Energy Efficiency: Engine of Economic Growth in Eastern Canada

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ABSTRACT

As investments in energy efficiency programs increase, it is necessary to understand economic effects on individual program participants and on the economy as a whole. ENE conducted a study to quantify the macroeconomic impacts – increased GDP, income, and employment – of expanded energy efficiency investments in Québec, New Brunswick, Nova Scotia, and PEI.

The analysis considered scenarios of expanded investment in energy efficiency programs for electricity, natural gas, and/or liquid fossil fuels (heating oil, propane, and kerosene), over a 15-year period. The expanded investment levels represent incremental growth over existing spending (Business As Usual +) and levels that approach and potentially capture all the cost-effective efficiency resource (Mid and High). Cost-effective energy efficiency refers to efficiency that is lower cost than supplying additional energy.

The four-Province simultaneous fuels scenario would increase GDP by approximately $45 billion (BAU+ scenario), $84 billion (Mid scenario), or $113 billion (High scenario) from 2012 to 2040, as consumers spend energy bill savings in the wider economy. This is a net increase that incorporates the cost of implementing the programs, and includes benefits from existing efficiency programs. The total increase in employment over the period of study is equivalent to approximately 330,000 job years (one full-time job for a period of one year), 625,000 job years, or 868,000 job years. Additional information on the REMI model, assumptions and results is available in the full length report, available at: www.env-ne.org.

Introduction

Energy efficiency is an important component of modern energy systems and has emerged as a key policy tool to help address high energy costs, improve productivity, and spur economic growth. Energy efficiency also reduces the burden on existing energy infrastructure, and the need for new and costly upgrades; reduces the energy burden of vulnerable populations, freeing income for other basic needs such as food, housing, and medication; and, cost-effectively reduces and avoids greenhouse gas and other air emissions.

As investments in energy efficiency programs increase, it is necessary to understand economic effects on individual program participants and on the economy as a whole. Microeconomic benefits to ratepayers and program participants are typically analyzed and verified through public program design processes. However, less is known about macroeconomic benefits of efficiency investments and how both costs and benefits impact the economy as a whole.

This study quantifies macroeconomic impacts – economic output, including Gross Domestic Product (GDP) and job growth – of expanded investment in energy efficiency in the provinces of Québec, New Brunswick, Nova Scotia, and Prince Edward Island. This analysis expands and corroborates studies which found – in theory and in practice – that investing in energy efficiency produces significant positive direct and non-direct economic benefits.

The analysis uses a detailed, spreadsheet-based model to develop and evaluate efficiency program costs and energy sector benefits. The results are then input into a multi-province policy forecasting model by Regional Economic Models, Inc. (REMI) to project macroeconomic impacts of expanded efficiency programs in comparison to a scenario where no programs exist. The study analyzes expanded efficiency programs for electricity, natural gas, and liquid fossil fuels – fuel oil, propane, and kerosene. Efficiency investments are modeled for a total of 15 years, including the ramp-up period. Energy savings and avoided costs were generated for an additional 15-20 years, depending on the scenario. However, economic impacts were modeled for a total of 29 years as Canadian data to populate the REMI model was only available until 2040. The results approximately capture the full economic benefits achieved over the life of efficiency measures.

The project team consisted of analysts from ENE, Dunsky Energy Consulting, Inc., and Economic Development Research Group, Inc. The team was assisted by the project steering committee, which consisted representatives from each of the study provinces and Natural Resources Canada, as well as an informal advisory group of government representatives, utility and program administrators, and other experts from the region. Steering and advisory committee input was solicited in the development of the input assumptions and the draft final report.

Energy Efficiency Assumptions Development

In order to evaluate potential impacts of increased investment in energy efficiency in the provinces, assumptions were made about efficiency program budgets, costs to achieve the energy savings, and energy prices and consumption levels during the modeled period. The input assumptions are based on extrapolations from current and proposed efficiency program data, utility and government projections, and experience in the provinces of study and elsewhere.

The key set of assumptions and inputs was developed in three phases, and then the investment scenarios were tested for cost-effectiveness. The first phase was to estimate annual energy savings, based on recommended annual efficiency savings targets. The second phase was to estimate unit program and participant costs for each efficiency savings target level, disaggregated by residential and commercial/industrial customer classes. The per-unit-of-energy-saved costs were then applied to the annual energy savings, producing the various annual investment levels that were modeled. The benefits values, based on the marginal (avoided) source of energy over the study period, were established and applied to the estimated energy savings to generate annual avoided energy costs.

Annual Efficiency Savings Targets

The modeled efficiency investment levels were generated using annual efficiency savings targets (i.e. annual consumption would be reduced by x% per year for each year of investment). A range of three annual efficiency savings targets were established for each fuel type (i.e. BAU+, Mid, and High). The targets in Table 1 are informed by existing provincial programs and plans, studies on cost-effective savings potential in the provinces, and experience in other jurisdictions. The three savings targets reflect: i) an incremental increase in effort over current levels (BAU+); ii) a level of effort that approaches all cost-effective efficiency (Mid); and, iii) a level of investment that would place the provinces among current leaders (High). This approach overcomes limited up-to-date and public information on the energy efficiency potential in each province and establishes a range of benefits based on a wider scope of potential investment. In the case of the electric sector, different savings targets were used for Québec/New Brunswick and Nova Scotia/Prince Edward Island to take into account the higher share of electric heating and of electric industrial processes in Quebec and New Brunswick.

Table 1. Annual Efficiency Savings Targets by Fuel Type and Province (% of Annual Consumption)

	BAU+ Savings Target	Mid Savings Target	High Savings Target
Electricity	QC, NB: 0.5% NS, PEI: 1.0%	QC, NB: 1.0% NS, PEI: 1.75%	QC, NB: 1.5% NS, PEI: 2.5%
Natural Gas (except PEI)	0.75%	1.25%	1.75%
Liquid Fossil Fuels	1.3%	1.75%	2.5%

The investment scenarios are top-down estimates and do not represent a portfolio of discrete cost-effective efficiency measures (i.e. not a traditional efficiency potential study). As a result, the investments and energy savings are high-level estimates. However, the investment scenarios were tested for cost-effectiveness using the Total Resource Cost Test, the Program Administrator Cost Test, and the Participant Costs Test.

Program Costs & Investment Levels

The cost of a particular efficiency measure is tallied in the year it occurs, while savings associated with that measure accrue for the duration of the measure's life. For example, a measure installed in 2012 will have its full cost reflected in that year, with per-year energy savings occurring every year over its lifespan. This provides a more accurate model of the measure's real-world economic impacts. Average annual lifespans of measures included in this study range from 10 to 26 years, depending on the fuel and scenario.

Funding for energy efficiency measures can be divided into two main categories: program and participant. Program spending derives from government or utility efficiency program budgets. For the purposes of the macroeconomic analysis, funding for the electric and natural gas scenarios is assumed to accrue exclusively from ratepayer funds. For liquid fossil fuels, while funding could come from fuel surcharges for all consumers of those fuels, it is assumed that the scenarios are funded by government. Participant spending consists of the customer co-pays required for most efficiency measures.

Levelized per unit values for annual program and participant costs, for each of the three efficiency savings targets, were developed by Dunsky Energy Consulting. Applying the per unit program and participant costs to the annual energy savings produced the annual and total efficiency investment levels that were input into the model. As an overview, average annual efficiency program investment levels are shown below in Table 2.

Table 2. Modeled Average Annual Efficiency Program Investment Levels over a 15-year Investment Period, Including Ramp-up Period (Million$)

	Electric	Natural Gas	Liquid Fuels
Québec			
BAU+	345	29	46
Mid	881	81	124
High	1,835	160	247
New Brunswick			
BAU+	27	2	9.5
Mid	70	5	26
High	145	9	51
Nova Scotia			
BAU+	55	0.8	13
Mid	121	2	34
High	225	4	68
Prince Edward Island			
BAU+	6	-	1.9
Mid	13	-	5.1
High	23	-	10

The ramp-up schedule typically results in a 3-5 year expansion period before the sustained levels of investment are reached. In cases where no program currently exists, a conservative first year budget is assumed. Efficiency investments are modeled for a total of 15 years, including the ramp-up period. Energy savings and avoided costs were generated for an additional 15-20 years, depending on the scenario. However, economic impacts were modeled for a total of 29 years as Canadian data to populate the REMI model was only available until 2040. This will approximately capture the full economic benefits achieved over the life of efficiency measures. Table 3 presents estimates of current efficiency program budgets in each of the provinces, across all administrators and agencies (2011/2012). The current levels of investment are compared to the total level of first year investment modeled for the expanded efficiency scenarios in each province (i.e. the starting point of the ramp-up).

Table 3. Current Investment in Electric, Natural Gas, and Liquid Fuels Efficiency Programs in 2011/2012 Compared to Modeled First Year Expanded Program[i]

All Fuels	2011/12 Efficiency Program Spending (Million$)	1st Year Expanded Efficiency Budget (Million$)
Québec	$307.7	$349.4
New Brunswick	$17.1	$32.5
Nova Scotia	$53.8	$56.0
PEI	$1.5	$5.8

Modeled efficiency programs are further divided into two market segments: commercial/industrial, and residential. The investment split between residential and commercial and industrial (C&I) market segments is presented in Table 4. It is also assumed that 10% of C&I spending is on public buildings, which are accounted for differently by the REMI model.

Table 4. Efficiency Program Spending "Split" – Residential and C&I Market Segments

	Residential	C&I
Electric		
QC & NB	35%	65%
NS & PEI	26%	74%
Natural Gas		
QC, NB, & NS	19%	81%
Liquid Fossil Fuels		
All provinces	19%	81%

It is important to note that while current or planned efficiency investments in a given province may not exactly match modeled investment levels, the goal of the analysis is to understand the overall macroeconomic benefits of expanded energy efficiency programs. The study results are applicable even if they do not exactly match planned investments and the results for GDP and jobs can be applied to more specific investment levels to generate estimates of economic benefits for a chosen provincial ramp-up plan.

Avoided Energy Costs

The benefits of avoided spending on electricity are based on the marginal avoided costs for electricity (i.e. the electric generation source that is at the margin – the first to be taken offline or not built from a loading order standpoint). Where possible, values for avoided electricity are calculated separately for each province. In Québec, the values are from Hydro Québec Distribution's Electricity Supply Plan 2011-2030, and are based on the short-term market price initially, followed by wind in 2023.[ii] In Nova Scotia, the study assumes avoided costs are based on a mix of renewables for the entire period of study.[iii] [iv] In New Brunswick and Prince Edward Island it is assumed that the marginal avoided cost of electricity is the short-term market price until 2029 and 2022, respectively, after which time the cost shifts to the levelized costs of a combined cycle gas turbine.[v] The avoided energy costs for electricity include energy and capacity costs for avoided generation, transmission, and distribution.

Gaz Metro's forecasts have been used to set the marginal avoided cost of natural gas for each of the provinces (QC, NB, and NS), which include production and distribution costs.[vi] The avoided costs for heating oil, propane, and kerosene in all of the provinces are based on the National Energy Board's 2009 Reference Case Scenario, and include the full delivered cost of energy (production, transportation, and distribution).[vii]

The impacts of reduced electricity consumption on overall energy and capacity prices, or Demand-Reduction-Induced Price Effects (DRIPE), while included in ENE's 2009 report for New England, are not included in this study. These price effects are not relevant in the context of vertically integrated utilities, and are not considered for natural gas and other heating fuels.

Efficiency Program Labour & Material

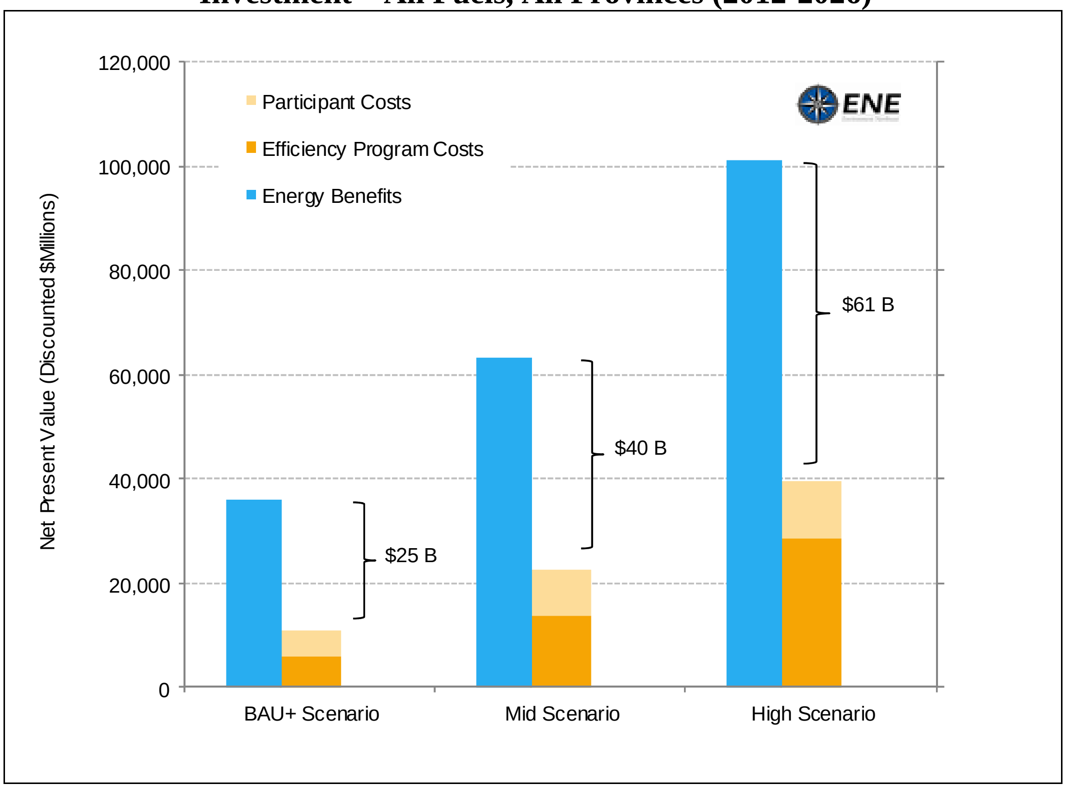
The breakdown of spending on labor, materials, and program administration was assigned to categories in the REMI model in order to create an allocation for efficiency work that more accurately reflects the actual work done in efficiency program implementation.

The contractor materials were further broken down to more accurately represent spending in efficiency programs. Most of this spending falls within the two broad REMI industry segments for general construction and construction trades. However, since the majority of economic activity in these categories is not related to energy efficiency, the REMI model inputs were adjusted to represent the impacts of energy efficiency spending on construction and construction trades.

Energy & Emissions Benefits of Efficiency Investments

Energy and emissions benefits based on the expanded energy efficiency scenarios, which were developed in part as inputs for the REMI model. All the expanded efficiency scenarios produce energy savings at a lower cost than supplying the energy (see Figure 1).

Figure 1. Total Direct Energy Savings versus Program and Participant Investment – All Fuels, All Provinces (2012-2026)



As shown in Table 5 below, the expanded energy efficiency programs would generate substantial reductions in energy consumption and a corresponding reduction in total energy bills for the region.

Reductions in energy consumption also reduce emissions. Avoided greenhouse gas emissions (Carbon Dioxide Equivalent or "CO2e") due to energy savings from expanded efficiency programs were calculated by multiplying the energy saved by the appropriate emissions factor for each fuel type and province. The avoided emissions factors for electricity are based on the marginal avoided source of generation in a given year, which in some provinces changes over the period of study. As mentioned above, the marginal sources of generation were determined based on utility plans and input from advisory and steering committee members. The avoided emissions factors for natural gas and liquid fossil fuels are based on Natural Resources Canada's estimates of the carbon content of the fuels.

Lower emissions not only provide environmental benefits, they also reduce consumer costs in an emissions regulatory framework. Energy efficiency investments decrease demand. Lower demand reduces emissions associated with energy production and/or consumption, which in the case of cap and trade, would reduce demand for emissions allowances, reduce prices for allowances, and reduce cap and trade costs. In general, energy efficiency is seen as an important and effective cost containment mechanism to achieve GHG emission reduction targets.

Table 5. Energy and Emissions Savings in Québec, New Brunswick, Nova Scotia, and Prince Edward Island

Regional Results	Electric	Natural Gas	Liquid Fuels
Energy Savings	**(GWh)**	**(Mm3)**	**(PJ)**
Maximum Annual Savings			
BAU+ Scenario	15,330	670	67
Mid Scenario	31,125	1,050	87
High Scenario	44,453	1,367	114
Maximum Savings vs. Business as Usual			
BAU+ Scenario	6%	11%	18%
Mid Scenario	13%	17%	23%
High Scenario	20%	22%	31%
Lifetime Savings (15 years of programs)			
BAU+ Scenario	227,270	10,715	1,066
Mid Scenario	448,310	18,900	1,563
High Scenario	719,660	28,700	2,397
Equivalent GHG Emissions Avoided	**kt CO_2e**	**kt CO_2e**	**kt CO_2e**
Maximum Annual Avoided Emissions			
BAU+ Scenario	5,060	1,270	4,910
Mid Scenario	9,170	1,990	6,400
High Scenario	12,240	2,580	8,410
Maximum Annual Avoided Emissions vs. 2010 Total Regional Emissions (122,960 kt CO_2e)[viii]			
BAU+ Scenario	4.1%	1.0%	4.0%
Mid Scenario	7.5%	1.6%	5.2%
High Scenario	10.0%	2.1%	6.8%
Lifetime Avoided Emissions			
BAU+ Scenario	34,790	20,260	78,580
Mid Scenario	60,390	36,740	115,250
High Scenario	80,580	54,270	176,670

Macroeconomic Model Framework

Each proposed energy efficiency future can be segmented into four major components which are relevant to generating an economic impact (positive or negative):

> Participants' (net) savings – the difference between the value of annual energy saved (here termed avoided cost) by a participating household/Commercial or Industrial worksite and their cost to add energy-efficiency components to the home/office/factory
> Investment spending – the annual dollars of new demand created through program-related spending and the participants' investment to add energy-efficiency components to the home/office/factory
> Ratepayer (net) costs – the cost to offer the program (residential program costs are assumed to be paid by residential ratepayers; C&I program costs by C&I ratepayers)
> Local sector off-sets due to reduced demand for fuels – depending on the case, this may include some reduction in local (cross province) Utility sector sales, some loss in refining production, and fuel retail sales (for unregulated heating fuels)

There is an inherent allocation to customer segments (Residential/Commercial/Industrial) for both the net savings and the ratepayer costs, and an allocation to specific industries which fulfill the investment spending on manufactured components and installation services. Therefore it was necessary to use an economic analysis model capable of (a) recognizing these distributive effects of the proposed energy efficiency programs, and (b) forecasting economic change as a result of changes in household cost of living/business costs of doing business.

The Regional Economic Models, Inc. (REMI) multi-region Policy Insight forecasting model was calibrated to represent the four provinces and used to generate the macroeconomic outputs. The modeling system allows the analyst to enter province-specific annual changes through select policy levers that pertain to the four components, defined above, and then annually re-solves an economic forecast for the provinces in the model's configuration. The model used forecasts for 58 different industries (approximating 3-digit NAICS definitions of business activity) through the year 2040. The model reports impacts on numerous economic and demographic metrics.

Economic Impacts of Efficiency Investments – Provincial and Regional Results

This section presents the total economic benefits (or impacts) for numerous expanded energy-efficiency investment scenarios involving at least one of three fuels. Energy efficiency deployment is envisioned to occur within the residential customer segment and the C&I segment, with varying emphasis depending on the fuel type/geography. The annual impacts – measured in terms of jobs, output ($CN of business sales), value-added ($CN of Gross Regional Product), and real disposable income represent the change to an economy relative to what would have occurred (that year) without this pathway of energy efficiency adoption.

Total economic impacts result from direct economic effects of increased efficiency investments. A comprehensive region-specific set of multiplier effects in the REMI economic simulation model create additional economic responses once the direct effects have been introduced. In the simplest form of economic impact measurement, this occurs via two economic mechanisms after the direct effects take place: changes in consumer demand (often labeled ‘induced’ effects) and changes in intermediate demand (often labeled ‘indirect’ effects).

The most important feature here is who is changing demand/spending – if it is households (induced) then it is consumer commodity driven. If it is a business (indirect), then it is predicated on the business’s production function (which describes what supplies and services the business requires to produce its Output). The REMI model reports a total impact concept, and although it does not report separate induced and indirect contributions, both are accounted for. The total economic impacts (jobs, sales, gross provincial/domestic product or real household income) are expressed as a difference relative to what that value (in year t) would be without the program.

The modeled scenario variants are as follows: 1) Cases A – Single fuel program is adopted by a single province at a specific target level (36 scenarios); 2) Cases B – Single province deploys all three fuel programs at a specific target level (12 scenarios); 3) Cases C – Single fuel program is simultaneously deployed across all four provinces at a specific target level (9 scenarios); and, 4) Cases D – All three fuel programs are simultaneously deployed across all four provinces at a specific target level (3 scenarios). Although sixty scenarios were assessed, for the purposes of this paper, the regional aggregate of the results for the scenarios where all province simultaneously implement a program for a single fuel type (Cases C) are presented in Table 6 and Figures 2 and 3.

Table 6. Aggregate Regional Economic Impacts when all Provinces Simultaneously Implement Efficiency Programs for a Single Fuel Type (2012-2040)

	BAU+	Mid	High
Electric			
Total Efficiency Program Costs ($Millions)	**4,721**	**11,537**	**22,973**
Increase in GDP ($Millions)	**22,848**	**45,459**	**71,237**
Maximum Annual GDP Increase ($Millions)	1,743	3,531	5,456
Dollars of GDP Increase per $1 Program Spending	4.8	3.9	3.1
Increase in Employment (Job years)	**183,876**	**367,633**	**585,940**
Maximum Annual Employment Increase (Jobs)	14,566	28,180	38,373
Jobs per $Millions of Program Spending	39	32	25
Jobs per $Millions of Program & Participant Spending	21	20	18
Natural Gas			
Total Efficiency Program Costs ($Millions)	**291**	**931**	**1,778**
Increase in GDP ($Millions)	**2,271**	**3,636**	**5,701**
Maximum Annual GDP Increase ($Millions)	167	283	404
Dollars of GDP Increase per $1 Program Spending	7.8	3.9	3.2
Increase in Employment (Job years)	**20,200**	**33,367**	**45,590**
Maximum Annual Employment Increase (Jobs)	1,269	1,890	2,579
Jobs per $Millions of Program Spending	69	36	26
Jobs per $Millions of Program & Participant Spending	29	24	19
Liquid Fuels			
Total Efficiency Program Costs ($Millions)	**757**	**1,992**	**3,850**
Increase in GDP ($Millions)	**19,652**	**26,681**	**35,525**
Maximum Annual GDP Increase ($Millions)	1,195	1,921	2,008
Dollars of GDP Increase per $1 Program Spending	26.0	13.4	9.2
Increase in Employment (Job years)	**125,654**	**171,398**	**232,211**
Maximum Annual Employment Increase (Jobs)	7,994	12,485	12,816
Jobs per $Millions of Program Spending	166	86	60
Jobs per $Millions of Program & Participant Spending	71	57	46

Figure 2. Total Increase in GDP in QC, NB, NS, and PEI (2012-2040), by Efficiency Investment Scenarios (BAU+, Mid, High), and Fuel Type – ***Aggregate of cases where provinces implement each fuel type program simultaneously***

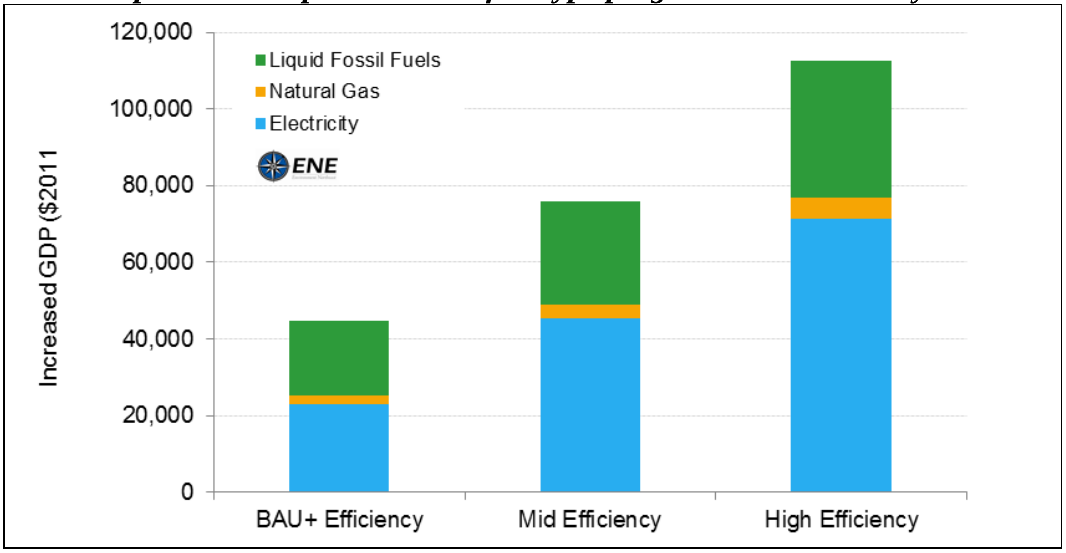
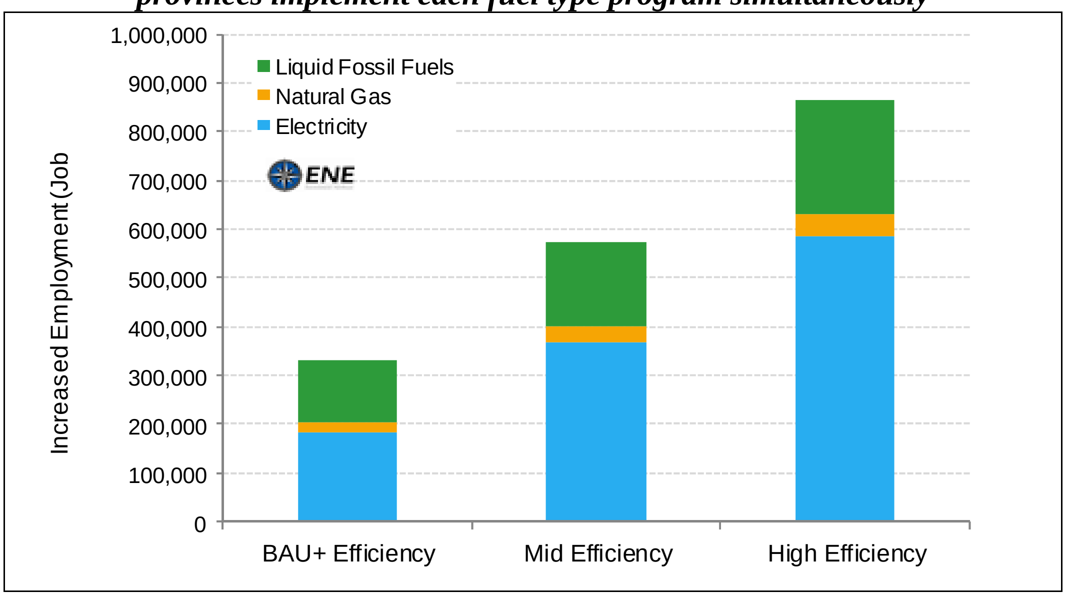


Figure 3. Total Increase in Employment in QC, NB, NS, and PEI (2012-2040), by Efficiency Investment Scenarios (BAU+, Mid, High), and Fuel Type – ***Aggregate of cases where provinces implement each fuel type program simultaneously***



Cases B, C, and D were modeled in order to investigate the complementary nature of efficiency programs across fuel types and jurisdictions. In all cases, the all fuels and/or simultaneous inter-provincial action resulted in greater economic benefits to a province or the region due to increased regional competitiveness, intra-provincial trade or other synergistic effects. For example, as shown in Table 7 below, under the Mid scenario there is a 14% increase in GDP in the region ($73,662 billion vs. $83, 955 billion from 2012 to 2040) and a 12% increase in employment (557,040 job-years vs. 625,112 job-years from 2012 to 2040) when provinces implement all fuels efficiency programs simultaneously versus alone.

Table 7. Comparison of Modeled Scenario Variants and the Total Regional (i.e. Program and/or Provincial Aggregate) Increase in GDP and Employment under the 'Mid' Level of Investment (2012-2040)

Regional Total	**Increased GDP ($2011 Million)**	**Increased Employment (Job-Years)**
Cases A: Individual Province w/Program for a Single Fuel Type (Aggregate of Isolated Programs)	73,662	557,040
Cases B: Individual Province w/Programs for All Fuel Types	73,869	558,024
Cases C: All Provinces Simultaneously Implementing Programs for a Single Fuel Type	75,776	572,398
Cases D: All Provinces Simultaneously Implementing Programs for All Fuel Types	83,955	625,112

Discussion

Increasing efficiency program investments for electricity, natural gas, and unregulated fuels in the four Provinces would deliver significant economic benefits to the region. Efficiency investments increase GDP, bolster trade, and create local employment. In essence, efficiency programs swap fossil fuel imports for local employment and economic growth.

Benefits from increased efficiency investments at the provincial and regional levels are significant for each fuel type as consumers spend energy bill savings in the wider economy and businesses reduce their costs, leading to an increase in employment. Existing programs are already delivering energy and cost savings and generating some of this economic growth in the region. If each province were to increase efficiency program investment to the Mid target level over 15 years, the total aggregate regional GDP and Employment would increase by approximately: $45 billion and 367,600 job-years for electric; $3.6 billion and 33,300 job-years for natural gas; and $34 billion and 223,000 job-years for liquid fossil fuels. While not presented here, ENE's full report includes the economic "spill over" effects in the provinces resulting from the increased economic activity in one province and cross-province interdependencies for labour and other goods and services.

When provinces moved from the "independent" scenarios to implementing programs across all fuel types or cases where all provinces implemented programs for one fuel type or all fuel types, the simultaneous action resulted in greater economic benefits to a province or the region due to increased competitiveness, intra-provincial trade or other synergistic effects.

Further, the macroeconomic benefits of efficiency derive from changes in the economy via increased spending on efficiency measures – and the corresponding increase in funding to enable this – and decreased spending on energy. The majority of these impacts (70-90%) result from the energy savings realized by households and business.[ix] Lower energy costs increase other forms of consumer spending such as dining out, travel/tourism, or discretionary purchasing. Lower energy bills reduce the costs of doing business in the region, bolstering the global competitiveness of local employers and promoting additional growth**.**

The modeled results of increased efficiency investments show that efficiency provides significant economy-wide benefits in addition to the direct participant savings on which efficiency programs are often justified. Expanding analysis from micro-level cost-benefit tests to macro-level assessments of the economic impacts of efficiency (including losses to electric generators and fuel suppliers) clearly illustrates that investing in energy efficiency is one of the most effective means of improving economic conditions widely, while saving consumers money and reducing emissions.

References

Estimate for Québec based on: Régie de l'énergie Order D-2011-028 in Docket No. R-3740-2010 of 03/09/2011 – HQD *Demand relative a l'établissement des tariffs d'électricité pour l'année tarifaire 2011-2012* (http://www.regie-energie.qc.ca/audiences/decisions/D-2011-028.pdf), and Régie de l'énergie Order D-2010-153 in Docket No. R-3709-2009 – *Demand relative a l'approbation annuelle du budget 2010-2011 des programmes et des interventions de l'Agence de l'efficacité de énergetique* (http://www.regie-energie.qc.ca/audiences/decisions/D-2010-153.pdf). Estimate for New Brunswick is based on: Budget 2011-2012 *Main Estimates* (www.gnb.ca/0160/budget/buddoc2011/ME2011-12.pdf); Estimate for Nova Scotia is based on: Efficiency Nova Scotia Corporation's revised Electric Efficiency and Demand Side Management Plan 2013-2015 (www.nsuarb.ca/index.php?option=com_content&task=view&id=73&Itemid=82), and Budget 2012-2013 *Estimates and Supplementary Detail for the Fiscal Year 2012-2013* (www.novascotia.ca/finance/site-finance/media/finance/budget2012/Estimates_And_Supplementary_Detail.pdf). Estimate for PEI based on personal correspondence with the PEI Office of Energy Efficiency.

Hydro Québec's Electricity Supply Plan 2011-2020. Available on-line at: http://www.hydroquebec.com/distribution/en/marchequebecois/planification.html

Nova Scotia Power's 2011 Load Forecast. Available on-line at: https://cleaner.nspower.ca/site-nsp/media/nspower/2011.10.Year.System.Outlook.Report.as.revised.Mar.2012.pdf

The study assumes renewables are highest-cost electricity in Nova Scotia during the studied time period, and thus would be the first taken offline or not built if efficiency increases. In reality, renewable (mostly wind) power will be used when available as NS legislation requires a growing ratio of renewable power in NS electricity production (40% by 2020). To meet these targets the utility's contracts with independent wind projects are "must run" when wind is available. The 20 year fixed price in the renewables contracts help stabilize electricity costs if fossil fuel prices rise during that time.

No publicly available information on avoided costs for electricity were available for New Brunswick and PEI. The avoided costs used in the study were provided by Dunsky Energy Consulting, and adjusted based on conversations with New Brunswick Power, Efficiency New Brunswick, and Maritime Electric.

Gaz Métro filing R-3752-2011 (http://internet.regie-energie.qc.ca/Depot/Projets/91/Documents/R-3752-2011-B-0244-DEMAMEND-PIECEREV-2011_08_31.pdf; http://internet.regie-energie.qc.ca/Depot/Projets/91/Documents/R-3752-2011-B-0061-PREUVE-AUTRE-2011_04_29.pdf; http://internet.regie-energie.qc.ca/Depot/Projets/91/Documents/R-3752-

2011-B-0351-DEMANDE-PIECEREV-2011_09_29.pdf) and R-3662-2008 (http://www.regie-energie.qc.ca/audiences/3662-08/Phase-2/PiecesPEN_3662-02/B-38_GM-10doc03_3662-2_13juin08.pdf)

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National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada, Part 3, Annex 15 – Provincial/Territorial Greenhouse Gas Emissions Tables, 1990-2009. Figure represents total GHGs for QC, NB, NS, PEI.

[ix] See Table 11 (page 29) in ENE's *Energy Efficiency: Engine of Economic Growth* (2009): www.env-ne.org/resources/open/p/id/964