended pipeline model (Bonvillian 2015), and integrating links with new theoretical concepts such as the Commercialization Readiness Index, which has only been recently published in 2014. Again, in terms of suggest topics for future research on policy mixes for sustainability transitions, Rogge & Reichardt (2016) had suggested that “the integration of the policy mix concept with other research approaches, such as the technological innovation systems approach, may further sharpen the analytical clarity and policy advice of such approaches in the context of sustainability challenges.” It is believed that this proposed integration, yielding several insights, was achieved in this thesis.

Finally, this thesis contributes to strengthening the research linkages between policy mix studies and the literature on whole-of-government (WoG) policy approaches. The experimental policy approach was shown to be a special case of a WoG policy approach in chapter 2. The methodology also borrowed concepts from the literature on WoG policy approaches to develop the methodology and measurement instrument used

to answer question 2. The WoG literature may be able to contribute additional concepts and methodologies for the further assessment and analysis of the experimental policy approach, in the future.

7.5 Relevance of Rogge & Reichardt Framework

This thesis utilized, as a primary analytical tool, the policy mix analysis framework outlined in Rogge & Reichardt (2016)⁸² and depicted in Illustration #2 in section 1.5.

This framework proved to be useful for the research as it provided: precise definitions of terms; an expanded and comprehensive conception of policy mixes; the three evaluation criteria for the early assessment of the experimental policy approach examined; as well as concepts for the development of the research methodology and measurement tools used in the assessment and comparison of the experimental and conventional policy approach.

The Rogge & Reichardt framework continues to be referenced by other researchers working in the fields of policy mix studies, innovation and socio-technical transitions. The journal *Research Policy* recently published a special issue of ten papers (Volume 48, Issue 10, Dec. 2019), titled *Policy mixes for sustainability transitions: New approaches and insights through bridging innovation and policy studies*, edited by Kern, Rogge and Howlett (2019), which was based, in large measure, on “a broader understanding” of policy mixes, as called for by Flanagan & al (2011) and Rogge & Reichardt (2016). This special issue introduced five major themes in the recent literature, which points to the usefulness of the framework for current and future research, including: “methodological advances, policy making and implementation, actors and

⁸² For reference, the title of the Rogge & Reichardt 2016 journal article is *Policy mixes for sustainability transitions: an extended concept and framework for analysis*.

agency, evaluating policy mixes, and the co-evolution of policy mixes and socio-technical systems” (Kern, Rogge & Howlett 2019). It should be noted that this thesis related directly to at least three of the above five themes (namely methodology, policy process, and evaluating policy mixes), and also touched on the other two themes (actors & agency, co-evolution of policy mixes and socio-technical systems). In addition to the above, the Rogge & Reichardt framework could be useful in contributing further insights related to the research started in this thesis in a number of areas. These include: guiding the design of formal audits and evaluations of the experimental case studies being planned in the coming 1-3 years, and providing insights on how to accelerate technological development as a key policy aim. The ways in which the framework could be useful for future research is also continued in the next section, which discusses next steps for the research.

7.6 Next steps for research

The research conducted in this thesis resulted in the first assessment and examination of the experimental policy approach in Canada. As such, this was just a beginning and there is much to do, to follow up on this research. Proposed next steps for the research are presented and organized along the following four forward agenda research topics:

- (i) Continued assessment of the experimental policy approach;
- (ii) Methods for the assessment of policy mixes;
- (iii) Further experimentation with implementation of the experimental approach; and
- (iv) Strengthening linkages between the research on experimental policy mixes and the literature on policy mixes, whole-of-government approaches, innovation theory and evaluation methods.

Continued assessment of the experimental policy approach

The assessment conducted in this thesis was only a preliminary, early assessment, given that experimental policy mixes have only been introduced in Canada since 2016-17 and are still at the implementation phase.

The first item on the forward agenda is to continue the assessment of the experimental policy mixes examined in this thesis. The early assessment completed looked only at short term indicators of success. There is an opportunity to look at medium term and longer-term indicators of success, including reviewing upcoming audits and evaluations to be conducted by NRCan on the policy mixes. There may be an opportunity to provide input as to the approach and methodology for such audits and evaluations, given that this will be the first time the experimental policy mixes will be formally assessed. There is also an opportunity to strengthen the correlation between the design and implementation features of experimental policy mixes and the early indicators, possibly through the use of additional surveys of public servants involved in their administration.

There is also the opportunity to conduct a more detailed and robust analysis of the comparative administrative costs, and ideally to quantify the dollar cost savings achieved in the experimental case studies examined.

With regards to the current, short-term assessment, it may be useful to further validate some of the findings and conclusions through additional research and work. For example, it may be useful to further validate that the fuller implementation of the experimental approach, observed in the Smart Grids and CERRC case studies, results in increased improvements and benefits. This could be accomplished by seeking feedback

on findings and conclusions, as well as through additional, structured interviews of public servants involved in the administration of the policy mixes.

There may also be an opportunity to study or assess additional cases of the use of the experimental approach, in other jurisdictions. For example, it may be fruitful to examine any assessments conducted by the US Department of Energy on the application of its ‘ecosystem approach’ on its buildings-related policy mix. There may also be examples of such cases and assessments in Europe, which would serve as useful comparable cases to the case studies examined in this thesis.

Finally, it would be necessary to look at trade-offs resulting from the implementation of the experimental policy approach compared to the conventional approach, including assessing potential downsides and limitations, as well as any mitigation measures to reduce any observed disadvantages. This could include an examination of the contexts and conditions under which the experimental policy approach would be most useful, and contexts and conditions under which it would be less useful, or not useful at all.

Methods for the assessment of policy mixes

As was suggested above, additional work on the assessment of the experimental approach would be helpful in strengthening the case for the approach, through increased evidence. To get there, there may be a need for developing new or improved assessment methodologies, particularly to assess medium term and longer-term indicators of success, as well as audit and evaluation methodologies that look at the policy mix as a whole. The literature on whole-of-government and policy mix approaches could be examined with a view to discovering proven methodologies that could be useful in this case.

The questionnaire used for the early assessment of experimental policy mixes could be improved, to help address limitations highlighted in section 3.10. Such a structured interview questionnaire could not be designed, at the outset of the research, because it was not clear what the range of answers would be to the research questions. Now that this thesis has been completed, a better designed questionnaire, including structured responses that utilize the full range of allowable responses (i.e., 1-5 or low to high), could help reduce variations or bias in the responses, in the future.

Improvements in methodology could be proposed to deal with the temporal offsets between instruments in a mix. For example, for long-term RD&D programs, efforts could be made to include R&D activities that occurred 5, 10 or 15 years prior to demonstration, deployment or commercialization instruments, as these older R&D activities are likely to be better correlated with the above than current R&D.

Further experimentation in the application and implementation of the experimental approach

Given that the experimental policy approach has been shown to be a promising approach, at least with regards to short term indicators of success, there is an opportunity for further experimentation with this approach. There is a considerable amount of potential future research that could be undertaken under this research topic.

First, there is an opportunity to increase the scope of applicability of the experimental approach. There may be an opportunity to experiment with the current case studies and/or new implementations along a number of dimensions, for example to increase the number and types of instruments and organizations involved in the policy mixes, for example adding instruments delivered by organizations outside of NRCan, and/or to add depth and coverage of policy instruments. This could help determine any

limitations in the number or instruments, size of policy mixes, or the number of organizations involved in an effectively functioning policy mix. It is expected that further experimentation with experimental policy mixes could evolve in a number of different directions, in terms of instrument coverage and/or depth, per Illustration 8, which is repeated from section 7.3, below.

Illustration 8 – Further experimentation with experimental policy mixes – evolution

For example, for a specific, targeted technology, it may be possible to add policy instruments to the mix, to better cover the later stages of the innovation chain. Instruments to promote the commercialization of specific technologies, delivered by other organizations, for example the Business Development Bank of Canada (BDC), Export Development Canada (EDC), or Innovation Science & Economic Development Canada (ISED), could help address some of the later stages of the innovation chain and the Commercialization Readiness Index, which are not currently covered by existing policy instruments in the mix. It may also be possible to add other, existing instruments at the R&D, demonstration or deployment stages, in order to better coordinate and integrate the government's efforts, from a whole-of-government perspective. If and as applicable, instruments and programming delivered by organizations such as Environment & Climate Change Canada or Sustainable Development Technology Canada could be integrated into the mix. It is assumed that such integration would have to happen in a gradual,

incremental manner, in order to work out any integration issues. The historical-institutional literature on change and development of policy mixes could be helpful in this case.

A potential forward research topic would be to examine opportunities for, and the processes of, dynamic change in the implementation of the experimental policy approach, over time. For example, it would be interesting to see if conventional policy mixes could be ‘changed’ through a targeted approach, to incorporate features of an experimental policy mix and result in improvements and benefits. Alternatively, research could be undertaken to see determine experimental policy mixes could be improved over time, for greater effectiveness. For example, future researchers could examine if some of the 11 conditions, suggested by the whole-of-government literature for successful implementation, could be improved during implementation and assess if this would result in further improvements and benefits. The examination of different variants of the experimental policy approach could be useful in the above research.

Another future research topic would be to look at how tightly bundled, complete and technology-specific policy mixes interact with the larger policy mixes, or existing policy regime, within which they operate, and whether there would be selected opportunities to improve the overall effectiveness of the larger policy mix, or whether it is best to focus on smaller, more focused policy mixes.

Yet another future research topic would be to look at potential ways to better deal with the temporal offset issue inherent with policy mixes to enable the development and adoption of new technologies. Further study of this issue could result in better ways to design, implement, and assess experimental policy mixes, in the future.

One of the forward research topics, identified by Rogge & Reichardt (2016), which could still be developed in the future, is the further, expanded use of the analytical framework for the analysis of policy mixes. Once data on the effectiveness and efficiency of the experimental policy mixes are better understood, it would be interesting to utilize the analytical framework to explore potential causal factors that may be responsible for the improvements in effectiveness and efficiency, if these are observed. Illustration 2 below, which is repeated from section 1.5, includes pathways, numbered 1-9, which could individually, or as a group, be part of the causal factors that lead to the enablement, or acceleration, of technological change. The assessment of such causal factors was outside of the scope of this thesis. However, it would be a useful forward research agenda topic.

Illustration 2 – Potential causal pathways for improvements in effectiveness and efficiency in the technology development and adoption process

Per supporting conclusion 5, outlined in section 7.3, another potentially interesting future research topic could be to determine the number of specific

technologies around which experimental policy mixes can be designed.

Finally, it would also be beneficial to further study and develop approaches to address the barriers and constraints to implementation that were outlined in section 6.6.

Further increasing linkages between the research on experimental policy mixes and the literature on WoG approaches, innovation theory and evaluation methods

This thesis established fairly strong connections between the experimental policy mixes and the literature on policy mixes, whole-of-government (WoG) approaches, innovation theory and transitions. The thesis made the case that the experimental policy approach is a special case of a WoG applied to technology development and adoption. There may be benefits to further strengthening linkages with the above literature in the future. It may also be fruitful to further develop the experimental policy approach by incorporating insights from Bonvillian's theories on barriers to innovation, especially barriers in large, legacy economic sectors. Finally, it may also be useful to strengthen the connections between the experimental policy approach and transition studies.

7.7 Final Thoughts

This thesis examined policy mixes that were designed and implemented to enable technological developments and adoption, in order to mitigate climate change and support a socio-technical transition to a low carbon energy future. This thesis specifically sought to assess the early experience with a new experimental policy mix approach, implemented by the Canadian federal Department of Natural Resources (NRCan) since 2016, in which the policy instruments in the mix were 'tightly bundled' in terms of design, implementation and evaluation; 'complete' in terms of coverage of the technology innovation chain; and 'technology/sector-specific'.

As mentioned in section 1.2, the opportunity to examine and assess this new

experimental policy mix approach came about as a result of fortuitous events, which occurred in 2016-17 and 2017-18, in which NRCan was seeking to develop a compelling case in support of a \$882M proposal to access a new source of funding for clean energy technology development, from Infrastructure Canada. Because NRCan needed to present a ‘united front’ and a compelling proposal, different groups within NRCan laid aside their traditional rivalries and developed an integrated plan, in which different instruments were combined together, in tightly bundled, complete and technology/sector-specific policy mixes. In the end, these proposals were indeed compelling and NRCan received \$882M in new multi-year funding, to support 5 different policy mixes, from a new funding source! All of these experimental policy mixes have been designed and launched, and are partway through their 4-8 year implementation phase, which is expected to end in the 2022-26 timeframe.

This thesis examined a subset of four out these five experimental policy mixes and compared them with policy mixes that had been delivered in the past, by NRCan, but which used the more conventional policy approach, in which the policy instruments are loosely bundled, i.e. designed and implemented in a ‘siloesd’ fashion, as separate, individual instruments; less complete, i.e. with partial coverage of the innovation chain; and not technology or sector specific, i.e. with instruments that targeted a large number of technologies and sectors, and which were not specifically tailored to address specific barriers affecting a particular technology or economic sector.

The thesis’ primary hypothesis is that the experimental approach is likely to result in hypothesized improvements and benefits, compared with the conventional approach, specifically improvements in consistency of elements, coherence of processes, and

comprehensiveness. These characteristics of policy mixes were defined in a key 2016 paper by Rogge & Reichardt titled *Policy mixes for sustainability transitions: an extended concept and framework for analysis*, which was used as the main analytical framework referred to in this thesis. A review of the literature provided a strong theoretical basis for expected improvements and benefits to be observed in the experimental cases, compared with the conventional approach. The experimental approach can be thought of as a special case of a whole-of-government policy approach, specifically tailored to enable the development and adoption of new technologies to reduce greenhouse gases from energy production and use, in a variety of applications such as electricity generation and distribution and on-road transportation.

The thesis used a comparative case study approach to compare 3 case studies of policy mixes that used the experimental approach against 3 cases that used the traditional, conventional approach. The thesis sought to answer 4 research questions: which included as the first and primary question, (i) whether the hypothesized improvements in consistency, coherence and comprehensiveness were observed more in the experimental group of cases, compared to the conventional group. The other 3 research questions were supporting questions, including (ii) whether conditions for success, suggested by the whole-of-government literature, are observed more in the experimental versus conventional group; (iii) whether there are differences in observed hypothesized improvements and benefits in the experimental case studies and what could help explain those differences; and (iv) whether there are barriers and constraints to the future implementation of the experimental approach.

The thesis resulted in seven conclusions, including one primary conclusion and

six supporting conclusions. The primary conclusion is that the experimental approach shows significant promise, has merit, and provides an alternative policy approach, which results in benefits and improvements, compared to the conventional approach. This is an important conclusion that suggests that there is sufficient evidence to support further experimentation and study of the experimental approach in the future.

The six supporting conclusions are that: (i) there is evidence for a preliminary theory of change that could help to provide a causal relationship between the design and implementation features of the experimental policy mixes and the observed improvements and benefits; (ii) there are variations in the design and implementation of the experimental approach, in the real world of policy making, which provide policymakers with flexibility and a diagnostic tool to assess policy mixes, with a view to improving them; (iii) there are opportunities to further improve the experimental policy mixes, in the future; (iv) there appears to be greater benefits related to a ‘fuller’ implementation of the experimental policy approach; (v) The number of ‘specific’ technologies and sectors, around which experimental policy mixes can be designed, is likely limited, which has a positive impact on the feasibility of implementing technology/sector-specific policy mixes; and (vi) the research has identified barriers and constraints to the future implementation of this approach, and an awareness of these could help reduce implementation risks.

Appendices

Appendix A - Definition of Key Terms

Administrative Cost: is defined as the cost for administering the different policy instruments in the policy mix, which consists primarily of the cost of personnel designing, implementing and evaluating the instruments in the policy mixes, as well as a multiplication factor to cover corporate functions (human resources, finance, training, facilities, information technology, etc.).

Attributes of a policy mix: “features” refers to three characteristics of policy mixes, relating to the degree to which instruments in the policy mix are: (1) bundled (i.e., the way in which instruments in the policy are designed, implemented and evaluated either as a group or individually); (2) complete (relating to the degree to which instruments in the policy mix policy cover the entire innovation chain); and (3) technology-specific (i.e., instruments target specific technologies applied in specific economic and industry sectors, such as buildings, transportation, and electricity generation as opposed to being general targeting any technology and application).

Augmented Policy Mix: augmented policy mix are defined as the formal policy mix, which is a new policy mix defined in a formal document such as the Treasury Board Submission, including where applicable, the addition of key existing policy instruments, which are understood to be included along with any new policy mix, again as documented in a Treasury Board Submission.

Complete Policy Mix: A policy mix where the instruments in the mix cover the entire innovation chain (i.e., fully cover the 5 stages in the innovation chain) as defined by the IEA (2008), namely basic R&D, applied R&D, demonstration, deployment, and commercialization / diffusion.

Conventional Policy Mix: a policy mix, designed using a more traditional policy approach, in which the different instruments in the mix are/were typically designed, implemented and evaluated independently of one another (i.e., they are defined as loosely bundled), and administered in separate “siloes”. Conventional policy mixes are also typically incomplete in terms of coverage of the innovation chain, especially for a specific technological stream. In addition, conventional policy mixes are often general in nature, targeting a large number of different technologies used in a variety of economic sectors.

Cornerstone instrument: “cornerstone” policy instruments refers to a central policy instrument in the policy mix, which is the main instrument used to achieve the policy mix’s objective or goal. Other instruments are included in the policy mix to support and/or extend the reach of the cornerstone instrument. Given that the focus of this thesis is on policy mixes to foster the development of new technologies, the cornerstone instrument, which are present in all case studies examined, are government Science Technology and Innovation (STI) programs.

Effectiveness: The outcomes of a program, policy or other entity, or the extent to which it is achieving its expected outcomes. (TBS 2016; McDavid, Huse & Hawthorn 2018)

Efficiency: The extent to which resources are used such that a greater level of output/outcome is produced with the same level of input or, a lower level of input is used to produce the same level of output/outcome. The level of input and output/outcome could be increases or decreases in quantity, quality, or both. (TBS 2016)

Formal policy mix: policy mix as defined in formal government policy mix documentation, such as the applicable Treasury Board Submission, the formal document describing a policy mix or instrument in the Canadian federal government. It is a planned policy mix that is expected to lead to expected outcomes.

Government STI Programs: Government STI programs provide direct funding for science, technology, and innovation projects, conducted by government scientists and/or by parties external to government such as private sector companies, universities, etc. Also known as a Research, Development and Demonstration (RD&D) program.

Incomplete policy mix: a policy mix in which the instruments do not fully cover the 5 stages in the innovation chain, as defined by the IEA (2008), namely basic R&D, applied R&D, demonstration, deployment, and commercialization / diffusion.

Innovation: is a broad term and a subject of much academic research. It is variously defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD 2005). Likewise, it is "a new product; a new process of production; the substitution of cheaper material, newly developed for a given task, in an essentially unaltered product; the reorganization of production, internal function, or distribution arrangements leading to increased efficiency, better support for a given product, or lower costs; or an improvements in instruments or methods of doing innovation" (Kline & Rosenberg 1986, p. 279). Brzustowski (2012) also proposes that "Innovation is a purposeful act of **change** to achieve some goal... It is the change achieved by developing a new idea and putting it into practice... [and] appears in many contexts and in many forms. A few innovations prove to be revolutionary; most others change things just a little... The many new ideas that are not put into practice are not innovations. This means that inventions themselves are not innovations. Zizlavsky (2013), quoting Schumpeter (1912), proposes that there are "five types of innovation: introduction of new products, the introduction of new methods of production, the opening of new markets, the development of new sources of supply for raw materials and other inputs, and the creation of new market structures in an industry." Innovation is considered the driving force of economic development (Schumpeter 1912, Zizlavsky 2013). The systems used in innovation are amongst the most complex known (both technically and socially) and the requirements for successful innovation vary greatly from case to case (Kline & Rosenberg 1986). The main societal value provided by innovation and technological change are new functionality (e.g., non-GHG emitting energy) at increasingly lower and comparable costs to existing

alternatives, as experience is gained.

Innovation Chain: a theoretical construct describing the temporal dimension of the innovation process. The essential idea behind an innovation chain is that it is a visual depiction (graphic) of the necessary elements, activities and steps required to bring a new technology from idea (basic research) to a commercial product that is commercially and ideally widely available. The innovation chain concept used in this thesis is the one developed by the International Energy Agency, which is depicted graphically as follows:

Figure 1 Schematic of the innovation system

Source: IEA, 2008.

Loosely bundled policy mix: a policy mix, designed using a more traditional policy approach, in which the different instruments in the mix are/were typically designed, implemented and evaluated independently of one another (i.e., they are defined as loosely bundled), and administered in separate “siloes”.

Net Zero Emissions: net zero emissions are defined as being achieved when any remaining human-caused GHG emissions are balanced out by removing GHGs from the atmosphere in a process known as carbon removal. To achieve net zero emissions, first and foremost, human-caused emissions — like those from fossil-fueled vehicles and factories — should be reduced as close to zero as possible. Any remaining GHGs would be balanced with an equivalent amount of carbon removal, for example by restoring forests or through direct air capture and storage (DACS) technology. The concept of net-zero emissions is akin to “climate neutrality.” (World Resource Institute: <https://www.wri.org/blog/2019/09/what-does-net-zero-emissions-mean-6-common-questions-answered>).

Policy (Public): is very broadly defined as “whatever governments choose to do or not to do” (Dye 1987). Public policy has been defined more precisely by others as: “the result of efforts made by governments to alter aspects of their own or social behavior in order to carry out some end or purposes and are comprised of (typically complex) arrangements of policy goals and means” (Howlett 2014a); “governmental activities or decisions that are designed to remedy some public problem... they are **formulated, implemented** and **evaluated** by authorities in a political system such as legislators, judges, executives and administrators. Public policies are always subject to change on the basis of new (or better) information about their effects” (Lester & Stewart 1996); and “a course of action or inaction chosen by public authorities to address a given problem or set interrelated set of problems” (Pal 2006). For purposes of this thesis, a public policy sets the direction for choice of policy mixes and subsequent policy instruments.

Policy design: a major subject of research in the field of policy studies, is a broad and complex term defined as “the effort to more or less systematically develop efficient and effective policies, through the application of knowledge about policy means gained from experience, and reason, to the development and adoption of courses of actions that are likely to succeed in attaining their desired goals or aims within specific policy contexts” (Howlett 2014). Policy design is linked to policy instruments and implementation. Thus, in the policy process, policy design thus straddles policy formulation, decision-making and implementation and involves actors, ideas and interests active at each of these stages (Howlett, Ramesh & Perl, 2009). Policy design can be considered to be both a verb, the action of designing or policy formulation, and a noun, the product of the design effort, the policy mix itself.

Policy experimentation: holds various definitions in the literature and comes in both strict and loose varieties. It is defined strictly, based on the high standard of the experimental method of randomized control trials, as “a temporary, controlled field-trial of a policy-relevant innovation that produces evidence for subsequent policy decisions” (McFadgen & Huitema 2018; Huitema & al 2018). In the above definition, the “assumption is that experiments should by definition have an underlying (action) theory, which can be proven correct or incorrect” (ibid). Policy experimentation, **or pilot projects**, are also defined more loosely in the literature as being “applied to introduced or test new practices, concepts or technologies” (Vreugdenhil et al. 2012, Howlett 2013). This thesis uses the loose definition of policy experimentation.

Policy innovation: is defined as “encompassing three vital activities: invention (and the sources it stems from), diffusion (and the policy-governance patterns it produces), and (the evaluation of) effects (Jordan & Huitema 2014). Policy innovations can also occur in any of the elements or components of policy design, such as in high levels goals, specific objectives, targets, or instruments and calibrations (Howlett 2013). In some cases, policy innovation can be constrained, especially in those cases where there is an existing policy mix already in place (ibid).

Policy instruments: basic building blocks of policymaking, are variously defined in the literature as the “**means** a government has at its disposal to achieve public policy

outcomes, by which policy objectives are pursued" (TBS 2007); as “**tools of government**, the mechanisms and techniques used to implement or give effect to public policies” through policy mixes or programs as defined by the Treasury Board (Salamon 2002, Howlett 2005); and/or, as “techniques of governance which, one way or another, involve the utilization of state resources, or their conscious limitation, in order to achieve policy goals” (Howlett, 2005). Policy instruments address policy problems within various policy mixes (Pal 2006, Rogge & Reichardt 2016).

Policy mix: are complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years (Kern & Howlett, 2009). Policy mix is also referred to, in the literature, as a policy bundle, policy packages, or policy portfolio. Per Flanagan et al. (2011), a policy mix encompasses more than just a combination of policy instruments; it also includes the policy processes by which such instruments emerge and interact. An expanded definition of policy mixes, per the assessment framework developed by Rogge & Reichardt (2016), therefore includes policy mix dimension (policy field in which the policies are applied, governance level, geography, and time); policy mix elements (strategy, objectives, plans, instruments) and the policy processes used to develop the policy mixes. This expanded view of policy mixes will be used throughout the thesis.

Policy process: is and has been one of the key subjects of research in the field of policy studies (Howlett, McConnell & Perl 2015, Ascher 1986). It is also referred to in the literature as policymaking. It has been described as “a series of steps in a cyclical model of decision making” (Howlett & Giest 2015). The policy process is often referred to as the **policy cycle**, because in reality the process incorporates feedback processes and once completed, is typically re-started or repeated in an iterative, cyclical way (Howlett, McConnell & Perl 2015). The policy process or cycle can be defined as “a political problem-solving process among constrained social actors in the search for solutions to societal problems, with the government as primary agent taking conscious, deliberate, authoritative and often interrelated decisions” (Howlett, Ramesh & Perl 2009; Rogge & Reichardt 2016). The policy cycle is not necessarily smooth or linear as it involves policy learning (Allen & al 2011) and politics (Unruh 2002).

Policy Studies or Policy Sciences: are “concerned with knowledge of, and in the decision processes of, the public and civic order” (Lasswell 1971). These studies “include 1) methods by which the policy process is investigated, 2) the results of the study of policy, and 3) findings of the disciplines” (Lasswell 1951). Policy studies also include the process of policymaking (the policy process) as well as the contents of policy (policy analysis), understood to be the development and analysis of policy options to implement governmental goals (Ascher 1986).

Program: In this thesis, the definition used is that included in Treasury Board’s Policy on Results (TBS 2016): Individual or groups of services, activities or combinations thereof that are managed together within the department and focus on a specific set of outputs, outcomes or service levels.

Research, Development and Demonstration: Whenever the terms R&D or RD&D is used in this thesis, it is assumed that this includes RSA. RSA has been identified by some academics as an important, but under-appreciated, science and technology activity (Doern 2006) and thus is included in the various definitions of R&D.

Term	Source	Definition
R&D	Frascati Manual (OECD 2005)	"Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."
Basic Research	Frascati Manual (OECD 2005)	"is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation or phenomena and observable facts, without any particular application or use in view."
Term	Source	Definition
Applied R&D	Frascati Manual (OECD 2005)	Includes the definition of applied research and experimental development in the Frascati Manual. "Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products, and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed."
Demonstration	Frascati Manual (OECD 2005); (Glennan et al. 1978)	"is a project involving an innovation operated at or near full scale in a realistic environment for the purpose of (i) formulating national policy or (ii) prompting the use of innovation".
Related Science & Technology Activities (RSA)	Frascati Manual (OECD 2005)	"includes scientific and technical information services, testing and standardization, feasibility studies, patent and intellectual property work, and policy-related studies."

Technology-Specific Policy Mix: A policy mix, where the instruments target specific technologies applied in specific economic and industry sectors, such as buildings, transportation, and electricity generation.

Tightly Bundled Policy Mix: A policy mix, where the policy instruments are designed, implemented and evaluated as a group, as opposed to individually.

Whole-of-government

Definitions of terms:

Term	Source	Definition
Whole of Government	Australian Management Advisory Committee, in its 2004 report titled Connecting Government (AMAC, 2004)	“Whole-of-government denotes public services agencies working across portfolio boundaries to achieve a shared goal and an integrated government response to particular issues. Approaches can be formal or informal. They can focus on policy development, program management, and service delivery.”
	Colgan et al 2014, Ling 2002	“‘Whole of Government’ (WoG) is an overarching term for a group of responses to the problem of increased fragmentation of the public sector and public sector and public services and a wish to increase integration, coordination and capacity”
Joined-Up Government	The Efficacy Unit (2009)	“Joined up government initiatives seek to enhance coordination and integration within public sectors that have become too disjointed. They also seek to align incentives, structures and cultures of authority in order to fit critical tasks that cross organizational boundaries.”
Horizontal Management	Bakvis & Juillet (2004) (p.8)	“Horizontal Management can be defined as the coordination and management of a set of activities between two or more organizational units, where the units in question do not have hierarchical control over each other and where the aim is to generate outcomes that cannot be achieved by units working in isolation. The structures and processes used to achieve coordination can range from informal networks to jointly managed secretariats.”
Collective Impact	Kania & Kramer (2011)	“Collective Impact Initiatives are long-term commitments by a group of important actors from different sectors to a common agenda for solving a specific social problem. Their actions are supported by a shared measurement system, mutually reinforcing activities and ongoing communication, and are staffed by an independent backbone organization.”

Zero Emission Vehicles (ZEVs): are defined as plug-in hybrid electric vehicles, battery electric vehicles, and hydrogen fuel cell vehicles.

Appendix B - Interview Guide

Questionnaire for Semi-structured Interviews

Name of interviewee: Pseudonym

Date of interview:

Voluntary Participation and Consent: Your participation in this interview is entirely voluntary. You will be asked to provide written consent, using an Informed Consent Form, approved by Carleton University's Research Ethics Board, to be signed prior to the interview. This Informed Consent Form contains information on the purpose of the research, what you will be asked to do, benefits and risks, your rights including your right to withdraw, confidentiality, and data security and retention.

Carleton University Research Board Review: The ethics protocol for this project was reviewed by the Carleton University Research Ethics Board, which provided clearance to carry out the research. (Clearance expires on: November 30, 2020). If you have any ethical concerns with the study, please contact the Carleton University Research Ethics Board-A (by phone at 613-520-2600 ext. 2517 or via email at ethics@carleton.ca).

Background and Definitions: Background information on the research topic as well as definitions are provide in the attachment, starting on page 4 of this document.

Questions prior to commencing: Do you have any questions, or do you require any clarifications, with regards to what is being evaluated or the nature of the questions to be asked during the interview?

* * * * *

There are a total of 10 questions in the interview (2 preliminary/context questions, 7 core questions addressing the two key questions to be addressed in the thesis, and 1 concluding/open question).

Preliminary / Context Questions (2 questions)

1. Can you please describe your role in the design, implementation and evaluation of the policy mixes listed above (i.e. the 6 different case studies)?

Experimental policy approach applied?	Number of Cases	Government STI program or initiative	Role of Interviewee (please check where applicable)		
			Design	Implementation	Evaluation
Yes	3	1. GI Ph. 1 & Ph. 2 - Electric Vehicle & Alt Fuels (2016+)			
		2. GI Ph. 2 - Clean Energy For Rural & Remote Communities			
		3. GI Ph. 2 - Smart Grids (2018+)			
No	3	1. Technology Early Action Measures (1998-2009)			
		2. Clean Energy Fund (2009-15)			
		3. GI Ph. 2 - Emerging Renewables (2018+)			
TOTAL		6			

2. For the experimental case studies listed above, to the best of your knowledge, was there any discussion about policy experimentation at the design stage? In your opinion, what was the context and reason for experimentation? Did the experimental approach develop by chance or was the experimental approach consciously developed to achieve specific goals? Which goals?

Core Interview Questions (7 questions in total: Q3 (4 questions), Q4 (3 questions))

3. In your opinion, does the evidence on early implementation of the experimental policy approach suggest that hoped-for benefits will be achieved, at a reasonable cost? In other words, what is the experience to date with the experimental approach, as presented by the case studies to be examined?
 - A. In your opinion, do the case studies utilizing the experimental approach indicate an expected improvement in consistency of elements, coherence of processes, credibility, and comprehensiveness compared to the conventional approach?

Dependent Variables		# variables	Variable types
Hoped-for Benefits	Consistency of elements - alignment over time	1	temporal consistency (1-5)
	Consistency of elements - overall - weak	1	Degree of absence of conflicting or contradictory elements (1-5)
	Consistency of elements - overall - strong	1	Degree of existence of synergies (1-5)
	Consistency of elements - strategy	1	Degree of alignment of policy objectives (1-5)
	Consistency of elements - instrument mix	1	Degree of reinforcement between instruments (1-5)
	Consistency of elements - policy mix	1	Degree of reinforcement of strategy and instrument mix (1-5)
	Coherence of processes - agenda setting; policy formulation; decision making; implementation and evaluation	5	Degree to which each of the 5 steps in the policy process is tightly coupled for the policy mix (1-5)
	Credibility - overall	1	Degree to which the policy is believable and reliable (1-5)
	Credibility - stability over time	1	Degree to which the policy mix is stable over time (1-5)
	Comprehensiveness - coverage of innovation chain	1	Degree to which the policy mix covers the entire innovation chain (1-5)
	Comprehensiveness - technology	1	Degree to which the policy mix is technology specific (1-5)
	Comprehensiveness - sector	1	Degree to which the policy mix is sector specific (1-5)
	Comprehensiveness - barriers	1	Degree to which the policy mix addresses all barriers (1-5)

Sub-Total - Dependent variables

17

- B. In your opinion, what are the primary design, implementation and evaluation factors, between the experimental and conventional approach, that would explain the improvements and benefits?
 - C. In your opinion, what are the incremental costs (\$, time, etc.) of the experimental approach vs. the conventional approach?
4. In the future, how might a tightly focused and complete policy mix approach be more effectively implemented in this policy field? In other words, what does the future hold for this experimental policy approach and what are the barriers (sticky points) and implementation difficulties in applying the experimental approach for government STI programs?
 - A. In your opinion, what policies, procedures or guidelines would need to be changed for future, expanded implementation of the experimental policy approach?
 - B. In your opinion, what are the barriers and implementation difficulties that would need to be overcome for future, expanded implementation of the experimental policy approach?

Closing Question (1 question)

5. Do you have any other comments or opinions that you wish to provide, on the use of the experimental versus the conventional policy approach?

Thank you!

Attachment to Questionnaire

Executive Summary - Ph.D. Thesis Proposal

Assessing Tightly Bundled, Complete and Technology-specific Policy Mixes to Accelerate Technological Change, Foster a Clean Energy Transition towards Low-Carbon Solutions, and Mitigate Climate Change, in Canada

Background: In order to mitigate climate change and achieve greenhouse gas (GHG) emission reduction targets made in international agreements, such as the 2015 Paris Agreement, there is a need for a clean energy transition towards low-carbon technologies and solutions, across numerous sectors of the economy (IEA 2016). Energy transitions, understood to mean “structural changes in the way energy is supplied, distributed and used” are inherently complex, and there is wide ranging agreement that a variety of policy instruments, combined in a policy mix, are needed to foster such transitions (Smil 2010, Rosenow, Kern & Rogge 2017). An important component of energy transitions is the acceleration of technological change, i.e. the development and commercialization of cost-effective low-carbon technologies and solutions (Rogge & Reichardt 2016). Government science, technology and innovation (STI) programs⁸³ are typically designed and implemented to help overcome barriers and accelerate such technological change. Government STI programs can be combined with other policy instruments, in policy mixes, to tackle issues such as the development of cost-effective clean energy technologies to reduce GHG emissions, in various sectors of the economy.

This thesis proposes to specifically examine and analyze policy mixes, which include government STI programs, combined with other policy instruments, to develop and advance clean energy technologies to reduce GHG emissions, in various industry sectors, in Canada. The thesis will focus specifically on government STI programs as a cornerstone instrument, within such policy mixes, as well as interactions of government STI programs with other policy instruments.

Problem Addressed: The public policy problem addressed by this thesis can thought of as consisting of four parts, as follows: (i) contrary to what might be expected from innovation theory, government STI programs are typically designed to address **only part** of the innovation chain; and thus, (ii) it is assumed that other policy instruments will cover the remaining parts of the innovation chain, such that the combined policy mix will effectively foster innovation. However, in practice, (iii) the different policy instruments

⁸³ Government STI programs provide direct funding for science, technology, and innovation projects, conducted by government scientists and/or by parties external to government such as private sector companies, universities, etc., to advance government objectives and are part of the mix of measures to develop new scientific knowledge, develop new technologies, and foster innovation, for society's benefit.

making up the policy mix are often designed, implemented and evaluated independently of one another. I will refer to this as the “**conventional**” policy approach, as this describes how policy mixes, that include government STI programs, have typically been implemented for clean energy programs to reduce GHG emissions in Canada, over the past 20 years. (iv) Because it is not purposefully and methodically integrated, there is the possibility that the above conventional policy approach can result in mismatches between policy instruments, for example in terms of objectives, resources or timing, which can affect the consistency, coherence, credibility and comprehensiveness of the policy mix, and this can ultimately affect its effectiveness and efficiency.

The above conventional policy approach can be contrasted with an **experimental approach** in which all of the policy instruments are “tightly coupled” (meaning where the policy instruments in a policy mix are designed, implemented and evaluated together as a group), are “complete” (meaning the policy mix covers the entire innovation chain), and are “technology-specific” (meaning that the policy mix targets a specific technology that is applied to a specific industrial sector, such as buildings, transportation, or electricity generation). The hoped-for benefits of this experimental approach include: better alignment; improved consistency of elements, coherence of processes, credibility, and comprehensiveness; and improved efficiency and effectiveness.

Experimentation: Recently, the Canadian and US federal governments have developed policy mixes that match the above experimental approach.

Research Approach: Given that the experimental policy mix approach is relatively new, there is an opportunity to examine the early experience with this approach through case studies, assess its potential to deliver early benefits, and compare it with the conventional policy approach. Does it show promise? The overall goal of the research will be to determine if early results with the experimental approach warrants continued experimentation and development in the future. The proposed research will include analyzing 6 case studies, 3 which use the experimental tightly bundled and complete policy mix approach, and 3 which use the conventional approach. The research will include a comparative analysis of the experimental versus the conventional approach, with design and implementation features as variables and improvements to key characteristics of the policy mix as independent variables. It will also include interviews with program staff and decision makers involved in the design, implementation and evaluation of the policy mix.

Boundaries & Limitations in the Scope of the Thesis: This thesis will limit its investigation to government STI programs in *Canada*, at the *federal* level, in which programs are administered by the Canadian Department of Natural Resources (*NRCan*), which is the leading clean energy technology funding organization. More specifically, this thesis will focus on a selection of *NRCan clean energy innovation* programs, which

have as their primary goal to develop clean energy technologies that will lead to greenhouse gas emission reductions in energy production, distribution and end use. It is reasonable to limit the scope of the thesis to these *energy-related technologies* and to the *energy sector* of the economy because, in Canada, the US, and many other countries around the world, 80% or more of greenhouse gas emissions are related to *energy-consuming* activities such as transportation, energy, and electricity production, heating and cooling of buildings, operations of appliances and equipment, and production of goods and provision of services (NRCan 2018, US EPA 2018).

Because the Canadian government has only recently started experimenting with this policy approach, it will be premature to investigate or assess benefits such as improved efficiency or effectiveness, which require the investigation of medium-term and longer-term outcomes achieved by the policy mix, as would be the case under a summative evaluation. Instead, the thesis will look at lessons learned from the early implementation of this policy approach. Thus, the thesis will **not** include an investigation of the potential for improving efficiency and effectiveness.

Key Terms and Definitions

Policy mixes are complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years. A policy mix is also referred to, in the literature, as a policy bundle, policy packages, or policy portfolio. Per Flanagan et al. (2011), a policy mix encompasses more than just a combination of policy instruments; it also includes the policy processes by which such instruments emerge and interact. An expanded definition of policy mixes, per the assessment framework developed by Rogge & Reichardt (2016), therefore includes policy mix dimension (policy field in which the policies are applied, governance level, geography, and time); policy mix elements (strategy, objectives, plans, instruments) and the policy processes used to develop the policy mixes.

Complete Policy Mix: A policy mix where the instruments in the mix cover the entire innovation chain, are technology specific, and are targeted to specific economic sectors.

Tightly coupled policy mix: Policy mix where the policy instruments are designed, implemented and evaluated as a group, as opposed to individually.

Technology-specific policy mix: the policy mix targets a specific technology that is applied to a specific industrial sector, such as buildings, transportation, or electricity generation

Characteristics of Policy Mixes (per Rogge & Reichardt 2016)

Consistency: is applied to the elements of a policy mix, i.e. “how well the elements of the policy mix are aligned with each other”. The above authors have proposed that consistency can be assessed on different levels, for example with regards to time, absence of conflicts, degree of synergies, strategy and objectives, interaction between instruments, and interplay of the instrument mix and policy strategy.

Coherence: is applied to policy processes, as “synergistic and systematic policy making and implementation processes contributing – either directly or indirectly – towards the achievement of policy objectives”. This can be achieved through “procedural mechanisms such as strategic planning, coordinating structures or communications networks”, and can be assessed across “policy fields and governance levels”, “capabilities of policy makers (Jacobsson & Bergek 2011)”, and “effect”, for example in terms of behaviors of actors and how the process shapes the policy mix.

Credibility is defined as “the extent to which the policy mix is believable and reliable (Newell & Goldsmith 2001), both overall and regarding its elements and processes”, which can be assessed on the basis of the “stability and temporal consistency of the policy mix, and the commitment from political leadership, followed by the consistency of the instrument mix and the support level of policy instruments (Bodeker & Rogge 2014).”

Comprehensiveness can be assessed by (i) inclusion of “both a policy strategy” (objectives, plans) and “at least one instrument... operationalizing the policy strategy”; (ii) “the degree to which the instrument mix addresses all market, system and institutional failures including **barriers** and bottlenecks (Lehmann 2012, Sorrell 2004, Sovacool 2009; Webec & Rohrer 2012); and (iii) how the policy mix addresses “all three instrument purposes of technology-push, demand-pull and systemic concerns”. They also define comprehensiveness, applied to policy processes, as being “influenced by their structure, rigor and thoroughness (Atuahene-Gima & Murray 2004)”.

Appendix C - CUREB-A Certifications

Office of Research Ethics
503 Robertson Hall | 1125 Colonel By Drive
Ottawa, Ontario K1S 5B6
613-520-2600 Ext: 2517
ethics@carleton.ca

CERTIFICATION OF INSTITUTIONAL ETHICS CLEARANCE

The Carleton University Research Ethics Board-A (CUREB-A) has granted ethics clearance for the research project described below and research may now proceed. CUREB-A is constituted and operates in compliance with the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (TCPS2).

Ethics Protocol Clearance ID: Project # 111832

Project Team Members: Mr. Marc Wickham (Primary Investigator)
Robert P. Shepherd (Research Supervisor)

Project Title: Ph.D. Thesis title: Assessing Tightly Bundled, Complete & Technology-Specific Policy Mixes to Accelerate Technological Change, Foster a Clean Energy Transition towards Low-Carbon Solutions, and Mitigate Climate Change in Canada

Funding Source (If applicable):

Effective: **November 26, 2019**

Expires: **November 30, 2020.**

Please ensure the study clearance number is prominently placed in all recruitment and consent materials: CUREB-A Clearance # 111832.

Restrictions:

This certification is subject to the following conditions:

1. Clearance is granted only for the research and purposes described in the application.
2. Any modification to the approved research must be submitted to CUREB-A via a Change to Protocol Form. All changes must be cleared prior to the continuance of the research.
3. An Annual Status Report for the renewal of ethics clearance must be submitted and cleared by the renewal date listed above. Failure to submit the Annual Status Report will result in the closure of the file. If funding is associated, funds will be frozen.
4. A closure request must be sent to CUREB-A when the research is complete or terminated.
5. During the course of the study, if you encounter an adverse event, material incidental finding, protocol deviation or other unanticipated problem, you must complete and submit a Report of Adverse Events and Unanticipated Problems Form, found here:
<https://carleton.ca/researchethics/forms-and-templates/>

Failure to conduct the research in accordance with the principles of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* 2nd edition and the *Carleton University Policies and Procedures for the Ethical Conduct of Research* may result in the suspension or termination of the research project.

Upon reasonable request, it is the policy of CUREB, for cleared protocols, to release the name of the PI, the title of the project, and the date of clearance and any renewal(s).

Please contact the Research Compliance Coordinators, at ethics@carleton.ca, if you have any questions.

CLEARED BY:

Date: November 26, 2019

Natasha Artemeva, PhD, Chair, CUREB-A

Janet Mantler, PhD, Vice-Chair, CUREB-A

Office of Research Ethics
4500 ARISE Building | 1125 Colonel By Drive
Ottawa, Ontario K1S 5B6
613-520-2600 Ext: 2517
ethics@carleton.ca

CERTIFICATION OF INSTITUTIONAL ETHICS CLEARANCE

The Carleton University Research Ethics Board-A (CUREB-A) at Carleton University has renewed ethics approval for the research project detailed below. CUREB-A is constituted and operates in compliance with the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (TCPS2).

Title: Ph.D. Thesis title: Assessing Tightly Bundled, Complete & Technology-Specific Policy Mixes to Accelerate Technological Change, Foster a Clean Energy Transition towards Low-Carbon Solutions, and Mitigate Climate Change in Canada

Protocol #: 111832

Project Team Members: Mr. Marc Wickham (Primary Investigator)
Robert P. Shepherd (Research Supervisor)

Department and Institution: Faculty of Public Affairs\Public Policy and Administration (School of), Carleton University

Funding Source (If applicable):

Effective: December 08, 2020
2021.

Expires: December 08,

Please ensure the study clearance number is prominently placed in all recruitment and consent materials: CUREB-A Clearance # 111832.

Restrictions:

This certification is subject to the following conditions:

1. Clearance is granted only for the research and purposes described in the application.
2. Any modification to the approved research must be submitted to CUREB-A via a Change to Protocol Form. All changes must be cleared prior to the continuance of the research.
3. An Annual Status Report for the renewal or closure of ethics clearance must be submitted and cleared by the renewal date listed above. Failure to submit the Annual Status Report will result in the closure of the file. If funding is associated, funds will be frozen.
4. During the course of the study, if you encounter an adverse event, material incidental finding, protocol deviation or other unanticipated problem, you must complete and submit a Report of Adverse Events and Unanticipated Problems Form.

5. It is the responsibility of the student to notify their supervisor of any adverse events, changes to their application, or requests to renew/close the protocol.
6. Failure to conduct the research in accordance with the principles of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2nd edition* and the *Carleton University Policies and Procedures for the Ethical Conduct of Research* may result in the suspension or termination of the research project.

Special requirements for COVID-19:

If this study involves in-person research interactions with human participants, whether on- or off-campus, the following rules apply:

1. Upon receiving clearance from CUREB, please seek the approval of the relevant Dean for your research. Provide a copy of your CUREB clearance to the Dean for their records. Please contact your Dean's Office for more information about obtaining their approval. See Principles and Procedures for On-campus Research at Carleton University and note that this document applies both to on- and off-campus research that involves human participants.
2. Provide a copy of the Dean's approval to the Office of Research Ethics prior to starting any in-person research activities.
3. If the Dean's approval requires any significant change(s) to any element of the study, you must notify the Office of Research Ethics of such change(s).

Upon reasonable request, it is the policy of CUREB, for cleared protocols, to release the name of the PI, the title of the project, and the date of clearance and any renewal(s).

Please email the Research Compliance Coordinators at ethics@carleton.ca if you have any questions.

CLEARED BY:

Date: December 08, 2020

Bernadette Campbell, PhD, Chair, CUREB-A

Natasha Artemeva, PhD, Co-Chair, CUREB-A

Appendix D - Case #1 - TEAM - Supplementary Information

Note: This appendix is meant to supplement section 4.4. Some of the text from section 4.4 is repeated here for completeness and better readability.

Background on the TEAM policy mix

The TEAM policy mix⁸⁴ (1998-2009) was part of a larger suite of measures developed, at the federal level, to meet the challenge of reducing greenhouse gas (GHG) emissions, following the Third Conference of the Parties (CoP3) to the United Nations framework Convention on Climate Change (UNFCCC), and the adoption of the Kyoto Protocol, on December 11, 1997. At that time, Canada and 150 other nations negotiated GHG emission reductions to be realized over the next 10-15 years. In 1997, in Kyoto, Canada agreed to reduce GHG emissions by 6% below 1990 levels (from 564 MT/year in 1990 to 531 MT/year), to be achieved by the 2008-12 time period, the so-called “Kyoto Attainment Period”. It took the Canadian federal government five more years to develop an approach to meet its commitments made in Kyoto. Canada ratified the Kyoto Protocol in December 2002. Given that the Canadian economy was growing, and that GHG emissions were also growing, it was estimated that under a business as usual basis, Canada would need to reduce GHG emissions by 21-25% in 2010, corresponding to a reduction of 138-178 MT/year (TEAM 1998), compared to 1990 levels, representing a reduction of 24-32%, which is quite significant.

For reference, during the timeframe of the TEAM policy mix (1998-2009), the federal government in power was Liberal, from 1993-2006 and Conservative, from 2006-

⁸⁴ The sources for much of the information in this Background section has been taken from the TEAM Business Plan and Management Framework, June 30, 1998 (see TEAM 1998 in the Bibliography).

2015. The Prime Ministers in power, during this time period, were Jean Chrétien (Liberal, Oct. 25, 1993 to Dec. 12, 2003), Paul Martin (Liberal, Dec. 12, 2003 to Feb. 6, 2006), and Stephen Harper (Conservative, Feb. 6, 2006 to Nov. 4, 2015).

The \$151M TEAM RD&D program, which is the cornerstone government STI program for this case study, was time-limited and had a duration of 11 years, and was implemented in 3 phases, with the first two phases funded under the Climate Change Action Fund (CCAF) (1998-2001) and CCAF Extension (2001-04), and the third phase funded under the Technology & Innovation Initiative, a component of the Climate Change Plan for Canada, adopted in Nov. 2002 (funding for the period 2004-09), as shown in Table 51 below:

Table 51 – TEAM RD&D program phases, Budget and Actual spending

TEAM				Budget		Funding	Actual
Phase	Authority	Fiscal Years	Term (Yrs.)	Allocation (\$M)	Lapsed (\$M)	Cuts/Add. (\$M)	Spending (\$M)
Phase I	CCAF	1998/99 to 2000/01	3	56		4	60
Phase II	CCAF extension	2001/02 to 2003/04	3	35	(2)		33
Phase III	Technology & Innovation Initiative	2004/05 to 2007/08	4	60		(19)	41
Phase III extension	Technology & Innovation Initiative	2008/09	1	-			-
TOTAL			11	151			134

The TEAM RD&D program was initially part of an umbrella initiative, called the Climate Change Action Fund (CCAF) that was set up to meet the challenge of reducing GHG emissions. The \$350M 6-year CCAF (including the CCAF extension) was one of nine (9) major federal initiatives, with a total budget of \$1.7B, implemented between 1997 and Dec. 2002, to address climate change (Canada 2003).

TEAM Phase 3 was funded under the Technology & Innovation Initiative, a component of the Climate Change Plan for Canada. It is interesting to note that the CCAF was developed as a response to the setting of targets following the CoP3 meeting in

Kyoto, Japan, in Dec. 1997; the CCAF extension provided an additional 3 years of funding to the CCAF to continue laying the policy and R&D foundations and further prepare for the ratification of the Kyoto Protocol by Canada in December 2002; and the Climate Change Plan for Canada, released in November 2002, was developed to support the implementation of a plan, and was released 1 month prior to the ratification of the Kyoto Protocol. Subsequent to the release of the Climate Change Plan for Canada, Budget 2003 allocated \$2B over 5 years, in support to innovation and GHG mitigation measures (Canada 2003), including the additional contribution to TEAM phase 3.

In summary, during the 11-year time period (1998-2009) for this case study, the federal government's climate change initiatives included a large number of initiatives, and an even larger number of instruments and projects, with a total budget of at least \$3.8B. This can be thought of as the "larger policy mix" to address climate change. In this case study, we will focus on a smaller policy mix consisting of the measures under the CCAF, CCAF Extension, and Technology & Innovation Initiative.

As was previously mentioned, by 2004, there were a large number of climate change initiatives and projects. In response to this, the federal government announced, in Budget 2005, a review of all climate change "programs", so that the government could assess and redirect funding to those "programs" that best met a number of criteria including: balance, competitiveness, partnership, innovation and cost-effectiveness (Canada 2005). As a result of several review processes conducted in 2006-07, i.e. in year 9 of 11 for the TEAM R&D program, it was decided that the TEAM RD&D program should be wound down and that the personnel administering TEAM be merged with the Office of Energy R&D, which was completed in 2007-08.

As additional background information, on Feb. 6, 2006, i.e. part-way through year 9 of 11 for the TEAM policy mix, the Conservatives under Stephen Harper won the federal elections and formed government, replacing the Liberals which had been in power since 1993. The Conservative government completed the review of climate change initiatives that had been initiated by the Liberals and cut spending to a number of these, including the TEAM RD&D program, which was cut by 31%. The Conservative government also approved funding for the \$226M ecoENERGY Technology Initiative, which was a new RD&D program that replaced TEAM. TEAM staff requested a 1-year extension, with no additional funding, to properly wind down operations in 2008-09.

Per the TEAM Fourth Progress Report (2005-08) (NRCan 2008), the TEAM RD&D program was defined as follows:

Technology Early Action Measures (TEAM) is a federal interdepartmental technology investment program established in 1998. TEAM brings together private and public sector partners to identify, develop and support the most promising environmentally-sound technologies that have the greatest potential to reduce greenhouse gases (GHGs). The program serves as a catalyst for innovation, operating under the leadership of Natural Resources Canada, Environment Canada and Industry Canada, with the participation of several other federal government departments.

The above definition only provides a partial definition of what the TEAM RD&D program actually was. During its implementation, the TEAM RD&D program was novel in a number of ways: (i) it was delivered by a dedicated, single-purpose organization, the TEAM Operations Office, made up of up to 13 employees; (ii) it was located in an offsite location, away from NRCan headquarters; (iii) it focused on the late-stage R&D and the demonstration stages of the innovation spectrum; (iv) it was a Grants & Contribution (G&C) “program” that provided funding primarily to external project proponents, such as private-sector companies and non-federal research organizations, to implement technology demonstration projects; (v) it fostered very strong, and possibly unique,

collaborations between federal researchers, which also received funding under this RD&D program, and G&C project proponents; (vi) it utilized a decentralized delivery model using federal delivery agents to source high quality proposals and deliver projects; (vii) it leveraged funding from other, large federal funding “programs” such as the Technology Partnerships Canada Program; and (viii) it developed a rigorous approach to measure project progress in reducing GHG emissions, which eventually led to the development and publishing of a global standard, the ISO 14064 standard (TEAM 2013). Additional information on the TEAM RD&D program is found in Table 52 below.

Table 52 – TEAM RD&D program information and statistics

Funding	Total Funding for TEAM program	\$134M actual spent; \$151M original budget
	Total Funding for projects	\$129M
	Administrative costs (over 11 years)	\$5M
Projects	Number of projects funded	140
	Average TEAM contribution per project	\$0.9M
	Average leverage from partners per project	\$7.3M
	Total \$s leveraged from partners	\$1,024M
	Total \$ value of projects	\$1,158M
Focus	Focus on innovation spectrum	Late-stage R&D and Demonstration
	Technology focus areas	8 technology areas: (1) clean fossil fuels (2) clean transportation systems (3) built environment (4) low emission industrial systems (5) distributed power generation (6) bio-based energy systems (7) clean coal & carbon capture & storage (8) other (information dissemination)
Partners	Number of unique partners participating in projects	450 private sector and government partners

Documents Reviewed

The number of documents available for review for this case study was fairly extensive, as listed in Table 53 below. Documents were available through NRCan’s Office of Energy R&D as well as through publically available web sites. The listing below includes frameworks describing the larger policy mix and context, design documents such as the TEAM business plans & management frameworks, various

progress reports, as well as evaluation reports.

Table 53 – TEAM case study – documents reviewed

Key Documents
TEAM Phase 1 (1998-2001)
TEAM Phase 1 - Business Plan and Management Framework (30. Jun. 1998)
Government of Canada Action Plan 2000 on Climate Change
Climate Change Action Fund (CCAF) 1998-2001 Report (2001)
TEAM Phase 2 (2001-2004)
Treasury Board Submission - The Extension of the Climate Change Action Fund (CCAF) (2001)
TEAM Phase 3 (2004-2009)
Treasury Board Submission - Funding for the Technology & Innovation Initiative, part of the Climate Change Plan for Canada
TEAM Phase III Business Plan and Management Framework (Dec. 2004)
TEAM - Overall, Reporting, and Evaluations
Foundation Paper - Technology Innovation for Mitigating Greenhouse Gas Emissions (Dec. 14, 1998)
Technology Issues Table - Enhancing Technology Innovation for Mitigating Greenhouse Gas Emissions (Dec. 10, 1999)
TEAM - [First] Progress Report on Climate Change Solutions (1998-2001)
TEAM - Second Progress Report (2001-2003)
TEAM - Third Progress Report (2003-2005)
TEAM - Fourth Progress Report (2005-2008)
TEAM Evaluation Summary Report (BearingPoint) (Jul. 19, 2005)
TEAM Case Study Summary Report (BearingPoint) 9Jul. 14, 2005)
Evaluation of Climate Change Action Fund (Apr.. 2005)
Treasury Board Climate Change Review (Aug. 2005)
Examination of Federal Environmental & Energy Science & Technology Investments - input by TEAM program (Feb. 24, 2006)
TEAM Final Report (Jul. 17, 2013)

Description of 3 attributes of TEAM case study as a conventional policy mix

Attribute #1 – Bundling

The nine instruments in the augmented TEAM policy mix were mapped against each step in the policy process and characterized as either loose or tight, based on information found in the policy mix documentation. While at the design stage, the instruments were grouped together in the Memorandum to Cabinet and Treasury Board Submission, at the implementation and evaluation stages, the instruments were only loosely bundled. The overall conclusion is that the policy mix was loosely bundled. This applies to both the formal and informal policy mixes.

Table 54 – TEAM policy mix - tool to determine level of bundling

		Design		Implemen- tation	Policy Evaluation
		Policy Formulation	Decision Making		
1	Team program	Tight	Tight	Loose	Loose
2	Foundation Building	Tight	Tight	Loose	Loose
3	Science, Impacts & Adaptation	Tight	Tight	Loose	Loose
4	Public Education & Outreach	Tight	Tight	Loose	Loose
5	International Policy & Related Activities	Tight	Tight	Loose	Loose
6	Technology & Innovation R&D	Tight	Tight	Loose	Loose
7	Hydrogen Economy - Innovation Excellence & Early Adopters	Tight	Tight	Loose	Loose
8	Climate Change Secretariat, Implementation & Monitoring	Tight	Tight	Loose	Loose
9	Program of Energy R&D (PERD)	Loose	Loose	Loose	Loose

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

As a first step in mapping the nine policy instruments along the innovation chain, each instrument is first mapped against the policy types proposed by the literature (IPCC 2007), described in chapter 2 Table 3, and tabulated in Table 55 below, as follows:

Table 55 – TEAM policy mix - mapping of nine policy instruments against instrument types

#	Policy Instrument	Policy Instrument Type
1	Team program	7. Research & Development
2	Foundation Building	8. Policy Development
3	Science, Impacts & Adaptation	7. Research & Development
4	Public Education & Outreach	6. Information Instrument
5	International Policy & Related Activities	8. Policy Development
6	Technology & Innovation R&D	7. Research & Development
7	Hydrogen Economy - Innovation Excellence & Early Adopters	7. Research & Development
8	Secretariat	8. Implementation
9	Program of Energy R&D (PERD)	7. Research & Development

Several of the above instruments were not instruments to enable technology development for climate change mitigation. Rather, they were policy instruments under the “other” category (category #8), which provide indirect support such as domestic policy development, international climate change negotiations, or implementation/monitoring of the policy mix. The nine policy instruments in the policy mix are then mapped against the innovation chain per Illustration 8 below. As can be

seen, some of the policy instruments do not have a direct impact on technology development and are thus shown under the “Not Applicable” column below.

Illustration 10 shows that the TEAM policy mix has good coverage of the RD&D stages of the Innovation Chain, but there are no instruments at the commercialization or diffusion stages. Thus, the policy mix can be said to be incomplete.

Illustration 9 – TEAM - Mapping of 9 policy instruments against the innovation chain

		Innovation Chain									
		Basic R&D		Applied R&D			Demonstration			Commercialization	Diffusion
		Technology Readiness Level (TRL)									
#	N/A	1	2	3	4	5	6	7	8	9	
1		Team program									
2	Foundation Building										
3		Science, Impacts &									
4	Public Education & Outreach										
5	International Policy										
6		Technology & Innovation R&D									
7		Hydrogen Economy - Innovation Excellence &									
8	Secretariat										
9		Program of Energy R&D (PERD)									

For completeness, the policy mix is mapped against the TRL and CRI scales in Tables 56 and 57 below. As can be seen, there is 100% coverage of the TRL scale, but only partial coverage of CRI levels 1 and 2 in the CRI scale. This additional detail confirms that the policy mix is incomplete, particularly at the later stages of the CRI.

Table 56 – Mapping of TEAM policy mix against TRL scale

	Technology Readiness Level								
	1	2	3	4	5	6	7	8	9
Policy Mix	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 57 – Mapping of TEAM policy mix against CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment								
	CRI 4 - Multiple commercial applications								
	CRI 3 - Commercial scale up								
	CRI 2 - Commercial trial		Yes	Yes	Yes	Yes	Yes		Yes
	CRI 1 - Hypothetical commercial proposition		Yes	Yes	Yes	Yes	Yes		Yes

Attribute #3 – Technology specificity

Using the tool to describe technology specificity, outlined in Chapter 3 Table 10, documentary evidence for each of the nine instruments were reviewed to determine their individual technology-specificity, as shown in Table 58 below. As can be seen, only one instrument out of the nine was technology specific. The conclusion is thus that the policy mix is non-technology-specific.

Table 58 – Tool to describe technology-specificity – TEAM policy mix

		Technology Specific	
		Yes or No	Technology or Sector Targeted
1	Team program	No	
2	Foundation Building	N/A	
3	Science, Impacts & Adaptation	No	
4	Public Education & Outreach	N/A	
5	International Policy & Related Activities	N/A	
6	Technology & Innovation R&D	No	
7	Hydrogen Economy - Innovation Excellence & Early Adopters	Yes	Hydrogen and fuel cells
8	Secretariat	N/A	
9	Program of Energy R&D (PERD)	No	

Conclusion

Per the above, the TEAM policy mix demonstrates the three attributes of an “ideal case” of a conventional policy mix, i.e. the policy mix is loosely bundled, incomplete, and non-technology-specific.

Data Tables

Table 59 – TEAM case study – 21 characteristics of the policy mix

Characteristics	Sub-characteristics	Description/Measure	TEAM	Comments (Based on document review)
Policy mix approach		Conventional or Experimental	Conventional	
Dimension	Policy Field	Technology development for clean energy transition	Clean Energy	
	Governance level	Federal government, all single department or organization	Federal	Multiple departments involved (NRCan, ECCC,ISED)
	Geography	Canada	Canada	
	Time	Timeframe	11 years	
		Temporal offset between instruments	Only R&D	Temporal offset between PERD and CCAF/T&I suite of programs
Policy process	Type	tightly coupled or loosely coupled	Loose	Only bundled at the Treasury Board Submission stage
Elements	Policy Strategy - Objectives	Degree of existence of objectives at the policy mix level (1-5)	2 (Med-Low)	At the CCAF level, goals were mostly instrument specific and not common.
	Policy Strategy - Principal Plans	Degree of existence of plans at the policy mix level (1-5)	2 (Med-Low)	At the CCAF level, plans were mostly instrument specific and not common.
	Number of instruments in policy mix	Number	9	
Instruments	Instrument - Type	Codes & standards, regulations, taxes & charges, tradable permits, voluntary agreements, subsidies and incentives, information, other	3	(1) Government STI program; (2) information instruments (public education), (8) Other
	Instrument - Goals	Degree of alignment of goals for sum of instruments (1-5)	1 (Low)	Goals at the instrument level are instrument specific (e.g. public education versus R&D); Degree of alignment of sum of instruments is therefore low.
	Instrument - Purpose or location on innovation chain	technology push, demand pull, or systemic concerns	3 (Med)	Covers R&D and Demo, and some systemic concerns. Deployment and diffusion are not covered.
	Instrument - Design Features	Legal or voluntary	Voluntary	
		Target actors	Many, Different	Different instruments target many, different actors.
		duration	Variable	Duration of different instruments varied. Some instruments dropped. Others added.
		differentiation (1-5)	5 (High)	Policy mix targets different sectors, technologies, size of plans, geographies.
	Cornerstone instrument	Government STI program or other	Govt STI program	TEAM program
	Interactions between instruments	Degree of interaction (1-5)	2 (Med-Low)	There was interaction of instruments at the governance stage, i.e. at the Climate Change Secretariat, but much less at the working level.
	Number of interactions between instruments	Count 1 for each pair of instruments (n-1)!	36	High number of potential interactions
Instrument Mix	Types of interaction between instruments	e.g. feedback loop	1	Feedback loop between TEAM demo program and PERD R&D program

Table 60 – TEAM case study – measurement tool with responses to question 1

Hope-d-for Improvement Q and benefit	Measure	Indicator	Measure	Low-High	Comments
1a. Do each of the three experimental policy mixes result in hoped-for improvements and benefits, namely improvements in:					
Consistency of elements	Alignment over time	temporal consistency (1-5)	1	Low	Different instruments have different timeframes: TEAM (demo with 3-10 yr horizon); Foundation Buildings (stakeholder engagement and policy development; immediate); Public Education (awareness raising and short term action); Science, Impacts & Adaptation (knowledge generation for use in the shorter term)
	Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)	3	Med	Conflict at mgmt level; rivalries; competition for resources to access reserve.
	Overall - strong consistency	Degree of existence of synergies (1-5)	2	Med-Low	Different instruments target different activities related to climate change mitigation. No direct synergies between climate change science and public education with technology development.
	Policy Strategy	Degree of alignment of policy objectives (1-5)	2	Med-Low	All instruments have climate change mitigation at a high level. Alignment is less clear at a lower level.
	Instrument mix	Degree of reinforcement between instruments (1-5)	2	Med-Low	Each instrument implemented separately, although there was some coordination for some time provided by the Secretariat. Limited reinforcement between instruments.
	Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)	2	Med-Low	Limited link between strategy and overall reinforcement between instruments.
	Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)	3	Med	Secretariat was developed with this in mind, but dropped after phase 1.
Coherence of processes	Organizational capacity	Degree of engagement between groups (1-5)	1	Low	Low engagement between groups.
	Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)	1	Low	Perceived effectiveness primarily based on performance of individual instruments.
	Barriers (market, institutional) - Coverage of TRL and CRI	Degree to which the policy mix addresses barriers, i.e. all stages in the TRL and CRI (1-5)	2	Med-Low	Good coverage of TRL. No coverage of later stages of innovation chain.
Comprehensiveness	Barriers (systemic) - Push, pull & systemic concerns	Degree to which the policy mix addresses all barriers - systemic / innovation process (1-5)	2	Med-Low	Commercialization Valley of Death not covered. Many barriers, particularly those related to deployment and commercialization unaddressed.

Table 61 – Team case study - measurement tool with responses to question 2

#	Conditions	Measure	TEAM	
			Indicator	Comment
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	Med-Low	The different instruments each operate independently to achieve their own individual goals, even if at a high level the common goal is to reduce GHG emissions.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med-Low	There is no evidence that different instruments utilized a shared measurement indicator, at the policy mix level, again except for the reduction of GHG emission.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med-Low	There was no evidence of coordination at the activity or plan of action level. The activities of the different instruments in the policy mix were designed to be mutually reinforcing, at a high level. There was no active coordination to ensure that these would actually be reinforcing, at the implementation stage.
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	Med-Low	There was some communication amongst different actors delivering the different instruments, on reporting of results, through the Secretariat, during Phase 1. However, in ph. 2 & 3, this communications between team was reduced.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	Med-Low	There was a backbone organization, the Secretariat, during Phase 1, but not during phases 2-3.
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	Med	There were champions advocating for their specific instruments and even some rivalry for resources. Some staff at the Secretariat, which was in place for phase 1, could be considered champions for the policy mix. However, the Secretariat was ceased after phase 1.
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	Med	There was initial recognition that there would be higher costs, especially with the inclusion of the Secretariat, during phase 1. Over time, this tolerance reduced, and the Secretariat was eliminated.
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	Med-Low	There was a bit of evidence that common tools, resources or capacity were developed. Examples include the GHG measurement framework developed by the TEAM program.
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med	Some involvement during the initial set up of the policy mix, as well as during program review. This involvement was reduced during the implementation phase.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	Med-Low	There was reporting at the policy mix level, during phase 1. This was reduced in phases 2-3.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	Med	At the planning level, there was more detail provided by central agencies, for individual instruments, but less so for the policy mix as a whole.
Summary			Med-Low to Med	

Appendix E - Case #2 - CEF - Supplementary Information

Note: This appendix is meant to supplement section 4.5. Some of the text from section 4.5 is repeated here for completeness and better readability.

Background on the CEF policy mix

The Clean Energy Fund (CEF), which is the cornerstone government STI program for this case study, was originally designed, per the federal Budget 2009, as a time-limited, stand-alone, \$1B government STI program, administered by NRCan's Office of Energy R&D (OERD). The CEF was part of the federal government's Economic Action Plan (EAP), which was a suite of measures implemented over two fiscal years (2009-10 and 2010-11), in response to the global financial crisis of 2007-08, which, at the time, was widely considered to be the second most severe financial crisis since the Great Depression that started in 1929. The government prepared regular reports to Canadians on the EAP's progress. In the 6th Report on the Canadian Economic Action Plan published in 2010-11, the government announced that the EAP provided \$66B in stimulus funding over 2 years (2009-10 and 2010-11), and was the third largest stimulus initiative in the G7. This report also stated that, over two years, the EAP supported 23,000 stimulus projects, which helped to create 430,000 jobs since July 2009⁸⁵.

For reference, the federal government in power, during the 2009-15 timeframe of the CEF, was Conservative (from Feb. 6, 2006 to Nov. 4, 2015), and the Prime Minister was Stephen Harper.

The CEF was also part of the government's broader suite of measures to address

⁸⁵ Source: OERD CEF files: 6th Report on the Canadian Economic Action Plan, government of Canada, 2010-11.

climate change and other environmental issues. The Auditor General of Canada points to two broad climate change policy agendas announced by the Conservative government over the CEF timeframe, namely Turning the Corner (2007) and the Climate Change Action Plan (2010)⁸⁶. The government operationalized the above frameworks into a more formal government policy framework referred to as the Clean Air Agenda (CAA). Under the CAA, the government's stated climate change goal was to reduce GHG emissions by 17% from 2005 levels by 2020⁸⁷, which is Canada's commitment in the Copenhagen Accord, agreed to by international governments at the Conference of Parties 15 meeting, on 18 December 2009. The Clean Air Agenda, over time, had 5-8 themes, and over 40 instruments delivered by at least nine (9) federal departments and agencies⁸⁸. The CEF fell under the Clean Energy Theme of the CAA. The CEF was also part of the Federal Sustainable Development Strategy (FSDS) and NRCan's Departmental Sustainable Development Strategy (DSDS), over the 2009-15 timeframe.

The EAP, Turning the Corner, the Climate Change Action Plan, the CAA Clean Energy Theme, the FSDS and NRCan's DSDS are all part of the larger policy frameworks, of which the CEF was part.

The CEF was originally announced as a \$1B government STI program, with funding allocations of \$150M for R&D in at least 8 technology areas, \$200M for small scale demonstration of clean and renewable energy technologies, and \$650M for

⁸⁶Source: AOG: http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201710_01_e_42489.html

⁸⁷ Source: OERD CEF files: NRCan CEF web site, archived page for 25 Feb. 2011.

⁸⁸ Source: ECCC Evaluation Review of the Clean Air Agenda Adaptation Theme <https://www.ec.gc.ca/ae-ve/default.asp?lang=En&n=A75F0606-1&printfullpage=true#f3> accessed 23 May 2020. NRCan web site <https://www.nrcan.gc.ca/plans-performance-reports/sustainable-development/departamental-strategy/433> accessed 23 May 2020.

demonstration of large-scale CCS projects in real world settings⁸⁹. In Budget 2010, in response to overwhelming demand for home energy efficiency retrofits as part of the economic stimulus plan, \$205M in funding was transferred from the CEF to NRCan's ecoENERGY Retrofit Homes Program⁹⁰. This effectively reduced the CEF's Budget allocation to \$795M, with changes in funding allocations from the above to \$24M for R&D, \$146M for small scale demonstrations, and \$610M for large-scale CCS demonstrations⁹¹, leaving \$15M for administration and other programming costs. In the end, the total actual spending was approximately \$306M, with \$27.8M of actual expenditures on the R&D component, \$111M spent on the small scale demonstration component and \$147M spent on the large-scale CCS demonstration component⁹².

Documents Reviewed

The number of documents available for review for this case study was quite complete, as listed in Table 62 below. Documents and file repositories were available through publically available sources as well as through NRCan's Office of Energy R&D. The listing below includes the key design documents, numerous files on implementation, as well as evaluation reports for the CEF and ecoETI RD&D programs. There was less detail on the Budget 2008 CCS RD&D program, given that most of the funding was through the Department of Finance. However, some of the key documents for the Budget 2008 CCS RD&D program were also accessed through the OERD.

⁸⁹ Source: OERD CEF files: NRCan CEF web site, archived page for 23 April 2009.

⁹⁰ Canada Budget 2010. <https://www.budget.gc.ca/2010/home-accueil-eng.html> accessed 23 May 2020.

⁹¹ Source: NRCan, Evaluation of the CEF <https://www.nrcan.gc.ca/evaluation/reports/2014/16534#a1-2-1> accessed 23 May 2020.

⁹² Source: for R&D: Evaluation of the CEF; for demo: Auditor General of Canada http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201710_03_e_42491.html accessed 23 May 2020.

Table 62 - CEF case study – documents reviewed

Key Documents
CEF and ecoETI programs - program design Memorandum to Cabinet Treasury Board Submission Amendment documents to program design, including Annual Reference Level Updates (ARLU) documents Finance Canada - Budget 2007, 2009 and Budget 2010 CEF and ecoETI programs - implementation Office of Energy R&D - Clean Energy Fund file repository, including project files CEF Large-scale CCS demonstration and ecoETI CCS programs Office of Energy R&D - Call for proposals documentation Office of Energy R&D - Individual CCS project files NRCan web site - project summary pages CEF - Reporting, and Evaluations Evaluation of Clean Energy Fund Policy Mix / Other Office of Energy R&D - Program of Energy R&D file repository Office of Energy R&D - Budget 2008 file repository Office of Energy R&D - ecoENERGY Technology Initiative file repository

Description of 3 attributes of CEF case study as a conventional policy mix

Attribute #1 - Bundling

The four instruments in the augmented CEF policy mix were mapped against each step in the policy process and characterized as either loose or tight, based on information found in the policy mix documentation, in Table 63 below. At most stages, the instruments were administered as separate, independent instruments, with separate Memoranda to Cabinet, Treasury Board Submissions, implementation and evaluations. Implementation could be considered tightly bundled for the CCS component of the CEF and ecoETI. The CEF itself was audited as a single policy instrument in 2010-11 and evaluated as a single policy instrument in 2014-15⁹³. The CEF was also included in an audit conducted by Canada's Commissioner of the Environment & Sustainable

⁹³ <https://www.nrcan.gc.ca/nrcan/plans-performance-reports/strategic-evaluation-division/reports-plans-year/evaluation-reports-2014/evaluation-clean-energy-fund-cef/16534>

Development, in 2017, titled Funding Clean Energy Technologies⁹⁴. This audit included the ecoETI and CEF, as well as projects funded by SDTC, an arms-length organization

Noting that the formal policy “mix” included only one instrument, the CEF, which was designed as a single, independent government STI program, not bundled with other instruments, the overall conclusion is that the policy mix was loosely bundled.

Table 63 - CEF policy mix - tool to determine level of bundling

		Design		Implemen- tation	Policy Evaluation
		Policy Formulation	Decision Making		
1	Clean Energy Fund	Loose	Loose	Loose	Loose
2	ecoENERGY Technology Initiative	Loose	Loose	Loose	Loose
3	Budget 2008	Loose	Loose	Loose	Loose
4	Program of Energy R&D (PERD)	Loose	Loose	Loose	Loose

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

As a first step in mapping the four policy instruments along the innovation chain, each instrument is first mapped against the policy types proposed by the literature (IPCC 2007), in Table 64 below, as follows:

Table 64 – CEF policy mix - mapping of four policy instruments against instrument types

#	Policy Instrument	Policy Instrument Type
1	Clean Energy Fund (CEF)	7. Research & Development
2	ecoENERGY Technology Initiative	7. Research & Development
3	Budget 2008	7. Research & Development
4	Program of Energy R&D (PERD)	7. Research & Development

The four policy instruments in the policy mix are then mapped against the innovation chain per illustration 11 below. This illustration shows that the CEF policy mix has good coverage of the RD&D stages of the Innovation Chain, but there are no instruments at the deployment or commercialization / diffusion stages. Thus, the policy

⁹⁴ https://www.oag-bvg.gc.ca/internet/English/parl_cesd_201710_e_42475.html

mix can be said to be incomplete.

Illustration 10 – CEF - Mapping of 4 policy instruments against the innovation chain

Innovation Chain											
Basic R&D		Applied R&D				Demonstration				Deployment	Commercialization / Diffusion
	Technology Readiness Level (TRL)										
#	1	2	3	4	5	6	7	8	9		
1	Clean Energy Fund										
2	ecoENERGY Technology Initiative										
3	Budget 2008										
4	Program of Energy R&D (PERD)										

For completeness, the policy mix was mapped against the TRL and CRI scales in Tables 65 and 66 below. As can be seen, there is 100% coverage of the TRL scale, but only partial coverage of CRI levels 1 and 2 in the CRI scale. On the CRI scale, I have indicated partial coverage in some spaces to indicate that CRI level 3 was achieved for one component of the CEF policy mix, namely the CCS component. This additional detail confirms that the policy mix was incomplete, particularly at the later stages of the CRI scale.

Table 65 – Mapping of CEF policy mix against TRL scale

Technology Readiness Level									
	1	2	3	4	5	6	7	8	9
Policy Mix	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 66 – Mapping of CEF policy mix against CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment								
	CRI 4 - Multiple commercial applications								
	CRI 3 - Commercial scale up	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial
	CRI 2 - Commercial trial	Partial	Yes	Yes	Yes	Yes	Yes	Partial	Yes
	CRI 1 - Hypothetical commercial proposition	Partial	Yes	Yes	Yes	Yes	Yes	Partial	Yes

Attribute #3 – Technology specificity

Using the tool to describe technology specificity, documentary evidence for each of the four instruments were reviewed to determine their individual technology-specificity, as shown in Table 67 below. As can be seen, three instruments out of the four were partially technology specific. The conclusion is thus that the policy mix is partially non-technology-specific or alternatively, partially technology-specific.

Table 67 – CEF policy mix – tool to describe technology-specificity

		Yes or No	Technology or Sector Targeted
1	Clean Energy Fund (CEF)	Partial	CEF CCS component was technology specific
2	ecoENERGY Technology Initiative	Partial	ecoETI CCS component was technology specific
3	Budget 2008	Partial	Budget 2008 component was technology specific
4	Program of Energy R&D (PERD)	No	

Conclusion

Per the above, the CEF policy mix displays attributes of a conventional policy mix, as two out of three attributes meet the requirements of a conventional policy mix, namely the policy mix is loosely bundled, incomplete. The third attribute is considered partially non-technology-specific.

Data Tables

Table 68 - CEF case study – 21 characteristics of the policy mix

Characteristics	Sub-characteristics	# sub-char.	Description/Measure	CEF	Comments (Based on document review)
Policy mix approach Dimension	Policy Field	1	Conventional or Experimental	Conventional	
	Governance level	1	Technology development for clean energy transition	Clean Energy	
		1	Federal government; all single department or organization	Federal	NRCan and the Department of Finance. That being said, there was a special relationship between the ecoETI, CEF and Alberta CCS Fund.
	Geography	1	Canada	Canada	
	Time	1	Timeframe	8 years	EcoETI (2007-13) to CEF (2009-15)
		1	Temporal offset between instruments	Only R&D	Temporal offset between PERD and R&D component of ecoETI and other instruments.
	Type	1	tightly coupled or loosely coupled	Loosely	CEF clearly designed as a stand-alone program
	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)	3 (Med)	There is no formal, explicit policy strategy at the policy mix level. There is a fairly strong, though non-explicit, policy strategy between the instruments, for CCS technology only.
	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)	3 (Med)	Similar to above, there are no formal, explicit plans at the policy mix level. However, there are loose, non-explicit plans.
	Number of instruments in policy mix	1	Number	4	
Instruments	Instrument - Type	1	(1) Regulations & standards; (2) Taxes & charges; (3) Tradable permits; (4) Voluntary agreements; (5) Subsidies and incentives; (6) Information; (7) Government STI programs (RD&D); (8) Other	1	(7) Government STI program. It should be mentioned that Alberta also conducted some important regulatory work that is not part of the defined policy mix.
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)	4 (Med-High)	Goals at the instrument level are aligned to a significant degree, even if informally. The overall goals are to support the development and adoption of new technologies, including CCS technologies
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns	3 (Med)	Covers R&D and Demonstration (partially only for CCS) only. Alberta's regulatory development, although not included in the policy mix, provided coverage of systemic concerns.
	Instrument - Design Features	1	Legal or voluntary	Voluntary	
		1	Target actors	(3) Fairly similar	Most instruments target similar actors, in this case, especially in the technology area of CCS, including technology developers and technology developers.
		1	duration	Different	Duration of instruments was quite different, covering different timeframes.
		1	differentiation (1-5)	3 (Med)	The CEF, ecoETI and PERD were designed as supporting a large number of different technologies. However, the CEF, Budget 2008 and ecoETI also had a very strong, singular focus on CCS technologies.
	Cornerstone instrument	1	Government STI program or other	Government STI	CEF program
	Interactions between instruments	1	Degree of interaction (1-5)	4 (Med-High)	For non-CCS technologies, there was some limited interaction between PERD, CEF and ecoETI R&D components. For the CCS component only, there was a quite a bit of interaction between the CEF, ecoETI and Budget 2008, as these programs were administered by the same team at NRCan.
	Number of interactions between instruments	1	Count 1 for each pair of instruments (n-1):	6	Relatively low number of potential interactions.
Instrument Mix	Types of interaction between instruments	1	e.g. feedback loop	Numerous	Feedback loop between different RD&D programs (CEF, ecoETI and Budget 2008).

Table 69 - CEF case study – measurement tool with responses to question 1

Hoped-for Improvement Q and benefit	Measure	Indicator	CEF		Comments	
			Measure	Low-High		
1a. Do each of the three experimental policy mixes result in hoped-for improvements and benefits, namely improvements in: Consistency of elements	Alignment over time		temporal consistency (1-5)			
			3	Med	Different instruments have quite different timeframes: ecoETI (2007-13), CEF (2009-15), and Budget 2008 (2008-09). PERD was defined as matching the CEF (2009-15). For the CCS component only, temporal consistency between the CEF, ecoETI and Budget 2008 programs was very strong.	
	Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)	4	Med-High	In general, there was a relative absence of conflicting elements.	
	Overall - strong consistency	Degree of existence of synergies (1-5)	3	Med	There were no significant synergies for technologies other than CCS. For CCS technologies, the synergies were quite strong.	
	Policy Strategy	Degree of alignment of policy objectives (1-5)	3	Med	For technologies other than CCS technologies, there was some, limited policy strategy at the policy mix level, at the R&D goal level. For CCS, there was an explicit strategy to support between 2-4 large-scale demonstration projects.	
	Instrument mix	Degree of reinforcement between instruments (1-5)	3	Med	For technologies other than CCS technologies, there was some reinforcement between instruments. For CCS, there was a strong reinforcement.	
	Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)	3	Med	For technologies other than CCS technologies, there was some, limited reinforcement. For CCS, there was a strong reinforcement.	
	Coherence of processes	Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)	3	Med	There was some, limited coordination, for the R&D component of programs, for non-CCS technologies. There was significant informal coordination and communications on CCS programs and projects.
		Organizational capacity	Degree of engagement between groups (1-5)	3	Med	Some limited engagement for non-CCS technologies. There was significant engagement for CCS technologies.
		Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)	3	Med	No significant direct effect of coherence for non-CCS technologies. There was significant direct effect of coherence for CCS technologies.
Comprehensiveness	Barriers (market, institutional) - Coverage of TRL and CRI	Degree to which the policy mix addresses barriers, i.e. all stages in the TRL and CRI (1-5)	3	Med	The degree to which barriers for non-CCS technologies were addressed was low for some CRI indicators. The degree to which such barriers for CCS technologies were addressed was high.	
	Barriers (systemic) - Push, pull & systemic concerns	Degree to which the policy mix addresses all barriers - systemic / innovation process (1-5)	3	Med	The degree to which all barriers for non-CCS technologies were addressed was low. The degree to which all barriers for CCS technologies were addressed was high.	

Table 70 - CEF case study - measurement tool with responses to question 2

			CEF	
#	Conditions	Measure	Indicator	Comment
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	Med	For non-CCS technologies, there were common R&D goals, between PERD, ecoETI and CEF. For CCS, there were common, formal goal to advance CCS demos between the CEF and ecoETI, but at a high level, and not at the policy mix level.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med	For non-CCS technologies, there was no formal shared measurement systems. For CCS, there was an informal measurement system between the CEF and ecoETI.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med	For non-CCS technologies, there were some, limited reinforcing activities between PERD, CEF and ecoETI. For CCS, there were reinforcing activities between the CEF and ecoETI.
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	Med	For non-CCS technologies, there was some communications between the PERD, ecoETI and CEF R&D components. For CCS, there was a fair amount of communications between the CEF and ecoETI.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	None	There was no backbone organization.
6	Catalysts and champions	Recognition of problem; trigerring events; role of specific individuals in championing the project. (0-5)	Med	For non-CCS technologies, OERD acted as a general catalyst and champion, to a moderate extent. For CCS, there was evidence that there were catalysts and champions advocating for advancement of common goals, in the OERD team administering the CCS component.
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	N/A	Not applicable as it was assumed that there would be cost savings in having the R&D and demo components administered by the same teams (OERD).
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	Med	For non-CCS and CCS technologies, there was little evidence of a need for new capacities. However, for the CCS component, there was a need for new capacities in interacting with Alberta, delivering very large projects, and knowledge sharing.
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med	Some involvement during the initial set up of the individual programs. This involvement was significantly reduced during the implementation phase.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	N/A	Not applicable as it appears each program was separately accountable.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	Med	At the planning level, there was some detail provided by central agencies on expected outcomes, for individual instruments, but not at the policy mix level.
Summary			Med	

Appendix F - Case #3 - ERPP - Supplementary Information

Note: This appendix is meant to supplement section 4.6. Some of the text from section 4.6 is repeated here for completeness and better readability.

Background on the ERPP policy mix

As was referenced above, the 5-year, \$200M ERPP was part of a suite of five policy mixes administered by NRCan, under the Budget 2017 GI phase 2 initiative, and is closely related to the three experimental case studies to be described in the next chapter. A brief introduction to the GI phase 2 initiative will be provided here, with more detail provided in chapter 5. In order to avoid repeating information, the reader is directed to section 5.3 for additional background details.

This conventional case study is part the Government of Canada's \$180B 12-year Investing In Canada Plan⁹⁵, the government's primary infrastructure initiative. While much of the Investing In Canada Plan is administered and delivered by Infrastructure Canada, some components of the plan are delivered by other federal departments, including NRCan⁹⁶.

Green Infrastructure (GI) is one of five major components of the Investing In Canada Plan, and received \$26.9B in Budget 2016 and Budget 2017⁹⁷. The goals of the GI component is to support infrastructure projects that support Canada's ongoing transition to a clean growth economy, including initiatives that will support the

⁹⁵ Infrastructure Canada, Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/about-invest-apropos-eng.html> . Accessed 16 Feb. 2019.

⁹⁶ Infrastructure Canada: Funding Delivered under the Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/funding-financement-eng.html> . Accessed 16 Feb. 2019.

⁹⁷ Infrastructure Canada: Green Infrastructure. <https://www.infrastructure.gc.ca/plan/gi-iv-eng.html> . Accessed 16 Feb. 2019.

implementation of the Pan-Canadian Framework on Clean Growth and Climate Change⁹⁸. NRCan administers 10 GI initiative which have a budget of \$967.5M over up to 12 years⁹⁹.

Of the 10 GI initiatives administered by NRCan above, the ERPP program is one of five integrated policy mixes that received \$882.3M in funding, and that were designed to be co-delivered in a synergistic fashion by different NRCan organizations. The five policy mixes were bundled together in one Treasury Board Submission, under GI Phase 2. Note that the Electric Vehicle & Alternative Fuels program has 2 phases and started a little earlier than the others. Of the five policy mixes below, four are assessed in this thesis. The five programs in the suite are shown in Table 71 below.

Table 71 – 5 Green Infrastructure integrated policy mixes managed by NRCan

	No. of Instruments in Formal Policy Mix	GI Ph.	Federal Budget	Program Timeframe		Funding \$M	Treasury Board Submission Date
				# Years	From/To		
GI Ph. 1 & 2 policy mixes							
GI Ph. 2 - Emerging Renewables Power (ERPP)	1	2	B2017	4	2018-23	200.0	07 Dec. 2017
GI Ph. 2 - Energy Efficient Buildings	8	2	B2017	8	2018-26	182.0	07 Dec. 2017
GI Ph. 2 - Clean Energy for Rural & Remote Communities (CERRC)	5	2	B2017	6	2018-14	217.8	07 Dec. 2017
GI Ph. 2 - Smart Grids	2	2	B2017	4	2018-22	100.0	07 Dec. 2017
GI Ph. 1 & Ph. 2 - Electric Vehicle & Alt Fuels (EVAF)	3	1	B2016	2	2016-18	62.5	14 Dec. 2016
		2	B2017	4	2018-22	120.0	07 Dec. 2017
				6	2016-22	182.5	
Total Funding						882.3	

The ERPP was designed differently than the other four policy mixes in the above suite. It was designed as a single, independent deployment incentive instrument, delivered by one organization, namely NRCan's Renewable & Electrical Energy Division (REED). The other integrated policy mixes were designed with a number of instruments

⁹⁸ Infrastructure Canada: Green Infrastructure. <https://www.infrastructure.gc.ca/plan/gi-iv-eng.html> . Accessed 16 Feb. 2019.

⁹⁹ Infrastructure Canada: Funding Delivered under the Investing in Canada Plan. <https://www.infrastructure.gc.ca/plan/funding-finance-eng.html>. Accessed 16 Feb. 2019.

bundled together, as indicated in the table above. Note that the ERPP is shown as having only 1 instrument in the “formal policy mix”.

In answer to the question as to why the ERPP was not designed or implemented in the same way as the others, two reasonable reasons provided are that: (i) the ERPP is designed based on the definition that “emerging” renewable technologies had already been deployed elsewhere in the world or demonstrated in Canada; thus, there may not have been a perceived need for a demonstration component (i.e. a government STI program), as was included in all other four policy mixes in the suite. And (ii) the amount of funding offered by Infrastructure Canada was relatively small (\$200 M) for a deployment incentive instrument of this nature. With an average contribution to projects in the \$20 M per project range, approx. 8 projects could be supported in total; so that it did not make any sense to divide this relatively low level of funding into 2 or more instruments. REED had previously managed the very successful \$1.4B ecoENERGY for Renewable Power (ecoERP) and \$330M Wind Production Power Incentive (WPPI) Programs, which were instrumental in kick-starting the Canadian wind and solar PV industry in Canada. In contrast, the \$200M, 5-year funding envelope was only 1/7th the size of the ecoERP, and thus it did not make sense to split this small amount of funding into several parts.

The ERPP expects to provide “up to \$200 million to expand the portfolio of commercially viable renewable energy sources available to provinces and territories as they work to reduce GHG emissions from their electricity sectors.”¹⁰⁰ The ERPP was

¹⁰⁰ NRCan web site, <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/emerging-renewable-power/20502> accessed 31 May 2020.

designed to mitigate “the risk of emerging renewable power projects through federal government funding, allowing emerging renewables to play a larger role in Canada’s electricity supply mix.”¹⁰¹

As of October 2020, the ERPP had announced \$96.1M in funding towards 4 projects: 2 geothermal, 1 instream tidal and 1 bi-facial solar photovoltaic projects¹⁰². On the ERPP website, there is a special note that specifically states that: “Demonstration projects are not eligible under this program”¹⁰³. This statement confirms that the ERPP does not include any formal linkages to government STI programs and is focused on deployment. A knowledgeable observer might argue that the types of technologies and projects actually supported are, in fact, similar to demonstration projects. Nevertheless, the formal design is as a single, standalone deployment incentive instrument.

Documents Reviewed

The number of documents available for review for this case study, as listed in Table 72 below, was fairly complete, taking into consideration that the policy mix is currently in year 3 of its 5 year implementation timeframe. So, the documentary evidence is not as strong as for the other 2 conventional case studies. Documents were available primarily through public sources, the Office of Energy R&D, and the Renewable Energy & Electricity Division (REED). The listing below includes the key design and implementation documents, in effect to date. There was no evaluation conducted to date.

¹⁰¹ Ibid.

¹⁰² Ibid.

¹⁰³ Ibid.

Table 72 - ERPP case study – documents reviewed

Key Documents
<p>Larger Policy Mix</p> <p>Infrastructure Canada: Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Funding Delivered under the Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Green Infrastructure - Canada Web Site</p> <p>ERP Program</p> <p>ERPP program - NRCan Web Site</p> <p>ERPP program - Applicants Guide - NRCan Web Site</p> <p>ERPP Program - Funding announcements - NRCan Web site</p> <p>Policy Mix - ORP</p> <p>Offshore Renewables Program - Communications with stakeholders - REED ORER Program Archive</p> <p>Offshore Renewables Program - NRCan Web site</p> <p>Policy Mix - PERD & EIP</p> <p>Energy Innovation Program - NRCan web site</p> <p>OERD G&C Project Listing - NRCan Web Site</p> <p>PERD Program - OERD Program Archive</p> <p>NRCan general</p> <p>NRCan 2019-23 Integrated Audit & Evaluation Plan - NRCan Web Site</p> <p>Past audits and evaluations - NRCan Web Site</p> <p>NRCan Funding Announcement - Google Searches</p>

Description of 3 attributes of ERPP case study as a conventional policy mix

Attribute #1 - Bundling

The four instruments in the augmented ERPP policy mix were mapped against each step in the policy process and characterized as either loose or tight, based on information found in the policy mix documentation, in Table 73 below. At all stages, the instruments were administered as separate, independent instruments, with separate Memoranda to Cabinet, Treasury Board Submissions and evaluations. For example, for Policy Evaluation, per NRCan's 2019-24 Integrated Audit & Evaluation Plan¹⁰⁴, each of the 4 instrumentss are evaluated in a separate evaluation, i.e. ERPP (2020-21), PERD (2020-21), EIP (2023-24) and ORP (not yet scheduled). Noting that the formal policy

¹⁰⁴ <https://www.nrcan.gc.ca/nrcan/transparency/reporting-accountability/plans-performance-reports/audit-evaluation/annual-plans/natural-resources-canada-2019-24-integrated-audit-evaluation-plan/22240>

“mix” included only one instrument, the ERPP, which was designed as a single, independent deployment incentive instrument, not bundled with other instruments, the overall conclusion is that the policy mix was loosely bundled.

Table 73 - ERPP policy mix - tool to determine level of bundling

		Design		Implement- ation	Policy Evaluation
		Policy Formulation	Decision Making		
1	Emerging Renewables Power Program (ERPP)	Loose	Loose	Loose	Loose
2	Offshore Renewables Program (ORP)	Loose	Loose	Loose	Loose
3	Energy Innovation Program (EIP)	Loose	Loose	Loose	Loose
4	Program of Energy R&D (PERD)	Loose	Loose	Loose	Loose

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

As a first step in mapping the four policy instruments along the innovation chain, each instrument is first mapped against the policy types proposed by the literature (IPCC 2007), in Table 74 below, as follows:

Table 74 – ERPP policy mix - mapping of four policy instruments against instrument types

#	Policy Instrument	Policy Instrument Type
1	Emerging Renewables Power Program (ERPP)	5. Subsidies & Incentives (deployment)
2	Offshore Renewables Program (ORP)	1. Regulations & Standards
3	Energy Innovation Program (EIP)	7. Research & Development
4	Program of Energy R&D (PERD)	7. Research & Development

As can be seen, the four policy instruments are of three types: R&D, subsidies & incentives (deployment) and regulations and standards. The four policy instruments in the policy mix are then mapped against the innovation chain, per illustration 12 below. This illustration shows that the ERPP policy mix has good coverage of the RD&D and deployment stages of the Innovation Chain, but there are no instruments at the commercialization/diffusion stages. In addition, there is a regulatory-type instrument,

which addresses framework conditions. Thus, the policy mix can be said to be incomplete.

Illustration 11 – ERPP - Mapping of 4 policy instruments against the innovation chain

		Innovation Chain										
		Basic R&D		Applied R&D			Demonstration			Deployment	Commercialization / Diffusion	
#	Framework Conditions	Technology Readiness Level (TRL)										
1		1	2	3	4	5	6	7	8	9		
2	Offshore Renewable Energy Program										ERPP	
3		Energy Innovation Program (EIP)										
4		Program of Energy R&D (PERD)										

For completeness, the policy mix was mapped against the TRL and CRI scales in Tables 75 and 76 below. As can be seen, there is 100% coverage of the TRL scale, but only partial coverage of the CRI scale, in levels 1-3. On the CRI scale, I have indicated coverage up to commercial scale up (level 3) across all indicators, to reflect the ERPP's objectives. This additional detail confirms that the policy mix is incomplete, particularly at the later stages of the CRI scale.

Table 75 – Mapping of ERPP policy mix against TRL scale

		Technology Readiness Level								
		1	2	3	4	5	6	7	8	9
Policy Mix		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 76 – Mapping of ERPP policy mix against CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment								
	CRI 4 - Multiple commercial applications								
	CRI 3 - Commercial scale up	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 2 - Commercial trial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 1 - Hypothetical commercial proposition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Attribute #3 – Technology specificity

Using the tool to describe technology specificity, documentary evidence for each of the four instruments were reviewed to determine their individual technology-specificity, as shown in Table 77 below. As can be seen, two instruments out of the four were partially technology specific, but don't cover all of the same technologies. The conclusion is thus that the policy mix is partially technology-specific.

Table 77 – ERPP policy mix – tool to describe technology-specificity

		Technology Specificity	
		Yes or No	Technology or Sector Targeted
1	Emerging Renewables Power Program (ERPP)	Yes	"Emerging" renewables
2	Offshore Renewables Program (ORP)	Yes	Offshore Wind
3	Energy Innovation Program (EIP)	No	Covers many, different technology types
4	Program of Energy R&D (PERD)	No	Covers many, different technology types

Conclusion

Per the above, the formal ERPP policy mix displays attributes of a conventional policy mix, because bundling is loose, coverage of the innovation chain is incomplete, and the technology specificity can be said to be partially technology-specific. The formal

ERPP policy mix is clearly conventional, because the ERPP was designed as a single, stand-alone deployment incentive instrument.

Data Tables

Table 78- ERPP case study – 21 characteristics of the policy mix

Characteristics	Sub-characteristics	# sub-char.	Description/Measure	ERPP	Comments (Based on document review)
Policy mix approach Dimension	Policy Field	1	Conventional or Experimental	Conventional	
	Governance level	1	Technology development for clean energy transition	Clean Energy	
	Geography	1	Federal government; all single department or organization	Federal	AI/NRCan
	Time	1	Canada	Canada	
		1	Time frame	5 years	
		1	Temporal offset between instruments	Only R&D	Temporal offset between PERD, EIP and other instruments
	Type	1	tightly coupled or loosely coupled	Loose	ERPP clearly designed as a stand-alone program
	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)	2 (Med-Low)	There is no formal, explicit policy strategy at the policy mix level. There is a loose, non-explicit policy strategy between the instruments, which is to advance technology development in the area of emerging renewables.
	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)	2 (Med-Low)	Similar to above, there are no formal, explicit plans. However, there are loose, non-explicit plans.
	Number of instruments in policy mix	1	Number	4	
Instruments	Instrument - Type	1	(1) Regulations & standards; (2) Taxes & charges; (3) Tradable permits; (4) Voluntary agreements; (5) Subsidies and incentives; (6) Information; (7) Government STI programs (RD&D); (8) Other	3	(1) Regulations & Standards; (5) Subsidies & Incentives (deployment), (7) Government STI program
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)	4 (Med-High)	Goals at the instrument level are aligned to a significant degree, even if informally. The overall goals are to support the development and adoption of new, emerging renewable energy technologies.
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns	4 (Med-High)	Covers R&D and Demo, deployment and one major systemic concern (i.e. regulation).
	Instrument - Design Features	1	Legal or voluntary	Voluntary	
		1	Target actors	(3) Fairly similar	Most instruments target similar actors, in this case, emerging renewable energy technology developers, project developers, and regulators.
		1	duration	Similar	Duration of instruments was 5 year or more.
		1	differentiation (1-5)	2 (Med-Low)	Different instruments target a specific sector only (emerging renewables only); medium to large size plants only (4 MW and over); only a few technologies; only geographies where technologies could be implemented.
	Cornerstone instrument	1	Government STI program or other	Deployment program	ERPP program
	Interactions between instruments	1	Degree of interaction (1-5)	2 (Med-Low)	There was a bit of informal interaction between instruments (some projects supported at RD&D and deployment stages).
	Number of interactions between instruments	1	Count 1 for each pair of instruments (n-1).	6	Low number of potential interactions
Instrument Mix	Types of interaction between instruments	1	e.g. feedback loop	Two types	Feedback loop between RD&D & deployment programs and between ERPP and ORP programs

Table 79 - ERPP case study – measurement tool with responses to question 1

Hoped-for Improvement Q and benefit	Measure	Indicator	ERPP		Comments
			Measure	Low-High	
1a. Do each of the three experimental policy mixes result in hoped-for improvements and benefits, namely improvements in:					
Consistency of elements	Alignment over time	temporal consistency (1-5)	5	High	Different instruments have similar timeframes: ERPP & ORP have same 5-year timeframe; PERD & EIP, being permanent programs, overlap with the 5-year timeframe.
	Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)	3	Med	Funding for ERPP was relatively low, with insufficient funding for R&D and demo in the formal policy mix. Therefore, medium rivalry.
	Overall - strong consistency	Degree of existence of synergies (1-5)	3	Med	Overall, good synergies between ERPP and ORP. Weaker overall synergies with PERD/EIP given very wide mandate for these 2 programs. Only 2 out of 4 projects linked, with strong links for 1 project (DEEP).
	Policy Strategy	Degree of alignment of policy objectives (1-5)	2	Med-Low	There is no formal, explicit policy strategy at the policy mix level. There is a loose, non-explicit policy strategy between the instruments, which is to advance technology development in the area of emerging renewables.
	Instrument mix	Degree of reinforcement between instruments (1-5)	2	Med-Low	Each instrument implemented separately.
Coherence of processes	Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)	2	Med-Low	Limited link between strategy and overall reinforcement between instruments.
	Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)	2	Med-Low	No formal coordination. Some informal coordination and communications on synergistic projects.
	Organizational capacity	Degree of engagement between groups (1-5)	1	Low	Low engagement between groups.
	Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)	2	Med-Low	Perceived effectiveness primarily based on performance of individual instruments.
Comprehensiveness	Barriers (market, institutional) - Coverage of TRL and CRI	Degree to which the policy mix addresses barriers , i.e. all stages in the TRL and CRI (1-5)	3	Med	Good coverage of TRL. Some coverage of CRI. One major regulatory instrument being worked on. Barriers related to offshore wind only partially addressed.
	Barriers (systemic) - Push, pull & systemic concerns	Degree to which the policy mix addresses all barriers - systemic / innovation process (1-5)	3	Med	Many barriers related to CRI still requiring to be addressed. Barriers related to commercialization/diffusion largely unaddressed. Barriers related to offshore wind only partially addressed.

Table 80 - ERPP case study - measurement tool with responses to question 2

#	Conditions	Measure	ERPP	
			Indicator	Comment
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	Med	At a high level and informally, yes, at the instrument level. However, there are no formal common goals at the policy mix level.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med-Low	There was no shared measurement of results at the policy mix level, however individual instruments focused on measuring similar results, related to electricity generating technologies.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med	There was no evidence of coordination at the activity or plan of action level, at the policy mix level. There were some, mutually reinforcing activities between the ERPP and the Offshore Renewable Program (ORP), as these were delivered by the same organization, i.e. REED. Some activities between the instruments are/were coordinated when supporting the same project or stakeholder (e.g. DEEP).
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	Med	There was some evidence of good communications between the ERPP and ORP again as they were both delivered by REED, but more limited communications between the ERPP and EIP in cases where there were common projects only.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	None	There was no backbone organization.
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	Med	There is/was evidence that there are catalysts and champions advocating for the experimental policy approach, especially in the case of ERPP and ORP, which had objectives in common.
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	N/A	Not applicable as this was a conventional policy mix.
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	N/A	Not applicable as this was a conventional policy mix.
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med	Some involvement during the initial set up of the policy mix. This involvement was significantly reduced during the implementation phase.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	N/A	Not applicable as this was a conventional policy mix and there was no accountability framework at the policy mix level.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	Med	At the planning level, there was more detail provided by central agencies, for individual instruments.
Summary			Med	

Appendix G - Case #4 - EVAF - Supplementary Information

Note: This appendix is meant to supplement section 5.4. Some of the text from section 5.4 is repeated here for completeness and better readability.

Background on the EVAF Policy Mix

This policy mix was developed to address GHG emissions from the transportation sector, which accounts for approximately a quarter of Canada's total emissions (24% in 2017)¹⁰⁵. While lower-carbon vehicles and fuels (specifically natural gas (NG) and hydrogen (H₂)) are commercially available, uptake of these vehicles and fuels is limited due to financial and other barriers, including higher costs, consumer awareness and confidence, and lack of recharging infrastructure. As there is a need to reduce costs and improve the performance, functionality and availability of charging and alternative fuels refueling infrastructure, the federal government developed a policy mix to specifically address technical, costs and other barriers.

The \$76M EVID (demonstration) RD&D program was designed¹⁰⁶ to address technical and non-technical barriers such as costs and improved technical performance, and support the demonstration of EV charging and H₂ refueling technologies for a variety of applications and settings, such as for multi-unit residential buildings or townhouse developments, and for EV owners who do not have garages (with individual owners' charging equipment). Other EV recharging infrastructure applications targeted include

¹⁰⁵ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/electric-vehicle-infrastructure-demonstration-evid-program/20467>

¹⁰⁶ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/electric-vehicle-infrastructure-demonstrations-evid/green-infrastructure-phase-ii-electric-vehicle-infrastructure-demonstration-program-request/22157>

freight transportation, vehicle fleets including taxis, public transit (eBuses), autonomous vehicles, bi-directional charging equipment, and solutions to minimize the impact of charging on the electricity grid. The H₂ refueling applications targets medium and heavy duty vehicles, i.e. trucks, only. Most of the funding is in the form of Grants & Contribution funds intended for stakeholders outside of the federal government. The EVID built upon research, development, and demonstration projects funded under PERD and the ecoENERGY Innovation Initiative (ecoEII), which provided the foundations upon which the EVID could be designed.

The EVID is administered by NRCan's Office of ENERGY R&D (OERD). As of October 2020, the EVID RD&D program had announced \$35M in funding to 16 projects¹⁰⁷. Some notable projects supported are: several electric bus demonstration projects in the cities of Newmarket and Brampton, in Ontario, and Vancouver and Burnaby, in BC.; a project to demonstrate fast charging EV charging stations along the Trans-Canada Highway in rural and remote areas addressing recharging in locations where the limited supply of electricity is partially compensated for with the use of electricity storage and local electricity generation using solar panels¹⁰⁸; and demonstrating EV charging stations and EV driving range in very cold climates, i.e. in Whitehorse, Yukon.

The \$96M EVAFIDI (deployment) was designed¹⁰⁹ to support the deployment of a coast-to-coast EV recharging network along Canada's major highways, to improve

¹⁰⁷ <https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/current-investments/21146#investments>

¹⁰⁸ <http://www.ecamion.com/fast-charging-stations-for-electric-vehicles-coming-to-trans-canada-highway/>

¹⁰⁹ <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/electric-alternative-fuel-infras/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352>

consumer confidence that there would be sufficient charging infrastructure to support consumer adoption. The EVAFIDI also targeted natural gas and H₂ refueling infrastructure along specific transportation corridors and regions. As with the EVID RD&D program, most of the funding is in the form of Grants & Contribution funds intended for stakeholders outside of the federal government. The EVAFIDI's goals are the installation of 900 EV recharging stations along the Trans-Canada Highway and other key commercial routes from Vancouver to Halifax, 15 natural gas refueling stations along major freight routes, and 12 H₂ refueling stations in large metropolitan areas. As of March 2020, according to NRCan, the EVAFIDI had selected projects enabling the installation of 837 EV fast chargers, 23 natural gas refueling stations along freight routes, and 8 hydrogen refueling stations for funding¹¹⁰. The EVAFIDI is administered by NRCan's Office of Energy Efficiency's Transportation & Alternative Fuels Division.

Documents Reviewed

There were a significant number of documents available for review for this case study, as listed in Table 81 below, taking into consideration that the formal policy mix is currently in year 5 of its 6 year implementation timeframe. Documents were available primarily through public sources, the Office of Energy R&D, and the Office of Energy Efficiency's Transportation & Alternative Fuels Division (TAFD). The listing below includes the key design and implementation documents, reviewed to date. There has been one joint audit and evaluation of the EVAFIDI completed to date.

¹¹⁰ <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation/electric-alternative-fuel-infras/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352>

Table 81 - EVAF case study – documents reviewed

Key Documents
<p>Larger Policy Mix</p> <p>Infrastructure Canada: Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Funding Delivered under the Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Green Infrastructure - Canada Web Site</p> <p>Policy Mix - EVID program</p> <p>EVID program - NRCan Web Site</p> <p>EVID program - Applicants Guide - NRCan Web Site</p> <p>EVID program - Funding announcements - NRCan Web site</p> <p>Policy Mix - EVAFIDI program</p> <p>EVAFIDI program - NRCan Web Site</p> <p>EVAFIDI program - Applicants Guide - NRCan Web Site</p> <p>EVAFIDI program - Funding announcements - NRCan Web site</p> <p>EVAFIDI program - Joint audit and evaluation - NRCan Web site</p> <p>Policy Mix - ZEVI program</p> <p>ZEVI program - NRCan Web Site</p> <p>ZEVI program - Applicants Guide</p> <p>Policy Mix - PERD & ecoEII/EIP</p> <p>ecoEnergy Innovation Initiative - OERD Program Archive</p> <p>ecoEnergy Innovation Initiative - Assessment</p> <p>OERD G&C Project Listing - NRCan Web Site</p> <p>PERD Program - OERD Program Archive</p> <p>NRCan general</p> <p>NRCan 2019-23 Integrated Audit & Evaluation Plan - NRCan Web Site</p> <p>Past audits and evaluations - NRCan Web Site</p> <p>NRCan Funding Announcement - Google Searches</p>

Description of 3 attributes of EVAF case study as an experimental policy mix

Attribute #1 - Bundling

The three instruments in the formal EVAF policy mix were mapped against each step in the policy process and characterized as either loose or tight, based on information found in the policy mix documentation, in Table 82 below. At the design stage, the three instruments were designed as a single policy mix, as documented in the Treasury Board Submissions. Implementation is characterized as loose, as the demonstration and deployment/codes and standards components were administered separately by the two organizations, OERD and TAFD, which delivered the policy mix components. For audit

and evaluation, per NRCan's 2019-24 Integrated Audit & Evaluation Plan¹¹¹, there are separate audits and evaluations planned for each of the demonstration, deployment and codes & standards components of the formal policy mix, therefore this is characterized as loosely bundled. A joint audit and evaluation of the EVAFIDI component has already been completed in 2019¹¹², while a joint audit and evaluation of the EVID component is scheduled for 2020-21 and none has yet been scheduled for the codes & standards component. The overall conclusion is that the policy mix is loosely bundled. This is slightly different from what was expected.

If the three other policy instruments that were included as part of the augmented policy are added to the above, it is noted that these three instrument would be shown as loosely bundled with the formal policy mix, for all stages of the policy process.

Table 82 - EVAF policy mix - tool to determine level of bundling

		Design		Implemen- tation	Policy Evaluation
		Policy Formulation	Decision Making		
1	EVAF - Government STI program - EVID	Tight	Tight	Loose	Loose
2	EVAF - Deployment program - EVAFIDI	Tight	Tight	Loose	Loose
3	EVAF - Codes & Standards	Tight	Tight	Loose	Loose

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

As a first step in mapping the three policy instruments in the formal policy mix along the innovation chain, each instrument is first mapped against the policy types proposed by the literature (IPCC 2007), in Table 83 below, as follows:

¹¹¹ <https://www.nrcan.gc.ca/nrcan/transparency/reporting-accountability/plans-performance-reports/audit-evaluation/annual-plans/natural-resources-canada-2019-24-integrated-audit-evaluation-plan/22240>

¹¹² <https://www.nrcan.gc.ca/nrcan/transparency/reporting-accountability/plans-performance-reports/audit-evaluation/reports-year/reports-2019/joint-audit-evaluation-electric-vehicle-alternative-fuel-infrastructure-deployment>

Table 83 – EVAF policy mix - mapping of policy instruments against instrument types

#	Policy Instrument	Policy Instrument Type
1	EVAF - Government STI program - EVID	7. Research & Development
2	EVAF - Deployment program - EVAFIDI	5. Subsidies & Incentives (deployment)
3	EVAF - Codes & Standards	1. Regulations & Standards
4	Zero Emission Vehicle Infrastructure (ZEV) program	5. Subsidies & Incentives (deployment)
5	ecoENERGY Innovation Initiative (ecoEII)	7. Research & Development
6	Program of Energy R&D (PERD)	7. Research & Development

As can be seen, the six policy instruments are of three types: R&D, subsidies & incentives (deployment) and regulations and standards. The six policy instruments in the policy mix are then mapped against the innovation chain, per Illustration 13 below. An important assumption built into this illustration is that the deployment instruments, EVAFIDI and ZEV, are large enough and comprehensive enough, to also cover the commercialization/diffusion stage, as well. The evidence for this is that a national charging network is expected to result from these two deployment instruments, along the entire Trans-Canada Highway, as well as in other areas, which will significantly address barriers to commercialization. This illustration shows that the EVAF policy mix has good coverage of the RD&D and deployment and commercialization/diffusion stages. In addition, there is a regulatory-type instrument, which addresses framework conditions. Thus, the policy mix can be said to be complete.

Illustration 12 – EVAF Mapping of 6 policy instruments against the innovation chain

		Innovation Chain											
		Basic R&D		Applied R&D			Demonstration			Deployment		Commercialization / Diffusion	
		Technology Readiness Level (TRL)											
#	Framework Conditions	1	2	3	4	5	6	7	8	9			
1							EVAF demonstration - EVID						
2												EVAF deployment - EVAFIDI	
3	EVAF Coes & Standards												
4							ecoENERGY Innovation Initiative (ecoEII)					Zero Emission Vehicle Infrastructure (ZEV) program	
5							Program of Energy R&D (PERD)						
6													

For completeness, the augmented policy mix was mapped against the TRL and CRI scales in Tables 84 and 85 below. As can be seen, there is 100% coverage of the TRL scale, and significant coverage of the CRI scale, in levels 1-5. I have stopped short

of indicating that all barriers have been addressed, given that the deployment instruments are still required and in process of being implemented, and that government subsidy instruments are still required to promote the deployment of EV charging and NG & H₂ refueling infrastructure, at the present time. This additional detail confirms that the policy mix is quite complete, particularly at the later stages of the CRI scale.

Table 84 – Mapping of EVAF policy mix against TRL scale

	Technology Readiness Level								
	1	2	3	4	5	6	7	8	9
Policy Mix	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 85 – Mapping of EVAF policy mix against CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial
	CRI 4 - Multiple commercial applications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 3 - Commercial scale up	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 2 - Commercial trial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 1 - Hypothetical commercial proposition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Attribute #3 – Technology specificity

Using the tool to describe technology specificity, documentary evidence for each of the three instruments in the formal policy mix were reviewed to determine their individual technology-specificity, as shown in Table 86 below. As can be seen, all three instruments were technology specific. The conclusion is thus that the policy mix is technology-specific. Even if the three additional policy instruments, included in the

augmented policy mix, are also assessed, one can see that the conclusion remains the same that the policy mix is technology-specific.

Table 86 – EVAF policy mix – tool to describe technology-specificity

	Technology Specific	
	Yes or No	Technology or Sector Targeted
1 EVAF - Government STI program - EVID	Yes	EV charging and H2 refueling infrastructure
2 EVAF - Deployment program - EVAFIDI	Yes	EV charging, natural gas & H2 refueling infrastructure
3 EVAF - Codes & Standards	Yes	EV charging, natural gas & H2 refueling infrastructure
4 Zero Emission Vehicle Infrastructure (ZEV) program	Yes	EV charging, natural gas & H2 refueling infrastructure
5 ecoENERGY Innovation Initiative (ecoEII)	Partial	General, but includes EV infrastructure
6 Program of Energy R&D (PERD)	Partial	General, but includes EV infrastructure

Conclusion

Per the above, the formal and augmented EVAF policy mixes exhibits attributes of experimental policy mixes, because bundling is partially tight for design (loose for implementation and evaluation); coverage of the innovation chain is quite complete ; and the technology coverage is specific to EV recharging and natural gas and H₂ refueling infrastructure.

Data Tables

Table 87- EVAF case study – 21 characteristics of the policy mix

Characteristics	Sub-characteristics	# sub-char.	Description/Measure	EVAF	Comments (Based on document review)
Policy mix approach Dimension	Policy Field	1	Conventional or Experimental	Experimental	R&D, demonstration, deployment, codes and standards
	Governance level	1	Technology development for clean energy transition	Clean Energy	
		1	Federal government, single department, two organizations	Federal	NRCan only, Office of Energy R&D (OERD) and Office of Energy Efficiency (OEE), Transportation & Alternative Fuels Division (TAFD)
	Geography	1	Canada	Canada	
	Time	1	Timeframe	6 years	EVAF 6 years (2016-22); ZEV1 5 years (2019-24); PERD assumed 6 years same as EVAF; EcoIII 6 years (2011-16) has a temporal offset compared to policy mix.
Policy process Elements		1	Temporal offset between instruments	Only R&D	Temporal offset between PERD (R&D) and ecoIII (2011-16) and the formal EVAF policy mix. ZEV1 also has 2 year temporal offset with formal EVAF policy mix.
	Type	1	tightly coupled or loosely coupled	Loosely	Tightly bundled at design stage. Loosely bundled at implementation and evaluation stage. Overall: loosely bundled.
	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)	4 (Med-High)	There are high level objectives at the policy mix level. However, each of the demonstration, deployment and codes and standards components of the formal policy mix have different objectives, which are quite different from one another. That being said, the objectives are complementary and enable technology development and adoption.
	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)	3 (Med)	There are high level plans at the policy mix level. However, each of the demonstration, deployment and codes and standards components of the formal policy mix are implemented separately.
	Number of instruments in policy mix	1	Number	3 formal/ 6 augmented	There are 3 policy instruments in the formal policy mix and 6 in the augmented policy mix.
Instrument Mix	Instrument - Type	1	(1) Regulations & standards; (2) Taxes & charges; (3) Tradable permits; (4) Voluntary agreements; (5) Subsidies and incentives; (6) Information; (7) Government STI programs (RD&D); (8) Other	3	(1) Regulations & standards; (5) Subsidies and incentives; (7) Government STI programs (RD&D).
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)	4 (Med-High)	Goals at the instrument level are aligned to a significant degree, formally in the Treasury Board Submission. Goals are very aligned given that they are technology-specific targeting different aspects of EV recharging and natural gas and H2 refueling infrastructure.
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns	4 (Med-High)	The augmented policy mix covers R&D, Demonstration, Deployment and Commercialization/Diffusion. The Codes & Standards component cover some framework concerns.
	Instrument - Design Features	1	Legal or voluntary	Voluntary	All instruments target similar actors, in this case, technology developers and users, including utilities, municipalities, vehicle/fleet owners.
		1	Target actors	(5) Very similar	Duration of instruments was quite different, covering different timeframes.
Instrument Mix		1	duration	Different	The instruments were highly targeted to EV recharging and natural gas & H2 refueling infrastructure (low differentiation). However, within this category, there was wide coverage of different applications (higher differentiation).
		1	differentiation (1-5)	2 (Med-Low)	
	Cornerstone instrument	1	Government STI program or other	Government STI	EVID program
	Interactions between instruments	1	Degree of interaction (1-5)	3 (Med)	Although at the design stage, the interaction was anticipated as high, at the implementation stage, interaction was limited, relative to other policy mixes in the GI suite. There was good interaction between the EVAFIDI and ZEV1 program, as well as between the EVAFIDI and codes and standards component.
	Number of potential interactions between instruments	1	Count 1 for each pair of instruments (sum of $n-1 + n-2 + \dots + 2 + 1$)	15	Relatively high number of potential interactions.
Instrument Mix	Types of interaction between instruments	1	e.g. feedback loop	Some	Feedback loop between different EVAFIDI and ZEV1 and Codes and Standards.

Table 88 - EVAF case study – measurement tool with responses to question 1

Q	Hoped-for Improvement and benefit	Measure	Indicator	EVAF		Comments
				Measure	Low-High	
1a. Do each of the three experimental policy mixes result in hoped-for improvements and benefits, namely improvements in: temporal consistency (1-5)	Consistency of elements	Alignment over time		3	Med	Different instruments have quite different timeframes: EVAF EVID and EVAFIDI 6 years (2016-22); EVAF Codes & Standards 4 years (2018-22); ZEVI 5 years (2019-24); ecoEII 6 years (2011-16); PERD assumed as as EVAF but in fact was temporarily offset.
		Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)	4	Med-High	In general, there is a relative absence of conflicting elements. In terms of conflicts for resources between EVID and EVAFIDI, these were originally designed to be similar in \$ value. The addition of the \$130M ZEVI skewed the mix in favour of deployment. EVID may have had some trouble allocating funds to projects, resulting in less need for funding.
		Overall - strong consistency	Degree of existence of synergies (1-5)	3	Med	There are some, limited synergies between demonstration and deployment, although this would be greater if there was a temporal offset between the demonstration and deployment component. There are theoretical synergies between EVID and ZEVI, as there is a slight temporal offset, but not significant enough of an offset to be significant. There are some synergies between EVID, EVAFIDI, ZEVI and the Codes and Standards component.
		Policy Strategy	Degree of alignment of policy objectives (1-5)	4	Med-High	There was good alignment between objectives of EVID, EVAFIDI and Codes & Standards.
		Instrument mix	Degree of reinforcement between instruments (1-5)	4	Med-High	There was some, albeit limited reinforcement between EVAF demo and deployment, as evidenced by the relatively small number of common proponents or projects. There was good reinforcement between PERD, ecoEII and EVID. There was also good reinforcement between the 2 deployment components (EVAFIDI and ZEVI), and between demo/deployment and codes & standards.
	Coherence of processes	Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)	3	Med	For technologies other than CCS technologies, there was some, limited reinforcement. For CCS, there was a strong reinforcement. That being said, overall, there was reinforcement in the objectives of high level goals.
		Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)	3	Med	There was good reinforcement at the design stage, but less so at the implementation and evaluation stages, as there was some separate administration at these stages.
		Organizational capacity	Degree of engagement between groups (1-5)	3	Med	Some engagement between OERD and TAFD, particularly at the design stage, less so at implementation, and limited at the evaluation stage.
		Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)	3	Med	Some impact of coherence in policy making (esp. design) on perceived effectiveness, especially with regards to a technology-specific focus on EV recharging. However, lack of common implementation and evaluation lowered the overall rating.
Comprehensiveness	Barriers (systemic) - Push, pull & systemic concerns	Barriers (market, institutional) - Coverage of TRL and CRI	Degree to which the policy mix addresses barriers, i.e. all stages in the TRL and CRI (1-5)	4	Med-High	The degree to which barriers for EV recharging infrastructure are addressed in quite high, per the TRL and CRI tables. It is lower for natural gas and H2 refueling infrastructure. In both cases, some barriers remain.
			Degree to which the policy mix addresses all barriers - systemic / innovation process (1-5)	4	Med-High	As above, the degree to which push, pull and systemic concerns was good, but some barriers remain.

Table 89 - EVAF case study - measurement tool with responses to question 2

			EVAF	
#	Conditions	Measure	Indicator	Comment
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	Med-High	The two organizations, OERD and TAFD, share a vision for change that includes a common understanding of the problem. The approach is complementary. There is a slight difference in focus, with demonstration focusing on EV recharging, and deployment focusing on EV recharging and natural gas/H2 infrastructure.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med	There is no official shared measurement, at the policy mix level. Nevertheless, moderately detailed indicators to measure success are developed for the individual instruments that have common elements. There are slight differences for demonstration, deployment, and codes & standards.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med	There are some, limited mutually reinforcing activities between demonstration and deployment, although the evidence shows just a few projects with common proponents. There are some mutually reinforcing activities between EVID, EVAFIDI, ZEVI and the Codes and Standards component.
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	Med	Communications was high at the design and early implementation stage, but is less during implementation and evaluation, especially on a relative basis, compared to other experimental case studies.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	None	There was no backbone organization.
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	Med	There were catalysts and champions at the design stage, but less so, for the policy mix, afterwards.
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	Med-Low	There was no expectation of incremental costs because there were cost savings at the design phases, and other phases were delivered as for a conventional policy mix.
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	Low	There is not much evidence that this was a need for such, at the policy mix level.
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med	Some central agency involvement during the design phase of the policy mix and other individual programs. This involvement was reduced during the implementation and evaluation phase.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	Med	There was only moderate evidence that the accountability framework was adjusted to account for the dual nature of accountabilities, given that only the design phase was tightly bundled.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	Med-High	At the design stage, there was some detail provided by central agencies on expected outcomes, for the policy mix and for individual instruments.
Summary			Med	

Appendix H - Case #5 – Smart Grids - Supplementary Information

Note: This appendix is meant to supplement section 5.5. Some of the text from section 5.5 is repeated here for completeness and better readability.

Background on the Smart Grids policy mix

In terms of background, smart grids refer to both a desired state of electricity transmission and distribution networks, and a class of clean energy technologies that “modernize the safe and secure delivery of electricity, provide foundations for new market structures and a higher quality of service for customers. They are a key enabler for GHG mitigation, as they increase the hosting capacity of renewable [electricity] generation, leverage more from the electricity infrastructure we have, and increase resiliency”¹¹³. In practice, smart grids are achieved through the installation of different technologies throughout the electricity transmission and distribution network. This can include equipment that is owned by (or located on premises of) electricity distribution companies and/or electricity consumers, whether residential or commercial clients. Examples of smart grid technologies include: (i) demand-response technology that allows electricity companies to control the timing of use of end use appliances such as residential electric hot water tanks, by switching them on or off at specific times, to manage peak electricity demand throughout the day, week, month and/or year; (ii) utility-scale battery-based electricity storage technology along with a distributed energy resource management system (DERMS), located in the electricity distribution network, that enable an electricity company to utilize battery power, at peak electricity demand

¹¹³ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793>

times, to reduce peak electricity demand, in a specific distribution zone or for a particular electricity customer; (iii) enhanced communications and control equipment that would enable electricity companies to bi-directionally route electricity produced on a distribution network, for example a new small solar farm located in a downtown park, to wherever the electricity was needed in the service area close to the park, and (iv) equipment that enable a distribution area to operate as a micro grid, that can be operated as an isolated “island”, in the case of a power failure or under other conditions when such a state would be desirable. The above examples were taken from actual projects funded by the Smart Grids policy mix, per NRCan’s web site¹¹⁴.

In terms of it being part of an “infrastructure” initiative, it should be noted that the electricity grid or network is considered to be infrastructure of national importance, interconnected between provinces, owned by a mix of provincial, municipal and private utilities, and operated for public benefit and use. Electricity is considered an essential service. The reliability and cost of delivering electricity is considered a key economic factor in economic competitiveness and growth (GOC 2017).

There is a perceived need for the Smart Grids policy mix because electric utilities have specifically highlighted the unique challenges they face in pursuing smart grid technologies, due to regulatory constraints on spending, and the nature of smart grids providing benefits to the entire systems, or to all users of the electricity system, while utilities can only recoup costs from their own ratepayers. In addition, utilities are reluctant to invest in smart grid technologies because these technologies are perceived as being too risky (Ibid).

¹¹⁴ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793>

The goals of the Smart Grids policy mix are to accelerate the transition to a clean growth economy, by better utilizing the existing capacity of electricity assets, increasing the penetration of renewable electricity generation, and increasing the reliability, resiliency, and flexibility of the electricity system, while maintaining cyber security¹¹⁵. At the design phase, the policy mix was expected to contribute to the further decarbonizing of the Canadian electricity network, which in 2018 was 80% non-emitting, and to contribute to GHG emission reductions in the electricity sector and to job growth, by 2030.

The Smart Grids policy mix is composed of two core components, which are meant to be delivered jointly by NRCan’s OERD and REED, through a “one-window” or “no wrong door” process for applicants:

- Demonstration component (\$35M) to fund demonstration projects of innovative and emerging smart grid technologies; and
- Deployment component (\$65M) to fund deployment projects of technologies that are at the commercial stage.

“One-window” is a Whole-of-government concept that is meant to streamline the delivery of government services, for users, by using a single point of contact, to be used by applicants and other users of the policy mix. The “no wrong door” approach means that stakeholders can interact with anyone administering the policy mix, or apply to any of the different components, and be directed to the proper staff or policy mix component. An example of a single point of contact would be for the proposal application process – in this case, there would be a single application process for applicants, for both

¹¹⁵ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793>

demonstration and deployments components. In this case, the Smart Grids policy mix was clearly developed with this concept in mind, from inception. The targeted end users in this case are electrical utilities, electrical system operators, and transmission system owners and operators only, as these are the entities that are most likely to adopt and implement smart grid technologies. In terms of “one window” process, in addition to having a single call for proposals for the two types of projects outlined above (demonstration and deployment), the review process was common in that projects would be selected under the two streams by a single review committee. This meant that, in practice, instead of implementing two separate processes for each policy mix component, there was a single process for every facet of the administration of the policy mix, from documentation of funding application requirements to communications with the public. According to Smart Grid staff, this integrated delivery has resulted in significant cost savings, even if it requires a higher degree of coordination and communications.

As of October 2020, the Smart Grid policy mix had announced that it had allocated \$73.1 M to support the implementation of 17 new projects, implemented by a variety of utilities in 8 different Provinces and Territories: 5 demonstration, 7 deployment, and 5 hybrid projects, which include features of both demonstration and deployment projects. Hybrid projects were not anticipated at the start of the policy mix. The fact that approximately 1/3 of projects supported are hybrid projects is a testament to the integrated nature of policy mix implementation¹¹⁶.

Documents Reviewed

There were a significant number of documents available for review for this case study, as

¹¹⁶ Ibid.

listed in Table 90 below, taking into consideration that the formal policy mix is currently in year 3 of its 4 year implementation timeframe. Documents were available primarily through public sources, and NRCan's Office of Energy R&D and Renewable Energy & Electricity Division (REED). The listing below includes the key design and implementation documents, reviewed to date. There has been no audits or evaluations completed to date.

Table 90 – Smart Grids case study – documents reviewed

Key Documents
<p>Larger Policy Mix</p> <p>Infrastructure Canada: Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Funding Delivered under the Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Green Infrastructure - Canada Web Site</p> <p>Smart Grids Policy Mix</p> <p>Smart Grids program - NRCan Web Site</p> <p>Smart Grids program - Applicants Guide - NRCan Web Site</p> <p>Smart Grids Program - Program Summary and Projects Selected - NRCan Web site</p> <p>Impact Canada Initiative</p> <p>Impact Canada Initiative - Government of Canada web site</p> <p>Impact Canada Initiative - Announcements</p> <p>Power Forward Challenge - ICI web site</p> <p>PERD & EIP</p> <p>Energy Innovation Program - NRCan web site</p> <p>OERD G&C Project Listing - NRCan Web Site</p> <p>PERD Program - OERD Program Archive</p> <p>NRCan general</p> <p>NRCan 2019-24 Integrated Audit & Evaluation Plan - NRCan Web Site</p> <p>Past audits and evaluations - NRCan Web Site</p> <p>NRCan Funding Announcement - Google Searches</p>

Description of 3 attributes of Smart Grids case study as an experimental policy mix

Attribute #1 - Bundling

The two instruments in the formal Smart Grids policy mix were mapped against each step in the policy process and characterized as either loose or tight, based on information found in the policy mix documentation, in Table 91 below. At all stages, the instruments were, or are planned to be, administered as a single policy mix, as documented in the Treasury Board Submissions. Implementation is characterized as

tightly bundled based on the documentary evidence that there were single calls for proposals for the two stream, a single review committee and common reporting. For audit and evaluation, per NRCan’s 2019-24 Integrated Audit & Evaluation Plan¹¹⁷, there is only one joint audit and evaluation planned for the policy mix as a whole, in 2020-21. The overall conclusion is that the policy mix is tightly bundled.

If the three policy instruments that were included as part of the augmented policy are added to the above, it is noted that these instruments would be shown as loosely bundled with the formal policy mix, at the design and evaluation stages of the policy process. However, the evidence is that all the government STI instruments were implemented in a fairly coherent manner. In any event, as the additional instruments were not conceived as part of the formal policy mix, therefore, there is no change to the conclusion that the policy mix is tightly bundled.

Table 91 – Smart Grids policy mix – tool to determine bundling

		Design		Implemen- tation	Policy Evaluation
		Policy Formulation	Decision Making		
1	Smart Grids - demonstration component	Tight	Tight	Tight	Tight
2	Smart Grids - deployment component	Tight	Tight	Tight	Tight

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

As a first step in mapping the five policy instruments in the augmented policy mix along the innovation chain, each instrument is first mapped against the policy types proposed by the literature (IPCC 2007), in Table 92 below, as follows:

¹¹⁷ <https://www.nrcan.gc.ca/nrcan/transparency/reporting-accountability/plans-performance-reports/audit-evaluation/annual-plans/natural-resources-canada-2019-24-integrated-audit-evaluation-plan/22240>

Table 92 – Smart Grids policy mix - mapping of five policy instruments against instrument types

#	Policy Instrument	Policy Instrument Type
1	Smart Grids - demonstration component	7. Research & Development
2	Smart Grids - deployment component	5. Subsidies & Incentives (Deployment)
3	ICI Power Forward Challenge (PFC)	7. Research & Development
4	Energy Innovation Program (EIP)	7. Research & Development
5	Program of Energy R&D (PERD)	7. Research & Development

As can be seen, the five policy instruments are of two types: R&D and subsidies & incentives (deployment). The five policy instruments in the policy mix are then mapped against the innovation chain, per illustration 14 below. This illustration shows that the Smart Grids policy mix has good coverage of the RD&D and deployment and no coverage of the commercialization/diffusion stages. Thus, the policy mix can be said to be at least partially complete.

Illustration 13 – Smart Grids - Mapping of 5 policy instruments against the innovation chain

Innovation Chain											
Basic R&D		Applied R&D				Demonstration				Deployment	Commercialization / Diffusion
#	Technology Readiness Level (TRL)										
	1	2	3	4	5	6	7	8	9		
1						Smart Grids (demonstration)					
2										Smart Grids (deployment)	
3					ICI Power Forward Challenge						
4						Energy Innovation Program (EIP)					
5	Program of Energy R&D (PERD)										

For completeness, the policy mix was mapped against the TRL and CRI scales in Tables 93 and 94 below. As can be seen, there is 100% coverage of the TRL scale, but only partial coverage of the CRI scale, in levels 1-4. On the CRI scale, I have indicated coverage up to multiple commercial applications (level 4) across most indicators, to reflect the Smart Grids policy mix's objectives. This additional detail confirms that the policy mix is partially complete, particularly at the later stages of the CRI scale.

Table 93 – Mapping of Smart Grids policy mix against TRL scale

Technology Readiness Level									
	1	2	3	4	5	6	7	8	9
Policy Mix	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 94 – Mapping of Smart Grids policy mix against CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment								
	CRI 4 - Multiple commercial applications	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial
	CRI 3 - Commercial scale up	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 2 - Commercial trial	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 1 - Hypothetical commercial proposition	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Attribute #3 – Technology specificity

Using the tool to describe technology specificity, documentary evidence for each of the five instruments were reviewed to determine their individual technology-specificity, as shown in Table 95 below. As can be seen, two instruments out of two in the formal policy mix, and three out of five in the augmented policy mix, are technology-specific. It is understood that two of the instruments (EIP and PERD) added in the augmented policy mix cover numerous technologies, but also cover smart grid technologies. Thus, the conclusion is thus that the policy mix is technology-specific.

Table 95 – Smart Grids policy mix – tool to describe technology-specificity

		Technology Specific	
		Yes or No	Technology or Sector Targeted
1	Smart Grids - demonstration component	Yes	Smart Grids technology
2	Smart Grids - deployment component	Yes	Smart Grids technology
3	ICI Power Forward Challenge (PFC)	Yes	Smart Grids technology
4	Energy Innovation Program (EIP)	Partial	Cover many technologies, including Smart Grids
5	Program of Energy R&D (PERD)	Partial	Cover many technologies, including Smart Grids

Conclusion

Per the above, the Smart Grids policy mix exhibits the three attributes of experimental policy mixes to a significant degree, because bundling is clearly tight especially for the formal policy mix, coverage of the innovation chain is mostly complete, and the policy mix can be said to be technology-specific and focused on smart grid technologies.

Data Tables

Table 96- Smart Grids case study – 21 characteristics of the policy mix

Characteristics	Sub-characteristics	# sub-char.	Description/Measure	Smart Grids	Comments (Based on document review)
Policy mix approach Dimension		1	Conventional or Experimental	Conventional	
	Policy Field	1	Technology development for clean energy transition	Clean Energy	
	Governance level	1	Federal government; all single department or organization	Federal	
	Geography	1	Canada	Canada	
	Time	1	Timeframe	4 years	
Policy process Elements		1	Temporal offset between instruments	RD&D	Temporal offset between PERD (R&D) and R&D component of EIP and two formal instruments (demonstration and deployment).
	Type	1	tightly coupled or loosely coupled	Tightly	
	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)	5 (High)	Per the Treasury Board Submission, there is an explicit policy strategy at the formal policy mix level. There are also explicit objectives and goals at the policy mix level, as well as at the instrument level.
Instruments	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)	4 (Med-High)	Per the Treasury Board Submission, there are explicit plans at the formal policy mix level. There are also explicit plans at the instrument level. Given that plans need to be typically more detailed than objectives, and that the plans are not that detailed, the rating is slightly lower on plans than for objectives (4 rather than 5).
	Number of instruments in policy mix	1	Number	5	There are 2 policy instruments in the formal policy mix and 5 in the augmented policy mix.
	Instrument - Type	1	(1) Regulations & standards; (2) Taxes & charges; (3) Tradable permits; (4) Voluntary agreements; (5) Subsidies and incentives; (6) Information; (7) Government STI programs (RD&D); (8) Other	2	There are 2 types of instruments in the formal and augmented policy mixes: (7) Government STI program and (5) Subsidies & Incentives (Deployment).
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)	4 (Med-High)	Goals at the instrument level are aligned to a significant degree, in the formal policy mix, and slightly less so in the augmented policy mix.
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns	3 (Medium)	Instruments at the augmented policy mix level cover R&D, Demonstration, and Deployment, and cover technology push and pull.
	Instrument - Design Features	1	Legal or voluntary	Voluntary	
		1	Target actors	(4) Similar	All instruments in the formal policy mix target exactly the same actors, in this case, electric utilities. The R&D programs added in the augmented policy mix target similar actors, as well as a broader list of actors including technology developers, academia, etc.
		1	duration	Same	Duration of instruments are all similar, covering very similar timeframes.
		1	differentiation (1-5)	2 (Med-Low)	The Smart Grids components target very specific applications in the smart grids technology area (lower differentiation).
	Cornerstone instrument	1	Government STI program or other	Government STI	Smart's Grids (demonstration component).
Instrument Mix	Interactions between instruments	1	Degree of interaction (1-5)	5 (High)	There is a very high degree of interaction between the two components of the formal Smart Grids policy mix. The interaction is slightly lower, but still significant, with instruments in the augmented policy mix. The rating is based on the formal policy mix.
	Number of interactions between instruments	1	Count 1 for each pair of instruments (sum of n-1 + n-2+ ... + 2 + 1)	2-10	Relatively low number of potential interactions (2 for formal policy mix; 10 for augmented policy mix).
	Types of interaction between instruments	1	e.g. feedback loop	A few	Feedback loop between deployment and demonstration components; and between demonstration/deployment and R&D components.

Table 97 – Smart Grids case study – measurement tool with responses to question 1A

Hoped-for Improvement and benefit	Measure	Indicator	Smart Grids	Comments	
					Measure
1a. Do each of the three experimental policy mixes result in hoped-for improvements and benefits, namely improvements in:					
Consistency of elements	Alignment over time	temporal consistency (1-5)	4	Med-High	Different instruments have very similar timeframes. However, there is a natural temporal offset between R&D programs and demonstration/deployment, and a smaller offset between demonstration and deployment.
	Overall - weak consistency	Degree of absence of conflicting or contradictory elements (1-5)	4	Med-High	In general, there were few conflicting or contradictory elements.
	Overall - strong consistency	Degree of existence of synergies (1-5)	4	Med-High	There were significant synergies between the demonstration and deployment components. One third of projects selected were hybrid projects, combining elements of both demonstration and deployment.
	Policy Strategy	Degree of alignment of policy objectives (1-5)	5	High	The degree of alignment of policy objectives was very strong and explicit.
	Instrument mix	Degree of reinforcement between instruments (1-5)	4	Med-High	There was strong reinforcement between the demonstration and deployment components of the policy mix.
	Policy mix	Degree of reinforcement of strategy and instrument mix (1-5)	4	Med-High	There was strong alignment between the strategy, goals and instrument mix.
Coherence of processes	Synergistic policymaking	Degree to which planning, structures & communications reinforce the achievement of policy objectives (1-5)	4	Med-High	The two instruments in the formal policy mix were administered in a highly coordinated fashion, at the design, implementation and evaluation stage. At the implementation stage, the two instruments used the same call for proposals process, same review committees to review and select proposals, and same communications process for announcements.
	Organizational capacity	Degree of engagement between groups (1-5)	4	Med-High	There was frequent and consistent engagement between OERD and REED on the design and delivery of the policy mix.
	Direct effect of coherence	Degree of impact of coherence on perceived effectiveness (1-5)	4	Med-High	The degree of synergistic policymaking and engagement is perceived as having a direct impact on the effectiveness of the policy mix.
Comprehensiveness	Barriers (market, institutional) - Coverage of TRL and CRI	Degree to which the policy mix addresses barriers , i.e. all stages in the TRL and CRI (1-5)	3.5	Med to Med-High	The degree to which barriers for were addressed was high for TRL and medium-low for some CRI indicators.
	Barriers (systemic) - Push, pull & systemic concerns	Degree to which the policy mix addresses all barriers - systemic / innovation process (1-5)	3.5	Med to Med-High	The degree to which all barriers was medium. There was a gap for regulatory barriers that has been identified during the implementation phase.

Table 98 – Smart Grids case study - measurement tool with responses to question 2

			Smart Grids	
#	Conditions	Measure	Indicator	Comment
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	Med-High	At the Treasury Board Submission stage, a common understanding of the problem and a joint approach to solving the problem was identified.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	Med-High	There were some shared metrics identified for the two components of the policy mix. There were also individual metrics identified for each.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	Med-High	There were some reinforcing activities: prior R&D led to demonstration and deployment projects.
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	High	There was frequent and regular communications between the OERD and REED program staff. Staff interacted on common processes, such as the calls for proposals, selection of projects, program communications, reporting, etc.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	None	There was no backbone organization.
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	Med-High	There were champions at the Senior Director and Director levels throughout the design and implementation phases.
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	Med-High	There was tolerance for the extra costs of coordination and communications. In the end, it was found out that administrative savings were greater than the extra costs of coordination and communications.
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	Med-High	OERD and REED developed common call for proposals materials, common proposal review and selection processes, processes for hybrid proposals, and will be working on common evaluation approach. There is room for additional work in this area.
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	Med-High	Central agencies were very involved at the design stage, but less so at the implementation stage.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	Med-High	Audit and evaluation frameworks are common to the two core instruments.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	Med-High	At the planning level, there was significant detail provided by central agencies on expected outcomes, for the policy mix.
Summary			Med-High	

Appendix I - Case #6 – CERRC - Supplementary Information

Note: This appendix is meant to supplement section 5.6. Some of the text from section 5.6 is repeated here for completeness and better readability.

Background on the CERRC policy mix

The focus of this policy mix is on approximately “200 remote [off-grid] communities and industrial sites that rely on diesel fuel for electricity generation and heat. Many of these communities, which are not connected to the continental [electricity] grid [or natural gas distribution system], are Indigenous or have significant Indigenous populations. While diesel generation is a well-known reliable source of energy in these communities, it comes with many with many environmental, social and economic disadvantages”¹¹⁸, such as having to import expensive diesel fuel into communities, diesel spills, and GHG and other air pollution. A map of the 200 rural and remote communities targeted by the policy mix is available as part of the national Atlas of Canada maintained by NRCan¹¹⁹. This map provides information on primary fuel use by remote community.

The goals of the policy mix are to improve resiliency of rural and remote off-grid community’s energy supply, by diversifying electricity generation and heat sources to include renewable energy, such as wind, solar and biomass, supplemented by energy storage, implement energy efficiency measures to reduce the amount of energy required in communities, and build community skills and capacity¹²⁰. In practical terms, the

¹¹⁸ <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/reducing-reliance-diesel.html>

¹¹⁹ <https://atlas.gc.ca/rced-bdece/en/index.html>

¹²⁰ <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/reducing-reliance-diesel.html>

primary goal of the policy mix is to reduce reliance on imported diesel to generate electricity and heat in rural, northern and remote communities and replace it with locally produced energy, including wind and solar, or locally harvested biomass.

The CERRC policy mix, which is designed and delivered by NRCan, is part of, and fits within, the federal government's larger policy frameworks to address climate change, energy efficiency, infrastructure, and housing in Canada's Arctic, as well as in northern and remote regions. The CERRC policy mix fits within the Pan-Canadian Framework on Clean Growth & Climate Change (PCF), as well as within Infrastructure Canada's Investing in Canada infrastructure plan, which has allocated an additional \$2B over 11 years for the "rural and northern community infrastructure stream", including "roads, food security, broadband communications infrastructure and energy"¹²¹. This \$2B in infrastructure funding includes \$400M in funding to the Arctic Energy Fund, which is funding provided by the federal government to Canada's three Territorial governments, to help them contribute to resilient and efficient energy systems¹²², including contributing funding to projects funded by CERRC. The CERRC is also complemented by the \$53.5M Northern REACHE (responsible energy approach for community heat & electricity) initiative, which has been delivered by Crown-Indigenous Relations & Northern Affairs Canada, another federal department, since 2003¹²³. Funding provided by the federal First Nations Infrastructure Fund, and administered by Indigenous Services Canada, can be

¹²¹ <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar72018.pdf>

¹²² <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar72018.pdf>

¹²³ <https://www.nrcan.gc.ca/reducingdiesel>

used by indigenous communities to co-fund projects supported by CERRC¹²⁴. The CERRC policy mix also complements work undertaken by Polar Knowledge Canada, a federal agency reporting to the federal Minister of Northern Affairs, which “is responsible for advancing Canada’s knowledge of the Arctic, strengthening Canadian leadership in polar science and technology, and promoting the development and distribution of knowledge of other circumpolar regions, including Antarctica. POLAR Knowledge operates the Canadian High Arctic Research Station (CHARS) campus, in Cambridge Bay, Nunavut, and conducts world-class, cutting edge Arctic research out of this facility.”¹²⁵

The CERRC policy mix is made up of 5 instruments, delivered by four different organizations within NRCan. The original parameters for each instrument are provided below, as defined in policy mix documentation shared with the public in 2018¹²⁶. These parameters have been slightly amended over time, based on input from stakeholders.

1. **Demonstration** – \$60M to demonstrate innovative renewable energy, energy efficiency, energy storage or smart-grid technologies to displace diesel fuel for power and/or heat. Funding of \$2-5M per project is expected to support approximately 15 projects. This instrument is delivered by NRCan’s Office of Energy R&D (OERD).
2. **Deployment** – \$90M million for deployment of commercially available renewable energy technologies for electricity. Heat may also be produced, but the primary output of the project must be electricity. Funding of \$4-8M per project is expected to support approximately 10-20 projects. This instrument is delivered by NRCan’s Renewable & Electrical Energy Division (REED).
3. **BioHeat** - \$55M for feasibility studies and/or deployment/installation of proven biomass combustion heating systems, district heating and combined heat and power systems that displace diesel or certain other fossil fuels used for heating. Electricity

¹²⁴ <https://www.nrcan.gc.ca/reducingdiesel>

¹²⁵ <https://www.canada.ca/en/polar-knowledge.html>

¹²⁶ <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar72018.pdf>

may be produced, but the primary output of the project must be heat. Funding of \$4-8M per project is expected to support approximately 20-40 projects. This instrument is delivered by NRCan's Canadian Forestry Service (CFS).

4. **Capacity Building** – \$10M for the development of energy literacy and local technical expertise through skills training and network participation in rural and remote communities. Funding of \$100-300k per project is expected to support approx. 20 projects. This instrument is delivered by NRCan's Renewable & Electrical Energy Division (REED).
5. **Energy Efficiency** - \$3M for “program” and policy support for the deployment of energy efficiency technologies through complementary “programs” led by federal partners. This instrument is delivered by NRCan's Office of Energy Efficiency's Housing Division and Building & Industry Division.

The budgeted funding for the first four policy instruments above consists primarily of Grants & Contribution (G&C) funds, which are allocated for project stakeholders outside of the federal government, in this case rural and remote communities that are expected to implement approx. 80 technology demonstration, deployment and capacity building projects.

The first three instruments above, i.e. demonstration, deployment and BioHeat deployment, are delivered through a “one-window” or “no wrong door” approach. This means that NRCan has a single web page providing information on the three instruments, issues a single call for proposal for all three policy mix components, selects proposals through a single process for all three components using the same team of experts on review committees, and announces funding decisions through a single process. The “no wrong door” approach means that stakeholders can interact with anyone administering the policy mix, or apply to any of the different components, and be directed to the proper staff or most appropriate policy mix component. This is similar to the “one-window” approach used for the Smart Grids case study. As was discussed in the section on Smart Grids, “one-window” is a Whole-of-government concept that is meant to streamline the

delivery of government services, for users, by using a single point of contact, to be used by applicants and other users of the policy mix. The “one-window” approach allows staff delivering the policy mix to seamlessly re-direct proposals that have been submitted under the wrong stream (e.g. demonstration) to the most appropriate stream (e.g. deployment). This approach is much more convenient and user friendly for applicants. This approach’s effectiveness has been enhanced, in this case, by coordinating the timing of call for proposals, such that these occur at the same time, for all three instruments. According to staff, “one-window” integrated delivery has resulted in significant cost savings, even if it requires a higher degree of upfront coordination and communications. It should be noted that the three policy instruments, using the “one-window” approach, are similar in that they target technology-oriented projects, i.e. demonstration or deployment of technologies.

The capacity building component of the policy mix is administered slightly differently than the above three instruments, because it is not oriented towards technology demonstration or deployment projects. Rather, this policy instrument’s goals are to support “community-level capacity building that will increase clean energy opportunities, including renewables and energy efficiency, and contribute to reducing diesel reliance in rural and/or remote communities”.¹²⁷ Funding allocated to this policy instrument is smaller (\$10M) than for the technology-oriented instruments (\$55-90 M per component), to support projects and activities such as “curriculum development, training,

¹²⁷ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-communities-capacity-building-stream/20477>

community networking on energy issues, energy planning, and energy literacy”¹²⁸.

The energy efficiency policy instrument is also administered differently than the other four instruments. As can be noted, budgeted funding is quite low, at \$3M over 8 years, being targeted at funding a few federal employees to provide “expert advice, policy and technical support to [other] federal programs targeting northern and remote communities” (GOC 2017). The “other” federal instruments in this case include instruments providing funding for residential and commercial buildings in northern and remote communities. Such programming is provided through the departments and organizations mentioned above, which are part of the larger policy mix, including Indigenous Services Canada (e.g. Northern REACHE Program), Infrastructure Canada, Canada Mortgage & Housing Corporation, and Polar Knowledge.

As of November 2020, the CERRC had formally announced that it had allocated \$58.5 M, or 29% of budgeted funds, to support the implementation of 28 technology demonstration and deployment projects, which are being implemented by a variety of communities in different Provinces and Territories¹²⁹. In addition, the CERRC had announced that it had allocated \$3.7M, or 37% of budgeted funds, to support 10 capacity building projects¹³⁰. Also as of November 2020, CERRC staff unofficially reported that the above figures only represented a fraction of actual projects selected, and that up to 88 projects had been selected for support, which is above the overall target of 80 for the

¹²⁸ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-communities-capacity-building-stream/20477>

¹²⁹ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-commun/clean-energy-rural-and-remote-communities-funded-projects/22524>

¹³⁰ <https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/clean-energy-rural-remote-commun/clean-energy-rural-and-remote-communities-funded-projects/22524>

policy mix as a whole. According to staff, the main reason that these other projects had not yet been announced was that there was a government-wide slowdown in non-COVID-19 related communications, during the height of the pandemic, during most of 2020-21.

Documents Reviewed

There were a significant number of documents available for review for this case study, as listed in Table 99 below, taking into consideration that the formal policy mix is currently in year 3 of its 6 year implementation timeframe. Documents were available primarily through public sources, NRCan's Office of Energy R&D and Renewable & Electrical Energy Division. The listing below includes the key design and implementation documents, reviewed to date, many of which were included as footnotes in this chapter. There have been no audits or evaluations completed to date.

Table 99 - CERRC case study – documents reviewed

Key Documents
<p>Larger Policy Mix</p> <p>Infrastructure Canada: Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Funding Delivered under the Investing in Canada Plan - Canada Web Site</p> <p>Infrastructure Canada: Green Infrastructure - Canada Web Site</p> <p>Clean Energy for Rural & Remote Communities Policy Mix</p> <p>Green Infrastructure Phase 2 - Treasury Board Submission</p> <p>CERRC demonstration, deployment & BioHeat - NRCan Web Site</p> <p>CERRC demonstration, deployment & BioHeat - Applicants Guide - NRCan Web Site</p> <p>CERRC demonstration, deployment & BioHeat - Projects Selected - NRCan Web site</p> <p>CERRC demonstration, deployment & BioHeat & capacity building - Projects Selected - NRCan Web site</p> <p>CERRC capacity building - NRCan Web Site</p> <p>Impact Canada Initiative</p> <p>Impact Canada Initiative - Government of Canada web site</p> <p>Impact Canada Initiative - Indigenous Off-Diesel Initiative - web site</p> <p>Impact Canada Initiative - Indigenous Off-Diesel Initiative - Announcements</p> <p>PERD & EIP</p> <p>Energy Innovation Program - NRCan web site</p> <p>ecoENERGY Innovation Initiative - NRCan web site</p> <p>OERD G&C Project Listing - NRCan Web Site</p> <p>PERD Program - OERD Program Archive</p> <p>NRCan general</p> <p>NRCan 2019-24 Integrated Audit & Evaluation Plan - NRCan Web Site</p> <p>Past audits and evaluations - NRCan Web Site</p> <p>NRCan Funding Announcement - Google Searches</p>

Description of 3 attributes of CERRC case study as an experimental policy mix

Attribute #1 - Bundling

The five instruments in the formal CERRC policy mix were mapped against each step in the policy process and characterized as either loose or tight, based on information found in the policy mix documentation, in Table 100 below. At all stages of the policy process, the instruments were designed to be administered as a single policy mix, as documented in the Treasury Board Submission.

Implementation is characterized as tightly bundled based on the documentary evidence that there is a single web page and a single calls for proposals for the demonstration, deployment and BioHeat deployment instruments; that there was a single proposal review committee for the demonstration and deployment components and some

overlap in members for the review committee for the BioHeat component; and that project announcements for all instruments with G&C components are on the same web page. The capacity building and energy efficiency instruments are implemented in a highly complementary manner with the other instruments. Importantly, there is a significant amount of communications between the four organizations delivering the instruments on a regular basis.

For audit and evaluation, per NRCan's 2019-24 Integrated Audit & Evaluation Plan, there is a plan to conduct one single joint audit and evaluation for the formal policy mix as a whole in 2021-22. The above confirm that the formal policy mix is tightly bundled to a significant degree.

Table 100 - CERRC policy mix - tool to determine level of bundling

#	Instrument	Design		Implemen- tation	Policy Evaluation
		Policy Formulation	Decision Making		
1	CERRC - Demonstration (government STI program)	Tight	Tight	Tight	Tight
2	CERRC - Deployment	Tight	Tight	Tight	Tight
3	CERRC- BioHeat	Tight	Tight	Tight	Tight
4	CERRC - Energy Efficiency	Tight	Tight	Tight	Tight
5	CERRC - Capacity Building	Tight	Tight	Tight	Tight

The other three instruments in the augmented policy mix, i.e. IODI, EIP and PERD, were designed separately. The Indigenous Off-Diesel Initiative is considered to be implemented in a partially tightly bundled manner with the five CERRC instruments, as this instrument is administered by the same NRCan staff that administers the five instruments in Table 100 above. PERD and EIP are administered by the same OERD staff that administers the CERRC demonstration component. For audit and evaluation, other instruments in the augmented policy mix are planned to be audited or evaluated separately: a joint audit and evaluation of the Impact Canada Initiative Clean Tech stream

is planned to be initiated in 2019-20, an evaluation of PERD is also planned to be initiated in 2020-21, and an evaluation of EIP is planned for 2023-24¹³¹.

Attribute #2 - Coverage of policy mixes along innovation chain, and TRL & CRI scales

As a first step in mapping the eight policy instruments in the augmented policy mix along the innovation chain, each instrument is first mapped against the policy types proposed by the literature (IPCC 2007), in Table 101 below, as follows:

Table 101 – CERRC policy mix - mapping of eight policy instruments against instrument types

#	Policy Instrument	Policy Instrument Type
1	CERRC - Demonstration (government STI program)	7. Research & Development
2	CERRC - Deployment	5. Subsidies & Incentives (Deployment)
3	CERRC- BioHeat	5. Subsidies & Incentives (Deployment)
4	CERRC - Energy Efficiency	8. Other (Policy Support)
5	CERRC - Capacity Building	8. Other (Capacity Building)
6	ICI Indigenous Off Diesel Initiative	7. Research & Development
7	Energy Innovation Program (EIP)	7. Research & Development
8	Program of Energy R&D (PERD)	7. Research & Development

As can be seen, the eight policy instruments are of three types: R&D, subsidies & incentives (deployment) and other (policy support and capacity building). The eight policy instruments in the policy mix are then mapped against the innovation chain, per illustration 15 below. The energy efficiency and capacity instruments are in support of technology demonstration and deployment instruments. The energy efficiency instrument is designed to support residential building deployment supported by other departments, such as Indigenous Services Canada and Canada Mortgage & Housing Corporation. The capacity building instrument is specifically designed to support future projects such as those supported by the demonstration, deployment and BioHeat deployment instruments. The illustration below shows that the CERRC policy mix has good coverage of the

¹³¹ <https://www.nrcan.gc.ca/nrcan/transparency/reporting-accountability/plans-performance-reports/audit-evaluation/annual-plans/natural-resources-canada-2019-24-integrated-audit-evaluation-plan/22240>

RD&D and deployment stages of the Innovation Chain, but there are no instruments at the commercialization/diffusion stages. Thus, the policy mix can be said to be partially complete.

Illustration 14 – CERRC - Mapping of 8 policy instruments against the innovation chain

Innovation Chain											
Basic R&D		Applied R&D			Demonstration			Deployment		Commercialization / Diffusion	
Technology Readiness Level (TRL)											
#	1	2	3	4	5	6	7	8	9		
1						CERRC - Demonstration					
2									CERRC - Deployment		
3									CERRC- BioHeat		
4									CERRC - Energy Efficiency		
5						CERRC - Capacity Building					
6						ICI Indigenous Off Diesel Initiative					
7						Energy Innovation Program (EIP)					
8	Program of Energy R&D (PERD)										

For completeness, the policy mix was mapped against the TRL and CRI scales in Tables 102 and 103 below. As can be seen, there is 100% coverage of the TRL scale, but only partial coverage of the CRI scale, in levels 1-4. On the CRI scale, I have indicated coverage up to multiple commercial applications (level 4) across all indicators, to reflect the wide technology coverage of the CERRC policy mix. This additional detail confirms that the policy mix is only partially complete, particularly at the later stages of the CRI scale.

Table 102 – Mapping of CERRC policy mix against TRL scale

Technology Readiness Level									
	1	2	3	4	5	6	7	8	9
Policy Mix	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 103 – Mapping of CERRC policy mix against CRI scale

		Indicators							
		Regulatory Environment	Stakeholder Acceptance	Technical performance	Financial Performance - costs	Financial performance - revenue	Industry supply chain & skills	Market opportunities	Company maturity
Status Level	CRI 6 - Bankable Grade Asset Class								
	CRI 5 - Market Competition driving widespread deployment								
	CRI 4 - Multiple commercial applications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 3 - Commercial scale up	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 2 - Commercial trial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	CRI 1 - Hypothetical commercial proposition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Attribute #3 – Technology specificity

Using the tool to describe technology specificity, documentary evidence for each of the eight instruments were reviewed to determine their individual technology-specificity, as shown in Table 104 below. As can be seen, five instruments out of five in the formal policy mix, and six out of eight in the augmented policy mix, are technology-specific. It is understood that two of the instruments (EIP and PERD) added in the augmented policy mix cover numerous technologies, but also cover technologies that are specifically targeted by the CERRC policy mix. The conclusion is thus that the policy mix is technology-specific.

Table 104 – CERRC policy mix – tool to describe technology-specificity

		Technology Specific	
		Yes or No	Technology or Sector Targeted
1	CERRC - Demonstration (government STI program)	Yes	Renewable energy (wind, solar) and storage to reduce diesel consumption in northern & remote communities
2	CERRC - Deployment	Yes	Renewable energy (wind, solar) and storage to reduce diesel consumption in northern & remote communities
3	CERRC- BioHeat	Yes	Renewable energy (biomass) to reduce diesel consumption in northern & remote communities
4	CERRC - Energy Efficiency	Yes	Residential energy efficiency to reduce diesel consumption in northern & remote communities
5	CERRC - Capacity Building	Yes	Renewable energy (wind, solar, biomass) and storage to reduce diesel consumption in northern & remote communities
6	ICI Indigenous Off Diesel Initiative	Yes	Renewable energy (wind, solar, biomass) and storage to reduce diesel consumption in northern & remote communities
7	Energy Innovation Program (EIP)	Partial	Cover many technologies, including those targeted by CERRC
8	Program of Energy R&D (PERD)	Partial	Cover many technologies, including those targeted by CERRC

Conclusion

Per the above, the CERRC policy mix is a policy mix that exhibits the three attributes of experimental policy mixes to a significant degree, because bundling is tight especially for the formal policy mix, coverage of the innovation chain is mostly complete, and the policy mix can be said to be technology-specific and focused on renewable energy technologies, including wind, solar and biomass systems along with electrical storage technologies, that are applied specifically in northern and remote communities to reduce diesel consumption.

Table 105- CERRC case study – 21 characteristics of the policy mix

Characteristics	Sub-characteristics	# sub-char.	Description/Mesure	CERRC	Comments (Based on document review)
Policy mix approach		1	Conventional or Experimental	Experimental	
Dimension	Policy Field	1	Technology development for clean energy transition	Clean Energy	
	Governance level	1	Federal government; all single department or organization	Federal	
	Geography	1	Canada	Canada	
	Time	1	Timeframe	6 years	2018-24
Policy process		1	Temporal offset between instruments	RD&D	Temporal offset between PERD (R&D) and R&D component of EIP and instruments in the formal policy mix (demonstration, deployment, BioHeat, capacity building, energy efficiency). Slight temporal offset between demonstration and deployment components.
Elements	Type	1	Tightly bundled or loosely bundled	Tightly bundled	Per the Treasury Board Submission, there is an explicit policy strategy at the formal policy mix level. There are also explicit objectives and goals at the policy mix level, as well as at the instrument level. The objectives were changed from technology development and diesel reduction objectives to community-focused objectives.
	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)	4 (Med-High)	
	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)	4 (Med-High)	Per the Treasury Board Submission, there are explicit plans at the formal policy mix level. There are also explicit plans at the instrument level. Given that plans need to be typically more detailed than objectives, and that the plans are not that detailed, the rating is slightly lower on plans than for objectives (4 rather than 5).
	Number of instruments in policy mix	1	Number	8	There are 5 policy instruments in the formal policy mix and 8 in the augmented policy mix.
Instruments	Instrument - Type	1	(1) Regulations & standards; (2) Taxes & charges; (3) Tradable permits; (4) Voluntary agreements; (5) Subsidies and incentives; (6) Information; (7) Government STI programs (RD&D); (8) Other	3	There are 3 types of instruments in the formal and augmented policy mixes: (7) Government STI program (RD&D); (5) Subsidies & Incentives (Deployment) and (8) Other (capacity building & policy & program support).
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)	4 (Med-High)	Goals at the instrument level are aligned to a significant degree, in the formal policy mix, and slightly less so in the augmented policy mix.
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns	4 (Medium-High)	Instruments at the augmented policy mix level cover R&D, Demonstration, and Deployment, and cover technology push and pull. In addition, several instruments cover different stages of the innovation chain to provide increased coverage within phases. There is little to no coverage of the commercialization/diffusion stage given the commercial maturity of the renewable energy technologies for remote communities.
	Instrument - Design Features	1	Legal or voluntary	Voluntary	4 of 5 instruments in the formal policy mix target exactly the same actors, in this case, rural and remote communities and their clean energy champions. The energy efficiency instrument targets these same actors in an indirect manner, through other programs delivered through ISC, CMHC and other federal departments. The R&D programs added in the augmented policy mix target similar actors, as well as a broader list of actors including technology developers, academia, etc.
		1	Target actors	(4) Very Similar	Duration of instruments in the formal policy mix are all similar (6 years), covering very similar timeframes. For the augmented policy mix, the ICI Indigenous Off-Diesel Initiative has a 4-year timeframe. However, if the final award from CERRC is included, the timeframe is extended to 6 years.
Instrument Mix		1	duration	(4) Very Similar	
		1	differentiation (1-5)	3 (Medium)	The CERRC policy mix components target very specific applications in the renewable energy technology area for application in remote communities (lower differentiation). That being said, a number of different technologies are targeted, including wind, solar, electrical storage, bioenergy, and energy efficient residential housing, which increases differentiation.
	Cornerstone instrument	1	Government STI program or other	Government STI	Renewable energy demonstration instrument
	Interactions between instruments	1	Degree of interaction (1-5)	4 (Med-High)	There is a high degree of interaction between four of the five instruments in the formal policy mix. However, the interaction is slightly lower for the energy efficiency component, but still significant. In the augmented policy mix, interaction is high with the ICI Indigenous Off-Diesel Initiative. The rating is based on the formal policy mix.
	Number of interactions between instruments	1	Count 1 for each pair of instruments (sum of $n-1 + n-2 + \dots + 2 + 1$)	10-28	Relatively high number of potential interactions (10 for formal policy mix; 28 for augmented policy mix).
	Types of interaction between instruments	1	e.g. feedback loop	Many	Feedback loops between (i) deployment and demonstration components; (ii) demonstration/deployment and R&D components; (iii) capacity building and demonstration and deployment components; ICI Off-Diesel Initiative and demonstration/deployment components.

Table 106 - CERRC case study – measurement tool with responses to question 1

Hoped-for Improvement Q and benefit	Measure	Indicator	CERRC		Comments
			Measure	Low-High	
Consistency of elements	Alignment over time	temporal consistency (1-5)	3	Medium	Different instruments have very similar timeframes, However, there were supposed to be natural temporal offsets between the capacity building --> demonstration --> deployment instruments. However, all instruments were implemented at the same time, so that this could not occur within the timeframe of the policy mix.
			4	Med-High	The objectives were changed after the launch of the policy mix from more conventional targets (TRL advancement, # liters reduced) to fit with what types of projects communities wanted to do. This was a slightly conflicting element in the strategy, but was adjusted for. Once adjusted for, there are few conflicting elements.
			4	Med-High	There were significant synergies between the demonstration and deployment components. There were not as many hybrid projects as in the Smart Grids policy mix.
			4	Med-High	The degree of alignment of policy objectives was very strong and explicit. The objectives had to be adjusted to align with what communities wanted to achieve. The possibility of adjustment of strategy is seen as a positive aspect.
	Coherence of processes	Degree of reinforcement between instruments (1-5)	4	Med-High	There was strong reinforcement between the demonstration and deployment components of the policy mix.
			4	Med-High	There was strong alignment between the strategy, goals and instrument mix.
			4	Med-High	Four out of five instruments in the formal policy mix were administered in a highly coordinated fashion, at the design, implementation and evaluation stage. The energy efficiency instrument was not implemented as tightly as the others. At the implementation stage, the three demonstration and deployment instruments used the same call for proposals process, same review committees to review and select proposals, and same communications process for announcements.
			4	Med-High	There was frequent and consistent engagement between OERD, REED and CFS on the design and delivery of the policy mix.
Comprehensiveness	Barriers (market, institutional) - Coverage of TRL and CRI	Degree of impact of coherence on perceived effectiveness (1-5)	4	Med-High	The degree of synergistic policymaking and engagement is perceived as having a direct impact on the effectiveness of the policy mix.
			4	Med-High	The degree to which all stages of the innovation chain were addressed was high for TRL and medium for some CRI indicators.
			4	Med-High	The degree to which all barriers were addressed was quite high, given that a large number of renewable energy technologies were specifically supported and the the policy mix included capacity building and energy efficiency.
			4	Med-High	

Table 107 - CERRC case study - measurement tool with responses to question 2

			CERRC		
#	Conditions	Measure	Indicator	Indicator	Comment
1	Common Goals	All participants share a vision for change that includes a common understanding of the problem and a joint approach to solving the problem through agreed-upon actions. (0-5)	5	Med-High	At the Treasury Board Submission stage, a common understanding of the problem and a joint approach to solving the problem was identified. Over time, this shared understanding was adjusted to incorporate feedback from communities.
2	Shared Measurement	All participating organizations agree on the ways success will be measured and reported, with a short list of common indicators identified and used for learning and improvement. (0-5)	4	Med-High	There were some shared metrics identified for the five components of the policy mix (reduction of diesel consumption), even if some most of the measurement metrics were specific to each instrument.
3	Mutually Reinforcing Activities	A diverse set of stakeholders, typically across sectors, coordinate a set of differentiated activities through a mutually reinforcing plan of action. (0-5)	4	Med-High	Many of the activities were designed to be reinforcing. The degree of reinforcement was not considered High, because all components were implemented at the same time. This meant that the natural temporal offset could not occur in practice, with this policy mix.
4	Continuous Communication	All players engage in frequent and structured open communication to build trust, assure mutual objectives, and create common motivation. (0-5)	5	Med-High	There was frequent and regular (i.e. weekly) communications between the OERD, REED, and CFS program staff. Staff interacted on common processes, such as the calls for proposals, selection of projects, program communications, reporting, etc.
5	Backbone Support	An independent, funded staff dedicated to the initiative provides ongoing support by guiding the initiative's vision and strategy, supporting aligned activities, establishing shared measurement practices, building public will, advancing policy, and mobilizing resources. (0-5)	0	None	There was no backbone organization.
6	Catalysts and champions	Recognition of problem; triggering events; role of specific individuals in championing the project. (0-5)	4	Med-High	There were champions at the Senior Director, Director, and program staff levels throughout the design and implementation phases.
7	Costs and benefits	"Tolerance" for incremental costs of working horizontally, more complex accountability arrangements, development of shared performance indicators, etc. (0-5)	4	Med-High	There was tolerance for the extra costs of coordination and communications. In the end, it was found out that administrative savings were greater than the extra costs of coordination and communications.
8	Tools and Resources, Capacity Building	Need for new capacities such as negotiation, communications and mediation skills. (0-5)	4	Med-High	OERD and REED developed common call for proposals materials, common proposal review and selection processes, and will be working on common evaluation approach. There is room for additional work in this area.
9	Role of Central Agencies	Direct involvement to overcome barriers. (0-5)	3	Med-High	Central agencies were very involved at the design stage, but less so at the implementation stage. Central agencies (i.e. Privy Council Office) was also involved in the design and implementation of the ICI Indigenous Off-Diesel Initiative.
10	Accountability Framework	Adjustments to accountability framework, to account for dual nature, i.e. departmental and new horizontal accountabilities. (0-5)	4	Med-High	Audit and evaluation frameworks are common to the two core instruments.
11	Mandate & Expected outcomes	Central agencies to provide more detail on expected outcomes. (0-5)	3	Med-High	At the planning level, there was significant detail provided by central agencies on expected outcomes, for the policy mix.
Summary			Med-High		

Appendix J - Results, Analysis & Findings – Supplementary Info

Table 108 – Comparison of experimental case studies – 21 characteristics

Table 1 – Comparison of experimental case studies – 21 characteristics

Characteristics	Sub-characteristics	# sub-char.	Description/Measure	Experimental Case Studies			
				EVAF	Smart Grids	CERRC	
Policy mix approach Dimension	Policy Field	1	Conventional or Experimental	Experimental	Experimental	Experimental	
	Governance level	1	Technology development for clean energy transition	Clean Energy	Clean Energy	Clean Energy	
	Geography	1	Federal government; all single department or organization	Federal	Federal	Federal	
	Time	1	Canada	Canada	Canada	Canada	
		1	Time frame	6 years	4 years	6 years	
Policy process Elements		1	Temporal offset between instruments	Only R&D	RD&D	RD&D	
	Type	1	tightly bundled or loosely bundled	Loosely	Tightly	Tightly bundled	
	Policy Strategy - Objectives	1	Degree of existence of objectives at the policy mix level (1-5)	4 (Med-High)	5 (High)	4 (Med-High)	
	Policy Strategy - Principal Plans	1	Degree of existence of plans at the policy mix level (1-5)	3 (Med)	4 (Med-High)	4 (Med-High)	
	Number of instruments in policy mix	1	Number	3 formal / 6 augmented	2 formal / 5 augmented	5 formal / 8 augmented	
Instruments	Instrument - Type	1	(1) Regulations & standards; (2) Taxes & charges; (3) Tradable permits; (4) Voluntary agreements; (5) Subsidies and incentives; (6) Information; (7) Government STI programs (RD&D); (8) Other	3 (1) Regulations & standards; (5) Subsidies and incentives; (7) Government STI programs (RD&D)	2 (5) Subsidies and incentives; (7) Government STI programs (RD&D)	3 (5) Subsidies and incentives; (7) Government STI programs (RD&D); (8) other	
	Instrument - Goals	1	Degree of alignment of goals for sum of instruments (1-5)	4 (Med-High)	4 (Med-High)	4 (Med-High)	
	Instrument - Purpose or location on innovation chain	1	technology push, demand pull, or systemic concerns	4 (Med-High)	3 (Medium)	4 (Medium-High)	
	Instrument - Design Features	1	Legal or voluntary	Voluntary	Voluntary	Voluntary	
		1	Target actors	(5) Very similar	(4) Similar	(4) Very Similar	
Instrument Mix		1	duration	Different	Same	(4) Very Similar	
		1	differentiation (1-5)	2 (Med-Low)	2 (Med-Low)	3 (Medium)	
	Cornerstone instrument	1	Government STI program or other	Government STI	Government STI	Government STI	
	Interactions between instruments	1	Degree of interaction (1-5)	3 (Med)	5 (High)	4 (Med-High)	
	Number of interactions between instruments	1	Count 1 for each pair of instruments (sum of n-1 + n-2 + ... + 2 + 1)	15	2-10	10-28	
	Types of interaction between instruments	1	e.g. feedback loop	Some	A few	Many	

Bibliography & References

- Agranoff, Robert, and Michael McGuire (2003). *Collaborative Public Management: New Strategies for Local Government*, Washington, DC: Georgetown University Press.
- Andrews, K.R., (1987). *The concept of corporate strategy*, in Perry, K. (Ed.), *The Concept of Corporate Strategy*. Richard D. Irwin, New York, pp. 13–34.
- Allen, C.R., Fontaine, J.J., Pope, K.L., Garmestani, A.S., (2011), *Adaptive management for a turbulent future*. *Journal of Environmental Management*. 92, 1339–1345.
- APSC (2007) Australian Public Service Commission, *Tackling Wicked Problems A Public Policy Perspective*, Australian Government, 2007, <http://www.apsc.gov.au/publications-and-media/archive/publications-archive/tackling-wicked-problems> Chreast3
- Ascher, William (1986). *The evolution of the policy sciences: Understanding the rise and avoiding the fall*, *Journal of Policy Analysis and Management*, 5 (2): 365–373. [doi:10.2307/3323551](https://doi.org/10.2307/3323551). JSTOR 3323551.
- Atuahene-Gima, K., Murray, J., (2004). *Antecedents and outcomes of marketing strategy comprehensiveness*. *J. Mark.* 68, 33–46.
- Bakvis, Herman, and Luc Juillet (2004). *The Horizontal Challenge: Line Departments, Central Agencies and Leadership*. Ottawa : Canada School of Public Services.
- Bingham, L. B., & O’Leary, R. (2006). *Conclusion: Parallel play, not collaboration: Missing questions, missing connections*. *Public Administration Review*, 66 (Suppl. 1), 161-167.
- Bingham, L. B., O’Leary, R., & Carlson, C. (2008). *Frameshifting: Lateral thinking for collaborative public management*. In L. B. Bingham & R. O’Leary (Eds.), *Big ideas in collaborative public management* (pp. 3-16). New York, NY: M. E. Sharpe.
- Bonvillian (2018), Ideas, 2018, per: www.bonvillian.org/services, accessed August 18, 2018.
- Bonvillian (2014), *The New Model Innovation Agencies: An Overview*, *Science and Public Policy* 41, no. 4 (July 2014), pp. 425-437.
- Bonvillian, William (2013), *The new model innovation agencies, an overview*, *Science and Public Policy*, Oxford University Press, 2013.
- Bonvillian, (2009) William B., *The Connected Science Model for Innovation: The DARPA Role*, 21st Century Innovation Systems for Japan and the United States:

- Lessons from a Decade of Change: Report of a Symposium, Committee on Comparative Innovation Policy: Best Practice for the 21st Century, The National Academies Press, Washington, D.C, 2009, p. 206.
- Bonvillian, William B. & Charles Weiss (2015), *Technological Innovation in Legacy Sectors*, Oxford University Press, New York, 2015.
- Borras, S. & C. Edquist (2013), *The Choice of Innovation Policy Instruments*, Technological Forecasting and Social Change, October 2013. DOI: 10.1016/j.techfore.2013.03.002.
- Braathén, N.A. (2007) *Instrument mixes for environmental policy: how many stones should be used to kill a bird?*, Int. Rev. Environ. Resour. Econ. 1 (2) (2007) 185–235.
- Brzustowski, Tom (2012), *Why We Need More Innovation in Canada*, Invenire Books, Ottawa, Canada, ISBN 978-1-927465-00-4, 2012.
- Buderi, Robert (1997), *The Invention that Saved the World*, New York: Simon & Shuster / Touchstone, 1997.
- Bush, Vannevar (1945) *Science—The Endless Frontier: A Report to the President on a Program for Postwar Scientific Research* (Washington, DC: National Science Foundation, reprinted 1990), pp. 1-21**. (Chapters 1 – 5).
<http://www.nsf.gov/about/history/vbush1945.htm>
- Canada (2003) *Budget Plan 2003*, Department of Finance, Ottawa, ON, ISBN 0-660-18999-2, 2003 <https://fin.gc.ca/budget03/pdf/bp2003e.pdf>.
- Cantner & al. (2016). Cantner, U., Graf, H., Herrmann, J., Kalthaus, M., 2016. *Inventor networks in renewable energies: the influence of the policy mix in Germany*, Research Policy.
- CAS (2004) Commonwealth of Australia. Management Advisory Committee, *Connecting Government: Whole-of-government Responses to Australia's Priority Challenges*, ISBN 097510151X, Canberra, Australia, 2004.
- CCMD (2001) Canadian Centre for Management Development, CCMD Roundtable of the Management of Horizontal Initiatives, *Moving from the Heroic to the Everyday: Lessons Learned from Leading Horizontal Projects*, 2001.
<http://publications.gc.ca/site/eng/9.662685/publication.html>
- CESD (2017) Commissioner of the Environment & Sustainable Development, *2017 Fall Reports of the Commissioner of the Environment and Sustainable Development to the Parliament of Canada*, Report 1 Progress on Reducing Greenhouse Gases – Environment and Climate Change Canada; October 3, 2017; <http://www.oag->

bvg.gc.ca/internet/English/mr_20171003_e_42600.html.

- Christensen, T. and Lægreid, P. (2007), *The Whole-of-Government Approach to Public Sector Reform*, *Public Administration Review*, Vol. 67, No. 6, pp 1059-66.
- Cohen, Stewart J., and Waddell, Melissa W. (2009), *Climate Change in the 21st Century*, McGill-Queens University Press; Canadian First edition (Nov. 30 2009), ISBN-10: 0773533273, ISBN-13: 978-0773533271, p. 3.
- Colgan et al (2014) Colgan, A., Kennedy, L.A. and Doherty, N, *A Primer on Implementing Whole-of-government Approaches*, Dublin, 2014, Centre for Effective Services.
- Commonwealth of Australia (2014) (Australian Renewable Energy Agency) *Commercial Readiness Index for Renewable Energy Sectors*, 2014.
<https://studylib.net/doc/7038316/commercial-readiness-index---australian-renewable-energy-...>
- Cooper, T. L., Bryer, T. A., & Meek, J. W. (2006). *Citizen-centered collaboration*. *Public Administration Review*, 66(Suppl. 1), 76-88.
- Crowe & al. (2011). Sarah Crowe, Kathrin Cresswell, Ann Robertson, Guro Huby, Anthony Avery and Aziz Sheikh, *The Case Study Approach*, BMC Medical Research Methodology 2011, 11:100, <http://www.biomedcentral.com/1471-2288/11/100>
- de Bri, F. and Bannister, F. (2010) *Whole-of-government: Beyond silos and toward 'wicked problems'*, Proceedings of the 10th European Conference on E-Government: National Centre for Taxation Studies, University of Limerick, Ireland, 17-18 June 2010.
- de Heide, M.J.L., 2011. R&D, *Innovation and the Policy Mix*, PhD Thesis. Tinbergen Institute, Erasmus Universiteit Rotterdam.
- del Rio & al (2010). del Río, P., Carrillo-Hermosilla, J., Könnölä, T., 2010. *Policy strategies to promote eco-innovation*, *J. Ind. Ecol.* 14, 541–557.
- Doern (2006) G. Bruce, *Federal Related Science Activities and Multi-Level Regulation*, In Bruce Doern and Robert Johnson, editors, *Rules, Rules, Rules, Rules Multi-Level Regulatory Governance*, University of Toronto Press, 2006, p. 80-100.
- Doern, G. Bruce and Jeff Kinder, (2007) *Strategic Science in the Public Interest: Canada's Government Laboratories and Science-based Agencies*, University of Toronto Press, 2007.

- Doern, G. B., & Phidd, R. W. (1992). *Canadian public policy: Ideas, structure, process* (2nd ed.). Toronto, ON: Nelson.
- Doern, B. G., & Phidd, R. W. (1983). *Canadian Public Policy Ideas, Structure, Process*, Toronto Methuen.
- Dunn, William N. (2004), *Public Policy Analysis: An Introduction*, 3rd ed. (Upper Saddle River, N.J.: Pearson Prentice-Hall, 2004), chap. 2, pp. 33-43.
- Dye, Thomas, (1987), *Understanding Public Policy* (Englewood Cliffs, N.J.: Prentice-Hall, 1987), chap. 1.
- Efficacy Unit, The (2009) *Joined-up Government*. Dublin: Research Division, Institute of Public Administration.
- Flanagan, K., Uyarra, E., Laranja, M., (2011), *Reconceptualising the 'policy mix' for innovation*, Res. Policy 40, 702–713.
- Forss, Kim, Mita Marra, Robert Schwartz, (2011), *Evaluating the Complex: Attribution, Contribution, and Beyond; Comparative Policy Evaluation*, Volume 18; Transaction Publishers, New Brunswick, New Jersey, 2011. ISBN 978-1-4128-1846-9.
- Geels, F. W. (2014) *Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective*, Theory Culture Society 31 (5) (2014) 21–40, <http://dx.doi.org/10.1177/0263276414531627>
- Geels, F.W. (2005). *Technological Transitions and System Innovations: a Co-evolutionary and Sociotechnical Analysis*, Cheltenham: Edward Elgar. <http://dx.doi.org/10.4337/9781845424596> .
- Geels, F.W. (2002). *Technological Transitions as Evolutionary Reconfiguration Processes: a Multi-level Perspective and a Case-study*, Research Policy 31(8–9): 1257–74. [http://dx.doi.org/10.1016/S0048-7333\(02\)00062-8](http://dx.doi.org/10.1016/S0048-7333(02)00062-8) .
- Geels, F.W., and J. Schot (2007). *Typology of Socio-technical Transition Pathways*, Research Policy 36(3):399–417. <http://dx.doi.org/10.1016/j.respol.2007.01.003> .
- Gerring, John (2007). *Case Study Research: Principles and Practices*, Cambridge University Press. p. 87. ISBN 978-0-521-85928-8.
- Godin, Benoit, (2004), *Neglected Scientific Activities: the (non) measurement of Related Scientific Activities*, Université du Québec à Montréal, Project on the History and Sociology of S&T Statistics, 2004.

- Goodwin, Brian, (1994). *How the Leopard Changed Its Spots: The Evolution of Complexity*. New York: Touchstone, 1994.
- GOC (2019), Government of Canada, *Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada*, Environment & Climate Change Canada; http://fsds-sfdd.ca/downloads/FSDS_2019-2022.pdf
- GOC (2018), Government of Canada, *Canada's Energy Transition: Getting to Our Energy Future, Together*, Generation Energy Council Report, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/CoucilReport_july4_EN_Web.pdf , accessed Nov. 17, 2018.
- GOC (2017), Funding for Green Infrastructure National Programming for Clean Electricity, Lower Carbon Transportation and Energy Efficiency, 2017.
- GOC (2015), Environment Canada, *Clean Air Agenda*, <https://www.tbs-sct.gc.ca/hidb-bdih/initiative-eng.aspx?Hi=12>
- GOC (2014), Industry Canada, *Seizing Canada's Moment: Moving Forward in Science Technology and Innovation*, [https://www.ic.gc.ca/eic/site/icgc.nsf/vwapj/Seizing_Moment_ST_I-Report-2014-eng.pdf/\\$file/Seizing_Moment_ST_I-Report-2014-eng.pdf](https://www.ic.gc.ca/eic/site/icgc.nsf/vwapj/Seizing_Moment_ST_I-Report-2014-eng.pdf/$file/Seizing_Moment_ST_I-Report-2014-eng.pdf) .
- Graddy, E. A., & Chen, B. (2009). *Partner selection and the effectiveness of interorganizational collaboration*. In R. O'Leary & L. B. Bingham (Eds.), *The collaborative public manager: New ideas for the twenty-first century* (pp. 53-70). Washington, DC: Georgetown University Press.
- Gray, B. (1985). *Conditions facilitating interorganizational collaboration*, *Human Relations*, 38(10), 911.
- Grubler, Arnulf (2012), *Grand Designs: historical patterns and future scenarios of energy technological change*. historical case studies of energy technology innovation chapter 24, in: A. Grubler, F. Aguayo, K.S. Gallagher, M. Hekkert, K. Jiang, L. Mytelka, L. Neij, G. Nemet, C. Wilson (Eds.), *The Global Energy Assessment*, Cambridge, University Press, Cambridge, UK, 2012.
- Gunningham, N., Grabosky, P. & Sinclair, D. (1998). *Smart Regulation: Designing Environmental Policy*. Oxford: Clarendon Press.
- Guy, K., Boekholt, P., Cunningham, P., Hofer, R., Nauwelaers, C., Rammer, C., (2009), *The 'Policy Mix' Project: Monitoring and Analysis of Policies and Public Financing Instruments Conducive to Higher Levels of R&D Investments*. The Policy Mix project: Thematic Report R&D–R&D Policy Interactions Vienna. Joanneum Research.

- Halligan, J., Buick, F. and O'Flynn, J. (2011) *Experiments with joined-up, horizontal and whole-of-government in Anglophone countries*. In: Andrew Massey (ed.), *International Handbook on Civil Service Systems*. Cheltenham: Edward Elgar Publishing Ltd. (pp. 74-99). Available at: http://www.e-elgar.co.uk/g_emag.lasso?ebook13isbn=9781781001080&title=International%20Handbook%20On%20Civil%20Service%20Systems
- Homer-Dixon, Thomas (2015), *Don't Peddle Climate Fantasies – Paris Plan is Impressive– but why peddle fantasies with unreachable targets?* Toronto Globe and Mail, December 14, 2015. <http://www.homerdixon.com/2015/12/14/dont-peddle-climate-fantasies/>
- Homer-Dixon, Thomas (2006), *The Upside of Down: Catastrophe, Creativity and the Renewal of Civilizations*, Toronto: Alfred A. Knopf Canada, 2006, p. 16.
- Howlett, M. (2014), *Policy design: What, who, how and why?*, in C Halpern, P Lascoumes, P Le Gales (eds) *L'instrumentation et Ses Effets*, Paris: Presses de Sciences Politiques.
- Howlett, M. (2014a), *From the 'old' to the 'new' policy design: Beyond globalization and collaborative governance*, Policy Sciences, Special issue on Policy Design, forthcoming.
- Howlett, Michael (2013), *Why are policy innovations rare and so often negative Blame avoidance and problem denial in climate change policy-making*, Elsevier: Global Environmental Change 29, 2014, pp. 395-403.
- Howlett, M., (2012), *The Lessons of Failure: Learning and Blame Avoidance in Public Policy-making*, International Political Science Review 33, 5, 539–55, doi:10.1177/0192512112453603.
- Howlett, M., (2011), *Designing public policies: Principles and instruments*, New York: Routledge.
- Howlett M. (2009), *Governance Modes, Policy Regimes and Operational Plans: A Multilevel Nested Model of Policy Instrument Choice and Policy Design*, in «Policy Sciences», n. 42, pp. 73-89.
- Howlett, M., (2009a), *Policy analytical capacity and evidence-based policy-making: lessons from Canada*, Canadian Public Administration 52, 2, 153–75.
- Howlett, M., (2005), *What is a policy instrument? Tools, mixes and implementation styles*, In: Eliadis, P., Hill, M.M., Howlett, M. (Eds.), *Designing Government - From Instruments to Governance*. McGill-Queen's University Press, Montreal, pp. 31–50.

- Howlett, Michael (2005a), Kim, Jonathan, Weaver, Paul, *Assessing Instrument Mixes: Methodological Issues in Contemporary Implementation Research*, Paper Presented to the Annual Meeting of the Canadian Political Science Association, University of Western Ontario, London, Ontario, June 2, 2005.
- Howlett, M., (2004), *Beyond good and evil in policy implementation: Instrument mixes, implementation styles and second generation theories of policy instrument choice*, *Policy and Society* 23, 2, 1–17.
- Howlett, M., (2000), *Managing the 'hollow state': Procedural policy instruments and modern governance*, *Canadian Public Administration* 43, 4, 412–31.
- Howlett, M., (1991), *Policy instruments, policy styles and policy implementation*, *Policy Studies Journal* 19, 2, 1–21.
- Howlett, M., del Río, P., (2014), *The parameters of policy portfolios: Verticality and horizontality in design spaces and their consequences for policy mix formulation*, *Environment and Planning*.
- Howlett M., Giest, S. (2015), *Policy Cycle*. In: James D. Wright (editor-in-chief), *International Encyclopedia of the Social & Behavioral Sciences*, 2nd edition, Vol. 18. Oxford: Elsevier, pp 288-292. ISBN: 9780080970868.
https://www.sfu.ca/~howlett/documents/C75031_9780080970868.pdf
- Howlett, M., Y.P. How, and P. del Rio, (2015), *The parameters of policy portfolios: Verticality and horizontality in design spaces and their consequences for policy mix formulation*, *Environment and Planning C: Government and Policy* 2015, volume 47, pages 1 – 13. doi: 10.1177/0263774X15610059
<https://www.sfu.ca/~howlett/documents/0263774X15610059.full.pdf>
- Howlett, M., Lejano, R., 2013, *Tales from the crypt: The Rise and fall (and re-birth?) of policy design studies*, *Administration and Society* 45, 3, 356–80
- Howlett, McConnell & Perl (2015) Michael Howlett, Allan McConnell & Anthony Perl (2015): *Weaving the Fabric of Public Policies: Comparing and Integrating Contemporary Frameworks for the Study of Policy Processes*, *Journal of Comparative Policy Analysis: Research and Practice*,
- Howlett, M. and Ramesh, M. (1995), *Studying Public Policy: Policy Cycles and Policy Subsystems*, Oxford University Press, Toronto, 1995.
- Howlett, M., Ramesh, M., (1993), *Patterns of policy instrument choice: Policy styles, policy learning and the privatization experience*, *Policy Studies Review*, 12, 1, 3–24.

- Howlett, M., Ramesh, M., Perl, A., (2009). *Studying Public Policy: Policy Cycles and Policy Subsystems*. Oxford University Press.
- Howlett, M, Rayner, J, (2013), *Patching vs packaging in policy formulation: Assessing policy portfolio design*, *Politics and Governance* 1, 2, 170–82.
- Howlett, M., Rayner, J., (2007), *Design principles for policy mixes: cohesion and coherence in 'New governance arrangements'*. *Policy Soc.* 26, 1–18.
DOI:10.1080/13876988.2015.1082261.
- Howlett, M, Rayner, J, (1995), *Do ideas matter? Policy subsystem configurations and the continuing conflict over Canadian forest policy*, *Canadian Public Administration* 38, 3, 382–410
- Huitema & al (2018) Dave Huitema, Andrew Jordan, Stefania Munaretto, Mikael Hildén, *Policy experimentation: core concepts, political dynamics, governance and impacts*, 2018, *Policy Sci* (2018) 51:143–159, <https://doi.org/10.1007/s11077-018-9321-9>.
- IEA (2021), *NetZero by 2050: A Roadmap for the Global Energy Sector*, International Energy Agency, Revised version July 2021, p. 3-4.
https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf
- IEA (2016), *World Energy Outlook*, OECD/IEA, Paris, 2016.
<https://iea.blob.core.windows.net/assets/680c05c8-1d6e-42ae-b953-68e0420d46d5/WEO2016.pdf>
- IEA (2011) International Energy Agency, *Good Practice Policy Framework for Energy Technology Research Development and Demonstration (RD&D)*, Joana Chiavari and Cecilia Tam, November 2011.
https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
- IEA (2008), International Energy Agency, *Energy Technology Perspectives 2008: Scenarios and Strategies to 2050*, OECD/IEA, Paris.
- IEA (2008a) International Energy Agency, G8 (Siracusa, Italy), *Ensuring Green Growth in a Time of Economic Crisis: The Role of Energy Technology*, 2008, Page 7.
https://www.iea.org/publications/freepublications/publication/ensuring_green_growth.pdf
- IPCC (2007), *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, section

12.2.2.2, p. 767. https://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4_wg3_full_report.pdf

IPCC (2014), *Summary for Policy Makers, Climate Change 2014: Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf

Jackson, Deborah J, (2011), *What is an Innovation Ecosystem?*, National Science Foundation, Arlington, VA, 15 March 2011

Jacobsson, S., Bergek, A., (2011), *Innovation system analyses and sustainability transitions: contributions and suggestions for research*. Environmental Innovations & Societal Transitions 1, 41–57.

Jenkins, Jesse & Sara Mankur (2011). *Bridging the clean energy valleys of death*, Breakthrough Institute, (November) 22. Available at: https://s3.us-east-2.amazonaws.com/uploads.thebreakthrough.org/legacy/blog/Valleys_of_Death.pdf

Jenkins (1978), William I., *Policy Analysis: A Political and Organizational Perspective*, London: Martin Robinson, 1978.

Jordaan, Sarah M. (2017) & Romo-Rabago, Elizabeth & McLeary, Romaine & Reidy, Luke & Nazari, Jamal & Herremans, Irene M., 2017. *The role of energy technology innovation in reducing greenhouse gas emissions: A case study of Canada*, Renewable and Sustainable Energy Reviews, Elsevier, vol. 78(C), pages 1397-1409. <https://www.sciencedirect.com/science/article/pii/S1364032117307700>

Jordan, A., Huitema, D., (2014). *Policy innovation in a changing climate: sources, pattern and effects*, Global Environmental Change 29, Elsevier, 2014, pp. 387-394.

Justice Canada (2011) [*Canada Foundation for Sustainable Development Technology Act*](#). [Laws-lois.justice.gc.ca](http://laws-lois.justice.gc.ca). Retrieved November 12, 2011.

Kania & Kramer (2011), Kania, John, and Mark Kramer. *Collective Impact*, Stanford Social Innovation Review 9, no. 1 (Winter 2011): 36–41.

Kania & al (2014) Kania, John, Fay Hanleybrown, & Jennifer Splansky Juster, *Essential Mindset Shifts for Collective Impact*, Stanford Social Innovation Review, Fall 2014 <http://www.fsg.org/publications/collective-insights-collective-impact> , accessed Jun 13, 2017.

- Kauffman, S. (1995) *At Home in the Universe: The Search for Laws of Self-Organization and Complexity*. New York: Oxford University Press, 1995.
- Kemp, R., Rotmans, J., (2005). *The management of the Co-Evolution of technical, environmental and social systems*. In: Weber, M., Hemmelskamp, J. (Eds.), *Towards Environmental Innovation Systems*. Springer, Heidelberg, pp. 33–55.
- Kern, F., Howlett, M., (2009). *Implementing transition management as policy reforms: a case study of the Dutch energy sector*. *Policy Sci.* 42, 391–408.
- Kern, Florian, Karoline S. Rogge, Michael Howlett (2019), *Policy mixes for sustainability transitions: New approaches and insights through bridging innovation and policy studies*; Elsevier: *Research Policy* 48, issue 10, 2019.
<https://doi.org/10.1016/j.respol.2019.103832>
- Kingdon (1995) J.W. , *Agendas, Alternative and Public Policies*, 2nd Edition, New York: Harper Collins College Publishers.
- Kingdon, J.W. (1984), *Agendas, Alternative and Public Policies*, (Boston: Little, Brown and Company).
- Kline & Rosenberg (1986) *An Overview of Innovation*, in *The positive sum strategy. Harnessing technology for economic growth*, Edition: National Academy Press, Editors: R. Landau, N. Rosenberg · January 1986. [DOI: 10.1142/9789814273596_0009](https://doi.org/10.1142/9789814273596_0009)
- Kolko, Jon (2012), excerpt from the book: *Wicked Problems: Problems Worth Solving*, Austin Centre for Design (AC4D), 2012, accessed on October 9, 2017 on the Stanford Social Innovation Review web site:
http://www.ssireview.org/articles/entry/wicked_problems_problems_worth_solving
- Kouri & Gagnon (2007) Denise Kouri and François Gagnon, *Whole-of-government Approaches: Two Canadian Examples*, presentation at IUHPE, Vancouver, June 12, 2007,
<https://www.ncchpp.ca/docs/IUHPE%20Vancouver%20June%202007.pdf>
- Lasswell (1971) Harold, *A Pre-View of the Policy Science*, New York: American Elsevier Publishing Co. Inc., chap. 1.
- Lasswell (1956) Harold, *The Decision Process: Seven Categories of Functional Analysis*, University of Maryland, College Park.
- Lasswell (1951) Harold, *The Policy Orientation*, in Daniel Lerner and Harold D. Lasswell, eds., *The Policy Sciences* (Calif.: Stanford University Press, 1951), pp. 3-15.

- Lehmann, P., (2010), *Using a policy mix to combat climate change—an economic evaluation of policies in the German electricity sector*, PhD thesis. Universität Halle-Wittenberg.
- Lester & Stewart (1996), James P. Lester and Joseph Stewart, Jr., *Public Policy: An Evolutionary Approach*, San Francisco: West Publishing, 1996.
- Levin, Kelly; Cashore, Benjamin; Bernstein, Steven; Auld, Graeme (2012). *Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change*, *Policy Sciences* 45(2): 123–152, 23 May 2012. doi:10.1007/s11077-012-9151-0.
- Ling, T. (2002), *Delivering joined-up government in the UK: Dimensions, issues and problems*, *Public Administration*, Vol. 80, No. 4, pp. 615-42.
- Management Advisory Committee (2004) *Connecting Government: Whole-of-government responses to Australia's priority challenges*. Canberra: Management Advisory Committee (Australian Government).
- Markard J. (2018): *The next phase of the energy transition and its implications for research and policy*. *Nature Energy*, 3(8), 628-633. doi: 10.1038/s41560-018-0171-7 .
- Mascarenhas, Oswald AJ (2009) (Ozzie), SJ , *Innovation as Defining and Resolving Wicked Problems*, unpublished paper, accessed on October 9, 2017.
- Mazzucato, M. (2013), *The Entrepreneurial State: debunking public vs. private sector myths*, Anthem Press: London, UK, ISBN 9780857282521
- Mankins, John C. (1995), *Technology Readiness Levels: A White Paper*, April 6, 1995, page 1.
- Mankins, John C. (2009), *Technology readiness assessments: a retrospective*, Elsevier, *Acta Astronautica* 65 (2009) p. 1216–1223.
- McDavid, Huse & Hawthorn (2018), James C. McDavid, Irene Huse and Laura R. Hawthorn, *Program Evaluation and Performance Management, 3rd Edition*, Sage Publishing, 2018.
- McFadgen, B., & Huitema, D. (2018). *Experimentation at the interface of science and policy: A multi-case analysis of how policy experiments influence political decision-makers*, *Policy Sciences*. <https://doi.org/10.1007/s11077-017-9276-2>.
- Meadowcroft, James, (2016). *Let's Get This Transition Moving!* *Canadian Public Policy* 42, S10–S17. <https://doi.org/10.3138/cpp.2015-02> .

- Meadowcroft, James, (2011). *Engaging with the politics of sustainability transitions*, Environmental Innovation & Societal Transitions 1 (1) (2011) 70–75, <http://dx.doi.org/10.1016/j.eist.2011.02.003> .
- Meadowcroft J, Layzell DB and Mousseau N. (2019), *The Transition Accelerator: Building pathways to a sustainable future*, Transition Accelerator Reports Vol. 1, Iss. 1, Pg 1-65. ISSN 2562-6264 French and English version of this document available at <http://www.transitionaccelerator.ca>
- Merten, Donna M. and Amy T. Wilson (2012), *Program Evaluation Theory and Practice: A Comprehensive Guide*. The Guilford Press, New York, ISBN 978-1-4625-0315-5, 2012.
- Metcalf, A. (2011) *Whole-of-government issues in public policy formulation*. Presentation to the Centre for Defence and Strategic Studies, Canberra, November 2011. Canberra: Department of Immigration and Citizenship, Australian Government. Available at: https://www.immi.gov.au/about/speeches-pres/_pdf/2010-11-02-whole-of-gov-issues-public-policy-formulation-slides.pdf
- Miles, R.E., Snow, C.C., (1978). *Organizational Strategy, Structure, and Process*, McGraw-Hill, New York.
- Miller, C., (2008), *Decisional comprehensiveness and firm performance: towards a more complete understanding*. Behavioral Decision Making 21, 598–620.
- Mintzberg, H., (1999), *And Over Here, Ladies and Gentlemen: The Strategic Management Best*. In: Henry Mintzberg, Bruce Ahlstrand, and Joseph Lampel (editors), *Strategy Safari: A Journey Through the Wilds of Strategic Management*. Simon & Schuster Inc., 1998 pp.1-22.
- Mueller, Mike, *Building an Innovation Ecosystem*, Amped Up, vol. 2 number 3, US Department of Energy, Office of Energy Efficiency and Renewable Energy, June 30, 2016, <https://energy.gov/eere/ampedup/articles/building-innovation-ecosystem> , accessed June 25, 2017.
- NASA (2019), US National Aeronautics & Space Administration, <https://earthobservatory.nasa.gov/world-of-change/DecadalTemp>, 2019 (accessed 23 Aug. 2019).
- NCCHPP (2013) National Collaborating Centre for Healthy Public Policy (2013), *Wicked Problems and Public Policy: Fact Sheet*, Institut national de santé publique (INSP) du Québec, http://www.ncchpp.ca/130/publications.ccnpps?id_article=927
- Niskanen (1971), William A. Niskanen Jr., *Bureaucracy and Representative Government*, Routledge (Taylor & Francis Group), London and New York, 1971.

- NOAA (2019), US National Oceans & Atmospheric Administration, <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide> (accessed 23 Aug. 2019).
- NRCan (2018) Natural Resources Canada, *Innovation and Clean Growth Research Development and Demonstration Programs – Applicants Guide to Terms and Conditions*, Ottawa, 2018 <https://www.nrcan.gc.ca/energy/science/programs-funding/eip/20024> , accessed Nov. 17, 2018.
- NRCan (2017) Natural Resources Canada, *Energy Fact Book 2017-18*, Ottawa, Ontario, ISSN 2370—3105, 2017. <https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/energy-and-greenhouse-gas-emissions-ghgs/20063#L1> , accessed July 7, 2021.
- OAG (2014) Office of the Auditor General of Canada, *2014 Fall Report of the Commissioner of the Environment and Sustainable Development*, Chapter 1, http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201410_01_e_39848.html#hd3c .
- OECD (2006), Organization for Economic Development, *Whole-of-government Approaches to Fragile States, DAC Guidelines and Reference Series*, Paris: OECD.
- OECD (2005), Organization for Economic Development, *Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development*. Paris, OECD.
- OECD (2005a), Organization for Economic Development, *Policy Coherence for Development: Promoting Institutional Good Practice*, Paris, OECD.
- Pal, L.A., (2006), *Policy Analysis: Concepts and Practice, Beyond Policy Analysis –Public Issue Management in Turbulent Times*. Nelson, Toronto, pp. 10–13.
- PCO (2019) Privy Council Office, <https://www.canada.ca/en/innovation-hub.html> , accessed August 19, 2019.
- Porter, Michael E., (1980). *Competitive Strategy*, Free Press, New York.
- Prairie Climate Centre (2019), *Climate Atlas of Canada, 2019*, <https://climateatlas.ca/climate-change-basics> (accessed 23 Aug. 2019).
- Rennings & al. (2003) Rennings, K., Kemp, R., Bartolomeo, M., Hemmelskamp, J., Hitchens, D., 2003: *Blueprints for an Integration of Science, Technology and Environmental Policy*.

- Ring, I., Schröter-Schlaack, C., (2011). Ring, Irene and Schröter-Schlaack, Christoph (Ed.), 2011. *Instrument Mixes for Biodiversity Policies*. POLICYMIX Report, Issue No. 2/2011, Helmholtz Centre for Environmental Research – UFZ, Leipzig. Available at <http://policymix.nina.no> Leipzig, June 2011 ISBN 978-82-426-2323-2.
- Rittel, H. W. J., & Webber, M. M. (1973), *Dilemmas in a general theory of planning*, Policy Sciences, 4(2). p. 155–169.
- Roberts, Nancy (2000). *Coping with Wicked Problems*. Working Paper. Monterey, California: Department of Strategic Management, Naval Postgraduate School.
- Roberts, Nancy (2001), Chapter 20. *Coping with wicked problems: The case of Afghanistan*, in Lawrence Jones, James Guthrie, Peter Steane (ed.) Learning from International Public Management Reform: Part B (Research in Public Policy Analysis and Management, Volume 11 Part 2) Emerald Group Publishing Limited, pp.353 - 375
- Rogers, Everett M., (2005) *Diffusion of Innovations* (5th ed.). New York, NY: Free Press. [ISBN 0743222091](#). [OCLC 782119567](#).
- Rogge, Karoline S., Florian Kern & Michael Howlett (2017) *Conceptual and empirical advances in analysing policy mixes for energy transitions*, Elsevier: Energy Research & Social Science 33 (2017) 1–10. <http://dx.doi.org/10.1016/j.erss.2017.09.025>
- Rogge, Karoline S. and Kristin Reichardt (2016), *Policy mixes for sustainability transitions: an extended concept and framework for analysis*, Research Policy 45 (8) (2016) 1620–1635, <http://dx.doi.org/10.1016/j.respol.2016.04.004> .
- Rosenbloom, Daniel and Jochen Markard (2020), *A COVID-19 recovery for climate*, Science 01 May 2020: Vol. 368, Issue 6490, pp. 447. DOI: 10.1126 / science.abc4887. <https://science.sciencemag.org/content/368/6490/447/tab-article-info>
- Rosenow, J., F. Kern and K. Rogge (2017), *The need for comprehensive and well targeted instrument mixes to stimulate energy transitions: The case of energy efficiency policy*, Elsevier: Energy Research & Social Science 33 (2017) 95–104.
- Rotmans, J., R. Kemp, and M. Van Asselt, (2001). *More Evolution than Revolution: Transition Management in Public Policy*. Foresight 3(1):15–31. <http://dx.doi.org/10.1108/14636680110803003>.
- Ruegg, Rosalie, Allan C. Connor, Ross J. Loomis, (2014), *Evaluating Realized Impacts of DOE/EERE R&D Programs*, August 2014. https://www1.eere.energy.gov/analysis/pdfs/evaluating_realized_rd_impacts_9-22-

- Ruttan, Vernon W. (2006), *Is War Necessary for Economic Growth? Military Procurement and Technology Development*, New York: Oxford University Press, 2006.
- Ruttan, Vernon W. (2001), *Technology Growth & Development: An Induced Innovation Perspective*, New York: Oxford University Press, 2001.
- Salamon, L.M., (2002). The new governance and the tools of public action: an introduction. In: Salamon, L.M. (Ed.), *The Tools of Government, A Guide to the New Governance*. Oxford University Press, Oxford, pp. 1–47.
- Schmidt & al. (2012). Schmidt, T.S., Schneider, M., Rogge, K.S., Schuetz, M.J.A., Hoffmann, V.H., 2012. *The effects of climate policy on the rate and direction of innovation: a survey of the EU ETS and the electricity sector*. *Environ. Innov. Soc. Trans.* 2, 23–48.
- Schumpeter, J.A. (1912) *Theorie der wirtschaftlichen Entwicklung*; Leipzig; Duncker und Humblot, 1912, p. 548 (per Zizlavsky)
- SDTC (2002), Sustainable Development Technology Canada, *2002 Annual Report*, https://www.sdtec.ca/uploads/2015/2002_AR.pdf, 2002, p. 7.
- Simon ((1991) Herbert A. Simon, 1991, *Bounded Rationality and Organizational Learning*, *Organization Science*, 2(1), pp. 125-134.
- Smil (2010), Vaclav, *Energy Transitions: History, Requirements, Prospects*, Praeger, Santa Barbara, CA, 2010. Hardcover: ISBN 978-0-313-38177-5.
- Sorrell, S., (2004). *Understanding barriers to energy efficiency*. In: Sorrell, S., O'Malley, E., Schleich, J., Scott, S. (Eds.), *The Economics of Energy Efficiency – Barriers to Cost-Effective Investment*. Edward Elgar, Cheltenham, pp. 25–94.
- Sorrell, S., Smith, A., Betz, R., Walz, R., Boemare, C., Quirion, P., Sijm, J., Konidari, D.M.P., Vassos, S., Haralampopoulos, D., Pilinis, C., (2003). *Interaction in EU climate policy*. SPRU, Sussex.
- Sovacool, Benjamin K., (2016), *How long will it take? Conceptualizing the temporal dynamics of energy transitions*, Elsevier: *Energy Research & Social Science* 13 (2016) pp. 202–215.
- Sovacool, Benjamin K., (2009). *The importance of comprehensiveness in renewable electricity and energy-efficiency policy*. *Energy Policy* 37, 1–1529.

Stern, Nicolas, (2007), *The Economics of Climate Change: The Stern Review*, Cambridge University Press, January 2007, isbn: 9780521700801, section 1-6, p. 21.

Steurer, Reinhard and Berger, Gerald (2010), *The Lisbon Strategy and Sustainable Development Strategies Across Europe: How Different Governance Arrangements Shape the European Coherence of Policy Documents* (January 1, 2010). InFER Discussion Paper 1-2010, Available at SSRN: <https://ssrn.com/abstract=2342118> or <http://dx.doi.org/10.2139/ssrn.2342118>

TBS (2016), Treasury Board of Canada Secretariat, *Policy on Results*, <https://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=31300#>

TBS (2007), Treasury Board of Canada Secretariat, *Assessing, Selecting, and Implementing Instruments for Government Action*, ISBN 978-0-662-05036-0, 2007. <https://www.tbs-sct.gc.ca/rtrap-parfa/asses-eval/asses-eval-eng.pdf>

UN (2020), United Nations, Department of Economic and Social Affairs, *Sustainable Development Goals, 2020*. <https://sdgs.un.org/goals>

UN (2007), *Thematic Debate of the General Assembly: Climate Change as a Global Challenge*, 31 July-1 August 2007, <http://www.un.org/ga/president/61/follow-up/climatechange/ClimateChangeBackgroundPaper.pdf>

UNFCCC (2011) *United Nations Framework Convention on Climate Change, Fact sheet: Climate change science - the status of climate change science today*, 2011, https://unfccc.int/files/press/backgrounders/application/pdf/press_factsh_science.pdf (accessed August 23 2019).

UNESCO (2018) <https://en.unesco.org/themes/investing-science-technology-and-innovation> (Investment in science, technology and innovation (STI) is essential for economic development and social progress. Research and development (R&D) can foster sustainable development by building greener, more inclusive societies.)

Unruh, G.C. (2002), *Escaping Carbon Lock-in*, Energy Policy 30, p. 125-137. <https://www.sciencedirect.com/science/article/pii/S0301421501000982>

Unruh, G. 2000. *Understanding Carbon Lock-in*, Energy Policy 28(12):817–30. [http://dx.doi.org/10.1016/S0301-4215\(00\)00070-7](http://dx.doi.org/10.1016/S0301-4215(00)00070-7) .

US DOE (2016) US Department of Energy, Energy Efficiency and Renewable Energy, *Building Technology Office Multi-Year Program Plan (2016-2020)*, <https://energy.gov/sites/prod/files/2016/02/f29/BTO%20Multi-Year%20Program%20Plan%20-%20Final.pdf> accessed August 1, 2017.

- US EPA (2018) United States Environmental Protection Agency, *Inventory of US Greenhouse Gas Emissions and Sinks 1990-2016*, 2018, https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf
- Vreugdenhil, H., Taljaard, S., Slinger, J.H., (2012). *Pilot projects and their diffusion: a case study of integrated coastal management in South Africa*, International Journal of Sustainable Development 15 (1/2) 148.
- Walker W., (2000), *Entrapment in large technology systems: institutional commitment and power relations*, Res. Policy 29 (7–8) (2000) 833–846.
- Weber, Max. (1948). *Bureaucracy*, In From Max Weber: Essays in Sociology, eds. H Gerth, C Wright and Trs Mills. London: Routledge, 1948.
- Weber, K.M., Rohrer, H., (2012). *Legitimizing research, technology and innovation policies for transformative change Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework*, Res. Policy 41, 1037–1047, 2009.
- Yin R.K. (2009), *Case study research, design and method*, 4 edition. London: Sage Publications Ltd.; 2009.
- Zizlavsky, Ondrej, (2013). *Past, Present and Future of the Innovation Process*, International Journal of Business Management, vol. 5, 2013.