GEC Response to Environmental Defence Interrogatory #1

Question:

Reference: Exhibit L.GEC.1, pp. 9 & 10 Topic 3: Budgets

Mr. Neme's report provides benchmarking of Union and Enbridge's gas savings targets in comparison to savings achieved in other jurisdictions.

(a) The gas savings targets of Enbridge and Union are compared to "leading" jurisdictions. Does Mr. Neme believe that the achievable cost-effective DSM potential for Enbridge and Union would be similar to the savings that have been achieved in these "leading" jurisdictions? Please explain why and any not.

(b) Is the benchmarking analysis one way to estimate the achievable cost-effective DSM potential for Enbridge and Union at a very high level? Please explain why or why not?

(c) Please provide a revised benchmarking comparison including only those utilities that are required to implement all cost-effective DSM programs?

(d) How does the benchmarking analysis compare to the utilities' estimates of the achievable cost-effective DSM in their service areas?

Response:

a) In aggregate, I expect that the levels of savings achieved in the leading jurisdictions that I cite should be cost-effectively achievable in Enbridge's service territory. As noted in my testimony, like Enbridge, these are jurisdictions that are in cold climates and have long histories of gas DSM. Also, the portion of their gas sales going to residential customers (ranging from just under 40% to about 50%) are very similar to Enbridge's (a little more than 40%).

I expect that Union could get even greater savings as a percent of sales because a larger portion of its sales go to larger customers from which it is typically easier and less expensive to acquire savings; conversely, a much smaller portion of its sales (only about one-quarter) go to residential customers from which it is typically harder and more expensive to acquire savings.

I should also emphasize that I have compared savings actually achieved in 2014 in leading jurisdictions to those the Ontario utilities are planning for 2 to 6 years into the future. There are reasons to believe that at least some of the leading jurisdictions will be

achieving greater savings in those future years than they achieved in 2014. For example, the Minnesota utilities are collectively proposing savings for 2016 that are 25% higher than what they achieved in 2014 (driven largely by a proposed 44% increase from Centerpoint, the state's largest gas utility). In Vermont, Vermont Gas will be subject to a requirement to acquire all cost-effective efficiency for the first time in 2016. It has largely set its own budgets and savings targets in the past, with relatively little regulatory scrutiny.

b) Yes, it is certainly one very legitimate way. Its principal advantage over other approaches, such as potential studies, is that it is based on actual real world results rather than hypothetical formulas that many potential studies (including Enbridge's most recent study) use to make assumptions about market adoption rates at different payback periods by consumers. The reality is that the world is more complex than such studies assume it to be. There are many different kinds of market barriers other than payback periods or even customer awareness levels (which some studies also try to formulaically include in their market penetration estimates). And there are many different program strategies for over-coming them.

c) Two of the four jurisdictions that I analyzed – Massachusetts and Rhode Island – currently have requirements to pursue all cost-effective efficiency. As noted above, a third jurisdiction – Vermont – has not lived under such a requirement in the past, but will starting in 2016. Minnesota does not have such a requirement. It only requires that utilities achieve savings equal to 1% of sales from eligible customers (though the utilities have collectively been exceeding that target, largely because of fairly aggressive efforts by the state's largest gas utility, Centerpoint Energy).

d) That is a difficult question to answer because Union has not conducted an achievable potential study in a number of years and Enbridge's recent study only estimated gross savings potential (i.e. not net of free riders).

GEC Response to Environmental Defence Interrogatory #2

Question:

Reference: Exhibit L.GEC.1, pp. 20-21 Topic 3: Budgets

Mr. Neme's report outlines a number of ways in which the sensitivity analysis completed by Union is flawed. If those flaws were corrected, how would that impact the overall achievable cost-effective DSM derived from Union's sensitivity analysis directionally speaking?

Response:

The savings Union could achieve with additional funds would increase relative to what the Company estimated.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #3

Question:

Reference: Exhibit L.GEC.1, pp. 21-24 Topic 3: Budgets

Mr. Neme's report outlines a number of ways in which the sensitivity analysis completed by Enbridge is flawed. If those flaws were corrected, how would that impact the overall achievable cost-effective DSM derived from Enbridge's sensitivity analysis directionally speaking?

Response:

The additional savings that Enbridge could achieve with higher budgets would be greater than what it estimated.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #4

Question:

Reference: Exhibit L.GEC.1, pp. 30-31 Topic 3: Budgets

(a) Mr. Neme's report notes that in 2013 and 2014 Union calculated the TRC benefits of its large industrial DSM programs based on a free rider rate of 54%. Does that mean that only 46% of the actual TRC benefits associated with these programs were counted in the cost-effectiveness screening undertaken for Union's DSM plans for those years? Does that also mean that, according to the Union's board-approved plans for those years, *all* of the TRC benefits reported by Union in relation to those programs would not have occurred without the utility's programs?

(b) Please file a copy of the studies regarding free ridership referred to on page 31.

(c) Mr. Neme's report states that "There is also no empirical evidence, from Ontario or any other jurisdiction, to support the hypothesis … that large customers would pursue all cost-effective efficiency investments on their own." Do the ACEEE and Navigant Consulting reports outlined on page 31 constitute solid empirical evidence showing that large customers likely will *not* pursue all cost-effective efficiency investments on their own?

(d) In Mr. Neme's professional opinion, are Union's large customers are sufficiently sophisticated and motivated to implement all cost-effective DSM measures on their own? Why or why not?

Response:

a) It means that only 46% of the benefits associated with the efficiency measures installed were counted in Union's cost-effectiveness screening of its program. It is also true that Union only claimed 46% of the savings from the measures installed through the program. Put another way, if 54% is an accurate estimate of free ridership, all of the savings that Union claimed would not have occurred without its program.

b) For the Navigant study for the TEC see M.GEC.APPrO.1. The ACEEE study was previously filed in EB-2012-0037 at Exhibit D6.1 The Utah study is attached.

c) Yes. And in my testimony I just referenced a few studies that suggest there is significant untapped efficiency potential among industrial customers. I provided other references in my testimony in the Union 2013-2014 DSM plan case (EB-2012-0337).

Witness: Chris Neme

d) I have no doubt that Union's large customers are quite sophisticated; nor do I doubt that they are motivated to acquire cheap savings. However, experience across North America suggests that they almost certainly are not capturing all efficiency that is more cost-effective than supply alternatives. That said, as suggested in my testimony, if the Board was concerned about the rare customer that may be addressing all cost-effective opportunities, it could deal with that concern by allowing such customers to "opt-out" of a program if an independent audit confirms such claims.

Evaluation Report for Utah's Self-Direction Credit Program (PY 2012 through 2013)

Prepared for:
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Executive Summary

This report describes the findings from Navigant's impact and process evaluation of Utah's Self-Direction Credit program years 2012 through 2013 (PY 2012-2013), including program- and project-level gross and net realization rates, program cost-effectiveness results, and feedback from program participants concerning satisfaction and areas for improvement for the program as a whole. These evaluation results generated recommendations for improving program processes, methods, and delivery as Self-Direction Credit transitions to the *wattsmart* Business program.

Program Background

The Self-Direction Credit program offered custom incentives and engineering services to Rocky Mountain Power's (RMP) commercial and industrial (C&I) customers in Utah for the implementation of energy efficiency measures.[1]

The program allowed maximum customer control to self-direct the Customer Efficiency Services Charge into qualified cost-effective efficiency improvement projects. To be eligible for the program, customers must have met one of the two following requirements:

- Minimum annual usage of 5,000,000 kilowatt-hours (kWh)
- Minimum peak load of 1,000 kilowatts (kW)

Customers could aggregate commonly owned meters to meet the 5,000,000 kWh requirement, but the 1,000 peak kW load must have come from a single site. New construction projects were eligible for the program if the projected annual electricity use met one of the aforementioned requirements. Upon review and approval by RMP customers completing a Self-Direction Credit project received a credit for the Customer Efficiency Services Charge on their monthly electric bills. The total program cap for new projects was $5 million in credits per year, with credits approved on a first-come, first-served basis. A third party program administrator, Nexant, Inc., (hereafter referred to as the program administrator) ran the Self-Direction Credit program on behalf of RMP.

Evaluation Objectives

This evaluation addressed the following objectives:

- Verify the annual and combined 2012 through 2013 gross and net energy and demand impacts of RMP's Self-Direction Credit program
- Review the effectiveness of program operations, highlight achievements, and identify opportunities for process improvements
- Characterize participant motivations
- Perform cost-effectiveness calculations on evaluated results for each year evaluated and in total

[1] Self-Direction Credit program description information was adapted from RMP Annual Reports, program brochures and promotional material, descriptive content in prior evaluations, and interviews with program administrative staff.

Impact Evaluation

The impact evaluation of RMP's Self-Direction Credit program involved the following activities:

- Quantifying the impacts of all measures and activities on annual gross energy consumption while accounting for any interactions among technologies
- Establishing post-implementation performance for installed measures and activities
- Explaining discrepancies between the results of this study and the reported savings estimates

Evaluation metrics and parameters reported through this effort include the following:

- Gross program demand and energy savings estimates and realization rates for projects
- Energy usage profiles for C&I technologies obtained through measurement and verification activities

Summary of Impact Findings

The evaluation team conducted a combination of in-depth project file reviews, spreadsheet reviews, weather-normalized utility meter analyses, interviews with facility staff, and on-site audits to evaluate the savings for each project sampled for the PY 2012-2013 evaluation period. The verification sample included 16 of the 59 projects that participated in PY 2012-2013 and represented 66 percent of reported program savings. This sample achieved a 90/4 confidence and precision at the program level.

The 2012 through 2013 program-level demand savings realization rate was 113 percent and the program-level energy savings realization rate was 91 percent. These numbers demonstrate the success the program has achieved. Table ES-1 provides the ***program-level*** reported and evaluated kW and kWh realization rates at the customer meter.

Table ES-1. Gross Program-Level Realization Rates for UT Self-Direct (PY 2012-2013)

Program Year	Program Reported kW	Gross Program Evaluated kW	Gross Program kW Realization Rate	Program Reported kWh	Gross Program Evaluated kWh	Gross Program kWh Realization Rate
2012	2,199	2,201	*100%*	15,514,585	14,557,457	*94%*
2013	2,907	3,594	*124%*	29,873,206	26,657,992	*89%*
All	5,106	5,795	*113%*	45,387,791	41,215,449	*91%*

Net-to-Gross (NTG) Ratio

The evaluation team calculated an NTG ratio of 1.04 for Utah's Self-Direction Credit program for years 2012-2013. Section 3.3 provides further detail on the NTG results by program year and in total.

Cost-Effectiveness

The evaluation team used a cost-effectiveness model, calibrated and updated with RMP's input parameters, to produce results for five primary cost tests: PacifiCorp's Total Resource Cost test (PTRC), Total Resource Cost test (TRC), Utility Cost Test (UCT), Rate Impact Measure test (RIM), and the Participant Cost Test (PCT), for calculating the program's benefit/cost ratios. Table ES-2 provides the cost-effectiveness results for the five cost tests over the evaluated PY 2012-2013.

Table ES-2. UT Self-Direct Cost-Benefit Results – 2012-2013 Combined (1.04 NTG)

Benefit/Cost Test Performed	Evaluated Gross kWh Savings	Evaluated Net kWh Savings	Evaluated Costs	Evaluated Benefits	B/C Ratio
Total Resource Cost Test (PTRC)	41,225,955	42,874,993	$12,817,188	$32,761,431	2.56
Total Resource Cost Test (TRC)	41,225,955	42,874,993	$12,817,188	$29,783,119	2.32
Utility Cost Test (UCT)	41,225,955	42,874,993	$10,056,082	$29,783,119	2.96
Rate Impact Test (RIM)	41,225,955	42,874,993	$37,907,870	$29,783,119	0.79
Participant Cost Test (PCT)	41,225,955	42,874,993	$11,361,814	$35,835,746	3.15

Process Evaluation

The process evaluation assessed the Self Direction Credit program from the perspective of program staff and participants in order to identify both existing strengths and areas for refinement that may better serve the Utah C&I market in future years. The evaluation team surveyed 22 participants in 2012 and 2013 and combined the results with information from program staff interviews to create a comprehensive view of the Self-Direction Credit program from 2012 to 2013. Notable findings include the following:

- **Bill credits and energy savings were the most influential components of the program.** Respondents indicated that the RMP credit and the ability to save energy influenced them to participate in the Self Direction Credit program. Respondents also appreciated the supporting program information on measure payback, indicating it encouraged further the installation of additional energy efficiency measures (EEMs).
- **Participants indicated they would like more communication with program administrators.** Two of six respondents suggested that more communication with program administrators would increase their overall satisfaction with the Self-Direction Credit program.
- **Participants of the program are aware of further energy efficient project opportunities.** The majority (82 percent) of participants believed additional energy efficiency opportunities exist at their organization, and most planned to participate in the Self Direction Credit program again. These findings indicate that participants are engaged and seeking out further efficiency opportunities.

- **Participants see costs as the primary barrier to conducting additional energy efficiency projects.** Of the participant respondents who thought they could take further energy-efficient actions, 33 percent reported costs to be a major barrier to conducting these projects. Specifically, these respondents cited high upfront costs and lack of access to capital as major barriers.
- **The majority of participants were very satisfied with the program.** Overall, 81 percent of respondents were satisfied with the program; 63 percent were very satisfied and 19 percent were somewhat satisfied. Most respondents reported that the energy savings related to each measure met their expectations and that they had seen non-energy benefits as well.

Program Evaluation Recommendations

- **Recommendation 1. Ensure measure classifications in database are correct.** Impact evaluation activities found incorrect measure classifications in the RMP program database. Ensuring correct classifications will help with future sampling efforts and file reviews. The shift to the improved procedures under the new *wattsmart* Business program will likely remedy this issue.

1 Introduction

This report describes the findings from Navigant Consulting, Inc.'s (Navigant's) impact and process evaluation of Utah's Self-Direction Credit program years 2012 through 2013 (PY 2012-2013). This section provides a description of Utah's Self-Direction Credit program, along with a review of the program theory and logic model that depicts the activities, outputs, and desired outcomes of the program.[2]

1.1 Program Description

The Self-Direction Credit program offers custom incentives to RMP's large commercial and industrial (C&I) customers to implement energy efficiency measures (EEMs).[3] The program's primary objective is to allow maximum customer control to self-direct the Customer Efficiency Services Charge on their monthly electric bill into qualified cost-effective efficiency improvement projects. To be eligible for the program, customers must meet one of the two following requirements: minimum annual usage of 5,000,000 kilowatt-hours (kWh) or a peak load of 1,000 kilowatts (kW). Customers may aggregate meters under common ownership to meet this requirement. New construction projects are eligible for the program if the projected annual electricity use meets one of the two requirements. Upon review and approval by RMP, customers completing a Self-Direction project will receive a credit for the Customer Efficiency Services Charge on their monthly electric bills. A third party program administrator, Nexant, Inc., runs the Self-Direction Credit program on behalf of RMP.

The following three project types are eligible under the 2012-2013 Self-Direction Credit program:

- **Completed Projects.** Cost-effective electric conservation projects completed by customers between January 1, 2012, and December 31, 2013. Customers must not have received incentives for the project through any other RMP energy efficiency (EE) program. Approved projects receive a Self-Direction credit for 80 percent of eligible expenses, subject to a $750,000 cap in any given year.
- **Pre-Approved Projects.** Similar to "Completed Projects," except that customers complete a pre-approval process by submitting an application to the program administrator. Approved applications receive a Self-Direction credit of 80 percent of eligible expenses, reserved for a limited time, ensuring that 1) the customer's project will be approved (assuming execution of project as designed) and 2) funding will be available in the program upon completion of the project.
- **Opt-Out Projects.** Customers who cannot demonstrate available remaining EE projects with a payback period of less than eight years are eligible for a 50 percent Self-Direction credit. Customers must perform a new energy audit to renew the credit every two years. This 50 percent credit will not be available to a customer during any time they are receiving another eligible credit under the program.

[2] In 2014, the program transitioned to become the custom portion of the *wattsmart* Business program and RMP no longer offers the program as Self Direction Credit. However, for purposes of the 2012-2013 program evaluation cycle, the Self Direction Credit program title, description, and theory still apply.

[3] Self-Direction Credit program description information was adapted from RMP Annual Reports, program brochures and promotional material, descriptive content in prior evaluations, and interviews with program administrative staff.

Customers interested in completing a Pre-Approved Self-Direction Credit Project first submit a Pre-Qualification Project Submittal and then repay any incurred engineering costs to RMP, if any. The program administrator may elect to perform an inspection based on the specifics of the project and would ultimately approve or reject the project. If approved, the customer signs and returns the Pre-Qualification Approval Letter and Program Agreement. The program administrator then reserves the credit funding for a limited time and the customer completes the project. After 24 months, the customer must re-apply for funds. For both pre-approved and completed projects, the customer submits a Complete Project Submittal to the program administrator, who arranges for an inspection and approves or rejects the project. For approved projects, the customer signs and returns the Approval Letter and Program Agreement and the program administrator credits the customer's account and notifies the customer of the final credit.

1.2 Program Changes from 20012 to 2013

During the evaluated period from January 2012 to December 2013, there were two notable changes to the Self-Direction Credit program (Tariff 192). First, in May of 2012, the existing expiration date for the tariff related to the charge offset by the Self-Direction Credit (Tariff 193) was removed and the approach to changing the rate of the charge was modified to reduce adjustments. This change ensured that qualifying customers would still be motivated to participate in the program, and did not make any changes to the program theory or delivery. In May of 2013, the company filed a request to cancel the existing C&I EE programs and consolidate them into a new *wattsmart* Business program (Tariff 140). The Public Service Commission of Utah approved this shift with an effective date of July 1, 2013. Therefore, the Self-Direction Credit program ceased to start new projects after July 1, 2013, but projects already in progress could be completed under the program. Marketing had already shifted to the *wattsmart* brand before this evaluation period.

1.3 Program Participation

PY 2012-2013 results included 59 Self-Direct completed projects in Utah: 33 projects in 2012 and 26 in 2013. The 59 projects included the installation of 61 EEMs and reported 45,387,791 kWh in energy savings over the two-year period. Table 1 summarizes the program project counts that included the installation of the associated measure category.[4]

[4] Measure categories here are from the program database and do not adjust for any incorrect classifications.

Table 1. Utah's Self-Direction Credit Measure Category Details for PY 2012-2013

Measure Category	Measure Type Counts[5]	Reported kWh Savings	Percentage of Total Savings
Lighting	38	18,220,510	40%
Motors	7	14,749,602	33%
HVAC	7	5,848,525	13%
Compressed Air	4	5,484,921	12%
Controls	3	709,030	2%
Other	2	375,203	1%
All	61	45,387,791	100%

1.4 Program Theory and Logic Model

Program logic models depict the primary program activities, actions required to implement the program, the outputs expected to result from each activity, and the expected short-, mid-, and long-term outcomes of those activities. This includes marketing, participant recruitment, and training, among others. The outputs depict tangible, tracked, or tallied "products" resulting from each primary activity (i.e., marketing materials, training documents, and databases of recruited participants). Outcomes represent the intended results of successful deployment of the identified activities.

Developing a logic model that clearly provides the theory of action and change is an important step in evaluation, allowing the evaluator and program actors to see inside the program "black box."[6] Program logic models provide a framework for an evaluation by highlighting key linkages between program activities and expected outcomes. The process and impact evaluations focus on these linkages, particularly those on the critical path to achieving savings goals. The evaluation identifies properly working linkages in the program logic model, as well as weak or broken linkages that could cause program shortfalls in achieving the intended outcome(s).[7] With this foundation, the evaluation team can then make informed choices related to the prioritization and focus of evaluation resources. The evaluation team reviewed program documentation and spoke with program managers and administrators to verify the underlying theory for the Self-Direction Credit program logic model (Figure 1).[8]

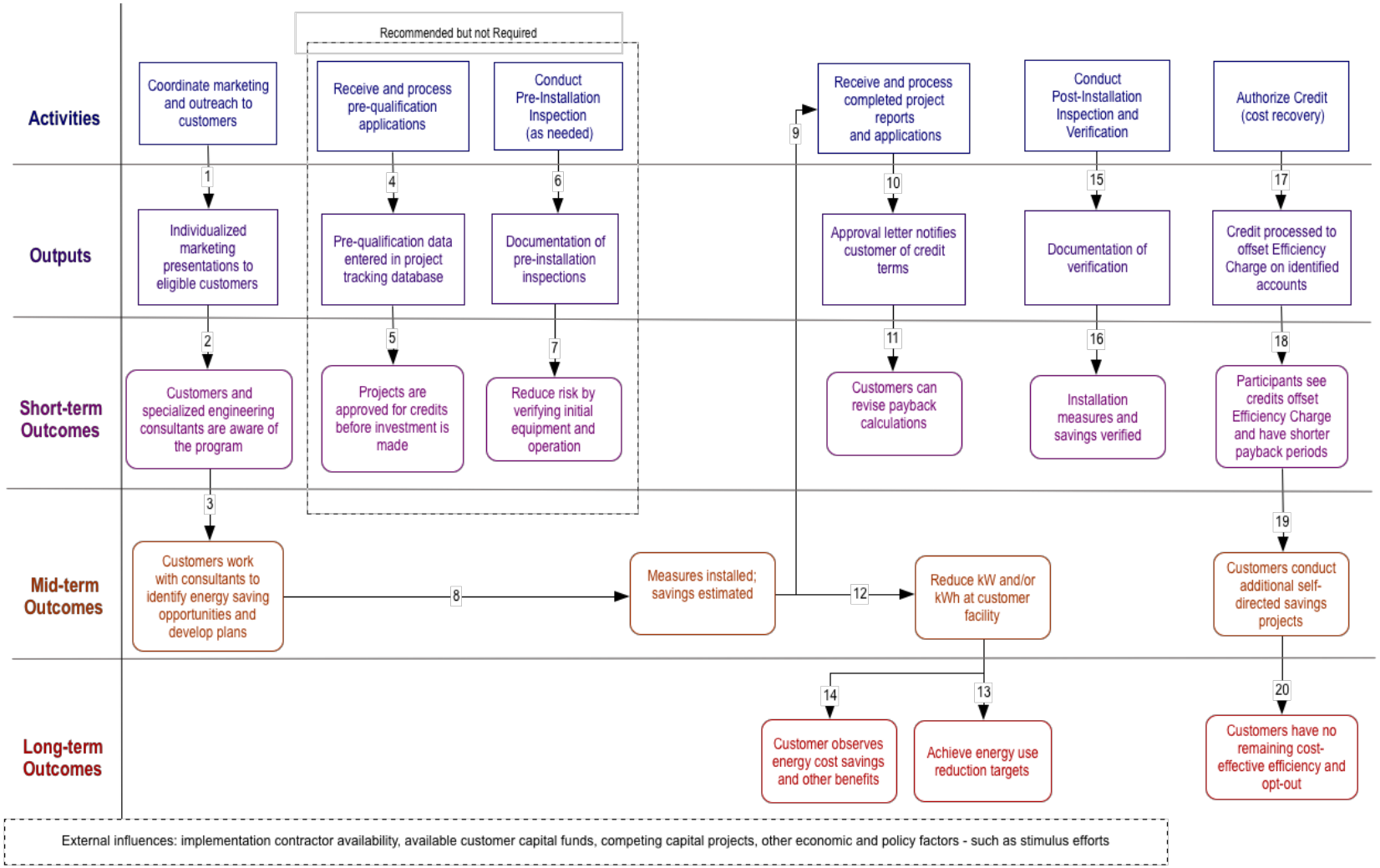
[5] For lack of a better term, Navigant uses "measure type counts" in this table even though these numbers more strictly align with *the number of line items in the tracking database* by measure category. A single project could have multiple line items in the tracking database for the same measure category, as well as include multiple measure categories.

[6] Sue Funnell and Patricia Rogers, 2011, *Purposeful Program Theory: Effective Use of Theories of Change and Logic Models*, John Wiley & Sons.

[7] Section 4.2, Question 3 provides more specifics on the logic model review.

[8] The Self-Direction Credit logic model described in this section depicts the program theory used for PY 2012-2013, but will become obsolete as the program transitions to the *wattsmart* Business program. Appendix C provides the new logic model and theory developed for the *wattsmart* program.

Figure 1. Utah Self-Direction Credit Program Logic Model (2011)



RMP designed their Self-Direction Credit program to provide credits to C&I customers who implement EE projects which can help overcome the common long payback period barrier that non-residential customers traditionally face. The following list describes the linkages within the program logic, with numbers corresponding to those shown in the logic model (Figure 1).

1. The RMP Project Manager (PM), program administrator, and account managers coordinate efforts to directly market the program to large customers. Individual presentations at the customer site provide comprehensive program information. The program administrator works with identified engineering firms to ensure they are aware of program requirements and have program-approved templates for project submittals.
2. Eligible customers and specialized engineering firms are aware of the program.
3. Customers identify projects that may qualify for the Self-Direction Credit, either alone, through RMP provided energy analyses, or through energy analyses performed by independent engineering firms.
4. Customers or their engineering firm may choose to submit a pre-qualification application to the program administrator to ensure the project qualifies before moving forward with implementation.
5. The project tracking database documents pre-qualification applications. Projects receive pre-approval, reducing uncertainty.
6. If deemed necessary, based on the project pre-qualification application, the program administrator may conduct an inspection of the customer facility before approving or rejecting the identified project.
7. Pre-qualification inspections reduce discrepancies between reported and verified energy savings by verifying initial equipment and operating conditions.
8. The customer or their contractor purchase and/or install EEMs.
9. Customers, or their engineering firm, submit project submittal reports and invoices to the program administrator. The program administrator reviews the project submittal report for quality control and insures the project qualifies. In general, engineering firms with existing program experience submit the project, easing communication constraints to ensure proper documentation. For projects that did not receive pre-qualification, this can be the first formal communication of the project between the customer and the program administrator. The program logic anticipates some projects transferring to the Self-Direction Credit program, including the buyout of engineering funded by RMP.
10. An approval letter notifies the customer of project acceptance for credits.
11. Customers can revise payback calculations to include the credits. This can free-up capital to invest in other projects.
12. EEMs reduce energy consumption at the customer's facility.
13. Reduced energy consumption contributes to meeting annual program targets.
14. Customers see energy cost reductions and possibly operations/maintenance benefits.

15. The program administrator (and sometimes the PM) inspect and verify installation of measures.
16. The final report documents verification. Verification ensures that expected savings occur.
17. The program administrator notifies RMP of project completion. The program administrator conducts a quality control review and assigns the project for cost recovery. RMP processes program credits to the customer account.
18. The customer receives program credit. Credit on monthly bills for length of credit term reduces the payback period for the project. RMP recovers cost for engineering analysis used to identify the project, if applicable.
19. Customers conduct additional self-directed capital improvements due to familiarity with costs and benefits of efficiency projects and success with credit on bills.
20. Customers can opt out of 50 percent of efficiency charge so long as they have no remaining cost-effective EE projects (cost-effective being with payback periods from one to five years before the credit).

As part of the program evaluation, the evaluation team compared program outcomes in place with the outcomes expected in the logic model. In order to make this comparison, the evaluation team identified indicators for each expected outcome as well as sources of indicator data. In some cases, these indicators are directly observable from program tracking data or other archives; in other cases, indicators are observed through analysis of survey or interview responses. Table 2 identifies key indicators and data sources for Utah's Self-Direction Credit program outcomes (short-, medium-, and long-term) shown in the logic model, above.

Table 2. Indicators and Data Sources for Program Outcomes

Outcome	Indicator	Data Source
Short-Term Outcomes		
Customers and specialized engineering consultants are aware of the program.	Non-participant awareness; energy engineers identified by RMP	Customer interviews; engineer resource list
Projects are approved for credits before investment is made.	Timeline for pre-approved projects	Program tracking data; customer interviews
Risk is reduced by verifying initial equipment and operation.	Site visits occurring for pre-approved projects	Program tracking data; customer interviews
Customers can revise payback calculations.	Customers use pre-approval in decision process.	Customer interviews
Installation of measures and savings is verified.	Verification in project file; inspection date	Project files; program tracking data
Participants see Credit offset Efficiency Charge and have shorter payback periods.	Customers receive credits; cost-recovery date	Program tracking data; customer interviews
Mid-Term Outcomes		
Customers work with specialized consultants to identify opportunities and establish plans.	Customers choose to self-direct savings through consultants.	Customer interviews
Measures are installed and savings are estimated.	Applications include measures and savings.	Customer interviews; energy engineer interviews
kW and/or kWh are reduced at customer facility.	Customers realize expected savings.	Customer interviews; ex post impact savings
Customers conduct additional self-directed savings projects.	Repeat participation	Program tracking data; customer interviews
Long-Term Outcomes		
Energy use reduction targets are achieved.	RMP meets targets.	Reported savings
Customers observe energy cost savings and other benefits.	Customers realize expected savings.	Customer interviews
Customers have no remaining cost-effective efficiency and opt out.	Opt out of participation	Program tracking database

2 Evaluation Methodology

The following section describes the evaluation methodologies used in Utah's 2012-2013 Self-Direction Credit program. The evaluation team developed and informed these methods through an independent review of evaluation best practices.[9]

2.1 Impact Evaluation Methodology

This section summarizes the impact evaluation methods used to develop project- and program-level realization rates for the Self-Direction Credit program. Findings provide RMP staff with the feedback they need to increase program efficacy and to advance the research and policy objectives of the Utah Public Service Commission by providing an independent quantitative review of program achievements.

The impact evaluation of Utah's Self-Direction program aimed to characterize energy and demand impacts for incented projects in the 2012 through 2013 program years, including the following:

- Quantifying the impacts of all measures and activities on annual gross energy consumption while accounting for any interactions among technologies
- Establishing post-implementation performance profiles for installed measures and activities
- Explaining discrepancies between the results of this study and the reported savings estimates

Evaluation metrics and parameters reported through this study include the following:

- Gross program demand and energy savings estimates and realization rates for incented projects
- Energy usage profiles for C&I technologies metered through on-site measurement and verification (M&V) activities

See section 3 for gross and net impact results.

The Self-Direction programs include only custom projects. The evaluation team used a combination of International Performance Measurement and Verification Protocol (IPMVP) Options A and B as the most common evaluation methods employed for these projects, where the evaluation team either metered the individual equipment power consumption or light operation or obtained facility data showing records of equipment operation.[10]

2.1.1 Project File Reviews

A thorough review of the Self-Direction project files allowed the evaluation team to increase the accuracy of calculated measure savings and demand reductions, thereby ensuring that they were representative of installed conditions.

[9] See Appendix B for detail on EM&V Best Practices.
[10] For more information regarding IPMVP options and definitions, see http://www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=397&lang=en.

The evaluation team reviewed each project file, characterizing any data gaps, looking for consistency issues, and checking the accuracy of the information used to estimate project-level savings. The team also assessed the variability and uncertainty between RMP's input assumptions and secondary studies, along with the relative impact on energy and demand savings. This type of sensitivity analysis was crucial in prioritizing and aligning task resources. The results of this effort informed the development of recommendations for input assumption revisions based on prior evaluation studies, upcoming policy requirements, and geographic factors.

Figure 2 presents an example of the overview of parameters verified through the project file review process. Overall, the evaluation team found the Self-Direction project files and assumptions to be sound and within industry standards. Note: the values below are fictitious and not actual examples from the RMP database.

Figure 2. Parameters Verified Through Project File Reviews (Example)

Site Name	Sample
Site Address	Address
Project #	SDC00_000081
Program	Utah Self-Direct
Customer Name	Contact name
Program Year	2013
Project Description	LED lighting retrofit
Measure Category(ies)	Lighting
Installation Date	May 2013
Incentive Amount	$30,860
Navigant M&V Report Author	Navigant
Navigant Field Staff Present on Site	Navigant
Site Visit Date(s)	August 26, 2014
Site Visit Type	Verification and logger installation

2.1.2 Sampling Frame Development

For the evaluation of the Self-Direction Credit program, the evaluation team adopted a ***ratio estimation*** approach to sampling, which achieved increased precision and reliability by taking advantage of a relatively stable correlation between an auxiliary variable and the variable of interest (i.e., the ratio of actual savings to program-reported savings). This approach served to reduce the overall coefficient of variation within the population.

Moreover, the evaluation team proportionately stratified the sample by program-reported savings into three subgroups (i.e., strata). The evaluation team selected projects proportionately within each stratum to ensure the following:

1. The evaluation of the largest projects and contributors to program performance
2. The fair representation of medium and smaller projects in the evaluation

The impact evaluation achieved a 90/4 confidence and precision across PY 2012-2013 by energy (kWh) savings. [11]. Table 3 provides an overview of the impact evaluation framework, representing 66 percent of the reported Self-Direction Credit program savings.

Table 3. Overview of the Impact Evaluation Sampling Framework

Sample Strata	kWh Threshold for Stratification (lower limit)	Total Number of Projects	Projects in Sample	Program Reported MWh	Gross Sample Reported MWh	Portion of Reported Savings Evaluated[12]
1	3,700,000	3	3	13,942	13,942	100%
2	900,000	7	6	16,456	14,057	85%
3	0	49	7	14,990	2,051	14%
Total	-	59	16	45,388	30,050	66%

2.1.3 Gross Energy and Demand Realization Rate Calculation

The impact evaluation team combined gross energy and demand realization rates for each project in the impact evaluation sample to form ***program-level*** realization rates for each program year. The team researched the following technical issues in order to accurately determine gross program impacts and realization rates:

- The appropriateness of the pre-installation technology performance baseline via project file and secondary literature review
- Installation and quantity of claimed measures
- Baseline and measure performance characteristics of the measures installed, and revision of performance variables (i.e., operating hours) as needed

[11] The evaluation team planned for 90/10 by program and state.
[12] This percentage represents the portion of the reported program savings that fell within the bounds of the evaluation sample frame. It does not represent the relation between the reported and evaluated savings numbers in the prior two columns.

- » Load shapes for the EEMs installed through the programs
- » Demand savings (kW) and energy savings (kWh) impacts of the efficiency measures installed for sampled projects[13]

The program-level realization rate is the ratio of the product of case weights and ***verified*** savings estimates from sampled projects and the product of case weights and ***reported*** savings estimates, as illustrated in the following equation:

$$Program\ Realization\ Rate_i = \frac{\sum_{i=1}^{n} Case\ Weight_i \times Verified\ Savings\ Estimate_i}{\sum_{i=1}^{n} Case\ Weight_i \times Reported\ Savings\ Estimate_i}$$

See Section 3 for energy and demand realization rate results.

2.1.4 Program Cost-Effectiveness

The cost-effectiveness of utility-funded programs in the state is typically analyzed using tests prescribed by the California Standard Practice Manual.[14] For the purposes of this evaluation, RMP specifically required the following cost-effectiveness tests:

- » PacifiCorp Total Resource Cost Test (PTRC)
- » Total Resource Cost Test (TRC)
- » Utility Cost Test (UCT)
- » Ratepayer Impact Measure Test (RIM)
- » Participant Cost Test (PCT)

The evaluation team worked with RMP to understand the PTRC and construct a tool that calculates the PTRC at measure, program, and portfolio levels. Table 4 presents details of the cost-effectiveness tests accepted by RMP.

[13] The evaluation team combined individual measure-strata realization rates into a weighted average realization rate for the given measure, as well as for the sample as a whole. The team applied the sample-level weighted realization rate to measures in the population not reflected or under-represented in the sample. The team also applied measure-level weighted realization rates to measures with sufficient representation in the sample (i.e., lighting and PC Power management) in order to extrapolate them to the population.

[14] The California Standard Practice Manual is an industry-accepted manual identifying cost and benefit components and cost-effectiveness calculation procedures. Definitions and methodologies of these cost-effectiveness tests can be found at http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF.

Table 4. Details of Cost-Effectiveness Tests[15]

Test	Acronym	Key Question Answered	Summary Approach
Participant Cost Test	PCT	Will the participants benefit over the measure life?	Comparison of costs and benefits of the customer installing the measure
Utility Cost Test	UCT	Will utility revenue requirements increase?	Comparison of program administrator costs to supply-side resource costs
Ratepayer Impact Measure	RIM	Will utility rates increase? Considers rate impacts on all participants, and potential for cross-subsidization	Comparison of program administrator costs and utility bill reductions to supply-side resource costs
Total Resource Cost Test	TRC	Will the total costs of energy in the utility service territory decrease?	Comparison of program administrator and customer costs to utility resource savings
PacifiCorp Total Resource Cost Test	PTRC	Will the total costs of energy in the utility service territory decrease when a proxy for benefits of conservation resources is included?	Comparison of program administrator and customer costs to utility resource savings including 10 percent benefits adder

2.2 *Validity and Reliability of Impact M&V Findings*

The evaluation team identified several sources of uncertainty associated with estimating the impacts of the Self Direction Credit program. Examples of such sources include the following:

- Sample selection bias
- Physical measurement bias (e.g., meter bias, sensor placement, and non-random selection of equipment or circuits to monitor)
- Engineering analysis error (e.g., baseline construction, engineering model bias, and modeler bias)
- Limited data (i.e., short-term trend data for facilities that may have long-term variations)

The evaluation team remained cognizant of these issues throughout the evaluation process and adopted methods to reduce the uncertainty arising from these sources, thereby improving the validity and reliability of study findings.

[15] "Understanding Cost Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy – Makers" NAPEE, November 2008. http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf.

2.2.1 Reducing Uncertainty from Sample Selection Bias

Evaluators recognize the problem that selection bias creates for program evaluation, even when adhering to impact evaluation sample design protocols, if the selected projects did not choose to participate in the evaluation effort. In an effort to minimize non-response bias, the evaluation team established and implemented the following recruitment protocols:

- Notified participants as early as possible in the evaluation process
- Accurately characterized M&V activities and the duration of the evaluation process
- Maintained brief and frequent communication with participants and informed them of any changes/additions to the evaluation effort

The intent of these protocols was to give each participant ample time to prepare documentation and secure the appropriate resources to support the evaluation effort. Brief and frequent contact with each participant ensured the participant remained engaged.

2.2.2 Reducing Uncertainty from Physical Measurement Error

Inevitable error occurs with all physical measurement. For the impact evaluation of the Self-Direction Credit program, a large measurement effort involved installing lighting/current/power loggers to determine the operating characteristics of incented technologies across a broad range of applications. The evaluation team took the following steps to minimize the possible introduction of uncertainty resulting from bias/error by this process:

- **Backup Loggers:** Prior evaluation experience indicates that lighting loggers sometimes fail in the field due to flickering or battery issues. To account for this possibility, the evaluation team deployed backup loggers for each site to ensure meeting the sample size requirements even if a percentage of the loggers failed.
- **Logger Calibration:** To minimize measurement error from improper calibration of the lighting/current/power loggers, the evaluation team checked all loggers used in the field to ensure proper calibration prior to deployment. Field staff received training to use consistent measurement intervals whenever possible, and to synchronize the logger deployment activities (i.e., time delay), to ensure proper data comparisons across a uniform period.
- **Logger Placement:** The field staff used a prescribed protocol for the placement and installation of loggers on circuits (i.e., current transformer placement) and fixtures (i.e., uniform distance from the lamps) to minimize biases arising from the improper placement of loggers.
- **Logging Period:** Usage patterns for retrofit measures may vary from month to month, so sampling for a short duration could introduce a degree of error into the overall results. The evaluation team reduced this type of error by typically deploying loggers for a minimum of four weeks, and supplemented them with available facility records (i.e., Energy Management System [EMS] trends, production logs). The team calibrated the facility records, which spanned multiple months or years, with the collected logger data.

» **Logged Data Quality:** Poor quality data can also be a significant source of error and uncertainty. The evaluation team applied various quality assurance checks to minimize the potential impact of this problem, including the use of consistent spot measurements comparable against both the EMS and logger data, and qualified analysts review all logger files to ensure results represented the investigated technologies.

» **Lighting Logger Review:** The evaluation team reviewed lighting loggers to identify inconsistencies in operating characteristics and/or extended periods of inactivity. The team followed up with field staff and facility managers to ensure that the suspicious findings were in fact reasonable, and removed inaccurate results from the analysis.

2.2.3 Reducing Uncertainty from Engineering Analysis Error

The evaluation team adopted the following protocols to minimize uncertainty from engineering analysis error in this study:

» Peer review of all project analysis findings to ensure the consistent use of methods and assumptions throughout the impact evaluation

» Data collection methods to yield appropriate inputs into the analysis models and review of all field observations with the evaluation team

2.3 Net-to-Gross (NTG) Estimates

The evaluation team used interviewee self-reported responses to assess the program's influence on the participants' decisions to implement EEMs and determine what would have occurred absent program intervention. This estimation included an examination of the program's influence on three key characteristics of the project: its timing, its level of efficiency, and its scope (i.e., the size of the project). This estimate represents the amount of savings attributed to the program that would have occurred without its intervention, referred to as "*free- ridership*."

The team's measurement of net savings then estimated program influence on the broader market because of the indirect effects of the program's activities. This estimate, referred to as "*spillover*," represents the amount of savings that occurred because of the program's intervention and influence but not currently reported by any PacifiCorp program. Navigant classified spillover savings into two categories based on measure types: "like" spillover and "unlike" spillover.

» **"Like" spillover** – energy savings associated with additional high efficiency equipment installed outside of the program of the same end-use as what that participant installed through the program. For example, if the participant installed high-efficiency lighting fixtures as part of the program, "like" spillover would be limited to any additional high efficiency lighting installed without any assistance from RMP but influenced by program activity. This type of spillover **is** quantifiable using program tracking savings as a proxy.

» **"Unlike" spillover –** the savings associated with any other high efficiency equipment installed outside of the program that are not of the same end-use category as what was installed through the program. Continuing the example above, if the participant installed high efficiency lighting through the program, the high efficiency HVAC equipment installed outside of the program would be considered "unlike" spillover as it is not the same end-use. This type of spillover is not quantifiable, but it is useful to document and track.

A program's net savings are adjusted by both free-ridership and spillover savings at the measure level and then extrapolated to the program. The net savings are the program-reported savings minus any free-ridership savings, plus any identified spillover savings – as shown in the following equation:

Net Program Savings = Gross Program Savings – Free-Ridership Savings + Spillover Savings

Often, this finding is described as a "net-to-gross ratio," defined as the net program savings divided by the gross program savings, or:

Net-to-Gross (NTG) Ratio = Net Program Savings / Gross Program Savings

The evaluation team calculated the Utah Self-Direction Credit NTG ratio of 1.04 using a different self-reported sample of 22 projects representing close to 23 percent of the total reported savings. Section 3.2 provides the results of the NTG analysis.[16]

2.4 Process Evaluation Methodology

This section describes the methodology used to complete the process evaluation.

2.4.1 Overview of Steps in the Process Evaluation

The evaluation team undertook the following activities in order to meet the objectives of this evaluation:

» **Develop Process Evaluation Research Questions.** The evaluation team and RMP staff established key process evaluation questions through the development of the PY 2012-2013 evaluation plan.

» **Review Program Documentation.** The evaluation team reviewed program documentation including regulatory filings, brochures, application forms, and websites.

» **Verify Logic Model.** The evaluation team worked with program staff to verify that the logic model for the Self-Direction Credit program describes the intended program design, activities, outputs, and outcomes.

[16] Where possible, Navigant adhered to the NTG guidelines as set forth by the Department of Energy (DOE) Uniform Methods Project (UMP) when calculating the NTG ratios. (Dan Violette and Pamela Rathbun, 2014, *Estimating Net Savings: Common Practices*, National Renewable Energy Laboratory [NREL]).

» **Collect Process Data.** The evaluation team collected process data through interviews with program staff, interviews with near-participants, and telephone surveys with participating customers.

» **Analyze and Synthesize Process Data.** The evaluation team assessed the effectiveness of the program processes by analyzing in-depth interview data and participant survey data.

2.4.2 Process Evaluation Research Questions

Discussions with program staff and a review of the program theory and logic identified seven overarching research questions to guide the process evaluation:

1. What are the program goals, concept, and design?
2. Do program staff and administrators have the resources and capacity to implement the program as planned, and if not, what more is needed?
3. Is the program being delivered in accordance with the logic model?
4. Is the program marketing effective? Specifically, how do customers find out about the program?
5. What is the program influence on participant actions? Specifically, what do participants identify as most important to their projects (i.e., program information, incentive/credit, payback, engineering, and their own company goals)?
6. What barriers are preventing customers from taking actions to reduce energy consumption and demand, and which jeopardize program cost-effectiveness?
7. Are participants achieving planned outcomes? Specifically, are participants feeling satisfied?

Evaluation staff used a mixed-methods approach to explore these questions including, program documentation review, interviews of program staff, near-participants, and participants. Table 5 shows the seven research questions and associated methods used to answer each.

Table 5. Process Evaluation Research Question Approach

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Program Documentation Review	X	X	X	X			
Program Staff and Administrator Interviews	X	X	X	X			
Participant Surveys				X	X	X	X

Section 4.2 provides the answers to these seven questions.

2.4.3 Program Documentation Review

The evaluation team reviewed program marketing materials, websites, program manuals, savings measurement tools regulatory filings, annual reports, previous evaluations, and project tracking data.

This review was designed to identify how the program is marketed, how trade allies are supported, and how the process for enrollment, administration, and tracking works.

2.4.4 Logic Model Verification

The evaluation team verified that the existing program logic model, developed in 2011 for the Self-Direction Credit program in Utah, continued to represent the program theory during the current evaluation.[17] To do so, the team used results from program administrator interviews and reviewed evaluation findings to assess whether the program produced the intended activities, outputs, and outcomes as defined in the 2011 model.

2.4.5 Process Data Collection Activities

Interviews and surveys with program staff and participants supported the development of the program overview and logic model, as well as aided in the evaluation conclusions and recommendations for the Self-Direction Credit program. The evaluation team reviewed all interview response data for missing or erroneous entries before tabulating the frequency of similar responses within categories. After they analyzed data from each data collection activity individually for findings, the evaluation team identified common process findings across activities.

2.4.5.1 Program Staff and Administrator Interviews

The evaluation team interviewed one program manager and one program administrator with the following objectives:

- Understand the design and goals of the Self-Direction Credit program
- Understand any program changes that have been implemented in Utah going into the 2012-2013 cycle, and changes occurring during this cycle
- Follow up on how recommendations were implemented (or not) from previous evaluations
- Support confirmation or revision of the existing program logic model
- Identify program strengths from program staff perspective
- Identify program weaknesses and opportunities for improvement from the program staff perspective
- Identify other actionable ideas the program staff hopes to gain from the evaluation

2.4.5.2 Participant Interviews

The evaluation team conducted four semi-annual telephone surveys. Due to a change in program evaluation objectives, these surveys were not identical. All four waves of surveys included questions about program influence and satisfaction. The last surveys also included additional process questions on

[17] RMP recently revamped the Self-Direction Credit program in Utah to be a part of the *wattsmart* Business program. However, the program theory and logic model created for the 2011 Self-Direction Credit program remained current as of this writing. Appendix C displays the logic model for the new *wattsmart* Business program theory.

how customers learned about the program and the equipment installed.[18] The evaluation team did not re-sample from the measures completed during previous cycles.

Table 6 identifies the timing and sampling frame for the 22 participant surveys. Due to survey re-structuring, the process team only asked the complete list of process questions to eight participants, those surveyed in the first half of 2012 and the second half of 2013.

Table 6. Sample Frame for Participant Surveys in 2012 and 2013

Time Period	Sample	Unique Sites	Program Projects
First Half 2012 (Projects completed Jan. 1, 2012-June 30, 2012)	6	12	15
Second Half 2012 (Projects completed July 1, 2012-Dec. 31, 2012)	9	14	17
First Half 2013 (Projects completed Jan. 1, 2013-June 30, 2013)	5	11	11
Second Half 2013 (Projects completed July 1, 2013-Dec. 31, 2013)	2	15	15
Total	22	52	58

Participant surveys were designed to do the following:

- Describe how customers come to participate in the program
- Understand overall customer satisfaction with the program, including (where appropriate) marketing, application materials, inspections, customer service, and the incentive or credit
- Understand program influence on customer actions, including free-ridership and spillover
- Identify barriers customers are facing that prevent increasing energy efficiency

[18] After the first semi-annual survey, conducted as interviews with Self-Direction Credit participants, the program evaluation direction was to focus only on net savings and drop the process evaluation. The program direction changed again before the last survey to re-include process evaluation.

3 Impact Evaluation Findings

This section summarizes the impact evaluation findings for projects included in the PY 2012-2013 impact evaluation sample.

The evaluation team characterized savings as "reported" and "evaluated." Reported savings present project savings estimated at the time of measure installation. Evaluated savings represents sampled energy savings verified at the time of evaluation, with results extrapolated to the entire population.

3.1 Gross kW and kWh Savings

The impact evaluation team conducted on-site verification activities for 16 of the 59 projects (representing 66 percent of reported savings) that participated during Utah's Self-Direction Credit PY 2012-2013. The program-level ***demand savings*** realization rate was 113 percent, and the gross program ***energy savings*** realization rate was 91 percent. Table 7 provides the ***program-level*** reported and evaluated kW and kWh realization rates.

Table 7. Program-Level Realization Rates for Utah Self-Direct

Program Year	Program-Reported kW	Gross Program Evaluated kW	Gross Program kW Realization Rate	Program-Reported kWh	Gross Program Evaluated kWh	Gross Program kWh Realization Rate
2012	2,198	2,201	*100%*	15,514,585	14,557,457	*94%*
2013	2,907	3,593	*124%*	29,873,206	26,657,992	*89%*
All	5,106	5,794	*113%*	45,387,791	41,215,449	*91%*

The realization rates reflect the difference between expected savings at the time of installation and evaluated savings one to three years after project completion. However, customers often modify their operating profiles for reasons unrelated to program influence. For example, the C&I sector is particularly sensitive to economic changes as production throughput, occupancy, and customer demand drive operating schedules. Changes in equipment usage also affect the efficiency of the baseline and replacement technologies for completed projects in the Self-Direction Credit program. Throughout the impact evaluation, the evaluation team remained cognizant of these factors, which can influence project-level savings. Table 8 provides *project-level* energy savings and realization rates for the 16 projects in the impact evaluation sample.

Table 8. Utah's Self-Direction Project-Level Energy (kWh) Realization Rates

Project ID	Year	Measure Group	Reported kWh	Evaluated kWh	Realization Rate
SDC00_000104	2013	Motors	6,344,299	1,341,154	21%
SDC00_000102	2013	Motors	3,848,762	4,362,003	113%
SDCSe_70144	2012	Lighting	3,749,344	4,392,183	117%
SDC00_000100	2013	HVAC	3,603,570	3,652,415	101%
SDC00_000103	2013	Compressed Air	2,853,791	2,450,757	86%
SDC00_000096	2013	Lighting	2,510,983	2,608,357	104%
SDC00_000080	2012	Lighting	2,114,046	2,642,215	125%
SDC00_000031	2012	Lighting	2,023,340	1,944,505	96%
SDC00_000081	2013	Lighting	951,172	890,508	94%
SDC00_000041	2013	Lighting	861,975	792,623	92%
SDC00_000060	2013	Lighting	589,428	496,713	84%
SDC00_000050	2012	HVAC	322,500	322,500	100%
SDC00_000063	2012	Controls	124,830	184,857	148%
SDC00_000067	2012	Lighting	89,276	77,412	87%
SDC00_000064	2012	Lighting	39,523	37,816	96%
SDC00_000082	2013	Motors	23,329	42,595	183%

Some projects included multiple measures with higher levels of realization rate variability. Table 9 displays the 4 projects that yielded evaluated energy savings that varied from reported values by more than 10 percent.

Table 9. Self-Direction Credit Projects with High Variance in Realization Rates

Project ID	Measure	kWh Realization Rates	Notes
SDC00_000104	Pump with VFD	21%	Gas pumps regularly cycled on and off at facility, reducing the verified connected load and hours of use. This, along with the lack of motor resizing as claimed, contributed to the low realization rate.
SDC00_000080	Package Lighting	125%	Occupancy sensors provided substantially more energy savings than expected.
SDC00_000063	Heated Air Dryer	148%	Dessicant dryer heat was cycling instead of running continuously.
SDC00_000082	Well Pump Motor Downsizing	183%	Substantial changes at facility resulted in reduced pump operation and increased savings. Demand savings decreased due to decommissioning of one affected pump.

Further explanation for a few of the more atypical ***measure-level*** realization rates are as follows:

» Projects **SDC00_000104** was a natural gas field with multiple pumps installing VFDs, but run hours were less than the *ex-ante* values resulting in reduced savings. The facility cycles the gas pumps on and off regularly and one pump, consisting of roughly one fifth of the claimed savings, was not operating during the verification site visit. The original project also claimed savings from resizing of motors which did not occur, further contributing to reduced savings.

» Project **SDC00_000082** was a production facility which had undergone substantial changes, resulting in reduced pump load and increased savings.

Table 10 displays the *project-level* demand (kW) savings and realization rates for the 24 projects in the impact evaluation sample.[19]

Table 10. Utah's Self-Direction Project-Level Demand (kW) Realization Rates

Project ID	Year	Measure Group	Reported kW	Evaluated kW	Realization Rate
SDC00_000104	2013	Motors	363	176	48%
SDC00_000102	2013	Motors	214	360	168%
SDCSe_70144	2012	Lighting	551	570	103%
SDC00_000100	2013	HVAC	310	300	97%
SDC00_000103	2013	Compressed Air	77	292	379%
SDC00_000096	2013	Lighting	389	373	96%
SDC00_000080	2012	Lighting	215	204	95%
SDC00_000031	2012	Lighting	247	237	96%
SDC00_000081	2013	Lighting	161	166	104%
SDC00_000041	2013	Lighting	178	180	101%
SDC00_000060	2013	Lighting	55	56	102%
SDC00_000050	2012	HVAC	209	209	100%
SDC00_000063	2012	Controls	13	13	102%
SDC00_000067	2012	Lighting	7	19	268%
SDC00_000064	2012	Lighting	4	4	98%
SDC00_000082	2013	Motors	23	15	65%

[19] Sites with no claimed demand savings show a realization rate of "NA."

3.2 *Program-Level Net Savings Results*

The evaluation team calculated an average NTG ratio of 1.04 using self-reported participant responses to free-ridership and spillover survey and interview questions for the current PY 2012-2013 evaluation (Table 11).

Table 11. Savings-Weighted Program Influence for PY2012-2013

Part of Year	Free-Ridership Score	Like Spillover Score	Unlike Spillover Score[20]	Net Savings Ratio
First Half 2012 (completed Jan. 1, 2012-June 30, 2012)	0.01	0.00	Yes, Not Scored	0.99
Second Half 2012 (completed July 1, 2012-Dec. 31, 2012)	0.05	0.03	Yes, Not Scored	0.99
First Half 2013 (completed Jan. 1, 2013-June 30, 2013)	0.00	0.37	Yes, Not Scored	1.37
Second Half 2013 (completed July 1, 2013-Dec. 31, 2013)	0.00	0.00	None	1.00
Savings Weighted Total	0.01	0.05	NA	1.04

Table 6 in section 2.4.5 provides the number of surveys completed during the identified timeframes.

Table 12 provides evaluated program-level demand and energy savings with the NTG ratio of 1.04 applied to evaluated savings estimates.

Table 12. Program-Level Net Realization Rates for Utah's Self-Direction Credit Program

Program Year	Program Reported kW	Program Evaluated kW	kW Realization Rate	Program Reported kWh	Program Evaluated kWh	kWh Realization Rate
2012	2,199	2,289	*104%*	15,514,585	15,139,197	*98%*
2013	2,907	3,737	*129%*	29,873,206	27,735,796	*93%*
All	5,106	6,026	*118%*	45,387,791	42,874,993	*94%*

3.3 *Cost-Effectiveness Calibration and Analysis*

The evaluation team initialized and validated the cost-effectiveness model used for this evaluation using prior inputs and outputs from previous evaluation cycles, to ensure similar inputs yielded similar outputs for the current cycle. The evaluation team worked through a range of input assumptions pertaining to avoided cost data formats, financial assumptions regarding discount and escalation rates,

[20] Research determined whether unlike spillover was present; however, Navigant recommends further research to estimate potential savings. See Section 2.3 for additional detail on like and unlike spillover.

participant costs and benefits, and other input parameters. Table 13 provides an overview of cost-effectiveness input values used by the evaluation team in the cost-effectiveness analysis.

Table 13. Utah Self-Direction Cost-Effectiveness Evaluation Input Values

Input Description	2012	2013	2012-2013
Discount Rate	7.17%	6.88%	-
Inflation Rate	1.80%	1.90%	-
Commercial Line Loss	8.71%	8.71%	8.71%
Industrial Line Loss	5.85%	5.85%	5.85%
Measure Life	13 Years	13 Years	13 Years
Commercial Retail Rate	$0.079	$0.082	-
Industrial Retail Rate	$0.054	$0.056	-
Gross Customer Costs	$4,485,732	$6,876,082	$11,361,814
Program Costs	$4,161,510	$5,894,571	$10,056,082
Program Delivery	$607,195	$393,706	$1,000,901
Incentives	$3,554,316	$5,500,865	$9,055,181

The discount rates and inflation rates are based on the 2011 IRP for 2012 and the 2013 IRP for 2013. Measure specific load shapes and the System Load Shape Decrement were used for all program years.
Program Delivery includes: engineering, program implementation, marketing, and utility administration costs.

Table 14 through Table 16 illustrate the costs, benefits, and benefit/cost ratio for the cost-effectiveness tests used in this evaluation using the calculated NTG ratio of 1.04.

Table 14. UT Self-Direct Cost-Effectiveness Results – 2012 (1.04 NTG)

Benefit/Cost Test Performed	Evaluated Gross kWh Savings	Evaluated Net kWh Savings	Evaluated Costs	Evaluated Benefits	B/C Ratio
PacifiCorp Total Resource Cost Test (PTRC)	14,556,920	15,139,197	$5,272,356	$13,640,192	2.59
Total Resource Cost Test (TRC)	14,556,920	15,139,197	$5,272,356	$12,400,174	2.35
Utility Cost Test (UCT)	14,556,920	15,139,197	$4,161,510	$12,400,174	2.98
Rate Impact Measure Test (RIM)	14,556,920	15,139,197	$14,118,079	$12,400,174	0.88
Participant Cost Test (PCT)	14,556,920	15,139,197	$4,485,732	$13,127,939	2.93

Table 15. UT Self-Direct Cost-Effectiveness Results – 2013 (1.04 NTG)

Benefit/Cost Test Performed	Evaluated Gross kWh Savings	Evaluated Net kWh Savings	Evaluated Costs	Evaluated Benefits	B/C Ratio
PacifiCorp Total Resource Cost Test (PTRC)	26,669,034	27,735,796	$7,544,832	$19,121,239	2.53
Total Resource Cost Test (TRC)	26,669,034	27,735,796	$7,544,832	$17,382,945	2.30
Utility Cost Test (UCT)	26,669,034	27,735,796	$5,894,571	$17,382,945	2.95
Rate Impact Measure Test (RIM)	26,669,034	27,735,796	$23,789,791	$17,382,945	0.73
Participant Cost Test (PCT)	26,669,034	27,735,796	$6,876,082	$22,707,808	3.30

Table 16. UT Self-Direct Cost-Effectiveness Results – PY 2012-2013 Combined (1.04 NTG)

Benefit/Cost Test Performed	Evaluated Gross kWh Savings	Evaluated Net kWh Savings	Evaluated Costs	Evaluated Benefits	B/C Ratio
PacifiCorp Total Resource Cost Test (PTRC)	41,225,955	42,874,993	$12,817,188	$32,761,431	2.56
Total Resource Cost Test (TRC)	41,225,955	42,874,993	$12,817,188	$29,783,119	2.32
Utility Cost Test (UCT)	41,225,955	42,874,993	$10,056,082	$29,783,119	2.96
Rate Impact Measure Test (RIM)	41,225,955	42,874,993	$37,907,870	$29,783,119	0.79
Participant Cost Test (PCT)	41,225,955	42,874,993	$11,361,814	$35,835,746	3.15

4 Process Evaluation Findings

This section describes the findings from the Self-Direction Credit process evaluation data collection activities including participant surveys and interviews with program staff.

4.1 Participant Findings

The evaluation team surveyed 22 participants of the program's 52 participants over the course of two surveys.[21] Respondents' firms represented a range of industries, including manufacturing, public administration, arts, entertainment, and recreation, among others. The most common industry was manufacturing, which included 41 percent of respondents. Table 17 provides a distribution of industry types included in the process evaluation sample.

Table 17. Primary Industry of Self-Direction Credit Respondents

Primary Activity	Respondents	Percent
Manufacturing	9	41%
Arts, Entertainment, and Recreation	4	18%
Accommodation	1	5%
Health Care	1	5%
Nonprofits and Religious Organizations	1	5%
Public Administration/Governmental Services	1	5%
Mining and Oil	1	5%
Higher Education	1	5%
Food Processing	1	5%
Airport Services and Equipment	1	5%
Don't Know/Not Sure	1	5%
Total	22	100%

4.1.1 Program Satisfaction

Participants reported high overall satisfaction with the program. The questions relating to participant satisfaction differed between the first and second participant surveys. Therefore, the evaluation team has reported satisfaction findings in two parts.

[21] While Navigant conducted four total surveys with participants, only the first and last survey included process-related questions. The respondents were not necessarily the same respondents for each survey; therefore, the *n* (number of respondents) may vary by question.

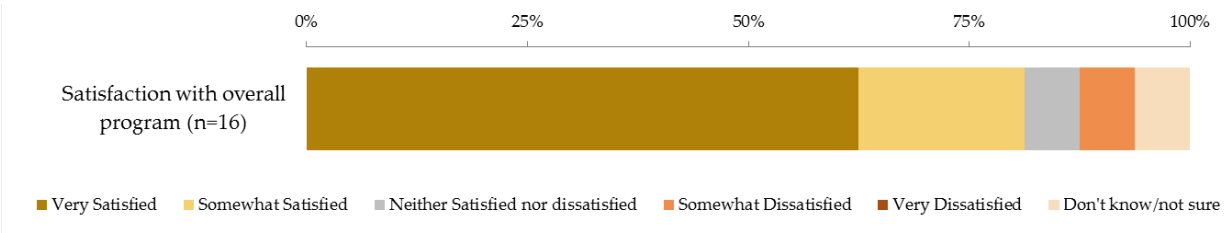
For the first participant survey, the evaluation team asked respondents whether they would participate in the program again. The team used these responses as a proxy for determining whether a respondent was satisfied with their previous program experiences. Five of the six participants in the first round reported that they would participate in the Self-Direction Credit program again, suggesting that they were satisfied with the program. The remaining respondent did not comment on future participation. When asked what changes they would like to see in the Self-Direction Credit program, two respondents offered the following suggestions:

» More aggressive incentives to encourage increased participation

» Increased communication with the program administrator

In the second survey, the evaluation team directly asked participants to what extent they were satisfied with the program. The majority (81 percent, or 13 of 16) reported relatively high satisfaction scores; 63 percent were very satisfied and 19 percent were satisfied (see Figure 3). The remaining three participants were reported neutral, dissatisfied, and not sure, respectively. For the respondent who was reportedly dissatisfied, this individual reported a preference for incentives over credits; under the new *wattsmart* Business program, these customers have a choice of a bill credit or an incentive. The participant who was reportedly neutral in terms of satisfaction stated that the program did not apply to their business; however, the participant qualified and directed their own measure through the program. .

Figure 3. Overall Program Satisfaction



4.1.2 Program Awareness and Motivation

Six out of eight participants indicated word-of-mouth marketing by RMP staff (i.e., account representatives and others) as the primary driver to program awareness. Other responses included previous RMP program participation and discussions with other business colleagues.

Respondents primarily identified costs and energy savings as the primary reasons their organizations participated in the program. In particular, five respondents mentioned payback period and project cost reductions as their reason for participation. Another four mentioned energy use reduction, and one indicated that it was the right thing to do. As an example, when probed on the subject, one respondent stated, "we pay into this fund; a percentage of our power bill goes into this fund and we want to recapture some of that back." Another respondent claimed, "[we are] a large user of electricity and this program gives us an opportunity to implement energy savings measures, making our dollar go further."

4.1.3 Program Process

The evaluation team asked respondents a series of questions related to the program process as it relates to participants. From the participant perspective, the process consists of four aspects: pre-qualification (optional), application process (including engineering support), installation of energy efficiency measures, and program interactions. Regardless of whether participants conduct pre-qualification steps, all participants must submit an application with invoices and savings information following installation.

When asked about their experience with the application process, participants reported no difficulty or concerns throughout the process, in either of the two participant surveys. In the first survey, the evaluation team asked whether respondents had initial concerns about participating in the program. Again, none of the six participants from the first survey reported having any initial concerns.

4.1.3.1 Pre-Qualification

Six participants were asked why they chose to apply for pre-qualification. Three respondents reportedly applied for pre-qualification because they thought that pre-qualification was a requirement. Another respondent had applied for pre-qualification because it gave him an opportunity to "fine tune things" and was an additional check in the process. The remaining two respondents reported that they were required to calculate the credit rebate in order to "sell" the project internally and justify it given the economic climate at the time.

4.1.3.2 Application Process (Including Engineering Support)

Although the Self-Direction Credit program does not require third-party involvement in the process, more than half of the survey respondents (five out of eight) consulted a third-party engineering firm before installing their project. The level of involvement from these firms varied; one firm only served as a design and construction advisor, while another handled all steps of the application and installation process. All respondents who identified a third-party firm were satisfied with the support they received, although one participant reportedly experienced a delay in the application process due to a misunderstanding about how to acquire the application form.

When asked whether they would recommend changes to the application process, only one respondent offered a suggestion. This respondent stated that the calculated savings estimates for the pre-inspection were difficult to assess. In particular, the respondent stated that RMP required savings estimates to match down to the kW and that, "It would be nice if [RMP] were a little looser on that process." While Navigant does not recommend decreasing the rigor of savings calculations, bringing third-party firms formally into the application process could help participants to ensure that their savings estimates are accurate and rigorous.

4.1.3.3 Installation of Energy Efficiency Measures

The process team asked eight participants about the types of measures installed through the Self-Direction Credit program; five installed non-lighting equipment while three installed lighting. The non-lighting equipment included: four VFDs fan and motors, an economizer, process air, and a snowmaker. Despite the variety of measures, the eight interviewed participants described a similar process for

installation: identifying the project, hiring or engaging contractors, and reaching out to RMP. Internal employees or contractors install the majority of the measures.

The eight participants expressed satisfaction with the measures installed and plan to keep them operating. Two participants indicated a need to replace some lighting measures since their installation, but that is not uncommon for very large lighting projects; one project included more than 600 ballasts.

Participants stated that they knew what to expect for energy savings, either because they had installed similar equipment before or because they had trusted information from their contracted engineers. Most of the participants (seven out of eight) indicated that they believed the project was delivering the savings that they expected. The one respondent that said he was not realizing energy savings said, "It seems like the bill has even increased."

Two respondents who had installed non-lighting projects had anticipated increased control and increased safety benefits. Both of the participants reported that they had seen these benefits since their projects were completed. No participants reported information on non-energy benefits for lighting measures.

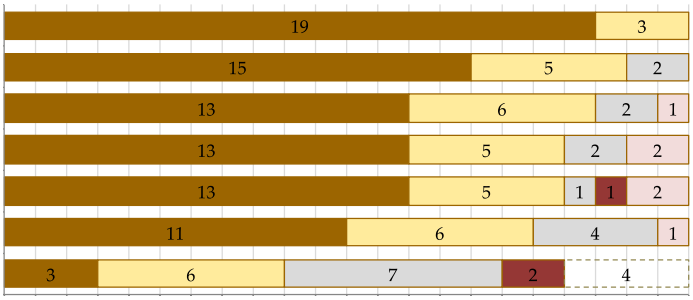
4.1.3.4 Program Interactions

The evaluation team asked participants about their interactions with RMP staff, including the context of the interactions and respondents' satisfaction with them. Respondents reportedly interacted with program staff at various times throughout the program process, from initial contract set-up to final project approval. All six respondents who had interacted with staff claimed they were either "somewhat satisfied" or "very satisfied" with their experiences working with RMP representatives. Only one respondent voiced the concern that not all of the funds collected through the customer efficiency charge would be available for credit later.

4.1.4 Program Influence

The evaluation team asked participants several questions about the extent to which the program influenced their decision to install the measures that they implemented through the program. Respondents were asked to rate the importance of each of seven factors on a scale of one to five, with one being "not at all important" and five being "extremely important." Relative influence varied across respondents for these factors, as shown in Figure 4.

Figure 4. Factors Influencing Project Decisions



The two most important factors in respondents' choice of equipment were the "RMP credit" and "information on payback."

4.1.5 Further Energy Efficiency Opportunities and Barriers

Participant surveys provided insight into the barriers to taking energy efficiency actions and respondents' future energy efficiency plans (Table 18). Eighty-two percent of respondents claimed that their organizations could take additional actions to improve their energy efficiency. Potential projects included additional commercial lighting, controls, VFDs for pumps and fans, better monitoring, and sub-metering. Of the 18 respondents who mentioned additional projects, 11 currently are working on project plans with RMP. These responses indicate that these respondents are engaged and actively seeking energy efficiency opportunities.

Table 18. Opportunities for Further Energy Efficiency

Potential for Further Energy Efficiency	Count	Percent
No potential for energy efficiency	4	18%
Potential for energy efficiency, but no plans in place	6	27%
Energy efficiency plans with RMP	11	50%
Energy efficiency plans without RMP	1	5%
Total	22	100%

For the 18 respondents who could implement further projects, major barriers to implementing these projects included high upfront costs (33 percent) and lack of access to capital (33 percent). Another 15 percent of respondents said that there were no barriers in their way of further energy efficiency (see Table 19). One customer identified long payback periods, while another cited internal concerns that operational changes to increase energy efficiency may be too complex for the organization.

Table 19. Barriers to Participants' Future Energy Efficiency Plans

Barriers to Energy Efficiency	Mentions	Most Important	Percent Most Important
High upfront cost	9	6	33%
Lack of access to capital	8	6	33%
None	4	4	22%
Operational procedure changes may be too complex	1	1	6%
Long payback period	3	1	6%
Total	25	18	100%

4.2 Overall Process Findings

Through program staff interviews and participant surveys, the evaluation team sought to answer seven process evaluation research questions. This section lists the questions and answers offered by program staff, and participants where appropriate.

1. **What are the program goals, concept, and design?**
   The Self-Direction Credit program in Utah sought to improve energy efficiency of existing equipment at large commercial and industrial sites by offering on-bill credit to customers. RMP expects this credit to shorten payback periods and allow large customers to afford and pursue additional, custom energy efficiency projects.

2. **Do program staff and administrators have the resources and capacity to implement the program as planned, and if not, what is needed?**
   Program managers and administrators indicated they had sufficient resources to implement the program as planned. Participants did not indicate any challenges related to staff resources or capacity.

3. **Is the program being delivered in accordance with the logic model?**
   Yes, activities and expected outputs and outcomes occurred as planned. This resulted in customers participating in the program, installing equipment, and receiving credits on their bill. Energy savings mostly met the participants' expectations. The majority (82 percent) believed they could take additional actions to further increase energy efficiency at their organization, and most of them planned to participate in the Self Direction Credit program again.

4. **Is the program marketing effective? Specifically, how do participants find out about the programs?**
   Participants reported to learn about the program through word of mouth. Respondents stated they learned about the program from another business colleague or Rocky Mountain Power staff.

5. **What is the program influence on participant actions? Specifically, what do participants identify as most important to their projects (i.e. program information, incentive/credit, payback, engineering, their own company goals, etc.)?**
   Participants indicated the potential to obtain a bill credit and the ability to save energy as the two most influential factors to program participation. The evaluation team asked respondents to rank the importance of certain factors in deciding which equipment to install for each project specified. The most important factors included the Rocky Mountain Power bill credit and information on payback. This implies that the financial and informational assistance provided by the program encouraged the installation of more efficient equipment.

6. **What barriers are preventing customers from taking actions to reduce energy consumption and demand, and which jeopardize program cost-effectiveness?**
   Participant respondents who thought there were further actions they could take reported costs to be a major barrier to conducting more energy efficiency projects. Specifically, 33 percent of participant respondents each reported high upfront costs and lack of access to capital. These participants have previously participated in programs to improve project financials, and the program will continue to meet this need. The program cannot address internal challenges identified by respondents.

7. **Are participants achieving planned outcomes? Specifically, are participants feeling satisfied?**
   Yes, participants are achieving planned outcomes. The majority (81 percent) of participant respondents were satisfied with the overall program: 63 percent were very satisfied and 19 percent were somewhat satisfied. The dissatisfied participant reported a preference for incentives over credits; under the new *wattsmart* Business program, these customers have a choice of a bill credit or an incentive. Most respondents reported that the energy savings related to each measure met their expectations.

5 Program Evaluation Recommendations

5.1 PY 2012-2013 Recommendations

RMP should consider undertaking the following steps to improve the program experience for participants, engineers, and program staff as the Self Direction Credit program transitions to the *wattsmart* Business program.

» **Recommendation 1. Ensure measure classifications in database are correct.** Impact evaluation activities found incorrect measure classifications in the RMP program database. Ensuring correct classifications will help with future sampling efforts and file reviews. The shift to the improved procedures under the new *wattsmart* Business program will likely remedy this issue.

5.2 PY 2009-2011 Recommendation Review

The evaluation team reviewed the recommendations made in the prior PY 2009-2011 program evaluation to track any progress made by RMP. The following lists the prior recommendations and the results of this review.

» **Extend outreach to inform more C&I customers that RMP provides technical assistance.** Just 5 percent of industrial class non-participants were aware that RMP offers technical assistance or energy analysis. Since about three-quarters of non-participants (73 percent) are not aware of things that their firm can do to improve efficiency further, identifying opportunities that resonate with this population may be key to expanding the program reach. RMP may best deliver this message via email, according to non-participant preference, or through other more proactive efforts to engage customers. Because reported energy savings exceeded targets in 2011, this effort to increase participation is forward-looking if the program seeks to expand.
Review Results *– RMP revised the marketing campaigns to roll out the wattsmart Business program. It would be appropriate to reevaluate Technical Assistance efforts in the next evaluation cycle, when the wattsmart Business program has been in place for the entire period.*

» **Require that participants provide data for verification purposes.** The evaluation team had difficulties obtaining data for verification from two projects, which comprised 27.7 percent of program savings. Lacking actual data introduces additional uncertainty into the evaluation results. Because of difficulties in obtaining data for these two projects, which were the largest in the program and not realistically replaceable in the sample, Navigant recommends that RMP require that customers provide evaluation data as a condition of participating in the Self Direction Credit program.
Review Results *– Clients were generally cooperative with the evaluation data needs, although some were slow in responding to requests due to other obligations. Navigant did not encounter any refusals as in the previous program cycle.*

Utah's Self-Direction Credit Program (PY 2012-2013)

APPENDIX

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March 18, 2015

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Appendix A Glossary[1]

Adjustments: For M&V analyses, factors that modify baseline energy or demand values to account for independent variable values (conditions) in the reporting period.

Allowances: Represent the amount of a pollutant that a source is permitted to emit during a specified time in the future under a cap and trade program. Often confused with credits earned in the context of project-based or offset programs, in which sources trade with other facilities to attain compliance with a conventional regulatory requirement. Cap and trade program basics are discussed at the following EPA website: <http://www.epa.gov/airmarkets/cap-trade/index.html>.

Assessment boundary: The boundary within which all the primary effects and significant secondary effects associated with a project are evaluated.

Baseline: Conditions, including energy consumption and related emissions, that would have occurred without implementation of the subject project or program. Sometimes referred to as "business-as-usual" conditions. Defined as either project-specific baselines or performance standard baselines.

Baseline period: The period of time selected as representative of facility operations before the energy efficiency activity takes place.

Bias: The extent to which a measurement or a sampling or analytic method systematically underestimates or overestimates a value.

Co-benefits: The impacts of an energy efficiency program other than energy and demand savings.

Coincident demand: The metered demand of a device, circuit, or building that occurs at the same time as the peak demand of a utility's system load or at the same time as some other peak of interest, such as building or facility peak demand. This should be expressed to indicate the peak of interest (e.g., "demand coincident with the utility system peak"). Diversity factor is defined as the ratio of the sum of the demands of a group of users to their coincident maximum demand. Therefore, diversity factors are always equal to one or greater.

Comparison group: A group of consumers who did not participate in the evaluated program during the program year and who share as many characteristics as possible with the participant group.

Confidence: An indication of how close a value is to the true value of the quantity in question. Confidence is the likelihood that the evaluation has captured the true impacts of the program within a certain range of values (i.e., precision).

[1] Glossary definitions are provided to assist readers of this report, and are adapted from the Model Energy Efficiency Program Impact Evaluation Guide, US Environmental Protection Agency, November 2007

Cost-effectiveness: An indicator of the relative performance or economic attractiveness of any energy efficiency investment or practice. In the energy efficiency field, the present value of the estimated benefits produced by an energy efficiency program is compared to the estimated total costs to determine if the proposed investment or measure is desirable from a variety of perspectives (e.g., whether the estimated benefits exceed the estimated costs from a societal perspective).

Database for Energy-Efficient Resources (DEER):
A California database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life.

Demand Side Management (DSM): See "Energy efficiency."

Deemed savings: An estimate of an energy savings or energy-demand savings outcome (gross savings) for a single unit of an installed energy efficiency measure that (a) has been developed from data sources and analytical methods that are widely considered acceptable for the measure and purpose and (b) is applicable to the situation being evaluated.

Demand: The time rate of energy flow. Demand usually refers to electric power measured in kW (equals kWh/h) but can also refer to natural gas, usually as Btu/hr, kBtu/hr, therms/day, etc.

Direct emissions: Direct emissions are changes in emissions at the site (controlled by the project sponsor or owner) where the project takes place. Direct emissions are the source of avoided emissions for thermal energy efficiency measures (e.g., avoided emissions from burning natural gas in a water heater).

Effective Useful Life (EUL): An estimate of the median number of years that the efficiency measures installed under a program are still in place and operable.

Energy efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way; or using less energy to perform the same function. "Energy conservation" is a term that has also been used, but it has the connotation of doing without a service in order to save energy rather than using less energy to perform the same function. Demand Side Management (DSM) is also frequently used to refer to actively-managed energy efficiency initiatives.

Energy Efficiency Measure (EEM): A permanently installed measure which can improve the efficiency of the Customer's electric energy use.

Engineering model: Engineering equations used to calculate energy usage and savings. These models are usually based on a quantitative description of physical processes that transform delivered energy into useful work such as heat, lighting, or motor drive. In practice, these models may be reduced to simple equations in spreadsheets that calculate energy usage or savings as a function of measurable attributes of customers, facilities, or equipment (e.g., lighting use = watts × hours of use).

Error: Deviation of measurements from the true value.

Evaluation: The performance of studies and activities aimed at determining the effects of a program; any of a wide range of assessment activities associated with understanding or documenting program performance, assessing program or program-related markets and market operations; any of a wide range of evaluative efforts including assessing program-induced changes in energy efficiency markets, levels of demand or energy savings, and program cost-effectiveness.

Evaluation, Measurement and Verification (EM&V): Data collection, monitoring, and analysis associated with the calculation of gross and net energy and demand savings from individual sites or projects which is performed in conjunction with a program or portfolio evaluation (see Evaluation).

Evaluated savings estimate: Savings estimates reported by an evaluator after the energy impact evaluation has been completed. Often referred to as "***Ex Post" Savings*** (from the Latin for "after the fact").

Free driver: A non-participant who has adopted a particular efficiency measure or practice as a result of the evaluated program.

Free rider: A program participant who would have implemented the program measure or practice in the absence of the program. Free riders can be total, partial, or deferred.

Gross savings: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.

Impact evaluation: An evaluation of the program-specific, directly induced changes (e.g., energy and/or demand usage) attributable to an energy efficiency program.

Independent variables: The factors that affect energy use and demand, but cannot be controlled (e.g., weather or occupancy).

Interactive factors: Applicable to IPMVP Options A and B; changes in energy use or demand occurring beyond the measurement boundary of the M&V analysis.

Load shapes: Representations such as graphs, tables, and databases that describe energy consumption rates as a function of another variable such as time or outdoor air temperature.

Market effect evaluation: An evaluation of the change in the structure or functioning of a market, or the behavior of participants in a market, that results from one or more program efforts. Typically, the resultant market or behavior change leads to an increase in the adoption of energy-efficient products, services, or practices.

Market transformation: A reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed.

Measurement: A procedure for assigning a number to an observed object or event.

Measurement and Verification (M&V): Data collection, monitoring, and analysis associated with the calculation of gross energy and demand savings from individual sites or projects. M&V can be a subset of program impact evaluation.

Measurement boundary: The boundary of the analysis for determining direct energy and/or demand savings.

Metering: The collection of energy consumption data over time through the use of meters. These meters may collect information with respect to an end-use, a circuit, a piece of equipment, or a whole building (or facility). Short-term metering generally refers to data collection for no more than a few weeks. End-use metering refers specifically to separate data collection for one or more end-uses in a facility, such as lighting, air conditioning or refrigeration. Spot metering is an instantaneous measurement (rather than over time) to determine an energy consumption rate.

Monitoring: Gathering of relevant measurement data, including but not limited to energy consumption data, over time to evaluate equipment or system performance (e.g., chiller electric demand, inlet evaporator temperature and flow, outlet evaporator temperature, condenser inlet temperature, and ambient dry-bulb temperature and relative humidity or wet-bulb temperature) for use in developing a chiller performance map (e.g., kW/ton vs. cooling load and vs. condenser inlet temperature).

Net savings: The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of free drivers, free riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand.

Net-to-gross ratio (NTGR): A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts.

Non-participant: Any consumer who was eligible but did not participate in the subject efficiency program, in a given program year. Each evaluation plan should provide a definition of a non-participant as it applies to a specific evaluation.

Normalized annual consumption (NAC) analysis: A regression-based method that analyzes monthly energy consumption data.

Participant: A consumer that received a service offered through the subject efficiency program, in a given program year. The term "service" is used in this definition to suggest that the service can be a wide variety of services, including financial rebates, technical assistance, product installations, training,

energy efficiency information or other services, items, or conditions. Each evaluation plan should define "participant" as it applies to the specific evaluation.

Peak demand: The maximum level of metered demand during a specified period, such as a billing month or a peak demand period.

Persistence study: A study to assess changes in program impacts over time (including retention and degradation).

Portfolio: Either (a) a collection of similar programs addressing the same market (e.g., a portfolio of residential programs), technology (e.g., motor efficiency programs), or mechanisms (e.g., loan programs) or (b) the set of all programs conducted by one organization, such as a utility (and which could include programs that cover multiple markets, technologies, etc.).

Potential studies: Studies conducted to assess market baselines and savings potentials for different technologies and customer markets. Potential is typically defined in terms of technical potential, market potential, and economic potential.

Precision: The indication of the closeness of agreement among repeated measurements of the same physical quantity.

Primary effects: Effects that the project or program are intended to achieve. For efficiency programs, this is primarily a reduction in energy use per unit of output.

Process evaluation: A systematic assessment of an energy efficiency program for the purposes of documenting program operations at the time of the examination, and identifying and recommending improvements to increase the program's efficiency or effectiveness for acquiring energy resources while maintaining high levels of participant satisfaction.

Program: A group of projects, with similar characteristics and installed in similar applications. Examples could include a utility program to install energy-efficient lighting in commercial buildings, a developer's program to build a subdivision of homes that have photovoltaic systems, or a state residential energy efficiency code program.

Project: An activity or course of action involving one or multiple energy efficiency measures, at a single facility or site.

Rebound effect: A change in energy-using behavior that yields an increased level of service and occurs as a result of taking an energy efficiency action.

Regression analysis: Analysis of the relationship between a dependent variable (response variable) to specified independent variables (explanatory variables). The mathematical model of their relationship is the regression equation.

Reliability: Refers to the likelihood that the observations can be replicated.

Remaining Useful Life (RUL): An estimate of the remaining number of years that a technology being replaced under an early retirement program would have remained in place and operable. Accurate estimation of the RUL is important in determining lifetime program savings and cost effectiveness.

Reported savings estimate: Forecasted savings used for program and portfolio planning purposes. Often referred to as "***Ex Ante" Savings*** (from the Latin for "before the event").

Reporting period: The time following implementation of an energy efficiency activity during which savings are to be determined.

Resource acquisition program: Programs designed to directly achieve energy and/or demand savings, and possibly avoided emissions.

Retrofit isolation: The savings measurement approach defined in IPMVP Options A and B, and ASHRAE Guideline 14, that determines energy or demand savings through the use of meters to isolate the energy flows for the system(s) under consideration.

Rigor: The level of expected confidence and precision. The higher the level of rigor, the more confident one is that the results of the evaluation are both accurate and precise.

Spillover: Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program, beyond the program-related gross savings of the participants. There can be participant and/or nonparticipant spillover.

Statistically adjusted engineering (SAE) models: A category of statistical analysis models that incorporate the engineering estimate of savings as a dependent variable.

Stipulated values: See "deemed savings."

Takeback effect: See "rebound effect."

Uncertainty: The range or interval of doubt surrounding a measured or calculated value within which the true value is expected to fall within some degree of confidence.

Appendix B EM&V Best Practices

The term "best practices" refers to practices that, when compared against other practices, produce superior results. In the context of this study, the evaluation team defined best practices to be those methods, procedures, and protocols that maximized the accuracy and statistical validity of impact evaluation findings. The specific best practices considered in this study were compiled through a review of secondary literature, a comparison of similar programs and evaluation outcomes, and prior evaluation experience. Table 1 details the specific evaluation, measurement, and verification (EM&V) studies reviewed for this effort.

Table 1. EM&V Best Practice Studies Reviewed

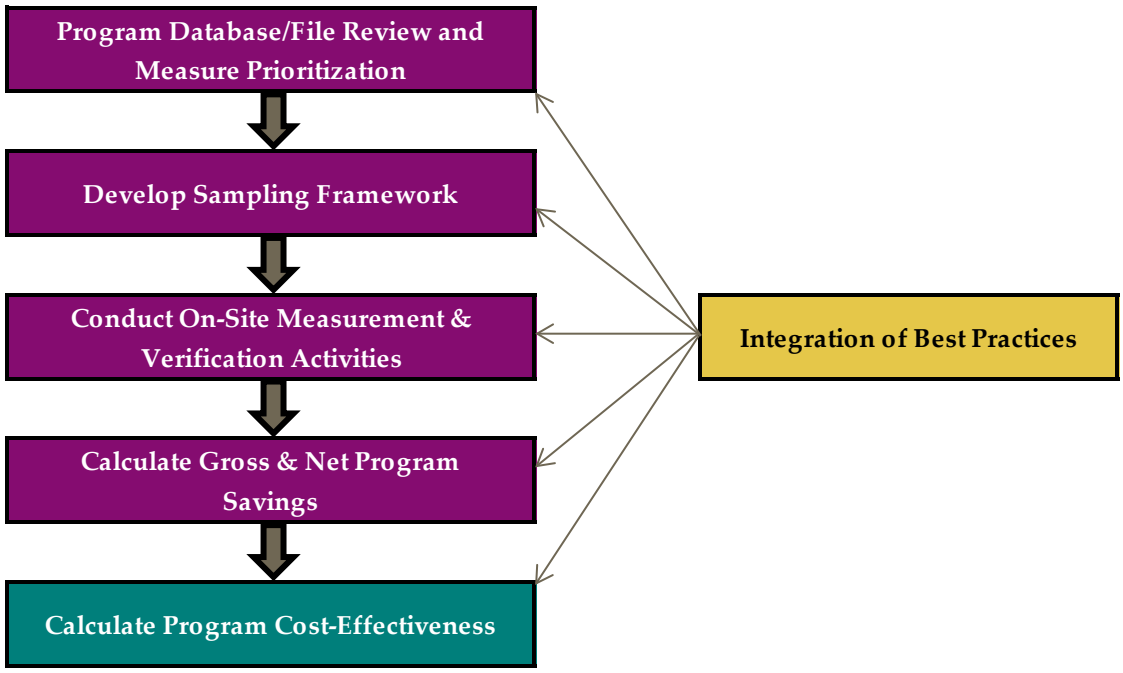
Organization	Study Name	Publication Year
National Renewable Energy Laboratory (NREL) Department of Energy (DOE)	The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures	2013
The Brattle Group	Measurement and Verification Principles for Behavior-Based Efficiency Programs	2011
Berkeley National Laboratory	Review of Evaluation, Measurement, and Verification Approaches Used to Estimate the Load Impacts and Effectiveness of Energy Efficiency Programs	2010
State of California, Public Utilities Commission	Best Practices Benchmarking for Energy Efficiency Programs	2009
Enbridge Gas Distribution	DSM Best Practices for Natural Gas Utilities: the Canadian Experience	2008
Consortium for Energy Efficiency	Energy Efficiency Program Evaluation: A Guide to the Guides	2008
Minnesota Office of Energy Security	Measurement and Verification Protocols for Large Custom CIP Projects - Version 1.0	2008
Northern California Power Agency	E, M &V Best Practices: Lessons Learned from California Municipal Utilities	2008
National Action Plan for Energy Efficiency Leadership Group	Model Energy Efficiency Program Impact Evaluation Guide: A Resource of the National Action Plan for Energy Efficiency	2007
State of California, Public Utilities Commission	California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals	2006
American Council for an Energy-Efficient Economy	America's Best: Profiles of America's Leading Energy Efficiency Programs	2003

Each report presented valuable insight into best practices within the field of EM&V. However, the evaluation team documented, characterized, and prioritized those best practices with the following properties:

- » Cross-cutting best practices with a high level of representation across each of the studies reviewed
- » Best practices consistent with past evaluation experience and interviews with program managers in other jurisdictions
- » Best practices demonstrating the most applicability towards Rocky Mountain Power's C&I Programs

The subsequent M&V methods developed for the Impact and Process Evaluation of Utah's 2011-2013 C&I Programs reflect the outcome of this independent review. Figure 1 provides an illustration of how the Best Practices Review informed the overall evaluation methods chosen for this effort.

Figure 1. Overview of Impact Evaluation Strategy



Appendix C *wattsmart* Business Program Logic Model

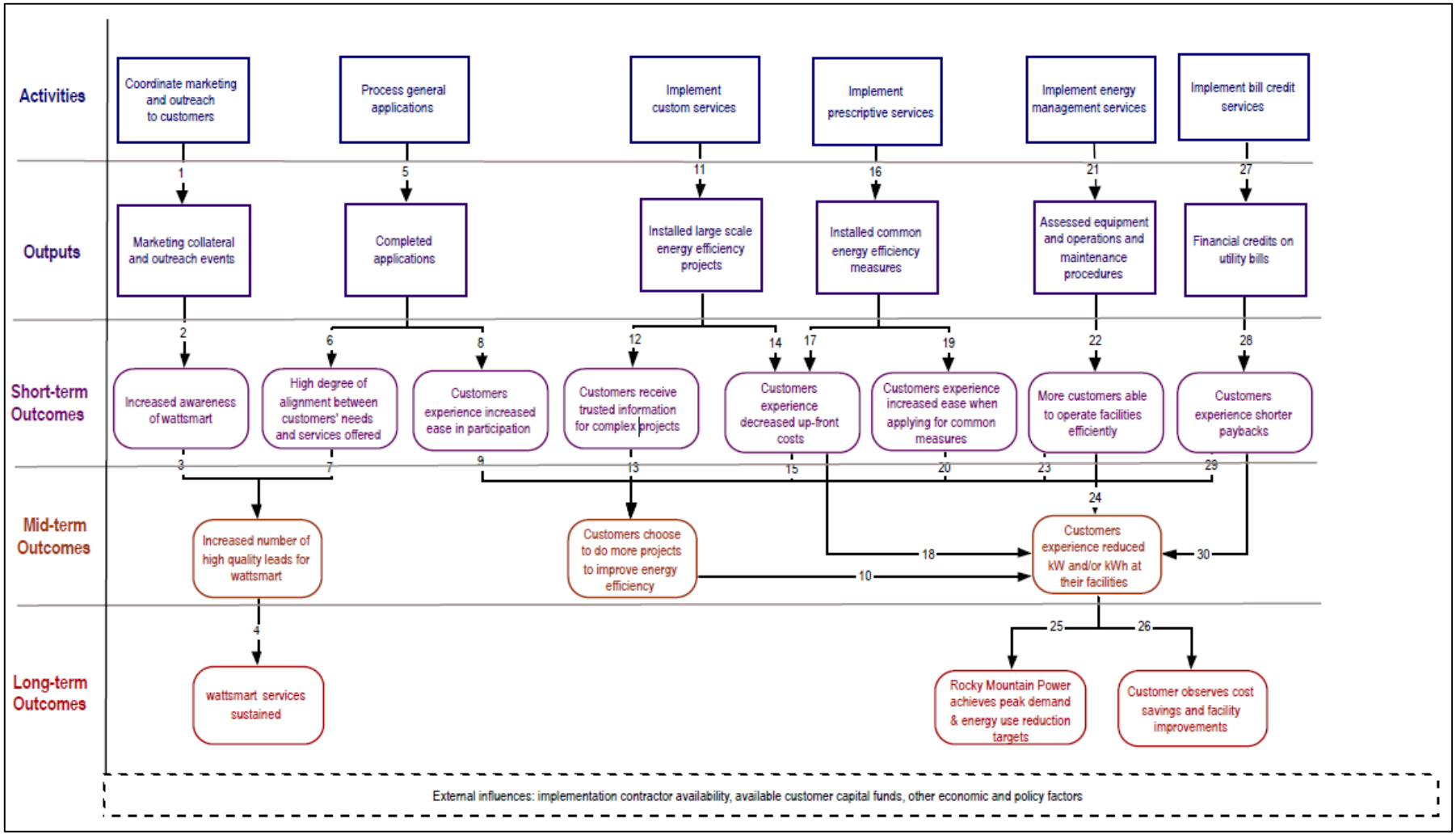
The *wattsmart* program is an umbrella program encompassing all of Rocky Mountain Power's energy efficiency services. The *wattsmart* program provides customers with a suite of programs based on the former Rocky Mountain Power energy efficiency programs:

- Energy FinAnswer – offered incentives for large-scale custom energy efficiency projects
- FinAnswer Express – offers incentives for small-scale energy efficiency projects, including prescriptive measures
- Energy Management Services (formally called Recommissioning) – offers incentives for optimizing equipment and operating and maintenance procedures
- Bill Credit Services – offers financial credits on utility bills for energy efficiency projects

The logic model presented in Figure C-1, therefore, depicts the logic for each activity carried out by implementers as part of the *wattsmart* program.

The overall purpose of developing the *wattsmart* program is to offer customers with a streamlined application process for energy efficiency services. By offering one energy efficiency program, customers do not need to choose a specific energy efficiency program. Instead, customers submit one application and program staff can direct customers to the most applicable service. By providing a suite of services catered to unique customer needs, *wattsmart* intends the program to generate higher quality leads and encourage customers to carry out more energy efficiency projects. Ultimately, implementers expect the program to generate enough energy savings and demand reductions for Rocky Mountain Power to meet its energy use reduction targets. The list following Figure C-1 describes the detailed program theory by referencing the numbered links in the figure.

Figure C-1. *wattsmart* Business Program Logic Model (2013)



Each number in the following list corresponds to a linkage in the logic model diagram and provides further details for the *wattsmart* program theory.

1. Rocky Mountain Power staff coordinates marketing and outreach to customers through marketing collateral and outreach events.
2. Marketing and outreach functions increase customer awareness of *wattsmart*.
3. Increasing customer awareness of *wattsmart* increases the number of high quality leads, defined as eligible customers that can directly benefit from program services than would have occurred without any marketing or outreach.
4. Program sustainability over time improves with increased customer awareness of *wattsmart*.
5. Program staff processes general applications to ensure completeness and direct customers to the best *wattsmart* service.
6. Processing general applications ensures that customers' needs align with program services.
7. Aligning customers' needs with program services means that more customers can or are willing to participate in *wattsmart*, resulting in greater leads for program services.
8. Allowing customers to submit general applications for the entire *wattsmart* program is intended to ease the customers' experiences with the application process, making it simpler and more direct.
9. By making the application process simple, customers will be more likely to conduct more energy efficiency projects.
10. When customers conduct more energy efficiency projects, they continue to experience reduced demand and/or energy savings at their facilities.
11. Customers may use the custom offerings portion of the *wattsmart* Business program to install large-scale, site-specific energy efficiency projects.
12. The custom portion of *wattsmart* provides customers with trusted information on complex energy efficiency project that they would not receive otherwise.
13. Providing trusted information to customers on complex projects allows them to follow through with more energy efficiency projects than they would have otherwise.
14. Participation in the custom portion of *wattsmart* provides customers financial incentives which help decrease upfront costs for energy efficiency projects.
15. By decreasing upfront costs, participants are able to conduct even more energy efficiency projects.
16. Customers may use the prescriptive offerings portion of *wattsmart* to install common energy efficiency measures such as lighting and/or HVAC equipment.
17. The prescriptive service provides incentives for common energy efficiency measures, thereby decreasing customers' upfront costs for efficiency improvements.

18. By helping to cover some of the upfront costs, customers are able to install energy efficiency equipment and hence reduce their energy costs or demand at their facilities.
19. The purpose of offering an "express" program is to provide customers with a simple means to receive financial incentives for common measures.
20. When customers feel that the incentive process is easy, they are more likely to conduct more energy efficiency projects through *wattsmart*.
21. Program staff provides a variety of energy management services to assess customers' operations and maintenance (O&M) procedures and equipment.
22. The overall purpose of providing energy management services is to help more customers operate their facilities efficiently.
23. By participating in this program, program staff identifies energy efficiency opportunities, which allow customers to install more energy efficiency projects in the future.
24. When customers operate their facilities efficiently, they generate demand reductions and energy savings.
25. When individual customers can generate demand reductions and energy savings, Rocky Mountain Power can achieve peak demand and energy use targets.
26. When customers are able to save energy, they also receive added benefits of energy cost savings and facility improvements.
27. Providing bill credit services allows customers to receive financial credits on their utility bills for energy efficiency projects.
28. Bill credits are intends to provide customers with shorter paybacks for energy efficiency projects.
29. Receiving bill credits allow customers to install more energy efficiency projects.
30. When install more energy efficient projects, they generate energy savings and reduced demand.

Appendix D Process Evaluation Survey Instrument

FX EF SD Participant Survey–REVISED 140331 for process and gap

Variables

Variable Name	Description	Type
&CONTACT	Respondent name	Text
&FIRM	Company name	Text
&PROGRAM	"FinAnswer Express" "Energy FinAnswer" "Self-Direction Credit"	Text
&PROG_CODE	1="FinAnswer Express" 2="Energy FinAnswer" 3="Self-Direction Credit"	Numeric
&SITE	Address	Text
&YEAR	Year of project completion	YYYY
&PACIFICORP	"Rocky Mountain Power" or "Pacific Power"	Text
&PREDATE	Date of first inspection	Date MMYYYY
&POSTDATE	Date of post inspection	Date MMYYYY
&INSTALLED_MEASURES	List of installed measures	Text
&MEASURE_1	Name of Measure 1	Text
&MEASURE_2	Name of Measure 2	Text
& MULT_MEASURES	Flag for more than one measure	BINARY
&INCENTIVE	Amount paid for participation	Numeric
&PM	Flag for PM delivered project 1 = PM deliver project	BINARY
&NC	Flag for New construction project 1 = new construction project	BINARY

Introduction and Screen

INTRO1. Hello, this is INTERVIEWER, calling on behalf of &PACIFICORP. We are conducting an independent evaluation of &PACIFICORP's energy efficiency programs. This is not a sales call. May I please speak with &CONTACT?

1. YES, THAT IS ME → **SKIP TO INTRO3**
2. YES, LET ME TRANSFER YOU
3. NOT NOW → **SCHEDULE APPT AND CALL BACK**
4. NO/REFUSED → **TERMINATE**

INTRO2. Hello, this is INTERVIEWER, calling on behalf of &PACIFICORP. We are conducting an independent evaluation of &PACIFICORP's energy efficiency programs. This is not a sales call. &PACIFICORP is evaluating its &PROGRAM program and would appreciate your input."

I'd like to let you know that this call may be monitored or recorded for quality assurance purposes. Also, all of your responses will be kept confidential and will not be revealed to anyone outside of the research

team. Do you have a few minutes to answer questions about your experience with the program? **[IF NEEDED, READ: "This survey is for research purposes only and will take about 15 minutes."]**

1. YES → **SKIP TO IS2**
2. NOT NOW → **MAKE APPT. TO CALL BACK**
3. NO/REFUSED → **TERMINATE**

INTRO3. &PACIFICORP is evaluating its &PROGRAM program and would appreciate your input. I'd like to let you know that this call may be monitored or recorded for quality insurance purposes. Also, all of your responses will be kept confidential and will not be revealed to anyone outside of the research team. Do you have a few minutes to answer questions about your experience with the program? **[IF NEEDED, READ: "This survey is for research purposes only and will take about 15 minutes."]**

1. YES → Thanks!
2. NOT NOW → **MAKE APPT. TO CALL BACK**
3. NO/REFUSED → **TERMINATE**

[IF VERIFICATION NEEDED, THEY CAN CALL SHAWN GRANT AT 801-220-4196].

IS2a. &PACIFICORP records indicate that your firm received an incentive from the &PROGRAM program in &YEAR after installing &INSTALLED_MEASURES at &SITE, is this correct?

1. YES → **SKIP TO IS3**
2. NO, DID NOT PARTICIPATE
3. NO, ONE OR MORE MEASURES ARE INCORRECT → **SKIP TO IS2d**
4. NO, ADDRESS IS INCORRECT → **SKIP TO IS2e**

88. DON'T KNOW/NOT SURE→ **TERMINATE**

99. REFUSED

IS2b. Is there someone else that might be familiar with this project?

1.Yes

2. No → **TERMINATE**

88. Don't know → **TERMINATE**

IS2c. May I speak with that person?

1.Yes → **RETURN TO INTRO2**

2. Not now→ **SCHEDULE CALLBACK**

3. No → **TERMINATE**

IS2d. Which of these efficiency improvements were installed? [READ AND SELECT ALL THAT APPLY]

1. &MEASURE_1
2. &MEASURE_2
3. &INSTALLED_MEASURES
4. None of these

88. DON'T KNOW/NOT SURE

99. REFUSED

[IF **IS2a** <> 4, SKIP TO **IS3**]
IS2e. What is the correct address where the equipment was installed?

1. [RECORD RESPONSE]
88. DON'T KNOW/NOT SURE
99. REFUSED

IS3. Are you the person most familiar with &FIRM's decision to move forward with this project?

1. YES
2. NO → **SKIP to IS2b**
88. DON'T KNOW/NOT SURE → **SKIP to IS2b**
99. REFUSED → **SKIP to IS2b**

Project Recall

PR1. Today, I'm going to focus on the project I mentioned with the &INSTALLED_MEASURES. To your knowledge, did you work with &PACIFICORP on other projects before this one?

1. YES
2. NO
88. DON'T KNOW/NOT SURE
99. REFUSED

PR2. And, to your knowledge, did you work with &PACIFICORP on other projects since this one?

1. YES
2. NO
88. DON'T KNOW/NOT SURE
99. REFUSED

Awareness & Participation

AP1. How did you first become aware of &PROGRAM? **[DO NOT READ; CHECK ALL THAT APPLY]**

1. Account Representative or Other &PACIFICORP Staff
2. &PACIFICORP Radio Advertisement
3. &PACIFICORP Print Advertisement
4. &PACIFICORP Printed Materials/Brochure
5. &PACIFICORP Online Advertisement
6. &PACIFICORP TV Advertisement
7. &PACIFICORP Newsletter
8. &PACIFICORP Website
9. Previous Participation in &PACIFICORP Programs

10. Conference, Workshop, or Event [SPECIFY]
11. &PACIFICORP Sponsored Energy Audit or Technical Assessment
12. From Trade Ally, Vendor, or Contractor
13. Another Business Colleague
14. Family, Friend, or Neighbor
15. Another Energy Efficiency Program (CONFIRM NOT A PACIFICORP PROGRAM)
16. Other [SPECIFY]
88. DON'T KNOW/NOT SURE
99. REFUSE

AP2. Why did your firm decide to participate in the program? **[DO NOT READ; CHECK ALL THAT APPLY]**

1. To save money on electric bills.
2. To save money on maintenance costs
3. To obtain an incentive.
4. To replace old or poorly working equipment.
5. To replace broken or failed equipment.
6. To acquire the latest technology.
7. Because the program was sponsored by &PACIFICORP
8. Previous experience with &PACIFICORP
9. To protect the environment/be "green"
10. To save energy (no costs mentioned)
11. To comply with a standard or policy requirement
12. Recommendation by contractors/vendors
13. Recommended by colleague
14. Recommended by family, friend or neighbor
15 To improve operations, production, or quality
16. To improve value of property
17. To improve comfort
18. Other [SPECIFY]: _____
88. DON'T KNOW/NOT SURE
99. REFUSE

[IF MORE THAN ONE RESPONSE TO AP2]
AP2a. Of those reasons, which one was most influential in the decision to participate in the program? **[ALLOW ONLY ONE RESPONSE..]**

1. To save money on electric bills.
2. To save money on maintenance costs
3. To obtain an incentive.
4. To replace old or poorly working equipment.
5. To replace broken or failed equipment.
6. To acquire the latest technology.
7. Because the program was sponsored by &PACIFICORP
8. Previous experience with &PACIFICORP

9. To protect the environment/be "green"
10. To save energy (no costs mentioned)
11. To comply with a standard or policy requirement
12. Recommendation by contractors/vendors
13. Recommended by colleague
14. Recommended by family, friend or neighbor
15 To improve operations, production, or quality
16. To improve value of property
17. To improve comfort
18. Other [SPECIFY]: _____
88. DON'T KNOW/NOT SURE
99. REFUSED

Website Section

WW1. Have you ever visited the &PACIFICORP *wattsmart* energy efficiency website?

1. YES
2. NO → **SKIP to EE1**

88. DON'T KNOW/NOT SURE → **SKIP to EE1**

99. REFUSED → **SKIP to EE1**

WW2. How many times have you visited the &PACIFICORP *wattsmart* energy efficiency website in the last year?

1. ONCE
2. SELDOM (LESS THAN ONCE PER MONTH; 2 to10 TIMES)
3. ABOUT ONCE PER MONTH (10 to 13 TIMES)
4. FREQUENTLY (MORE THAN ONCE PER MONTH; MORE THAN 13 TIMES)

88. DON'T KNOW/NOT SURE

99. REFUSED

WW3. Why did you visit the &PACIFICORP *wattsmart* energy efficiency website?

1. **[RECORD RESPONSE]**

88. DON'T KNOW/NOT SURE

99. REFUSED

WW4. Were you able to find the information you needed on the *wattsmart* website?

1. YES
2. NO

88. DON'T KNOW/NOT SURE

99. REFUSED

Pre-Installation Section

[IF &PROG_CODE=2 OR &PREDATE not NULL, ask EE1; ELSE, skip to EE3]

EE1. When you first became involved with the &PROGRAM program, representative from &PACIFICORP came out to your facility to inspect existing equipment. Using a scale of 1 to 5 where 1 indicates 'very dissatisfied' and 5 indicates 'very satisfied', how satisfied were you with the energy engineer who came out to your facility?

1. VERY DISSATISFIED
2. SOMEWHAT DISSATISFIED
3. NEITHER SATISFIED NOR DISSATISFIED
4. SOMEWHAT SATISFIED → **SKIP TO EE3**
5. VERY SATISFIED → **SKIP TO EE3**

88. DON'T KNOW/NOT SURE → **SKIP TO EE3**
99. REFUSED → **SKIP TO EE3**

EE2. What could the representative have done differently that would have made you more satisfied?

1. [RECORD RESPONSE]

88. DON'T KNOW/NOT SURE
99. REFUSED

EE3. Using a scale of 1 to 5 where 1 indicates 'very dissatisfied' and 5 indicates 'very satisfied', how satisfied were you with the vendor you worked with on this project? [A vendor may be a retailer, engineer, or distributer]

1. VERY DISSATISFIED
2. SOMEWHAT DISSATISFIED
3. NEITHER SATISFIED NOR DISSATISFIED
4. SOMEWHAT SATISFIED → **SKIP TO EE5**
5. VERY SATISFIED → **SKIP TO EE5**

6. DID NOT WORK WITH A VENDOR → SKIP TO EE5
7. DO NOT RECALL→ SKIP TO EE5

88. DON'T KNOW/NOT SURE → **SKIP TO EE5**
99. REFUSED → **SKIP TO EE5**

EE4. What could they have done differently that would have made you more satisfied?

1. [RECORD RESPONSE]

88. DON'T KNOW/NOT SURE
99. REFUSED

[IF &PROG_CODE=2 OR &PM=1, ASK EE5; ELSE, skip to IM1]

EE5. As part of the program, you received a report from the energy analysis that included recommendations of equipment retrofits and other energy efficiency improvements. Did you find this report valuable?

1. YES → **SKIP TO IM1**
2. NO

3. DON'T RECALL RECEIVING A REPORT → **SKIP TO IM1**
88. DON'T KNOW/NOT SURE → **SKIP TO IM1**
99. REFUSED → **SKIP TO IM1**

EE6. Why not?

1. **[RECORD RESPONSE]**
88. DON'T KNOW/NOT SURE
99. REFUSED

Installed Measures

[IF &NC=1, SKIP to FR1]

READ: I'm going to ask a few questions about the equipment that you installed.

[SET &MEASURE_# = &MEASURE_1]

IM1. Did the &MEASURE_# installed through the program replace existing equipment or was it a new installation?

1. REPLACED EXISTING EQUIPMENT → **SKIP TO IM2**
2. TOTALLY NEW INSTALLATION → **SKIP TO IM3**
88. DON'T KNOW/NOT SURE → **SKIP TO IM1A**
99. REFUSED → **SKIP TO IM1A**

IM1A. Could you please provide contact information for someone who would know the specifics of the equipment installation?

1. [COLLECT: IM_CONTACT_NAME, IM_CONTACT_PHONE, and IM_CONTACT_EMAIL] → **SKIP TO IC1**

IM2. What was the operating condition of the equipment that the &MEASURE_# replaced?

1. EXISTING EQUIPMENT HAD FAILED
2. EXISTING EQUIPMENT WORKING BUT WITH PROBLEMS
3. EXISTING EQUIPMENT WORKING WITH NO PROBLEMS
4. OTHER **[SPECIFY]:** _____
88. DON'T KNOW/NOT SURE
99. REFUSED

IM3. Have the energy savings related to this equipment met your expectations?

1. YES
2. NO
88. DON'T KNOW/NOT SURE
99. REFUSED

IM4a. Did you anticipate any other benefits beyond energy savings from the $MEASURE_#?

1. YES
2. NO → **SKIP TO IM5**

88. DON'T KNOW/NOT SURE → **SKIP TO IM5**
99. REFUSED → **SKIP TO IM5**

IM4b. What other benefits did you anticipate? **[CHECK ALL THAT APPLY; DO NOT READ]**
1. Better lighting quality (lighting specific)
2. Quicker on/off (lighting specific)
3. Increased control (lighting specific)
4. Less frequent replacement (lighting specific)
5. Decreased heat output (lighting specific)
6. Increased water pressure (sprinkler specific)
7. Other [**SPECIFY**]
88. DON'T KNOW/NOT SURE
99. REFUSED

IM4c. Since the project was completed, have you seen those benefits?
1. YES
2. NO
3. ONLY SOMEWHAT **[SPECIFY]**
88. DON'T KNOW/NOT SURE
99. REFUSED

IM5. Using a scale of 1 to 5 where 1 indicates 'very dissatisfied' and 5 indicates 'very satisfied', overall, how satisfied were you with the performance of the &MEASURE_#?
1. VERY DISSATISFIED
2. SOMEWHAT DISSATISFIED
3. NEITHER SATISFIED NOR DISSATISFIED
4. SOMEWHAT SATISFIED → **SKIP TO PI1**
5. VERY SATISFIED → **SKIP TO PI1**
88. DON'T KNOW/NOT SURE → **SKIP TO PI1**
99. REFUSED → **SKIP TO PI1**

IM6. What would have made you more satisfied with the performance of this equipment?
1. **[RECORD RESPONSE]**
88. DON'T KNOW/NOT SURE
99. REFUSED

[IF MULT_MEASURES=1 SET &MEASURE_#=&MEASURE_2 GO BACK TO IM1; ELSE GO TO NEXT SECTION]

Post-Installation

[IF &PROG_CODE =2 OR &PROG_CODE=3 OR &POSTDATE not NULL, ask P11; else, skip to FR1]

PI1. After your project was installed, [IF &POSTDATE >0, "around &POSTDATE"], a program representative came out to your facility to verify your installation. Using a scale of 1 to 5 where 1 indicates 'very dissatisfied' and 5 indicates 'very satisfied', how satisfied were you with the inspection?
1. VERY DISSATISFIED
2. SOMEWHAT DISSATISFIED

3. NEITHER SATISFIED NOR DISSATISFIED
4. SOMEWHAT SATISFIED → **SKIP TO FR1**
5. VERY SATISFIED → **SKIP TO FR1**
88. DON'T KNOW/NOT SURE → **SKIP TO FR1**
99. REFUSED → **SKIP TO FR1**

PI2. What could the engineer have done differently that would have made you more satisfied with the inspection?

1. **[RECORD RESPONSE]**
88. DON'T KNOW/NOT SURE
99. REFUSED

Free Ridership

FR1. With the &PROGRAM program, &FIRM received [IF &PM=1 or &PROG_CODE=2 add "technical assistance identifying energy saving opportunities and"] financial incentives of &INCENTIVE for installing &INSTALLED_MEASURES with the program.

On a scale from 1 to 5, with 1 being not important at all and 5 being extremely important, how important was each of the following factors in deciding which equipment to install. If a factor is not applicable to you, please say so. **[NOTE: Respondents can also state that a particular factor is Not Applicable, please code N/A as 6.]**

A. RECOMMENDATION FROM CONTRACTOR OR VENDOR
B. INFORMATION PROVIDED BY &PACIFICORP ON ENERGY SAVING OPPORTUNITIES
C. INFORMATION ON PAYBACK
D. THE &PACIFICORP INCENTIVE [if &PROG_CODE = 3, replace "Incentive" with "credit"]
E. FAMILIARITY WITH THIS EQUIPMENT
F. PREVIOUS PARTICIPATION WITH A &PACIFICORP PROGRAM
G. CORPORATE POLICY REGARDING ENERGY REDUCTION

[IF &MULT_MEASURES=1, say "I'll be asking the next questions first about &MEASURE_1 and again for &MEASURE_2]

[SET &MEASURE_# = &MEASURE_1]

[READ: "When answering these next questions, think specifically about &MEASURE_ # installed through the program."]
[

FR2A. Without the program, meaning without either the technical assistance or the financial incentive, would you have still completed the exact same &MEASURE _# project?

1. YES
2. NO → **SKIP TO FR3**
88. DON'T KNOW/NOT SURE → **SKIP TO FR3**

99. REFUSED → **SKIP TO FR3**

FR2B. Without the program, meaning without either the technical assistance or the financial incentive, would you have still installed the &MEASURE _# at the same time?

1. YES → **SKIP TO FR7**
2. NO → **SKIP TO FR4**

88. DON'T KNOW/NOT SURE → **SKIP TO FR4**
99. REFUSED → **SKIP TO FR4**

FR3. Without the program, would you have installed any &MEASURE _# equipment?

1. YES
2. NO → **SKIP TO FR7**

88. DON'T KNOW/NOT SURE
99. REFUSED

FR4. Would you have installed this equipment within 12 months of when you did with the program?

1. YES
2. NO → **SKIP TO FR7**

88. DON'T KNOW/NOT SURE → **SKIP TO FR7**
99. REFUSED → **SKIP TO FR7**

FR5. Relative to the energy efficiency of &MEASURE_# installed through the program, how would you characterize the efficiency of equipment you would have installed without the program?

1. Just as efficient as installed with the program
2. Lower than installed through the program, but better than the standard efficiency
3. Standard efficiency

88. DON'T KNOW/NOT SURE
99. REFUSED

FR6. Would you have installed more, less, or the same amount of &MEASURE _#?

1. MORE→ **Compared to the installed amount, how much more? [RECORD in FR61]**
2. LESS→ **Compared to the installed amount, how much less? [RECORD in FR62]**
3. SAME

88. DON'T KNOW/NOT SURE
99. REFUSED

FR7. In your own words, can you please describe what impact the program had on your decision to complete these energy efficiency improvements for &MEASURE _#??

1. [RECORD RESPONSE]

88. DON'T KNOW/NOT SURE
99. REFUSED

[IF MULT_MEASURES=1 SET &MEASURE_#=&MEASURE_2 GO BACK TO FR2A; ELSE GO TO NEXT SECTION]

Spillover

SP1. Now I'd like to ask about energy efficiency improvements other than those you installed through the program. Since participating in this program, have you purchased or installed any additional energy efficiency improvements for your organization?

1. YES
2. NO → **SKIP TO B1**

88. DON'T KNOW/NOT SURE → **SKIP TO B1**
99. REFUSED → **SKIP TO B1**

[IF &MULT_MEASURES=1, say "I'll be asking the next questions first about &MEASURE_1 and again for &MEASURE_2]

[SET &MEASURE_# = &MEASURE_1]

SP2. Did you purchase or install any energy efficiency improvements that are the same as &MEASURE_#?

1. YES --> SP3
2. NO --> **[IF MULT_MEASURES=1 SET &MEASURE_#=&MEASURE_2 GO BACK TO SP2; ELSE GO TO SP9]**
3. 88. DON'T KNOW/NOT SURE → **SKIP TO SP9**
4. 99. REFUSED → **SKIP TO SP9**

SP3. How many did you purchase or install?

1. **[RECORD RESPONSE]**

88. DON'T KNOW/NOT SURE
99. REFUSED →

SP4. Relative to the energy efficiency of the equipment installed through the program, how would you characterize the efficiency of this equipment?

1. Just as efficient as installed within the program
2. Lower than installed through the program, but better than the standard efficiency
3. Standard efficiency

88. DON'T KNOW/NOT SURE
99. REFUSED

SP5. Did you receive an incentive from &PACIFICORP or another organization for this equipment?

1. YES
2. NO → **SKIP TO SP7**

88. DON'T KNOW/NOT SURE → **SKIP TO SP7**
99. REFUSED → **SKIP TO SP7**

SP6. What program or sponsor provided an incentive?

1. **&PACIFICORP**
2. **[RECORD RESPONSE]**

88. DON'T KNOW/NOT SURE
99. REFUSED

SP7. I'm going to read a statement about the equipment that you purchased on your own. On a scale from 1 to 5, with 1 indicating that you "strongly disagree" and 5 indicating that you "strongly agree", please rate the following statement:
My experience with &PACIFICORP's &PROGRAM program influenced my decision to install additional high efficiency equipment on my own. Would you say you…**[READ 1-5]**

1. STRONGLY DISAGREE
2. SOMEWHAT DISAGREE
3. NEITHER AGREE OR DISAGREE
4. SOMEWHAT AGREE
5. STRONGLY AGREE

88. DON'T KNOW/NOT SURE
99. REFUSED

[IF SP6 <> 1]
SP8. Why did you not apply for an incentive from &PACIFICORP for this equipment?

1. **[RECORD RESPONSE]**

88. DON'T KNOW/NOT SURE
99. REFUSED

[IF MULT_MEASURES=1 SET &MEASURE_#=&MEASURE_2 GO BACK TO SP2; ELSE GO TO SP9]

SP9. Did you purchase or install any other equipment? **[DO NOT READ; CHECK ALL THAT APPLY. SPECIFY DETAILED INFORMATION ABOUT EQUIPMENT TYPE] [IF NEEDED:]** What type of equipment is that?

1. Lighting [SPECIFY]: _____
2. HVAC (heating and cooling) [SPECIFY]: _____
3. Variable drive [SPECIFY]: _____
4. Efficient motor [SPECIFY]: _____
5. Refrigeration [SPECIFY]: _____
6. Building envelope [SPECIFY]: _____
7. Compressed air [SPECIFY]: _____
8. Chiller [SPECIFY]: _____
9. Pump [SPECIFY]: _____
10. Irrigation (gaskets, drains, sprinklers) [SPECIFY]: _____
11. Automatic Milker Takeoffs [SPECIFY]: _____
12. Other [SPECIFY]: _____

88. DON'T KNOW/NOT SURE
99. REFUSED

Barriers

B1. Now I'd like to ask about other potential energy efficiency improvements. Do you think there are other changes that you could make to improve electric efficiency at &FIRM?

1. YES
2. NO → **SKIP TO IC1**
88. DON'T KNOW/NOT SURE → **SKIP TO IC1**
99. REFUSED → **SKIP TO IC1**

B2. Could you provide some examples of changes you think would improve electric efficiency at &FIRM?

1. [RECORD RESPONSE: PROBE FOR ADDITIONAL]
88. DON'T KNOW/NOT SURE
99. REFUSED

B3. Are plans in place to make any of those changes?

1. YES
2. NO → **SKIP TO B5**
88. DON'T KNOW/NOT SURE → **SKIP TO B5**
99. REFUSED → **SKIP TO B5**

B4. Is assistance from &PACIFICORP part of those plans?

1. YES
2. NO
88. DON'T KNOW/NOT SURE
99. REFUSED

B5. What factors could prevent &FIRM from making these changes? **[DO NOT READ; CHECK ALL THAT APPLY]**

1. HIGH UPFRONT COSTS
2. LACK OF ACCESS TO CAPITAL
3. LONG PAYBACK PERIOD; SLOW RATE OF RETURN
4. LOW PRIORITY/LACK OF INTEREST OF SENIOR/CORPORATE MANAGEMENT IN ENERGY EFFICIENCY
5. LACK OF INFORMATION ABOUT SAVINGS AND PERFORMANCE
6. LACK OF ASSIGNED ENERGY STAFF
7. OTHER [SPECIFY]
8. NONE
88. DON'T KNOW/NOT SURE
99. REFUSED

[IF MORE THAN ONE RESPONSE TO B5]

B6. Which of these do you think is the most challenging factor? **[IF B5 = 7 and > 2 "other" reasons, enter most important reason in option 8 at B6]**

1. HIGH UPFRONT COSTS
2. LACK OF ACCESS TO CAPITAL
3. LONG PAYBACK PERIOD; SLOW RATE OF RETURN
4. LOW PRIORITY/LACK OF INTEREST OF SENIOR/CORPORATE MANAGEMENT IN ENERGY EFFICIENCY
5. LACK OF INFORMATION ABOUT SAVINGS AND PERFORMANCE
6. LACK OF RESPONSIBLE/ACCOUNTABLE ENERGY STAFF
7. DISPLAY OTHER FROM B6
8. OTHER (SPECIFY MOST IMPORTANT OTHER REASON IN B6, IF > 2 REASONS):

88. DON'T KNOW/NOT SURE
99. REFUSED

Satisfaction

IC1. Using a scale of 1 to 5 where 1 indicates 'very dissatisfied' and 5 indicates 'very satisfied', how satisfied were you overall with the program?

1. VERY DISSATSIFIED
2. SOMEWHAT DISSATISFIED
3. NEITHER SATISFIED NOR DISSATISFIED
4. SOMEWHAT SATISFIED → **SKIP TO FB1**
5. VERY SATISFIED → **SKIP TO FB1**

88. DON'T KNOW/NOT SURE → **SKIP TO FB1**
99. REFUSED → **SKIP TO FB1**

IC1A. What could the program have done that would have made you more satisfied with the program overall?

1. **[RECORD RESPONSE]**

88. DON'T KNOW/NOT SURE
99. REFUSED

Firmographics

FB1. Now I have a few final, general questions about your company for comparison purposes only. Which of the following best describes your company's primary activities?

1. ACCOMMODATION
2. ARTS, ENTERTAINMENT, AND RECREATION
3. CONSTRUCTION
4. DAIRY / AGRICULTURAL
5. EDUCATIONAL SERVICES
6. FINANCE AND INSURANCE
7. FOOD SERVICES
8. FOOD PROCESSING
9. HEALTH CARE
10. MANUFACTURING

11. MINING
12. NON-PROFITS AND RELIGIOUS ORGANIZATIONS
13. PROFESSIONAL, SCIENTIFIC, AND TECHNICAL SERVICES
14. PUBLIC ADMINISTRATION / GOVERNMENTAL SERVICES
15. OIL AND GAS
16. RETAIL
17. REFRIGERATED WAREHOUSE
18. REAL ESTATE / PROPERTY MANAGEMENT
19. REPAIR AND MAINTENANCE SERVICES
20. TRANSPORTATION
21. WAREHOUSES OR WHOLESALER
22. OTHER **[SPECIFY]:** _____
23. NOT COMPANY, RESIDENCE
88. DON'T KNOW/NOT SURE
99. REFUSED

FB2. Approximately what percentage of your total annual operating costs does your electricity bill at this site represent?

1. **[RECORD RESPONSE]**
88. DON'T KNOW/NOT SURE
99. REFUSED

FB3. About how many people does your firm employ at this site?

1. **[RECORD RESPONSE]**
88. DON'T KNOW/NOT SURE
99. REFUSED

END1. Those are all of the questions that I have for you. Is there anything about your experiences with &PACIFICORP's &PROGRAM program you'd like to mention that we did not talk about today?

1. **[RECORD RESPONSE]**
88. DON'T KNOW/NOT SURE
99. REFUSED

[THANK RESPONDENT AND TERMINATE SURVEY]

GEC Response to Environmental Defence Interrogatory #5

Question:

Reference: Exhibit L.GEC.1, pp. 30-31 Topic 3: Budgets

On page 31, Mr. Neme's report states that "a recent jurisdictional scan conducted by Navigant Consulting for the Ontario gas Technical Evaluation Committee found that the average free rider rate from evaluations of twenty-four different gas utility Custom C&I programs – which are typically targeted to the largest customers – was between 30% and 40% (meaning 60% to 70% of savings would not have occurred without the utility programs)."

In Mr. Neme's professional opinion, is it likely that Union's large industrial DSM program could achieve a free rider rate of between 30 to 40%?

Response:

While it is possible, I would not go so far as to say it is likely. In fact, I suspect that the Company's free rider rate is more likely to be closer to the 54% it is currently estimating. That said, if some of the program design changes that I proposed in my testimony were adopted, I would expect the free rider rate for the revised program to be in this range.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #6

Question:

Reference: Exhibit L.GEC.1, p. 21 Topic 3: Budgets

Mr. Neme's report notes as follows: "because the rate reducing impacts from price suppression, reduced purchases of expensive gas, reduced investment in T&D and reduced GHG mitigation costs are shared among customer groups, the cancellation of this program would harm all customers."

Taken together, how much would Union's residential customers save if Union were to reinstate its large industrial DSM program as recommended by Mr. Neme's report? Please make any appropriate assumptions and confer with Paul Chernick as necessary.

Response:

Neither Mr. Chernick nor Mr. Neme have done this analysis. Doing so would require some care and more time than is available.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #7

Question:

Reference: Exhibit L.GEC.1, p. 34 Topic 3: Budgets

The Board's 2015-2020 Natural Gas DSM Framework make an annual shareholder incentive available to each Enbridge and Union that is equal to a total annual maximum of $10.45 million (p. 22).

(a) Please confirm that, for the first time, the incentive for each utility is capped and will not increase or decrease relative to the approved DSM budgets.

(b) As a result of the new cap on the shareholder incentive, would Mr. Neme agree that the utilities have no financial incentive to seek increases to their DSM budgets beyond the "maximum budget guideline" set by the Board (i.e. $85M for Enbridge and $70M for Union, see pages 17 and 18 of the Board's 2015-2020 Natural Gas DSM Framework)?

Response:

a) That is my understanding. If anything, it could be interpreted as a reduction in shareholder incentives, relative to recent years, because the maximum incentive can only be earned once the utility reaches 150% of its goals (under the Board's guidelines which Enbridge followed but Union did not) instead of 125% in the past.

b) Yes.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #8

Question:

Reference: Exhibit L.GEC.1, p. 34 Topic 3: Budgets

(a) Do the utilities have a financial incentive to seek approval of gas savings targets that are as low as possible so as to increase the chances that they would achieve and beat the targets and thus obtain incentive payments?

(b) If yes, do the utilities also have a financial incentive to minimize or downplay estimates of the achievable DSM potential so as to justify lower and more easy to achieve gas savings targets?

Response:

a) Yes, at least within a "band" of values that could be defended with a "straight face".

b) I suppose so. However, I don't think that is the main reason potential studies end up being very conservative in their projections of achievable potential.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #9

Question:

Reference: Exhibit L.GEC.1, pp. 9 & 34 Topic 3: Budgets

Page 9 of Mr. Neme's report states as follows: "In Union's case, a near doubling of spending from 2014 to 2020 is forecast to result in a 40% to 50% reduction in both incremental annual savings and lifetime savings."

(a) Please confirm that Union will still be eligible to obtain the maximum shareholder incentive under the DSM guidelines despite the 40 to 50% forecast reduction in savings from its proposed program.

(b) Please confirm that utilities have no financial incentive to propose DSM plans that will result in the *maximum* amount of gas savings that are attainable because the shareholder incentive is based on meeting or surpassing approved targets, not on the magnitude of the targets themselves.

Response:

a) Confirmed.
b) Confirmed.

Witness: Chris Neme

GEC Response to Environmental Defence Interrogatory #10

Question:

Reference: Exhibit L.GEC.1 Topic 3: Budgets

In Mr. Neme's professional opinion, will the Board's DSM Framework enable the achievement of all cost-effective DSM that result in a reasonable rate impact? Please explain why or why not. Please attach any relevant submissions or reports that would support your answer (e.g. materials submitted during the consultations on the DSM Framework).

Response:

No.

I'll begin by noting that the Board's DSM Framework clearly constrains how much cost-effective savings can be achieved in two major ways:

1. Suggesting budget caps equal to DSM spending of $2 per month per residential customer; and
2. Suggesting the discontinuation of Union's large customer self-direct program.

As noted in my testimony, there are several reasons to suggest that both of these limitations constrain savings much more than just if the principle was to limit spending to levels at which there are undue rate impacts.

First, given the Province's policy priorities, including its commitment to addressing climate change, as well as the economic benefits to the economy of pursuing more cost-effective DSM and the potential to craft an efficiency program portfolio that could offer opportunities for all customers to save and benefit directly over time, one could question whether anything above $2 per month is an "undue" rate impact. As noted in my testimony, the utilities' proposed spending levels are well below those of leading jurisdictions.

Second, spending limits and rate impacts are not the same thing. While spending puts upward pressure on rates, there are benefits of efficiency that put downward pressure on rates. As my testimony makes clear, the downward pressure on rates from the savings the utilities' plans are forecast to produce are estimated to be on the order of $3 per month (or more) over the life of the savings – more than offsetting the upward pressure cause by the spending that would produce them. Put yet another way, even if the utilities doubled their proposed levels of DSM spending (for a total of $4 per month of upward rate pressure) and got no additional savings from the increases (so the downward pressure remained at $3 per month), the net effect of the total spending and the total benefits on residential rates would still be on the order of just $1 per

month. Of course, if the utilities double their spending, they should also significantly increase savings, producing even more benefits that put downward pressure on rates. It is worth noting that, given the compressed timeframe for developing new guidelines, the Board did not have the benefit of the evidence presented in this proceeding when establishing its budget guidelines.

Finally, the Board's decision to propose the termination of Union's large industrial program was not made out of concern about undue rate impacts. Indeed, DSM spending levels for Union's large industrial customers have historically been very low per m^3 of gas consumed by those customers. Rather, the Board appeared to make its decision on two grounds: (1) the premise that those customers are likely to pursue cost-effective efficiency investments on their own; and (2) a concern about customers cross-subsidizing improvements for their competitors. As noted in my testimony, neither of these concerns stand up to close scrutiny. Again, this may be a function of the Board having to put new guidelines in place in a compressed timeframe that did not allow for adequate consideration of all relevant evidence on the topics being addressed.

GEC Response to Environmental Defence Interrogatory #11

Question:

Reference: Exhibit L.GEC.2, pp. 24 & 25

At pages 24 and 25, Mr. Chernick calculates a cost of carbon based on the 15% non-energy benefits adder prescribed by the Minister of Energy for electricity conservation measures. What is the equivalent implied carbon value in the 15% non-energy benefits adder stipulated by the Board's DSM Guidelines? Please make and state any assumptions as appropriate.

Response:

If *all* of the 15% non-energy benefits adder were assumed to be related to carbon emissions, the implied carbon valuation would be 15% of Union's average avoided cost for 2016–2020 (about $\$0.22/m^3$) or about $\$0.033/m^3$. Each m^3 emits approximately 1.89 kg or 0.00189 tonne of CO_2, so the implied value is $\$0.033 \div 0.00189 = \$17.5$/tonne.

The $17.46/ tonne is about a third of the $53/tonne implied by the Minister's adder for electricity, if 100% of the 15% electricity adder is attributed to carbon.

Since the Minister stated that the 15% electric adder was intended to reflect all non-energy benefits, "such as environmental, economic and social benefits," the carbon value implied by a 15% adder on natural-gas avoided cost would be much lower than $17.46/tonne.

Witness: Paul Chernick

GEC Response to Environmental Defence Interrogatory #12

Question:

Reference: Exhibit L.GEC.2

Please file the documents referenced in your report that relate to Ontario's policies regarding energy and climate change, including the documents referenced in footnotes 11 and 12.

Response:

Attachment 1:

Feeling the Heat: Greenhouse Gas Progress Report 2015, Environmental Commissioner of Ontario, July 2015.

Attachment 2:

Cap and Trade System to Limit Greenhouse Gas Pollution in Ontario, news release, Office of the Premier, April 2015.

Attachment 3:

Ontario's Climate Change Update 2014, Ministry of Environment & Climate Change, September 2014.

Witness: Paul Chernick

Feeling the Heat:

Greenhouse Gas Progress Report 2015

Environmental Commissioner of Ontario

July 2015

The Honourable Dave Levac
Speaker of the Legislative Assembly of Ontario

Room 180, Legislative Building
Legislative Assembly
Province of Ontario
Queen's Park

Dear Speaker:

In accordance with Section 58.2 of the *Environmental Bill of Rights, 1993*, I am pleased to present the Annual Greenhouse Gas Progress Report 2015 of the Environmental Commissioner of Ontario for your submission to the Legislative Assembly of Ontario. This Annual Report is my independent review of the Ontario government's progress in reducing greenhouse gas emissions for 2014-2015.

Sincerely,

Ellen Schwartzel
Environmental Commissioner of Ontario (Acting)

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June

1. Introduction: Ontario's Changing Climate

1.1 Rebooting the Climate Change File

Ontario's climate is changing – both environmentally and in its policy mindset. In recent years, Ontario has struggled to make much progress on reducing greenhouse gas (GHG) emissions outside of the electricity sector. However, this seems poised to change as the government has recently unveiled several measures that suggest 2015 will be a key year for climate policy in Ontario.

Over the past year, Ontario has declared its commitment to major action on climate change. In June 2014, the government added "Climate Change" to the name of the Ministry of the Environment. In September 2014, the newly re-elected Premier issued a mandate letter to the Minister of the Environment and Climate Change that included clear instructions to update Ontario's climate change strategy, engage the public, and integrate climate change considerations into government decision-making processes.[1]

The government established a Climate Change Directorate in late 2014, housed within the Ministry of the Environment and Climate Change (MOECC), to co-ordinate, report on and drive climate action across all provincial ministries.[2] Ontario has also deepened its relationships with other provinces such as Alberta, British Columbia and especially Quebec, aiming to work together on climate and energy issues through bilateral action, as well as in other inter-provincial fora. In November 2014, Ontario signed a Memorandum of Understanding with Quebec on climate change that outlines key areas for future co-operation, including carbon pricing and regulatory alignment on emissions reporting. In March 2015 the government announced the appointment of a special advisor and an external advisory council on climate change. On April 13, 2015, the government announced that it will create a cap-and-trade system to achieve emissions reductions across sectors.[3]

Drivers for Action

The push for Ontario's reboot on climate change has been growing steadily for years, with pressure coming from stakeholders, increasingly evolved climate science, more evidence of climate change impacts, and increasing international climate action. Municipalities, corporations and conservation authorities have been clamouring for greater provincial leadership, policy guidance and support (including financial support) to address climate change issues.

Over the past year, climate change has gained considerable attention at the highest political levels in the world's largest economies, providing further motivation for Ontario to act. The U.S. will be targeting emissions reductions in its highest emitting sector, electricity,[4] as well as methane emissions from oil and gas production.[5] The U.S. and China also announced a historic joint commitment to strengthen bilateral co-ordination on climate change.[6] Carbon pricing continues to spread across the globe; according to the World Bank, as of May 2014, there was some form of carbon price in over 40 countries and in 20 sub-national jurisdictions, covering 12 per cent of global GHG emissions.[7]

Despite little progress at past United Nations Framework Convention on Climate Change Conferences of the Parties, December 2015's session in Paris, France seems poised for a potential agreement. In anticipation, many jurisdictions are gearing up for Paris by introducing new climate change policies and plans – including Ontario.[8] Recently, Ontario and other sub-national governments have been playing a more prominent role in international climate diplomacy. The Compact of States and Regions, first announced at the September 2014 Climate Summit in New York City, with further signatories added at the Conference of the Parties in December 2014, looks to be a promising initiative to drive climate action at the state and regional government level.

An even bigger impetus for a reboot, however, is the growing recognition of the rapidly changing climate and the high costs of inaction. Thousands of scientific reports and peer-reviewed articles have established that the Earth's climate is changing. In Chapter 1 of the ECO's 2014 GHG Report, the ECO described the conclusions of Working Group I for the *Fifth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC); specifically, the IPCC concluded – with 95 per cent confidence – that human activities have been the dominant cause of climate warming since the 1950s. The IPCC findings, along with other reports, highlight how global average temperatures have increased and are expected to continue to rise, as well as the observed and expected intensification of extreme weather events such as heat waves and storms. It has become harder and harder to ignore the potential looming costs – economic, environmental and social – of climate change for Ontario.

In 2014 the IPCC released the remainder of its findings for the *Fifth Assessment Report*, culminating in a *Synthesis Report*. Among many other conclusions, that report calls for additional mitigation actions by all levels of government to decrease the likelihood of the many serious risks that the IPCC identifies from increased warming. The IPCC's *Synthesis Report* further highlights the need for adaptation measures to those climate change impacts that are unavoidable based on emissions already in the atmosphere (see **Appendix 1** for a more detailed summary of this report).

As the IPCC continues to publish increasingly stark, authoritative climate science reports, much of the world has moved beyond the old debates about whether and why climate change is happening. In keeping with this trend, the Ontario Legislature unanimously passed a motion on March 12, 2015, recognizing that climate change science and the serious threats it represents for Ontarians are now also beyond debate in Ontario politics.

The ECO has moved on as well; rather than expend pages in the introduction of our report making the case that climate change is occurring in Ontario, **Appendix 2** provides an overview of climate trends and projections for Ontario.

1.2 The Economic and Social Impacts of Climate Change

Climate change is not only altering our weather patterns and environment, it has also already begun to affect Ontario's economy and communities. Although the changing climate brings mixed positive and negative effects, it is predicted that the increasing economic costs related to damage to both public and private infrastructure and other property will be fiscally unsustainable for government.[9] Costs to the government associated with inaction also include potential negligence lawsuits, further discussed in the box on page 7. These costs of climate change impacts justify the upfront capital costs that are needed by the public and private sectors to adapt to the changing climate and more extreme weather events.[10]

At the same time, the long-standing belief that economic growth necessitates a certain degree of increasing GHG emissions has been debunked. As Ontario's *Climate Change Update 2014* indicates, economic growth in Ontario can break from this historic trend of emissions growth.[11] A low-carbon economy presents important economic opportunities for the province.

Economic Impacts to Industry

Many sectors of the Ontario economy will be challenged by a changing climate. Resource-based industries will be especially hard-hit. Although a warmer climate potentially brings a longer growing season, a 2014 Natural Resources Canada (NRCAN) study explains that Ontario agriculture could be at greater risk from drought, pests, disease and climate variability.[12] The costs to the province could be enormous; between 2000 and 2004 alone, droughts in Ontario resulted in crop insurance payouts of $600 million, and according to the National Round Table on the Environment and the Economy (NRTEE) in 2010, this figure will only rise.[13]

Climate change has already had variable effects on Ontario's tourism industry. For example, NRCAN's 2014 study highlights how recent warm winters have had negative impacts on the ski industry, while warm weather activities, such as golf, may benefit from an extended summer season.[14] This same report discusses how many other sectors of the economy will be affected by climate change; for example, the manufacturing sector may be negatively affected as a result of extreme weather damaging infrastructure and interrupting supply chains, as well as higher temperatures and humidity affecting employee health and productivity.[15]

Even where increases in annual average precipitation are projected, increased evaporation and evapotranspiration due to higher temperatures may lead to overall lower water levels.[16] Lower water levels could negatively affect important transportation networks, such as the Great Lakes-St. Lawrence Seaway. Shallower navigation channels, docks and harbours reduce the amount of cargo that ships can carry and may require more trips; as a result, shipping costs could increase.[17] According to the NRTEE, lower water levels in lakes and rivers will also reduce the potential for hydro-electric generation in parts of Ontario and could lead to economic losses of $660 million per year, as well as result in energy shortages during peak summer demand.[18]

In the Far North of Ontario, the winter road network is a vital link for communities and resource industries that are not serviced by a permanent road system. Shortened, warmer winters mean a reduced season for building and operating winter roads.[19]

Risks to Public Assets and Government Operations

Ontarians face costly climate change-related risks to public assets and government operations, including infrastructure (e.g., roads, the electricity grid and buildings), services (e.g., emergency response), and finances (e.g., consequences of reduced insurance affordability). Additional investment over a number of years will be required to make public infrastructure more resilient to extreme weather. Delivery of government services will be affected in different ways: some impacts may be sudden due to extreme weather and others more gradual due to longer-term climatic shifts. For example, in 2012, Emergency Management Ontario projected that emergency management services will be challenged to keep up with the increased frequency and greater severity of natural disasters, such as floods, predicted under a changing climate.[20]

The provincial government has already begun to encounter the need to make additional financial payouts due to extreme weather (ultimately coming out of taxpayers' pockets). Periodic provision of emergency funding to hard-hit municipalities or individuals may be needed, as was required during the Burlington flood in 2014 and the December 2013 ice storm in the Greater Toronto Area. As the number and magnitude of natural disasters increase, Ontario's disaster fund, the Ontario Disaster Relief Assistance Program[i], will be under additional stress to provide financial support to hard-hit communities and individuals. Furthermore, under its proposed expansion of crop insurance for Ontario farmers, the government will likely need to make additional payouts for crop failure due to extreme weather. Existing government insurance or emergency management programs such as Ontario's disaster fund were not designed with climate change in mind, highlighting the need for a more strategic approach to funding adaptation.

[i]Changes to Ontario Disaster Relief Assistance Program (ODRAP) are likely coming; in the 2014 mandate letter to the Minister of Municipal Affairs and Housing, the Premier instructed the Minister to examine ODRAP to ensure its design and eligibility criteria reflect current needs in addressing extreme weather events. The future of this program is more important than ever given that, as of February 1, 2015, the federal government reduced financial support for the provinces from the Disaster Financial Assistance Arrangements program, meaning Ontario will have to cover an increased share of disaster-related rebuilding costs.

Provincial Legal Liability for Damage Caused by Climate Change

Extreme weather events have already begun to stress infrastructure in Ontario, and will continue to do so, even in the best-case GHG mitigation scenario.[21] The resulting damage to personal property and/or human health may create legal liabilities for the provincial government, most likely in the form of negligence lawsuits.[22] Such lawsuits, if successful, could result in costly awards or settlements.

Some legal research states that the provincial government could be held legally liable for negligence in relation to an extreme weather event in circumstances where the following basic elements are present:

- an individual or group has suffered personal or property damage;
- the damage was, at least in part, caused by the provincial government's acts or omissions;
- the provincial government had a legal duty to the individual/group; and
- the provincial government ought to have reasonably known its act or omission could cause a risk for that individual/group (and knowledge of extreme weather events might factor into this reasonableness analysis).[23]

The provincial government is responsible for managing or regulating various types of infrastructure. Depending on how the province executes such responsibilities, these obligations could create liability for the government as a potential defendant in a negligence lawsuit. For example, the province could face liability arising from its role in establishing design standards[24] and in providing regulatory approval authority for stormwater systems.[25] Extreme weather events increase the likelihood of flooding and sewer back-ups, which can cause significant property damage (see the ECO's 2013 GHG Report.)

Another example is publicly-owned electricity transmission infrastructure. The courts have found that Ontario's crown corporation Hydro One has a duty to deliver electricity safely and that the former Ontario Hydro had a duty to have adequate emergency response systems in place.[26] Similarly, the provincial government has been found to have a responsibility to protect against hazards from electrical infrastructure on provincially owned land that may cause physical harm to members of the public.[27] As extreme weather events increase, the province will face greater potential liability, both via its ownership of electricity transmission assets and as an owner of land where electrical infrastructure is installed, from weather-related electrical hazards.[28]

The province also has a duty to plan, design, maintain and repair provincial roads and highways[29] and to ensure they are safe for use.[30] The province's potential liability with respect to this responsibility could increase as a result of the predicted rise in intense rain events, freeze-thaw cycles, and climate variability.[31] What's more, the government's own precipitation projections suggest the province should be aware of these climate change risks, factoring into the reasonableness analysis of the province's actions (or inactions) under the law.[32]

In negligence cases, the court will consider various factors when determining liability, including whether the action or inaction that lead to the damage was reasonable.[33] The assessment of "reasonableness" could take into account relevant statutory requirements and guidance, publicly available knowledge, as well as government custom and practice.[34] Government policy decisions are generally immune from liability; however, legal experts have pointed out that governments that fail to consider climate change in policy making will not be immune from potential negligence claims if this information would have been considered by a reasonable person (or government) in similar circumstances.[35]

Climate Change and Human Health

Climate change also holds serious consequences for the health of Ontarians. NRCAN reported in 2008 that by 2050, cities such as Toronto and Windsor can expect double the current average number of days exceeding 30°C.[36] As a result, the report continues, mortality due to heat could also double by the 2050s, while mortality from air pollution could rise as well.[37]

The warming climate is also heightening the risk of certain diseases. As the ECO wrote in our 2009/2010 Annual Report, and NRCAN discussed in a 2014 report, black-legged ticks – the species that transmits Lyme disease – are spreading northward into Canada at a rate of 35–55 km/year, exposing more of Ontario to this debilitating disease.[38] Annual incidences of Lyme disease in Canada have already increased from approximately 144 cases in 2009 to 682 cases in 2013.[39] In 2010 the NRTEE reported that warmer winters and warm, humid summers may also result in the spread of mosquitoes that carry West Nile Virus.[40]

Extreme weather can bring about other health risks. According to the Report of the Walkerton Inquiry, one of the many factors that contributed to the deadly outbreak of *E. coli* in Walkerton in 2000 was the heavy rain that assisted the transport of manure into the drinking water supply.[41] The 2008 NRCAN scientific literature review on the impacts of climate change on Ontario also reported that intense rainfall and ice storms can result in traffic accidents, while flooded homes can lead to the spread of toxic molds and poor indoor air quality.[42]

2. Ontario's Latest GHG Numbers

The Environmental Commissioner of Ontario reports annually to the Legislative Assembly of Ontario on the progress of the Ontario government towards reducing the province's GHG emissions, as required by the *Environmental Bill of Rights, 1993*. This section uses the most recent Environment Canada data to assess the province's progress towards meeting its GHG emissions reduction targets, established in 2007.[43] The three provincial targets are to reduce Ontario's annual GHG emissions by:

- 6 per cent below 1990 levels by 2014 (to approximately 171 Megatonnes [Mt] CO_2 equivalent);
- 15 per cent below 1990 levels by 2020 (to approximately 155 Mt); and
- 80 per cent below 1990 levels by 2050 (to approximately 36 Mt).

Ontario recently announced a 2030 mid-term target of 37 per cent below 1990 levels (equivalent to 115 Mt).

2.1 Overall Emissions in 2013

According to the 2015 National Inventory Report (NIR), Ontario's GHG emissions in 2013 were 171 Mt, equivalent to emissions in 2012 (and 2009).[44] This figure is the lowest annual level of emissions since the baseline year of 1990 (and 1991), when emissions were 182 Mt. (Note: this baseline number is higher than previously reported based on the use of newer methods of calculating GHG emissions; see box.)

Revised Framework for Calculating GHG Emissions

In this year's edition of the National Inventory Report, it became mandatory for Environment Canada to use the revised United Nations Framework Convention on Climate Change emissions reporting guidelines. This resulted in recalculations of previous years' emissions, and the 1990 baseline year is now higher than was reported in previous years (e.g., the baseline was reported to be 177 Mt in 2014, but was increased to 182 Mt in 2015).[ii] The recalculation is mainly due to an updated value for the global warming potential of two greenhouse gases, methane and nitrous oxide, resulting in higher carbon emissions across all years. The sectors most affected by this change are residential buildings, agriculture, and waste.

[ii] Each year Canada produces a National Inventory Report, which provides the most recent, as well as historic, GHG data for Canada and each province. Due to continual improvements to the way emissions estimates are modelled and calculated, historic data is often restated. Accordingly, historic numbers for some years, including the baseline year of 1990, may not exactly align with data on which the ECO has previously reported and commented.

With Ontario's emissions projected to be lower in 2014 due to the closure of its final coal-powered electricity plant, Ontario looks likely to meet its 2014 target (which is also 171 Mt). As shown in **Figure 1**, the last several years have witnessed a significant decline from the peaks experienced roughly between 2000 and 2005, when emissions from coal-fired electricity generation were highest.

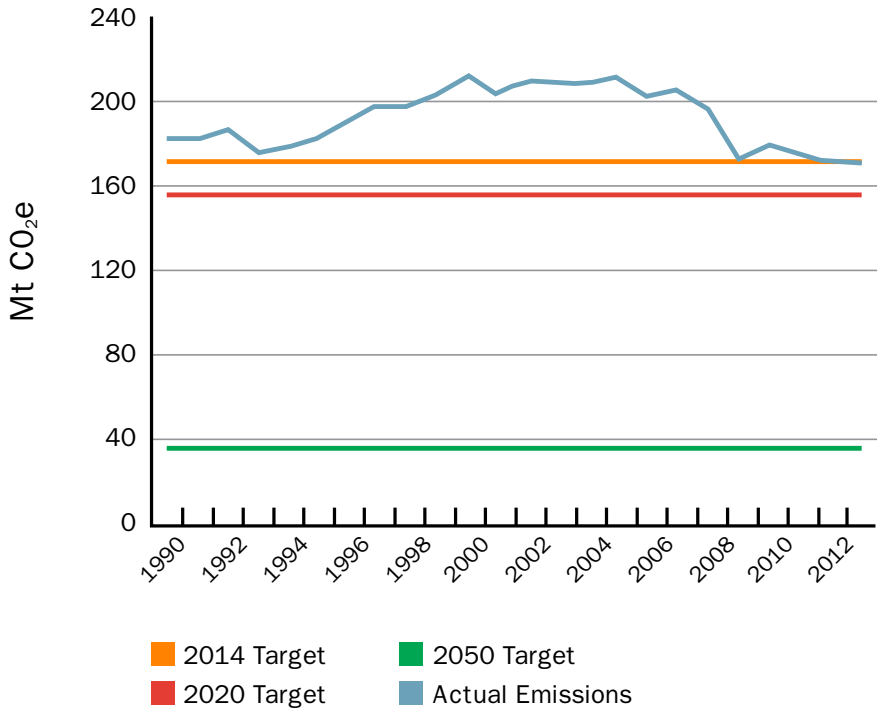


Figure 1. Ontario greenhouse gas emission trends and targets (1990-2013). (Sources: Environment Canada. National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990-2013 (2015); Go Green: Ontario's Action Plan on Climate Change (2007); Ontario's Climate Change Update 2014 (2014)).

However, meeting the 2020 target will prove more difficult. Ontario faces a large gap (19 Mt – equal to 11 per cent of its total current GHG emissions[iii]) between the province's projected 2020 emissions based on current policies and trends and the 2020 target. Without new policy initiatives, the majority of Ontario's emissions reductions (78 per cent in 2020) will have come from the single initiative of phasing out the use of coal in the electricity sector. The government's biggest climate change challenge going forward is to achieve sufficient GHG reductions beyond the electricity sector to meet its 2020 target.

[iii] This 19 Mt gap was as of September 2014 and is based on the previous year's National Inventory Report.

2.2 Sector-Specific Emissions

Figure 2 shows Ontario's GHG emissions from each sector and how they have changed from 1990 to 2013. The electricity sector alone has seen a 58 per cent reduction in emissions over this time period, with the industrial sector contributing a further 26 per cent reduction, mostly due to reduced industrial production in the province.[46] The closure of the coal plants will not be fully reflected in Ontario's emissions profile until the 2015 emissions data becomes available.

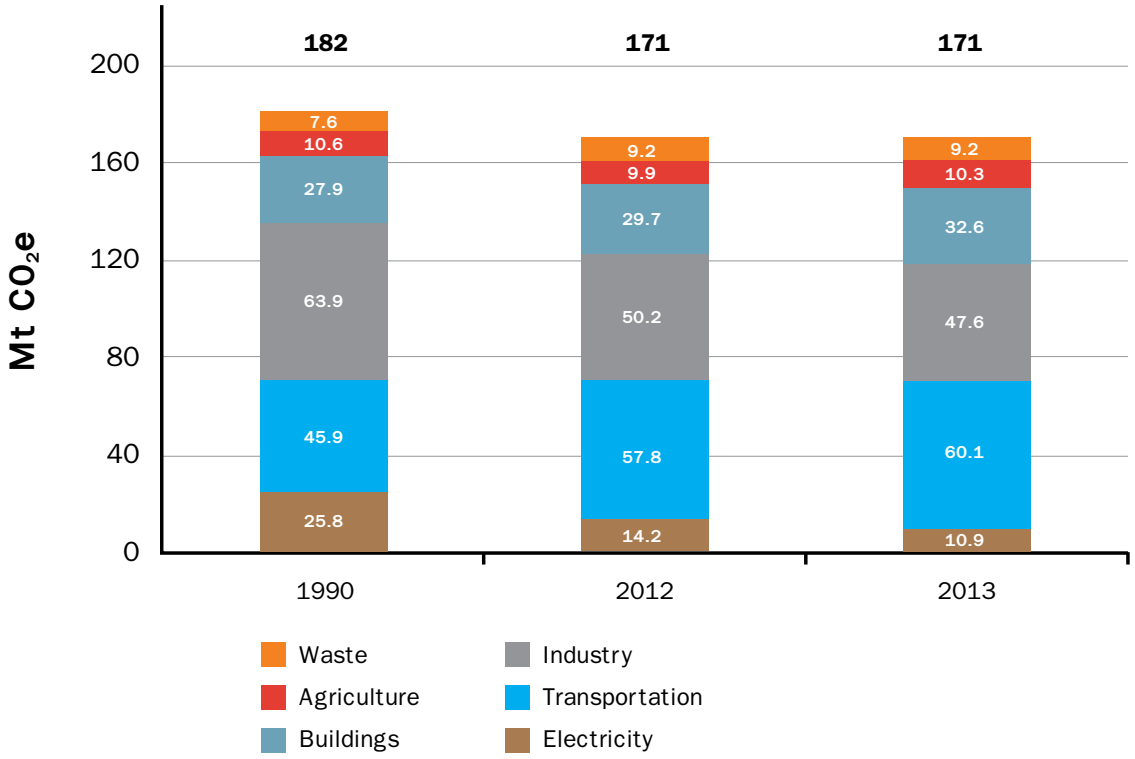


Figure 2. Ontario greenhouse gas emissions by sector for 1990, 2012 and 2013. (Source: Environment Canada. National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990-2013 (2015)).

Since 1990, emissions reductions in the electricity and industry sectors have been partially offset by the 31 per cent increase in emissions from the transportation sector. Emissions in the buildings and waste sectors have also risen (17 per cent and 20 per cent, respectively). The transportation sector remains the largest contributor to the overall provincial inventory, with emissions rising 4 per cent from 2012 to 2013. Although emissions intensities have fallen in many sectors, in some sectors these gains are at least partially offset by economic and population growth.[47]

A more detailed breakdown of sector emissions is provided in **Table 1**.

Table 1. Ontario's Greenhouse Gas Emissions 1990–2013 (Source: Environment Canada. National Inventory Report – Greenhouse Gas Sources and Sinks in Canada 1990-2013 (2015)).

Sources	Emissions (Mt CO_2e)		Change from 1990 - 2013		Percentage each sector contributes to 2013 total
	1990	2013	Mt CO_2e	%Δ	%
Electricity	25.8	10.9	-14.9	-58	6
Transportation	45.9	60.1	+14.2	+31	35
Road (passenger)	27.3	32.7	+5.4	+19.8	
Road (freight)	8	13.4	+5.4	+67.5	
Off-road (gasoline and diesel)	5.6	9.2	+3.6	+64.3	
Domestic Aviation	2.2	2.3	+0.1	+4.5	
Domestic Marine	1.0	1.2	+0.2	+20	
Rail	1.8	1.3	-0.5	-27.8	
Industry	63.9	47.6	-16.3	-25.5	28
Fossil fuel refining	6.1	6.1	0	0	
Manufacturing	22	16.1	-5.9	-26.8	
Mineral Production (cement, lime, mineral products)	4.1	3.6	-0.5	-12.2	
Chemical Industry	10	0	-10	-100	
Metal Production (iron and steel)	10.9	7.7	-3.2	-29.4	
Fugitive Sources	1.6	1.3	-0.3	-18.8	
Other[iv]	9.3	12.8	+3.5	+37.6	
Buildings	27.9	32.6	+4.7	+17	19
Commercial and Institutional	9.1	11.9	+2.8	+30.8	
Residential	18.8	20.7	+1.9	+10.1	
Agriculture	10.6	10.3	-0.3	-3	4
Enteric Fermentation	4.4	3.6	-0.8	-18.2	
Manure Management	2.1	1.9	-0.2	-9.5	
Agricultural Soils	3.9	4.6	+0.7	+17.9	
Waste	7.6	9	+1.4	+19	5
Solid Waste Disposal on Land	7.1	8.4	+1.3	+18.3	
Wastewater Handling	.2	.3	+0.1	+50	
Waste Incineration	.3	.3	0	0	
TOTAL	182	171	-11	-6	100

[iv]The "other" category includes emissions from stationary combustion in mining, construction, agriculture and forestry; emissions from pipelines; emissions associated with the production and consumption of halocarbons; and emissions from the use of petroleum fuels as feedstock for petrochemical products. Subsector figures do not exactly match sector totals due to rounding errors and the fact that this table does not list all minor subsectors. The ECO adds up the emissions subcategories to calculate the sector totals so they may not exactly match the rounded numbers presented in the NIR.

3. Review of Ontario's Progress on GHG Reductions

The Environmental Commissioner of Ontario annually reviews all government reports on climate change and GHG reductions published during the previous year, as required by the *Environmental Bill of Rights, 1993*. This section reviews the Ontario government's most recent GHG annual report, Ontario's *Climate Change Update 2014*, which provides an update of Ontario's GHG emissions and progress towards meetings its GHG reduction targets as set out in the government's 2007 *Climate Change Action Plan*.[48] This section also reviews additional climate change-related policy developments that occurred between July 9, 2014 (the release date of the ECO's last GHG report) and April 15, 2015.

The Ontario government's *Climate Change Update 2014*, released by the MOECC in September 2014, provides a detailed analysis of Environment Canada's 2014 National Inventory Report emission numbers for Ontario (supplemented by the MOECC's data and projections). The 2014 update report explains the sources of emissions in the province and why they may be rising or falling, including the impact of policies on GHG emissions. The report also discusses expected future emissions trends in the province based on current government policies, and mentions some potential new policy directions for each sector.

The following sections outline both existing government policies and progress towards developing new policies and regulations to reduce GHG emissions across the transportation, building, industry, agriculture, electricity, and waste sectors. The discussion focuses on progress and barriers towards meeting a rapidly approaching deadline: Ontario's 2020 GHG emissions reduction target. The sectoral reviews are presented from highest to lowest emitting sector.

3.1 Cross-Sectoral Developments

In the ECO's 2014/2015 reporting year, the government announced a number of measures that demonstrate a renewed commitment to climate action, such as adding "Climate Change" to the name of the Ministry of the Environment and including a strong emphasis on climate change in the Premier's mandate letter to the Minister of the Environment and Climate Change (see Section 1.1 of this report for more detail).

In addition, on February 12, 2015, the government posted a climate change discussion paper on the Environmental Registry for a 45-day public comment period (Environmental Registry #012-3452). The paper supported a comprehensive stakeholder engagement process that the province carried out in early 2015 to underpin the development of its new climate change plan. The paper outlined the key areas in which the government intends to introduce new policies to: take action in each sector, including putting a price on carbon; support science, research and technology; and promote climate resilience and risk management.

In April 2015, the government announced that it will introduce a cap-and-trade system. As stated in previous GHG reports, the ECO is supportive of carbon pricing in general as an economically efficient approach to reducing emissions.[49] Although globally cap-and-trade systems targeting GHG emissions are still in the initial stages of implementation, research has shown that they have been able to incent emissions reductions.[50]

The province has committed to completing its updated climate change strategy (covering both climate mitigation and adaptation) by the end of 2015.[51] With that, the ECO expects 2015 to bring numerous climate policy announcements.

No Breakdown of GHG Emissions Projections

The ECO assesses the province's progress in reducing emissions in each of the key sectors: transportation, industry, buildings, electricity, agriculture and waste. However, the ECO's role in assessing the province's progress in reducing GHG emissions on an initiative-by-initiative basis for each sector is hindered by the MOECC's "lumping" approach to reporting.

The MOECC has long used a lumping approach in its climate change progress reports when reporting projected emissions reductions for each sector; the ministry reports the expected emissions reductions for each sector as an aggregate of all GHG-reduction initiatives listed for that sector. For example, within the transportation sector, Ontario's *Climate Change Update 2014* lists six separate initiatives (though one of these is a federal initiative), but lists their projected GHG reductions in one lump figure. Although this approach is likely used due to the difficulty of attributing emissions reductions to any single initiative, it makes it challenging to ascertain whether fluctuations in the projections for a sector over time are due to the success or failure of any specific policy, or due to revised modelling assumptions.

The ECO highlighted this problem in our 2011 GHG Progress Report, but the MOECC has not changed its approach.

3.2 Transportation

At 60.1 Mt (35 per cent of total emissions), the transportation sector – including road, rail, domestic air and marine modes – remains Ontario's largest source of GHG emissions, and consequently, the biggest hurdle to achieving its 2020 GHG reduction target. What's more, GHG emissions from this sector have grown significantly, from 45.9 Mt in 1990, to 57.8 Mt in 2012, to 60.1 Mt in 2013. That is a 31 per cent increase in transportation emissions since 1990.

The ministry's emissions projections for transportation have fluctuated significantly over time. In 2007, the province projected that emissions cuts from transportation would contribute 19 Mt of GHG emissions reductions in 2020.[52] In the MOECC's *Climate Change Progress Report 2012*, the province dramatically scaled back its projected reductions for this sector in 2020 to only 3.9 Mt.[53]

Most recently, the MOECC's *Climate Change Update 2014* projected a slightly more ambitious reduction for the sector for the year 2020 – an improvement from 3.9 to 4.6 Mt.[54] The only new transportation initiative listed in Ontario's *Climate Change Update 2014* compared to its *Climate Change Progress Report 2012* is the Greener Diesel regulation (O. Reg. 97/14) made under the *Environmental Protection Act*; nonetheless, it is not possible to attribute the additional projected reduction of 0.7 Mt to this specific transportation initiative with certainty because of the ministry's aggregated reporting. The new projection could be the result of revised modelling of GHG reductions from other listed transportation initiatives, such as the province's Big Move regional transportation plan.

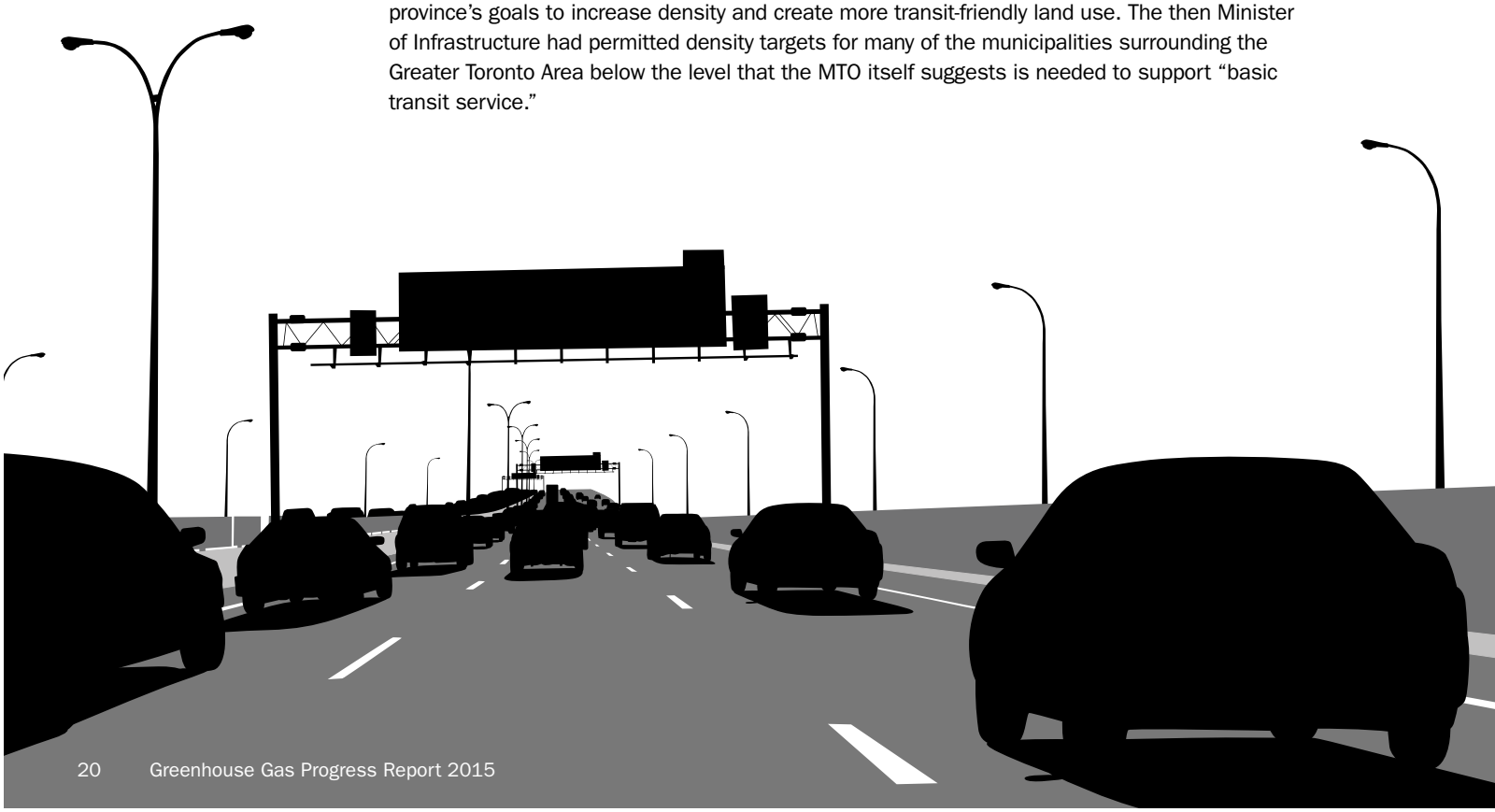
Since Ontario's *Climate Change Update 2014* was released in September, the Ministry of Transportation (MTO) continues to work on implementing pre-existing transit, electric vehicle, and cycling policies (though the latter two have represented GHG reductions too insignificant to be listed in Ontario's *Climate Change Update 2014*). The Premier's 2014 mandate letter to the MTO also called on the ministry to prioritize the implementation of high-occupancy toll (HOT) lanes; however the MTO has stated that it does not currently have sufficient data to calculate, model, or predict the impacts of HOT lane projects.[55] Beyond these measures, no new transportation initiatives have been implemented or proposed that would result in significant GHG reductions.

Another challenge in the transportation sector is the uncertainty that fluctuations in gasoline prices present for future GHG emissions. In the province's *Climate Change Progress Report 2012*, emissions projections for the sector were lowered partly based on higher prices for gasoline.[56] However, contrary to this forecast, gas prices dropped in 2014. A sustained period of lower gas prices could encourage drivers to drive more and purchase higher gas-consuming vehicles (such as pickup trucks and sport-utility vehicles) and actually increase the sector's GHG emissions, highlighting how unpredictable market forces can be within the sector.

Transit

The MTO continues to fund and expand public transit throughout the province, which if done well could help get people out of their cars – the largest source of transport emissions.[57] For example, in 2014, 96 municipalities received a total of $325.1 million in funding for improved public transit via the province's gas tax; a source of funding that was made permanent in 2013.[58] The ministry is also continuing to work on important transit expansion projects, including the Eglinton Crosstown Light Rail Transit line and the Union-Pearson Express in Toronto, as well as transforming existing GO commuter rail into an electrified rapid transit system for the Greater Toronto and Hamilton Area.

Ontario's *Climate Change Update 2014* also points to the *Provincial Policy Statement, 2014* and Ontario's *Growth Plan for the Greater Golden Horseshoe, 2006* as supporting policies that promote mixed land uses and higher densities. This in turn should encourage greater use of transit, as well as reduce vehicle kilometres travelled through other means (i.e., fewer and shorter car trips; more walking, cycling and car-pooling). However, when the ECO examined the implementation of the Growth Plan in our 2013/2014 ECO Annual Report, we found that it was not achieving the province's goals to increase density and create more transit-friendly land use. The then Minister of Infrastructure had permitted density targets for many of the municipalities surrounding the Greater Toronto Area below the level that the MTO itself suggests is needed to support "basic transit service."



The government is currently reviewing the *Growth Plan for the Greater Golden Horseshoe, 2006*. In addition, on March 5, 2015, the government proposed Bill 73, the *Smart Growth for Our Communities Act, 2015*, which proposes to (among other things) amend the *Development Charges Act, 1997* to enable increased revenue for municipal transit. The Premier's 2014 mandate letter to the Minister of Municipal Affairs and Housing had directed the Minister to amend the *Development Charges Act, 1997* to support "the development of sustainable, transit-friendly complete communities" through improved land use planning and smarter growth.

Electric Vehicles

Ontario's low-carbon electricity mix means that electric vehicles have the potential to greatly reduce emissions in the transportation sector. In 2009, the MTO established an ambitious goal to have 1 in 20 vehicles driven in Ontario by 2020 be an electric vehicle (EV).[59] The MTO has been subsidizing electric vehicle sales and charging stations in the province through its "Electric Vehicle Incentive" and "Electric Vehicle Charging Incentive" programs, but progress towards this EV target has been very modest. As of February 2015, there are only 4,030 electric vehicles in the province – to put this number in perspective, it represents approximately 1 in 1,900 passenger vehicles in Ontario in 2014.[60] As it stands, the MOECC has not determined the EV initiative to warrant being listed in Ontario's *Climate Change Update 2014*, presumably because the GHG reductions are too small.

Low Carbon Fuel

In 2007, the government committed to establishing a Low Carbon Fuel Standard (LCFS) for vehicles. The LCFS commitment was expected to reduce the carbon intensity of transportation fuels by 10 per cent by 2020. However, the Ministry of Energy has made little measurable progress toward establishing an LCFS in Ontario in the almost eight years since the commitment was made.[62] In light of stalled progress, in our 2012 Energy Conservation Progress Report the ECO called on the province to act on this commitment and recommended that responsibility for implementing an LCFS in Ontario be reassigned to the Ministry of the Environment (now the MOECC).[63]

The MOECC has proven it is better positioned to take charge of an LCFS for two reasons: the ministry already has responsibility for regulating other transportation fuel qualities to control emissions; and, the MOECC has demonstrated through design elements of the Greener Diesel Regulation (primarily using lifecycle analysis to model GHG emissions[64]) that some of the issues the Ministry of Energy deemed insurmountable to establishing an LCFS can in fact be resolved, at least partially.[65] The ECO reiterates our previous recommendation that responsibility for implementing a low-carbon fuel standard be assigned to the MOECC.[66]

3.3 Industry

The industrial sector accounts for the second highest share of GHG emissions in Ontario at 28 per cent or 47.6 Mt. This sector reduced its GHG emissions by 21 per cent between 1990 and 2012, but recently emissions have been increasing and the MOECC projects GHG emissions will continue to increase. GHG reductions in this sector are attributable primarily to reduced industrial production (including plant closures) in recent years, as well as some improvements in energy efficiency. For example, the MOECC reports that the average emissions intensity of manufacturing decreased by 34 per cent between 1990 and 2012.[67]

The industrial sector has historically been subject to relatively weak policies and oversight aimed at reining in its GHG emissions; the sole GHG policy initiative aimed at the industrial sector that is mentioned in Ontario's *Climate Change Update 2014* is the natural gas demand side management program (discussed below, in the Buildings section). However, the sector will soon be targeted for greater emissions reductions, as a result of two policy developments.

In April 2015, Ontario announced that it will introduce a cap-and-trade system under the Western Climate Initiative (WCI), of which it has been a member since 2008. Ontario intends to join Quebec and California, the other two jurisdictions in North America that have implemented cap-and-trade systems through WCI. WCI creates a common design and administrative framework for emissions trading, thus enabling the future linking of systems across jurisdictional boundaries.[68] While the exact design details of Ontario's system had not been made public at the time of publication, WCI design documents, Quebec and California's systems, as well as Ontario's past carbon pricing discussion papers[69] provide general information about the likely design decisions Ontario will make. The system will likely initially cover large industrial emitters (facilities that emit more than 25,000 tonnes of GHGs in a year). These large emitters have already been reporting their emissions to the MOECC since 2010.[70] Emissions in other sectors of the economy can be targeted indirectly by targeting upstream fuel distributors or directly by allowing offsets (as Quebec[71] and California[72] have done).

Second, on April 13, 2015, the MOECC released a new regulation that aims to reduce coal and petroleum coke use in energy-intensive industries such as cement, lime, iron and steel.[v] In 2012, 29 per cent of the cement industry's energy use came from coal; whereas in the iron and steel sector, 4.3 percent of energy use was from coal and 49 percent was from coke.[73] The regulation encourages facilities to switch to fuels that have lower carbon emissions intensity than coal or petroleum coke (e.g., various forms of biomass and other organic matter). Given the uncertainties regarding how many plants will choose to participate and the exact nature of the replacement fuel, the GHG benefits of the regulation are difficult to predict. The ECO will review this regulation in a future report.

[v] O. Reg. 79/15: Alternative Low Carbon Fuels, made under *Environmental Protection Act, R.S.O. 1990, c. E.19*.

3.4 Buildings

The buildings sector in Ontario continues to be the third largest source of GHG emissions. In 2013, it represented 32.6 Mt, or 19 per cent, of Ontario's GHG emissions. Building emissions have risen fairly steadily since 1990, increasing by 17 per cent between 1990 to 2013, tied to economic and population growth; amid the general upward trend are some annual fluctuations in emissions due to changes in weather patterns (determining heating and cooling demand) and commercial activity.[74] The MOECC projects that this sector's rising emissions trend will continue.

While the electricity sector continues to decarbonize, the reliance of the buildings sector on natural gas for space and water heating presents a key challenge to the Ontario government as it attempts to meet its 2020 emissions reduction target. Between 1990 and 2012, demand for natural gas in the building sector has increased in both the residential (23 per cent increase) and commercial/institutional (30 per cent increase) building sectors, mostly due to large increases in floor space.[75]

Policies that the government has implemented in recent years to drive emissions reductions in this sector include changes to the Ontario Building Code (the latest update – the 2012 code – came into effect on January 1, 2014 and is renewed in five-year year cycles),[76] natural gas demand side management programs, energy efficiency regulations and standards, and changes to the *Provincial Policy Statement, 2014* that promote more compact building types.[77] Ontario's *Climate Change Update 2014* predicts that these initiatives will achieve 2-3 Mt of emissions reductions by 2020.[78] The only policy initiative that underwent a change in the reporting year is the natural gas demand side management program, discussed in more detail below.

Natural Gas Demand Side Management Programs

The province's main initiative to reduce natural gas use in the buildings sector is through demand side management (DSM) programs, which are programs designed to reduce consumer demand for energy. These programs are offered by the natural gas utilities, with provincial oversight and guidelines.[79]

The Ontario Energy Board sets the DSM budgets for the natural gas utilities in multi-year plans.[vi] The provincial framework for DSM programs was updated in 2014.[80] There are two main changes that are relevant to the sector's GHG emissions. First, the Minister of Energy issued a directive to the Ontario Energy Board in March 2014, ordering the Board to bring natural gas DSM into closer alignment with the Ontario government's Conservation First energy policy, which should increase the focus on natural gas conservation. Second, when the natural gas utilities conduct cost-benefit analyses for proposed DSM programs, 15 per cent can now be added to the total estimated monetized benefits to account for environmental benefits.[81] An Ontario Energy Board letter from February 2015 specifically identified carbon reduction as one of the environmental benefits to be considered.[82] As a result of these changes, more DSM programs may pass the cost-benefit test and be approved, which could further reduce emissions in the sector.

The Ontario Energy Board also significantly increased the recommended maximum annual budget for natural gas utility DSM spending to $135 million, more than double the $65 million approved for 2014.[83] It remains to be seen whether the gas utilities will spend their maximum budgets in order to pursue as much conservation as possible.

[vi] These budgets are capped to discourage any potential upward pressure on gas rates.

3.5 Electricity

The electricity sector's contribution to Ontario's GHG emissions continues to decline. In 2013, it represented 10.9 Mt or just 6 per cent of Ontario's total GHGs. Emissions from the sector peaked in 2000, but have fallen significantly since 2007 due to the closure or conversion of Ontario's coal-fired power plants.[84] The last coal-fired power plant, operated by Ontario Power Generation, stopped burning coal in April 2014. The bulk of the remaining GHG emissions from the power sector come from the 29 natural gas-fired power plants located across the province.[85]

Under the 2013 Long-Term Energy Plan, Ontario is expected to refurbish four nuclear units at Darlington generating station and six units at Bruce generating station between 2016 and 2031. Natural gas-fired power plants will fill some of the gap, which may increase the sector's emissions. The Independent Electricity System Operator[vii] projects an increase of about 1,040 MW in natural gas-fired generation capacity from 2016 to 2017 due to diminished nuclear supply.[86] After 2017, natural gas-fired supply is projected to stay constant. The rest of the supply gap is to be partially met by increases in low-carbon, non-hydro renewables (e.g., wind, solar) between 2017 and 2020 and through energy conservation after 2020. However, it is expected that additional energy resources will also be needed after 2020. These resources are classified as "Planned Flexibility," meaning that the government has not yet determined what type of energy source (or combination of sources) will be used.

Ontario is producing an ever-increasing share of its electricity from renewable energy sources such as wind and solar power.[87] As of Ferbruary 2015, there were 2,543 MW of installed wind capacity on the transmission grid – about 7.4 per cent of total system capacity.[88] By September 2016 a total of 280 MW of solar generation projects will be connected to the transmission grid.[89] This will complement approximately 2,500 MW of "embedded" solar and wind facilities – those connected to and located within the service areas of local distribution companies – that were in operation by May 2015.[90] By 2020, nearly 10,700 MW of non-hydro renewables will represent about 26 percent of total grid capacity.[91] Further, the government's Long-Term Energy Plan has indicated that renewable generation targets will be reviewed annually as part the Ontario Energy Report.

[vii] As a result of a government decision in 2014, the Ontario Power Authority and the Independent Electricity System Operator were merged into one agency, effective January 1, 2015, named the Independent Electricity System Operator, which will assume the functions of the two agencies.

Critics maintain that due to the intermittency of wind and solar power, there will always be a need for back-up generation, primarily provided by natural gas-fired plants (when the wind isn't blowing or the sun isn't shining). However, rapid developments in the field of energy storage are now challenging this assumption. In addition to advancements in battery technology being made outside of Ontario, there are many small demonstration projects in Ontario using a variety of technologies (e.g., compressed air, batteries and flywheels)[92,93] that will allow stored energy to be integrated into Ontario's grid. In 2014, the Minister of Energy directed the Independent Electricity System Operator to procure 50 MW of storage. So far, it has procured 33 MW with the remainder to be contracted in 2015. Additional government investment in smart grid technologies such as grid automation through its smart grid fund will also enable the integration of more renewable energy into the grid.

Many older natural-gas fired electricity generating stations currently operate under contracts that pay them for producing power around the clock, whether the energy is needed or not. These stations are known as non-utility generators (NUGs). Most NUG contracts will be up for renewal in the coming years. This presents a GHG emissions reduction opportunity, as under the new contracting framework, these plants should operate less frequently.[94] However, it is difficult to confirm that this will be the case, as NUG contracts renewed to date have not been made public. The province appears to be reviewing its approach to NUG contract renewal. In late 2014, the Minister of Energy instructed the Independent Electricity System Operator to assess the framework for NUG contracting in Ontario, temporarily freezing procurement.[95]

3.6 Agriculture

Ontario's agricultural sector's GHG emissions have been steady at between 9.9-11 Mt since 1990.[96] Emissions in this sector largely result from fertilizer and manure use (55 per cent), methane from livestock (29 per cent) and manure management (16 per cent).[97] In Ontario's *Climate Change Update 2014*, the MOECC stated that the agricultural and waste sectors will only contribute 1.8 Mt (or 4 per cent) of Ontario's emissions reductions by 2020.

Ontario's *Climate Change Update 2014* mentions few concrete policies that could reduce the sector's emissions other than on-farm biogas facilities (which will contribute a reduction of only 11 kilotonnes in 2020) and tillage practices.[98] However, there are encouraging signs that the Ontario Ministry of Agriculture, Food and Rural Affairs is attuned to the need to promote and support a more comprehensive approach to soil management as a means to reduce GHG emissions in the sector (among other benefits). The Ontario government's *Climate Change Update 2014* mentions that the sector plays a critical role in the carbon cycle.[99] Improving soil health (e.g., through minimizing tillage, encouraging cover crops and crop rotations, and regularly applying compost to fields) can reduce the need for fertilizer, thus minimizing nitrous oxide (N_2O) emissions, and enable soil to sequester more carbon.[100]

3.7 Waste

Emissions in the waste sector have been steadily increasing since 1990, but fell slightly in 2013.[101] Most (92 per cent) of Ontario's 9 Mt of GHG emissions from this sector arise from methane generated in landfill sites, primarily caused by the anaerobic decomposition of organic waste.[102] The effects of methane emissions can be reduced by capturing methane and either flaring or burning it to generate electricity. Preferably, methane emissions can be avoided by decreasing or eliminating organics in landfill sites.

In 2008, Ontario implemented regulations requiring large landfills to capture and destroy generated methane (O. Reg. 216/08 and O. Reg. 217/08). However, there have been no new waste policies introduced during the period covered by this report that are aimed at further reducing the sector's GHG emissions. As the ECO has noted in previous reports, reducing (or banning altogether) organics from landfill sites would result in significant emissions reductions in the waste sector.

4. ECO Comment

The science is clear and beyond dispute: human-caused climate change is already affecting Ontario. Profound changes in our economy and way of life are essential, and the provincial government has a clear leadership role to play in enabling and promoting these changes. The province must create a policy environment that will steadily reduce the carbon footprint of our economy and lifestyles. The costs of climate inaction are material, while the potential economic opportunities from transitioning to a low-carbon economy are substantial.

Ontario has made noteworthy strides in climate change policy since 2007, particularly by closing its coal-fired power plants and thus decarbonizing its electricity sector to a large degree. Unfortunately, this bold action was followed by a period of relative inaction. As a result, under the current suite of policy initiatives, Ontario will not meet its 2020 GHG emissions reduction target; nor will it ensure the province is prepared to manage climate change risks.

Encouragingly, the government has recently recognized the urgent need to act, and has signalled its intention to introduce policies that could put Ontario on a path to meeting its 2020 (and beyond) GHG targets. Over the past year, the government made several policy announcements for the transportation, building, electricity and industrial sectors that should result in GHG reductions over time. These are promising signs, but far more aggressive policies are still needed across all sectors to close the 2020 emissions gap. The government's level of ambition on climate change is encouraging, but the short time period between the likely introduction of new (or enhancement of existing) GHG reduction policies and the year 2020 make achieving the target extremely challenging.

In our 2014 Greenhouse Gas Annual Progress Report, the ECO recommended policy approaches with the potential to achieve substantial GHG emissions reductions in the transportation sector. These recommendations remain relevant and include: more transit-friendly urban planning; increased investments in public transit; and better efforts to encourage the use of low carbon fuels, and energy efficient and alternative energy vehicles.

In the buildings sector, the ECO believes that this year's developments at the Ontario Energy Board should result in a greater number of natural gas conservation programs, and will hopefully reduce the building sector's carbon footprint.

In the electricity sector, the ECO is encouraged by the longer-term move away from fossil-fuel based electricity sources and the potential for improved electricity storage technologies. The public interest would benefit from full transparency of all energy procurement contracts, particularly with regards to non-utility owned natural gas plants, whose production contracts are not tied to the province's actual energy needs.

For industrial emitters, the introduction of a cap-and-trade program would mark a huge change in the government's approach to reducing emissions in this sector. If designed well, there is the potential for significant emissions reductions.

In the agricultural sector, policies that support healthy soils (which sequester more carbon) should be considered. Phasing out organics from landfill sites would help reduce emissions in the waste sector.

Finally, to more transparently connect projected GHG emissions reductions to specific government initiatives, the ECO recommends that the MOECC provide estimated breakdowns of GHG emissions reduction projections for each initiative, and for each sector.

Beyond the fanfare of the United Nations Framework Convention on Climate Change conference in Paris in December 2015, the hard work of implementing more stringent GHG reduction policies will begin. With this in mind, the ECO looks forward to tracking the province's future progress in reducing its GHG emissions.

Appendix 1 – IPCC's New Science: A Call to Mitigate and Adapt

Last year's ECO Annual GHG Report highlighted the pivotal climate change science released by Working Group I of the Intergovernmental Panel on Climate Change (IPCC); specifically, the IPCC's finding – with 95 per cent confidence – that human activities have been the dominant cause of climate warming since the 1950s.

Since the ECO's last progress report, the IPCC's Working Groups II and III released their respective findings focused on climate change impacts, adaptation and vulnerability, and on mitigation. The IPCC also released a *Synthesis Report* (SYR) summarizing the work of all three working groups. Together, these reports identify a wide range of future climate change risks and call upon all levels of governments to:

1) take mitigating actions now, to ensure maximum efficiency, limit costs and minimize risks of abrupt and irreversible climate change impacts; and
2) take adapting actions *now*, to limit the negative effects of those climate change impacts, which are unavoidable even in the best-case emissions reduction scenarios, to minimize cost and maximize resiliency of people and ecosystems.

The IPCC's findings are particularly relevant to Ontario, as subnational governments play a key role in both adaptation and mitigation efforts.[104] Accordingly, this section will provide an overview of the IPCC's most recent findings regarding mitigation and adaption measures as set out in the *Synthesis Report*.

Impacts, Hazards and Risks Identified by the IPCC Report

The IPCC outlines various climate change **impacts** that have occurred on people and ecosystems. Each observed impact is provided with its associated certainty rating that expresses the likelihood or confidence level that it is related to climate change; these impacts include:

- a decrease in cold temperature extremes and an increase in warm temperature extremes, increased heat waves in some regions (*likely*), causing increased heat-related mortality (*medium confidence*);
- increased frequency and intensity of heavy precipitation events in North America and Europe (*medium confidence*);
- changing precipitation patterns and melting snow and ice, affecting the quantity and quality of water resources in some regions (*medium confidence*);
- shifted geographic ranges, abundances and interactions of many species (*high confidence*); and
- an overall decrease in crop yields (*high confidence*).[105]

Certainty for IPCC findings is based on the authors' evaluations of the underlying scientific evidence and agreement. Where appropriate, findings are expressed as facts. Otherwise, certainty is expressed either as a qualitative level of confidence (from very low to very high) or probabilistically with a quantified likelihood of something occurring (e.g., very likely represents 90–100 per cent likelihood, likely represents 66–100 per cent likelihood, more likely than not represents >50–100 per cent likelihood). In some cases the level of underlying scientific evidence (limited, medium, or robust) and agreement (limited, medium, or high) is indicated. (Source: IPCC, 2014: Climate Change 2014: *Synthesis Report of the Fifth Assessment Report,* p.1).

The IPCC uses the term "**hazard**" broadly to mean the potential occurrence of many effects, including: climate-related physical events or trends or their physical impacts that may cause loss of life, injury, or other health impacts, damage and loss to property, infrastructure, livelihoods, service provision, as well as degradation of ecosystems, and environmental resources.[106] As a result of the unavoidable increase in temperature throughout this century, the IPCC predicts the following climate-related hazards:

- Heat waves will occur more often and last longer (*very likely*);
- Fewer cold temperature extremes and more frequent hot temperature extremes will occur (*virtually certain*);
- Extreme precipitation events will become more intense and frequent in many regions (*very likely*);
- Arctic sea ice will continue to recede;
- The ocean will experience increased acidification;
- Glacier volume, with few exceptions, will decrease by at least 15 per cent (*medium confidence*); and
- The ocean will continue to warm and the mean sea level rise (*very likely*).[107]

Climate change **risks** result from the interaction of climate related hazards (events and trends) with the vulnerability and exposure of human and natural systems, including their ability to adapt.[108] The climate change hazards set out above are predicted to result in the following risks, among many others:

- Extinctions of a large fraction of species (*high confidence*);
- Threats to global food security in a business-as-usual emissions scenario, combined with increasing food demand (*high confidence*); and
- Major impacts on water supply, food security, infrastructure, and agricultural incomes for those in rural areas.

More generally, in urban areas, heat stress, storms, extreme precipitation, flooding, landslides, air pollution, and water scarcity will increase risks to people, assets, economies and ecosystems (*very high confidence*) – especially for people lacking essential infrastructure and services.[109]

The risk of irreversible and abrupt changes in the climate system increase as the magnitude of warming increases.[110] Without additional mitigation efforts – under the business-as-usual scenario – most models predict warming is more likely than not to exceed 4°Celsius (C) above pre-industrial levels by 2100.[111] The above-noted risks will be exacerbated in such a scenario.[112]

In response to these predicted climate change risks, the IPCC outlines a variety of complementary mitigation and adaptation opportunities aimed at avoiding the most significant negative impacts on humans, animals, and the built and natural environment.[113]

Mitigation Efforts Proposed by the IPCC

The IPCC uses several emissions[viii] scenarios to model future climate change risks based on differing degrees of mitigation. Even its most aggressive emissions mitigation scenario involves increased warming until 2100 relative to the present temperature due to concentrations of greenhouse gases (GHG) already in the atmosphere.[114] The amount of global warming for the latter half of this century will depend greatly on the extent to which emissions have been mitigated (i.e., aggressive versus business-as-usual) in the first half of this century.[115] (see **Figure 1**).

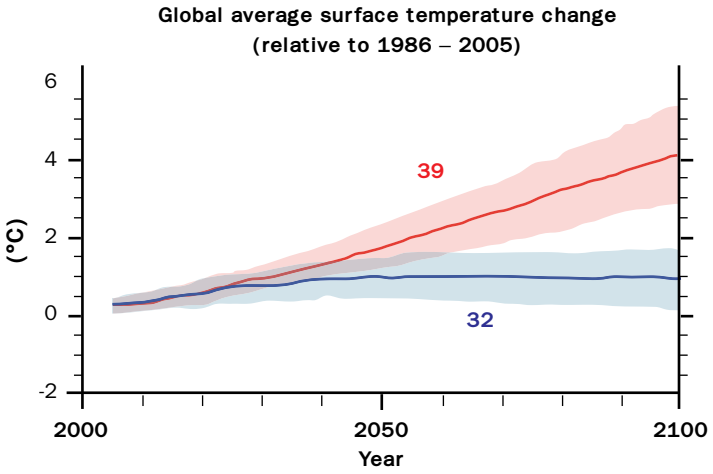


Figure 1: Global average surface temperature change from 2006 to 2100 as determined by multi-model simulations. All changes are relative to 1986–2005. A measure of uncertainty (shading) is shown for the best-case mitigating scenario (blue) and the worst-case (i.e., business-as-usual) (red). The number of models used to calculate the mean is indicated. (Source: IPCC, *Climate Change 2014: Synthesis Report of the Fifth Assessment Report*, 2014, Fig. 2.1(b))

The IPCC believes that the mitigation efforts listed in the box on the right, undertaken now and within the next few decades, can significantly reduce exposure to climate change risks within this century.

Limiting warming to a less than 2°C increase over pre-industrial levels (generally considered the tipping point for severe and irreversible climate change risks)[116] will require substantial emissions reductions over the next few decades and near-zero emissions of GHGs by the end of the century.[117] The sooner mitigation actions are taken, the better the odds for effective adaptation, and the lower the costs and challenges of mitigation in the longer term.[118] For example, delaying mitigation activities, even to 2030, would require substantially higher rates of emissions reductions, a more abrupt shift from high-carbon to low-carbon energy use, more reliance on carbon dioxide removal technologies, and a higher rate of spending.[119]

[viii] The IPCC's AR5 provides climate projections based on "scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases, aerosols, chemically active gases, as well as land use/land cover," the AR5 refers to these scenarios as representative concentration pathways (RCPs), namely: RCP 2.6, RCP 4.5, RCP 6, and RCP 8.5. These four scenarios range from business-as-usual (RCP 8.5), in which emissions continue increasing over time, to RCP 2.6 in which emissions are reduced substantially over time. (IPCC, report, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., et al. (eds.)] Glossary, p.1461, 2013.)

Examples of IPCC Suggested Mitigation Policies and Measures

(Certainty notations relate to the likelihood that the policy or measure would have a GHG mitigating effect)

Cross-sectoral

- Reducing subsidies for GHG-related activities (*high confidence*).
- Putting a price on carbon, either by use of strict caps that have a restraining effect or taxes that have restraining and substitution effects, if imposed alongside other complementary policies (*high confidence*).

Electricity Supply

- Decarbonizing electricity generation (*medium evidence, high agreement*), by way of:
  - o renewable energy subsidies (*high confidence*); and
  - o supporting technology development, diffusion and transfer (*high confidence*).

Energy Demand

- Efficiency enhancements and behavioural changes (*robust evidence, high agreement*), by way of energy efficiency regulations and labelling (*medium evidence, medium agreement*).

Forestry

- Afforestation, sustainable forest management and reduced deforestation (*medium evidence, high agreement*).

Agriculture

- Cropland and grazing land management, and restoration of organic soil (*medium evidence, high agreemet*).

The IPCC observed that mitigation policies are more cost-effective if they integrate multiple approaches across various sectors, such as: reducing energy demand and the GHG intensity of key sectors like transport, industry, and buildings; decarbonizing the energy supply; and increasing carbon sequestration opportunities.[121]

Adaptation Strategies Proposed by the IPCC

The IPCC report states with high confidence that adaptation measures can help secure populations, assets, and ecosystem goods against the climate change risks outlined above; however, the IPCC notes that there are limits to their effectiveness, particularly in the face of unmitigated climate change.[122] The IPCC recommends a range of adaptation measures; see box.

Examples of IPCC Suggested Adaptation Policies and Measures [123]

- Hazard and vulnerability mapping (e.g., flood plain mapping).
- Storm and wastewater disaster risk management and structural and physical improvements.
- Transport and road infrastructure improvements.
- Ecosystem management (e.g., maintaining wetlands, watershed, and urban green spaces).
- Power plant and electricity grid adjustments.
- Ecological restoration (e.g., soil conservation, reforestation, and afforestation).
- Green infrastructure development (e.g., shade trees, green roofs).
- Sustainable fisheries management (e.g., control overfishing and fisheries co-management).
- Assisted species migration and dispersal (e.g., ecological corridors).
- Financial incentives (e.g., payment for ecosystem services).
- Disaster planning and preparedness.
- Education (including sharing indigenous, traditional, and local knowledge, and knowledge sharing and learning platforms).

Adaptation policies need to address current vulnerability and exposure to climate change risks, while also incorporating a longer-term perspective.[124] The IPCC outlines several methods for improving adaptation planning and implementation, including the need for research and monitoring of adaptation effectiveness, co-ordinated and complementary actions across all levels of government, and public education about climate change risks.[125]

Appendix 2 – Climate Trends and Projections for Ontario

Climate data and projections drive climate change mitigation and adaptation policy. Climate science is continuously evolving and there is a large body of scientific research on the subject (even in Ontario), making it difficult for Ontarians to critically assess all the available science. At the international scale, the IPCC plays a critical role in providing authoritative climate science (although it does not endorse any specific projections), including some regional climate information. There is no comparable authoritative scientific body that vets and synthesizes Ontario-specific climate science. It is not the ECO's role to assess and aggregate all climate science applicable to Ontario. However, given the importance of using available climate science to make decisions, this section presents an illustrative range of climate projections that have been made for Ontario, as well as past observations that showcase how Ontario's climate is changing.

In the absence of an IPCC-like body for Ontario, the ECO reviewed federal and provincial climate change reports that have taken on the task of critically analyzing and synthesizing the best available information.[ix] Much of the government's regional-specific climate data and analysis, however, is already several years old (in many cases from 2008 or earlier), pointing to a clear need for more current Ontario-specific data. In addition, in assessing the various projections, it is important to understand the nuances of climate modelling that can lead to widely ranging projections. Different researchers use different base climate models, incorporate different parameters (or integrate them into the model in different ways), use different techniques to downscale the data to a more local level (or don't downscale at all), and so on.

It is important to note that climate projections vary based on the climate model and emissions scenario used. For further information about the climate projections summarized in this Appendix, please see the original sources listed in the endnotes.

Over the past few decades, Ontario's climate has exhibited a marked increase in temperature that has outpaced the global average. While the global average temperature has increased by 0.85 degrees Celsius (°C) since 1880[126], according to recent research out of York University, Ontario's summer and winter temperatures rose by an average of 1.0°C and 2.2°C, respectively, between 1900 and 2012.[127] Correspondingly, the number of frost days per year in Ontario decreased by 18 days between 1979 and 2009.[128] Natural Resources Canada (NRCAN) research from 2008 found that northern Ontario generally has experienced a higher rate of warming than southern Ontario; findings that were supported by recent downscaled climate projections under the IPCC's AR5 scenarios (see **Appendix 1**) by York University's Laboratory of Mathematical Parallel Systems (LAMPS) in 2014.[129, 130]

Ontario's annual average temperatures are expected to continue climbing. In fact, warming in Ontario is predicted to continue along the historic trend to outpace global increases; for example, the IPCC estimates that warming near the Great Lakes is projected to be about 50 per cent

[ix] Appendix 2 summarizes the scientific findings featured in reputable reports, such as the most recent reports from the IPCC, Ontario's (then) Ministry of Natural Resources (MNR), Natural Resources Canada (NRCAN) and the National Round Table on the Environment and the Economy (NRTEE). It is important to note that much of this government-endorsed or mandated regional-specific climate research needs to be updated. More recently, the MOECC funded (but does not endorse) Ontario-specific climate change science via grants to several academic institutions, including the University of Toronto. The ministry also funded interactive public climate data portals produced by the University of Regina (Ontario Climate Change Data Portal) with climate data and projections provided at a resolution of 25 km^2, and a at a resolution of 45 km^2 by York University's LAMPS laboratory, each based on different climate models.

greater than that of the global mean warming. Moreover, northern Ontario is forecast to continue warming faster than southern Ontario, especially with regard to winter temperatures (See **Table 1**). The trends are consistent across most climate research. For example, ongoing research from the University of Toronto (partially funded by the MOECC) that focuses on capturing the impact of the Great Lakes on Ontario's climate found that Southern Ontario would experience 2-3°C of average annual warming in 2050-2060 compared to 1979-2001, whereas northern Ontario would experience 3-4°C.[132]

Table 1: Summary of MNR, NRCAN and NRTEE Climate Projections for Ontario.[133]

Changes in Temperature		
	Southern Ontario	**Northern Ontario**
Summer	• Southern Ontario is expected to increase by 2-4°C by 2050, and by 4-5°C by 2071 • Southwestern Ontario is expected to increase by 5-6°C by 2071.	• Northern Ontario is expected to increase by 2-4°C by 2071.
Winter	• Southern Ontario is expected to increase by 2-5°C by 2050.	• Northern Ontario is expected to increase by 2-7°C by 2050. • The Hudson Bay area is expected to increase by 9-10°C by 2071. • The northwestern section of Ontario's Far North is expected to increase by 8-9°C by 2100.
Changes in Precipitation and Flooding		
	• Southern and central Ontario are expected to receive anywhere from 10 per cent more to 10 per cent less summer precipitation by 2050, depending on the region. • Southern Ontario flooding is expected to increase by 10-35 per cent by 2046-2065, and by 35-50 per cent by 2081-2100.	• Overall, northern Ontario is expected to receive 10-20 per cent more precipitation between spring and fall, and 10-40 per cent more winter precipitation. • But, parts of northwestern Ontario are expected to receive anywhere from 10 per cent less to 20 per cent more summer and winter precipitation.[134]
Changes in Freezing Rain Events		
	• Total number of freezing rain days between December and February are expected to increase by 35-100 per cent by 2046-2065, and by 35-155 per cent by 2081-2100. This trend will be exacerbated farther north.	
	• Toronto and Windsor are expected to experience 35-55 per cent more freezing rain days by 2045-2065.	• Kenora, Thunder Bay and Timmins are expected to experience 70-100 per cent more freezing rain days by 2045-2065.
Changes in Water Surface Temperature		
	• Great Lakes surface temperatures are expected to continue the current warming trend, increasing by an additional 2.5-4.4°C by 2100.	

Along with rising air temperatures, water temperatures are warming as well. The National Round Table on the Environment and the Economy (NRTEE) reported in 2010 that between 1968 and 2002, Lake Huron warmed by 2.9°C, Lake Ontario warmed by 1.6°C, Lake Erie warmed by 0.9°C and since 1980, Lake Superior warmed by 2.5°C.[135] Great Lakes surface temperatures are expected to increase by an additional 2.5-4.4°C by the end of the century, according to a 2008 MNR report.[136] Similar warming trends were observed by a MNR study in 2007 for the lakes further north.[137]

Rising temperatures also affect the amount and timing of precipitation. Changes in rain and snowfall patterns are already evident in much of Ontario. For example, between 1990 and 2008 annual precipitation had already increased between 5-35 per cent in some parts of southern Canada.[138] However, precipitation patterns are regionally variable; recent data out of York University indicates that there has been a greater increase in both summer and winter precipitation with spatial variations from region to region; southern and central Ontario has experienced more increased winter precipitation than northern Ontario, while summer rainfall has increased more in northwestern and central Ontario than in other regions.[139]

Although total annual precipitation is projected to increase for the province overall, regional and seasonal variations are predicted to continue. For example, a 2008 Ministry of Natural Resources (MNR) study and a 2007 NRCAN study conclude that parts of southwestern Ontario could experience reduced summer and fall precipitation,[140] and the same MNR study suggests that certain areas of northwestern Ontario may also receive less summer and winter precipitation (see **Table 1**).[141]

Increases in precipitation do not necessarily occur smoothly – a changing climate is also a volatile one. The 2008 MNR study referenced above also states that precipitation will often come in the form of more frequent and intense storms,[142] something that the province has already begun to experience (see Chapter 4 of the ECO's 2014 GHG Annual Report). This trend will only strengthen; in 2014 an NRCAN study concluded that flooding due to storms is expected to increase in southern Ontario anywhere from 10-50 per cent by the end of the century (see **Table 1**).[143] This same study projected that extreme weather will extend into the winter season as well; more freezing rain days are expected province wide, with parts of northern Ontario experiencing the greatest increase (see **Table 1**).[144]

A warming climate will also affect ice cover and permafrost (ground that is frozen at or below 0°C for at least two consecutive years). According to a 2012 MNR study, warmer air and water temperatures mean that Ontario's lakes will be covered in ice for shorter periods and that ice thickness will decrease.[145] A 2014 NRCAN study projected that the warming climate is expected to melt and degrade permafrost across Canada, including in Ontario's Far North.[146] In turn, warming of Ontario's Far North, an ecosystem with some of the highest soil carbon densities in the world, is predicted to substantially alter the area's carbon storage capacity.[147]

Ontario's Ecosystems in a Changing Climate

Ontario's biodiversity is under enormous pressure from a variety of threats, including pollution, fragmentation and loss of habitat, invasive species and unsustainable harvesting of species. Climate change presents another major threat to species and ecosystems, both in and of itself, and in its potential to compound or catalyze other existing pressures.

Rising air and water temperatures, along with changes to rain and snow patterns, will reshape the ecology of the province. Some native plants and animals will be able to move with or adapt to these changing conditions, others will not. The ranges of other species – not previously found in Ontario – will expand into our province.

The effects of climate change – including increasing air and water temperatures, decreasing ice cover, and changes in precipitation – will alter Ontario's aquatic ecosystems. The then MNR noted that the effects of climate change will affect fish distribution, growth, reproduction, and survival. Rising water temperatures may cause a substantial decline in the productivity of some cold-water species (such as lake trout and brook trout), while many warm-water fish are projected to benefit from rising temperatures. For example, the habitats of smallmouth bass and walleye are expected to expand in northern Ontario;[148] this northward expansion of some fish species, however, can in turn disrupt other existing cold-water fish populations.[149]

These changes to Ontario's ecology will have profound repercussions. Indeed, Ontario's Biodiversity Council warned that climate change has the potential to dramatically alter our province's natural environment. According to this council, the potential effects of climate change on biodiversity include:[150]

- Changes in species' distributions (e.g., scientists have already observed northward shifts in some species' ranges);
- Changes in the timing of events, like the flowering of plants and the breeding and migration of animals; and
- Changes in the interactions between species that interrelate and/or depend on each other for survival (i.e., predators and prey; insects and host plants; parasites and host insects; and insect pollinators and flowering plants), for example, the timing of important events in the species' respective life cycles can become out-of-sync.

Ontario's Biodiversity Council's *2010 State of Ontario's Biodiversity* report contains specific indicators related to climate change that show worsening trends, including those related to ice coverage of all the Great Lakes in recent decades as well as reduced survival rates for the province's polar bears.[151]

The Ontario government's Far North Science Advisory Panel echoed many of these concerns about the current and future impacts of climate change for northern Ontario.[152] From the loss of peatlands, to melting of permafrost, to species' shifts in the boreal forest, the ecological effects of warming temperatures will cause sweeping environmental changes.

In southern Ontario, scientific experts appointed by the government have also warned about the ecological impacts of climate change. For example, the Lake Simcoe Science Committee identified that climate change has already had measurable effects on that watershed for which action is required now. These experts outlined the scope of impacts including on water quality, water quantity, water use, species composition, terrestrial habitat quality, the occurrence and abundance of native and invasive species, fish spawning times and production, fishing opportunities, stream flow, and plant and animal diseases.[153] The binational International Joint Commission has reported similar concerns affecting all parts of the Great Lakes[154] and the Ontario's government's Expert Panel on Climate Change Adaptation also raised profound concerns about these types of ecological impacts.[155]

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1. […] To achieve the ultimate objective of the Convention to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, we shall, recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius[…]

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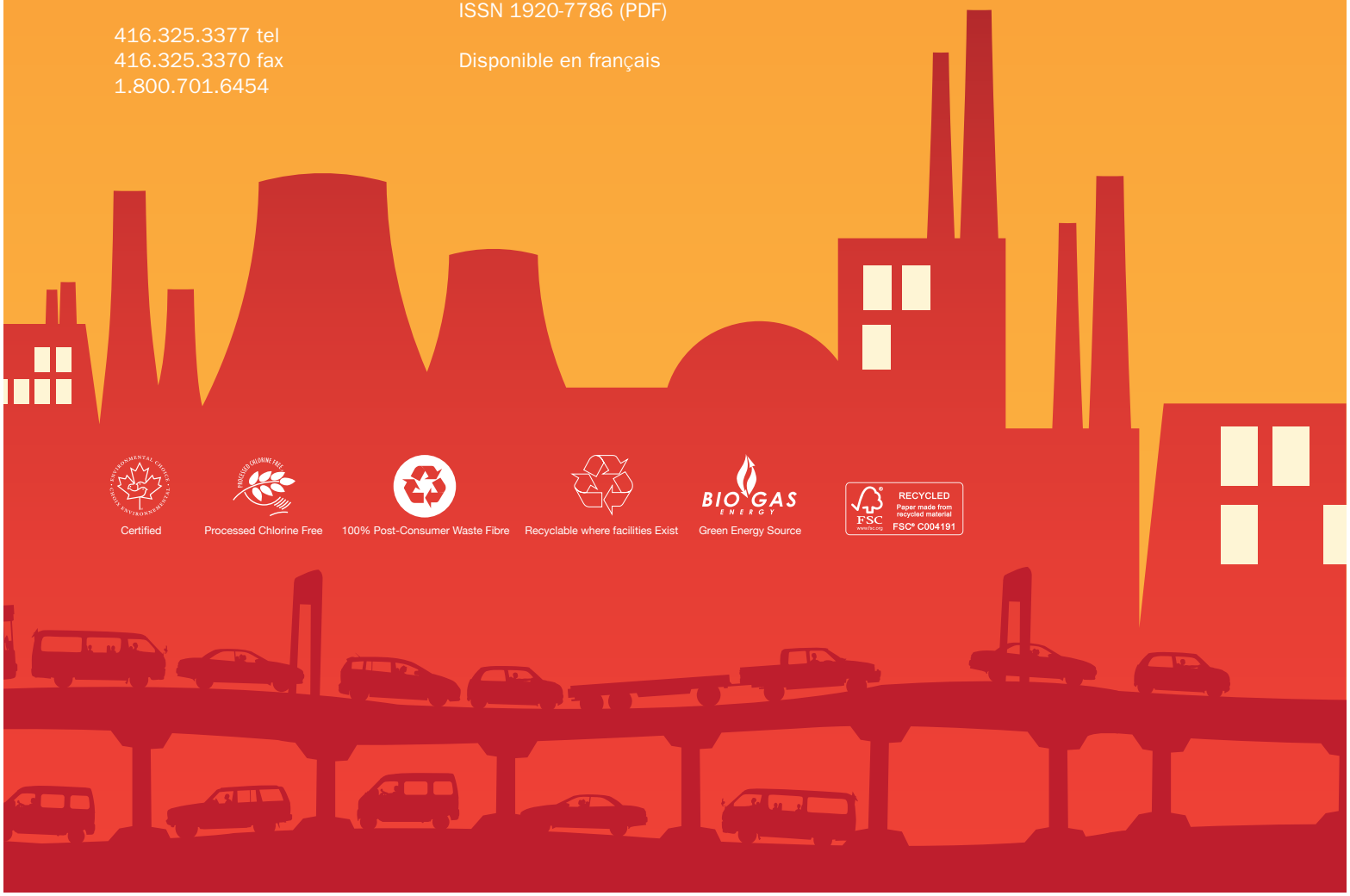

Ontario

NEWS

Office of the Premier

Cap and Trade System to Limit Greenhouse Gas Pollution in Ontario

Provincial System will Reward Innovative Companies and Create More Opportunities for Investment in Ontario

April 13, 2015 9:15 A.M.

To fight climate change -- one of the greatest challenges mankind has faced -- Ontario is putting a limit on the main sources of greenhouse gas pollution through a cap and trade system to protect the air we breathe, the water we drink and the health of our children and grandchildren.

Climate change is already hurting our environment, causing extreme weather like floods and droughts, and hurting our ability to grow food in some regions. Over the near term, it will increase the cost of food and insurance, harm wildlife and nature, and eventually make the world inhospitable for our children and grandchildren.

In this context, Ontario is joining other jurisdictions, including Québec and California, by imposing a hard ceiling on the pollution allowed in each sector of the economy. Known as cap and trade, this system effectively reduces the amount of greenhouse gas pollution in our atmosphere by setting a limit on emissions, rewarding innovative companies, providing certainty for industries and creating more opportunities for investment in Ontario.

Ontario intends to join the cap and trade system under the Western Climate Initiative. Under the cap and trade system, businesses will have their own greenhouse gas quota and will then be able to sell it if they don't need it because of their own efficiency.

The government will reinvest the money raised through cap and trade in a transparent way back into projects that reduce greenhouse gas pollution and help businesses remain competitive. Projects may include helping families consume less energy through more energy-efficient appliances or housing, building more public transit to reduce the number of vehicles on the road, and helping factories and businesses reduce greenhouse gas pollution. Through cap and trade, Ontario is building on the progress it has already made, such as closing coal plants and continuing to invest in public transit.

Good environmental policy is good economic policy. Reducing our use of fossil fuels, such as coal, oil and gas, will create jobs now and form a central pillar of our prosperity in the coming years.

Fighting climate change while keeping industries competitive and strong is part of the government's economic plan for Ontario. The four-part plan is building Ontario up by investing in people's talents and skills, building new public infrastructure like roads and transit, creating a dynamic, innovative environment where business thrives, and building a secure retirement savings plan.

QUOTES

" Climate change is a problem that is both critically important and urgent. It is causing extreme weather events, which can increase insurance costs, hurt wildlife, damage our environment and affect farming. Climate change needs to be fought around the globe, and it needs to be fought here in Canada and Ontario. The action we are taking today will help secure a healthier environment, a more competitive economy and a better future for our children and grandchildren."
- Kathleen Wynne
Premier of Ontario

" We face two critical challenges with climate change. We must reduce greenhouse gas pollution fast enough to avoid a crisis, and in so doing, seize the opportunities of a low-carbon economy. Today we are taking strong action to help us meet both of those challenges."
- Glen Murray
Minister of the Environment and Climate Change

QUICK FACTS

- Ontario has the fastest growing clean-tech sector in Canada, with 2,700 clean-tech firms employing 65,000 people and generating annual revenues of more than $8 billion.
- With Ontario’s introduction of a cap and trade system, more than 75 per cent of Canadians will live in a province with some form of carbon pricing.
- Ontario’s actions to close coal-fired electricity plants, curb the use of cosmetic pesticides and protect 1.8 million acres of land have resulted in fewer smog days and cleaner water.
- Ending coal-fired power is the single largest greenhouse gas reduction initiative in North America, equivalent to taking seven million cars off the road.
- Ontario will host a Climate Summit of the Americas from July 7-9, 2015, to advance collaborative action on climate change ahead of the Conference of the Parties in Paris in December.
- During Ontario’s comprehensive public and stakeholder consultations on climate change, more than 1,500 people attended in-person consultations in locations across the province, and more than 300 ideas and 31,000 votes were submitted through the online consultation tool.

LEARN MORE

- Start a dialogue on climate change with a downloadable, mobile friendly conversation kit
- Climate Change Discussion Paper
- Ontario Climate Change Update 2014
- Climate Summit of the Americas
- Follow and join the conversation on Twitter with #ONclimate

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Ontario

NEWS

Ministry of the Environment and Climate Change

How Cap and Trade Works

April 13, 2015 8:58 A.M.

A cap and trade program effectively reduces the amount of greenhouse gas pollution going into our atmosphere by setting a limit on emissions, rewarding innovative companies, providing certainty for industries, and creating more opportunities for investment. The province will work with communities and will consult with industry on the design over the next six months to ensure the system is a made- in-Ontario solution that works best for the province.

The "cap" sets a maximum limit on the amount of greenhouse gas pollution industry can produce. Over time, the cap is lowered, reducing greenhouse gas pollution.

The "trade" creates a market for pollution credits where industries that do not use all their credits can sell or trade with those that are over.

Cap and trade can reward industries that innovate. The less they pollute, the less they pay.

With this move, more than 75 per cent of Canadians will live in a province with some form of carbon pricing.

The proceeds from the program will be reinvested in a transparent way back into projects that reduce greenhouse gas pollution and help businesses remain competitive. These actions will protect the air we breathe, the water we drink and the health of our children and grandchildren.

Financial Impacts of Climate Change

Climate change is already costing the people of Ontario -- it has devastated communities, damaged homes, businesses and crops and increased insurance costs. The 2013 ice storm alone resulted in $200 million in insurance payouts and severe floods in the GTA resulted in nearly $1 billion in damages. The National Round Table on the Environment and the Economy estimated that the economic costs of climate change in Canada would rise from around $5 billion annually in 2020 to between $21 billion and $43 billion annually by 2050.

Carbon Pricing in Other Jurisdictions

As of May 2014, 39 national and 23 sub-national jurisdictions were implementing or were scheduled to implement carbon pricing, and another 27 jurisdictions were considering carbon pricing. Carbon pricing is already in place in jurisdictions that are responsible for more than 22 percent of global emissions.

In British Columbia, five years after a carbon price was first implemented, fossil fuel use had decreased by 17 per cent and the province's economy had outperformed the economy of other provinces.

A report by the University of California Berkeley estimated that cap and trade will add 2.6 cents per litre to the price of gasoline. However, the California Air and Resources Board expects that the amount the average person spends on fuels will decrease from $1,400 to $1,000 by 2020 as a result of improved vehicle fuel efficiency and other measures to reduce fuel use.

In Québec, estimates by government and the oil industry range from 2-3.5 cents per litre on the cost of gasoline.

Ontario first joined the Western Climate Initiative in 2008. Ontario intends to link its market with North America's largest cap and trade system currently in place in California and Québec. In the coming months, Ontario will work closely with both jurisdictions to align its market.

Cap and trade is one of many actions Ontario needs to take to fight climate change. The province will release a strong, forward-looking climate change strategy and action plan to reach its 2020 pollution reduction goal, informed by a recent comprehensive province-wide consultation, including in-person discussions attended by more than 1,500 people, more than 300 ideas and 31,000 votes submitted through a new online consultation tool and over 420 comments on the Climate Change Discussion Paper.

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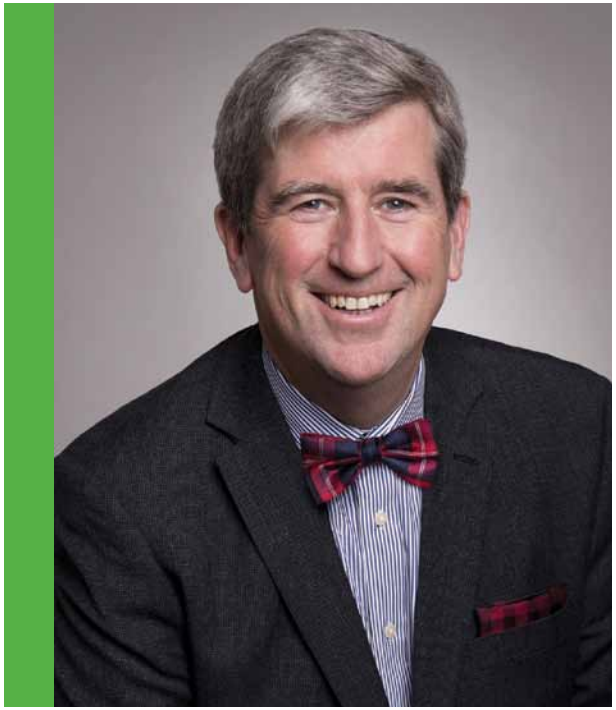
MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

ONTARIO'S CLIMATE CHANGE UPDATE 2014

Ontario



Minister's Message

Climate change is a tremendous force disrupting and challenging every facet of our lives, from our homes and businesses to the activities, food and places we enjoy and often take for granted. We must act now to protect our health, wellbeing and work together towards a cleaner, brighter future.

Ontario has the skills, technological knowledge and capacity to be a world leader in finding and demonstrating solutions to climate change.

Where we live, where we work and how we move between our homes and our jobs determines the largest share of our greenhouse gas emissions. To keep reducing emissions with a growing population, we need to build for the future. More energy-efficient buildings, smart urban planning, low-carbon transportation options, and green infrastructure are just some of the solutions we need. And, as the world transitions to a low carbon economy, we need to design products for our children, not the dump.

Our government is already making strides in all of these areas – through investments in transit, our regional planning initiatives, and our energy and environmental policies, and there is more to do.

This report reflects on Ontario's actions towards addressing climate change and I am proud of the progress we have made to date. However, our government has set important targets for 2020 and 2050 that will require new approaches to adaptation, mitigation and science.

Let's rise to the challenge of fighting climate change and leave future generations with an essential legacy: a healthy and beautiful planet.

Glen Murray
Minister of the Environment and Climate Change

This Report

Ontario reports regularly on climate change progress. Regular, transparent reporting supports the observation of trends in the economy and society that influence greenhouse gas emissions. In addition, it enables the assessment of policies, programs and other actions as well as the forecasting of future trends. Finally, the report helps to highlight areas for further action.

We determined these targets as part of a coordinated global effort to avoid the dangerous impacts of climate change on our planet and quality of life, but also to help ensure a cleaner future for Ontario.

We expect to achieve our 2014 target, the first of three targets set out in the province's plan. While we are more than two thirds of the way to meeting our 2020 target, we know we have to act quickly to meet the target. Ontario uses 1990 as a base year for its targets, which is common practice and aligns with the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Some jurisdictions such as the Government of Canada (which uses 2005) have adopted different base years for targets. All nations reporting to the UNFCCC report historical emissions back to 1990.

In 1990, GHG emissions in Ontario were 177 megatonnes (Mt). In 2012, according to the Government of Canada's latest National Inventory Report (the Inventory), emissions in Ontario were down to 167 Mt (or 5.9%[2] below 1990 levels). Since 2007, emissions are down in Ontario by about 35 Mt (or 17%) driven primarily by the phase-out of coal-fired electricity generation. As of April 2014, Ontario no longer uses coal to generate electricity and has reintroduced legislation to ensure that, if passed, coal-burning generation on the electricity grid will never happen again.[3]

This report provides an update of Ontario's greenhouse gas emissions (GHGs) and progress towards the targets set out in the 2007 Climate Change Action Plan.[1]

The targets are:

- 2014 target: 6% below 1990 levels
- 2020 target: 15% below 1990 levels
- 2050 target: 80% below 1990 levels

Total GHG emissions forecast for 2014 are 165 Mt, which is below the target of 167 Mt. **This means Ontario is expected to not only achieve, but surpass its 2014 target.** Given current policies and trends, emissions in 2020 are forecast to be 170 Mt — which would achieve 69% of the emission reductions required[4] to meet the 2020 target.

1 Ontario, *Go Green: Ontario's Climate Change Action Plan* (Toronto: Queen's Printer for Ontario, 2007).
2 5.9% is the per cent reduction. This number is the accurate ratio when using the unrounded numbers; in 1990, actual emissions were 177,248 Mt and in 2012 were 166,878 Mt.
3 Bill 9, Ending Coal for Cleaner Air Act, 2014, 1st Session, 41st Legislature, Ontario.
4 Progress is calculated as the ratio of projected reductions in emissions (from Business as Usual) to reductions required to meet the target.

Overview of Sections

The information presented in this report is based on Environment Canada's *National Inventory Report 1990–2012: Greenhouse Gases Sources and Sinks*, released in April 2014.[5] Ontario relies on this report to evaluate historical emission changes in several sectors of the provincial economy. Its underlying data also forms the basis of the emission forecasts in this report.

SECTION 1

Summarizes the major sources of emissions in the province, long- and short-term trends, and the province's updated emission forecasts to 2014, 2020 and 2030.

SECTION 2

Breaks down emissions by sector — discussing the key factors influencing GHG emissions and the impacts of specific policies.

SECTION 3

Describes the modelling approach and associated uncertainty.

5 The Inventory is available here: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php.

SECTION 1

ECONOMY-WIDE EMISSION TRENDS AND FORECAST

Sources of Emissions

Ontario's estimated GHG emissions comprise GHGs that are emitted *within* the province's boundaries — for instance, from buildings, vehicles and industrial plants operating in Ontario.

Estimated GHG emissions do *not* include "consumption-based emissions" from the production of fuels, goods and services outside the province that are bought or consumed inside Ontario. This approach to estimating GHGs is consistent with most other jurisdictions, including the Government of Canada.

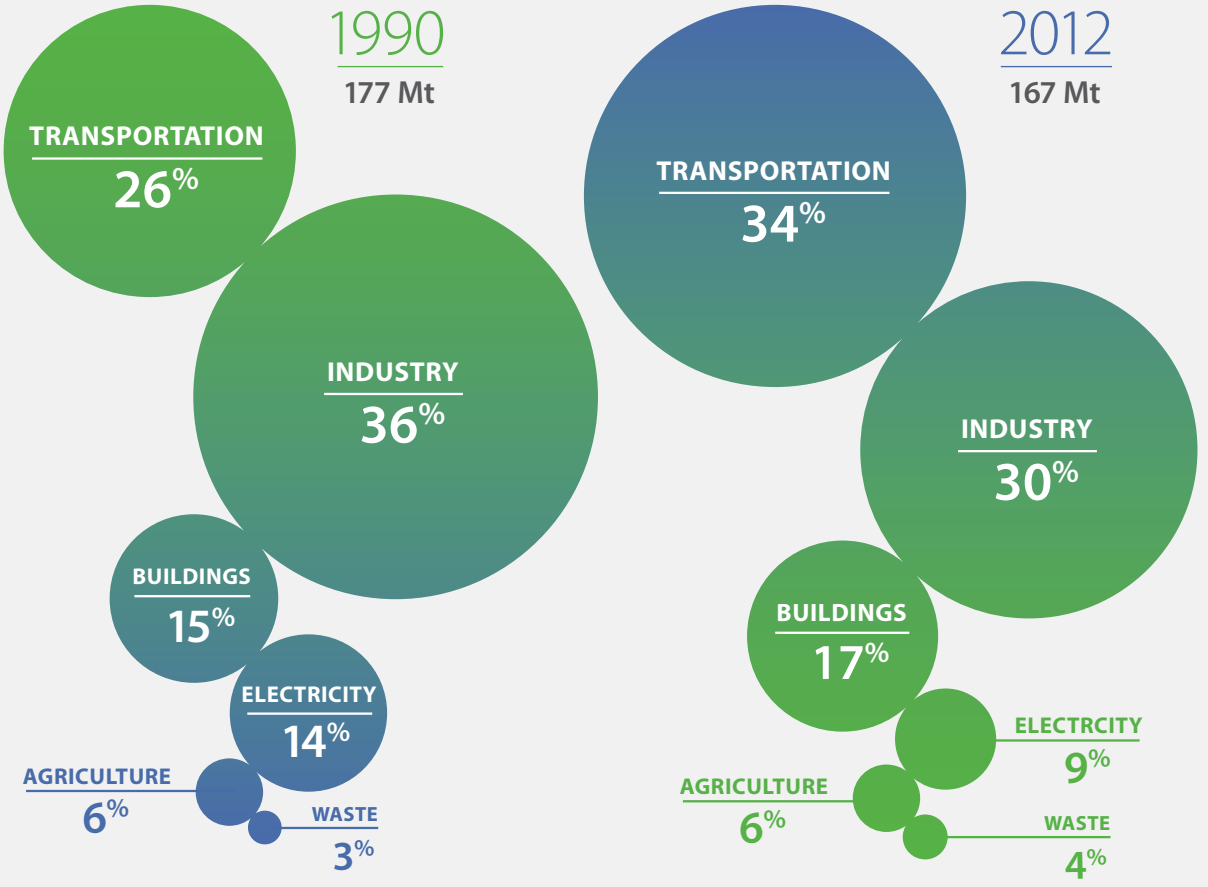
GHG emissions come from virtually all aspects of Ontario's society and economy. The main sources by far are the fossil fuels used to heat homes, run vehicles, power industries and generate electricity. But GHGs also come from waste disposed in landfills, some industrial processes, livestock, fertilizer use, and from appliances leaking refrigerants. In this report, sources are categorized into the economic sectors described in Table 1 (further detail is also provided in Section 3: Methodology).

TABLE 1 Sector Descriptions

Sector	Sources of Greenhouse Gas Emissions
Transportation	The combustion of fossil fuels such as diesel, gasoline and propane by passenger and commercial vehicles on and off roads, as well as rail and Ontario's share of domestic marine and air travel
Industry	Some industrial processes and stationary combustion of fossil fuels such as coke, natural gas and coal used in mining; pipelines; construction; greenhouses; production of cement, iron and steel, chemicals, paper and wood products; and other manufacturing
Buildings	The combustion of fossil fuels such as natural gas in residential, commercial and institutional buildings for space and water heating
Electricity	Generating electricity and heat by electric utilities using fossil fuels such as natural gas
Agriculture	Enteric fermentation, manure management and fertilizer application
Waste	Solid waste disposal on land, wastewater handling and waste incineration

The "land use, land use change and forestry" sector also plays an important role in both adding GHGs to and removing GHGs from the atmosphere. This sector reflects the role of forests, grasslands, croplands, wetlands and settlements in the carbon cycle. Forests and other lands can absorb and store carbon for long periods — these are known as carbon sinks. However, carbon sinks can also release carbon back into the atmosphere as conditions change and organic material degrades. Many of these processes are natural; however, how forests and croplands are managed and land use is changed from forest to agricultural lands or other uses can have a climate impact. The federal government models and reports these emissions and removals at a national level in the National Inventory Report. However, in accordance with UN accounting conventions, Canada's emissions and removals of GHGs from the Land Use, Land Use Change and Forestry sector are *not* included in Canada's National Inventory totals. Therefore, these sources and sinks are not included in Ontario's assessment of GHGs at this time. As better data become available, Ontario will consider how to incorporate these into its accounting and targets.

FIGURE 1 Emissions by Sector, 1990 and 2012



Source: the 2014 National Inventory Report: 1990–2012 data

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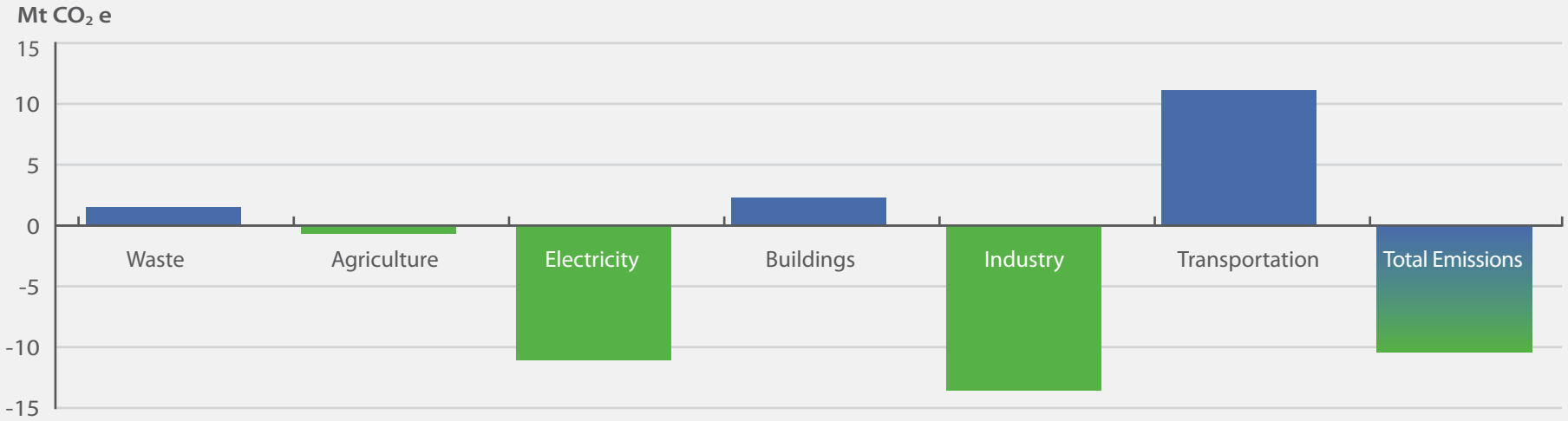
Ontario's emissions in 2012

For 2012, Ontario's GHG emissions are estimated to be 167 megatonnes (Mt). The 1990 and 2012 shares of emissions by sector are shown in **Figure 1**. Over these 22 years, the distribution of emissions by sector in Ontario has changed, reflecting changes in the economy and the electricity sector. The share of emissions in the transportation sector has grown from 26% in 1990 to 34% in 2012, while the share of industrial emissions has declined from 36% to 30%. Note that 2012 emissions do not yet reflect the full impact of the closure of coal-fired electricity in the province.

Long-term trends in Ontario's emissions (1990–2012)

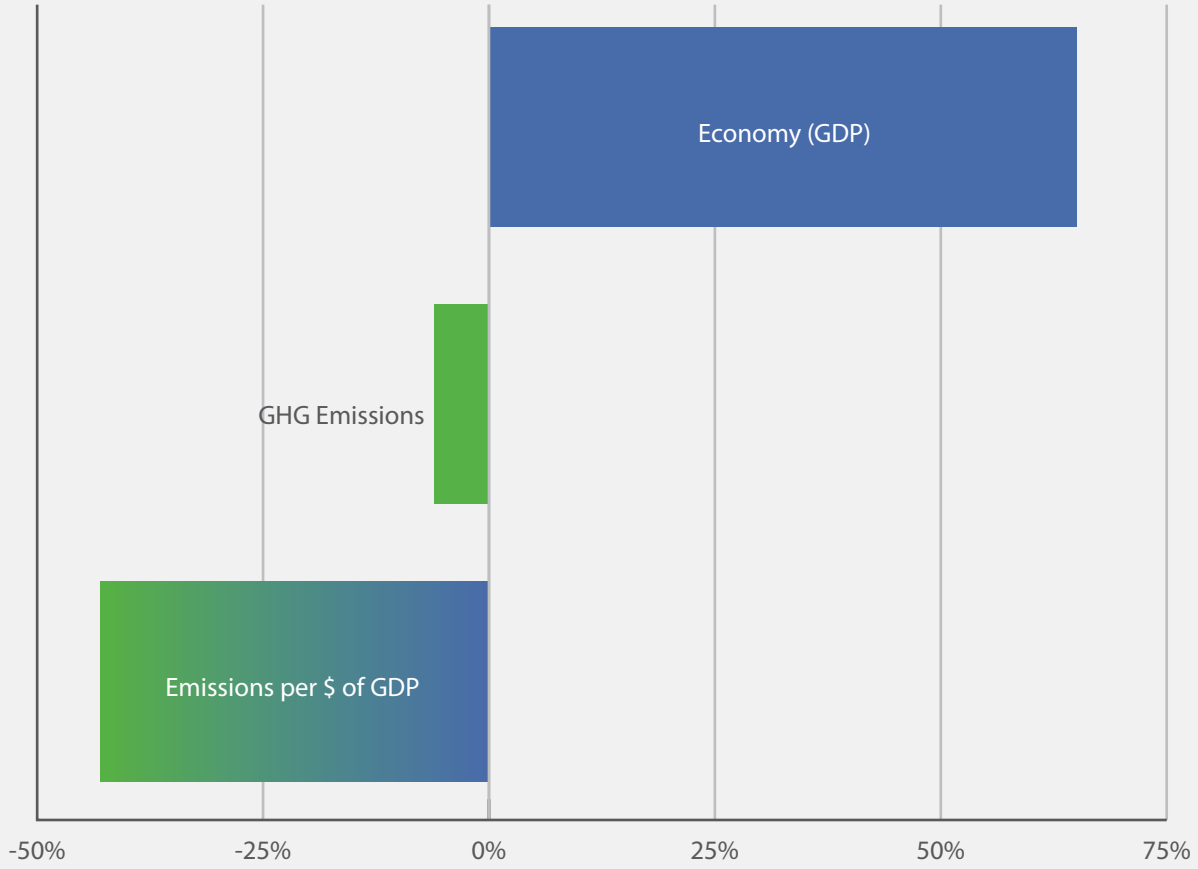
Figure 2 shows the percentage changes in emissions from 1990–2012.

FIGURE 2 Long-Term Changes in Ontario Emissions by Sector, 1990–2012



Source: The 2014 National Inventory Report 1990-2012 data

FIGURE 3 Changes in Key Drivers of Emissions, 1990-2012



Sources: the 2014 National Inventory Report: 1990–2012 data; *National Energy Use Database (2014); Statistics Canada CANSIM Tables 127 0001 and 127 0007*; *Ontario Ministry of Finance*, Long-Term Report on the Economy *(2014)*

Greenhouse gas emissions are influenced by population and economic growth as well as by the use and sources of energy that support that growth. Over the period 1990–2012, Ontario's population and economy have grown steadily — putting upward pressure on greenhouse gas emissions. However, over the same period Ontario has reduced the carbon emitted from electricity generation, and made improvements in the energy efficiency of buildings, industries and vehicles.

Figure 3 shows the economy is one driver of emissions in Ontario. Other drivers such as population, housing stock and the number of passenger vehicles have all increased significantly since 1990. Yet, over the same period, emissions have declined.

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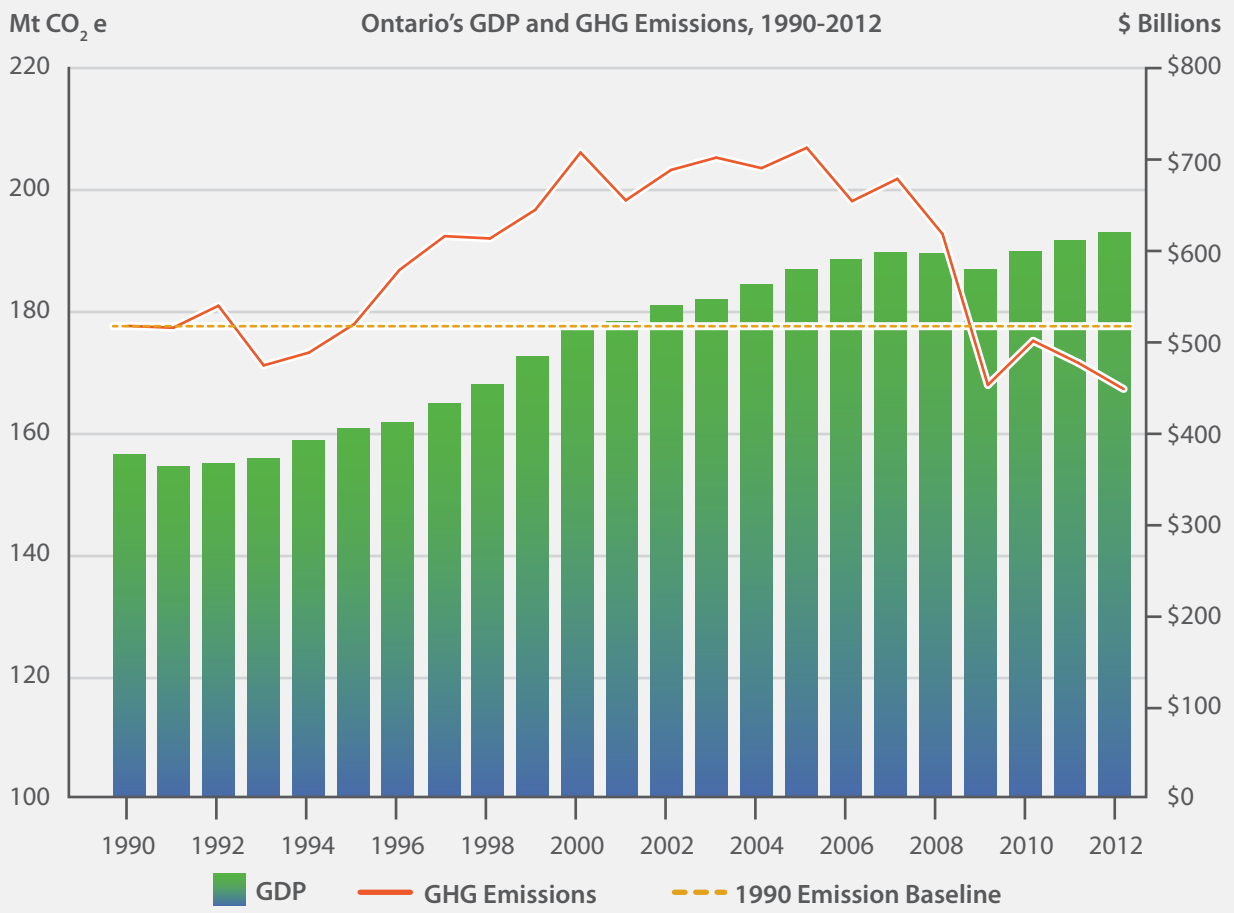
From 1990–2012, Ontario's emissions fell by 5.9%; **Figure 4** shows this long-term trend compared with GDP. Emissions grew from 1990 to the early 2000s, then stabilized and declined in recent years. Improved energy efficiency, the changing mix of electricity generation and the shifting composition of Ontario's industrial base are mitigating the impact on greenhouse gas emissions of population and economic growth.

FIGURE 4 Long-Term Trends

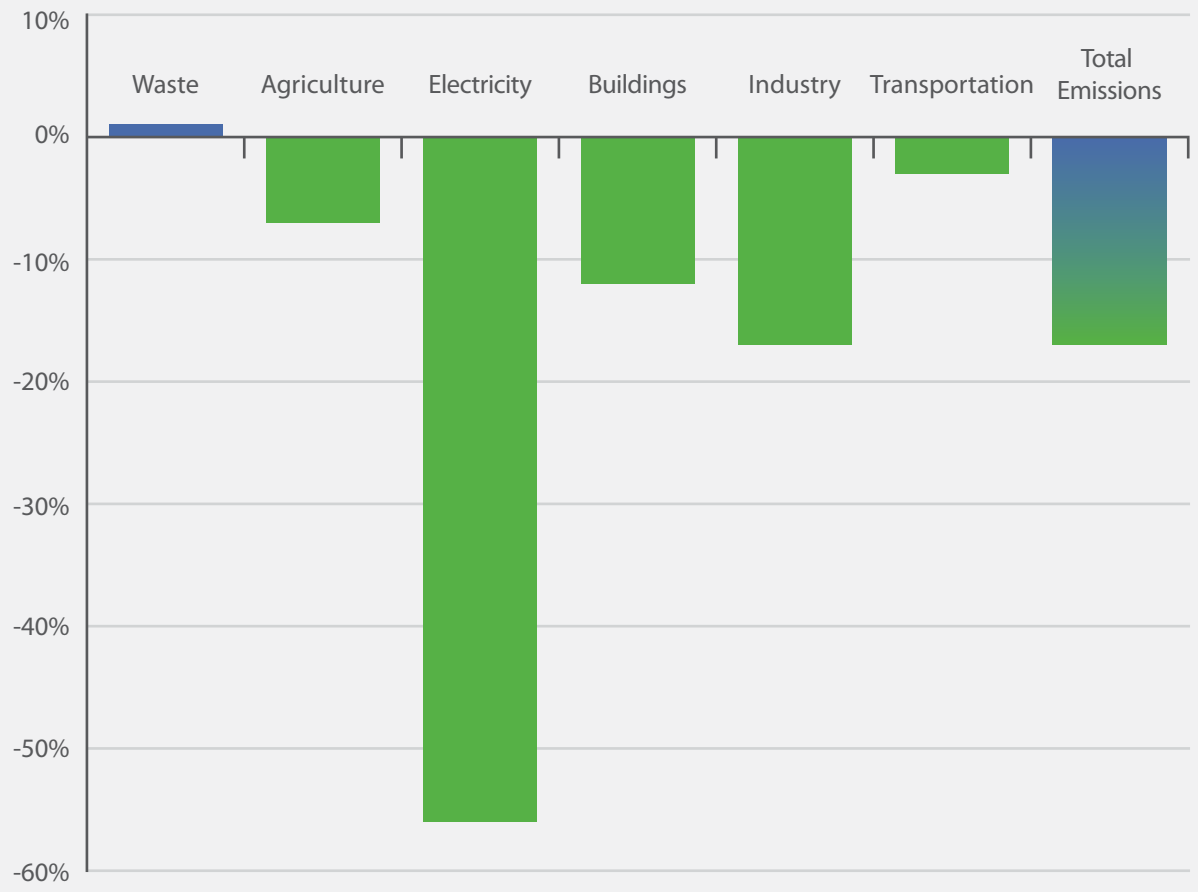


Sources: the 2014 National Inventory Report: 1990–2012 data; *Ontario Ministry of Finance*, Long-Term Report on the Economy *(2014)*

Short-term trends in Ontario's emissions (2007–2012)

In 2007, Ontario released a Climate Change Action Plan that set out its emissions reduction targets and identified policies intended to help meet those targets. Since 2007, total emissions in Ontario have declined by approximately 34 Mt or 17%. The greatest reductions are in the electricity and industrial sectors (see **Figure 5**). The reduction in electricity is attributable to the phasing out of coal-fired electricity generation. The reduction in the industry sector is attributable to reduced production — including plant closures — and improved emissions intensity. Buildings' emissions also declined as energy efficiency improved due to policies and programs in the sector. See Section 2 for more detail on sectoral trends.

FIGURE 5 Short-Term Changes in Ontario Emissions by Sector, 2007–2012



Source: the 2014 National Inventory Report: 1990–2012 data

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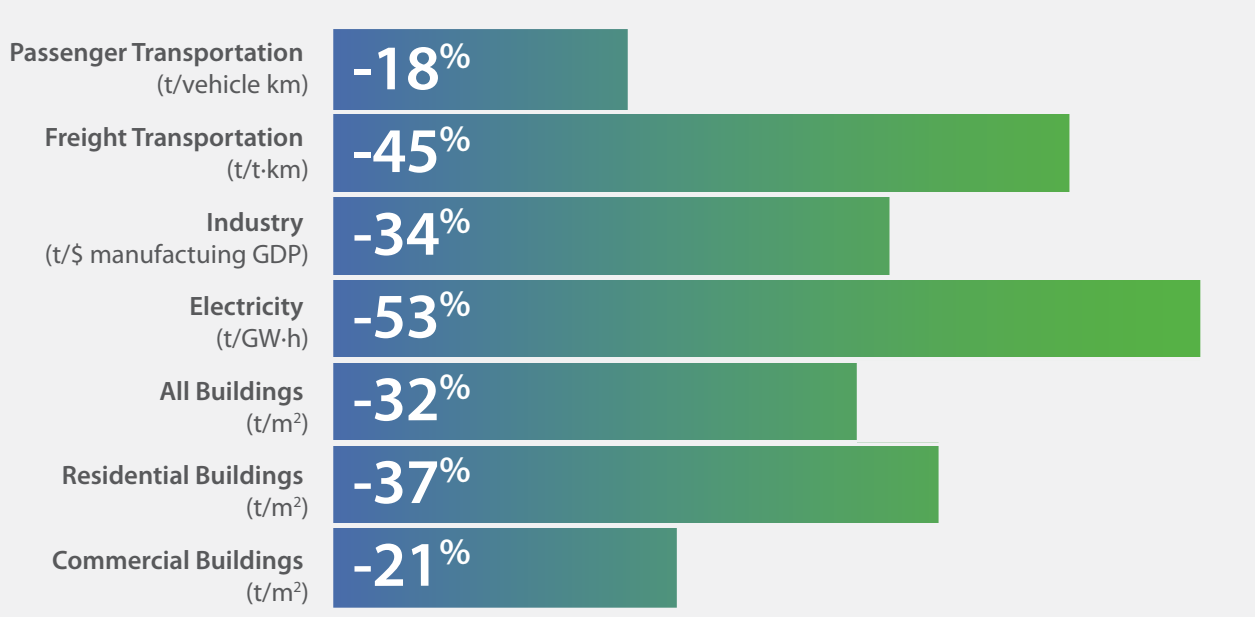
Emission Intensities

Emission intensities across most sectors improved between 1990 and 2012, which indicates a trend towards a less carbon-intense economy. **Figure 6** depicts emission intensities based on greenhouse gas drivers such as buildings, electricity, industry and transportation. Trends in specific sectors are described in more detail in Section 2 of this report.

FIGURE 6 Changes in Emission Intensities of Key Activities, 1990–2012



Sources: the 2014 National Inventory Report: 1990–2012 data; *National Energy Use Database (2014)*; *Statistics Canada CANSIM Tables 127 0001 and 127 0007; Ontario Ministry of Finance,* Long-Term Report on the Economy *(2014)*

TRANSPORTATION

Between 1990 and 2012, emissions per passenger vehicle kilometre travelled in Ontario decreased by 18% while emissions per freight tonne-kilometre decreased by 45%. Passenger vehicle intensity saw most of its decrease after 2006. Most of the improvements in freight intensity occurred before 2000.

INDUSTRY

In the industrial sector, most emissions are generated by manufacturing industries. **Figure 6** shows the emission intensity of overall manufacturing, calculated as emissions per dollar of manufacturing GDP. In 2012, emissions intensity was 34% lower than in 1990. Note that this figure does not show the variability across the sector and should not be taken to mean that every industry has reduced its emissions since 1990.

BUILDINGS

In the buildings sector, the measurement of emissions per unit of floor space gives an indication of changes in the "carbon intensity" of the sector, which is linked to energy use and the type of energy being used. **Figure 6** shows changes in emission intensity, measured as emissions per square metre of floor space in residential and commercial/institutional buildings.

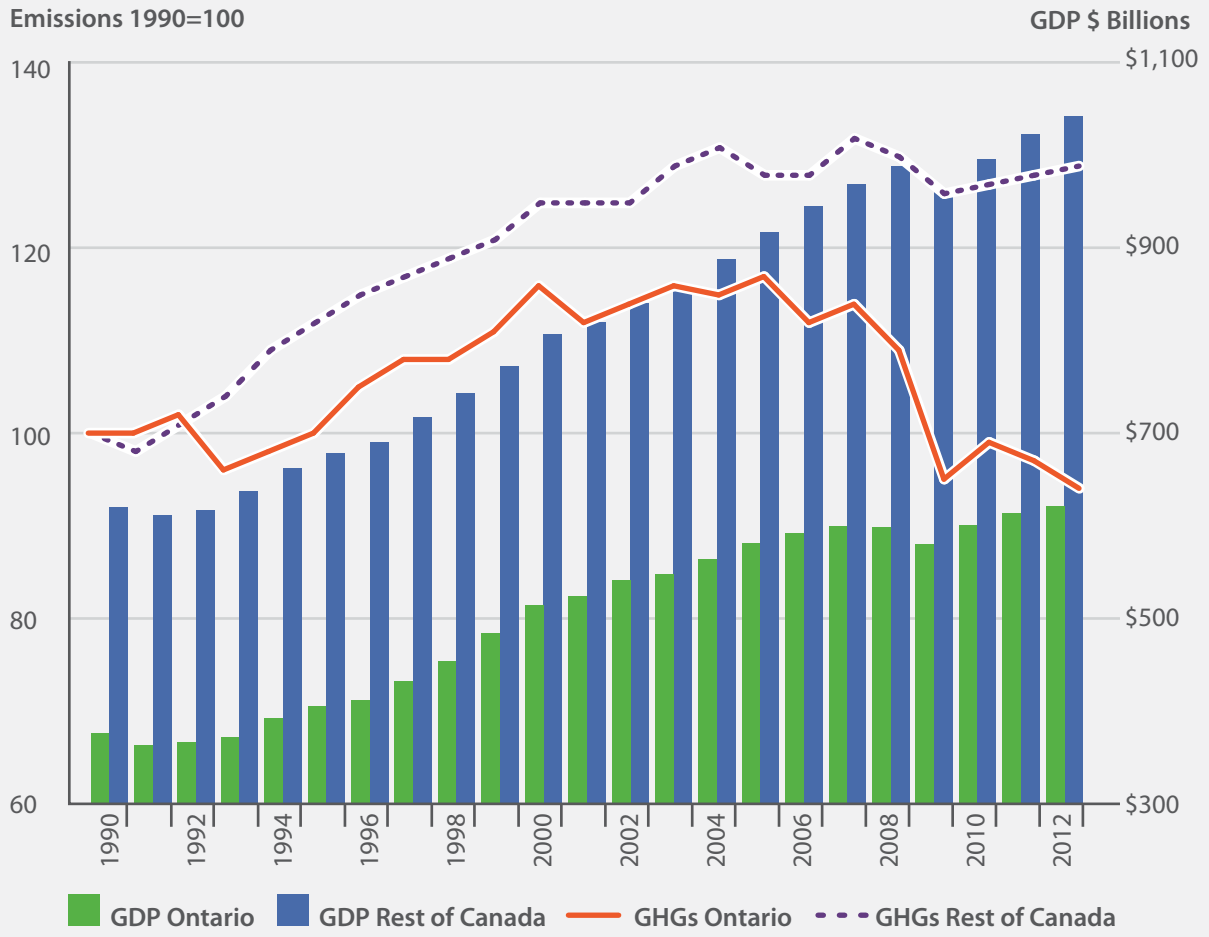
Building emission intensities improved by about 32% from 1990–2012, in both the residential (37%) and the commercial/institutional (21%) sub-sectors.

ELECTRICITY

In the electricity sector, emissions per unit of electricity generated (tonnes per gigawatt-hour) give an indication of changes in the emission intensity of electricity generation at Ontario's utilities. **Figure 6** shows changes in the emission intensity relative to the base year 1990.

Emission intensity improved by about 53% from 1990–2012. This means that greenhouse gases (tonnes of carbon dioxide equivalent) per gigawatt-hour of electricity generated was less than half what it was in 1990.

FIGURE 7 Changes in GHG Emissions, 1990–2012 (Ontario and the Rest of Canada)



Source: the 2014 National Inventory Report: 1990–2012 data; *Statistics Canada CANSIM Table 384 0038*

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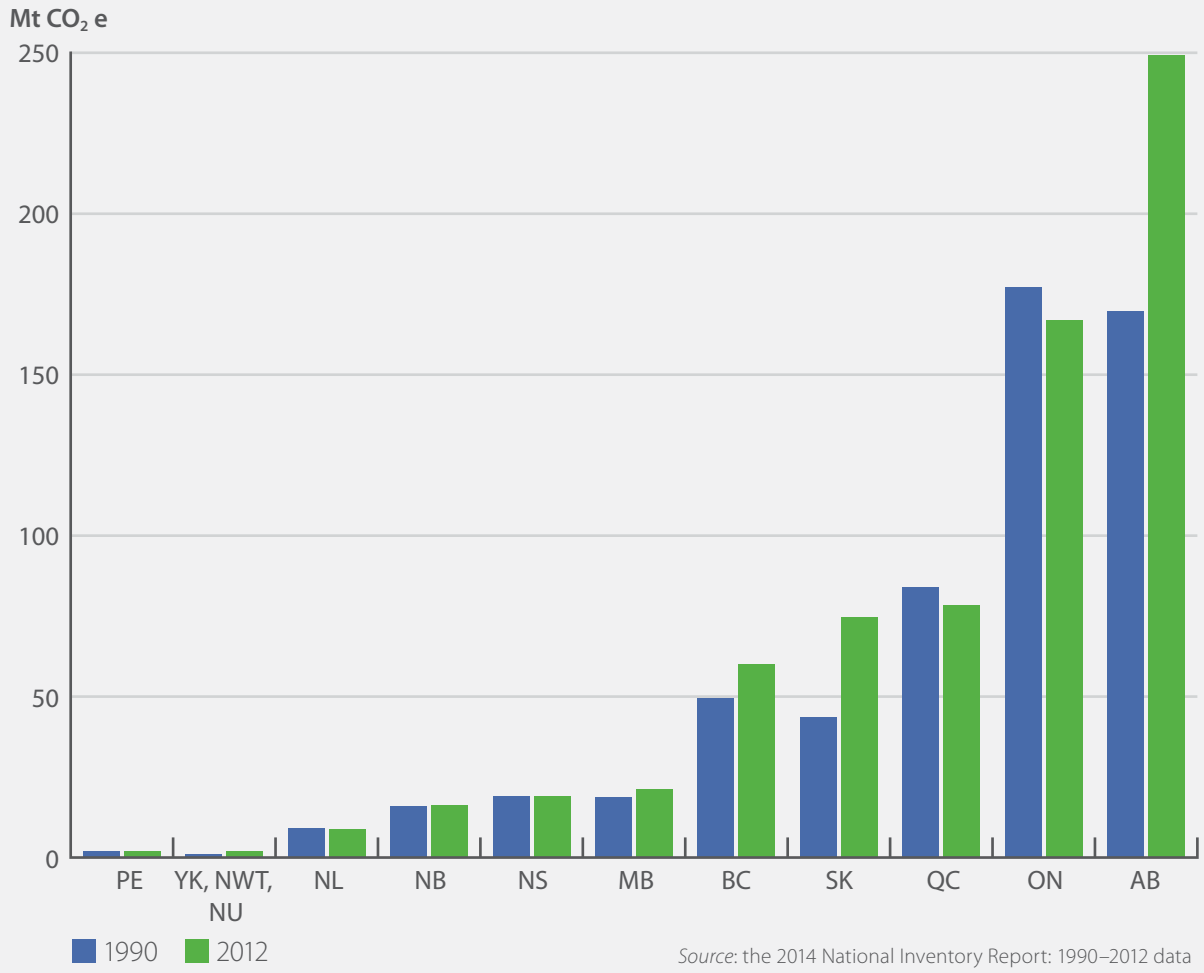
FIGURE 8 Provincial/Territorial Emissions, 1990 and 2012



Source: the 2014 National Inventory Report: 1990–2012 data

Interprovincial Comparisons

Greenhouse gas emission trends across Canada are quite different than those in our province, with clear increases in areas of expanded resource development and slower growth or decreases in other areas. Overall, Canada's emissions have increased 18.2% since 1990 but have declined in recent years, primarily because of the significant reductions in Ontario. **Figure 7** compares emission changes in Ontario to those of Canada overall.

Emission profiles and trends vary significantly across Canada. **Figure 8** shows the change in emissions by province since 1990.

TABLE 2 Provincial/Territorial Emission Intensities, 2012

Province/ Territory	Emission Intensity of the Economy (Mt CO_2 eq./$ billion GDP)	Rank
QC	0.24	1
YK, NWT, NU	0.27	2
ON	**0.27**	**3***
BC	0.29	4
NL	0.32	5
MB	0.39	6
PE	0.40	7
NS	0.53	8
NB	0.58	9
AB	0.86	10
SK	1.28	11

Province/ Territory	Emissions per Capita (t/capita)	Rank
QC	9.69	1
ON	**12.32**	**2**
BC	12.96	3
PE	13.30	4
MB	16.63	5
NL	17.03	6
YK, NWT, NU	17.92	7
NS	20.03	8
NB	21.70	9
AB	63.81	10
SK	68.84	11

Sources: the 2014 National Inventory Report: 1990–2012 data; *Statistics Canada CANSIM Tables 051 0001 and 384 0038*

* YK, NWT, NU's emission intensity is lower. When rounding the number, it appears to be equal to Ontario.

In contrast to Ontario's stable-to-declining emissions, the national trend is one of increasing emissions. In 2012, Canada's GHG emissions totalled 699 Mt, an increase of 18% since 1990. However, increases by province vary. Ontario and Quebec are the only jurisdictions in Canada with significantly declining greenhouse gas emissions. Ontario's emissions decreased by 6% and Quebec's decreased by 7%. In absolute emissions, Ontario's decrease of 10 Mt since 1990 is the largest in Canada.

Both the emission intensity of Ontario's economy — measured as emissions per unit of GDP — and per capita emissions are among the lowest in Canada (see **Table 2**).

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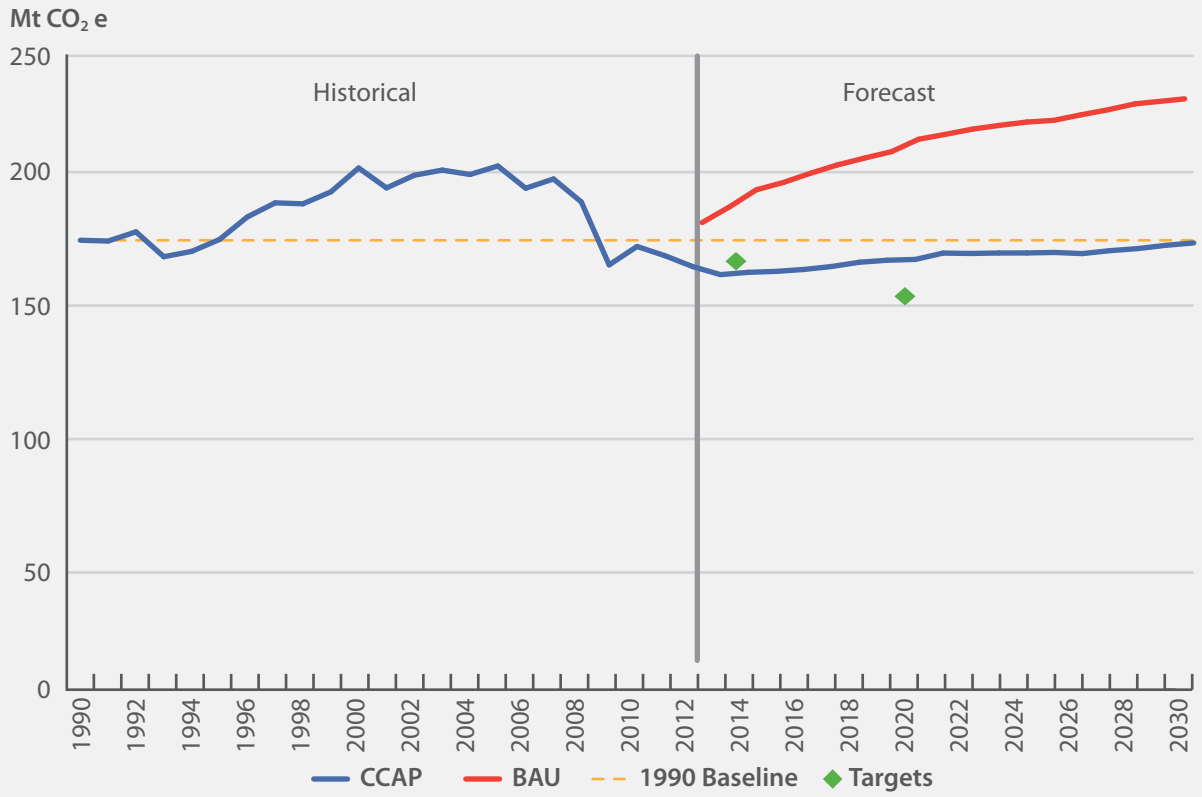
Emission Forecast to 2030

Figure 9 shows historical and forecast emissions for the province out to 2030. This forecast takes into consideration provincial and federal policies up to March 2014 that are expected to affect emissions, including Ontario's regional transportation plan for the Greater Toronto and Hamilton Area.[6] The initiatives section below describes the transportation plan further.

In addition, in order to illustrate the progress Ontario is making towards its 2007 Climate Change Action Plan targets, a "business as usual" (BAU) emission projection is also forecast. The BAU is an estimate of what Ontario's emissions would have been in the absence of policies introduced since CCAP. The BAU provides a reasonable estimate of what GHG emission levels would have been if the CCAP had not been in place, taking into account actual economic, demographic and activity trends.

42 Mt from BAU in 2020

FIGURE 9 Ontario's Historical and Forecast Emissions, 1990–2030



Source: the 2014 National Inventory Report: 1990-2012 data; MOECC forecast

[6] The transportation plan is called *The Big Move: Transforming Transportation in the Greater Toronto and Hamilton Area* (November 2008 Metrolinx); updates to the plan as of February 2013 were also incorporated http://www.metrolinx.com/thebigmove/en/ .

Table 3 shows the most recent forecast of progress to Ontario's GHG targets. Since the 2012 progress report, Ontario's progress to its greenhouse gas targets has improved. The main reason for these improvements is the 2013 revision of the *Long-Term Energy Plan* and its associated energy demand and clean energy generation forecasts. Furthermore, both the recent historical emission data and current economic forecasts are slightly lower than in 2012. Lower, more conservative economic forecasts tend to translate into lower emissions trends, since lower economic growth generally means lower energy-consuming activity and lower energy use.

TABLE 3 Projected Reductions, Progress and Gaps to Targets

2014 Update	2014	2020
Annual Projected Reductions (Mt)	26	42
Progress to Target	expected to surpass target	69%
Gap (Mt)	expected to surpass target	19

2012 Report	2014	2020
Annual Projected Reductions (Mt)	31	42
Progress to Target	91%	60%
Gap (Mt)	3	28

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Initiatives

Ontario has undertaken a wide range of initiatives to reduce greenhouse gas emissions throughout the economy. Examples from specific sectors will be highlighted in the sections following. Many efforts are inter-related (such as the phase-out of coal-fired electricity generation with increases in renewable generation and conservation) or have overlapping impacts (such as federal vehicle efficiency standards with Ontario's ethanol blending requirements for gasoline). Therefore, estimated impacts are grouped by sector. Ontario's climate change initiatives cross all emission sources and economic sectors and represent a combination of short-, medium- and long-term reductions. The initiatives considered for this report include activities that are both within and outside the direct control of the Ontario Government, including federal policies that affect provincial emissions. New initiatives announced after March 2014 have *not* been included in the forecast, such as Ontario's proposal for *Reducing Coal Use in Energy-Intensive Industries*[7] and any new initiatives in *Moving Ontario Forward*,[8] the government's plan to make available nearly $29 billion over the next 10 years for investments in transit, transportation and other critical infrastructure projects across the province.

Table 4 shows the expected impact of initiatives by sector in 2014 and 2020.

[7] Environmental Bill of Rights Registry Number 012 1559.

[8] *Building Opportunity and Securing Our Future Act (Budget Measures), 2014*, S.O. 2014, c. 7. Note that any projects included in The Big Move and funded out of Moving Ontario Forward are included in the current emissions projections. Many projects that have already been announced in the Greater Golden Horseshoe Growth Plan have also been included in estimates.

TABLE 4 Emission Reductions by Sectoral Initiatives

Sector	Initiative	Projected Reductions (Mt)	
		2014	2020
Transportation	The Big Move regional transportation plan and Greater Golden Horseshoe Growth Plan[9] Passenger vehicle efficiency regulations Freight truck speed limiter regulation Municipal hybrid bus purchase and Green Commercial Vehicle programs[10] Ethanol in Gasoline regulation[11] Greener Diesel regulation[12]	1.9	4.6
Industry	Natural gas utility conservation programs	0.3	0.8
Buildings	Greater Golden Horseshoe Growth Plan Natural gas utility conservation programs Building Code amendments Residential retrofits	0.9	2.3
Electricity	Long-Term Energy Plan: coal phase-out; Feed-In Tariff program; residential, commercial and industrial demand management programs; and related electricity plans	20.5	32.5
Agriculture and Waste	Biogas Financial Assistance Program Landfill Gas Collection and Control regulation[13]	1.5	1.8
	All initiatives	**26.0**	**41.9**

Emission reductions for all initiatives together may differ from the sum of individual initiative reductions due to interaction between them.

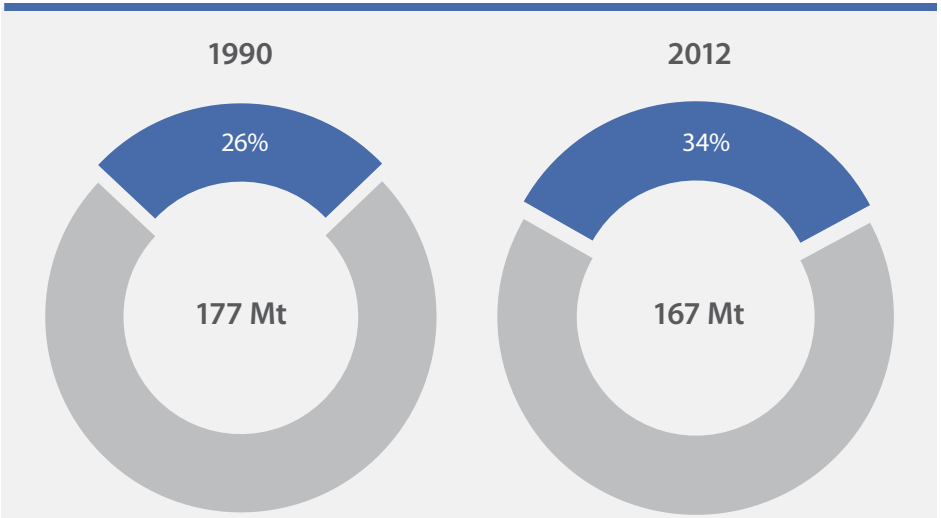
[9] The regional transportation plan is an official long-term plan, produced by Metrolinx. However, capital projects are approved and funded individually as the plan is implemented over 25 years and may be subject to change. Therefore, modelling for this initiative is inherently more uncertain than for other initiatives.
[10] The Green Commercial Vehicle Program ended in 2012.
[11] O. Reg. 535/05 made under the *Environmental Protection Act*.
[12] O. Reg. 97/14 made under the *Environmental Protection Act*.
[13] O. Reg. 216/08; O. Reg. 217/08 made under the *Environmental Protection Act*.

SECTION 2

EMISSIONS BY SECTOR

This section provides specific information about GHG emissions by sector, including a description of the main sources, drivers of trends, a sector-specific forecast and sectoral initiatives.

Transportation Sector



Transportation Emissions

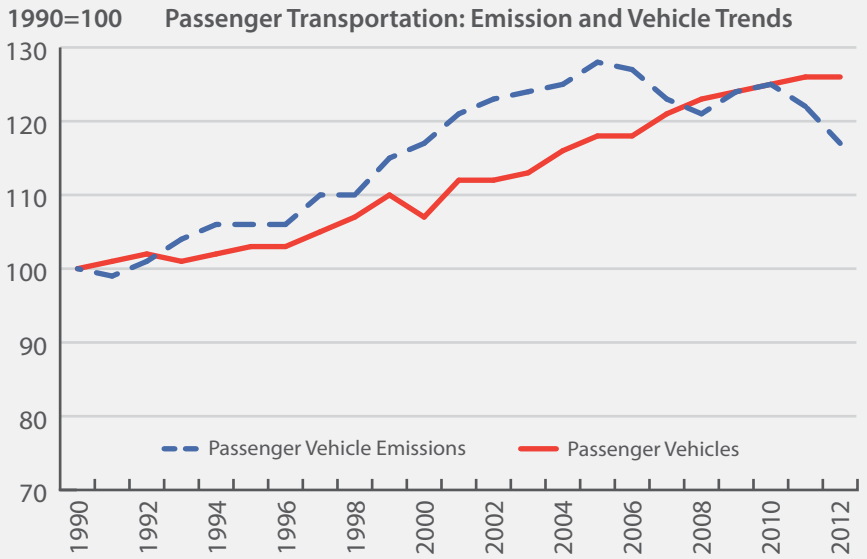
1990: 45.5 Mt
2012: 56.6 Mt
% Change: +24%

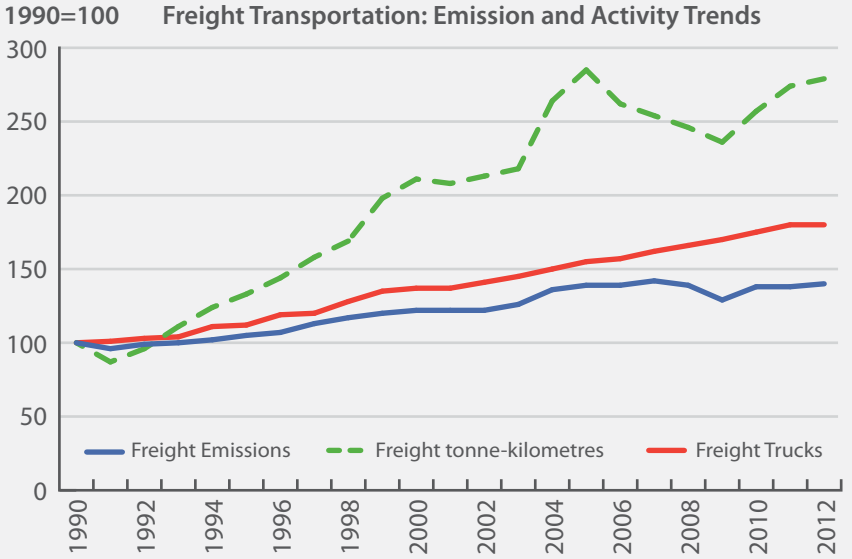
For 2012, the transportation sector represents approximately 34% of Ontario's greenhouse gas emissions. Transportation GHGs are emitted from combustion of fossil fuels in vehicles, mainly gasoline and diesel, and mostly from road travel. The largest sources are passenger cars and light-duty trucks, accounting for over half of the sector's emissions. The remainder come from other modes of transportation such as freight trucking and domestic air, ship and rail travel. International air and marine travel are not included in the Inventory. It should be noted that while public transit vehicles (i.e., buses, commuter trains, etc.) are sources of emissions, transit use contributes to reducing overall emissions levels by removing car trips from the road.

TRENDS

Emissions in the transportation sector have grown by 24% since 1990; road transportation is responsible for the greatest increase. **Figure 10** shows how historical emission levels have changed from 1990 to 2012 for passenger vehicles and freight transportation compared to changes in the number of vehicles and amount of freight in tonne-kilometres. A tonne-kilometre represents the measure of freight [tonne] carried over the distance of a kilometre. Through the 1990s, emissions increased as travel increased with population and economic activity. Furthermore, specialization and globalization in the economy have increased the distances freight is shipped. Vehicle efficiency improvements, along with other policies, have contributed to these trends flattening in recent years.

FIGURE 10 Historical Trends in Transportation





Source: the 2014 National Inventory Report: 1990–2012 data; *National Energy Use Database (2014)*

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IMPACT OF INITIATIVES

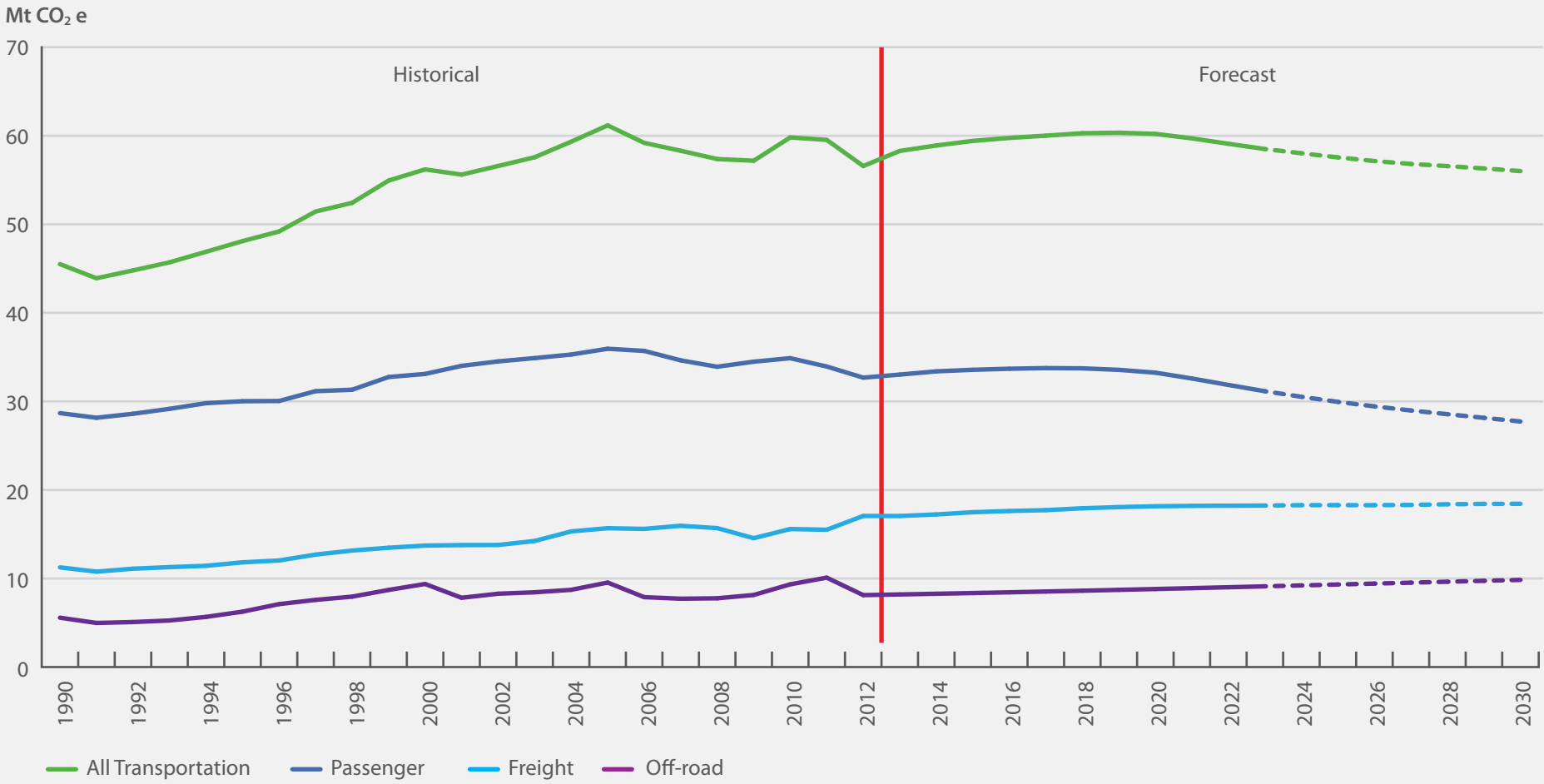
Many policies contribute to more carbon-efficient transportation. Ontario's Ethanol in Gasoline regulation (O. Reg. 535/05) has improved vehicle emission intensities in recent years. The recently introduced Greener Diesel regulation promotes the use of diesel fuels with better environmental performance. Combined with federal fuel efficiency standards, these regulations are expected to continue to improve intensities. Speed limiter requirements for freight trucks also contribute modest reductions.

Investments in public transit; the Provincial Policy Statement, 2014; and Ontario's Growth Plan encourage and promote a shift from individual car trips to car-pooling, land use, densities and mix of uses that minimize length and number of vehicle trips, and encourage the use of transit, walking and cycling — which in turn leads to fewer vehicle kilometres travelled and the associated emissions. For example, in 2012, there was an increase of more than 193 million passenger trips on municipal transit systems, compared to 2003. This has removed approximately 161 million car trips from Ontario roads.

Several major transit projects underway in the Greater Toronto and Hamilton Area (GTHA), Ottawa and Waterloo will come into service by 2020, which are projected to result in overall GHG reductions. As these lines mature and additional transit investments are made, positive impacts will continue beyond 2020.

Figure 11 shows forecast emissions from passenger, freight and off-road transportation out to 2030. The combined impact of transportation initiatives is forecast to be about 4–5 Mt from the business-as-usual projection in 2020. The impacts of current policies do not entirely offset increases that will come from population and economic growth, so near-term emissions are forecast to rise. However, emission growth after 2020 is expected to be tempered by increasing impacts of policies.

FIGURE 11 Historical and Forecast Transportation Emissions



Source: the 2014 National Inventory Report: 1990–2012 data; MOECC forecast

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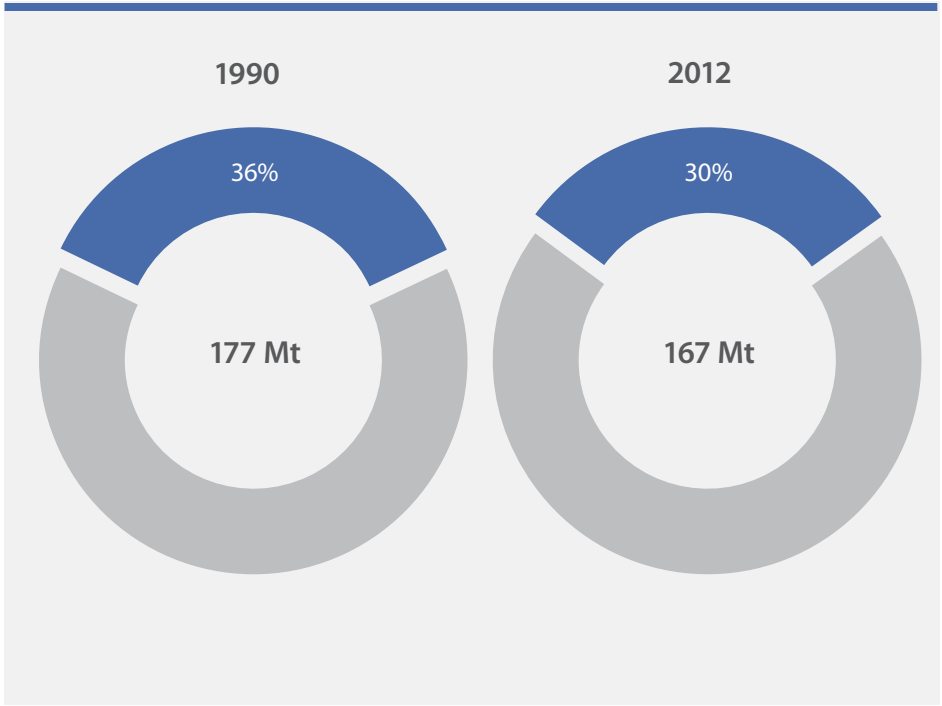
Industrial Sector

In 2012, the industrial sector represents approximately 30% of Ontario's greenhouse gas emissions. Emissions in this sector come from the combustion of fossil fuels, such as natural gas and fuel oil. Some industrial processes themselves emit greenhouse gases. For example, when limestone is transformed into clinker, a precursor to cement, the process releases CO_2. These are called "process emissions."

Large industrial emitters in Ontario are required to report their greenhouse gas emissions.[14] Since small emitters are not required to report, this facility data does not represent the entire industrial sector in Ontario. However, this data is used to corroborate the trends estimated below.



Industrial Emissions

1990: 63.9 Mt
2012: 50.3 Mt
% Change: -21%

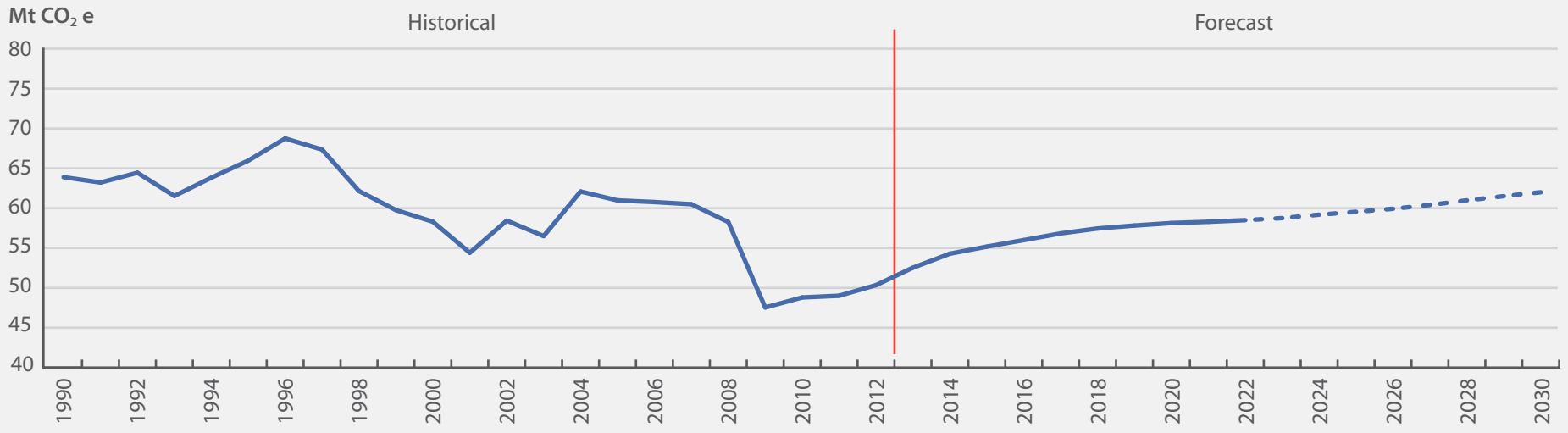
[14] Ontario's industrial emitters' report can be found here: http://www.ontario.ca/environment-and-energy/greenhouse-gas-emissions-reporting-facility.

TRENDS

Ontario's industrial emissions have dropped by 21% since 1990. In some cases, this was due to improvements in energy efficiency. This was also due to shifts in the economy from a predominance of manufacturing to a more diversified economy with a greater share of service industries. The overall improvement does not tell the story of significant variability across industries. For example, pulp and paper production has declined significantly and so too have emissions. Ontario's only adipic acid production plant reduced its emissions when it installed a catalytic emission abatement system in 1997. In 2009 this plant was indefinitely idled.

Figure 12 shows historical emissions from 1990–2012 and forecast emissions to 2030. Emissions decreased 10 Mt (17%) over the 2007–2012 period. This sharp drop was due to the recession; since then, emissions have been increasing. As the economy grows, it will be important to take the opportunity to find ways to level or decrease emission trends.

FIGURE 12 Industrial Emission Trend



Source: the 2014 National Inventory Report: 1990–2012 data; MOECC forecast

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In the industrial sector, most emissions are generated by the manufacturing subsector (see Section 3: Methodology for more detail). In 2012, the emission intensity of manufacturing industries, calculated as emissions per dollar of manufacturing GDP, was 34% lower than in 1990.

IMPACT OF INITIATIVES

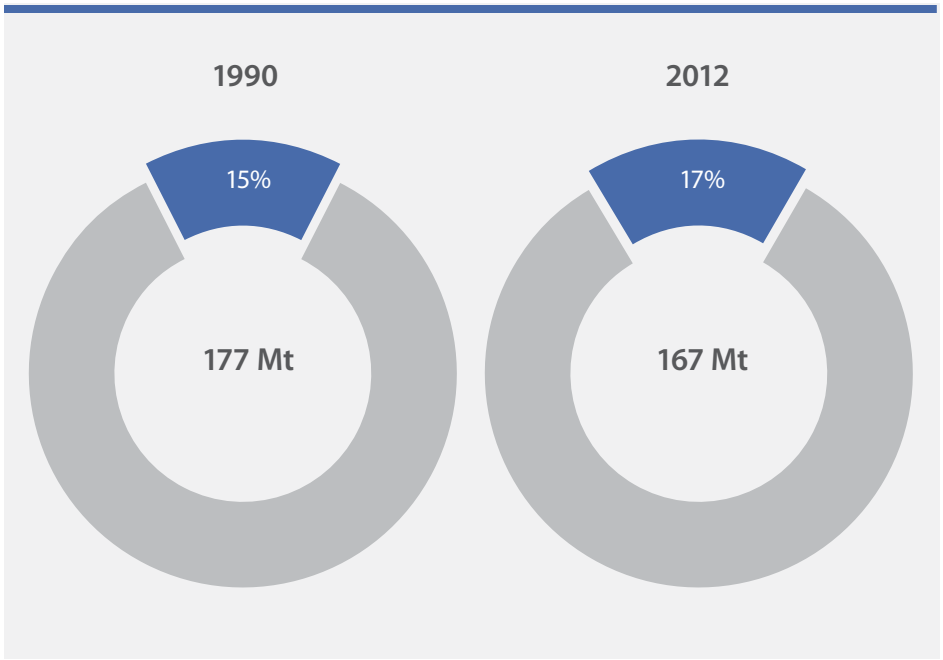
By 2020, total industrial emissions are projected to increase by 15% from the 2012 level, both combustion and process emissions. The carbon intensity of those emissions, measured as emissions per dollar of manufacturing GDP, is projected to decrease. This expected future decrease will likely be consistent with an existing decreasing trend (see **Figure 6**, p. 10).

Natural gas demand-side management programs are expected to reduce approximately 1 Mt of GHGs annually by 2020, compared to business as usual.

Looking ahead to 2020 and beyond, we will look to continue to work with industry towards the goals of clean-tech innovation and high resource productivity. Ideally, highly resource-efficient industries would increase profits and maintain a competitive edge in the global marketplace while reducing greenhouse gas emissions.

Buildings Sector

In 2012, the buildings sector represents approximately 17% of Ontario's greenhouse gas emissions. This sector includes emissions related to fossil fuel combustion — primarily natural gas — for space heating, water heating and other direct emission sources in residential, commercial and institutional buildings. While buildings also use a significant amount of electricity for lighting, air conditioning and appliances, these are considered *indirect emissions* resulting from electricity use and are included in electricity sector emissions.



Buildings Emissions

1990: 26.3 Mt
2012: 28.7 Mt
% Change: +9%

TRENDS

In Ontario, emissions in the buildings sector have grown steadily since 1990 along with population and the economy. These trends are expected to continue.

Figure 13 shows historical emissions from 1990–2012 and an emission forecast out to 2030. Annual fluctuations in historical emissions can be attributed to changes in heating demand due to weather and changes in activity in the commercial sector. Building emission intensity improved by about 32% from 1990–2012. This was due to improvements in both the residential (37%) and the commercial/institutional (21%) segments of the sector.

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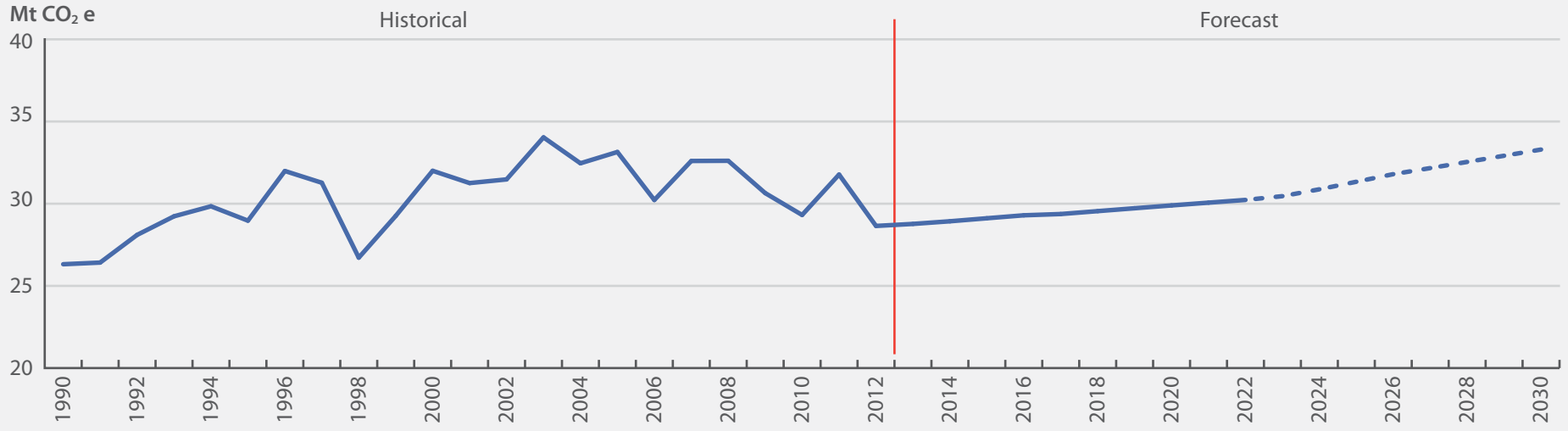
FIGURE 13 Buildings Sector Emission Trend



Source: the 2014 National Inventory Report: 1990–2012 data; MOECC forecast

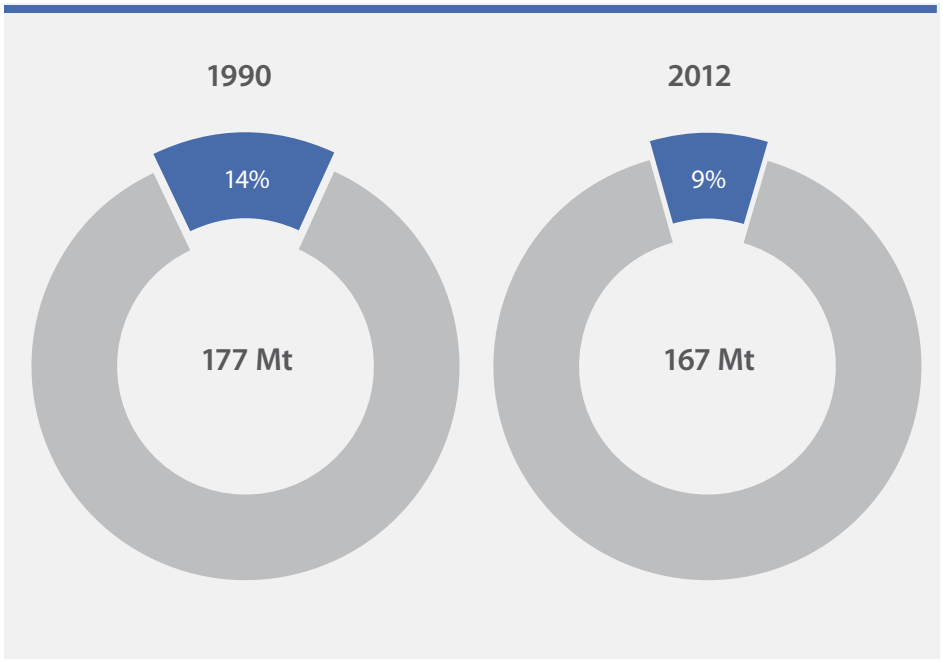
IMPACT OF INITIATIVES

Recent changes to the Ontario Building Code mandate more efficient new buildings. For building stock already constructed, property owners have added insulation, sealed cracks, upgraded windows and have taken advantage of incentives from utilities and government. New furnace standards require higher efficiency appliances. As a result of these and other initiatives, the energy use per square metre in Ontario has decreased by more than 30% (see **Figure 6**, p. 10). The Provincial Policy Statement, 2014 promotes compact land use and development forms that will contribute to the reduction of greenhouse gas emissions from the building sector and the built environment. The expected combined impact of all of the activities described here will be about 2–3 Mt from the business-as-usual projection in 2020.

However, these improvements are not expected to completely counteract emission growth in building space overall — emissions are projected to rise in the coming years.

Electricity Utilities

In 2012, the electricity sector emitted approximately 9% of Ontario's greenhouse gases. Greenhouse gases are emitted from electric generation burning fossil fuels — natural gas or coal in the province. Note that Ontario fully eliminated coal as a source of electricity generation in April 2014. Emissions from the sector are driven by the demand for electricity and the carbon intensity of the generation source.



Electricity Emissions

1990: 25.5 Mt
2012: 14.5 Mt
% Change: -43%

TRENDS

There was a sharp increase in Ontario's electricity emissions from the early 1990s to 2000, when coal-fired power plants represented a larger portion of energy generation. Emissions peaked in 2000 at around 70% above 1990 levels and have been decreasing ever since (see **Figure 14**).

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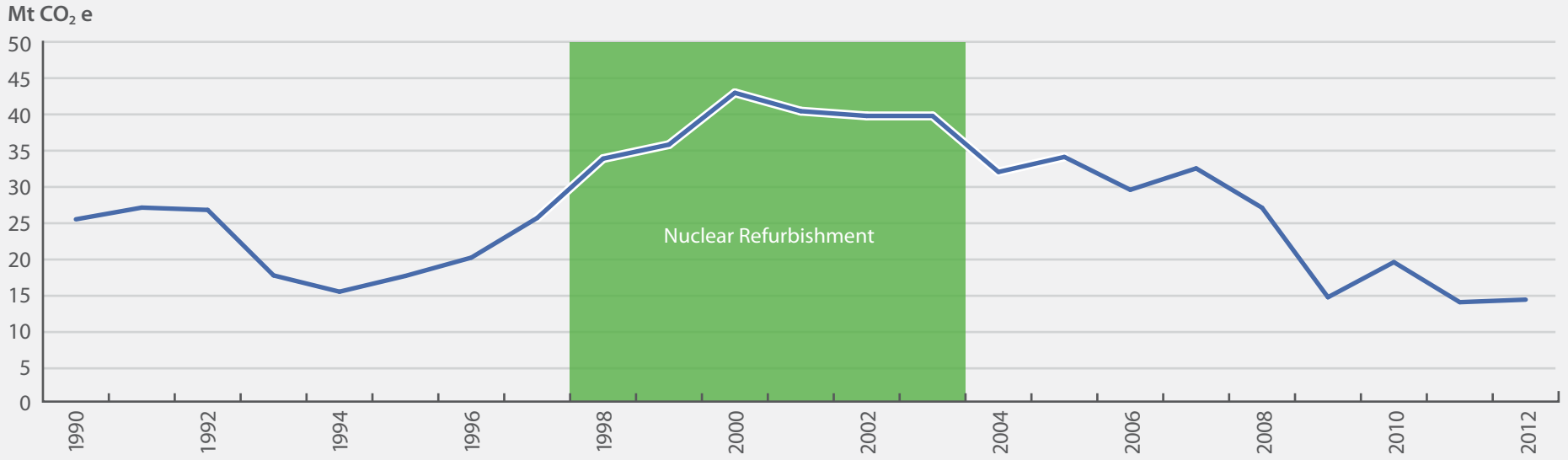
FIGURE 14 Electricity Generation Historical Emissions, 1990–2012



Source: the 2014 National Inventory Report: 1990–2012 data

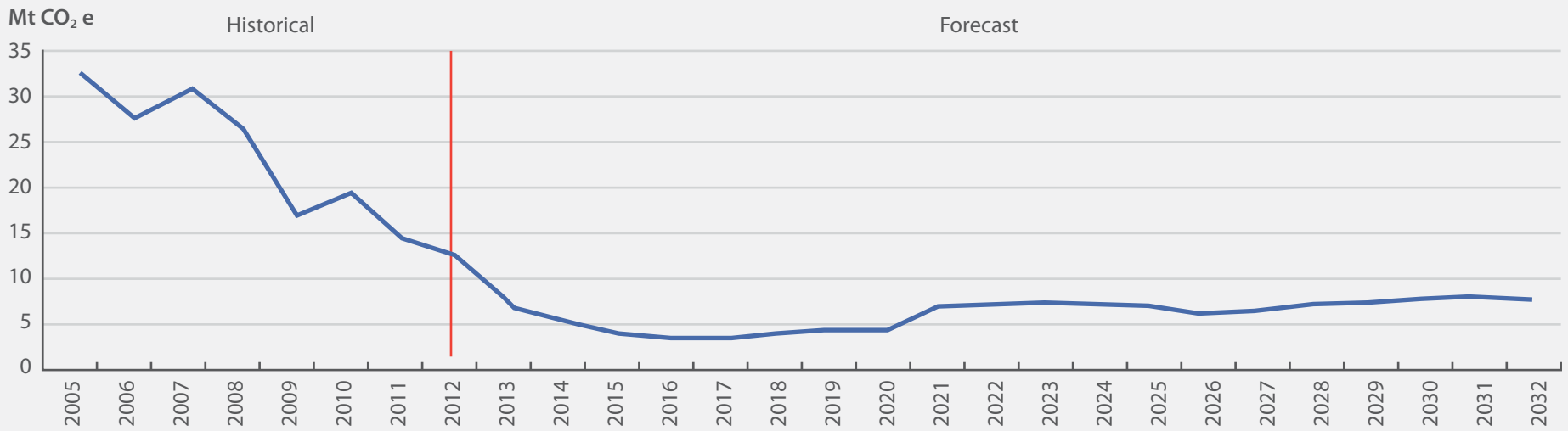
Since 2007, electricity emissions have decreased due to the phase-out of coal-fired electricity (see above). Emissions in 2012 were about the same as in 2011. Phasing out coal-fired electricity has improved the intensity of electricity in Ontario. Combined with demand management, this reduces the use of fossil fuels by electricity utilities.

IMPACT OF INITIATIVES

Phasing out coal-fired electricity generation is the single largest climate change initiative in North America to date and with associated electricity policies is projected to reduce Ontario's emissions by 32.5 Mt in 2020 from business-as-usual (see **Figure 15**).

32.5 Mt from BAU in 2020

FIGURE 15 Electricity Sector Greenhouse Gas Emission Forecast



Source: Achieving Balance: Ontario's Long-Term Energy Plan *data (2013)*

Between 2010 and 2014, the Ontario Government reduced the use of coal in power plants, closing or converting all generating units at these plants. *The Green Energy and Green Economy Act*, 2009 and the 2013 *Long-Term Energy Plan* have replaced coal with hydroelectric power, nuclear power, renewable electricity generation, demand management and conservation (see **Figure 16**). In the near term, the power grid will also rely on natural gas generation, so emissions from this sector many increase, especially during the refurbishment of some nuclear plants.

We also note that Ontario's reductions in the carbon intensity of electricity generation means households, businesses and industries have a smaller carbon footprint. This change also provides opportunities for electricity to be a low-carbon alternative to other, more carbon-intense energy sources. For example, the carbon footprint of the operation of an electric vehicle in Ontario is substantially lower not only than that of a gasoline vehicle but also of an electric vehicle used in a jurisdiction dependent on coal-fired electricity.

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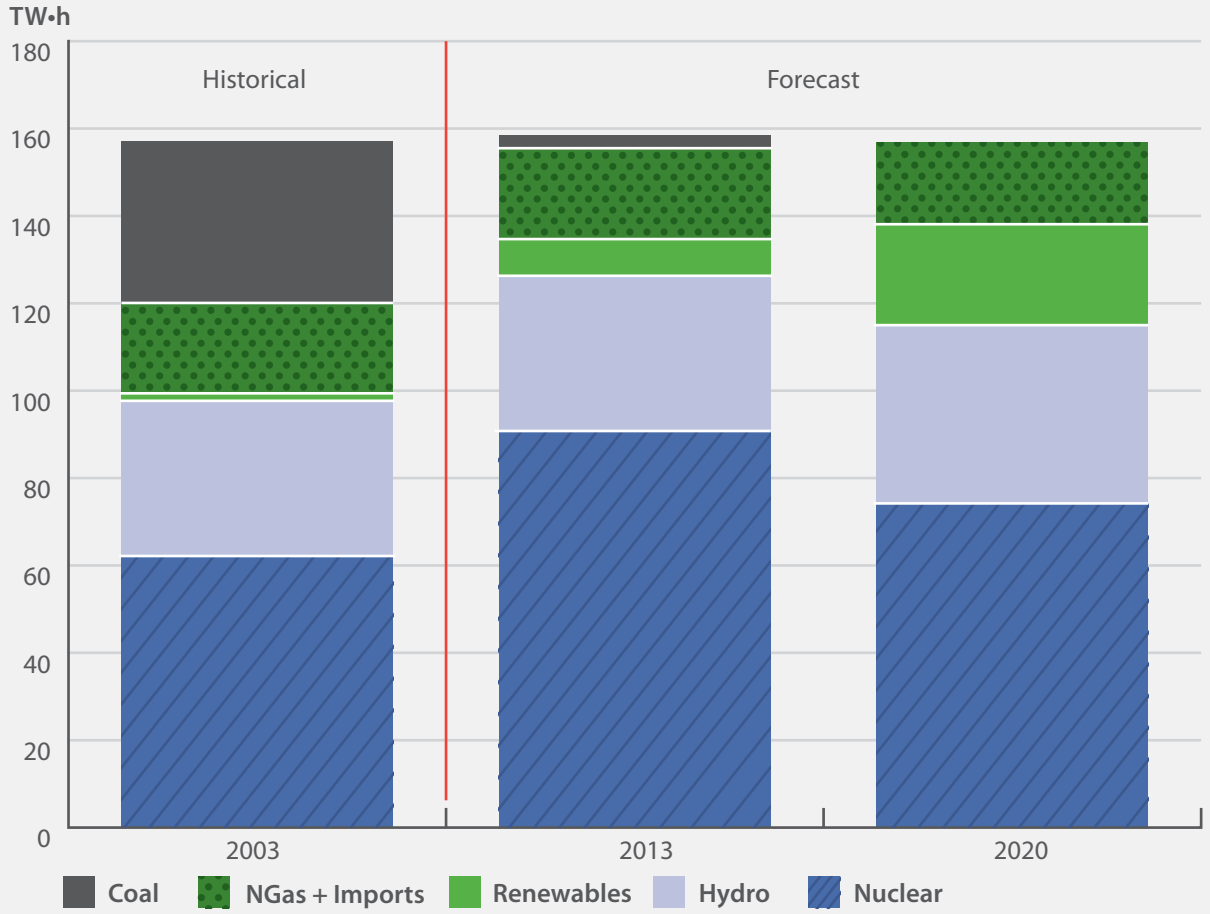
In the future, we will continue to look to further develop Ontario's clean energy sources and new technologies, as well as promote energy and resource efficiency and conservation across government, and among businesses and individuals.

FIGURE 16 Ontario's Electricity Production by Source



Sources: Ontario's Long-Term Energy Plan: Building Our Clean Energy Future *(2010)*; Achieving Balance: Ontario's Long-Term Energy Plan *data (2013)*

Agriculture Sector

Agriculture has numerous roles with respect to greenhouse gas emissions and the carbon cycle. Many agricultural activities are sources of GHG emissions, while others *remove* carbon from the atmosphere and store it in soils. According to the UN accounting conventions, emissions and removals of GHGs from agricultural lands are part of the Land Use, Land Use Change and Forestry (LULUCF) sector, which are estimated but *not* included in Inventory totals. Ontario does not include LULUCF emissions and removals in this report. Emissions from fossil fuels used in agricultural equipment like combines and tractors are included in the transportation sector, while emissions from fuels used to heat greenhouses are included in the industrial sector.

For the purposes of this report, emissions from the agriculture sector are restricted to livestock and crop production. A more detailed description of the sources can be found in the Inventory.

Agriculture Emissions

1990: 10.0 Mt
2012: 9.4 Mt
% Change: -6.5%

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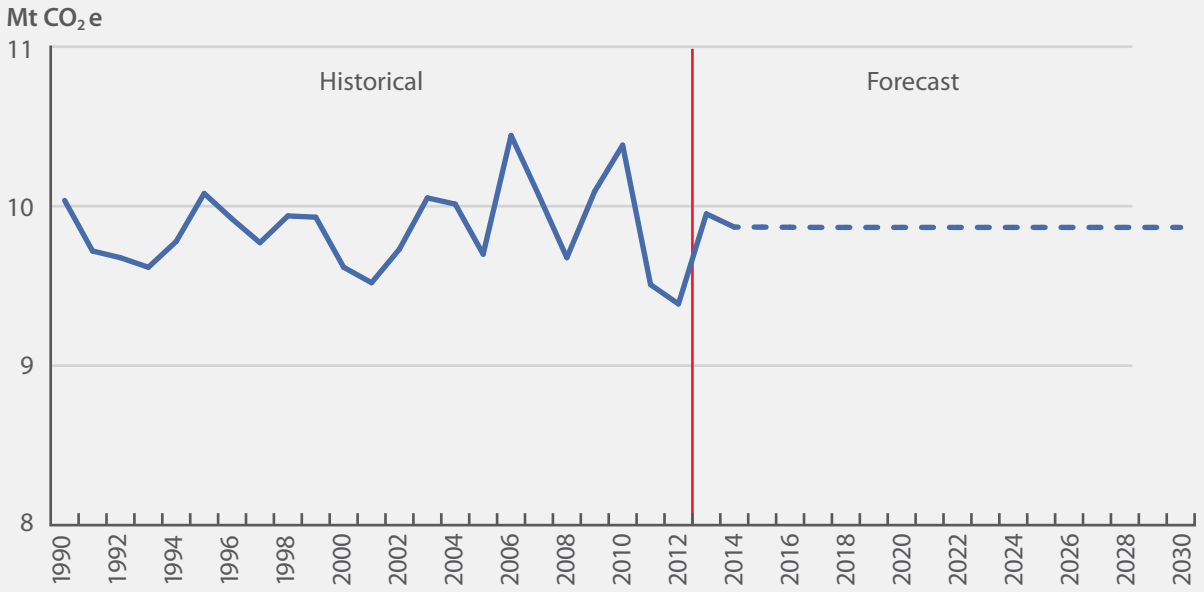
TRENDS

In 2012, the agricultural sector was responsible for 9.4 Mt (6%) of total GHG emissions in Ontario (6.5% below 1990 levels). Most of the agricultural emissions accounted for in this sector are from the application of nitrogen-based fertilizers and manure to agricultural soils (55%), followed by methane from the digestive processes of livestock (enteric fermentation (29%)) and manure management (16%).

The agriculture sector emissions have remained fairly constant since 1990 (see **Figure 17**).

FIGURE 17 Agriculture Forecast Emissions to 2030



Source: the 2014 National Inventory Report: 1990–2012 data; MOECC forecast

While the direct emissions from agriculture in Ontario are relatively small, the sector plays a critical role in the carbon cycle and the production of bio-fuels, which can displace fossil fuels in other sectors. On-farm biogas facilities (which were funded under the Ontario Biogas Systems Financial Assistance Program) are expected to achieve a reduction of 11 kilotonnes in 2020. Tillage practices can have an impact on emissions from agricultural soil; however, most of this impact is accounted for in the cropland category of the LULUCF sector and is not included in Ontario's inventory or forecast at this time.

Waste Sector

Emissions from Ontario's waste sector are primarily methane from the disposal of solid waste on land and, to a lesser extent, emissions from wastewater handling and waste incineration. Methane is generated from the decomposition of organic material over time in a landfill. The rate of methane generated depends on the amount and nature of the waste disposed and the conditions of the landfill.

Emissions from landfills are determined using a simulation model to account for the slow, long-term generation and release of these emissions.

Waste Emissions

1990: 5.9 Mt
2012: 7.5 Mt
% Change: +25%

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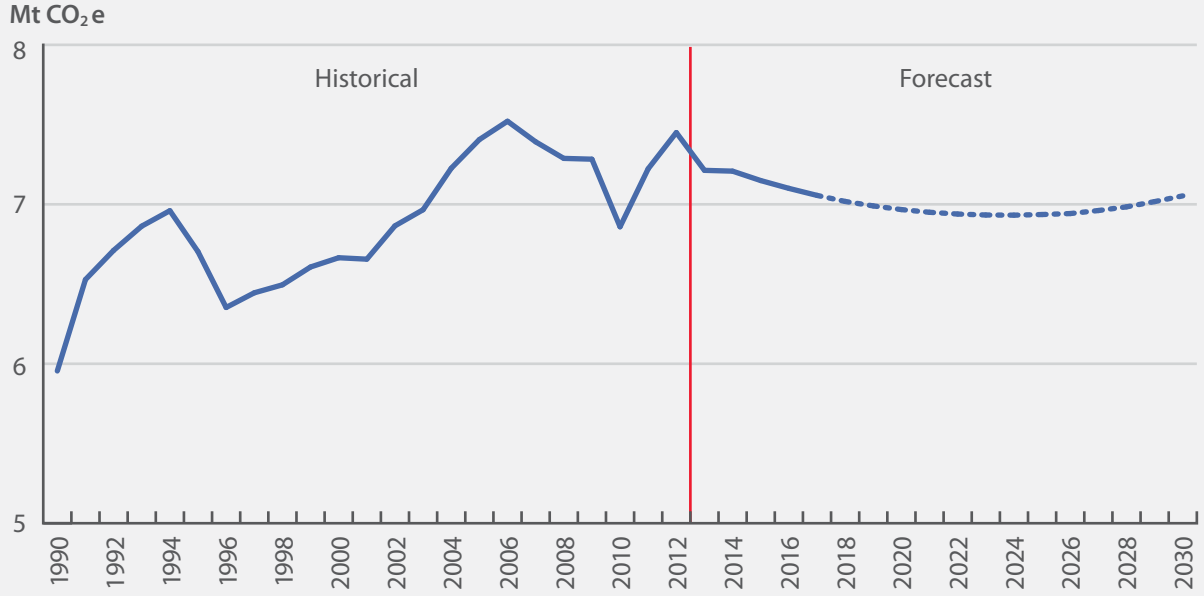
TRENDS

In 2012, the waste sector in Ontario was responsible for 7.5 Mt (4%) of the total GHG emissions in Ontario. Most of these (92%) came from methane emitted by public and private landfills. **Figure 18** shows the emission trend and forecast for the waste sector. From 1990–2012, emissions grew by 25% as waste disposal on land increased. There are initiatives underway to reverse this trend that could be expanded; for example, by diverting organic matter from landfill and capturing or destroying the methane generated. Methane from landfill gas can also be used to generate electricity or heat.

FIGURE 18 Waste Forecast Emissions to 2030



Source: the 2014 National Inventory Report: 1990–2012 data; MOECC forecast

IMPACT OF INITIATIVES

Waste emissions are expected to remain relatively stable in coming years. Ontario has implemented regulations[15] requiring large landfills to capture and destroy methane generated. To date, 31 landfills are capturing landfill gas and these systems are expected to reduce emissions by 1.8 Mt in 2020.

[15] O. Reg. 216/08; O. Reg. 217/08. Made under the *Environmental Protection Act*.

SECTION 3

METHODOLOGY

How Ontario estimates GHG emissions

Ontario's approach reflects Canada's *National Inventory Report 1990–2012*. Each year, Environment Canada submits an updated Inventory to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat.[16]

Historical emissions in Ontario's report are taken from the latest Inventory, which covers the period 1990–2012. As discussed in the introduction (see p. 5), the data cover most activities in Ontario's economy that influence GHGs but do *not* include impacts relating to land use, land-use change, and forestry at this time.

The Inventory uses numerous categories defined by UNFCCC reporting protocols. It is important to be aware that these often do not match categories used by many sources of economic, industrial and environmental data. For Ontario's report, the categories are rolled up into six key sectors (see **Table 1** on p. 4).

It should also be noted that international air and marine transport are currently not included in national inventories. In this report, the pipeline transportation of petroleum products is included in the industry sector. In addition to pipelines, the main non-manufacturing subsectors included in industry are mining, construction, energy emissions from agriculture and forestry. Emissions from manufacturing comprise more than two thirds of the industry sector, which is why its intensity is calculated using manufacturing GDP.

Improvements in the *National Inventory Report*

Environment Canada continually works to refine the data and methods used to estimate national and provincial emissions. These refinements lead to recalculations or re-statements of emission estimates for the whole time period of the Inventory (dating back to 1990). This means that provincial 1990 base year emissions and historical trends can change with each release of the Inventory — which consequently influences Ontario's emission forecasts and assessment of progress. These recalculations and improvements are documented in each Inventory Report. The improvements made to the inventory since the 2013 report have not significantly changed Ontario's overall emissions or their general breakdown.

[16] Canada's submission can be found here: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php.

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Emission modelling overview

Ontario's emission forecast has been updated to reflect new Inventory data, macroeconomic forecasts,[17] demographic forecasts,[18] 1–2 more years of program compliance data and the latest Long-Term Energy Plan.[19] This forecast takes into consideration provincial and federal policies up to March 2014 whose impacts on emissions are expected to be significant and can be estimated with reasonable confidence, as well as Ontario's regional transportation plan for the Greater Toronto and Hamilton Area.[20]

Reporting on the progress of Climate Change Action Plan initiatives and projecting future emissions are essential to understanding Ontario's progress towards meeting its targets. Ontario's model is updated periodically to incorporate the latest data available and refinements based on best practices. In addition, the projections of emission reductions are adjusted as required to incorporate data collection and changes to programs or policies.

This information was used to create:

- A *Business-as-Usual* (BAU) projection (assumes underlying historical emission trends continue without impact from reduction initiatives while taking account of the current economic and demographic outlook for Ontario)
- A *Climate Change Action Plan* (CCAP) projection (includes the anticipated future impact of emission reduction initiatives)

Uncertainty

The emission forecasts estimated in this report are based on a single set of economic, demographic, energy, and policy assumptions (except for the absence of policies in the BAU case). As with any modelling of this kind, there are significant uncertainties inherent in this projection.

Projections used to forecast Ontario's emissions usually start with historical emissions. Historical data from the Inventory are estimates of emissions of each greenhouse gas in each sector in each year. They are subject to a range of uncertainties.[21] Generally, uncertainties associated with time series trends and aggregated totals are much lower than those associated with individual gases, sectors, years and provinces. Unfortunately, the Inventory only analyses uncertainties in the national inventory; no assessment is made of uncertainties in provincial breakdowns. At the national level, total emissions from the Inventory's "Energy" category had the least uncertainty, followed (in increasing levels of uncertainty) by "Industrial Process Emissions," "Solvent and Other Product Use," "Waste" and ending with "Agriculture" with the highest levels of uncertainty.

[17] Consistent with Ministry of Finance's projections in Ontario's *Long-Term Report on the Economy* (April 2014).

[18] Consistent with Ministry of Finance's projections in Ontario's *Long-Term Report on the Economy* (April 2014).

[19] Ministry of Energy, *Achieving Balance: Ontario's Long-Term Energy Plan* (November 2013).

[20] Metrolinx, *The Big Move: Transforming Transportation in the Greater Toronto and Hamilton Area* (November 2008); updates to the plan as of February 2013 were also incorporated http://www.metrolinx.com/thebigmove/en/. Note that, although the regional transportation plan is an official long-term plan, capital projects are approved and funded individually as the plan is implemented over 25 years and may be subject to change. Therefore, modelling for this initiative is inherently more uncertain than for other initiatives.

[21] For a more detailed analysis of estimate uncertainty, see Annex 7 of the *National Inventory Report 1990–2012* (2014).

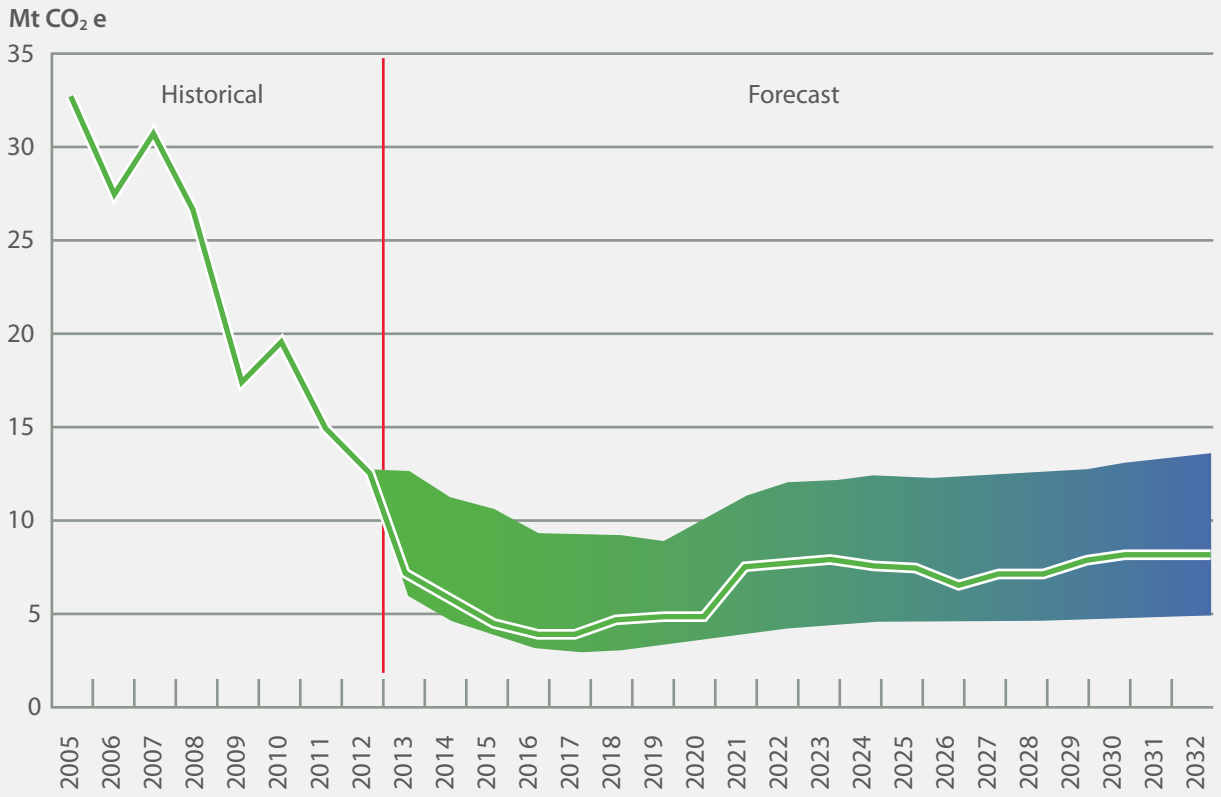
Although the uncertainty in Ontario's forecast is not quantified, the following points can be made about the forecast:

- Trends over time should be less uncertain than individual years
- Policy case emissions should be less uncertain than BAU
- Total aggregate emissions should be less uncertain than sectoral emissions
- Nearer-term (pre-2020) emissions should be less uncertain than later (post-2020) emissions

As a rough example of the model's sensitivity, if in 2020 both real GDP and population were 1% higher than forecast, the projected non-electricity emissions would be almost 1 Mt greater (about 0.5% of non-electricity emissions). This change is a generalized effect — the increase could be significantly higher or lower depending, for example, on whether energy-intensive manufacturing's output is higher than that of the service sector.

On the electricity side, the 2013 *Long-Term Energy Plan* contains a reasonable range for the projected sector emissions (see **Figure 19**). Electricity emissions are sensitive to weather — more frequent hot summer afternoons, especially combined with higher GDP, would increase emissions much further.

FIGURE 19 Range of Electricity Sector GHG Emissions



Source: Long-Term Energy Plan (2013) data

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Third-party validation

To provide confidence in the province's forecasts, Ontario has periodically had its emission forecasting methodology and assumptions validated by independent third parties. Starting in 2009, Ontario was the first jurisdiction to undertake a validation of its forward-looking emission reduction forecasts. Validation ensures these are reasonable and align with best practices where available. For Ontario's 2012 climate change report, Ontario retained Navius Research Inc., who concluded the estimates were a fair representation of greenhouse gas forecasts using current best practices in GHG emission forecasting and evaluation of GHG mitigation programs.[22] Since no significant methodological changes were incorporated into the model since Navius's conclusion, the current report has not been validated. Ontario expects that its next report will contain new initiatives and possibly changes to methodologies.

[22] Ontario, *Climate Vision: Climate Change Progress Report* (2012), Appendix C.

Learn more about Ontario's efforts to address climate change by visiting:

Ontario.ca/climatechange

Ontario