Appendix F – PEI Energy Efficiency Potential Study Prepared by Dunsky Energy Consulting

List of Reports

- 1. Prince Edward Island Energy Efficiency Potential Study A Comprehensive Assessment of Energy Efficiency and Demand Response Opportunities 2021 2030 (Volume I: Final Results)
- 2. Prince Edward Island Energy Efficiency Potential Study A Comprehensive Assessment of Energy Efficiency and Demand Response Opportunities 2021 2030 (Volume II: Appendices)



Prince Edward Island Energy Efficiency Potential Study:

A Comprehensive Assessment of Energy Efficiency and Demand Response Opportunities 2021-2030

(Volume I: Final Results)

Prepared for:

efficiency PEI





Submitted to:

efficiencyPEI

www.princeedwardisland.ca/en/topic/energy-efficiency



Prepared by:

Dunsky Energy Consulting

50 Ste-Catherine St. West, suite 420 Montreal, QC, H2X 3V4

www.dunsky.com | info@dunsky.com + 1 514 504 9030



With support from: Ad Hoc Research

Photo credit: Wendy Nordvik-Carr

About Dunsky

Dunsky provides strategic analysis and counsel in the areas of energy efficiency, renewable energy, and clean mobility. We support our clients – governments, utilities, and others – through three key services: we **assess** opportunities (technical, economic, market); **design** strategies (programs, plans, policies); and **evaluate** performance (with a view to continuous improvement).

Dunsky's 35+ experts are wholly dedicated to helping our clients accelerate the clean energy transition, effectively and responsibly.



Contents

Table of Contents

С	ntents	i
	able of Contents	i
	ist of Figures	iii
	ist of Tables	v
	ist of Acronyms	vi
	Definitions	vii
E	ecutive Summary	1
	ntroduction	1
	Energy Efficiency Potential Efficiency Program Savings Results Efficiency Program Cost-Effectiveness Efficiency Programs Key Takeaways	1 2 5 6
	Demand Response Potential Demand Response Program Savings Demand Response Program Cost-Effectiveness Demand Response Program Key Takeaways	7
	Combined System Impacts Electricity Consumption Impacts Annual Peak Electricity Demand Impacts Key Takeaways	11 11 12 13
1	Introduction	14
	 1 Study Overview	14 14 14
	3 Market Segmentation	15
	4 Achievable Scenarios and Sensitivities	16
	5 Baseline Energy and Demand Forecasts	18
	6 Savings Terminology	
		20
2	Energy Efficiency	21
	2.1.1 Approach 2.1.2 Program Scenarios	21 21 22
	2.2 Program Savings	23

	2.2.1	Program Savings by Market Sector	27
	2.2.2	Residential Program Savings by End-use	29
	2.2.3	C&I Program Savings by End-use	
	23 Portf	olio Metrics	38
	2.3 1010	Program Costs	38
	2.3.2	Cost-Effectiveness	42
	2.0.2		
	2.4 Sens	Itivity Analysis	
	2.4.1	Enabling Activities	
	2.4.2		45
	2.5 Agric	ultural Sector Savings	
	2.5.1	Limitations to the Agricultural Sector Assessment	48
	2.5.2	Agricultural Market Characterization	
	2.5.3	Specialized Agricultural Saving Measures	
	2.5.4	Benchmarking Agriculture Sector Savings	51
2	Domano	1 Response	52
3	Demano	d Response	52
3	Demano 3.1 Appr	d Response	52
3	Demand 3.1 Appr 3.1.1	d Response oach Achievable Scenarios	52 53
3	Demand 3.1 Appr 3.1.1 3.1.2	d Response oach Achievable Scenarios Load Curve Analysis	52 53 55 55
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie	d Response oach Achievable Scenarios Load Curve Analysis	
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario	52 53 55 55
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario	52 53 55 55 61 64
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2 3.2.3	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario TOU Rate Scenario	52 53 55 55 57 57 61 64 64 66
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2 3.2.3 3.3 Key 1	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario TOU Rate Scenario Fakeaways	52 53 55 55 57 61 64 64 66 68
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2 3.2.3 3.3 Key 1	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario TOU Rate Scenario Fakeaways	52 53 55 55 57 57 61 64 64 66 68
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2 3.2.3 3.3 Key 1 Conclus	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario TOU Rate Scenario Fakeaways	52 53 55 55 57 61 64 64 66 68 70
3	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2 3.2.3 3.3 Key 1 Conclus 4.1 Com	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario TOU Rate Scenario ToU Rate Scenario	52 53 55 55 57 61 64 66 68 70 70 70
4	Demand 3.1 Appr 3.1.1 3.1.2 3.2 Achie 3.2.1 3.2.2 3.2.3 3.3 Key 1 Conclus 4.1 Com	d Response oach Achievable Scenarios Load Curve Analysis evable Potential Results Customer Incentives Scenario Customer Incentives + Interruptible Rate Scenario TOU Rate Scenario Fakeaways.	52 53 55 55 57 61 64 64 66 68 70 70

List of Figures

 Figure E-1. New Lifetime Electricity Savings by Year (All Scenarios) Figure E-2. Lifetime Savings for Enabling Strategies Compared to Varied Incentive Levels Figure E-3. Comparison of Lifetime Savings under Mid Scenario and Baseline Consumption Breakdo (% of Total) by Sector Figure E-4. Annual Electric Demand Savings from Efficiency Measures by Year (All Scenarios) Figure E-5. Estimated Program Costs by Year (2021-2023; All Scenarios) Figure E-6. Demand Response Program Scenario Descriptions Figure E-7. Demand Response Achievable Potential Figure E-8. Demand Response Program Costs per Year (2021-2025) and Average Annual for 2026-2030 Figure E-9. Impact of Electric EE Program Savings on Forecasted Electricity Sales (2021-2030; Program Scenarios) Figure E-10. Impact of DSM Programs on Forecasted Utility Annual Peak Load (2021-30; All Progra 	2 3 own 4 5 6 9 - 10 12 im 13
Figure 1-1. Achievable Program Scenario Descriptions	17
Figure 1-2. Baseline Energy and Peak Demand Forecasts	19
Figure 2-1. EE Module Program Scenario Descriptions	22
Figure 2-2. Cumulative Electric Savings by 2023 (All Scenarios)	24
Figure 2-3. Electric Incremental Lifetime Savings by Year (All Scenarios)	25
Figure 2-4. Electric Demand Incremental Annual Savings from Efficiency Measures by Year (All	07
Scenarios)	21 1
2023: All Scenarios)	1- 28
Figure 2-6. Electric EE Savings by Segment (Average Incremental Lifetime Savings (2021-2023); M	id
Figure 2-7 Residential Electric Average Lifetime Savings (2021-2023) by Segment All Scenarios	23
Figure 2-8. Residential Electric FE Savings by End-use Average Incremental Lifetime Savings (2021)	-
2023: All Scenarios)	31
Figure 2-9. Top 10 Residential Measures – Avg. Annual (left pie) and Lifetime (right pie) (2021-2023	3;
Mid Scenario; GWh)	32
Figure 2-10. C&I Electric Average Lifetime Savings (2021-2023) by Segment, All Scenarios	34
Figure 2-11. C&I Electric EE Savings by End-use Average Incremental Lifetime Savings (2021-2023	3;
All Scenarios)	35
Figure 2-12. Top 10 C&I Measures – Avg. Annual and Lifetime (2021-2023; Mid Scenario; GWh)	36
Figure 2-13. Proportion of C&I Lighting Savings by Measure Type (2021-23 Average Incremental	~ 7
Lifetime Savings; Mid Scenario)	37
Figure 2-14. Estimated Program Costs by Year (2021-2023; All Scenarios)	38
Figure 2-15. Schematic Example of Adoption Theory	41
Figure 2-16. Incremental Lifetime Savings Compared to Baseline wild and wax incentive Scenarios.	44
Savings Compared to Baseline (2021-2023; Mid Scenario: GW/b)	; 16
Figure 2-18 Impact of Electric Rate and Avoided Cost Sensitivities on Average Incremental Appual	+0
Savings Compared to Baseline (2021-2023: Mid Scenario: GWh)	46
Figure 3-1. Demand Response Potential Assessment Approach	
Figure 3-2. Demand Response Program Scenario Descriptions	
Figure 3-3. Standard Peak Day Load Shape with Percentile Distribution	56

Figure 3-4. Demand Response Achievable Potential
Figure 3-5. Demand Response Program Costs
Figure 3-6. Peak Load Profile (2030)60
Figure 3-7. Customer Incentives Scenario – Achievable Potential by Program
Figure 3-8. Customer Incentives + Interruptible Rate Scenario – Achievable Potential
Figure 3-9. TOU Rates Scenario Achievable Potential
Figure 4-1. Impact of Electric EE Savings on Forecasted Electricity Sales (2021-2030; Technical,
Economic, and Program Scenarios)7
Figure 4-2. Impact of Electric EE Demand Reduction on Forecasted Peak Load (2021-30; All Program
Scenarios)72

List of Tables

Table E-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate 8 Table E-3. Demand Response PAC Test Results 10 Table I-3. Sensitivity Scenario Descriptions 16 Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental 17 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 26 Program, All Scenarios, GWh 30 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023) by 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All 36 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-11. Impact on Average Lifetime and Annual Savings, and Cost per First Year Savings 45 Table 2-12. PEI Agriculture Segments and Products by Segment. 49 Table 2-13. Suggested End-Uses and Technologies 50 <th>Table E-1. Average Estimated Savings Unit Cost (2021-23; All Scenarios)</th> <th> 5</th>	Table E-1. Average Estimated Savings Unit Cost (2021-23; All Scenarios)	5
and 100 scenarios 6 Table E-3. Demand Response PAC Test Results. 10 Table 1-3. Sung Control State S	Table E-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate	0
Table E-3. Definition Response PAC rest Results. 10 Table 1-1. Study Data Sources and Uses 15 Table 1-2. Study Market Sectors and Segments. 16 Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental 17 Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental 17 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 30 Table 2-3. Residential Electric Evaluated Results and Average Incremental Lifetime Savings (2021-2023) by 33 Table 2-4. C&I Electric E Valuated Results and Average Incremental Lifetime Savings (2021-2023) by 33 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 34 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Scenarios and Sensitivities (2021-2023) 45 Table 2-10. Average Annual Investment, Average Annual Savings (2021-2023) in Mid Scenario under +/- 10% To% Rate and Avoided Costs Sensitivities (2021-2023) 45 Table 2-12. PEI Agriculture Segments and Products by Segment 47 </td <td>Table F. 2. Demand December 2007 Test Decults</td> <td> ð 10</td>	Table F. 2. Demand December 2007 Test Decults	ð 10
Table 1-1. Study Data Sources and Uses 15 Table 1-2. Study Market Sectors and Segments 16 Table 1-3. Sensitivity Scenario Descriptions 17 Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023) 26 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 90 Program, All Scenario, 30 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023) by Program, All 30 Scenarios 34 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All 31 Scenarios 34 Table 2-4. C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 40	Table E-3. Demand Response PAC Test Results	.10
Table 1-2. Study Market Sectors and Segments 16 Table 1-3. Sensitivity Scenario Descriptions 17 Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental 26 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) 26 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023) by 30 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, AII 33 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 34 Scenarios 34 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, AII 34 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (AII Scenarios) 39 Table 2-7. Average Estimated Sector Cost stot roots to 2023 (AII Scenarios) 42 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (AII Scenarios) 42 Table 2-9. EE Module Sensitivities (2021-2023) 43 Table 2-10. Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 10%	Table 1-1. Study Data Sources and Uses	.15
Table 1-3. Sensitivity Scenario Descriptions 17 Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental 26 Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023) 26 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 30 Toble 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023) by Program, All Scenarios 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All Scenarios 34 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Senarios and Sensitivities (2021-2023) 45 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 47 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-12. PEI Agriculture Segments and Products by Segment 49	Table 1-2. Study Market Sectors and Segments	.16
Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023) 26 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 30 Program, All Scenarios, GWh 30 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021- 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All 34 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 45 Table 2-12. PEI Agriculture Segments and Products by Segment 47 Table 2-13. Suggested End-Uses and Technologies 50 Table 2-14. Jurisdictional Scan of Potential Savings 51 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios 57 Table 3-3. Demand Response PAC Test Results <td>Table 1-3. Sensitivity Scenario Descriptions</td> <td>.17</td>	Table 1-3. Sensitivity Scenario Descriptions	.17
Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023) 26 Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 30 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023); 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023); 33 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 34 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 45 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 49 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and 60 Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives + Interruptible Rate Scenario - Measures <t< td=""><td>Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental</td><td></td></t<>	Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental	
Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by 30 Program, All Scenarios, GWh 30 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023); Mid Scenario) 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Sector Costs Ratios in 2023 (All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 45 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 40 10% Rate and Avoided Costs Sensitivities 47 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and 57 Table 3-3. Demand Response PAC Test Results 60 Tab	Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023)	.26
Program, All Scenarios, GWh 30 Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023); Mid Scenario) 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All Scenarios 34 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-5. Top 10 C&I Electric EE Measures (Average Annual Savings, and Cost per First Year Savings 30 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +-10% Rate and Avoided Costs Sensitivities 47 Table 2-12. PEI Agriculture Segments and Products by Segment	Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by	
Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023); Mid Scenario) 33 Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All 34 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 39 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 45 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 47 10% Rate and Avoided Costs Sensitivities 49 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives Scenario - Measures 62	Program, All Scenarios, GWh	.30
2023); Mid Scenario)	Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-	
Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All 34 Scenarios 34 Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario) 36 Table 2-6. Estimated Sector Costs by Year (All Scenarios) 39 Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios) 39 Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 45 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 40 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives Scenario - Measures 62 Table 3-5. Customer Incentives PAC Test Results 68 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievabl	2023); Mid Scenario)	.33
Scenarios	Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, Al	.
Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario)36 Table 2-6. Estimated Sector Costs by Year (All Scenarios)	Scenarios	.34
Table 2-6. Estimated Sector Costs by Year (All Scenarios)39Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios)39Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios)42Table 2-9. EE Module Sensitivity Descriptions43Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings43under the Achievable Scenarios and Sensitivities (2021-2023)45Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/-4710% Rate and Avoided Costs Sensitivities47Table 2-12. PEI Agriculture Segments and Products by Segment.49Table 2-13. Suggested End-Uses and Technologies50Table 3-1. Peak load forecast for PEI (2021-2030)56Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and57Table 3-3. Demand Response PAC Test Results60Table 3-4. Customer Incentives + Interruptible Rate Scenario – Measures62Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures63Table 3-6. Demand Response PAC Test Results68Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking60Verifiered6868Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking60	Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario)	.36
Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios)	Table 2-6. Estimated Sector Costs by Year (All Scenarios)	.39
Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios) 42 Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 43 under the Achievable Scenarios and Sensitivities (2021-2023) 45 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 47 10% Rate and Avoided Costs Sensitivities 47 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives Scenario - Measures 62 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 65 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios)	.39
Table 2-9. EE Module Sensitivity Descriptions 43 Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings 43 under the Achievable Scenarios and Sensitivities (2021-2023) 45 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 47 10% Rate and Avoided Costs Sensitivities 47 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 2-14. Jurisdictional Scan of Potential Savings 51 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives + Interruptible Rate Scenario – Measures 62 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 65 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios)	.42
Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings under the Achievable Scenarios and Sensitivities (2021-2023)	Table 2-9. EE Module Sensitivity Descriptions	.43
Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023). 43 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 47 10% Rate and Avoided Costs Sensitivities 47 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 2-14. Jurisdictional Scan of Potential Savings 51 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 62 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 63 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings	15
10% Rate and Avoided Costs Sensitivities 47 10% Rate and Avoided Costs Sensitivities 49 Table 2-12. PEI Agriculture Segments and Products by Segment 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 3-1. Peak load forecast for PEI (2021-2030) 51 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 62 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	Table 2.11 Impact on Average Lifetime and Appuel Sovings (2021-2023) in Mid Separate under 1/	.40
Table 2-12. PEI Agriculture Segments and Products by Segment. 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 2-14. Jurisdictional Scan of Potential Savings 51 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 62 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	100/ Pete and Avoided Casts Sensitivities	17
Table 2-12. PET Agriculture Segments and Products by Segment. 49 Table 2-13. Suggested End-Uses and Technologies 50 Table 2-14. Jurisdictional Scan of Potential Savings 51 Table 3-1. Peak load forecast for PEI (2021-2030) 56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and 57 Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives Scenario - Measures 62 Table 3-5. Customer Incentives + Interruptible Rate Scenario - Measures 65 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	Table 2.12, DEL Agriculture Segments and Products by Segment	.47
Table 2-14. Jurisdictional Scan of Potential Savings .51 Table 3-1. Peak load forecast for PEI (2021-2030) .56 Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and .57 Table 3-3. Demand Response PAC Test Results .60 Table 3-4. Customer Incentives Scenario - Measures .62 Table 3-5. Customer Incentives + Interruptible Rate Scenario - Measures .62 Table 3-6. Demand Response PAC Test Results .63 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking .60	Table 2-12. Suggested End-I lses and Technologies	50
Table 3-1. Peak load forecast for PEI (2021-2030)	Table 2-14 Jurisdictional Scan of Potential Savings	.00
Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios	Table 3-1. Peak load forecast for PEI (2021-2030)	56
TOU Rates scenarios	Table 3-2 Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate a	and
Table 3-3. Demand Response PAC Test Results 60 Table 3-4. Customer Incentives Scenario - Measures 62 Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures 65 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	TOU Rates scenarios	57
Table 3-4. Customer Incentives Scenario - Measures 62 Table 3-5. Customer Incentives + Interruptible Rate Scenario - Measures 65 Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking 60	Table 3-3. Demand Response PAC Test Results	.60
Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures	Table 3-4. Customer Incentives Scenario - Measures	.62
Table 3-6. Demand Response PAC Test Results 68 Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking Invisit at integers	Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures	.65
Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking	Table 3-6. Demand Response PAC Test Results	.68
	Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking	
JURISAICTIONS	Jurisdictions	.69

List of Acronyms

AMF	Advanced metering functionality	
ASHP	Air source heat pump	
BAU	Business as Usual	
BYOD	Bring your own device	
DCV	Demand control ventilation	
DEEP	Dunsky Energy Efficiency Potential model	
DER	Distributed energy resource	
DLC	Direct load control	
DMSHP	Ductless mini-split heat pump	
DR	Demand response	
DSM	Demand side management	
EE	Energy efficiency	
EMS	Energy management system	
EUL	Effective useful life	
GDP	Gross domestic product	
GHG	Greenhouse gas	
GWh	Gigawatt-hour	
HER	Home energy report	
HPWH	Heat pump water heater	
HVAC	Heating, ventilation, and air conditioning	
LED	Light-emitting diode	
MW	Megawatt	
O&M	Operation and maintenance	
PAC	Program Administrator Cost test	
tCO ₂ e	Tons of carbon-dioxide equivalent	
TLED	Tubular light-emitting diode	
TOU	Time of use rate	
TRC	Total Resource Cost test	

Definitions

Term	Definition
Achievable potential	The savings from cost-effective opportunities once market barriers have been applied, resulting in an estimate of savings that can be achieved through demand-side management programs. For each module, three achievable potential scenarios are modeled to examine how varying factors such as incentive levels and market barrier reductions impact uptake.
Cumulative savings	A rolling sum of all new savings that will affect energy sales, cumulative savings exclude measure re-participation (i.e., savings toward a measure are counted only once, even if customers can participate again after the measure has reached the end of its useful life) and provide total expected grid-level savings.
Economic potential	The savings opportunities available should customers adopt all cost-effective savings, as established by screening measures against the Total Resource Cost Test (TRC), without consideration of market barriers or adoption limitations.
Enabling activities	Enabling activities or strategies help participants overcome barriers to participating in efficiency programs and include but are not limited to direct install programs, contractor training and support, upstream programs, targeted marketing, building and home energy labeling requirements, and financing programs.
Energy end-use	In this study, energy end-uses refer to grouping of energy saving measures related to specific building component (i.e., water heating, HVAC, lighting etc.).
Demand Side Management	The use of programs that offer financial incentives, education, and other support to encourage the efficient use of energy both in terms of the amount and timing of the energy used.
Incremental annual savings	Savings from measures incentivized through programs in a given year expressed in terms of savings in the first year of each measure's life. Incremental annual savings include savings attributable to measure re-participation (i.e., when a customer in incentivized to participate in a program again after the original measure has reached the end of its useful life).
Incremental lifetime savings	Savings from measures incentivized through programs in a given year expressed in terms of savings expected over the lifetime of each measure. Incremental lifetime savings include savings attributable to measure re-participation (i.e., when a customer in incentivized to participate in a program again after the original measure has reached the end of its useful life).
Market sector	The market of energy using customers on Prince Edward Island is broken down into four sectors based on the primary occupants in the building: residential (including single family and multi-family buildings), low-income residential, commercial, and industrial.
Market segment	Within each sector, market segments are defined to capture key differences in energy use and savings opportunities that are governed by building use and configuration.
Measure re- participation	The re-participation of a customer in a program after the original incentivized measure has reached the end of its useful life. Re-participation is counted in program savings (i.e. incremental lifetime savings and incremental annual savings), but it does not impact cumulative savings since the customer's net consumption is not impacted by replacing an efficient technology with an equally efficient technology.
Program Savings	Savings from measures incentivized through programs in a given year. Program savings include measure re-participation and are generally expressed in terms of incremental lifetime savings or incremental annual savings.
Annual Peak	The annual peak demand refers to the hour in each year that exhibits the highest system demand in MW, on a system-wide basis not accounting for local constraints.

Introduction

The Government of Prince Edward Island (PEI) has established a province-wide electricity savings goal of reducing annual consumption by 2% per year. efficiencyPEI's programs are ramping up to achieve this target while at the same time helping to lower customer and electric system costs, improve grid resiliency, and achieve other public policy goals.

The Prince Edward Island Energy Efficiency Potential Study ("the Potential Study") assesses the degree to which efficiencyPEI's Demand Side Management (DSM) programs can reduce electricity use on PEI, covering both Maritime Electric Corporation and Summerside Electric customers. The study quantifies the consumption savings (expressed in kWh) that are achievable from energy efficiency (EE) programs as well as peak load reductions (expressed in kW) resulting from Demand Response (DR) programs. It includes adoption forecasts of all commercially viable efficiency technologies, supported by program incentives and associated strategies over the ten-year period spanning from 2021 to 2030.

This Potential Study is intended to inform province-wide energy efficiency and peak demand reduction targets, and support program design strategies for the coming DSM program planning periods. As such it includes a comprehensive assessment of program costs and benefits, providing a comparison among the various program options and their relative cost-effectiveness, as expressed from the utilities' perspective.

Energy Efficiency Potential

The energy efficiency potential was assessed under three program investment levels, for which customer incentives and rebates were varied from the current levels (referred to in the "business as usual" scenario) to an upper end limit where the program incentives would eliminate all additional costs to customers for installing efficiency equipment (referred to in the "maximum" scenario), as outlined below:

BAU

A lower bounds scenario meant to reflect a **Business as Usual (BAU)** approach by applying existing efficiencyPEI incentives, enabling activities, and costs while at the same time expanding to new measures and adding three new programs (Home Energy Reports, Appliance Recyling and the newly launched Community Energy Solutions Program).

Mid

A scenario where incentive levels are increased above current levels to cover at least 75% of the extra costs of installing a more efficient piece of equipment in comparison to a standard option. (Example: if a more efficient piece of equipment was \$100 more expensive, then a \$75 rebate would be provided.)

Max

An upper bound scenario that eliminates all extra costs associated with installing energy efficient equipment for the consumer. Under this scenario, incentives cover 100% of the additional cost of installing energy savings technologies in comparison to standard equipment.

The impact of enabling activities (e.g., direct install programs, contractor training and support) were explored through sensitivities to the Mid scenario

Efficiency Program Savings Results

Dunsky's Demand and Energy Efficiency Potential (DEEP) model was used to test the impact of different incentive levels and program strategies on the overall potential achievable electric efficiency savings opportunity as well as the associated impact on peak demand. Throughout the report the achievable savings results are broken down by measure type, end-use, segment, and sector.

The Impact of Increased Incentives over the Current (BAU) Levels

The potential study shows that under all scenarios, PEI customers can significantly reduce the amount of energy consumed while still receiving the same quality of service. Over efficiencyPEI's next three-year program planning cycle (2021-2023), Figure E-1 shows that energy efficiency programs have the potential to deliver, on average, between 208 GWh to 477 GWh of lifetime savings per year. Lifetime savings refer to the savings that will accumulate over the lifetime of a measure installed in a given year. The BAU results in this study are higher than the 2019/20 program results primarily due to the recent expansion of the range of incentivized efficiency technologies offered under efficiencyPEI's commercial and institutional programs.



Figure E-1. New Lifetime Electricity Savings by Year (All Scenarios)

The study found that while efficiency savings in the initial years are quite high, they are projected to decline in the later years. This is largely the result of the successful transition from inefficient incandescent and halogen lighting to solid state (LED) lighting that is taking place in the market. For example, it is predicted that by 2026 LED bulbs will become the norm for almost all PEI homes. For businesses, the transition to LED linear lighting will occur steadily over the study period, slowly drawing down the number of new customers who can be encouraged to switch to high efficiency LED linear lights.

There is also a projected decline in the number of home and business retrofits (such as adding roof or basement insulation) conducted in each year over the study period, as more and more buildings become

insulated and the opportunity becomes saturated. The steepness of this decline will depend largely on how successful efficiencyPEI programs can be in the initial years, and in reality, these savings could be more equally distributed across all years in the study, depending on program goals and designs.

The Impact of Program Strategies that Reduce Customer Friction

Beyond simply raising customer incentives, the study also explored the potential impact of efficiencyPEI's investment in strategies that reduce market friction and enable customers to adopt efficient technologies. This could include strategies such as enhanced marketing; contractor training; encouraging home and building energy reporting and disclosure that helps to value efficient properties in the sales and rental markets; pursuing "direct install" type programs that deliver simple-to-install technologies such as lightbulbs, efficient shower heads and air-sealing directly to the customer's doors; or providing "upstream" incentives to suppliers and distributors that help to reduce the cost of efficient equipment at the point of sale without requiring customers to apply for rebates. Given that efficiencyPEI's programs are still relatively new, there are many options that could be pursued, and the study results indicate that these enabling strategies can help increase achievable savings significantly.

As shown in Figure E-2, adding a moderate level of enabling strategies alongside the Mid scenario incentives increases savings levels to, on average, 480 GWh of lifetime savings (2021-2023) – roughly the level of savings achieved under the Maximum incentive scenario. Moreover, investing in extensive enabling strategies brings the Mid scenario above the Max with 556 GWh of average lifetime savings over the first three years.





Savings by Market Sector and Segment

Savings are essentially evenly split between the residential sector (47 percent) and the commercial and industrial (C&I) sector (53 percent) over the first three-year period of the study. The savings breakdown

closely tracks the consumption breakdown between the sectors as shown in Figure E-3. This suggests that both sectors are both important and that efficiencyPEI should invest in both equally.



Figure E-3. Comparison of Lifetime Savings under Mid Scenario and Baseline Consumption Breakdown (% of Total) by Sector

Overall, the single family, industrial/agriculture, and office market segments represent the bulk of electric energy efficiency savings, accounting for approximately 75% of the savings, and therefore should be the focus of efficiency programs on PEI. Low-income homes and the retail market round out the top five segments, representing 85% of total savings.

It should be noted that for the purposes of this study agricultural customers were considered C&I and grouped with industrial accounts due to a lack of data and information that would allow Dunsky to model a stand-alone segment at this time. Section 2.5 of the report provides an overview of agricultural electric efficiency measures and benchmarks agricultural savings to results from potential studies in other jurisdictions. While there are some limitations due to available sector-specific information and data, the high-level review shows that the savings targets in this study are likely reasonable for the agricultural sector and useful for program planning purposes.

Peak Load Reduction from Efficient Technologies

Energy efficient technologies can also reduce the peak demand on the electricity network, which can help to increase system reliability or avoid/defer investments in electricity distribution infrastructure, thereby saving costs for all customers on PEI. Figure E-4 shows that annual reductions in the peak demand vary from 4.2 MW (BAU) to 9.1 MW (Max), over the 2022-2024 period, and decline slowly from those levels in the later years of the study.

Figure E-4. Annual Electric Demand Savings from Efficiency Measures by Year (All Scenarios)



Note: The above figure represents passive demand reductions from efficiency measures and does not include demand response programs, which are covered in the next section.

Efficiency Program Cost-Effectiveness

The study only considered savings from efficiency measures and programs that are cost-effective from the utility perspective. Measures were screened out of the results using the Program Administrator's Cost (PAC) Test, which provides a ratio of the energy savings benefits to the utilities (in the form of the avoided costs of electricity supply), over the incentive costs to encourage customers to adopt the measures. These account for program additionality, by removing savings from program free-riders (i.e. those who would take the rebates even though they would have installed the measure without it).

Table E-1 below shows the cost-effectiveness results for the residential and C&I programs. A PAC ratio greater than 1.0 is considered cost-effective, and the higher the ratio the more cost effective the programs are expected to be. This is reflected in the cost per kWh saved over the lifetime of the installed measures, which at 2.8 to 5.0 cents per kWh are cheaper than the costs of supply on PEI (at the time this report was written, tier one residential rates were 14.92 cents per kWh and tier one general service commercial rates were \$18.31 cents per kWh).

Table E-1. Average Estimated Savings Unit Cost (2021-23; All Scenarios)

Metric	BAU	Mid	Max
\$ per Incremental Lifetime kWh	0.028	0.048	0.050
Residential Portfolio PAC ratios	1.8	1.3	1.2
C&I Portfolio PAC ratios	6.2	2.4	1.8

The resulting efficiency program costs are assessed to range between \$5.9 (BAU) to \$23.8 (Max) million dollars on average per year over the first three years of the programs as shown in Figure E-5. This is in comparison to efficiencyPEI's approved budget of \$4.7 million in 2019/20 (in actuality, efficiencyPEI spent

\$2.6 million in 2019/20 for reasons outlined in its annual plan). It should be noted that program cost assessments in this study represent an upper end estimate and have not accounted for optimization strategies that can be applied in effective program design.



Figure E-5. Estimated Program Costs by Year (2021-2023; All Scenarios)

Note: Electric portfolio costs include incentive and administration (fixed and variable costs)

Efficiency Programs Key Takeaways

Based on the energy efficiency potential analysis, the following key findings emerge:

- 1. Increasing program investments can unlock a significant amount of cost-effective new savings. Expanding current programs to a broader range of measures and increasing investments in incentives and enabling strategies can significantly increase savings for PEI homes and businesses. Moving from the BAU to Mid incentive scenario increases average (2021-2023) incremental lifetime savings by 97% and by 130% under the Max incentive scenario. However, these increased savings require notably higher annual portfolio budgets, which can be contained to a degree by strategically applying increased incentives and investing in new enabling strategies.
- 2. Program strategies that can help reduce customer barriers to energy efficiency can be employed to drive further savings and also help optimize program investments. Enhancing program designs by applying further enabling activities that help address customer barriers to energy efficiency can play a key role in helping efficiencyPEI meet its targets. The results show that when moderate enabling strategies are added alongside the Mid scenario incentives, the resulting lifetime savings (2021-2023) increase by 16 percent, which is approximately equal to the savings under the Max scenario but are achieved at a budget that is \$2 million lower than the Max scenario program costs. This suggests that focusing on enabling activities may be a more effective way to pursue higher savings than simply raising

incentives alone. Program design strategies that focus on enabling strategies, alongside targeted adjustments to incentive levels, can help to optimize program impacts and cost-effectiveness.

- 3. Focusing on envelope measures on PEI homes is a key opportunity alongside HVAC measures, in particular high-efficiency heat pumps: Single family homes represent a major portion of the saving potential. Because PEI has a high penetration of electric heating and a high growth rate in new home starts, high efficiency new construction along with envelope improvement measures such as adding attic and basement insulation to existing homes offer the largest opportunity for reducing energy consumption on PEI homes. Higher performing building envelopes also help contractors to right-size heating equipment, such as high efficiency heat pumps, which combined with optimized use of the systems can further reduce equipment and energy costs for PEI homeowners.
- 4. There is significant opportunity to derive further electricity savings on PEI's businesses and institutions. This study shows that there are significant savings opportunities within PEI's businesses and institutions (equal to roughly the same amount of savings potential as that on PEI homes). The program scenarios show notably higher savings in the C&I market than were delivered in 2019/20 by efficiencyPEI's commercial sector programs. The introduction of efficiencyPEI's new Community Energy Solutions program, along with adding new measures, using targeted incentives, and applying new enabling strategies, can play a key role in tapping into the savings opportunities in the C&I market.

Demand Response Potential

The study assessed the potential for reducing utility peak loads by curtailing electricity usage on PEI homes and buildings, either through adjusting customer energy use behaviour, or by the utility centrally controlling energy using equipment. Programs that enlist customers to participate in peak reduction strategies are referred to as Demand Response (DR) programs. DR opportunities were assessed using Dunsky's Demand Reduction Optimized Potential (DROP) model, which analyses the ability for each measure to reduce the province-wide electricity demand peak, and accounts for the possibility that shifting energy use to another time may create new demand peaks. The model assesses all measures together, accounting for their cumulative interaction on the utility load curve and gives priority to the most cost-effective measures.

To determine the program achievable potential, the DROP model accounts for the propensity of customers to participate in DR programs, based on the financial incentives offered, utility marketing investments, and level of intervention that each DR measure entails (i.e., does it require equipment to be installed? how many peak reduction events will be called in a given year? etc.). The achievable potential for DR programs was assessed under three scenarios, each representing a different utility strategy to reduce peak demand: 1) Customer Incentives, 2) Customer Incentives as well as engaging large C&I Interruptible rates customers in DR events,¹ and 3) via the application of Time of Use (TOU) electricity rates that carry higher prices during peak demand hours (i.e., winter mornings and evenings) and reduced rates during lower use hours (i.e.,

¹ MECL offers some large C&I customers a lower electricity rate in return for them agreeing to curtail their usage during system reliability events. This scenario assesses the impact of expanding those agreements to include curtailment during peak demand events as well.

middle of the day and overnight). For new programs and measures, program set-up costs and ramp-up factors were applied to account for the time and investments needed to enroll customers.



BASE CASE	CUSTOMER INCENTIVES	 DR programs with event-based incentives set at levels commonly used in other jurisdictions. This scenario excludes C&I interruptible customers. Sensitivity with increased spending (double incentives) is applied to this scenario.
	CUSTOMER INCENTIVES + INTERRUPTIBLE RATES	Applies the Customer Incentives scenario measures and programs, along with the impact of enrolling large C&I interruptible rates customers to participate in DR events.
	TOU RATES	Assessment of the impact of TOU Rates for both residential and C&I customers (beginning in 2025).

Demand Response Program Savings

Overall, the results indicate there is significant potential to reduce province-wide peak electricity demand on PEI. By 2030, the total achievable savings range from 10.7 MW (via TOU Rates) to 31 MW (via Customer Incentives and Interruptible Rates), which represents between 3.1% to 8.8% of the overall forecasted electricity demand peak in 2030 (see Table 3-2, below).

Table E-2.	Customer Incentives scene	rio compared to the	Customer Incentives	+ Interruptible Rate and	l TOU scenarios
		,		,	

Scenarios	Customer Incentives Scenario	Customer Incentives & Interruptible Rates Scenario	TOU Rates Scenario
Achievable Potential (MW)	21	31	10.7
% of System Peak in 2030	5.9%	8.8%	3.1%

Figure E-7, below, provides the annual peak reduction potential from DR programs under each scenario. The chart also indicates the relative contributions from Residential and C&I sector programs, which reveals that the inclusion of Interruptible Rate customers in DR events, could offer significant peak reduction potential. Conversely, if it is not possible to engage Interruptible Rate customers² in DR events, then Residential programs offer the greatest potential for peak load reduction under either the Customer Incentives scenario or the TOU Rates scenario.

² Interruptible Rate customers refer to those large industrial customers that are on a reduced rate in exchange for the ability to reduce or interrupt the customers' electric service during reliability events (i.e., emergency events).

Figure E-7. Demand Response Achievable Potential



Demand Response Program Cost-Effectiveness

In Figure E-8, below, the annual DR program costs are provided. The dark portion of the cost bars represent the up-front costs associated with investments in program set-up, customer enrollment, and installing controls and equipment. The lighter blue portion represents the on-going annual costs associated with running the program, marketing, and customer incentives. It is important to note the DR program savings only persist for as long as the programs remain active, and new programs typically require a significant initial set up investment, followed by an ongoing period of annual – and relatively lower – costs to maintain participation.

In both the Customer Incentives and Customer Incentives & Interruptible Rates scenarios, the results show significant up-front costs in the initial years (~\$2M to \$4.5M), followed by lower annual costs over the 2025-2030 period. For the TOU Rates scenario, the costs are much lower and are concentrated largely on costs associated with running the program and marketing. It should be noted that the TOU Rates scenario costs do not include the cost of establishing smart-meter (advance metering infrastructure) capabilities, as it is assumed that these will be in place before the TOU Rates program begins.



Figure E-8. Demand Response Program Costs per Year (2021-2025) and Average Annual for 2026-2030

A cost-effectiveness assessment was conducted to determine if the value of the peak load benefits to the utilities would exceed the cost of setting up and running the programs. The PAC test is applied, and the results for each scenario are presented in Table 3-3. These account for total benefits and costs over the 2021-2030 period. A PAC ratio greater than 1.0 indicates that the benefits out-weigh the costs, and from these results it is clear that all scenarios pass this cost-effectiveness screen.

Table E-3. Demand Response PAC Test Results

Scenario	PAC Ratio
Customer Incentives	1.3
Customer Incentives & Interruptible Rates	1.8
TOU Rates	8.7

The TOU Rates scenario is by far the most cost-effective option, but as is noted above, it delivers only a fraction of the peak savings compared to the other scenarios. That said, it should be noted that it may be possible to optimise an eventual DR program design by combining TOU rates with other peak reducing measures such as heating system and water heater controls devices and energy storage.

Demand Response Program Key Takeaways

Based on the DR program potential analysis, the following key findings emerge:

- 1. There is significant potential to reduce peak loads via DR programs on PEI: Even with a relatively flat load curve, there is up to 31 MW of peak reduction potential by 2030 via a combination of Customer Incentives and engaging Interruptible Rate customers in DR events. Alternatively, the TOU Rates could deliver 10.7 MW of peak reduction potential by leveraging the upcoming AMI investments, and this could be combined with strategic selection of other targeted customer incentive measures to create an optimized DR program portfolio.
- 2. The key to success will be to focus DR program design on optimized measure mixes: There is significant cost-effective peak reduction potential on PEI and focusing on a few key programs can provide the most savings while optimizing the overall cost-effectiveness. Overall, most of the potential can be achieved through the following measures:
 - a. Load reducing measures that do not experience a bounce-back effect (i.e., an increase in demand following a DR event that may create a new peak) such as medium & large commercial customer load curtailment, dual fuel systems, and battery energy storage that strictly reduce peak demand.
 - b. Residential thermal energy storage and electric storage water heaters.
 - c. Smart thermostats connected to electric heating systems, which offer additional benefit by integrating efficiency and peak reduction programs.
- 3. Enrolling Interruptible Rates customers in DR events should be a priority: Expanding the current interruptible rates agreement with large C&I customers to include peak demand events, could yield up to 18MW of peak load reduction potential. This is the largest single measure for reducing system peaks and could be combined with other customer incentive measures and/or TOU rates to deliver a significant amount of cost-effective peak load reduction potential. Exploring the ability to make this adjustment to the interruptible rates agreements should be an initial step in an eventual DR program design.

Combined System Impacts

The following presents the *cumulative* impact on electricity consumption on PEI resulting from efficiency and demand response programs. These results provide a rolling sum of all new savings from measures that are incentivized by efficiency and demand response programs. Cumulative savings provide the total expected impact on electricity sales and annual peak demand and can be used to help plan for the province's long-term energy needs.

Electricity Consumption Impacts

By 2030, achievable electric efficiency savings could reduce annual electricity consumption by a total of 92 GWh (BAU scenario) to 200 GWh (Max scenario). This translates into a 5% to 11% reduction in electricity sales by 2030 relative to the province-wide consumption forecast in the absence of efficiency programs, as shown Figure E-9.

Overall, the study indicates that energy efficiency programs can effectively flatten electricity consumption in the province over the 2021-2025 period by offsetting projected growth. However, as the new savings opportunities decline in the later years of the study period, the programs are less able to offset consumption growth.



Figure E-9. Impact of Electric EE Program Savings on Forecasted Electricity Sales (2021-2030; Program Scenarios)

Note: Y-axis in above figure does not begin at zero.

Over the first three years (i.e., 2021-2023), the average achievable electric efficiency savings are equivalent to reducing forecasted electricity sales by 1.0 percent (BAU scenario) to 2.2 percent (Max scenario) per year and represent an increase over efficiencyPEI's 2019/20 program savings which were approximately 0.5 percent of electricity sales in that year. To note, the Province has set an annual electricity reduction target of 2% of consumption. The results of this study show that the target is achievable under the higher scenarios, especially when enabling activities are deployed alongside incentives.

Annual Peak Electricity Demand Impacts

Efficiency and demand response programs can also help reduce the programs annual peak demand for electricity, which is important to maintaining system reliability, and can help defer or avoid costly expansions to electricity transmission and distribution infrastructure.

Figure E-10 provides the forecasted growth in annual peak demand for electricity (red line) and compares this to the projected annual peak demand when the potential impacts of DSM programs are considered (blue and green lines). The efficiency program BAU scenario (blue line) shows the potential to keep annual peak demand relatively stable for the 2021-2025 period, after which a steady increase occurs as customer growth impacts outstrip peak savings from efficiency programs. When DR program impacts are added alongside efficiency programs, the annual peak load is reduced further, staying within the range of 260MW – 300MW for most of the study period. The impact of TOU Rates is introduced in 2025, and while the impact is not as pronounced as with the other scenarios, it does result in a 3% reduction in peak in 2030.



Figure E-10. Impact of DSM Programs on Forecasted Utility Annual Peak Load (2021-30; All Program Scenarios)

Note: Y-axis in above figure does not begin at zero.

Key Takeaways

Overall, the Potential Study shows that there is significant potential for efficiencyPEI's DSM programs to curtail the projected growth in electricity consumption in the province over the coming decade.

- 1. PEI's electricity energy efficiency savings targets are achievable: While current energy efficiency programs do not appear sufficient to meet the provincial government's goal of 2% electricity savings per year, there is a reasonable path to that target, albeit at higher costs and covering a broader range of eligible measures coupled with a greater focus on enabling activities. In addition, Demand Response offers a new opportunity to engage the Island community to help mitigate the growing annual peak in the province and reduce overall system costs.
- 2. Efficiency and Demand Response programs can help manage electric system peak demand growth: Over the first half of the study period, energy efficiency and DR programs can flatten and even bend forecasted load growth downward. This can help maintain system reliability, and possibly allow the utilities to defer or avoid expansion of the transmission and distribution infrastructure over the coming decade.

1 Introduction

1.1 Study Overview

This report presents the results of the Prince Edward Island Energy Efficiency Potential Study ("the Potential Study"). The Potential Study includes two modules covering the following savings streams:

- Electric energy efficiency (EE),
- Electric demand response (DR),

The Potential Study includes electric savings measures only and covers the ten-year period spanning the calendar years 2021 to 2030. Included are electric energy efficiency savings, electric demand reduction savings associated with the energy efficiency measures, and active demand response savings as well as the costs and cost-effectiveness ratios associated with these savings. Secondary fuel savings, such as oil or propane savings, associated with the electric efficiency measures are assessed to determine benefits, but are not quantified in this report. The study covers the entire province of Prince Edward Island, which is served by Maritime Electric and Summerside Electric.³

1.1.1 Uses for the Potential Study

The Potential Study is a high-level assessment of electric savings opportunities on Prince Edward Island over the next ten years. The main purpose of this study is to quantify the cost-effective savings opportunities for energy efficiency and demand response. In addition to this objective, the Potential Study can support:

- Resource planning
- Program planning
- Provincial policy and strategies

While the Potential Study provides granular information such as savings for specific measures in specific building segments, the study is not a program design document meant to accurately forecast and optimize savings and spending through efficiency programs in a given future year. The Potential Study is meant to quantify the total universe of opportunities that exist under specific parameters as defined under each program scenario and the cost-effectiveness test used.

1.2 Data Sources and Uses

The Potential Study leverages Prince Edward Island specific data to populate the models used to estimate market potential. Where Prince Edward Island specific data is not available or insufficient, data from nearby jurisdictions is leveraged to fill gaps and produce a more robust representation of market parameters in the

³ Maritime Electric serves approximately 90% of electric customers on the Island and the City of Summerside's electric utility serves approximately 10%.

province. Table 1-1 provides an overview of the key data sources used in the study. A more detailed description of the sources, inputs, and assumptions can be found in Appendix C.

Table 1-1. Study Data Sources and Uses

Data source	Application in study			
Utility customer data	Anonymized utility customer data from Maritime Electric and Summerside Electric is used to determine the number of customers and overall consumption in each market segment.			
PEI market baseline survey data	As part of this study, Ad Hoc Research conducted a phone survey to establish equipment penetration and saturations in the model for select end-uses.			
Program evaluation reports	Program data from recently completed program evaluations is used to characterize programs for model input (e.g., incentive levels, administrative costs) and used to benchmark results.			
PEI Home Heating Survey	Results from the most recent Home Heating Survey was used to supplement the primary research and refine equipment penetration and saturation levels as well as inform our barriers assessment.			
Maritime Electric's historical load	Historical hourly load data from 2019 was used to assess peak demand and evaluate demand response potential.			
Dunsky's Market Archetype	Where Island specific baseline data is not available (or was based on a low number of observations), baseline data from neighboring jurisdictions, in particular New Brunswick and Newfoundland is leveraged and adjusted for PEI specific attributes wherever possible.			
Measure Characterizations	Measure savings algorithms, estimated lives, incremental costs and specifications are derived from technical reference manuals published in analogous jurisdictions and are adjusted to reflect PEI program evaluation results.			

1.3 Market Segmentation

Based on an analysis of anonymized customer data from Maritime Electric and Summerside Electric, the Potential Study segments the electric customers into two sectors with the Residential sector split into three market segments and the Commercial and Industrial (C&I) sector split into nine as presented in Table 1-2.

Table 1-2. Study Market Sectors and Segments

Sector / Segment	Number of Customers
Residential	75,021
Single Family	47,699
Multi-Family⁴	16,070
Low-Income	11,253
Commercial & Industrial	6,989
Office	2,411
Retail	724
Food Service	311
Healthcare & Hospitals	168
Campus & Education	75
Warehouse	120
Lodging	294
Other Commercial	883
Industrial/Agriculture	2,002
Total	82,010

It should be noted that all agricultural accounts are included in the Industrial/Agriculture market segment. While most agricultural accounts are currently under a residential rate tariff, for the purposes of this study these customers were considered C&I and grouped with industrial accounts as there is no market characterization specific to the agricultural sector on PEI nor a market archetype that would allow Dunsky to model a stand-alone segment at this time. Section 2.5 provides an overview of agricultural electric efficiency measures and benchmarks agricultural savings to results from potential studies in other jurisdictions. While this high-level review shows that the savings targets in this study are likely reasonable for the agricultural sector, as a result of the limited sector-specific data, the measure level details may differ from market reality.

1.4 Achievable Scenarios and Sensitivities

As is standard practice in potential studies, the study assesses potential at the technical, economic, and program achievable levels. For each module, the study explores three program achievable scenarios (as well as sensitivities) to determine how various levels of incentives and enabling activities can impact achievable savings. In general, achievable potential is the focus of this analysis.

Figure 1-1 provides general descriptions for each achievable energy efficiency scenario. The Demand Response scenarios and more detailed descriptions are provided for each module in their respective chapters.

⁴ The multi-family population count represents individual residential units within multi-family buildings. This segment includes apartments, condos, and duplexes.

Figure 1-1. Achievable Program Scenario Descriptions⁵

_	BAU	Applies incentives, enabling activities and costs that are in line with ePEI's 2019/20 programs – plus the addition of three new programs – to simulate business as usual.
Focus of Reporting	Mid Incentive	Incentives are raised to a minimum of 75%, and enabling activities kept at BAU levels.
	MAX Incentive	Incentives are raised to 100% to completely eliminate costs and show the full potential of incentives to increase participation.

Dunsky explored <u>increased enabling activities</u> (above and beyond current levels) **through sensitivities to the Mid scenario.** This approach allows us to isolate and report on the impact of incentives vs. enabling activities, which can be helpful from the perspective of program design.

The study tests various modules against multiple sensitivity scenarios as summarized in Table 1-3.

Sensitivity Scenario	Baseline	Sensitivity		
Enabling Activities	Adoption barrier levels are set to reflect current program enabling activities.	For the Mid energy efficiency scenario, barrier levels are reduced by a half step and a full step impacted adoption under enhanced enabling activities. ⁶		
Retail Rates	Retail electricity rates are forecasted in line with current best information.	Forecasted retail electricity rates are increased/decreased by 10% impacting bill savings associated measures that impact energy consumption.		
Avoided CostsEnergy and capacity avoided costs are forecasted in line with current best information.Forecasted avoided energy increased/decreased by 1 new spending or reduced capacity costs.		Forecasted avoided energy costs are increased/decreased by 10% to account for possible new spending or reduced future energy and/or capacity costs.		

Table 1-3. Sensitivity Scenario Descriptions

 ⁵ efficiencyPEI's programs (and reported costs and savings) are for the 2019/20 fiscal year (April 1, 2019 through March 31, 2020). They are used to calibrate the BAU scenario in the model, which provides results based on a calendar year.
 ⁶ A half step barrier reduction reflects a notable investment in enabling strategies (e.g., contractor training, direct install measures) to reduce non-economic market barriers to participation. A full step would represent an absolute limit of what could be achieved by applying a full range of strategies. See Section 2.4 and Appendix A for additional detail.

1.5 Baseline Energy and Demand Forecasts

To help discern the impact of the various measures analyzed in the Potential Study on overall energy consumption and demand on PEI, the study establishes baseline energy and demand forecasts for the study period. The electric consumption forecast was developed using anonymized consumption data from Maritime Electric which was then scaled to account for Summerside Electric customers.⁷ The first year of the study forecast (2021) was then compared to the 2021 electricity sales forecast in Maritime Electric's 2018 rate case filing.⁸ After adjusting Maritime Electric's rate case forecast upward by 10% to include the Summerside service territory, the study's year one (2021) forecast – based on actual historical consumption – was comparable to the 2021 forecast in the rate filing.⁹ Moreover, the study's forecast through 2025 is reasonably in-line with the sales forecast in Maritime Electric's 2020 Integrated System Plan.

The demand forecast is based on the peak load forecast included in the 2016/17 PEI Energy Strategy.¹⁰ A more detailed description of the approach used to derive these forecasts is included in Appendix C. As with the energy forecast, the study demand forecast was compared to Maritime Electric's 2020 Integrated System Plan and found to be in-line with that forecast through 2025.

Figure 1-2 presents the baseline forecasts for electricity sales and peak demand. Electricity consumption as well as electric peak demand are expected to increase over the study period at annualized rates of 2%. These forecasts are used to illustrate the cumulative impacts of savings within each study module chapter as well as overall system impacts in Chapter 2.

⁷ Summerside Electric's overall electricity consumption is roughly 10% that of Maritime Electric. Consumption by sector is also approximately equal, and therefore a 10% adder to Maritime Electric's forecasts is an appropriate proxy for determining total electricity consumption (and demand) for PEI.

⁸ Maritime Electric 2019 General Rate Application (November 2018). Schedule 7-3. Available at:

https://www.maritimeelectric.com/media/1424/2019-general-rate-application-filed-november-30-2018.pdf

 ⁹ Maritime Electric 2020 Integrated System Plan. Available at: http://www.irac.pe.ca/infocentre/documents/Electric-MECL-2020_Integrated_System-093020.pdf. To note, the forecasts (energy and demand) do not include energy efficiency savings.
 ¹⁰ Prince Edward Island Provincial Energy Strategy 2016/17 (March 2017). Table 1. Comparison of PEI Peak Load to Existing Available Resources. Available at:

https://www.princeedwardisland.ca/sites/default/files/publications/pei_energystrategymarch_2017_web.pdf. This forecast was also compared to Maritime Electric's most recent IRP and found to be roughly in-line with that forecast.



Baseline Electricity Consumption



*Forecasted peak demand was not disaggregated by sector.

1.6 Savings Terminology

This report expresses results in terms of *cumulative savings* and *program savings*.

Cumulative savings are a rolling sum of all new savings from measures that are incentivized by efficiency programs that will affect energy sales. Cumulative savings provide the total expected impact on energy sales and electric peak demand and are used to determine the impact of efficiency programs on long-term energy consumption and peak demand. Where applicable, cumulative savings are adjusted to account for mid-life baseline adjustments and the retirement of efficiency equipment that has reached the end of its effective useful life (EUL).

Program savings provide the level of savings from measures that are incentivized by efficiency programs *in a given year*. Efficiency targets and plans are generally expressed in terms of program savings – i.e., the amount of savings programs procure in a given year.

Incremental annual savings are expressed in terms of savings achieved in the first year of all measures incentivized through efficiency programs.

Incremental lifetime savings are expressed in terms of the savings expected over the entire useful lives of all measures incentivized through efficiency programs.

2 Energy Efficiency

2.1 Overview

The following chapter presents results for the energy efficiency (EE) module of the Prince Edward Island Potential Study. The EE module estimates energy savings for electricity measures as well as peak demand savings (i.e., passive demand reductions) for electric measures. It does *not* include savings from demand response (DR), which is discussed in the subsequent chapter, nor does it include savings or consumption impacts from heating electrification, electric vehicles, or customer-sited solar, which were not within the scope of this study.

The chapter first briefly summarizes key results, the approach used to estimate EE potential, and the program scenarios explored in the analysis. A full description of the methodology can be found in Appendix A. A more detailed analysis of results is then presented in the following order:

- **Program savings**. Savings are presented in terms of incremental lifetime savings achieved during the study period for electricity. Where warranted, incremental annual savings are also presented for comparison purposes.
- **Portfolio metrics**. The benefits and costs of efficiency savings are presented at the portfolio-level.
- Sensitivity analysis. The impact of various sensitivities scenarios on program savings and portfolio metrics are presented.
- System impacts. Savings are presented in terms of *cumulative* savings to provide an assessment of system-level impacts of efficiency savings.

2.1.1 Approach

The market potential for EE is assessed using the Dunsky's Demand and Energy Efficiency Potential (DEEP) model. DEEP employs a bottom-up modelling approach that assesses thousands of "measure-market" combinations, applying program impacts (e.g., incentives and enabling activities that reduce customer barriers) to assess energy savings potentials across multiple scenarios. Rather than estimating potentials based on the portion of each end-use that can be reduced by energy saving measures and strategies (often referred to as a "top-down" analysis), the DEEP's approach applies a highly granular calculation methodology to assess the energy savings opportunity for each measure-market segment opportunity in each year.

DEEP estimates interactive effect impacts for measures that may have material impacts on secondary fuel usage (e.g., the installation of LEDs leading to increased fuel oil usage from space heating systems since LEDs produce less heat than incandescent or halogen bulbs). Interactive effect impacts are included within each fuel-specific savings stream (i.e., electric savings from measures that indirectly increase or decrease electricity consumption are accounted for under electric program savings). The interactive effect impacts

can be found in Appendix D, which provides detailed results for measures at the end-use level for each savings stream. A more detailed description of the methodology can be found in Appendix A.

Benchmarking EE Results

To provide additional context to the study results, this chapter compares results to savings achieved by efficiency PEI in program year 2019/20, which are taken from a recent set of program evaluation reports. These reports provide final efficiency savings achieved for the entire 2019/20 program year.

2.1.2 Program Scenarios

The EE module explores three achievable program scenarios as described in Figure 2-1. In many areas of the report the Mid incentive scenario is the focus as it represents a reasonable level of growth for programs on PEI.





The BAU scenario is designed to emulate savings that may be achieved under incentive levels and enabling activities indicative of efficiency PEI's current programs albeit with measures and technologies that may not be currently offered by existing programs. In addition, the BAU scenario includes three additional programs not previously offered in efficiencyPEI's portfolio: Home Energy Reports, Appliance Recycling, and the recently established Community Energy Solutions program. The Mid scenario increases average incentive levels to at least 75% of incremental costs¹¹ for all programs but maintains the same level of enabling

¹¹ Incentives are applied to the incremental cost of a new, more efficiency measure. The incremental cost is the difference between the baseline technology and the new measure.

activities (see Chapter 1 for more information on program enabling activities). Finally, the Max scenario increases incentives to 100% of incremental costs so that customers do not pay any additional cost for efficient technologies while maintaining the same enabling activities assumed in the BAU scenario.

As noted, enabling activity impacts are treated as a sensitivity, which allows for a high-level assessment of the savings, and associated costs, resulting by applying enhanced enabling activities. See Section 2.4 for more details and the results of the comparative analysis.

For a more complete description of program characterization and assumptions underlying each scenario, please see Appendix C.

2.2 Program Savings

Figure 2-2 presents cumulative savings over the first three-year period of the study (2021-2023). Cumulative savings over the entire 10-year study period are included in the figure, below, and in Appendix D. The study estimates that, over the initial study period, the achievable scenarios capture approximately 23% (BAU) to 48% (Max) of the economic potential.¹² This is reasonable given what is seen in other jurisdictions and suggests that there is room to grow programs to realize a larger portion of the economic savings. It is important to note:

- These are incentive-only scenarios As discussed above, enabling activities have been held constant at current program levels. The addition of enabling activities above business as usual explored in the sensitivity analysis in section 2.4 further drives adoption and increases energy savings by 17% under the Mid Incentive + Enabling (half step) and 36% under the Mid Incentive + Enabling (full step) on average over the first three years.
- Max incentives under a PAC screen does not necessarily result in max savings Using the PAC test to screen for cost-effectiveness with 100% incentives reduces the number of measures that pass the cost-effectiveness screen. This approach does not optimize potential achievable savings. For this reason and diminishing returns from higher incentives we see a Mid and Max scenario that are close in terms of total savings.
- Economic savings at 99% of technical savings: Most measures pass the cost-effectiveness screen. This close agreement is somewhat an artifact of the study parameters, where only measures that are commercially viable were characterized for the model.

¹² See Appendix A (section A.4.1) for a discussion of technical and economic potential.

Figure 2-2. Cumulative Electric Savings by 2023 (All Scenarios)



As shown in Figure 2-3, below, the study estimates that efficiency programs can procure an average of 208 GWh (BAU) to 477 GWh (Max) of incremental lifetime savings per year over the first three years (2021-2023) or an average of 157 GWh (BAU) to 355 GWh (Max) of incremental lifetime savings each year over the entire ten-year study period. As shown in Figure 2-3, incremental lifetime savings remain relatively stable across the first three years of the study period – fluctuating by ~ 0.5-2.5% year-over-year.¹³ Starting in 2024, incremental lifetime savings begin to decline more rapidly for reasons explored below. To note the second five-year period (2026-2030) is reported as average incremental lifetime savings over that period.

¹³ The average increment lifetime savings over the first three years of the study ranges from 250 GWh (BAU) to 529 GWh (Max).





The decline in savings – which is also true for incremental annual savings – is being primarily driven by the fact that the lighting market is transforming. By 2026, it is assumed that all residential lighting opportunities will become exhausted, as LED bulbs become the baseline technology option. In the C&I sector, as the market becomes more saturated with LEDs there are fewer opportunities to generate new savings from replacing T8 and T12 linear lights.

In addition to lighting, we also see a degree of decline over time in savings from retrofit measures that are added to buildings, such as insulation. This is primarily an artifact of the model diffusion curve, that reflects the ability of programs to aggressively pursue these additional opportunities in the initial years. In reality, these savings could be equally distributed across all years in the study, depending on program goals and designs.

Table 2-1, below, summarizes the incremental lifetime and annual savings over the first three years of the study period, as well as the 2021-2023 averages. As a percent of annual sales, these scenarios represent, on average over this period, a 1.0% reduction (BAU), 1.9% reduction (Mid), and a 2.2% reduction (Max) in electricity use. As a point of reference, efficiencyPEI achieved a 0.3% and 0.5% reduction in electricity use as a percent of sales in program years 2018/19 and 2019/20. To note, the C&I sector is driving the difference between the BAU scenario and evaluated 2019/20 results due to: 1) the addition of new measures not currently in or going through existing programs; 2) new savings opportunities beyond current programs; and 3) the addition of the Community Energy Solutions program.

The higher savings scenarios approach or exceed PEI's goals of 2% annual electricity savings, and as demonstrated in Section 2.4, the addition of enabling activities delivers even more savings thus allowing efficiencyPEI to achieve the provincial policy target under the Mid scenario.

Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023)

Program Savings	Scenario	2021	2022	2023	Average
Incremental Lifetime Savings (GWh)	BAU	209.1	209.1	206.1	208.1
	Mid	414.4	412.2	400.6	409.1
	Max	481.9	482.1	468.3	477.4
	Mid + Enabling	565.8	561.0	542.3	556.4
Incremental Annual Savings (GWh)	BAU	15.3	16.0	16.4	15.9
	Mid	29.1	29.6	29.2	29.3
	Max	33.3	33.9	33.3	33.5
	Mid + Enabling	39.3	39.6	38.6	39.2
% of Annual Sales	BAU	1.0%	1.0%	1.0%	1.0%
	Mid	1.9%	1.9%	1.9%	1.9%
	Max	2.2%	2.2%	2.1%	2.2%
	Mid + Enabling	2.6%	2.6%	2.4%	2.5%

In terms of peak demand reduction stemming from efficiency measures, incremental annual savings range from an average of 4.5 MW (BAU) to 9.0 MW (Max) across the first three years as shown in Figure 2-4. The cumulative annual demand savings by 2023 are approximately equal to 4.6% to 9.0% of the 300 MW of forecasted load in 2023.


Figure 2-4. Electric Demand Incremental Annual Savings from Efficiency Measures by Year (All Scenarios)

Note: The above figure represents passive demand reductions from EE measures and does not include active demand response.

2.2.1 Program Savings by Market Sector

Based on incremental lifetime savings, the C&I sector accounts for on average 53% of savings across all scenarios, as shown in Figure 2-5, while the residential sectors accounts for approximately 47% of savings over the first three-year period. The savings breakdown closely tracks the sectors' relative portion of overall electricity consumption on the Island, which was forecast to be roughly 50/50 in 2021.¹⁴

There is essentially no difference when the share of overall electric savings by sector is measured in terms of incremental annual savings – commercial sector BAU scenario is 47%, Mid is 52%, and Max 54%.

¹⁴ Maritime Electric 2019 General Rate Application (November 2018). Schedule 7-3. Available at: https://www.maritimeelectric.com/media/1424/2019-general-rate-application-filed-november-30-2018.pdf



Figure 2-5. Proportion of Electric EE Savings by Sector (Average Incremental Lifetime Savings (2021-2023; All Scenarios)

At the segment level, the single family, industrial/agriculture, and office segments represent the bulk of electric EE savings. Under the Mid scenario, nearly 75% of all electric energy efficiency savings come from these three segments (see Figure 2-6). Low income and retail round out the top five segments for electric EE savings and represent 85% of total savings.

To note, these results are indicative of general trends. There were some challenges mapping consumption data to segments based on the data received and thus a level of uncertainty with respect to the balance of savings between the various segments. As such the savings by segment should be considered directional and not absolute.



Figure 2-6. Electric EE Savings by Segment (Average Incremental Lifetime Savings (2021-2023); Mid Scenario; GWh)

2.2.2 Residential Program Savings by End-use

In the residential sector, the single-family segment dominates with a 70% share of the savings, followed by low-income (21%) and multi-family (9%).

Figure 2-7. Residential Electric Average Lifetime Savings (2021-2023) by Segment, All Scenarios



Table 2-2 presents the savings breakdown by program and scenario. Where possible, the savings are compared to evaluated results from efficiency PEI's current programs. The primary takeaway is that

insulation, equipment, and new constructure are emerging opportunities. The following is also noteworthy:

- Energy Efficient Equipment sees a reduction in savings in the BAU scenario compared to evaluated results since evaluated savings used baseboards as the baseline whereas this study uses a mix of baseboards and heat pumps in the baseline. In addition, the BAU, Mid and Max scenarios are essentially the same as we have held heat pump incentives constant between the scenarios based on discussions with efficiencyPEI.
- The Instant Energy Savings program is approximately 97% lighting and returns lower BAU savings on account of a much lower NTG ratios used in this study compared to the evaluation.
- Winter Warming and Home Comfort all have 100% incentives starting in the BAU scenario, which explains why the savings levels are the same between the scenarios (as incentives are the only variables in these scenarios). Moreover, we applied full distribution for the Home Energy Report measure under all scenarios.

	2019-20 Results (GWh)	BAU (GWh)	Mid (GWh)	Max (GWh)
Energy Efficient Equipment	38	21	20	22
Home Insulation Rebates	16	18	35	36
Instant Energy Savings	21	16	31	29
New Home Construction	24	23	70	100
Winter Warming	4	7	7	7
Home energy report	-	5	5	5
Appliance recycling	-	0	14	13
Home Comfort	-	9	9	9

Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All Scenarios, GWh

For the residential sector, incremental lifetime savings are distributed among multiple end-uses with over half (58%) coming from envelope measures (of which roughly 70% is new construction) under the Mid scenario. The bulk of the remaining saving come from HVAC (17%) and appliances (13%) – although as seen in Figure 2-8, the measures contribution to total savings varies depending on the scenario. To note, lighting savings do not change among the scenarios as the measure is already covered by 100% incentive starting in the BAU scenario.

With respect to New Home Construction, the relatively high level of savings reflects the recent and rapid trend in population growth and new housing starts on the Island.^{15,16} However, a slowdown in new

¹⁵ PEI 46th Annual Statistical Review (2019). "The Canada Mortgage and Housing Corporation (CMHC) estimate that there were 1,504 new housing starts on Prince Edward Island in 2019. This is up by 415, or 38.1%, from 2018 and the largest number of housing starts since 1927."

¹⁶ The residential growth rate used in the model is 1.23% per year applied to 2019 base year consumption data provided by Maritime Electric.

construction would lead to a reduction in savings potential. It is also worth noting that a slowdown in housing starts would have an impact on other measures that have an adjustment factor based on new construction. In general, the results signal a strong response from incentives, but we note that this program will likely also benefit from an investment in enabling activities to overcome other non-economic market barriers.



Figure 2-8. Residential Electric EE Savings by End-use Average Incremental Lifetime Savings (2021-2023; All Scenarios)

The following provides a breakdown of the top ten measures in terms of average annual and lifetime savings under the Mid scenario. As can be seen, there are important differences between looking at savings from the perspective of annual versus lifetime. For example, new home construction and other longer lasting envelop measures (shaded in blue) are much more prominent when considered on a lifetime basis.



Figure 2-9. Top 10 Residential Measures – Avg. Annual (left pie) and Lifetime (right pie) (2021-2023; Mid Scenario; GWh)

Note: Envelope measures and DMSP measures are grouped by the same colours.

Home Energy Reports

This behavioral measure provides an outsized proportion of residential incremental annual savings relative to their portion of residential incremental lifetime savings. The reason for this difference is that savings from home energy reports only persist for one to three years under the assumption that savings would dissipate in the event the program is discontinued. For other technologies, such as efficient furnaces or air conditioners, savings incentivized through a program will continue to exist even if the program is discontinued later.

It is also important to note that while home energy reports generate direct savings through behavioral changes, they are also an effective enabling strategy to drive uptake of other efficiency measures, which is not explicitly quantified in this study.

The prevalence of envelope measures – new construction as well as insulation and air sealing – in the top ten measures suggest an important opportunity for Prince Edward Island. As noted above, a significant amount of the potential is predicated on the continuation of the current growth in new housing. There is also an opportunity for continued savings by incentivizing the use of high-efficiency ductless mini-split heat pumps (DMSHP) at current levels. Heating systems such as DMSHP have long useful lives, therefore incentivizing the purchase and optimal use of more efficient systems results in significant incremental lifetime savings.

Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023); Mid Scenario)

Measure	Description	GWh
New Home Construction	The construction of new homes that achieve ENERGY STAR certification, or R2000 certification.	70
Electric Resistance Heating to DMSHP	The installation of a DMSHP to displace heating from an electric resistance heating system (baseboards)	14
Attic Insulation	The installation of additional insulation in the attic/ceiling	10
Basement Insulation	The installation of additional insulation to basement walls	13
Air Sealing	Thermal shell air leaks are sealed through strategic use and location of air-tight materials	8
Ductless Mini-split Heat Pump (DMSHP) – Cold Climate	The installation of a high efficiency cold-climate DMSHP instead of a standard DMSHP in a) homes with existing DMSHP, or b) homes that were planning on installing a standard DMSHP.	17
LED A-Lamp (Interior)	The installation of LED A-lamps instead of incandescent or CFL lamps.	10
Home Energy Report	A report sent to customers that displays home energy consumption in comparison with peers and prompts energy conserving behavior	5
LED Reflector (Interior)	The installation of LED reflectors instead of incandescent lamps.	3
Duct Insulation	The addition of insulation to uninsulated ducts located in unconditioned space.	2

2.2.3 C&I Program Savings by End-use

In the C&I sector, industrial/agriculture and offices are the most important segments. Under the Mid scenario, industrial/agriculture and offices both account for 34% of average lifetime savings per year. These are followed by retail (7%), grocery/restaurant (6%), and other commercial (5%). In general, the savings are driven by lighting and motors although building envelope and HVAC also provide important contributions.





In general, the results of this study show that there is significant potential in the C&I sector in both the existing Business Energy Rebate and the planned Community Energy Solutions programs. This is responsible in large part for the significant difference between the 2019/20 evaluated results and the BAU scenarios (see Table 2-4).

Table 2-4. C&I Electric Evaluated Results and Average Lifetime saving	s (2021-2023) by Program, All Scenarios
---	---

	2019-20 Results (GWh)	BAU (GWh)	Mid (GWh)	Max (GWh)
Business Energy Rebates	19	63	123	142
Community Energy Solutions	-	46	93	115

Approximately half of average incremental lifetime electric efficiency savings over the first three years come from lighting measures (see Figure 2-11). Motors and compressors also offer meaningful potential, driven largely by the industrial/agricultural segment.



Figure 2-11. C&I Electric EE Savings by End-use Average Incremental Lifetime Savings (2021-2023; All Scenarios)

Noteworthy from these results:

• C&I lighting remains by far the largest opportunity, both in terms of annual and lifetime savings. While Tubular LEDs (TLEDs) are becoming a more and more important commercial lighting technology, there has not yet been the same level of market transformation as has been seen with A-Lamps and specialty bulbs. As a result, programs that incentivise efficient commercial lighting technologies are expected to continue to offer significant potential over the study period.

However, C&I lighting is saturating and therefore there is lower turnover per year as LEDs have longer EULs. It is likely that future evaluation reports may show declining NTGs as Linear LEDs become the norm in the market.

 Refrigeration is low due to availability of data. The model includes a small number of prescriptive measures that target refrigeration. This study does not include any custom HVAC measures because these are quite dependent on the jurisdiction, and without in-depth market research or historical data to leverage, there would be high uncertainty around the measure. It is likely that, for example the addition of agriculture specific refrigeration measures, would further increase savings in this end use.

Lighting and lighting control measures are four of the top ten C&I electric efficiency measures as shown in Figure 2-12. The remaining six measures in the top 10 list relate to a mix of end uses, including HVAC, motor controls, and envelope.

Figure 2-12. Top 10 C&I Measures – Avg. Annual and Lifetime (2021-2023; Mid Scenario; GWh)



Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario)

Measure	Description	GWh
LED Luminaire	The installation of an LED in a luminaire lighting fixture	63
Linear LED Tube	The installation of an LED in a linear tube lighting fixture	14
LED High Bay	The installation of an LED in a high bay lighting fixture	12
Energy Management System (EMS)	The installation of system to more efficiently manage energy consuming equipment and activities within a building	11
Lighting Controls (Interior), Occupancy	The installation of a device to turn lights on/off in the presence/absence of room occupants	10
Motor Controls – Pump	The installation of VFDs and synchronous belts for motors used for hydraulics.	10
Motor Controls – Process	The installation of direct digital controls and synchronous belts for motors used for other processes.	9
Roof Insulation	The installation of additional insulation to a flat roof.	8
Mini-split Ductless Heat Pump (DHP) – Cold Climate	The installation of a high efficiency cold-climate DMSHP instead of a standard DMSHP in a) buildings with existing DMSHP, or b) buildings that were planning on installing a standard DMSHP.	8
HVAC VFD – Fan	The installation of VFD on an HVAC fan.	6

Lighting will continue to play an important role in C&I programs over the study period. These savings are concentrated among four measure groups – LED Luminaires, Linear LED Tubes, LED High Bays, and Lighting Controls – as shown in Figure 2-13.

While markets are shifting for luminaires and tubes toward more common adoption of TLEDs, advanced lighting controls, including networked lighting, is a growing opportunity as new technologies and products integrate efficiency savings with increased functionality and non-energy benefits. These offer an emerging opportunity that also faces notable challenges including limited cross-compatibility among products from different manufacturers, limited customer awareness of the options and benefits, and timing re-lamping efforts with controls change-outs. Achieving the potential savings from advanced lighting controls will likely require investment to identify the most effective delivery strategies and tracking product development and roll out.



Figure 2-13. Proportion of C&I Lighting Savings by Measure Type (2021-23 Average Incremental Lifetime Savings; Mid Scenario)

2.3 Portfolio Metrics

Overall, the study shows there is significant potential for energy efficiency on Prince Edward Island. As A-Lamps and specialty lighting markets transform, the heat pump market becomes more saturated, and efficiencyPEI ramps up efforts in new areas, program delivery, costs, and impacts will be affected. This section provides high-level estimated cost and benefit projections for the achievable potential scenarios. While these projections may offer a valuable directional assessment of program opportunities and the associated costs over the study period, these are largely informed by past program designs and performance on PEI. However, as the efficiency technology mix evolves, and new delivery approaches are required, the actual costs and program balances could vary significantly from these projections and could be higher or lower.

2.3.1 Program Costs

The study estimates that efficiency program costs will range between an average of \$5.9 (BAU) to \$23.8 (Max) million dollars per year over the first three years of the programs.¹⁷ Under these incentive-only scenarios, program costs rise steeply between the achievable scenarios. We note that efficiencyPEI's budgets come from multiple sources, including ratepayers, the Province, and increasingly from federal funds such as the Low Carbon Economy Fund.





Note: Electric portfolio costs include incentive and administration (fixed and variable costs).

¹⁷ efficiencyPEI's approved budget for the 2019/20 fiscal year was \$4,660,785, including Enabling Strategies and Evaluation. This is for all fuel types. A total of \$2,630,281 was actually spent in that year due to lower-than-expected participation in two programs and because two of three commercial programs were not launched.

Table 2-6, below, provides a budget breakdown by sector and scenario over the first three years.

Portfolio	Scenario	2021	2022	2023	Average
	BAU	4.4	4.5	4.5	4.4
Residential	Mid	10.4	10.4	10.1	10.3
	Max	12.6	12.6	12.	12.5
C&I	BAU	1.5	1.5	1.4	1.5
	Mid	7.5	7.5	7.2	7.4
	Max	11.3	11.6	11.1	11.3
	BAU	5.9	5.9	5.9	5.9
Total	Mid	18.0	17.9	17.3	17.7
	Max	23.9	24.2	23.3	23.8

Table 2-6. Estimated Sector Costs by Year (All Scenarios)

The average unit cost of savings increases as well under the Mid and Max scenarios as presented in Table 2-7. Marginal costs per unit savings grow substantially between BAU to Mid and to a lesser extent between Mid and Max. Under the BAU scenario, first-year costs are \$0.379 per annual kWh and increase to \$0.605 and \$0.710 per kWh under the Mid and Max scenarios, respectively. For comparison, efficiencyPEI's first year portfolio level costs were \$0.325 per annual kWh for the 2019/20 fiscal year. The cost per lifetime kWh saved (i.e., the cost of the energy efficiency savings over the lifetime of the measures) is much lower - \$0.028 per kWh (BAU), \$0.048 per kWh (Mid), and \$0.050 (Max).

Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios)

Metric	BAU	Mid	Max
\$ per Annual kWh (First year cost)	0.379	0.605	0.710
\$ per Lifetime kWh	0.028	0.048	0.050

These results are to be expected as costs will typically increase as incentives are raised and more customers participate in programs under the Mid and Max scenarios. The unit cost of savings will increase as well for two primary reasons. First, raising incentives increases the cost not just for newly acquired savings, but also for savings that would have been obtained under lower incentive levels and thus at a lower per unit cost. Second, the higher incentives may drive more uptake of measures with higher unit savings costs associated with their lower savings to incremental cost ratios. However, the precise magnitude of cost increases under these scenarios should be interpreted with the following caveats:

Cost estimates are based on historical cost data. Fixed and variable program cost inputs were developed based on historical spending data for efficiencyPEI's efficiency programs in 2018/19 and 2019/20. These inputs do not vary over the study period to account for factors that may increase costs (e.g., higher labor or technology costs as programs increased demand for specific services and/or equipment drives up prices) or decrease costs (e.g., lower program implementation costs as programs mature and become more efficient or employ new delivery strategies). For example, program administrators have historically placed emphasis on creating cost-effective lighting

programs as this is where the majority of savings were found. However, as lighting savings decrease, programs administrators will likely begin focusing more on programs offering non-lighting savings, which will impact program implementation effectiveness and costs relative to current implementation practices today.

• The program scenarios are not optimized for program spending. For each achievable scenario in the DEEP model, incentives levels are set at the program level as a portion of the incremental costs for each eligible measure in the program. However, a real-world program design would likely set unique incentive levels for each measure, applying higher incentive levels for measures that may have had limited uptake in the past, and maintaining or lowering incentive levels for measures that meet their expected adoption. The text box below describes how a more granular approach to incentive setting could lead to significantly lower program spending at minimal expense of reducing savings.

The exception in this is analysis is DMSHPs. Based on discussions with efficiencyPEI it was determined that current DMSHP incentive levels already cover a high portion of the incremental cost of efficient heat pumps (and there has been rapid penetration of the measure to date). Dunsky therefore held these incentive levels constant at current levels among all scenarios.¹⁸.

In addition, as discussed elsewhere in the report, the budgets reflect incentive-only scenarios. Program design optimization – increasing enabling activities along with targeting incentive to key measures – can help right-size program budgets.

DEEP's Adoption Methodology and Optimizing Program Savings

The DEEP model calculates market adoption as a function of customer payback and a technology's underlying market barrier level. Increasing incentives will improve the customer payback, pushing a measure further to the right along the adoption curve. However, because the adoption curve is not linear, the degree of market reaction will depend on where the measure sits on its allocated adoption curve. This means increasing incentives for measures on the lower end of the adoption curve will result in much greater proportional increase in adoption compared to measures at the higher end of the adoption curve.

Figure 2-15 illustrates this effect. In this example, consider two theoretical measures, Measure 1 and Measure 2. Both are offered within the same program and share the same barrier level assignment, meaning they follow the same adoption curve. Due to differences in the relationship between the incremental costs and the energy savings of the two measures, each sits at a different point on the adoption curve. Measure 1 starts at point A, indicating that the customer payback is not sufficient to drive the majority of potential customers to adopt this technology. Measure 2 has a much higher ratio of energy savings to incremental costs, and thus it sits at point C, wherein most customers will likely adopt the efficient option.

¹⁸ While comprehensive, potential studies are high-level in nature and do not account for different equipment between manufacturers. It is possible that the incremental costs of efficiency DMSHPs may vary significantly among manufacturers, and further market research could reveal opportunities to adjust incentive levels in future program designs.

As incentives are increased for both measures, the customer payback is increased, and moving both measures up and to the right along the adoption curve (to Points B and D for Measures 1 and 2, respectively). As can be seen from the figure, this results in a significant increase in adoption for measure 1, which is in the steep part of the adoption curve. However, for Measure 2 the incremental change in adoption is minimal, despite the increased incentives. Ideally, an optimized program design would target Measure 1 for an increased incentive but may not change incentive levels for Measure 2 and would prioritize driving incremental savings from Measure 2 through enabling strategies, marketing, and/or novel delivery pathways rather than through additional incentives.





In this study, the impact of this non-linear relationship between incentive costs and savings achievement described above will be particularly pronounced under the Max scenario. Since all measures receive a 100% incentive under the Max scenario, every measure will traverse the higher-end of the adoption curve where incremental increases in incentive payments will induce progressively smaller incremental increases in customer adoption and savings. For this reason, cost estimates under the Max scenario in particular likely significant overstate the cost per unit of savings that could be achieved under an optimized portfolio approach.

2.3.2 Cost-Effectiveness

Table 2-8 presents the PAC ratios at the end of the three-year period (2023) by program and scenario. All programs are cost effective under each of the savings except for the lighting portion of the Instant Energy Savings program. It should be noted, however, that Instant Energy Savings – lighting does pass the TRC test under all scenarios with a benefits/cost ratio of 1.27, which suggests that there may still be a rationale for including residential lighting measures in the portfolio.

Sector	Program	BAU	Mid	Max
	Energy Efficient Equipment	2.8	2.6	2.6
	Energy Efficient Equipment - Low Income	1.7	1.6	1.2
	Home Insulation Rebates	1.6	1.1	1.3
	Home Insulation Rebates - Low Income	1.2	1.2	1.2
	Instant Energy Savings - lighting	0.5	0.5	0.5
Residential	Instant Energy Savings - other		1.1	1.0
	New Home Construction		1.4	1.1
	Winter Warming	2.4	2.4	2.4
	Home energy report	2.4	2.4	2.4
	Appliance recycling	4.1	1.3	1.2
	Home Comfort		1.4	1.4
Commercial and	Business Energy Rebates		2.8	2.1
Industrial	Community Energy Solutions	4.7	1.9	1.5

Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios)

2.4 Sensitivity Analysis

The sensitivity of the efficiency potential results is tested against three key factors as described in Table 2-9. The first sensitivity assesses the impact of investing further in enhanced enabling activities on program savings and costs. The other sensitives explore the impact of economic factors on the achievable potential by assessing the impact of increases or decreases in retail electricity rates and avoided cost forecasts. Each sensitivity is tested against the Mid scenario, but the impacts under the BAU and Max scenarios is expected to be similar in relative magnitude.

Table 2-9. EE Module Sensitivity Descriptions

Sensitivity Scenario	Baseline	Sensitivity
Enabling Activities	Adoption barrier levels are set to reflect current program enabling activities.	For the Mid energy efficiency scenario, barrier levels are reduced by a half step and a full step impacted adoption under enhanced enabling activities.
Retail Rates	Retail electricity rates are forecasted in line with current best information.	Forecasted retail electricity rates are increased/decreased by 10% impacting bill savings associated measures that impact energy consumption.
Avoided Costs	Energy and capacity avoided costs are forecasted in line with current best information.	Forecasted avoided energy costs are increased/decreased by 10% to account for possible new spending or reduced future energy and/or capacity costs.

2.4.1 Enabling Activities

Up to this point, the achievable potential scenarios in this study have explored the impact of increased incentive levels to drive further savings from the efficiency programs. However, efficiencyPEI's programs have been offered for only a few years, and there is an ongoing interest adapt and enhance its program strategies, which suggests that there may be opportunities to incorporate further enabling strategies into the programs to help drive further savings.

Enabling strategies that help overcome participant barriers to participating in efficiency programs include, but are not limited to:

- Direct install programs
- Contractor training and support
- Upstream programs
- Targeted marketing
- Building and home energy labeling requirements
- Financing programs

The program scenarios assessed in this study capture the impact of current program strategies applied by efficiencyPEI by calibrating the BAU scenario achievable potentials to current portfolio savings. The potential impact of investing further in enabling strategies is assessed under this sensitivity scenario, using the Mid incentive scenario.

Where possible, barrier level reductions are applied to capture the impact of additional enabling activities not already included incurrent efficiencyPEI programs. While the potential study does not identify the specific enabling strategies engaged or the associated barriers addressed, the results are intended to provide a quantitative assessment of additional savings that can be unlocked through enabling strategies.

Two sensitivities were tested, 1) moderate enabling strategies – represented by a half step barrier reduction, and 2) extensive enabling strategies – represented by a full step barrier level reduction.¹⁹ In terms of the cost of the enabling strategies sensitivities, for the moderate enabling strategies variable program administration costs were increased by 25% and fixed costs by 15%. For the extensive enabling strategies scenario, variable program administration costs were increased by an additional 5% and fixed costs by an additional 10%.²⁰ More detail on program characterization and enabling activities can be found in Appendix C.

The addition of enabling strategies further drives achievable scenarios, with the half step reduction in barriers increases the Mid scenario to be nearly equivalent to the savings achieved under the Max Incentive scenario (i.e., 2.2% of sales over the first three-year period). The full step reduction in barriers brings the Mid scenario above the Max, and translates into approximately 2.5% of sales, on average, over the first three years.





As shown in Table 2-10, the \$ per annual kWh saved is higher in the sensitivities compared to the Mid Incentive scenario, but lower than the Max Incentive scenario. By increasing the enabling activities and reducing barriers by a half step, PEI can access more savings at lower cost – i.e., achieve just over the Max scenario but with \$1.9M less investment. Increasing enabling activities further and reducing barriers by a full step surpasses the Max scenario in terms of savings as well as budget. While the marginal costs

¹⁹ A half step barrier reduction reflects a move to a higher adoption curve and thus assumed level of participant uptake. This would be a notable investment in enabling strategies, and a full step – moving to an even higher adoption curve – would represent a reasonable limit of what could be achieved by applying a full range of enabling strategies. See Appendix A for additional details. ePEI's programs are relatively new and therefore it is reasonable to assume that additional enabling activated can be leveraged. As noted above, the assessment does not consider specific enabling activities, but these may include direct install programs, contractor training and support and/or the others listed on the previous page.

²⁰ The full step reduction requires a highly targeted approach, including working more closely with the industry conducting the retrofits. In this case there is a stronger link to volume as opposed to setting things up (i.e., general marketing, structure for a trade ally network, etc.) and thus variable costs increase more than fixed.

for the Mid Incentive + Extensive Enabling Strategies are lower, because the scenario is achieving that much more savings the resulting budget is higher than the incentive-only scenario.

Scenario	Average Annual Cost (\$Million)	Average Annual Savings (GWh)	Average Annual Cost per Savings (\$ per annual GWh)
BAU	5.9	15.9	0.37
Mid	17.7	29.3	0.60
Mid + Enabling (half step)	21.9	34.1	0.64
Mid + Enabling (full step)	26.5	39.2	0.68
Max	23.8	33.5	0.71

Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings under the Achievable Scenariosand Sensitivities (2021-2023)

2.4.2 Electric Rates & Avoided Costs

In theory higher electricity rates will drive greater participation in efficiency programs, while lower electricity rates should reduce participation. This change is participation is driven entirely by the change in the financial attractiveness of efficiency measures for customers due to more (or less) expensive retail electricity rates. The change in retail rates impacts bill savings and the cost-effectiveness test used to calculate adoption.

Higher avoided costs will also lead to greater achievable potential as energy savings become more costeffective, increasing benefits, and therefore resulting in more measures passing the cost-effectiveness test screen. Conversely, lower avoided costs will likely screen out more measures, thus reducing potential participation and savings. However, since almost all measure pass the PAC test and the +/-10% adjustment will only impact a limited number of measures, the impact from the avoided cost sensitivity should be less pronounced than that of changes to rates.

Figure 2-17 shows the change in *average lifetime electric savings* (2021-2023) relative to the Mid scenario baseline savings value (409 GWh) under the rate and avoided cost sensitivity scenarios. Reducing electricity rates by 10% resulted in a reduction in savings of 12 GWh while a 10% increase in rates increased savings by 11 GWh. The avoided cost sensitivity had less of an impact; 3 GWh fewer savings under lower avoided costs, although a comparatively larger impact – 8 GWh more savings – when avoided costs are raised by 10%.

Figure 2-17. Impact of Electric Rate and Avoided Cost Sensitivities on Average Incremental Lifetime Savings Compared to Baseline (2021-2023; Mid Scenario; GWh)



Figure 2-18 shows the impact on *average annual savings* (2021-2023) relative to the Mid scenario baseline. Each figure includes the impact from a 10% increase or decrease in rates as well as a 10% increase or decrease in avoided costs. The Mid scenario base savings level (GWh) is included as a reference point. The results follow a similar trend to the lifetime savings impacts above.

Figure 2-18. Impact of Electric Rate and Avoided Cost Sensitivities on Average Incremental Annual Savings Compared to Baseline (2021-2023; Mid Scenario; GWh)



Table 2-11 includes the values for average annual lifetime and annual savings (2021-2023) under the rate and avoided cost sensitivities as well as the percent difference relative to the Mid scenario.

	Average Lifetime Savings, 2021-2023 (GWh)			Average Annual Savings, 2021-20 (GWh)		
	Mid	Low Value (-10%)	High Value (+10%)	Mid	Low Value (-10%)	High Value (+10%)
Electricity Rates Sensitivity	409	397	420	29.3	28.5	30.0
% Difference		-3%	+3%		-3%	+2%
Avoided Costs Sensitivity	409	406	417	29.3	28.9	29.9
% Difference		-0.7%	+2.0%		-1.4%	+2.0%

 Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 10% Rate and Avoided Costs

 Sensitivities

The results indicate that increasing or decreasing electricity rates or avoided costs does lead to the expected increase or decrease in electricity savings, program costs, and customer benefits. Changing customer rates has a larger impact as the economics become more or less favourable for potential participants and impact adoption. Avoided costs have less of an impact, especially since most of the measures included in the model are likely to already be cost effective. The results indicate that a limited number of measures are on the margin (i.e., have benefits costs ratios around 0.90 to 0.99).

2.5 Agricultural Sector Savings

Representing approximately 43% of the Prince Edwards Island's land-use, the agricultural sector is an integral part of PEI's economy and many Islanders' livelihoods. The size and nature of the industry also makes it a significant consumer of energy. Energy is consumed in every stage of agricultural production: from lighting greenhouses to running tractors to heating and cooling buildings.

Reducing the amount of energy consumed by the sector can reduce operating costs, increase local profits, and reduce greenhouse gas emissions. This can be accomplished by increasing the adoption of energy-efficient equipment upgrades (e.g., motors, pumping, and HVAC system). Yet despite the potential benefits, the agricultural sector is often subject to substantial market barriers to energy efficiency and as a result this sector is typically underserved by efficiency programs. These include a lack of awareness of energy-efficient technology, underestimating equipment lifetime energy costs, and limited access to the capital needed to implement efficiency upgrades.

While it was beyond the scope of this Potential Study to perform a detailed bottom-up assessment of energy efficiency measures on PEI's agricultural sector, this assessment shows that this sector offers significant potential for efficiency program savings. This chapter is intended to offer initial insights that can be leverage for future work by efficiencyPEI and others, including in the design of comprehensive energy efficiency programs for farms of all sizes and configurations.

A high-level review of energy efficiency measures in the agricultural sector is provided based on a literature review of leading agricultural efficiency programs in other jurisdictions. Moreover, a comparison of the achievable savings assessed in this study, where the Industrial and Agricultural sectors were modelled together as a single market segment, are compared to results from potential assessments that included a dedicate agricultural segment in the analysis. This is intended to give a directional indication of whether the combined Industrial/Agriculture segment savings provide valid savings targets for PEI's agricultural sector.

2.5.1 Limitations to the Agricultural Sector Assessment

There are several important limitations that impacted our ability to assess the potential in the agricultural sector:

- 1. No baseline study was performed for the agricultural sector, and efficiencyPEI does not currently have energy savings characterizations for agricultural measures.
- 2. There is a limited amount of background research available on energy efficiency in the agricultural sector compared to other sectors. Therefore, it was necessary to use findings from other jurisdictions, some of which exhibit notably different markets and climates from that of PEI (e.g., California).
- 3. The potential study is covers electric savings measures only, and while some measures may also provide fossil fuel savings these impacts are not captured here.

As a result, the bottom-up potential assessment detailed in this report, modeled the Industrial and Agricultural sectors as a combined market, and hence it was not possible to differentiate the specific savings attributable to the agricultural sector electric customers in the DEEP model.

2.5.2 Agricultural Market Characterization

The PEI agricultural sector is large, diverse and consists of many different agricultural products, including potatoes, grains and oilseeds, fruits and honeybees, and vegetables. The sector utilized close to 595,000 acres of land and contributed ~ \$278.1 million dollars to the Island GDP in 2019.^{21,22} As a percentage of sales, potatoes make up the majority of crop sales (75%), and a significant amount of total agricultural sales (49%).²³ Therefore, special attention should be given to this crop when performing energy efficiency potential modeling and program design in the agricultural sector.

It is also worth noting that under Maritime Electric's current rate structure the majority of farms – regardless of size – are classified as residential customers. The Island Regulatory and Appeals has requested that Maritime Electric revisit this classification, which will mean many if not most farms will fall under a commercial tariff in the near future.

To best understand the agricultural sector's potential energy efficiency savings, we first split PEI's agricultural sector into segments and end-uses. Energy efficiency measures and programs are often designed to specific segments and end-uses, which will allow for more efficient program delivery and evaluation. See Table 2-12 below for a list of segments and typical agricultural products in those segments. These can be applied in future program designs to target agricultural measures and programs.

Table 2-12. PEI Agriculture Segments and Products by Segment

Segments	PEI Products in Segment
Dairy and Livestock	Poultry, Hogs, Beef and Dairy
Greenhouses	Vegetables, Fruits
Farm Crops	Potatoes ²⁴ , Grains and Oilseeds, Fruit Production and Honeybees, Vegetables

2.5.3 Specialized Agricultural Saving Measures

The agricultural sector applies a range of specialized equipment, much of which offers unique energy savings opportunities for Agricultural Sector focussed efficiency programs. Table 2-13, below, outlines the specific measures identified that may apply to PEI's key agricultural market segments and end-uses.

Many of these overlap with the standard efficiency measures applied in the DEEP model assessment of the combined Industrial/Agricultural segment, but further refinement of these measures to the specific characteristics and usage paters for agricultural applications may reveal further savings in agricultural programs.

²¹ https://www.princeedwardisland.ca/en/publication/annual-statistical-review

²² https://www.princeedwardisland.ca/sites/default/files/publications/af_stat_tab4.pdf. Note GDP in chained 2012 dollars.

²³ https://www.princeedwardisland.ca/sites/default/files/publications/af_stat_tab4.pdf

²⁴ While this list aggregates all farm crops together, due to its size, the potato segment might justify its own segment due to the importance of the product on the market.

Table 2-13. Suggested End-Uses and Technologies²⁵

End-Use	Technology Category	Example Technologies / Behaviors			
Lighting	High-Efficiency LEDs and HPS Upgrades	 Indoor and Linear Fixtures Specialty Lamps Exterior Bulbs Single-ended HPS to double-ended HPS or single metal halide 			
	Lighting Controls	 Occupancy Sensors Daytime Controls Sunlight Optimization 			
	Pumps	 Pump Retrofits VFDs High to Low-Pressure Irrigation Pump Scheduling/Controls 			
Motor / Drives	Air Compressors	 Leak repair Controls VFDs Operation and Maintenance 			
	Other Motors	Other Motor Upgrades / VFDsWaterer Upgrades			
	Ventilation System Upgrades	 High-Speed Fans Circulation Fans Exhaust Fans Variable Speed Drive Fans High Volume; Low-Speed Fans Optimized Fan Placement 			
	Electric Water Heating	 Water Heater Maintenance Efficient Hot Water Heaters Upgrades Heat Recovery Unit 			
HVAC and Water Heating	HVAC	 Optimization and Maintenance Replacing or Adding Insulation Air Sealing Night Curtains (Green Houses) Electronic Thermostats / Humidity Controls Plant Trees (West or Southwest planting for Greenhouses) Natural Ventilation Systems (Greenhouses) Combined Heat & Power (CHP) Systems 			
	Other	Block Heater Timers			
	Process Heating	 Process Controls Efficient Drying Heat Recovery Units Natural Drying 			
Process Heating and Refrigeration	Process Refrigeration	 Efficient Milk Cooling/Harvesting: (e.g., Plate Heat Exchanger; Well Water Pre-Cooler; Scroll Compressors; Heat Recovery Units) Cold Water Pre-Cooling Refrigeration Maintenance/Tune-Up 			
	Cold Storage Improvements	 Floating Head Pressure Controls Evaporator Fan Controls Evaporator Fan Economizers 			

²⁵ This list was vetted and adapted with expert advice given by the EnSave. They provided details to supplement available information found via published secondary sources.

It is important to note that the savings will vary by measure, and that some measures are segment-specific (such as livestock waterers or night curtains) while others have broad applicability throughout all segments (e.g., pumps). It is expected that a few measures will offer particularly importance savings, including VFDs for motors, variable speed fans for drying and air circulation, and block heat timers for tractors and other farm machinery. As noted above, a more detailed review of these measures and the market is needed to enable program design or bottom-up energy efficiency potential modelling.

2.5.4 Benchmarking Agriculture Sector Savings

Table 2-14 below compares the average annual achievable savings from the Industrial/Agricultural segment in the PEI potential study to the achievable savings in agriculture segments in other potential studies. These are compared on the basis of annual savings as a portion of annual consumption in the sector.

Jurisdiction	Period	Average Annual Savings (GWh/year)	Annual Savings as % of Electricity Consumption in Sector		
PEI: Combined Industrial/Agriculture	2021-2023	2.4 – 7.4	0.72% - 2.23%		
lowa	2018-2037	15.0	3.4%		
Wisconsin	2019-2030	19.3	0.78% - 1.28%		
Ontario	2019-2023	22.5	0.5% - 0.78%		

Table 2-14. Jurisdictional Scan of Potential Savings

This assessment shows that the notable efficiency potential on PEI's Industrial/Agricultural sector is aligned with savings assessed in other jurisdictions, and therefore may offer a reasonable range for setting targets for future Agricultural electric efficiency programs on PEI. To design an effective agricultural sector program, further research may be of benefit, including further market research, characterizing specialized measure savings and costs for agricultural applications, and developing enabling strategies that target the specific barriers faced in the agricultural sector.

3 Demand Response

The following chapter presents results for the demand response (DR) module of the Potential Study. The active peak demand reduction potential, herein referred to as DR potential, is assessed by analyzing the ability of behavioral measures, equipment controls and industrial and commercial curtailment to reduce the system-wide annual peak demand.²⁶ A dynamic rate-specific scenario is also included to assess the impact of Time-of-Use (TOU) rates that would be enabled by the possible roll out of advanced metering functionality (AMF) beginning in 2025.

Annual DR potential is modelled over the study period (2021-2030), and the results represent a **net impact** considering all measure interactions with the hourly load curve. The most cost-effective measures are given priority ranking in the DR measure "queue." Once a cost-effective measure is selected by the model, all associated potential for that measure is incorporated before moving on to the next most cost-effective measure. This continues until the DR window peaks cannot be further reduced or shifted without creating new peaks elsewhere on the curve. This has the effect of crowding out some DR measures that are less cost-effective. As we will discuss in the results section, the shape of a jurisdictions' curve has an important impact on the measures pursued and how much DR potential can be captured.

Depending on the demand reduction goal, program design, and technologies used, demand response can have a varying impact on load. In this study we consider measures that either **reduce peak** or **shift consumption** from the peak period to off-peak hours, as outlined in the visual, below.



Peak Reduction

- Reduce system peak with no bounce back
 Measures include dual fuel systems, emergency
- generators, curtailment (e.g. interruption of processes)



Peak Shifting

- Shifting load from on-peak to off-peak periods; overall consumptions stays ~ the same
- Measures such as direct load control Wi-Fi thermostats (to preheat with system compensating when event is over)

²⁶ In all cases in this report, the annual peak demand refers to the hour in the year that exhibits the highest system peak demand in MW. It is assessed on a system-wide basis, not accounting for local constraints across the transmission and distribution system.

3.1 Approach

We applied Dunsky Demand Reduction Optimized Potential (DROP) model to assess the DR potential on PEI. Figure 3-1 provides an overview of the steps applied in this study.

Step one in the DR potential analysis is to define the standard peak day load curve and apply the impacts of load growth projections. The standard peak day curve is based on Maritime Electric's historic system hourly (8,760) load curve and annual peak demand.²⁷ Establishing a standard peak day curve allows the model to assess each measure's net reduction in the annual peak, considering that the new annual peak may occur on a different day or hour than the initial peak due to the way that DR measures alter the utility load curve.

In some cases, this may lead to results that are contrary to initial expectations, especially when DR programs such as dynamic rates or equipment direct load control (DLC) measures are looked at only from the



Figure 3-1. Demand Response Potential Assessment Approach

perspective of how they may impact individual customer peak loads at the originally identified peak hour. A more detailed description of the DR modeling approach applied in this study can be found in Appendix C.

The standard peak day utility load curve is then used to characterize measures and assess the measurespecific peak demand reduction potentials at the technical and economic potential levels. This includes applying **peak shift** (or Type 1) measures such as direct load control water heaters to baseline use and defining the control schemes and adjusted load curves. This also includes applying **peak reduction** (or Type 2) measures such as C&I curtailment wherein curtailable loads are identified and constraints (e.g., number of events per year, event duration) are applied. The optimizer function then determines the overall net impact on annual peak demand.

The final step in the process is to assess the DR scenarios. Similar to energy efficiency, we consider the technical, economic, achievable potential and achievable potential under specific program scenarios. The box on the following page provides a description of each type of potential.

²⁷ Maritime Electric's 8760 load curve from 2019 was scaled by 10% to include Summerside Electric's service territory.

Technical, Economic, and Achievable DR Potential

Technical potential is estimated as the total possible coincident peak load reduction for each individual measure multiplied by the saturation of the measure or opportunity in each market segment.

Economic potential is estimated as the net demand reduction possible from each individual measure when assessed against the utility load curve. It accounts for the difference between the utility peak load before and after the measure is applied, when examining the 24-hour peak day curve and the 8,760 annual hourly curve accounting for individual measure bounce-back impacts or peak time shift impacts.

Depending on the shape of the peak day curve these impacts may create new peaks. For example, a load curve with a relatively high/distinct peak over a few hours (a) offers more opportunity to reduce and shift load without creating a new peak whereas a flatter curve (b) requires targeted measures and can limit DR potential.



The measures are then screened against the PAC Test, and only those that pass the threshold are retained for inclusion in the achievable potential scenarios.²⁸

Achievable potential is assessed under three scenarios by applying mixes of all cost-effective measures and programs, giving priority to the most cost-effective measures first. For each year, the DR potential is assessed accounting for existing programs from previous years, as well as new measures or programs starting in that year. Unlike many efficiency measures, the DR peak savings only persist as long as the program is active. For new and expanded programs, ramp-up factors were applied to account for the time required to recruit participants.

Because DR measures interact via their effects on the utility load curve, technical and economic DR potentials are not considered to be additive and are therefore not presented in aggregate in this report. To ensure that the combined achievable potential results were truly additive in their ability to reduce annual peak loads, combinations of programs were assessed against the hourly load curve to capture inter-program interactions that could affect the net impact of each program. Further details of this approach are provided in Appendix C.

²⁸ For energy efficiency the benefit-cost threshold was set below 1.0 (at 0.8) for low-income programs which is supported by the fact that energy efficiency offers direct customer benefit which LI customer should have access to even though these programs are typically more expense. For DR, there is less direct customer benefit – although all ratepayers benefit from reduced system costs – and thus the same justification for reducing the LI threshold for DR is not supported.

3.1.1 Achievable Scenarios

The achievable potential is assessed under three scenarios corresponding to varied DR approaches or strategies as outlined below. The scenarios in this study include: 1) Customer Incentives, 2) Customer Incentives + Interruptible Rates, and 3) Time of Use (TOU) Rates. Figure 3-2 provides an overview of each achievable scenario and further details on the specific programs and the related inputs for each scenario are provided in Appendix C.

Figure 3-2. Demand Response Program Scenario Descriptions

BASE CASE	CUSTOMER INCENTIVES	 DR programs with event-based incentives set at levels commonly used in other jurisdictions. This scenario excludes C&I interruptible customers. Sensitivity with increased spending (double incentives) is applied to this scenario.
	CUSTOMER INCENTIVES + INTERRUPTIBLE RATES	Applies the Customer Incentives scenario measures and programs, along with the impact of enrolling large C&I interruptible rates customers to participate in DR events.
TOU RATES		Assessment of the impact of TOU Rates for both residential and C&I customers (beginning in 2025).

3.1.2 Load Curve Analysis

The standard peak day load curve for the electric system is defined by taking an average of the load shape from each of the top ten peak days in the historical hourly load data provided (Figure 3-3).²⁹ The average shape of the peak day is scaled to align with the 97.5th percentile peak to generate a standard peak day load shape for the PEI system.

²⁹ For this study, one year of historical data, from 2019, was used to establish the standard peak day load curve.



The shape of the peak day is then maintained over the study period, but the curve is projected forward such that the daily peak is equal to the Island's forecasted annual peak in each of the study years (2021-2030), resulting in the peak load listed in Table 3-1 below.

Table 3-1. Peak load forecast for PEI (2021-2030)³⁰

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Demand (MW)	286	294	300	307	313	320	327	334	341	348

The analysis finds that PEI's system has a relatively flat load curve with an evening peak as well as a second peak in the morning, which is not uncommon in winter-peaking jurisdictions with a significant penetration of electric heating. The duration and steepness of the peak curve indicate that measures with significant bounce-back or pre-charge effects close to the peak will likely have limited potential to reduce the annual peak as they risk creating new peaks by shifting load from one hour to another. In addition, the shape of

Figure 3-3. Standard Peak Day Load Shape with Percentile Distribution

³⁰ The peak demand forecasted is based on the load forecast in the 2016/17 PEI Energy Strategy. It was then compared to Maritime Electric's 2020 Integrated System Plan and is in-line with that forecast through 2025. It is important to note that the forecast does not include energy efficiency savings from efficiencyPEI's 2018/19 or 2019/20 programs or future years, which are estimated to contribute 10 MW of savings by 2025. But while the demand forecast used in this study is higher than the ISP + DSM forecast in early years, the two essentially align when the ISP + DSM forecast is projected out from 2025 to 2030. It should also be noted that it is unclear to what extent heat pump and EV adoption is incorporated into the ISP forecasts.

PEI's peak day load curve suggests that targeting DR measures that can be used to address an evening and/or morning peak would be beneficial for the province.

It should also be noted that increasing penetration of electric space heating in general, heat pumps and electric vehicles will have an impact on the system peak load and shape. The trend on PEI toward increasing dependence on electricity for space heating could have the effect of increasing system peaks, which may increase the opportunity for, and value of, DR. Heat pumps alone introduce the potential to shift from an evening to morning peak, which has been seen in other jurisdictions. With respect to electric vehicles, we would expect adoption to be driven by passenger vehicles over the study period. This will have an impact on morning and evening peak with a greater emphasis on the evening; however, there is also an opportunity for load control and shifting for EVs

While not part of this assessment, heat pump and EV forecast studies would provide additional insights into how the timing of the peak may shift (more likely towards the end of the study period and onward) as a result of increased adoption.

3.2 Achievable Potential Results

The DR potential study provides numerous insights which can be used to inform DR program design on PEI. This section presents overall and scenario-by-scenario results for each achievable potential scenario. Key takeaways from the analysis are also included below.

Overall, the results indicate there is significant DR potential on Prince Edward Island. By 2030, the total achievable savings range from 10.7 MW (TOU Rate) to 31 MW (Customer Incentives + Interruptible Rate), which is approximately 3.1% to 8.8% of the forecasted system peak in 2030 (see Table 3-2, below).

Scenarios	Customer Incentives Scenario	Customer Incentives + Interruptible Rate Scenario	TOU Rate Scenario	
Achievable Potential (MW)	21	31	10.7	
% of System Peak in 2030	5.9%	8.8%	3.1%	

Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios

The C&I sector, in particular large interruptible customers, could represent a significant opportunity as shown by the Customer Incentives + Interruptible Rate scenario in Figure 3-4. In the absence of interruptible customers, residential measures become more prominent and take a larger share of the cost-effective DR savings potential under the Customer Incentives scenario and the TOU Rate scenario.

Figure 3-4. Demand Response Achievable Potential³¹



Figure 3-5, below, provides the program costs for each scenario, broken down between upfront costs and annual running costs. Upfront costs (dark blue bars) include customer enrollment incentives as well as controls and equipment installation costs. Annual costs (light blue bars) include annual incentive to maintain participation as well as recurring program administration costs.

In both the Customer Incentives and Customer Incentives + Interruptible Rate scenarios, the results show significant up-front costs in the initial years (~\$2M to \$4.5M). In these scenarios, **we assume all new programs are deployed**,³² which involves enrolling new customers in the programs and putting inplace new equipment and control systems. These initial investments are followed by greater emphasis in the later years on incentives to maintain participation in the programs. To note, for the TOU Rate

³¹ The total achievable potential in each year for each scenario reflects the overall peak load reduction potential when all the constituent programs are assessed together against the utility load curve, accounting for the combined interactions among programs, and reasonable ramp-up schedules for new measures and programs.

³² While this is the underlying modeling assumption, our analysis and discussion in the following sections suggest that PEI has an opportunity to focus its efforts on a few impactful measures. Program design optimization can help reduce actual program costs.

scenario, the costs only include those that are incremental to the AMI investment. It is assumed that the rates will be designed to achieve revenue neutral benefits.

It is important to note that while the DR programs require significant up-front costs in early years of the programs, the demand savings persist for on average nine years (with annual incentives to help maintain participation levels). Thus, investments made within the study period (e.g., 2025 or 2030) will continue to provide load reduction savings and system benefits into the future.





Under all scenarios the benefits of the DR programs outweigh the costs at the portfolio level. The Program Administrator Cost (PAC) Test was applied to assess cost-effectiveness a benefit-cost ratio of 1.0 as the cut-off threshold for all measures and assuming a 9-year program life. Table 3-3 below provides the cumulative average cost-effectiveness results for each scenario, accounting for the costs and benefits for newly added demand reduction program capacity between 2021 and 2030.

Table 3-3. Demand Response PAC Test Results

Scenario	
Customer Incentives	1.3
Customer Incentives + Interruptible Rate	1.8
TOU Rates	8.7

PEI's Flat Load Curve is the Primary Constraint

The analysis reveals that the shape of PEI's current load curve is the limiting factor in terms of the overall DR potential. In other words, DR potential is not constrained by cost-effectiveness or customer participation in DR programs, but a relatively flat load profile which limits the potential by creating a new peak outside the targeted peak hour.

Figure 3-6 demonstrates this phenomenon, by providing the resulting utility load profiles under the each of the three achievable scenarios. The varying load curve shapes result from the measure mix in each scenario. In each case, the programs are successful in decreasing demand at the peak hours, but peaks emerge at new times which become the limiting factor. A more detailed optimization and program design may be able to somewhat further reduce load at the new peak hours, but that level of analysis was beyond the scope of this study.



Figure 3-6. Peak Load Profile (2030)

3.2.1 Customer Incentives Scenario

The Customer Incentives scenario captures the DR potential from developing a variety of DR programs under basic incentive levels and delivery approaches.³³ Figure 3-7, below, shows that PEI can achieve up to 21 MW by 2030. This comes primarily from the residential programs with a combined potential of 14 MW by 2030. The C&I programs offer an additional 6.5 MW reduction potential, mainly through a curtailment program targeting mid-sized customers.

It is important to note that large C&I customers already enrolled in the interruptible rates program were not included in this scenario which explains the absence of potential from these customers.³⁴ Large C&I customers were excluded from this DR scenario because it is unclear whether they will in fact be able or willing to participate in DR events under their current interruptible rates contracts. The Customer Incentives scenario offers insights that can be used for program design if large C&I customers who are on the interruptible rate do not participate. Large C&I customers are however included in the second scenario – Customer Incentives + Interruptible Rate to show how they impact the overall savings and mix of measures.



Figure 3-7. Customer Incentives Scenario – Achievable Potential by Program

Table 3-4, below, provides the measure-level savings for the 2025 and 2030 DR potentials³⁵ along with each program cost-effectiveness results over an assumed 9-year usable program life span. The results show that the largest potential comes from the residential sector with a few measures offering notable opportunities.

³³ Delivery approaches refer to different program delivery strategies. For example, Bring-Your-Own-Device versus a DLC program where the device is provided and installed by the program administrator.

³⁴ As shown in the Customer Incentives + Interruptible Rate, when included, large C&I customers under an interruptible rate captures a significant portion of the achievable potential; however, it is unclear how many of these customers would actually be available for DR events, and under what conditions. For this reason, we included a scenario without large interruptible customers so that ePEI would have visibility regarding other opportunities for program design.

³⁵ Diesel back-up generators were excluded from this study as they do not align with other public policy considerations.

On the C&I side, medium and large customers provide most of the potential with little contribution from the small C&I customers.

Table 3-4. Customer Incentives Scenario - Measures

Measures	Achievable Potential 2025 (MW)	Achievable Potential 2030 (MW)	PACT Results
Medium & Large C&I Curtailment	4.6	4.7	
Medium C&I Curtailment	4.0	4.1	2.3
Large C&I Curtailment	0.6	0.6	
Residential Energy Storage	1.8	3.4	
Thermal Energy Storage	1.7	3.3	1.4
Residential Battery Energy Storage - BYOD	0.10	0.13	
Residential DLC	5.7	6.8	
Residential Wi-Fi Thermostat	2.2	2.4	
Residential Wi-Fi Thermostat (Heat Pump)	0.5	1.0	1.4
Residential Storage Water Heater	2.8	3.0	
Residential Other Smart Appliances	0.2	0.4	
Commercial DLC	0.18	0.22	
C&I Wi-Fi Thermostat	0.17	0.20	0.2
Storage Water Heater	0.01	0.02	
C&I Commercial Battery Storage - BYOD	1.5	1.6	1.4
Dual Fuel System	3.8	4.0	1.1
TOTAL	17.6	20.6	1.3

Key observations:

- Residential thermal energy storage systems and electric storage water heaters achieve 3.3 MW and 3.0 MW of peak reduction potential, respectively. Both measures benefit from their capacity to target the peak hour while managing the bounce back effect through their storage capacity. These measures are also extremely promising because they offer the flexibility to reduce the load for several hours without impacting the participant's level of comfort,³⁶ which can be a limiting factor for other measures such as Wi-Fi thermostats.
- Wi-Fi thermostats paired with central electric heating systems also show potential through different delivery approaches by enrolling customers who already own their device ("Bring-Your-Own-Device" program (BYOD)) and by enrolling customers who would require their installation as part of the program³⁷. To note, it is possible that an integrated efficiency and DR incentive delivery

³⁶ Provided that the program strategies are carefully designed.

³⁷ BYOT program customers are assumed to receive sign-up incentives to join the program while customers without devices are considered not eligible to sign-up incentives.
approach for Wi-Fi thermostats could yield higher adoption rates, thereby increasing the BYOD potential relative to the direct install opportunity.

- In the C&I sector, the mid-sized commercial and industrial curtailment measures show the largest potential. These programs tend to be very cost-effective programs when customers leverage their own building management systems. Additionally, there is also potential to enroll installed commercial battery storage capacity in the DR programs as the study progresses.
- Under the Customer Incentives scenario, almost all programs pass the PACT threshold once the programs ramp up. The exception is the commercial DLC program, likely due to the limited achievable potential available to the program relative to the set-up and equipment costs. Details on each measure potential and cost-effectiveness by segment are provided in Appendix E.

The analysis also reveals that **dual fuel systems** can effectively reduced the peak load by as much as 4 MW by 2030. This measure considers the replacement of electric central heating systems such as an electric furnace with dual fuel systems that can switch fuel during peak events. While this measure is useful to reduce the peak demand, an integrated approach to leverage current dual fuel systems (heat pump with combustible fuel fired back-up heating) could potentially achieve meaningful impacts and help mitigate growth in winter peak loads that are expected to result from increased electrification of residential heating in the province.

Enhance Incentive Sensitivity Analysis

To assess the impact of incentives on DR adoption and achievable potential, Dunsky conducted a sensitivity analysis wherein incentive levels were doubled for all measures included in the Customer Incentives scenario.

Key results and observations:

- Achievable potential did not increase because most of the measures were already constrained by the load shape (i.e., would create a new peak) rather than by program potential participation.
- The only difference between the sensitivity and the base scenario is that the most cost-effective measures (such as C&I curtailment) were able to capture slightly more of the achievable potential due to higher market adoption on account of the increased incentives. This reduced the available potential for other cost-effective measures (i.e., crowded them out), and ultimately reducing their overall contribution in the final measure mix.
- Doubling incentives in this scenario significantly increased program costs but had little to no effect on increasing the DR potentials. This implies that if PEI is to implement a suite of DR programs, the focus should be on selecting an optimized combination of programs and measures, and to provide attractive, yet moderate participation incentives.

3.2.2 Customer Incentives + Interruptible Rate Scenario

Under the Customer Incentives + Interruptible Rate scenario, DR programs from the base scenario are assessed in combination with expanding the large C&I interruptible rates program to include DR events. Under this scenario, the potential is assessed for calling DR events among PEI customers who are currently enrolled in their interruptible rates program that is currently used only for system reliability events, not peak reduction per se³⁸. Since these customers are already enrolled in an interruptible rate, the cost of the preferential rate is not accounted for in the DR assessment. As detailed in Figure 3-8 below, the overall achievable potential increases, with large interruptible customers driving significant DR potentials. In this scenario, DR program incentives were kept at the same levels as in the base scenario, and a \$30 per kW additional incentive was offered to existing IR customers.



Figure 3-8. Customer Incentives + Interruptible Rate Scenario – Achievable Potential

The measure and program potentials under this scenario are provided in Table 3-5 below as well as each program cost-effectiveness over a 9-year program lifetime. Because the interruptible rates for large C&I customers are so cost-effective, they capture most of the potential, thereby leaving less opportunity for the DR program measures to further flatten load curve.

³⁸ In 2017, PEI had 15 MW of curtailment enrolled under large C&I Interruptible Rate programs, this was considered to be fully available for DR events, and was scaled up to account for market growth over the study period.

Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures

Measures	Achievable Potential 2025 (MW)	Achievable Potential 2030 (MW)	PACT Results
Medium & Large C&I Curtailment	3.8	3.9	
Medium C&I Curtailment	3.3	3.4	2.2
Large C&I Curtailment	0.5	0.5	
Residential Energy Storage	0.1	0.13	
Thermal Energy Storage	0	0	0.1
Residential Battery Energy Storage - BYOD	0.10	0.13	
Residential DLC	1.0	2.7	
Residential Wi-Fi Thermostat	0.9	1.5	
Residential Wi-Fi Thermostat (Heat Pump)	0	0	1.0
Residential Storage Water Heater	0	1.1	
Residential Other Smart Appliances	0.1	0.1	
Commercial DLC	0	0	
C&I Wi-Fi Thermostat	0	0	0
Storage Water Heater	0	0	
C&I Commercial Battery Storage - BYOD	1.5	1.6	1.4
Dual Fuel System	3.8	4.0	1.1
Large Interruptible	17	18.7	4.7
TOTAL	27.2	31.0	1.8

Key observations:

- Interruptible rates for large C&I customers generate most of the potential with 18.7 MW by 2030. This measure assumes that interruptible rate customers could be called on to respond to reduce their load over a 6-hour event window during peak time. To proceed to designing an interruptible rate DR program, a deeper analysis would be needed to determine the degree to which interruptible rates customers would be willing to participate in DR event calls under their existing contracts with the PEI utilities.
- Medium and large commercial curtailment can further increase the potential by up to 3.9 MW, which is slightly lower than the first scenario. Leveraging C&I battery storage can add an additional 1.6 MW of potential to the mix.
- **Residential DLC** is significantly lower in this scenario, with up to 2.7 MW total divided between storage water heater (1.1 MW) and Wi-Fi thermostat (1.5 MW). This is because these measures compete against the others and were ultimately crowded out.
- **Dual fuel systems** achieve up to 4 MW by 2030 (as in the Customer Incentives scenario). Since this measure is not constraint by any bounce back effect, its potential is cumulative to the large interruptible one.

It is worth recalling that the modelling methodology follows a cost-effectiveness priority ranking in order to provide realistic scenarios, as described in the methodology. Moreover, all measures are assessed based on their ability to reduce the peak load during the defined DR event windows. However, program optimization may reveal further potential from measures that fall lower down the cost-effectiveness list in this analysis in two ways.

First, it may identify measures that can address the new peaks that emerge outside of the current DR windows, caused by load shifting from the more cost-effective measures.

Second a change to the program designs in some cases can shift upfront costs from the program to the customer, thereby improving the program cost-effectiveness. For example, for thermal energy storage, the study considers the initial costs of equipment as a utility initial incentive. However, by offering a well-designed rate structure such as Summerside, these costs can be transferred to the customers which could significantly increase the program cost-effectiveness. These variations should be carefully studied during the program design stage to find the best optimisation scenario.

While the portfolio cost-effectiveness has increased due to the large contribution of the large interruptible measure, some of the other programs result less cost-effective. This is due to the fact that the program development and fixed costs are applied to a smaller pool of participants.

3.2.3 TOU Rate Scenario

The TOU Rate scenario analyses the achievable potential if PEI were to implement dynamic rates (specifically, Time-of-Use rates) to encourage customer behaviour that reduces peak time usage. The analysis focused on a two-tier, 3:1 peak-to-off-peak TOU rate ratio, that is applied to all customers, but with an opt-out option. This rate was applied across all residential and commercial customers and the savings are presented in Figure 3-9. When compared to the Customer Incentives and Customer Incentives + Interruptible Rate scenario, the TOU scenario offers limited peak reduction reaching 10.7 MW of potential by 2030 (equal to 3.1% of the system peak). The majority of the achievable peak reduction potential comes from the residential sector (60%).

Figure 3-9. TOU Rates Scenario Achievable Potential



Key observations:

- While TOU can be an effective approach to leverage AMI and achieve peak demand reductions, its effectiveness can be further increased by combining it with other strategies, such as rate enabled devices (i.e. Wifi Thermostats) or critical peak pricing during DR events. Critical peak pricing rates combined with TOU have proven to be effective on residential customers while peak time rebates tend to be more attractive for commercial customers. While an optimization exercise is not within the scope of this study, it should be considered if PEI proceeds to consider dynamic rates in the future.
- Our analysis shows that the C&I sector is less responsive than the residential customers to TOU rates, especially small C&I customers.

3.3 Key Takeaways

Using Dunsky's DROP model, DR program potentials were assessed using three scenarios, each representing a different DR program strategy (DR equipment, interruptible rates, and time of use rates). Based on these results, the following key findings emerge.

1. Significant DR Load Reduction Potential is Available under Each Scenario

Overall, these results show that there is a significant amount of cost-effective DR potential on PEI. Even with a relatively flat load curve, there is up to 31 MW of demand response potential by 2030 under the Customer Incentives + Interruptible Rate scenario, representing about 8.8% of the system peak. Alternatively, the TOU Rates scenario suggests that 10.7 MW of potential is achievable by leveraging the upcoming AMI infrastructure for the residential and commercial customers. The Customer Incentives scenario realizes 21 MW of load reduction by 2030.

Table 3-6. Demand Response PAC Test Results

Scenario	
Customer Incentives	1.3
Customer Incentives + Interruptible Rate	1.8
TOU Rates	8.7

As discussed early, customer participation is not the limiting factor in terms of achievable potential – PEI's relatively flat load curve constrains the level of peak load reduction that is possible without creating new peaks outside of the DR windows.

2. Focus on Optimizing a Few Key DR Programs

There is significant cost-effective potential on PEI but focusing on a few key programs can provide the most savings while improving overall cost-effectiveness. By focussing on a few key equipment-based measures, PEI can capture most of the peak load reduction potential and by including DR events in the interruptible rates program for large C&I customers a higher total reduction can be achieved. Overall, most of the potential is achievable through the following measures:

- Load reducing measures that do not experience a bounce back effect are particularly well suited for PEI. This includes adding DR event calls to the large C&I interruptible rates program, (representing up to 18 MW of potential under this approach alone). Other potential load shift measures include medium & large curtailment, dual fuel systems, and battery energy storage.
- Other key measures are residential thermal energy storage and electric storage water heaters that can provide up to 6.3 MW of cost-effective potential.
- Smart thermostats can also provide additional potential. To increase the cost-effectiveness of this measure, efficiencyPEI could explore an integrated EE/DR approach that offers combined incentives

for participants to deliver both EE and DR savings or that allows EE incentive takers to be preenrolled in the DR program.

In general, our analysis shows that a combination of interruptible rates strategies with equipment-based DR programs can provide the highest DR potential. Further potential may be possible by optimizing the combination of measures to introduce further measures that can target the new peaks that emerge outside of the modeled DR windows. The program design stage will be crucial to achieve the most savings while improving overall cost effectiveness.

3. Results for PEI are In-line with Other Winter-Peaking Jurisdictions

Table 3-7, below, benchmarks the achievable DR potential from all scenarios to DR potential study findings in other jurisdictions. Overall, these show that the PEI DR potential is similar to other winter peaking jurisdictions, which indicates that the assessment has captured the majority of the available peak load reduction potential from DR programs.

Table 3-7. Benchmarking of th	he achievable DR Potentia	l (Mid Scenario) to oti	her summer neakina i	lurisdictions
rubic 5 7. Deneminarking of th	ic acific vabic bit i otcitta	1 (Ivila Sectiario) to oti	iei suimiei peuking s	unsuictions

	PEI (2021)	Newfoundland & Labrador (2020)	Northwest Power & Cons. Council (2015)	Nova Scotia (2019)	New Brunswick (2019)
Portion of Peak Load	3.1% - 8.8% (2030)	12% (winter peak)	8.8% (winter peak)	4.1% – 5.7% (winter peak)	6%-7% (winter peak)
Avoided Costs	\$200 / kW	\$430 / kW	n/a	\$160-\$200 / kW	\$0-\$108 / kW

4 Conclusion

The concluding section of this report presents overall system impacts in terms of energy and demand savings followed by a summary of our key takeaways from the Potential Study assessment.

4.1 Combined Consumption and Peak Load Impacts

The following presents the *cumulative* system-wide impacts resulting from efficiency and demand response programs. As described in Chapter 1, cumulative savings are a rolling sum of all *new* savings from measures that are incentivized by efficiency and demand response programs. Cumulative savings provide the total expected impact on energy sales and electric peak demand overtime and are used to determine the impact of efficiency programs on long-term energy consumption and peak demand.

This section also provides cumulative results for technical and economic potential in addition to achievable scenario potential. There are two key caveats for understanding the technical and economic potential as presented in this section.

First, the **DEEP model estimates all potentials (technical, economic, and achievable) on an annual phasedin basis**. The model assumes that most efficient measures are not eligible for deployment until the existing equipment it is replacing reaches the end of its useful life or becomes a viable early replacement measure. For retrofit addition measures, the model applies a diffusion curve to release the market in a phased-in manner as well. This limits the number of opportunities available for efficiency upgrades each year. For this reason, technical and economic potential will increase each year of the study as more baseline equipment is eligible to be replaced.

Second, technical potential in the EE module represents all savings from *commercially viable* measures as opposed to all *technologically possible* savings. As explained further in Appendix A, the efficiency measures included in this study were limited to currently commercially viable options, and those that may become commercially viable over the study period (based on Dunsky's professional experience). In some cases, Dunsky excluded measures that were highly unlikely to pass the PAC cost-effectiveness test in the study period due to relatively low savings and/or high incremental costs or measures that have extremely low market penetration.

By 2030, achievable electric efficiency savings could reduce annual electric consumption by approximately 92 GWh (Low) to 200 GWh (Max). This would reduce annual electricity sales by between 5% (BAU) and 11.0% (Max) of forecasted levels in 2030 as shown in Figure 4-1. If all economic savings were captured, electricity consumption would decline by approximately 643 GWh (37% of forecasted 2030 sales), and if all technical savings were captured, electricity consumption would decline by 726 GWh (41% of sales).



Figure 4-1. Impact of Electric EE Savings on Forecasted Electricity Sales (2021-2030; Technical, Economic, and Program Scenarios)

Note: Y-axis in above figure does not begin at zero.

From these results, the following observations can be made:

- Technical and economic potential are nearly the same. Cumulative economic potential for electric EE in 2026 is approximately 99% of cumulative technical potential. As previously described, the initial exclusion of measures that are not currently commercially viable and are not expected to become viable within the study period screens out technologically possible savings that would be unlikely to pass economic screening (see Appendix C for the full measure list).³⁹ This reduces overall technical potential without reducing economic potential.
- Up to a third of the economic potential can be captured by the achievable scenarios. The achievable scenarios capture between 14% (BAU) and 31% (Max) of economic savings in 2030. This suggests that market barriers for efficient technologies are relatively high on PEI, which likely reflect the relatively recent ramp-up in energy efficiency efforts in the province. We see additional potential captured when enabling activities that further reduce market barriers are included.
- Achievable savings are relatively clustered together. As can be seen in Figure 4-1, there achievable savings potentials under all scenarios helps offset some of the forecasted load growth. The spread among the achievable scenarios is relatively narrow, especially between the Mid and Max scenarios. This is primarily due to the fact that many of efficiencyPEI's programs already offer high or 100%

³⁹ Commercial availability and viability of measures was assessed through a review of available secondary sources such as technical resource manuals as well as Dunsky's professional judgment.

incentives and therefore there is less opportunities to induce additional savings through enhanced incentives – especially between the Mid and Max scenarios.

• **Programs flatten projected growth in electricity sales in early years**. Figure 4-1 also shows that the energy efficiency programs significantly reduce and even flatten the energy forecast in the first three years. Starting in 2024, however, none of the scenarios are able to prevent the anticipated growth in consumption in the province.

In addition to reducing electricity consumption, EE and DR programs can reduce province-wide peak electric demand. As shown in Figure 4-2, demand savings from the BAU energy efficiency scenario essentially flattens projected load growth in the first three years. When DR programs are included, the BAU EE scenario plus the Customer Incentives and Customer Incentives + Interruptible Rate scenarios result in a significant reduction in peak load compared to the demand forecast. The impact of TOU Rates as modeled are introduced in 2025, and while the impact is not as pronounced as with the other scenarios, on its own it does result in a 3% reduction in peak in 2030.

To note, technical and economic savings are not shown here as they are assessed at the measure level and are not considered to be realistically additive across the system. It is also noteworthy that even the energy efficiency demand savings and highest DR scenario only keep peak load steady until 2024, after which there is notable growth in the annual peak demand.



Figure 4-2. Impact of Electric EE Demand Reduction on Forecasted Peak Load (2021-30; All Program Scenarios)

Note: Y-axis in above figure does not begin at zero.

4.2 Key Takeaways

Based on the results presented in this report, the following key take-aways emerge:

- 1. PEI's electricity energy efficiency savings targets are achievable. While current energy efficiency programs do not appear sufficient to meet the provincial government's targe of 2% electricity savings per year, there is a reasonable path to that target, albeit at higher costs and covering a broader range of eligible measures as well as a greater focus on enabling activities. Demand Response offers a new opportunity to engage the Island community to help mitigate the growing annual peak in the province and reduce overall system costs.
- 2. Increasing program incentives can unlock a significant amount of cost-effective new savings. Expanding current programs to a broader range of measures and increasing incentives (and budgets) can significantly increase savings in the residential and commercial sectors. Moving from the BAU to Mid incentive scenario increases average (2021-2023) incremental lifetime savings by 97% and by 130% under the Max incentive scenario. However, these increasing savings come at notably higher annual portfolio budgets. In particular between BAU and Max (the PAC screening tests limits a meaningful increase in savings between the higher savings scenarios and thus budgets.) It should be noted that the potential assessment applied "blanket" incentive level increases in the Mid and Max scenarios, which may not be representative of program costs after strategies and optimisations are applied in program designs.
- 3. Focusing on barrier-reducing enabling activities can deliver further potential and help optimize program design and costs. Enhancing program designs by applying further enabling activities that help address customer barriers to energy efficiency can play a key role in helping efficiencyPEI meet it targets. The results show that when moderate enabling strategies are added alongside the Mid scenario incentives, the resulting lifetime savings (2021-2023) increase by 16% to approximately the Max savings levels, but for \$2 million less. This suggests that focusing on enabling activities may be a more effective way to pursue higher savings than simply raising incentives alone. Program design strategies that focus on enabling strategies, alongside targeted adjustments to incentive levels, can help to optimize program impacts and cost-effectiveness.
- 4. Focusing on envelope measures in the residential sector is a key opportunity. The single-family segment is critical to the portfolio given the achievable savings potential. New construction and other envelope measures such as adding attic and basement insulation are the largest opportunity in terms of lifetime energy savings within the sector. Higher performing building envelopes also help to right-size equipment, such as high efficiency heat pumps, which continue to be an important energy savings opportunity going forward.
- 5. The commercial sector offers a key opportunity for expansion. The results of this assessment show that there is also significant opportunity within the commercial sector (equal to roughly the same amount of savings potential as that of the residential sector). In all cases the achievable scenarios showed notably higher savings than are currently accessed by the existing commercial sector programs. The introduction of the new Community Energy Solutions program, introducing new enabling activities as well as targeted incentives and new measures can play a key role in tapping into this potential.



This report was prepared by Dunsky Energy Consulting. It represents our professional judgment based on data and information available at the time the work was conducted. Dunsky makes no warranties or representations, expressed or implied, in relation to the data, information, findings and recommendations from this report or related work products.



Prince Edward Island Energy Efficiency Potential Study:

A Comprehensive Assessment of Energy Efficiency and Demand Response Opportunities 2021-2030

(Volume II: Appendices)

Prepared for:

efficiency PEI





Submitted to:

efficiencyPEI

www.princeedwardisland.ca/en/topic/energy-efficiency



Prepared by:

Dunsky Energy Consulting

50 Ste-Catherine St. West, suite 420 Montreal, QC, H2X 3V4

www.dunsky.com | info@dunsky.com + 1 514 504 9030



With support from: Ad Hoc Research

About Dunsky

Dunsky provides strategic analysis and counsel in the areas of energy efficiency, renewable energy and clean mobility. We support our clients – governments, utilities and others – through three key services: we **assess** opportunities (technical, economic, market); **design** strategies (programs, plans, policies); and **evaluate** performance (with a view to continuous improvement).

Dunsky's 30+ experts are wholly dedicated to helping our clients accelerate the clean energy transition, effectively and responsibly.



Contents

Table of Contents

Contents		i
Table of (Contents	i
List of Fig	gures	iii
List of Tal	, bles	iv
	r Efficiency Methodology	5
A.1		c
A.2	The Dunsky Energy Efficiency Potential Model	5
A.3	DEEP Model Inputs	6
A.3.1	Measure Characterization	6
A.3.2	Market Characterization	
A.3.3	Program Characterization	
A.3.4	Economic Parameter Development	
A.3.3		
A.4	Assess Potential	
A.4.1	Technical and Economic Potential	
A.4.2	Achievable Potential and Scenario Modeling	
A.4.3	Measure Competition	
A.4.4	Measure Interactions (Chaining)	10
B. Deman	nd Response Methodology	17
B.1	Overview	17
B.2	Load Curve Analysis	
B.2.1	Identify Standard Peak Day	
DЭ	DP Maguros Charaotorization	01
D.3 В 3 1	Magguro Specific Model Inpute	
B.3.1	Technical Potential (Measure Specific)	23
B.3.3	Economic Potential (Measure Specific)	
	Accompany of Aphicyphic Detential Sconarios	25
D.4 R/1	Assessing Achievable Potential	
B 4 2	DR Programs and Scenarios	
D. 1.2		20
C. Study	Inputs and Assumptions	
C.1	Measure Characterization	
C.1.1	Energy Efficiency Measure List	
C.1.2	Lighting Standards and market evolution	
C.2	Market Characterization	
C.2.1	Customer Population Counts	

C.2.2	Market Baseline Data	
C.2.3	Growth Factors	
C.3	Program Characterization	35
C.3.1	Residential and C&I Programs	
C.4	Economic and other parameters	
C.4.1	Discount and Inflation Rates	
C.4.2	Avoided Costs	
C.4.3	Retail Rates	
C.4.4	Emission Factors	
C.4.5	Baseline Energy and Demand Forecasts	
C.5	Demand Response Inputs	
C.5.1	Standard Peak Day	
C.5.2	End-Use Breakdowns	
C.5.3	Future impacts	41
C.5.4	Measures	
C.5.5	Dynamic Rates	
C.5.6	Programs	
D. Energy	Efficiency Model Assumptions and Outputs	51
E. Deman	d Response Model Outputs	52
E.1	DR Technical and Economic Potential	
E.1.1	Medium and Large Commercial and Industrial Programs	
E.1.2	Small Business – Equipment Control Program	
E.1.3	Residential Programs	
F2	Demand Response Achievable Potential	54
F.2.1	Active Demand Potential Results by Measure	
E.2.2	Active Demand Potential Detailed Results	

List of Figures

Figure A-1. Representative Example of Adoption Curves	13
Figure A-2. Example of DEEP Measure Competition	15
Figure A-3. Example of Savings Calculation for DEEP Chained Measures	16
Figure A-4. Representative Example of Adoption for DEEP Chained Measures	16
Figure B-1. Demand Response Assessment Steps	18
Figure B-2. Load Curve Analysis Tasks	19
Figure B-3. Standard Peak Day Load Curve	20
Figure B-4. Measure Characterization Tasks	21
Figure B-5. Illustrative Domestic Hot Water (DHW) Bounce-Back Effect Example	23
Figure B-6. Achievable Potential Assessment Tasks	26
Figure C-1. Standard Peak Day – PEI	40
Figure C-2. Standard peak day – Sector breakdown	41
Figure C-3. Standard peak day – End-use breakdown	41
Figure C-4. Dynamic Rate Peak Reduction	48
Figure C-5. Dynamic Rate Peak Reduction	49

List of Tables

Table A-1. DEEP Measure Characterization Parameters	7
Table A-2. DEEP Measure Type Descriptions	8
Table A-3. DEEP Treatment of Technical, Economic, and Achievable Potential	11
Table B-1. DR Benefits and Costs Included in Determination of the PACT	24
Table C-1. Measure Characterization Sources	28
Table C-2. Residential Energy Efficiency Measures	29
Table C-3. C&I Energy Efficiency Measures	30
Table C-4. Customer Sector and Segment Population Counts.	33
Table C-5. Summary of Residential phone survey respondents by type of building and income	34
Table C-6. Summary of C&I phone survey respondents by segment	34
Table C-7. New growth factors	35
Table C-8. Residential and C&I Energy Efficiency Program Enabling Activity Descriptions	35
Table C-9. Residential Energy Efficiency Program Inputs (Low Scenario)	36
Table C-10. Discount and inflation rates	38
Table C-11. Peak Demand Forecast for Prince Edward Island	42
Table C-12. Residential Demand Response Measures	43
Table C-13. Non-Residential Demand Response Measures	46
Table C-14. DR Program Administration Costs Applied in Study (excluding DR equipment costs)	50
Table E-1. Medium and Large Commercial and Industrial Potential	52
Table E-2. Commercial Equipment Control Potential	53
Table E-3. Residential Equipment Control Potential	54
Table E-4. Residential Achievable Potential Results by Measure by Scenario (MW)	55
Table E-5. C&I Achievable Potential Results by Measure by Scenario (MW)	55

A. Energy Efficiency Methodology

A.1 Overview

The market potential for energy efficiency was estimated using the Dunsky Energy Efficiency Potential (DEEP) model. DEEP employs a multi-step process to develop a bottom-up assessment of the technical, economic and achievable potentials. This appendix describes DEEP's modeling approach, the process of developing DEEP model inputs and the underlying calculations employed to assess energy efficiency potential.



A.2 The Dunsky Energy Efficiency Potential Model

DEEP's bottom-up modelling approach assesses thousands of "measure-market" combinations, applying program impacts (e.g., incentives and barrier reducing enabling activities) to assess energy savings potentials across multiple scenarios. Rather than estimating potentials based on the portion of each enduse that can be reduced by energy saving measures and strategies (often referred to as a "top-down" analysis), the DEEP's approach applies a highly granular calculation methodology to assess the energy savings opportunity for each measure-market segment opportunity in each year. Key features of this assessment include:

• Measure-Market Combinations: Energy saving measures are applied on a segment-by-segment basis using segment-specific equipment saturations, utility customer counts, and demographic data to create unique segment-specific "markets" for each individual measure. The measure's impact

and market size are unique for each measure-market segment combination, which increases the accuracy of the results.

- Phase-In Potential: DEEP assesses the phase-in technical, economic, and achievable potential by applying a measure's expected useful life (EUL) and market growth factors to determine the number of energy savings opportunities for each measure-market combination each year. This provides an important time series for each energy savings measure upon which estimated annual achievable program volumes (measure counts and savings) can be calculated in the model, as well as phase-in technical and economic potentials.
- Annual and Cumulative Savings: For each measure-market combination in each year, DEEP calculates the annual and cumulative savings accounting for mid-life baseline adjustments and program re-participation where appropriate.¹ This provides a read on the cumulative savings (above and beyond natural uptake), as well as the annual savings that will pass through DSM portfolios.

Key Limitations

The key limitations for estimating energy efficiency potential in this study are the availability of market data.

The ability to forecast results is connected to the availability of market data and past market behavior. Where this data is not available, secondary sources and professional judgement must be employed. As discussed in more detail in Appendix C, this study utilizes Prince Edward Island specific information wherever possible, but in many cases alternative data sources were used to fill data gaps.

A.3 DEEP Model Inputs

DEEP requires an extensive set of model inputs related to energy savings measures, markets, economic factors, and adoption parameters to accurately assess energy efficiency potential. These inputs are developed through several concurrent processes that include measure characterization, market characterization, program characterization, economic parameter development and adoption parameter development. The remainder of this section outlines each process.

A.3.1 Measure Characterization

Measure characterization is the process of determining the costs, savings, and lifetimes of potential energysaving technologies and services and their baseline equivalents that will then be used as inputs to the DEEP model. The measure characterization process begins by developing a comprehensive list of energy saving measures.

In this study, an initial measure list was proposed based on the full range of existing measures in efficiencyPEI's energy efficiency programs as well as a number of emerging opportunities. Measures were limited to currently commercially viable options, and those that may become commercially viable over the study period (based on Dunsky's professional experience). In some cases, Dunsky excluded measures that

¹ Mid-life baseline adjustments are required for early retirement measures after the useful life of the existing equipment expires and new equipment (at a more efficient baseline) would have been purchased. Program re-participation occurs when a customer may receive an incentive for a new efficient measure to replace an efficient measure previously received through the program at the end of its life, which results in *program* savings but no additional *cumulative* savings.

were highly unlikely to pass the Program Administrator Cost Test in the study period due to relatively low savings and/or high incremental costs or measures that have extremely low market penetration due to existing baselines. The measure list was vetted and approved by efficiencyPEI finalized prior to measure characterization. Appendix C provides the full measure list.

Measure characterization is accomplished by compiling primary and secondary data (as available) on the efficient and baseline (e.g., non-efficient) energy-consuming equipment available in a given jurisdiction. Measures are characterized using segment-specific inputs when available yielding segment specific characterizations for each measure-market combination.

Measures are characterized in terms of their **market unit** such as savings per widget, savings per square foot, or savings per ton of cooling capacity. Each measure in the measure list was characterized by defining a range of specific parameters. Table A-1 describes these parameters.

Table A-1. DEEP Measure Characterization Parameters

Parameter	Description	
Market unit	The unit in which the measure is characterized and applied to the market (e.g., per widget, per building, per square foot, etc.)	
Measure type	 The measure type, which can be at least one of the following: Replace on Burn-out Early Replacement Additional Measures New Construction/Installation 	
Annual gross savings	The annual gross savings of the measure per market unit in terms of both energy (e.g., kWh, MMBtu), demand (e.g., kW) and other factors (e.g., water) as applicable	
Measure costs	The incremental cost of the measure (e.g., the difference in cost between the baseline technology and the efficient technology)	
Measure life	The effective useful life (EUL) and/or remaining useful life (RUL) of both the efficient measure and the baseline technology	
Impact factors	Any factors affecting the attribution of gross savings including net-to-gross adjustments, in-service factors, persistence factors and realization rates.	
Load factors Any factors affecting modulating gross savings including summer and wi peak coincidence factors as well as seasonal savings distributions.		
Program allocation	The program(s) to which the measure applies – in some instances, measures will be allocated to multiple programs on a pro-rated basis if the measure is offered through multiple programs	

As PEI does not currently have a Technical Resource Manual (TRM), measures were characterized using other best in class TRMs from other jurisdictions. See Appendix C for the complete measure list and accompanying TRM sources used in this study.

Measure Types

DEEP incorporates four types of measures – replace on burnout, early replacement, addition, and new construction/installation. DEEP treats each of these measure types differently in determining the maximum annual market available for phase-in potential. Table A-2 provides a guide as to how each measure type is defined and how the replacement or installation schedule is applied within the study to assess the phase-in potentials each year.

Table A-2. DEEP Measure Ty	pe Descriptions
----------------------------	-----------------

Measure Type	Description	Yearly Units Calculation
Replace on Burnout (ROB)An existing unit is replaced by an efficient unit after the existing unit fails. Example: Replacing burned out bulbs with LEDs		The eligible market is the number of existing units divided by EUL. ²
Early Replacement (ER) ³	An existing unit is replaced by an efficient unit before the existing unit fails. These measures are generally limited to measures where savings are sufficient enough to motivate a customer to replace existing equipment earlier than its expected lifespan. <i>Example: Replacing a functional, but inefficient, furnace</i>	The eligible market is assumed to be a subset of the number of existing units based on a function of the equipment's EUL and remaining useful life (RUL)
Addition (ADD)A measure is applied to existing equipment or structures and treated as a discretionary decision that can be implemented at any moment in time.Example: Adding controls to existing lighting systems, adding insulation to existing buildings		The eligible market is distributed over the estimated useful life of the measure using an S-curve function.
New Construction/ Installation (NEW)	A measure that is not related to existing equipment. Example: Installing a heat-pump in a newly constructed building.	The eligible market is measure- specific and defined as new units per year.

A.3.2 Market Characterization

Market characterization is the process of defining the size of the **market** available for each characterized measure. Primary and secondary data are compiled to establish a **market multiplier**, which is an assessment of the market baseline that details the current penetration (e.g., the number of lightbulbs) of energy-using equipment and saturation of energy efficiency equipment (e.g., the percentage of lightbulbs that are LEDs) in each market sector and segment. The market multiplier is applied to each market segment's **population** to establish each measure's market. The market multiplier can be understood as the average number of opportunities per customer within the market segment in terms of the measure's market unit.

² The EUL is set at a minimum of 3 years to spread installations over the potential study period. Note: Home Energy Reports are a special case with an EUL of one year.

³ Early replacement measures are limited to measures where energy savings are sufficient enough to motivate a customer to replace existing equipment prior to the end of its expected lifespan.



This study characterized markets by leveraging anonymized Maritime Electric and Summerside Electric customer data, Prince Edward Island specific baseline data, and market data from other jurisdictions in the region. Residential and C&I baseline information was received through primary data collection via telephone surveys conducted by Ad Hoc Research in summer 2020. This data was supplemented by the 2020 PEI Home Energy Survey. When Prince Edward Island specific baseline data was not available (or was based on a low number of observations), baseline data from neighboring jurisdictions in the region – namely New Brunswick and Newfoundland – was leveraged and adjusted for PEI specific attributes wherever possible.

A.3.3 Program Characterization

Program characterization is the process of estimating the average administrative program costs in terms of fixed and variable costs, incentive levels, and enabling activity impacts of existing efficiency programs. Inputs generated through the program characterization process include:

- Fixed costs are the portion of non-incentive administrative costs that are independent of the amount of savings attributable to the program.
- Variable costs are the portion of non-incentive administrative costs that change in magnitude with the amount of savings attributable to the program.
- **Incentives** are the portion of the measure's incremental costs that are covered by the program. Incentive levels vary by program scenario.
- Enabling activities are strategies employed by programs to reduce market barriers (e.g., effective marketing and delivery processes, contractor training, etc.). For details on the enabling strategies considered in this study please refer to Appendix F.

This study characterized programs through an extensive review of recently completed evaluation reports and accompanying spreadsheets for each of efficiencyPEI's current programs as well as conversations with efficiencyPEI's program specialists to develop initial estimates of program costs, incentives, and enabling activities across all programs. The initial program characterization was reviewed by efficiencyPEI and subsequent updates were made. Appendix C provides more information on the specific inputs resulting from program characterization.

A.3.4 Economic Parameter Development

DEEP harnesses key economic parameters such as avoided costs, retail energy rates, and discount rates to assess measure cost-effectiveness and customer adoption. Appendix C outlines the development of these inputs, which were used across all modules of this study.

A.3.5 Adoption Parameter Development

DEEP requires several key inputs to determine achievable measure adoption including market barrier levels and measure ramp-up levels.

- Market barrier levels define maximum adoption rates and are assigned for each measure-market combination based on market research and professional experience. Different end-uses and segments exhibit different barriers. Barrier levels may change over time if market transformation effects are anticipated.
- Measure ramp-up levels modify the initial uptake of measures not offered by existing programs and/or offered at lower levels than expected given the market context to account for ramping up new programs and measure marketing. In this study, measures that represent significant savings and are not currently offered by existing programs (i.e., Home Energy Reports) have ramp rates of 33%, 66%, and 100% applied in the first three years of the study, respectively.

A.4 Assess Potential

Using the comprehensive set of model inputs, DEEP assesses three levels of energy savings potential: technical, economic, and achievable. In each case, these levels are defined based on the governing regulations and practice in the modeled jurisdiction, such as applying the appropriate cost-effectiveness tests, and applying the relevant benefit streams and net-to-gross (NTG) ratios to ensure consistency with evaluated past program performance. Table A-3 provides a summary of how DEEP treats each potential type.

Table A-3. DEEP Treatment of Technical, Economic, and Achievable Potential

APPLIED	TECHNICAL	ECONOMIC	ACHIEVABLE
CALCULATION	POTENTIAL	POTENTIAL	POTENTIAL
1. ECONOMIC SCREENING	No Screen	Cost-Effectiveness (Program Administrator Cost Test)	Cost-Effectiveness (Program Administrator Cost Test)
2. MARKET BARRIERS	No Barriers	No Barriers	Market Barriers
	(100% Inclusion)	(100% Inclusion)	(Adoption Curves)
3. COMPETING	Winner	Winner	Competition
MEASURES	takes all	takes all	Groups Applied
4. MEASURES	Chaining	Chaining	Chaining
INTERACTIONS	Adjustment	Adjustment	Adjustment
5. NET SAVINGS	Not Considered	Not Considered	Program Net-to-Gross Ratios (NTGR)

For each level of potential, DEEP calculates annual and cumulative potential:

- Annual potential is the incremental savings attributable to program activities in the study year. It <u>includes</u> re-participation in programs (e.g., when a customer may receive an incentive for a new LED lightbulb to replace a burnt-out LED lightbulb previously received through the program). DEEP expresses annual potential both in terms of incremental lifetime savings and incremental annual savings. This is the most appropriate measure for annual program planning and budgeting.
- Cumulative potential is the total savings attributable to program activities from the beginning of the study period to the relevant study year. It accounts for mid-life baseline adjustments to measures implemented in previous years, as well as the retirement of savings for measures reaching their end of life. As such it <u>does not include</u> new savings for re-participation in programs, thereby providing an assessment of the cumulative impact of the measure/program (e.g., the reduction in energy sales). This is the most appropriate measure for resource planning.

A.4.1 Technical and Economic Potential

Technical potential is all theoretically possible energy savings stemming from the applied measures. Technical potential is assessed by combining measure and market characterizations to determine the maximum amount of savings possible for each measure-market combination without any constraints such as cost-effectiveness screening, market barriers, or customer economics. This excludes early replacement and retirement opportunities, which are to be addressed in the subsequent achievable potential analysis. Technical potential is calculated for each year in the study period.



DEEP's calculation of technical potential accounts for

markets where multiple measures compete. In these instances, the measure procuring the greatest energy savings is selected while all other measures are excluded to avoid double counting energy savings while maximizing overall technical energy savings (see description of measure competition below for additional detail).

Additionally, the calculation of technical potential also accounts for measures that interact and impact the savings potential of other measures (see description of measure interactions below for additional detail).

Economic potential is a subset of technical potential that only includes measures that pass costeffectiveness screening. Economic screening is performed at the measure level and only includes costs related to the measure. All benefits and costs applied in the cost-effectiveness screening are multiplied by their corresponding cumulative discounted avoided costs to derive a present value (\$) of lifetime benefits. All benefits and costs are adjusted to real dollars expressed in the first year of the study. Economic screening does not include general program costs. Like technical potential, the calculation of economic potential also accounts for measure competition and interaction.

This study screened measures based on the Program Administrator Cost Test ("PAC Test"). The PAC test assesses the net costs (including incentives) from the perspective of the program administrator.⁴ For energy efficiency, measures that had a benefit-cost ratio above 1.0 were included in the economic potential, except for low-income measures where a benefit-cost threshold of 0.8 or higher was used.

⁴ As defined by the California Standard Practice Manual. Benefits include avoided energy and demand, avoided T&D, avoided capacity. Costs include fixed and variable program administration costs, incentive costs, and any other related cost borne by the program administrator.

A.4.2 Achievable Potential and Scenario Modeling

Achievable potential is the energy savings stemming from the customer adoption of energy-savings measures. Rooted in the United States' Department of Energy (U.S. DOE) adoption curves,⁵ DEEP defines annual adoption rates based on a combination of customer cost-effectiveness and market barrier levels. Customer cost-effectiveness is calculated within the model based on inputs from measure and program characterization as well as economic and adoption parameters. Figure A-1 presents a representative example of the resulting adoption curves.

While this methodology is rooted in the U.S. DOE's extensive work on adoption curves, it applies two important refinements as described below:





Figure A-1. Representative Example of Adoption Curves

Refinement #1: Choice of the cost-benefit criteria. The DOE model assumes that participants make their decisions based on a benefit-cost ratio calculated using discounted values. While this may be true for a select number of large, more sophisticated customers, experience shows that most consumers use simpler estimates, including simple payback periods. This has implications for the choice and adoption of measures, since payback period ignores the time value of money as well as savings after the break-even point. The model converts DOE's discount rate-driven curves to equivalent curves for payback periods and applies

⁵ The USDOE uses this model in several regulatory impact analyses. An example can be found in <u>http://www.regulations.gov/contentStreamer?objectId=090000648106c003&disposition=attachment&contentType=pdf, section 17-A.4.</u>

simple and discounted payback periods based on sector. Generally, DEEP assumes residential customers assess cost-effectiveness by considering a measure's simple payback period, while commercial customers assess cost-effectiveness by considering a discounted payback period.

Refinement #2: Ramp-up. Two key factors – measure awareness and program delivery structure – can limit program participation, especially during the first few years after a program's launch or redesign and result in lower participation than DOE's achievable rates would suggest. For example, a new home retrofit program that requires the enrollment and training of skilled auditors and contractors by program vendors could take some time to achieve the uptake assumed using DOE's curves. As described under adoption parameter development, this study adjusts adoption rates on a case-by-base basis where appropriate.

Scenario Modeling

Multiple levels of achievable potential are modeled within DEEP by applying varying incentive and market barrier levels, which impact the degree of customer adoption. Additional details on parameters for each scenario can be found in Appendix C.

Varying levels of achievable adoption will also impact program spending by modulating incentive payments and variable program costs. As part of program characterization, variable program costs may be adjusted between scenarios to account for increased program expenses for providing additional enabling activities above current program levels.

It is important to note that program cost estimates are based on historical budgets and DEEP does not consider dynamic impacts on program budgets resulting from internal (to the program) and external factors impacting program and incremental costs. For example, the variable cost of delivering programs may decline overtime as program learnings are applied to future administrative and delivery practices within a program or incentive costs may decline if incremental costs decline over time. Likewise, program costs may increase if factors lead to increasing measure costs, for example, the lack of enough contractors to deploy high adoption measures leading to an increase in overall labor costs.

A.4.3 Measure Competition

Measure competition occurs when measures share the same market opportunity but are mutually exclusive. For example, LED troffers, T5 lamps and Super T8 lamps can all serve the same market opportunity but will not be simultaneously adopted. In these cases, DEEP assesses the market potential for each measure as follows:

- Technical Potential: 100% of the market is applied to the measure with the highest savings.
- Economic Potential: 100% of the market is applied to the measure with the highest savings that passes cost-effectiveness screening.
- Achievable Potential: The market is split between all cost-effective measures by pro-rating the achievable adoption rate based on the maximum adoption rate and each of the measures' respective adoption rates.

Figure A-2 presents an example where three measures compete: LED troffers, Super T8 and T5 lamps. First, the adoption rate is calculated for each measure independent of any competing measures, as outlined

in the figure below. Based on this assessment, the maximum adoption rate is 60%, corresponding to the measure with the highest potential adoption. Next, the adoption of each measure is pro-rated based on their relative adoption rates to arrive at each measure's share of the 60% total adoption rate. As a result, the total adoption rate is still 60%, but it is shared by three different measures.



Figure A-2. Example of DEEP Measure Competition

A.4.4 Measure Interactions (Chaining)

Measure interactions occur when the installation of one measure will impact the savings of another measure. For example, the installation of more efficient insulation will reduce the savings potential of subsequently installing a smart thermostat. In DEEP, measures that interact are "chained" together and their savings are adjusted when other chained measures are adopted in the same segment. Chaining is applied at all potential levels and these interactive effects are automatically calculated according to measure screening and uptake at each potential level.

DEEP applies a hierarchy of measures in the chain reducing the savings from each measure that is lower down the chain. The model adjusts the chained measures' savings for each individual measure, with the final adjustment calculated based on the likelihood that measures will be chained together (determined by their respective adoption rates) and the collective interactive effects of all measures higher in the chain. Figure A-3 provides an example of the calculations used to determine the interactive savings effects for a customer where insulation is added in addition to a smart thermostat and a heat pump.

Figure A-3. Example of Savings Calculation for DEEP Chained Measures



The model estimates the number of customers adopting chained measures based on the relative adoption rates of each measure. In an example where insulation has a 50% adoption rate and heat pumps have a 40% adoption rate in isolation, when chaining is considered, the model might assume 40% of customers adopting insulation will also install a heat pump, which means 50% of customers adopting a heat pump will also improve their installation levels. This segments the market into customers adopting only one of the measures, customers adopting both measures, and customers adopting none of the measures as shown in Figure A-4.





Note: The above figure is representative of the DEEP model's treatment of chained measures only and not representative of any actual program or measure inputs. In many cases, efficiency programs require weatherization prior to the incentivization of a heat pump.

B.1 Overview

The following sections outline Dunsky's Demand Response Model methodology, used to assess the technical, economic and achievable peak-hour demand savings from electric demand response programs. The strength of Dunsky's approach to analyzing demand response (DR) potential, is that it takes into account two specific considerations that differentiate it from energy efficiency potential assessments.

1. DR Potential is Time-Sensitive

- DR measures are often subject to constraints based on when the affected demand can be reduced and for how long.
- DR measure "bounce-back" effects (caused by shifting loads to another time) can be significant, creating new peaks that limit the achievable potential.
- DR measures impact one another by modifying the System Load Shape thus the entire pool of measures (at all sites) must be assessed together to capture these interactive effects and provide a true estimate of the achievable potential impact on the system peak.
- 2. Many DR Measures Offer Little or no Direct Economic Benefits to Customers
- Participants must receive an incentive over and above simply covering the incremental cost associated with installing the DR equipment.⁶
- Incentives can be based on an annual payment basis, a rebate/reduced rate based on a participant agreement to curtail load, or through time-dependent rates that send a price signal encouraging load reduction during anticipated system peak hours.
- Savings are expected to persist only as long as programs remain active.

A limitation of the methodology is that it may not be consistent with how utilities quantify their DR impacts, which may focus on reducing demand only at certain pre-determined peak hours, regardless of how load may vary at other hours, or if a new peak emerges outside of the targeted hours.

Figure B-1 presents an overview of the analysis steps applied to assess the DR potential in this study. For each step, system-specific inputs are identified and incorporated into the model. Each step is described below.

⁶ This study did not account for reductions in customer peak demand charges that may arise from DR program participation. Since DR events are typically called for a small number of days each month, the impact on commercial monthly peak demand charges is assumed to be minimal.

Figure B-1. Demand Response Assessment Steps



B.2 Load Curve Analysis

The first step in Dunsky's modelling approach is to define the baseline load forecast and determine the key parameters of the utility load curve that influence the DR potential. The process begins by conducting a statistical analysis of historical utility data to determine the 24-hour load curve for the "Standard Peak Day" against which DR measure impacts are assessed. The utility peak demand forecast period is then applied to adjust the amplitude of the standard peak day curve over the study period. Finally, relative market sector growth factors are applied to further adjust the peak day load curve (growth factors used in the study can be referenced in Appendix C.2.3).

Identify standard peak day 24-hour load curve Apply annual peak load forecasts to peak day Apply market growth and efficiency to alter peak day curve

Once complete, the load curve analysis provides a tool which can assess the individual measure, and combined program impacts against a valid utility peak baseline curve that evolves to reflect market changes over the study period. The sub-section below presents the initial Standard Peak Day for Prince Edward Island.

B.2.1 Identify Standard Peak Day

The **Standard Peak Day** is assessed through an analysis of historical hourly annual load curves. For each provided year, a sample of the peak days are identified (e.g., 10 top peak demand days in each year that historical data is available) and a pool of peak days is established⁷. From this the average peak day shape is established as from the pool of peak day hourly shapes. The standard peak day load curve is then defined by raising the average peak day load curve such that the peak moment matches the projected annual peak demand (keeping the shape consistent with the average curve) as shown in Figure B-3, below.

⁷ The analysis is based on the 8760-load curve for year 2019 provided by MECL.



Note: Each blue shading area represents a 10-percentile gradient.

From the standard peak day curve, two DR windows were identified – evening peak as well as a second peak in the morning – which represents an overall 7-hour time period in which to capture the highest demand hours. These are used to characterize certain DR measures, providing guidance on which hours to target for time-of-use (TOU) high-rate tiers, customer driven curtailment periods, and to create pre-charge/reduction/re-charge curves for equipment control measures, as described in the next step.

B.3 DR Measures Characterization

DR potential is assessed drawing on Dunsky's database of specific demand reducing measures developed from a review of commonly applied approaches in DR programs across North America, and emerging opportunities such as battery storage.⁸ Measures are characterized with respect to the local customer load profiles, and the technical and economic DR potentials are assessed for each individual measure.

Figure B-4. Measure Characterization Tasks



Once complete, the measure-specific economic potential is loaded into the model to assess the achievable potential scenarios when all interactive load curve effects are considered.

B.3.1 Measure Specific Model Inputs

Measures are developed covering all customer segments and end-uses, and can be broadly categorized into two groups:

- Type 1 DR Measures (typically constrained by demand bounce-back and/or pre-charging):
 - These measures exhibit notable pre-charging or bounce-back demand profiles within the same day as the DR event is called. This can create new peaks outside of the DR window and may lead to significant interaction effects among measures when their combined impact on the utility peak day curve is assessed.
 - Typically, Type 1 measures can only be engaged for a limited number of hours before causing participant discomfort or inconvenience. This is reflected in the DR measure load curves developed for each measure-segment combination. (example: direct load control of a residential water heater)
 - Dynamic Rates (Time-of-Use or TOU) are a sub-category of measures developed independently than the others. These measures are designed to alter customer behaviour with time and cannot be engaged by the utility to respond to a specific DR event but must be set in place and exert a prolonged effect on the utility load curve shape.

⁸ A detailed list of measures applied in this study is provided in Appendix C.5.

- Type 2 DR Measures (unconstrained by load curve):
 - These measures do not exhibit a demand bounce-back and are therefore not constrained by the addressable peak.
 - Some of them can be engaged at any time, for an unlimited duration. (example: back-up generator at a commercial facility)

Peak Shift (Type 1 measures)	Peak Reduction (Type 2 measures)	Dynamic Rates (TOU)
Example: DLC Water heaters	Example: C&I Curtailment	Example: TOU opt out program
<text><list-item></list-item></text>	 Assume loads are shifted outside of 24hr period. Identify curtailable loads from load curve observation. Apply constraints (events per year, max hours per year, event duration) Optimizer determines overall net impact on annual peak demand 	 Define on and off-peak pricing to maintain average annual billing. Redistribute shifted loads. Account for efficiency savings (approx. 2% of shifted kWh)

Dunsky's existing library of applicable DR measure characterizations was then applied and adjusted to reflect hourly end-use energy profiles for each applicable segment. Key metrics of the characterization are:

- 1. Load Shape: Each measure characterization relies on defined 24-hour load shape both before and after the demand response event. The load shapes are based on the population of measures within each market segment and are defined as the average aggregate load in each hour across the segment.
- 2. Effective Useful Life (EUL): Effective useful life of the installed equipment/control device.
- 3. **Costs:** At measure level, the costs include the initial cost of the installed equipment (i.e., controls devices and telemetry) and the annual operational cost (program administration, customer incentives etc.).
- 4. **Constraints:** Some measures are subject to specific constraints such as the number of hours per day or year, maximum number of events per year and event durations.
Once the measures are adapted to the utility customer load profiles and markets, the technical and economic potentials are assessed for each measure independently as outlined below. Because these are assessed independently (i.e., not considering interactions among measures), the technical and economic potentials are not considered to be additive, but instead provide important measure characterization inputs to assess the collective achievable potential when measures are analyzed together in step 3.

B.3.2 Technical Potential (Measure Specific)

The technical potential represents a theoretical assessment of the total universe of controllable loads that could be applicable to a DR program. It is defined as the technically feasible load (kW) impact for each DR measure considering the impact on the controlled equipment power draw coincident with the utility annual peak.

More specifically, the technical potential is calculated from the maximum hourly load impact during a DR event multiplied by the applicable market of the given measure. It is important to note that the technical potential assessment does not consider the utility load curve constraints, such as the impact that shifting load to another hour may have on the overall annual peak.

B.3.3 Economic Potential (Measure Specific)

The assessment of each measure's economic potential is conducted in three key steps: adjustment of the technical potential, screening for cost-effectiveness, and adjusting for market adoption limitations.

1. Net Technical Potential Adjustment: The measure's hourly load curve impact is applied to the utility standard peak day load curve, to assess the net impact after pre-charge and bounce-back effects are accounted for. For each individual measure, an optimization algorithm that assesses various control schemes and market portions is applied to arrive at the maximum number of participants and impact for the given measure, without creating a new system peak, either during the standard peak day, or over the sample annual hourly load profile.

Net Impact Determination:

By considering the bounce-back effect associated with water heaters recharging their reservoirs after the evening DR window has passed, Figure B-5 illustrates how adding too many water heaters to the DR program would risk creating a new peak outside of the DR window. This new peak is used to assess the net impact of the measures, which is determined as the difference between the peak before the DHW controls were applied and the new peak after the DHW controls were applied.





2. Cost-Effectiveness Screening: Once each measure's net impact on the peak is assessed, measures are screened using the applicable cost-effectiveness test, considering installation costs and baseline incentive costs.⁹ It is important to note the customer incentives are not treated as a pass through cost for DR programs because they typically do not cover a portion of the customers' own equipment incremental costs (i.e. customers typically have no direct equipment costs, unlike in efficiency programs where the incentives provided cover a portion of the participant's incremental costs for the efficiency upgrade).

Benefits	Costs
Avoided Capacity Costs Other ancillary benefits (as applicable)	Controls and equipment installation Controls and equipment Operations and Maintenance (O&M) (if required) Annual incentives (\$/ participant) Peak reduction incentives (\$/kW contracted)

Table B-1. DR Benefits and	Costs Included in	Determination of the PA	СТ
----------------------------	-------------------	-------------------------	----

3. Market Adoption Adjustment: The market for a given DR program or measure may be constrained either by the impact on the load curve, or by the expected participation (or adoption) among utility customers.

In the first case, the economic potential assessment (described above) determines the number of devices needed to achieve the measure's maximum impact on the utility peak load. Adding any further participation will come at a cost to the utility, but with little or no DR impact benefits.

In the second case, the model determines the expected maximum program participation based on the incentive offered, the need to install controls equipment, the level of marketing, and the total number of eligible customers, by applying DR program propensity curves (described in the call out box below) developed by the Lawrence Berkeley National Laboratory.¹⁰

The DR model assesses both the utility curve economic potential market and the maximum adoption at the resulting incentive levels, then constrains the market (maximum number of participants) to the lower of the two. This is then applied as a measure input for the achievable potential assessment described in the next step.

⁹ Any measure that cannot achieve a PAC Test > 1 is not retained for further consideration in the model.

¹⁰ Lawrence Berkeley National Laboratory, March 2017. 2025 California Demand Study Potential Study, Phase 2 Appendix F. Retrieved at: http://www.cpuc.ca.gov/General.aspx?id=10622

Demand Response Propensity Curves

For each measure the propensity curve methodology, as developed by the Lawrence Berkeley National Laboratory to assess market adoption under various program conditions, is applied. The curves represent achievable enrollment rates as a function of incentive levels, marketing strategy, number of DR calls per year, and the need for controls equipment. Their development is based on empirical studies, calibrated to actual enrollment from utility customer data. Specific curves are available for each sector.

Sector	Inputs
Residential	 Annual incentives (\$/yr.), Marketing (low mid high)
Small Business	 Installed equipment (yes/no)
Large C&I	 Annual incentive (\$/kW-yr.) # of events (hours per yr.)



B.4 Assessment of Achievable Potential Scenarios

The achievable potential is determined through an optimization process that considers market adoption constraints, individual measure constraints, and the combined inter-measure impacts on the utility load curve.

Scenarios are developed to assess the combined impact of selected programs and measures. For example, one scenario may assess the achievable potential of the impact of applying TOU rates and industrial curtailment, while another may assess the combined potential from direct load control of customer equipment and industrial curtailment. This approach recognizes that there can be various strategies to access the DR potentials from the same pool of equipment (i.e., TOU rates can exert a reduction in residential water heating peak demand, thereby reducing or eliminating the potential from a water heater DLC program). The scenarios are assembled from logical combinations of programs and measures designed to test various strategies to maximize the achievable peak load reduction.

B.4.1 Assessing Achievable Potential

For each scenario, measures are applied in groups in order starting with the least flexible/most constrained measures and progressing to the measures/groups that are less and less constrained, as per the order illustrated in figure below.

Apply Curve Shaping Measures (e.g. TOU rates)

Apply Load Control Measures (Type 1) Apply Large Customers Curtailment Apply Unconstrained Measures (Type 2)

- **Curve Shaping:** Rates Based Measures (such as time of use rates) are typically applied first as these are designed to alter customer behaviour with time, and are considered the least flexible (i.e., with the exception of critical peak pricing, they cannot be engaged by the utility to respond to a specific DR event but must be set in place and exert a prolonged effect on the utility load curve shape). Curve shaping can also include passive demand reduction via increased adoption of efficiency measures.
- Type 1 Load Control Measures: Direct control of connected loads such as water heaters and thermostats, and customer controlled shut-off or ramp down of commercial HVAC loads are applied next. These are typically constrained to specific times of day based on the utility peak load shape, and the controlled equipment load shape (i.e., turning of residential water heaters at midday may be feasible but deliver next to no savings as there is minimal hot water demand at that hour). These are assessed against the load curve altered by any shaping measures, and measures that may double count savings are eliminated. A new aggregate utility load curve is then created, applying the achievable load control peak reductions, and bounce-back effect.
- Industrial / Commercial Curtailment: Next customer curtailment is applied, which typically carries constraints related to the number of curtailment hours per day (consecutive and total), the number of events per year, and in some cases the time of day that curtailment can be applied (but does not carry same-day bounce-back effects). These are applied to the adjusted load curve to assess the potential impact of large industrial and commercial curtailment measures on the magnitude and timing of the overall annual peak.
- Type 2 Unconstrained Measures: Finally, the Type 2 measures that have less constraints on the duration, frequency or timing of their application are applied. These may include measures such as dual-fuel heating and back-up generators which can be engaged as needed and whose potential is not impacted by the shape of the utility load curve.

B.4.2 DR Programs and Scenarios

Dunsky has developed a set of best-in-class program archetypes based on a review of programs in other jurisdictions. For each program, development, marketing and operating costs are estimated and applicable

measures are mapped to the corresponding program, applying key features from the program archetypes, and taking into account current programs offered by the utility.

The model first determines the achievable DR potential of the combined measures within all programs, and then assesses the program level cost-effectiveness, summing all program and measure costs, as well as applicable measure benefits. A 9-year delivery period is assumed for each program, except where the program is based on control devices with a longer EUL, in which case the program is assumed to cover the entire device life. In cases where DR device EULs are shorter than 9 years, preparticipation / re-installation costs are applied. This approach allows the model to fairly assess the programs costs and benefits for an on-going program.

New measure and program ramp-up: Where applicable, new programs and measures can be ramped up accounting for the time needed to enroll customers and install controls equipment to reach the full achievable potential. Ramp up trajectories applied to the achievable potential markets after all interactive effects (i.e., new peaks created or program interactions that affect the net impact of any other program) have been assessed. An S-curve ramp-up over a five-year period is applied in this study. In addition, given the limited number of existing DR initiatives in the province, all programs were treated as new and thus up-front costs were applied to each.

Based on these steps the achievable DR potential for each measure, program and scenario are developed, along with an appropriate assessment of the measure, program and scenario level cost-effectiveness.

C. Study Inputs and Assumptions

The following appendix describes the key inputs used in this study and how they were derived.

C.1 Measure Characterization

C.1.1 Energy Efficiency Measure List

The following tables lists the energy efficiency measures and characterization sources used in this study. Table C-1 lists the various Technical Resource Manuals (TRM) and other sources used to characterize measures.

Table C-1.	Measure	Characterization	Sources
10010 0 11	measure	characterization	500,005

Jurisdiction/TRM Name	Version		
Commercial Measures			
Iowa - Volume 3: Nonresidential Measures	Version 2 (July 12 th , 2017)		
Illinois - Volume 2: Commercial and Industrial Measures	Versions 8.0 (Oct. 17 th , 2019), 7.0 (Sep. 28 th , 2018) and 6.0 (Feb. 8 th , 2017)		
Massachusetts Technical Reference Manual	Plan Versions 2019-2021 and 2016-2018		
Maine – Commercial/Industrial/Multifamily	Version 2018.3		
NB Power TRM	September 2017 version		
Mid-Atlantic (Northeast Energy Efficiency Partnerships (NEEP))	Version 8.0 (May 2018)		
New York - Residential, Multi-Family, and Commercial/Industrial Measures	Version 5 (July 17 th , 2017)		
OEB TRM	Version 3.0, December 3 rd 2018		
Pennsylvania TRM	June 2015 version		
Efficiency PEI 2018-20 Evaluation Reports	2020		
PSEG Long Island	2019 Version, June 14, 2018		
Residential Measures			
Efficiency PEI 2018-20 Evaluation Reports	2020		
Mid-Atlantic (Northeast Energy Efficiency Partnerships (NEEP))	Version 8.0 (May 2018)		
Massachusetts – 2019 Plan- Year Report Version	May 2020		
Iowa - Volume 2: Residential Measures	Version 2 (July 12 th , 2017)		
Illinois - Volume 3: Residential Measures	Version 8.0 (Oct. 17 th , 2019)		
Maine - Retail/Residential	Version 2018.3		
New York - Residential, Multi-Family, and Commercial/Industrial Measures	Version 7 (April 15 th , 2019)		
California Public Utility Commission appliance recycling program impact evaluation, 2014	2014		

Table C-2 and Table C-3 list each residential and C&I energy efficiency measure included in this study along with the TRM source from which the measure was characterized. These typically reference the source of the algorithms used to determine the measures savings and impacts, which were then applied to the PEI specific market, equipment saturations, climate, and customer consumption data used as inputs to the study.

Class	Measure	Source
Appliance	Air Purifier	ENERGY STAR
Appliance	ENERGY STAR Clothes Dryers	NEEP, 2018
Appliance	Clothes Washer	NEEP, 2018
Appliance	Dehumidifier	PEI, 2020
Appliance	Dehumidifier Recycle	MA. 2019
Appliance	Dishwasher	NEEP, 2018
Appliance	Freezer	NEEP, 2018
Appliance	Freezer Recycle	California, 2014
Appliance	Heat Pump Clothes Dryers	NEEP, 2018
Appliance	Refrigerator	NEEP, 2018
Appliance	Refrigerator Recycle	California, 2014
Behavioral	Home Energy Report	PEI, 2020
Envelope	Air Sealing	IA, 2018
Envelope	Attic Insulation	IL, 2019
Envelope	Basement Insulation	PEI, 2020
Envelope	Efficient Windows	IA, 2018
Envelope	New Home Construction	PEI, 2020
Hot Water	Faucet Aerator	PEI, 2020
Hot Water	Heat Pump Water Heater (HPWH)	NY, 2019
Hot Water	Low Flow Shower Head	PEI, 2020
Hot Water	Thermostatic Restrictor Shower Valve	NEEP, 2018
HVAC	Air Source Heat Pump (ASHP) Tune Up	IA, 2017
HVAC	Duct Insulation	ME, 2018
HVAC	Duct Sealing	IA, 2018
HVAC	ENERGY STAR Ceiling Fan	NEEP, 2018
HVAC	Ground Source Heat Pump (GSHP)	NEEP, 2018
HVAC	Heat Recovery Ventilator	ENERGY STAR
HVAC	Electric Resistance to DMSHP	PEI, 2020
HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019
HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019

Table C-2. Residential Energy Efficiency Measures

HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019
HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019
HVAC	Thermostat Programmable	NEEP, 2018
HVAC	Thermostat Wi-Fi	PEI, 2020
HVAC	Thermostat Wi-Fi	PEI, 2020
Lighting	LED A-Lamp (exterior)	PEI, 2020
Lighting	LED A-Lamp (interior)	PEI, 2020
Lighting	LED Linear Tube	NEEP, 2018
Lighting	LED Reflector (exterior)	PEI, 2020
Lighting	LED Reflector (interior)	PEI, 2020
Other	Advanced Smart Strips	MA, 2017

Table C-3. C&I Energy Efficiency Measures

Class	Measure	Source
Envelope	Building Shell Air Sealing	IA, 2017
Envelope	Roof Insulation	NB, 2017
Envelope	LEED Certified	Custom
Envelope	Net-Zero Ready	Custom
Envelope	Attic Insulation	IL, 2019
Hot Water	Heat Pump Water Heaters	PA, 2015
Hot Water	Heat Pump Water Heaters	PA, 2015
Hot Water	Faucet Aerator	IA, 2017
Hot Water	Low Flow Shower Head	NB, 2017
Hot Water	Pre-Rinse Spray Valve	NY, 2017
Hot Water	Thermostatic Restrictor Shower Valve	NEEP, 2018
Hot Water	Recirculation Pump with Demand Controls	IA, 2017
Hot Water	Circulator Pump EC Motor	ME, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Air Source Heat Pumps (ASHP) - Cold Climate	NEEP, 2018
HVAC	Air Source Heat Pumps (ASHP) - Cold Climate	NEEP, 2018
HVAC	Air Source Heat Pumps (ASHP)	NEEP, 2018
HVAC	Ground Source Heat Pump	NB, 2017
HVAC	Ground Source Heat Pump	NB, 2017
HVAC	Water Cooled Chiller, Centrifugal	PSEGLI, 2019

Class	Measure	Source
HVAC	Air Cooled Chiller	PSEGLI, 2019
HVAC	Energy Recovery Ventilator (ERV)	OEB, 2018
HVAC	HVAC EC Motor	MA, 2016-18
HVAC	Demand Control Ventilation (DCV)	IL, 2017
HVAC	Kitchen Demand Control Ventilation	IL, 2017
HVAC	Dual Enthalpy Economizer Controls	NB, 2017
HVAC	Energy Management System (EMS)	Custom
HVAC	Guest Room Energy Management	IA, 2017
HVAC	Advanced Thermostat (Wi-Fi Thermostat)	MA, 2016-18
HVAC	Refrigeration Heat Recovery	Custom
HVAC	Retro-commissioning Strategic Energy Manager (RCx SEM)	Custom
Kitchen	Dishwasher	IA, 2017
Kitchen	Fryer	MA, 2016-18
Kitchen	Oven	MA, 2016-18
Kitchen	Steamer	MA, 2016-18
Lighting	LED Bulbs	PEI, 2020
Lighting	Linear LED Tube	PEI, 2020
Lighting	LED Luminaire	PEI, 2020
Lighting	LED High Bay	PEI, 2020
Lighting	LED Exit Sign	NB, 2017
Lighting	LED Parking Garage (Exterior)	ME, 2018
Lighting	LED Pole Mounted (Exterior)	NB, 2017
Lighting	LED Wall Pack (Exterior)	ME, 2018
Lighting	LED Refrigerated Case Lighting	PSEGLI, 2019
Lighting	Lighting Controls (Interior), Daylighting	NB, 2017
Lighting	Lighting Controls (Interior), Occupancy	NB, 2017
Motor/Compressor	HVAC VFD - Cooling Tower	NB, 2017
Motor/Compressor	HVAC VFD - Fan	NB, 2017
Motor/Compressor	HVAC VFD - Pump	NB, 2017
Motor/Compressor	High Efficiency Air Compressor	PSEGLI, 2019
Motor/Compressor	High Efficiency Air Compressor	PSEGLI, 2019
Motor/Compressor	Air Receiver for Load/No Load Compressor	PSEGLI, 2019
Motor/Compressor	Air Receiver for Load/No Load Compressor	PSEGLI, 2019
Motor/Compressor	Low Pressure Drop Filters	IL, 2018
Motor/Compressor	Zero Loss Condensate Drain	NB, 2017
Motor/Compressor	Refrigerated Air Dryer	PSEGLI, 2019
Motor/Compressor	Motor Controls - Process	Custom
Motor/Compressor	Motor Controls - Conveyors	Custom

Class	Measure	Source
Motor/Compressor	Motor/Compressor Motor Controls - Pumps	
Office Equipment	Advanced Smart Strips	MA, 2019-20
Office Equipment	Advanced Smart Strips	MA, 2019-20
Refrigeration	Refrigerated Case Anti-Sweat Door Heaters	PSEGLI, 2019
Refrigeration	Refrigerated Case Anti-Sweat Door Heaters	PSEGLI, 2019
Refrigeration Refrigerated Case Door Gaskets		NY, 2017
Refrigeration Refrigerated Case Door Gaskets		NY, 2017
Refrigeration	Refrigerated Case Night Cover	MA, 2016-18
Refrigeration	ENERGY STAR Ice Maker	MA, 2016-18
Refrigeration	Refrigerated Case EC Motor	PSEGLI, 2019
Refrigeration	Refrigerated Walk-ins EC Motor	PSEGLI, 2019
Refrigeration	Refrigerated Walk-ins Evaporator Fan Control	PSEGLI, 2019

Measure Ramp-Up

Home Energy Report measures represent significant savings and are not currently offered by existing programs, so ramp rates of 33%, 67%, and 100% are applied in the first three years of the study, respectively.

C.1.2 Lighting Standards and market evolution

At the time of this study, Natural Resources Canada has announced a revision of lighting standards; however, no date has been set. Lighting standards are typically done in step with the U.S. DOE standard setting process, but again the timing has not yet been confirmed. Irrespective of potential new lighting standards, the lighting market has been evolving towards LEDs becoming the baseline for bulbs. As such, Dunsky is using a net-to-gross (NTG) of 0.3 for bulbs in both the residential and C&I sectors.

In addition, for the residential sector, it is assumed that the market dominance of LEDs is still growing but the study sunset the lighting measures after five years. At this point the market will be fully transformed or a new standard will be adopted and thus no more savings can be claimed. For C&I, a similar market transformation assumption is used; however, savings are claimed for different timescales depending on the Hours of Use (HOU) in a segment.

C.2Market Characterization

C.2.1 Customer Population Counts

Customer population counts are a key parameter for defining market opportunities. Population counts were estimated using anonymized monthly customer meter data provided by Maritime Electric and then scaled to include Summerside Electric customers. The final population counts for each sector and segment are presented in Table C-4.

Table C-4. Customer Sector and Segment Population Counts.

Sector / Segment	Number of Customers		
Residential	75,021		
Single Family	47,699		
Multi-Family ¹¹	16,070		
Low-Income	11,253		
Commercial & Industrial	6,989		
Office	2,411		
Retail	724		
Food Service	311		
Healthcare & Hospitals	168		
Campus & Education	75		
Warehouse	120		
Lodging	294		
Other Commercial	883		
Industrial/Agriculture	2,002		
Total	82,010		

To arrive at these population estimates, the customer data was treated with the following approach.

- Residential Metered accounts under rate codes 110 (Residential Urban) and 130 (Residential Urban) were included. Based on information provided by Maritime Electric, one meter is assumed to be one customer. Note, seasonal accounts were excluded from the study. The Maritime Electric data does not include a breakdown by residential segment therefore the results of the primary market data collection and the 2016 Statistics Canada Census were used to estimate the number of single family, multi-family, and low-income customers. These were then escalated by 10% to include Summerside Electric customers.
- Commercial & Industrial Maritime Electric provided C&I consumption by rate code as well as total consumption by three-digit SIC code and the associated number of meters. Dunsky mapped the SIC codes into groups, segments, and divisions of the classification structure, aggregating the consumption data into the appropriate C&I segment. Residential accounts were removed from the dataset and some adjustments were made based on additional information provided by Maritime Electric (e.g., education was isolated from offices). Based on information provided by Maritime Electric, it is assumed that C&I customers have on average 1.8 meters; this was used to convert the data from meters to number of customers. These were then escalated by 10% to include Summerside Electric customers. To note, electricity consumption related to agriculture is included under the industrial segment.

¹¹ The multi-family population count represents individual residential units within multi-family buildings. This segment includes apartments, condos, and duplexes.

C.2.2 Market Baseline Data

The DEEP model requires detailed baseline information, including stock, size and efficiency of existing energy-intensive equipment as well as information pertaining to typical building characteristics (e.g., heating fuel mixes, year of construction, building size) that can impact use. Ultimately, this information is used to determine which homes, commercial buildings, processes, and equipment might be eligible for more efficient equipment and the level of savings that might be achieved from various measures.

The study uses residential and C&I baseline information derived from telephone surveys conducted by Ad Hoc Research in the summer of 2020. This includes 150 residential and 200 commercial and industrial observations. The total number of observations by sector is a sufficient sample size to ensure a validity rate of 70% of the survey rate, which is typically considered acceptable for a high-level market baseline study. A snapshot of the residential and C&I respondents is provided in the tables below.

	Total	Single Family	Multi / Plex / Condo	Other	Low Income (less than \$50K)	Higher Income (\$50K or more)
Unweighted Counts	150	128	19	3	41	63
Prince	37	32	3	2	12	19
Queens	96	82	14	0	22	36
Kings	17	14	2	1	7	8

Table C-5. Summary of Residential phone survey respondents by type of building and income

Table C-6. Summary of C&I phone survey respondents by segment

	Total	Offices	Retail	Food Services	Health / Hospital	Campus / Education	Warehouse	Lodging	Indus. / Ag	Other
Unweighted Count	200	20	24	23	15	17	23	25	18	35
Weighted Count	200	38	56	18	13	9	15	9	12	31

Where Prince Edward Island specific baseline data was not available (or was based on a low number of observations), baseline data from neighboring jurisdictions, in particular New Brunswick and Newfoundland and Labrador, was leveraged and adjusted for PEI specific attributes wherever possible.

C.2.3 Growth Factors

Table C-7 lists the growth factors used in this study.

Table C-7. New growth factors

Sector	Growth Factor
Residential	1.23%
Commercial and Industrial	0.30%

C.3Program Characterization

Program characterization was performed by reviewing past EE program investments and savings. These were then compared to Dunsky's internal database of program incentive levels from other potential studies and program design work and the program costs, incentive levels and measure barrier reductions resulting from enabling activities in each program were set for each of the program scenarios.

C.3.1 Residential and C&I Programs

Table C-8 describes each residential and C&I program characterized for this study and the default barrier reductions applied based on existing enabling activities.

Program	Description	Barrier reductions
Energy Efficient Equipment	The program provides rebates for high efficiency equipment such as heat pumps and boilers.	Half step barrier reduction due to subsidized energy audits and availability of financing.
Home Insulation Rebates	The program encourages homeowners to perform energy efficient upgrades by providing information about the energy efficiency of their homes through home energy assessments and financial incentives to implement EE upgrades.	Half step barrier reduction due to subsidized energy audits and the availability of financing.
New Home Construction	The program encourages homeowners and builders to implement EE features in their new builds by providing customized EE recommendations through a review of house plans (evaluated by energy advisors) and financial incentives.	Half step barrier reduction due to subsidized energy evaluation of home plans.
Winter Warming	The program provides low to moderate income Islanders free-of charge direct installation of EE products.	Full step barrier reduction as program is direct install.
Instant Energy Savings	Instant cash rebates (in store and spring/fall campaigns) for lighting products, low-flow products, and appliances.	Half step barrier reduction due to in-

able C-8. Residential	and C&I Energy	Efficiency Program	Enabling Activity	Descriptions

Program	Description	Barrier reductions
		store promotional materials and customer engagement events.
Home Comfort	This is a low-income program that is run in parallel with the Department of Social Development and Housing.	Full step barrier reduction due to turn- key nature of the program, with efficiencyPEI approving quotes and paying contractors directly.
Home Energy Report	NEW	No barrier reduction
Busines Energy Rebates	The program provides commercial, industrial and agricultural customers with rebates for qualified high-efficiency products	No barrier reduction – list of contractors provided but largely
Community Energy Solutions	such as lighting, controls and heat pumps. This program provides energy audits and rebates for energy efficiency measures to businesses, community centers, and agricultural operations.	participant driven. Half step barrier reduction due to free energy audit.
Appliance Recycling	NEW	Half step barrier reduction (assumed to be similar to Instant Energy Savings)

BAU Scenario: Current Programs

The BAU Scenario applies current program parameters as per 2019/20 evaluated program results.

Table C-9.	Residential	Energy	Efficiency	Program	Inputs	(BAU Scenario)

Program Name	Fixed Administrative Costs	Variable Administrative Costs (\$/annual kWh)	Incentive as a percentage of incremental cost ¹²	NTG
Energy Efficient Equipment	33,845		27%	0.74
Energy Efficient Equipment Low- Income	3,761	0.02	54%	1
Home Insulation Rebates	15,889	0.11	43%	0.77

¹² Incentive as a percentage of incremental costs refers to the portion of the incremental cost of the new, more efficient measure that will be incentivized by the program administrator. In other words, if a high-efficiency heat pump replaces an older, less efficiency heat pump, the incremental cost between the two (cost of new minus old heat pump) is reduced by x%. The percentage is based on current efficiencyPEI program incentive levels and the primary or mix of technology baselines.

Home Insulation Rebates Low Income	1,765		70%	1
Instant Energy Savings - lighting	\$15,668	0.00	100%	0.30
Instant Energy Savings - other	\$491	0.09	14%	0.62
New Home Construction	20,466	0.14	29%	0.62
Winter Warming	13,600	0.04	100%	1
Home Energy Report	2,204	0.15	100%	1
Appliance Recycling ¹³	0	0.09	14%	1
Business Energy Rebates	41,251	0.04	50%	0.7 for lighting, 1 for heat pumps, 0.84 otherwise
Community Energy Solutions	17,654	0.11	50%	1

Note: Incentives are expressed as the portion of efficient equipment incremental costs covered by the program.

Mid Scenario: Best in class incentives

The Mid Scenario increases incentives to 75% except where they already exceeded this level with the exception of heat pumps, which were held constant at the BAU incentive level. Barrier reductions were held constant at BAU levels as the Mid scenario does not assume additional enabling activities beyond what is currently in place.

However, two enabling activity sensitivities were applied to the Mid Scenario. For the first, where feasible, a ½ step barrier reduction was added to each program to represent additional enabling activities and the fixed costs increased by 25% and variable costs by 15% to account for increased program investments. For the second, where feasible, a full step barrier reduction was added to each program to account for the additional enabling activities. An additional 5% increase in fixed costs and a 10% increase in variable costs was also applied to reflect the corresponding increase in program investments.

Max Scenario: 100% Incentives

Under the Max scenario, all incentives are increased to 100%, with the exception of heat pumps, which were held constant at BAU levels. As was the case for the Mid Scenario, barrier reductions were held constant at BAU levels.

¹³ The appliance recycling program was modelled as if it were an addition to the Instant Energy Savings program; however, as a new element it has been included separately for reporting purposes.

C.4Economic and other parameters

C.4.1 Discount and Inflation Rates

The discount and inflation rates were sourced from efficiencyPEI's most recent program evaluation reports as well as Maritime Electric's 2019 General Rate Application filing.

Table C-10. Discount and inflation rates

Rate Name	Rate Value
Nominal Discount	3.200%
Real Discount	1.276%
Inflation	2.000%

C.4.2 Avoided Costs

Avoided costs for energy and demand were sourced from efficiencyPEI's program evaluation reports and confirmed through a review of Maritime Electric's 20219 General Rate Application filing. Only one year of avoided cost information was available and therefore avoided costs forecasts were calculated using NB Power's avoided cost annual escalation rates for both energy and capacity.

The aggregated avoided cost inputs used in this study are available in a separate workbook accompanying this report. The values are reported in 2021 real-dollar terms.

C.4.3 Retail Rates

The study uses marginal retail rates to estimate customer bill impacts – one component of calculating adoption and thus achievable potential – for energy savings measures. Marginal electric retail energy and demand rates were developed by reviewing Maritime Electric's Schedule of "Adjusted Rates" as per the 2016 General Rate Agreement. To estimate the marginal rates by segment, Dunsky aggregated the rate variable costs by rate classes (e.g., residential market, general service, small industrial, and large industrial). Using consumption data by size and segment, Dunsky then blended the C&I rates to create general C&I segment rates.

The electricity rates were then forecasted through 2050 using the same yearly percent increases as use for avoided costs as the rate escalators.

C.4.4 Emission Factors

Marginal emission factors were sourced from efficiencyPEI.

Marginal emission factors

Rate Name	Value
Electricity	22g CO2e/kWh

C.4.5 Baseline Energy and Demand Forecasts

To help discern the impact of the various measures analyzed in the Potential Study on overall energy consumption and demand in Prince Edward Island, the study establishes baseline energy and demand forecasts for the study period.

Anonymized customer consumption data from Maritime Electric was used to set the base year energy forecast for the residential, commercial, and industrial sectors.¹⁴ Sector consumption was escalated using annual rates based on average historic annual growth rates presented in Schedule 7-3 of Maritime Electric's 2019 General Rate Application. A 10% adder was then applied to account for Summerside Electric customers, thus generating an Island-wide electricity forecast. This forecast was checked against the energy sales forecast included in Schedule 7-3 and the total was found to be 1% lower than the 2021 forecast in Schedule 7-3.¹⁵ It was also compared against Maritime Electrics 2020 Integrated Systems Plan.

The peak demand forecast is based on the Island-wide load forecast in the 2016/17 PEI Energy Strategy, which itself is based on Maritime Electric and Summerside Electric forecasts. The 2021 and 2022 values were used and then escalated using an average annual escalation rate derived from the peak load forecast in the energy strategy. The demand forecast was also compared against Maritime Electrics 2020 Integrated Systems Plan.

C.5 Demand Response Inputs

C.5.1 Standard Peak Day

MECL provided Dunsky with hourly historical load data for 2019. This historical data was used to create a standard peak day for the system.

¹⁴ To note, seasonal accounts were removed.

¹⁵ To note, for the sector comparison, customer consumption associated with the agriculture sector was isolated. 75% of this was then moved from residential sales in the General Rate Application Schedule 7-3 to account for the fact that most agricultural operations are currently included as residential customers. This consumption was then added to industrial customers, as agriculture is incorporated into the study's industrial energy forecast.





When considering all the impacts on peak demand, it should be noted that with increasing penetration of heat pumps, there is the potential to shift from an evening to morning peak, which has been seen in other jurisdictions. While not part of this assessment, a heat pump forecast study would provide additional insights into how the timing of the peak may shift (more likely towards the end of the study period).

C.5.2 End-Use Breakdowns

Dunsky developed end-use load curves for each market sector and end-use and where relevant, for individual segments. Note that these breakdowns are for the electric consumption only, not the whole building (all fuel) energy use. These provide a basis for three study processes:

- 1. They were used to assess standard peak day adjustments for DR addressable peak determination.
- 2. They were used to develop savings for custom measures, which are expressed as the potential savings as a portion of the associated end-use consumption.
- 3. They were used to benchmark savings when calibrating the model.

The end-use load curves were developed from the following sources:

- US Department of Energy (US DOE) published load curves, taken from buildings in comparable climate zones to the PEI climate zones, and adjusted to account for heating energy source.
- Engineered load profiles and Dunsky's in-house developed sample consumption profiles.
- Data from the Ad Hoc primary data collection survey results.

In this study, the industrial sector was grouped into one segment "Manufacturing / Industrial". The segment was modeled using one industrial end-use ("Industrial"), as seen in Error! Reference source not found.6. Industrials were evaluated using Dunsky's internal datasets.

Using this breakdown, an annual (hourly – 8670 hours) building energy consumption simulation from the US DOE (*Commercial Reference Buildings & Building America House Simulation Protocols*) allowed for the recreation of the end-use breakdown for a standard peak day. The figures below present the sector and end-use breakdown of the electric system.









C.5.3 Future impacts

The standard peak day was forecasted using the same peak demand forecast as the rest of the potential study. It is presented in the table below.

Table C-11. Peak Demand Forecast for Prince Edward Island

Year	Peak (MW)
2021	286
2022	294
2023	300
2024	307
2025	313
2030	348

C.5.4 Measures

To assess the DR potential in the jurisdiction, Dunsky characterized over 25 specific demand reducing measures, based on commonly applied approaches in DR programs across North America, and emerging opportunities such as battery storage. As defined in Appendix B, the measures are covering all customer segments and can be categorized into two groups: Type 1 (constrained by the load curve) and type 2 (unconstrained by load curve). Measures of all types have the following key metrics:

- Load shape of the measure
- Constraints
- Measure Effective Useful Life (EUL)
- Costs

Dunsky applied our existing library of applicable DR measure characterizations and adjusted them to reflect end-use energy use profiles in Prince Edward Island's climate. Each measure was evaluated independently for each segment of the study. Tables 4 and 5 provide an overview of each measure characterization and approach.

Table C-12. Residential Demand Response Measures

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST		
Appliances						
Clothes Dryer - DLC	Appliance shut off during event	Smart Plug	Number of non-smart clothes dryers in the jurisdiction	Smart Plug		
Clothes Dryer – BYOD ¹⁶	Appliance shut off during event	Smart Appliance	Number of smart clothes dryers in the jurisdiction	Incentive upon program inscription		
Clothes Washer - DLC	Appliance shut off during event	Smart Plug	Number of non-smart clothes washers in the jurisdiction	Smart Plug		
Clothes Washer - BYOD	Appliance shut off during event	Smart Appliance	Number of smart clothes washers in the jurisdiction	Incentive upon program inscription		
Dishwasher - DLC	Appliance shut off during event	Smart Plug	Number of non-smart dishwashers in the jurisdiction	Smart Plug		
Dishwasher - BYOD	Appliance shut off during event	Smart Appliance	Number of smart dishwashers in the jurisdiction	Incentive upon program inscription		
Hot Tub/Spa	Temperature setpoint reduction during event	Smart Switch	Number of hot tubs in the jurisdiction	Smart Switch		
Hot Water						
Resistance Storage Water Heater - DLC	Appliance shut off during event	Smart Switch	Non-smart electric water heater (excl. heat pump water heater)	Smart Switch		
Heat Pump Storage Water Heater – BYOD	Appliance shut off during event	Smart Heat Pump Water Heater	Smart heat pump water heater	Incentive upon program inscription		
HVAC						
Central Heating – DLC	Temperature setback	Wi-Fi Thermostat	Households with electric central	Installation of a Wi-Fi		

¹⁶ Bring-Your-Own-Device (BYOD) programs are a type of Direct Load Control (DLC) programs.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
	(including pre-heating strategies)		heating and with manual or programmable thermostat	thermostat
Central Heating – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with electric central heating and with Wi-Fi Thermostat	Incentive upon program inscription
Baseboards - DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with electric baseboards and with manual or programmable thermostat	Installation of a Wi-Fi thermostat
Baseboards - BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with electric baseboards and with Wi-Fi Thermostat	Incentive upon program inscription
Ductless HP – DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ductless HP	Installation of a Wi-Fi thermostat
Ductless HP – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ductless HP and a smart thermostat	Incentive upon program inscription
Ducted HP – DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ducted HP	Installation of a Wi-Fi thermostat
Ducted HP – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ducted HP and a smart thermostat	Incentive upon program inscription
Dual-fuel Systems	Fuel-switching at peak hours	Integrated Controls	Households with an electric central heating system.	Replacement of the existing system for a dual-fuel system.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
Electric Thermal Storage (ETS)	Stored heat (in ceramic bricks) is released throughout the peak hours	Integrated Controls	Households with compatible heating systems	Full cost of installing a new ETS system.
Other				
Electrical Vehicle (EV)	Shut off during event	Smart Electric Vehicle Supply Equipment (EVSE) or Smart Plug (such as FloCarma Plug)	Number of EVs in the jurisdiction x % charged at home	Smart EVSE or Smart Plug
Battery Energy Storage (BES) – BYOD	Battery discharges during event	Battery	All households with an existing BES system	Incentive upon program inscription
Time-of-Use (TOU) Rates	Implementation of a TOU Rates	AMI	All commercial and institutional buildings	None

Table C-13. Non-Residential Demand Response Measures

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
Appliances				
Commercial Refrigeration	Refrigeration loads shed	Auto-DR	Refrigeration load per building with low-temperature cases x number of buildings (Grocery only)	Automated demand response
Water Heater				
Resistance Storage Water Heater - DLC	Appliance shut off during event	Smart Switch	Non-smart electric water heaters (excl. heat pump water heater)	Smart Switch
HVAC				
Wi-Fi Thermostat – DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Small C&I buildings with central AC and with manual or programmable thermostat	Wi-Fi Thermostat
Wi-Fi Thermostat – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Small C&I buildings with central AC and with Wi-Fi thermostat	Incentive upon program inscription
Medium C&I – HVAC Curtailment	HVAC demand curtailment	Manual, BAS or existing Auto-DR	All medium-sized C&I buildings	None
Medium C&I – HVAC Curtailment (Auto-DR)	HVAC demand curtailment	Auto-DR	All medium-sized C&I buildings without existing systems	Auto-DR system
Large C&I – HVAC Curtailment	HVAC demand curtailment	Manual, BAS or existing Auto-DR	All medium-sized C&I buildings	None
Large Cpl – HVAC Curtailment (Auto-DR)	HVAC demand curtailment	Auto-DR	All medium-sized C&I buildings without existing systems	Auto-DR system
Lighting				
Medium C&I – Lighting Curtailment	Turning off some of the fixtures or reducing	Manual, BAS or Auto-DR	All medium-sized C&I buildings	None

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
	lighting levels during peak events			
Large C&I – Lighting Curtailment	Turning off some of the fixtures or reducing lighting levels during peak events	Manual, BAS or Auto-DR	All large-sized C&I buildings	None
Other				
Electrical Vehicle (EV)	Shut off during event	Smart Electric Vehicle Supply Equipment (EVSE) or Smart Plug	Number of EVs in the jurisdiction x % charged at the office	Smart EVSE or Smart Plug
Energy Storage	Battery Energy Storage (BES) discharges during event	BES	All C&I buildings with an existing BES system.	Incentive upon program inscription
Large Interruptible Loads	Load shifting with no intraday rebound, via expansion of interruptible rates	Manual, BAS or Auto-DR	All large-sized buildings	None
Time-of-Use (TOU) Rates	Implementation of a TOU Rates	AMI	All commercial and institutional buildings	None

C.5.5 Dynamic Rates

Dynamic rates impacts were assessed using a peak to off-peak ratio. Figure C-4presents this relationship that was established in a meta-analysis of TOU and dynamic rates by the Brattle Group¹⁷. This relationship is used to estimate peak savings and the energy shifted outside of the peak hours. Finally, based on Ontario's TOU roll-out, little to no energy conservation was reported when implementing TOU rates. For this reason, the study assumes a small 2% savings on the energy displaced over peak hours.





Ultimately a two-tier, 3:1 peak to off-peak TOU rate design, applied to residential customers, was found to deliver a reasonable benefit/cost ratio, when applied in the absence of other DR programs and measures. This was applied to the peak day load shape to create two peak rate windows (7-9 am and 4-7pm). Figure C-5, below, presents this TOU rate structure as well as the normalized energy redistribution profiles from the TOU demand savings.

¹⁷ Peak reduction from dynamic rates was assessed from "Arcturus: International Evidence on Dynamic Pricing", A. Faruqui and S. Sergici. 2013.

Figure C-5. Dynamic Rate Peak Reduction



The two-tier 3:1 TOU Rate design was applied to the system peak day, and it reduced the peak demand by 10.7 MW in 2030.

C.5.6 Programs

Table C-14 below presents the program costs for each major program type applied in the DR potential model. Program costs account for program development (set up), annual management costs, and customer engagement costs. These are added over and above any equipment installation and customer incentive costs to assess the overall program cost-effectiveness. In some cases, a program's constituent measures may be cost-effective, but the program may not pass cost-effectiveness testing due to the additional program costs. Under those scenarios, the measures in the underperforming program are eliminated from the achievable potential measure mix, and the DR potential steps are recalculated to reassess the potential and cost-effectiveness of each measure and program.

 Table C-14.
 DR Program Administration Costs Applied in Study (excluding DR equipment costs)

Program Name	Development Complexity	Development Costs	Program Fixed Annual Costs	Other Costs (\$/customers) for marketing, IT, admin
Residential DLC	Medium	\$150,000	\$75,000	\$35
Small Commercial DLC	Medium	\$150,000	\$75,000	\$40
Medium & Large C&I Curtailment	Medium	\$150,000	\$75,000	\$30
Residential Energy Storage	Medium	\$150,000	\$75,000	\$30
C&I Energy Storage	Medium	\$150,000	\$100,000	\$25
Dual Fuel Program	Medium	\$150,000	\$75,000	\$30
Large Interruptible Rates	Small	\$100,000	\$150,000	\$25
TOU Rates	High	\$300,000	\$150,000	\$5
	/			

D. Energy Efficiency Model Assumptions and Outputs

Appendix D contains additional detailed results tables for the energy efficiency module of the Potential Study as needed and is provided in an Excel Workbook format.

E.1 DR Technical and Economic Potential

The analysis applies a range of DR programs, assessing the ability of each to address the PEI annual peak. A description of each individual program assessed follows.

It is important to note that in this section the technical and economic potentials are assessed for each measure individually, interactions within each individual measure are included but no interactions among the measures are considered. The following technical and economic potential results provide the DR potential of each measure, across all applicable segments, including currently enrolled demand reduction capacity.

Measures that cost-effectively deliver sufficient peak load reductions individually are retained and applied in the achievable potential scenario analysis to determine their achievable potential, the results of which are presented later in this chapter. Consistent with the other savings modules in this study, only cases where the measure yields a Program Administrator Cost (PAC) Test value in excess of 1.0 are retained in the economic potential. In all cases test values presented here are those associated with the specific installation year indicated, covering just the market segments that yield PAC Test values that exceed the threshold.

E.1.1 Medium and Large Commercial and Industrial Programs

MECL and Summerside have already enrolled a certain amount of large commercial and industrial load reductions through their current large interruptible load agreement (15MW based on PEI Energy Strategy). This is comprised of facility load curtailment, as well as self-generation capacity, that can be currently engaged in emergency cases. Table E-1, below, presents the measures providing a notable degree of peak load reduction.

	20	25	2030	
Measure	Technical Potential (MW)	Economic Potential (MW)	Technical Potential (MW)	Economic Potential (MW)
Battery Energy Storage (BYOD)	10.5	10.5	11.4	11.4
Medium & Large Curtailment	39.2	34.9	39.9	35.6
Large Interruptible	16.7	16.7	18.3	18.3

Table E-1. Medium and Large Commercial and Industrial Potential

Curtailment measures assumed a 4-hour curtailment window. These measures cover all HVAC measures (setpoint reduction, fresh airflow reduction, etc.) along with other various end-uses and processes (hot water, pumps, etc.). For larger buildings, lighting curtailment can be implemented alongside HVAC system curtailment, applying manual controls at the facility level during DR calls.

As limited data was available regarding the medium & large customers, it was assumed that most of the large customers willing to participate in a DR program were already enrolled under the interruptible program. For the purpose of this study, the interruptible measure refers to interruptible customers that would be willing to participate in DR-specific events in exchange for an additional performance incentive. Finally, battery energy storage measure leverages existing batteries without any up-front costs from the utility¹⁸.

E.1.2 Small Business – Equipment Control Program

Small Business Equipment Control measures include Bring-Your-Own-Device (BYOD) and utility Direct Load Control (DLC) measures, similar to the residential sector programs of the same names. These measures were applied just to the portion of each commercial segment that would be considered a small building or premises.

	20	25	2030	
Measure	Technical Potential (MW)	Economic Potential (MW)	Technical Potential (MW)	Economic Potential (MW)
Battery Energy Storage (BYOD)	0.5	0.5	0.5	0.5
Water Heater (BYOD & DLC)	0.8	0.3	0.9	0.4
Wi-Fi Thermostat (BYOD & DLC)	3.2	3.2	3.5	3.5

Table E-2. Commercial Equipment Control Potential

E.1.3 Residential Programs

Residential programs include a range of existing and new equipment control measures. It includes both Bring-Your-Own-Device (BYOD) and utility provided Direct Load Control (DLC) measures, as listed in

¹⁸ Assuming that market penetration grows up to 5% of large customers and 3% of medium customers.

Table E-3, below.

Table E-3. Residential Equipment Control Potential

	20	25	2030	
Measure	Technical Potential (MW)	Economic Potential (MW)	Technical Potential (MW)	Economic Potential (MW)
Clothes Dryer (BYOD & DLC)	7.6	0.7	8.4	1.0
Clothes Washer (BYOD & DLC)	0.5	0	0.55	0
Dishwasher (BYOD & DLC)	0.6	0	0.7	0
Spa (DLC)	0.59	0.59	0.63	0.63
Wi-Fi Thermostat – Central (BYOD & DLC)	12.6	12.6	13.5	13.5
Wi-Fi Thermostat – Baseboards (BYOD & DLC)	4.3	3.6	4.6	3.9
Wi-Fi Thermostat – Ductless HP (BYOD & DLC)	11.2	11.2	13.1	13.1
Wi-Fi Thermostat – ASHP (BYOD & DLC)	3.3	3.3	3.6	3.6
Dual Fuel Systems	33	31.2	35	33.2
Thermal Energy Storage	14.7	14.7	16.3	16.3
Water Heater (BYOD & DLC)	22.7	22.7	24.1	24.1
Battery Energy Storage (BYOD)	0.3	0.3	0.35	0.35
EV Charging (DLC)	0.2	0.2	0.5	0.5

Most of the economic potential lies in Wi-Fi Thermostat (setpoint control), thermal energy storage systems, dual fuel systems, and smart water heaters. EV load management potential is limited by the projected uptake of EVs over the study period. It should be noted however that as EV adoption accelerates, it is expected to amplify the peak and shift it later in the evening, making EV load management ever more important.

E.2 Demand Response Achievable Potential

E.2.1 Active Demand Potential Results by Measure

Tables below displays the achievable potential for each residential and C&I measures that passed the costeffectiveness screening. Table E-4. Residential Achievable Potential Results by Measure by Scenario (MW)

		2030		
Program	Measure	Customer Incentives	Customer Incentives + Interruptible Rates	
Residential BYOD	Wi-Fi Thermostat – Central	0.3	0.3	
Residential BYOD	Wi-Fi Thermostat – Baseboard	0	0	
Residential BYOD	Wi-Fi Thermostat – Ductless HP	0.6	0.6	
Residential BYOD	Wi-Fi Thermostat – ASHP	0.1	0	
Residential BYOD	Smart Clothes Dryer	0.1	0	
Residential DLC	Wi-Fi Thermostat – Central	1.5	1.2	
Residential DLC	Wi-Fi Thermostat – Baseboard	0.5	0	
Residential DLC	Wi-Fi Thermostat – Ductless HP	0	0	
Residential DLC	Wi-Fi Thermostat – ASHP	0.3	0	
Residential DLC	Electric Vehicle	0.1	0	
Residential DLC	Spa (smart switch)	0.1	0	
Residential DLC	Resistance Storage Water Heater (smart switch)	3.0	1.1	
Residential Energy Storage	Battery Energy Storage	0.1	0.1	
Residential Energy Storage	Thermal Energy Storage	3.3	0	
Dual Fuel Program	Dual Fuel System	4.0	4.0	

Table E-5. C&I Achievable Potential Results by Measure by Scenario (MW)

		2030		
Program	Measure	Customer Incentives Scenario	Customer Incentives + Interruptible Rates	
Medium & Large C&I Curtailment	Commercial Refrigeration (Auto- DR)	0.1	0	
Medium & Large C&I Curtailment	Medium Curtailment	3.7	3.1	
Medium & Large C&I Curtailment	Medium Curtailment (Auto-DR)	0.4	0.3	
Medium & Large C&I Curtailment	Large Curtailment	0.5	0.5	
Medium & Large C&I Curtailment	Large Curtailment (Auto-DR)	0	0	
Small Commercial BYOD/DLC	Resistance Storage Water Heater (smart switch)	0	0	
Small Commercial BYOD/DLC	Wi-Fi Thermostat	0.2	0	
C&I Energy Storage	Small Battery Energy Storage	0	0	
C&I Energy Storage	Large Battery Energy Storage	1.3	1.3	
C&I Energy Storage Medium Battery Energy Storage		0.3	0.3	
Large Interruptible	Large Interruptible	0	18.3	

E.2.2 Active Demand Potential Detailed Results

A detailed set of model outputs are included in a separate Excel spreadsheet. The spreadsheet includes achievable potential per segment as well as costs and cost-effectiveness results by measure by year.



This report was prepared by Dunsky Energy Consulting. It represents our professional judgment based on data and information available at the time the work was conducted. Dunsky makes no warranties or representations, expressed or implied, in relation to the data, information, findings and recommendations from this report or related work products.