COMMUNITY ENERGY PLANNING
GETTING TO IMPLEMENTATION
IN CANADA

Methods for Measuring the Economics of Community Energy Plans

An Introduction for Community Energy Managers

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Acknowledgments

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Executive Summary

The value proposition for Community Energy Plan (CEP) implementation is compelling: opportunities to strengthen local economies, reduce current and future energy costs and greenhouse gas (GHG) emissions, and create local jobs. The ability to demonstrate this economic potential, through economic analysis, is a critical ingredient for securing the required investment and the political, staff, and stakeholder support for CEP implementation. Economic analysis can also help with developing a CEP that maximizes economic, environmental, and social benefits.

This report, on methods for measuring the economic benefits of CEPs, is a companion to the publication *Community Energy Planning: the Value Proposition*. Its purpose is to help Community Energy Managers choose which economic analysis method is best suited to their community's CEP approach, needs, and resources.

Two questions should therefore guide the Community Energy Manager's choice of economic method: What approach is our community taking to CEP development? And, which economic analysis method is most useful to support the needs of senior decision-makers and elected officials?

The report introduces six major methods of economic analysis: community energy cost, financial feasibility, levelized unit energy cost, marginal abatement cost curve, community socioeconomic benefits, and cost-benefits. Each method includes advice on consideration in interpretation of results, the need for specialized expertise, the approximate cost and level of effort, and data requirements. Each method is also illustrated with an example drawn from a Canadian CEP analysis.

Different methods of economic analysis serve different purposes, and provide different information. The choice of economic method needs to align with a community's approach to CEP development, and to be aware of the knowledge base of the audience. While economic analysis should only go as broad and deep as is needed to gain support for CEP implementation from senior decision makers and elected officials, greater analysis may also lead to better informed choices. But, more comprehensive analysis is more resource-intensive and more complex to develop, interpret, and communicate. A thoughtful balance needs to be struck between informed decision-making and analysis paralysis.

Section 1

Introduction and purpose

The value proposition for Community Energy Plan (CEP) implementation is compelling: opportunities to strengthen local economies, reduce current and future energy costs and greenhouse gas (GHG) emissions, and create local jobs. Growing evidence from communities as they move from CEP planning to implementation substantiates this promise.[1]

The ability to demonstrate this economic potential, through economic analysis, is a critical ingredient for securing the required investment and the political, staff, and stakeholder support for CEP implementation. Economic analysis can also help with developing a CEP that maximizes economic, environmental, and social benefits. Yet a recent survey of Canada's CEPs found that a slight majority analyzed only one action, or contained no economic analysis at all, while just under half analyzed three or more actions.[2] Most of the analysis that is conducted is at a simple level, such as return on investment calculations. More comprehensive assessments of broader community economic impacts, such as comparative cost of GHG reduction options, changes in household income, local job creation, or economic benefits over extended periods of time, remain rare.

This report, on methods for measuring the economic benefits of CEPs, is a companion to the publication *Community Energy Planning: the Value Proposition.* Its purpose is to help Community Energy Managers make informed choices when initiating economic analysis of their CEPs. It introduces the main methods of economic analysis suitable to community-level energy plans and projects, in order to help managers choose which economic analysis approach is best suited to their community's CEP approach, needs and resources.

Section 2 discusses the importance of careful scoping of the objective for the economic analysis, in order to choose the method that best aligns with a community's approach to CEP development, and summarizes the purpose of six major methods of analysis. Section 3 goes into each method in more detail, profiling the method; considerations in choice of assumptions or interpretation of results; need for specialized expertise; approximate cost and level of effort; data requirements; and an example of the approach in use. Section 4 summarizes the six methods with an emphasis on the relation between increasing knowledge of the full economic impacts of CEP investments, and the greater resources and expertise required to complete, interpret, and communicate the analysis.

[1] Quality Urban Energy Systems of Tomorrow (QUEST), 2016. Community Energy Planning: the Value Proposition. Retrieved from http://gettingtoimplementation.ca/community-energy-planning-the-value-proposition/

[2] Quality Urban Energy Systems of Tomorrow (QUEST), 2015. National Report on Community Energy Plan Implementation. Retrieved from http://gettingtoimplementation.ca/national-report-community-energy-plan-implementation/

Section 2

Choosing between methods

Different methods of economic analysis serve different purposes and provide different information. All are relevant to strengthening the economic, environmental, and social benefits of CEPs, and to increasing user knowledge of the full economic impacts of these investments. While some methods provide more thorough portrayals of full economic impacts, they also require more complex models and assumptions, and demand more data, human resources, and economic expertise. In some situations, this more complex analysis could confuse decisions. A thoughtful balance needs to be struck between informed decision-making and analysis paralysis. The economic analysis to support a CEP should only go as deep as is needed to gain support from senior decision-makers and elected officials.

The first question for the Community Energy Manager to consider, therefore, is-*What approach is our community taking to CEP development?* Various approaches to CEP development are summarized in Table 1, and discussed in more detail in the Community Energy Implementation Framework.[3]

Table 1 – Approaches to Community Energy Planning

CEP Approach	Description
Inventory	A community energy inventory is the first step in defining community needs around energy.
Get Started	Focusing on a specific project, initiative or opportunity can often be done expediently and economically and can help garner the support needed to develop a CEP.
Practical Tactics	Communities with energy and emissions inventories can develop projections and a year-by-year implementation plan. These plans can be renewed frequently (e.g. every 3-5 years).
Targeted Plan	Larger communities can develop more comprehensive and long-term plans. These plans can be renewed every 5-7 years.
Comprehensive Plan	Communities with greater resources can include more comprehensive analyses when developing their CEP, including a broader range of energy end uses (e.g. food production).

Source: Community Energy Implementation Framework at www.gettingtoimplementation.ca/resources

The next question for the Community Energy Manager to consider is-*Which economic analysis method will be most useful to support the needs of senior decision-makers and elected officials?* Table 2 summarizes the purpose of each of six major methods of economic analysis, and relevant CEP development approaches.

Table 2 – Purpose of economic analysis methods and relevant CEP approach

Method	Purpose	Relevant CEP approach[4]
Community energy cost	Discuss total community energy use in a metric everyone understands, in order to generate different conversations with elected officials and stakeholders	Inventory
Financial feasibility	Screen and prioritize measures, programs, or portfolios to identify if, and when, the investment will break even.	Get Started, Practical Tactics
Levelized unit energy cost	Compare the per kWh or per GJ costs of different energy generating technologies across the expected lifetime of the asset.	Get Started
Marginal abatement cost curve	Compare GHG emission reduction options according to which will cost the least or deliver the most financial savings, and according to their potential impact on GHG reductions.	Get Started, Practical Tactics; Targeted Plan; Comprehensive Plan
Community socioeco-nomic benefits	Inform the decision-making process, and stakeholders, on the total value to the local community and economy of a CEP, considering how expenditures recirculate through local businesses, households, and governments.	Targeted Plan, Comprehensive Plan
Cost benefits	Screen and prioritize measures, programs, or portfolios to identify if benefits over time exceed initial costs, and to identify a portfolio of measures that maximize the economic, environmental, and social benefits from CEP implementation.	Targeted Plan, Comprehensive Plan

Source: Community Energy Implementation Framework at www.gettingtoimplementation.ca/resources

Additional considerations will include the economic background of decision makers, which may influence what type of information they will require, and the resources (staff, budgets for consultants) available for the analysis. These issues are explored in more detail, below.

Section 3

Profiles of major methods of economic analysis

This section profiles each of six major methods of measuring the economics of CEPs, with the following information:
- Outline of general approach;
- Considerations related to methodology and interpretation of results;
- Need for specialized expertise;
- Approximate level of effort for local government staff, and/or cost for consultant or data fees; and
- Data requirements.

The profile for each method concludes with an example of its use, drawn from one of Canada's CEPs.

3.1 – PROFILE: COMMUNITY ENERGY COST

Best for:

Discussing energy use in a metric everyone understands (costs), in order to generate different conversations with elected officials and stakeholders

What is it?
The total cost of energy spend is a metric through which everyone can readily understand the 'size of the prize', and how shaving that spending through a CEP can offer economic benefit to the community. A community energy cost profile builds directly from the CEP baseline study of energy consumption in the community. The cost profile monetizes this data to understand the total cost of energy in the community and the profile of energy costs across sectors.

Energy expenditures are a significant cost for businesses and some households. The rising cost of energy prices is a critical concern for many businesses, particularly for small businesses in the retail, accommodation, food, and arts sectors.[5] At the individual household level, energy costs account for approximately 7 percent of Canadian household expenditures,[6] often requiring low-income households to cut back on other necessities.[7]

An analysis of community energy cost can be used to identify opportunities to reduce these costs. Tracking this information over time allows energy efficiency gains to be communicated in terms of dollars saved by the community. Such calculations have to adjust for fluctuations in fuel and electricity prices.

This analysis can also estimate what portion of a community's energy dollars leave the community, and opportunities to keep this money in the community through energy efficiency and conservation, fuel shifting, and distributed local generation.

Considerations:
- A proxy methodology is used to estimate costs; as such, the findings should always be represented as approximate, and rounded off "to two significant figures".
- Forecasting of future costs of energy relies on assumptions about future utility rates, commodity prices, and the price of carbon.
- Utilities and energy service providers are required by federal and provincial regulations to provide a high standard of data privacy, and may require a non-disclosure agreement (NDA) to ensure that data privacy is upheld. This is particularly relevant if the information is visualized, and the community includes a large, identifiable energy user in a specific neighbourhood (e.g., an industry, hospital, or university).[8]

Need for specialized expertise:
- None. Can be done by the staff who put together the community energy inventory.

Approximate cost and level of effort:
- Can be done internally with no consulting resources required, however there may be a modest (>$250) charge for data access.
- Level of effort depends on i) availability of energy pricing information, and ii) granularity of analysis. In British Columbia, for example, energy consumption information is available in the Community Energy and Emissions Inventory, and if local energy pricing information in known, then a simple cost of energy analysis may take under an hour. In other jurisdictions, energy pricing information needs to be collected, and this would take 1-3 days depending on the number of utilities needing to be contacted, and the granularity of information needed. Further analysis, such as proportion of energy dollars staying in the community, which will vary by community, would take 1-3 days.
- Can be updated for similar level of effort.

[3] See at www.framework.gettingtoimplementation.ca
[4] See *Table 3: Approaches to Community Energy Planning* in the Community Energy Implementation Framework at www.framework.gettingtoimplementation.ca
[5] The Gandalf Group. 2015. View from the Top: The C-Suite's View of Energy and the Environment. Presentation at Green Economy Ontario Conference.
[6] Scotiabank. 2014. Rising Energy Prices Squeeze Household Budgets. Retrieved from http://www.gbm.scotiabank.com/English/bns_econ/spjune6.pdf
[7] See, e.g., Low Income Energy Network at www.lowincomeenergy.ca; and R.Boyd and H. Corbett. 2015. Energy Poverty—An Agenda for Alberta, All One Sky Foundation. Retrieved at http://allonesky.ca/wp-content/uploads/2015/12/Energy-Poverty-An-Agenda-for-Alberta-Dec-6-2015.pdf
[8] QUEST, 2016. *Community Energy Planning and Data: An Assessment for Small and Rural Communities in Ontario*. Retrieved from http://www.questcanada.org/files/download/c4bd74bef445d63

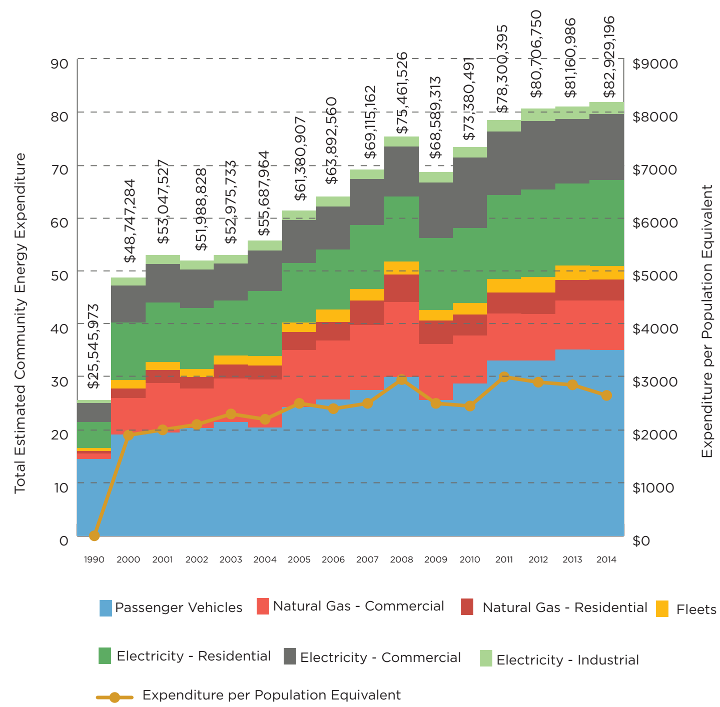
Data requirements and sources:

- Community energy inventory.
- Customer rate structure information from electricity and natural gas utilities (may be available from their websites).
- Fuel price data for retail and wholesale prices for gasoline and diesel; home heating oil; propane; and wood, available from energy service providers, provincial ministries of energy or consultants.
- Related taxes and special charges.

Example: Resort Municipality of Whistler, BC

The estimated annual collective energy expenditure within Whistler increased from $49 million in 2000 to $83 million in 2014. This trend underscores the importance of increasing both energy conservation and energy efficiency across the community. Figure 1 shows the split in energy expenditures since 1990. Fuel for passenger vehicles is the largest proportion of energy expenditures, at thirty-five percent in 2014 expenditures. This figure includes an estimate of consumption for all vehicle kilometres travelled within Whistler boundaries, including the portion within municipal boundaries of commuter and visitor transportation. Fuel prices for gasoline increased markedly between 2009 and 2013, resulting in an increase of $9.5 million in these expenditures. Energy expenditures for buildings (both commercial and residential) remained relatively constant at $42-44 million per year, although there has been a shift from natural gas to electricity expenditures.[9]

Figure 1 – Estimated Whistler Community-Level Energy Expenditures.



Source: Resource Municipality of Whistler, 2015. Whistler Energy Consumption and Greenhouse Gas Performance Trends: 2014 Annual Report.

Further resources:

- City of London, June 2016. 2015 Community Energy and Greenhouse Gas Inventory. Appendix 4. Cost Estimates for Community Energy Use. https://www.london.ca/residents/Environment/Energy/Documents/2015%20Inventory%20Report.pdf
- Community Energy and Emissions Inventory. Government of British Columbia. At http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/community-energy-emissions-inventory
- QUEST Canada. 2016. Community Energy Planning and Data: An Assessment for Small and Rural Communities in Ontario. At http://www.questcanada.org/files/download/c4bd74bef445d63

3.2 – PROFILE: FINANCIAL FEASIBILITY OF SPECIFIC MEASURES, PROGRAMS, OR PORTFOLIOS

Best for:

Screening and prioritizing measures, programs, or portfolios to identify if, and when, the investment will break even.

What is it?

Financial feasibility assessments are simple calculations for evaluating whether and under which conditions, an investment in a specific measure, program, or portfolio will break even. This method compares investment costs to cost savings and new revenue, from a couple of perspectives.

The simple payback period looks at the number of years it would take to recoup an investment, based on simple cash flow—in other words without accounting for the time value of money. A shorter payback period identifies a more attractive economic investment.

The Internal Rate of Return (IRR) looks at the interest rate at which an investment breaks even, taking into account the time value of money – in other words, cash flows are adjusted to reflect the decreased value today of cash outflows and inflows that take place in the future. In economic language, the IRR is the discount rate that makes the net present value of all cash flows equal to zero.

The hurdle rate is the minimum return that an investor needs to earn to make a given investment. In order for a project to proceed, the IRR must equal or exceed this hurdle rate. For government bodies, the hurdle rate is usually equal to or close to the long-term bond rate. A higher hurdle rate is usually required for riskier projects, and private companies may also have a higher rate than regulated utilities or government bodies.

Generally speaking, the higher a project's IRR, the more desirable the project is an economic perspective. An IRR analysis can group investments into three categories: i) financially feasible (IRR well above the hurdle rate); ii) financial feasibility warrants more research (IRR at or close to the hurdle rate); and iii) not financially feasible (IRR below the hurdle rate)-- should either be discarded, or only considered as part of a larger portfolio of measures which net out, on average, above the IRR.

These financial feasibility calculations can be used to rank specific measures and programs under consideration (see example, below), and to do so under multiple energy and/or carbon price-forecast scenarios. They can also identify what level of government subsidy would be needed to encourage the desired household and business investments.

This information can be used to assemble, and cost, the most cost-effective portfolio for achieving energy or carbon reduction targets, starting with measures and programs that have the best financial performance.

Considerations:

- Economic background and expertise is not needed to understand these approaches, which are similar to assessments used even at a household or small business level. This makes them an obvious first point of analysis for Community Energy Managers.
- These methods may be a good choice if they are currently used in other local government decisions, and familiar to decision-makers.
- The appropriate cut-off for maximum payback period will depend on the needs of the investor (governments, homeowners, commercial property owners, developers or institutional building owners). Government and public sector organizations can accept longer payback periods because of the long-term nature of their responsibilities and capital investments.
- Assumptions on cost of capital (discount rate) and price of energy can significantly affect the analysis of financial feasibility. Approaches for managing this include using a conservative discount rate, i.e. a higher cost of capital, and conducting a cost sensitivity analysis using various prices of energy.

Need for specialized expertise:

Internal staff data collection needs to be supported by expert analysis from an economist experienced with these approaches (consultant or internal expert). The primary value added by the expert is experience in checking the data, identification of any errors, professional judgment on the assumptions that influence the results, and guidance on how to interpret results.

Approximate cost and level of effort:

- This approach relies largely on internal staff resources, complemented by expert financial analysis. This expertise may be available internally in larger local governments, or through consultants.
- Level of effort will depend on the number of projects or programs assessed. Roughly one-half as much time as for a CEP baseline study (7-10 days of internal staff time on top of initial investment of 13-20 days staff time for CEP baseline study).
- Consulting fees for a mid-sized community would be in the $5,000-$10,000 range, with cost driven by the amount of analysis requested (e.g. number of energy price scenarios).

[9] Resource Municipality of Whistler, 2015. Whistler Energy Consumption and Greenhouse Gas Performance Trends: 2014 Annual Report. Retrieved from https://www.whistler.ca/sites/default/files/related/rmow_2014_annual_energy_-_ghg_emissions_performance_report_0.pdf

Data requirements:

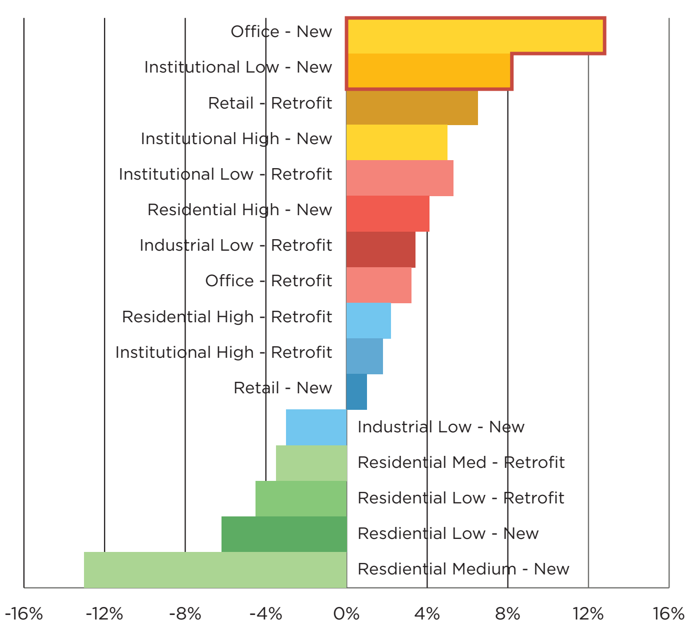
- Community energy and energy cost inventory (plus emissions inventory if cost of carbon being considered) disaggregated to the sub-categories targeted by proposed measures or programs.
- Upfront capital cost investment, energy cost savings, return on investment, and payback period for each proposed measure or program; plus GHG emission reductions if cost of carbon is being considered.

Example: City of Barrie, Ontario

An assessment of financial performance for a number of possible energy efficiency building programs was done for the City of Barrie, Ontario. A conservative IRR of 6 percent was chosen, slightly above the long-term bond rates from risk-free provincial and crown corporations at the time; the standard practice for a public agency or municipality. The assessment grouped programs into those that would be economically feasible (IRR>8 percent); probably economically feasible (IRR of 4 percent – 8 percent); and not economically feasible (IRR<4 percent), based on the 6 percent IRR threshold.

Only two out of 16 possible programs were deemed economically feasible, and another four were flagged as probably feasible but requiring for further analysis (Figure 2). The remaining 10 programs were not considered financially feasible.

Figure 2 – Internal Rates of Return for Building Efficiency Improvement Options, City of Barrie

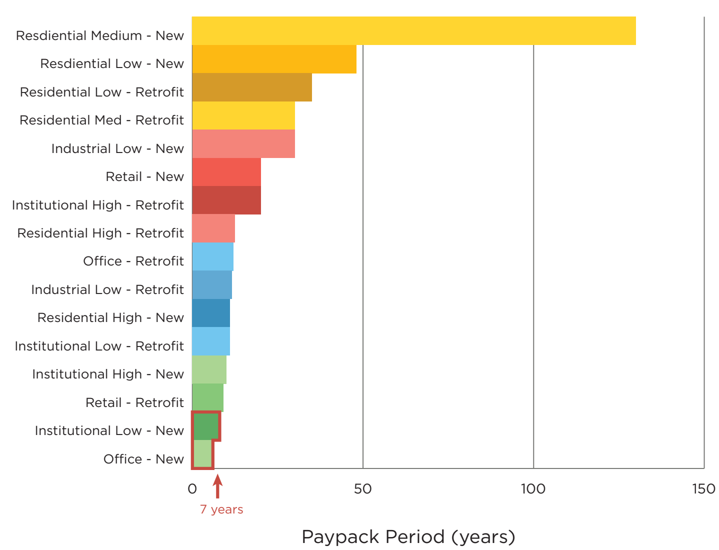


Source: Canadian Urban Institute, 2011.
City of Barrie: Integrated Energy Mapping Strategy.

A series of cost sensitivity tests for higher electricity and gas prices were conducted. At a 5 percent annual electricity and gas price increase, one program moved into the financially feasible bracket, and five more at a 10 percent price increase.

A simple payback period calculation, using undiscounted cash flows, was also done to look at these investments from a building-owner's perspective. Based on research on the payback periods required by different categories of buildings owners (residential, institutional, commercial, industrial) an upper payback period of 7 years was used. Only one of the programs met this cut off (Figure 3). This program had also had the highest IRR, and therefore was identified as a sound financial investment through both tests.[10]

Figure 3 – Payback Period for Building Efficiency Improvement Options, City of Barrie



Source: Canadian Urban Institute, 2011. City of Barrie: Integrated Energy Mapping Strategy.

Further resources:

- Carther, Shauna. Understanding the Time Value of Money. At http://www.investopedia.com/articles/03/082703.asp
- Rocky Mountain Institute. 2014. How to Calculate and Present Deep Retrofit Value. At http://www.rmi.org/retrofit_depot_deepretrofitvalue
- U.S. Environmental Protection Agency. 1998. Business Analysis for Energy-Efficiency Investments. EPA-430-B-97-002. At http://www.griequity.com/resources/BusinessGuides/entrepreneur/epafinanalysis.pdf

3.3 – PROFILE: LEVELIZED UNIT ENERGY COST

Best for:
Comparing the "all-in" unit costs of different energy generating technologies across the expected lifetime of the generating asset.

What is it?
The Levelized Unit Energy Cost (LUEC, sometimes also called levelized cost of energy, LCOE) is a summary measure of the overall cost per megawatt hour (MWh) energy produced of different heat and/or electricity technologies over their assumed financial life.

The LUEC allows for a simple "apple to apple" economic comparison of technologies such as solar, wind, cogeneration, combined cycle gas, etc., which have unequal profiles for financing, building, operating and maintaining, and different life spans, risks, capacity factors and utilization rates. For example, a renewable energy asset, such as wind or solar, may be more expensive to build than a conventional generating asset, but has lower maintenance costs and no fuel costs. It may also be eligible for subsidies. The LUEC considers this full range of building and operating costs across the design lifetime of a generating asset, combining all present and future costs into one number, real dollars per MWh. A sensitivity analysis to fuel prices or carbon price is often included.

The LUEC will change with evolving technology, changing fuel price, changing carbon costs or government incentives. For electricity generating assets, it will depend on specific factors of the regional electricity market, such as the existing resource mix, how much additional capacity is needed, whether there is more need for baseload, on-request, or peaking power, and transmission constraints, etc. For these reasons, it will vary by region. For thermal generating assets, like district energy systems, local variations may be even greater than for electricity generating assets.

The LUEC calculation does not take into account social and environmental externalities which may affect the practical feasibility of specific options (e.g. social costs of distributed generation, environmental consequences of generating technologies, etc.). Nor does it account for reliability-related considerations (e.g. transmission and back-up generation costs associated with certain energy technologies), unless these have already been factored into market prices.

Electric system operators or power/hydro agencies often commission LUEC calculations at provincial or regional scales for electricity generating assets as part of integrated resource planning. Community Energy Managers can use these studies for initial scoping of the economic competiveness of competing electricity generating technologies within their regional energy market, prior to conducting assessments for specific projects.

Considerations:
- LUECs reflect local factors (e.g., wind or solar resource, cost of energy) and assumptions. As such, they are specific to a local area or project.
- As with all economic analysis, LUEC depends on many assumptions. Community Energy Managers should thoroughly understand these.
- LUEC estimates for fuel consuming projects will depend on estimates of future fuel costs, which are very uncertain. Because of this, energy technologies with ongoing fuel costs are higher risk than those without. Community Energy Managers should carefully study the sensitivity analyses at a range of fuel prices. Similarly, LUEC estimates for most electricity generating projects will depend on estimates of future revenue for electricity generation, which will depend on the price paid per MWh delivered. However, usually a long-term contract can be signed with the utility that guarantees the price paid per unit of electricity, which reduces uncertainty over the life of that contract. Thermal generating projects face similar uncertainty about long-term prices, but that risk can also be partially mitigated through contracts.
- Assumptions on interest rates can significantly change the LUEC of an energy source. Most LUEC calculations assume a fixed cost of capital, but in reality, these interest rates are affected by macro-economic conditions and micro-economic considerations such as type of technology, credit-worthiness of the developer, and location of the project. In addition, there may be multiple sources of capital with different rates.
- Assumptions on facility life and capacity factors should try to reflect actual operations, but may not do so.

Need for specialized expertise:
LUECs can be calculated by municipal staff, using standard equations,[11] assuming that a project feasibility study has already gathered data for the proposed project.

[10] Canadian Urban Institute, 2011. City of Barrie: Integrated Energy Mapping Strategy. Retrieved from http://www.barrie.ca/living/environment/conservation/documents/integrated%20energy%20mapping%20strategy%20-%20draft%20report%2020110521.pdf

[11] LCOE calculation:
1. Calculate the annuity factor: a = [{(1+p)^n}-1]/[p(1+p)^n] where a is annuity factor, n is years of utilization (lifetime, etc.), p is interest / discount rate.
2. Levelized Cost of Energy equation: LCOE = I/aE + TOM/E where I is Initial Costs, a is annuity factor, E is annual energy production, and TOM is Total of Operating & Maintenance costs, per year. (Note that this equation assumes that TOM will be the same each year.)

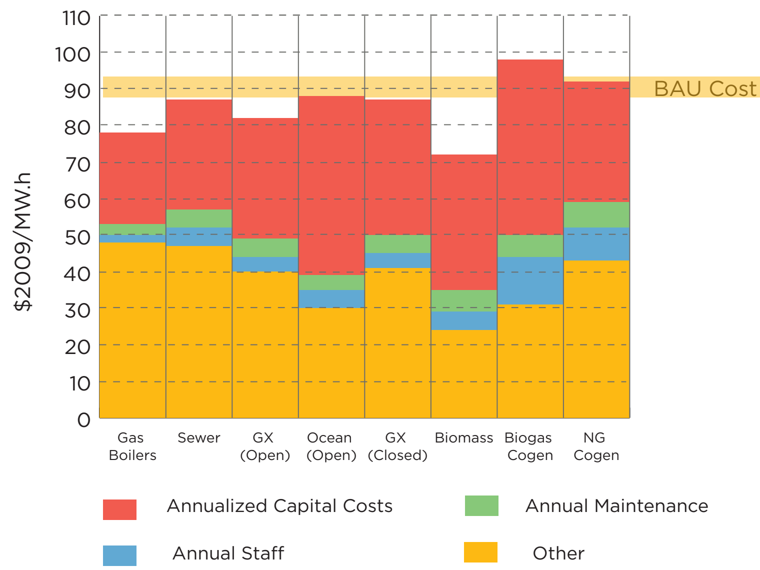
Approximate cost and level of effort:
Under one hour staff or consultant time, assuming a feasibility study has already gathered data for the proposed project.

Data requirements:
- Investment or capital cost expenditures
- Fixed operations and maintenance expenditures
- Variable operations and maintenance
- Fuel costs
- Estimated annual energy generation
- Construction lead time
- Discount rate
- Facility life
- GHG emissions
- Tax credits or other subsidies

Example: Lazard's Levelized Cost of US Energy Analysis
Lazard, an international financial advisory and asset management consultancy, produces a highly respected levelized cost of energy analysis for the US market. Their Levelized Cost of Energy Comparison analysis shows the cost-competitiveness of alternative energy generation technologies to conventional generation technologies, without including any subsidies. Some of these are already competitive on a cost basis, and become more so when available subsidies are included in the calculations[12] (not shown).

Example: Squamish, BC, Levelized Cost of Alternative District Energy Technologies
Squamish, BC, commissioned a full feasibility study to determine the technical and financial viability of a Neighbourhood Energy Utility to provide central space heating and domestic hot water in and around the Squamish downtown waterfront. Figure 4 summarizes the findings on the levelized costs of eight system alternatives, expressed in 2009 dollars. Based on these findings, plus screening on GHG emissions and potential contribution to total heating loads, three options—biomass (heating only), ocean thermal, and natural gas cogeneration—were taken to a more detailed business analysis stage.

Figure 4 – Levelized Cost of Alternative District Energy Technologies, Squamish, BC



Source: Compass Resource Management. 2010. District of Squamish Neighbourhood Energy Utility Feasibility Report. At http://squamish.ca/assets/Land-Use-Policies/Squamish-NEU-Final-Feasibility-Report.pdf

Further resources:
- National Renewable Energy Laboratory. Levelized Cost of Energy Calculator. (A simple calculator that compares capital costs, operations and maintenance, performance, and fuel costs. Does not include financing issues, discount issues, future replacement, or degradation costs.) At http://www.nrel.gov/analysis/tech_lcoe.html
- Spark Library. 9 Reasons why LCOE Can Mislead. At https://www.sparklibrary.com/9-reasons-why-lcoe-can-mislead/

3.4 – PROFILE: MARGINAL ABATEMENT COST CURVES

Best for:
Comparing GHG emission reduction options according to which will cost the least or deliver the most financial savings, and according to their potential impact on GHG reductions.

What is it?
A Marginal Abatement Cost Curve (MACC) summarizes GHG emission reduction options (projects or policy interventions) in a graphical format (see example, below) that makes it easy to compare the cost per tonne of carbon dioxide equivalent (CO_2e) reduced, and to see the potential volume of reductions from each option. It is useful for initial prioritization of options, and can also be used to identify what level of subsidy, or what carbon price, would make specific options break even. Although most commonly used to compare GHG reduction options, it can also be used to compare energy efficiency options.

The total community cost (public and private) of implementation, and the total resulting community savings are calculated for each option, working from a baseline of business-as- usual (BAU) policies, technology choices and behaviours, and costs. The results are ordered from the lowest cost to the highest cost opportunities. The vertical axis on the graph represents the net marginal cost. An option breaks even when the net marginal cost equals zero. Options with net marginal costs below zero offer the potential for net savings compared to BAU practices. Options with net marginal costs above zero will only break-even with a subsidy, or an additional carbon price, equal to this net marginal cost. The horizontal axis represents the amount of GHG reductions available from an option—the widest block representing the greatest GHG reduction potential.

A MACC is a very useful tool for initial scoping and communication of options. However, they should be used with an understanding of their strengths and limitations.

The calculation of net marginal cost considers only two dimensions (potential and costs), and uses a narrow financial definition to quantify net savings. There may be additional savings such as reduced air pollution, or health benefits of active transport options, or intangible benefits such as improved energy security or job creation, which are not captured in the MACC focused on GHGs or energy efficiency.

MACC curves imply that the provision of a subsidy, or imposition of a carbon tax will lead to all measures with costs below that level being implemented. However, some costs are not covered in these calculations, such as transaction costs or the costs of broad awareness programs to stimulate technology adoption. In addition, there are often non-financial barriers to implementation, which is why not all options that promise net savings are tapped out.

Because the GHG reduction potential of the options are quantified in isolation of each other, a MACC does not capture the potential interaction of options. The cumulative outcome of two or more options may be more, or less, than the sum of the parts, and options may be mutually exclusive. A MACC is also a static representation of costs at a fixed point in time, and does not reflect learning effects or path dependency. Therefore, the cumulative reduction potential cannot be derived by a simple addition of the reduction potentials of individual options.

Marginal abatement cost calculations are done for a fixed point in time, and thus do not take into account changes in behaviours, technologies and prices over time. Because of this, MACCs are dynamic and need to be updated occasionally to confirm the business case for potential initiatives.

Considerations:
- The quality of data on the cost and potential benefit of an option is critical. Localized data must be used, and for this reason, one community's marginal abatement costs and GHG reduction potential may be different from another's.
- As with all economic modeling, it is important to thoroughly understand and support the choice of assumptions used in the analysis. Presenting the assumptions alongside the MACC curve can help ensure transparency, comprehensibility and accountability.
- The costs represented in a MACC are annualized costs over the assumed life-time of the option, and are therefore dependent on the choice of discount rate. As discussed in Section 3.2, private companies have substantially higher discount rates than do government bodies. The choice of the appropriate discount rate is therefore a key consideration, and may need to be customized by option.
- Uncertainty is inherent in forecasts of future costs and technical potential. The cost differentials between options may be less than the cost uncertainties within each option. Sensitivity analysis, modelling MACCs for several future cost and technology scenarios is one way to capture this uncertainty.

Need for specialized expertise:
- MACCs are typically calculated by consultants with data on the costs of potential options.

[12] 2015. Lazard's Levelized Cost of Energy Analysis – Version 9.0. Retrieved from https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf

Approximate cost and level of effort:

- Costs and level of effort depend on how much baseline data is already available in the community.
- If baseline data is available, local government staff level of effort around 1-2 days.
- If baseline data is available, consulting fees around $7,500.
- If baseline data is available, one month.

Data requirements:

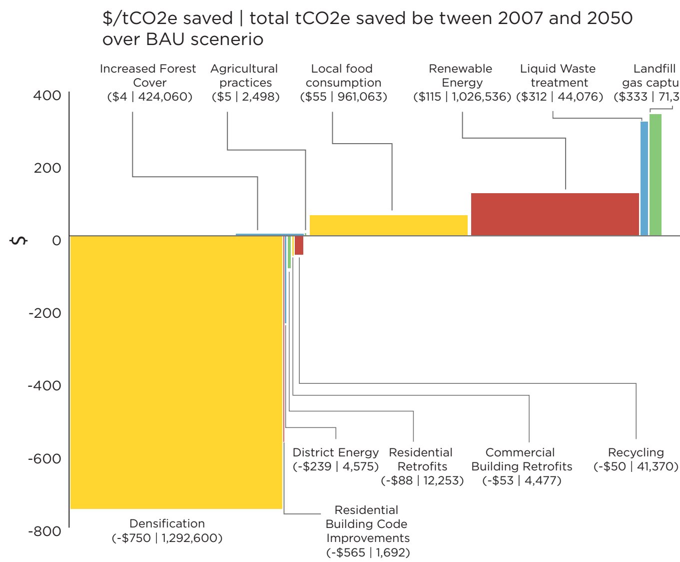
- Baseline community energy profile broken down by energy source and by stock of residential, commercial, industrial, transportation, and waste.
- Energy consumption and energy source for each proposed option, and of the option it would replace.
- Costs (capital, operational, and maintenance) of each proposed option, and of option it would replace.
- Emissions factors for energy sources, and emissions intensity of electricity supply.
- Electricity and fuel prices.
- Projected technology penetration or policy effectiveness for each proposed option.
- Lifetime of technologies for each proposed option and the technology it would replace.
- Where local data is not available, assumptions are derived from relevant literature.

Example: North Cowichan, British Columbia

In North Cowichan, BC (population 28,800), the municipality examined long-term scenarios for meeting a 33 percent reduction in GHG emissions by 2020 or 2025 (depending on the scenario), relative to 2005 levels. A MACC was constructed as a ready means of visualizing which strategies would cost the least or deliver the most financial savings. This analysis does not include co-benefits such as health, new jobs, or improved air quality.[13]

In the North Cowichan graph, Figure 6, the height of a bar represents the marginal abatement cost of each potential strategy, while the width represents the amount of GHG reductions available from each strategy. Bars below the zero line denote strategies which offer a net saving, even at current costs. For example, densification was identified as the most cost-effective strategy, offering a savings of $750/t$CO_2$e saved, and a potential savings of 1,292,000 total tCO_2e in emissions over the 2007-2050 period. Residential building code improvements, district energy, residential retrofits, commercial retrofits, and recycling could all be done for a net saving. Other strategies would require a subsidy or a higher carbon price—for example, renewable energy options would require a subsidy, or a carbon price, of $115/t$CO_2$e to break even, with an emissions reduction potential of 1,026,536 total tCO_2e in emissions over the 2007-2050 period.

Figure 5 – North Cowichan's Marginal Abatement Cost Curve



Source: Sustainability Solutions Group, 2013. Municipality of North Cowichan Climate Action & Energy Plan.

Further resources:

- Ekins, Kesicki, Smith, April 2011. Marginal Abatement Cost Curves: A call for caution. UCL Energy Institute, London. At https://www.bartlett.ucl.ac.uk/energy/news/documents/ei-news-290611-macc.pdf
- http://www.cityswitch.net.au/Resources/CitySwitchResources/Planning,reportingandmonitoring/Planning,reportingandmonitoringarticle/TabId/150/ArtMID/787/ArticleID/10273/Using-Marginal-Abatement-Cost-curves-.aspx

3.5 – PROFILE: QUANTIFYING COMMUNITY SOCIOECONOMIC BENEFITS

Best for:

Informing the decision-making process, and stakeholders, on the total value to the local economy of a CEP, considering how direct expenditures recirculate through local businesses, households, and tax revenue.

What is it?

An analysis of community socioeconomic benefits measures how a dollar spent on the CEP or a program within the CEP changes the local economy. This includes how spending circulates and re-circulates within the whole community, for example through changes in economic output (GDP), employment, household income, and government tax revenues. This more comprehensive analysis is significant if a community is trying to develop a truly triple bottom line understanding of their CEP impacts.

Total economic benefits are estimated at three layers of influence: direct, indirect and trickle- down (or induced) impacts:

- Direct economic benefits are gained at the front end of a CEP project: to the businesses or households directly implementing a particular investment to reduce energy costs, through changes in savings or spending, new income to businesses, and new jobs. Capital expenditures are normalized to a base year and reported in current dollars.
- Indirect benefits arise in economic sectors that supply the inputs for the direct investment, such as equipment or technical services. The more a community can provide the goods and services needed for the CEP, the greater the share of indirect benefits that will remain in the community.
- Communities as a whole also benefit via the ripple effect of the dollars generated from energy savings or from new local energy-related jobs being re-circulated in the local economy. This is often referred to as trickle down economic benefits, and economists call it induced economic benefits.

This type of economic impact analysis is typically used to demonstrate the socioeconomic value of large projects, such as roads or sports arenas. Applying it to a CEP allows the investment needs for a CEP to be considered on an "apple to apple" basis with other community investments. It can be a powerful tool for building stakeholder support for a more ambitious CEP plan or a major capital project.

Calculating community socioeconomic benefits uses Statistics Canada economic multipliers for defined industry sector groups. Because these multipliers vary by region, the ability to do this type of analysis is generally restricted to the country or provincial level. Regional multipliers are sometimes developed for other sectors of the economy, and can be adapted to CEP analysis, as was done for the Regional Municipality of Durham (see example, below). To help address this problem, Natural Resources Canada (NRCan) has created a streamlined spreadsheet tool to assess the socioeconomic assessment of the direct and indirect benefits of district energy developments, which are often considered within a CEP; the tool is in Beta version and should be used with that caution.

Considerations:

- Model results are only as good as model inputs, and these depend on the suite of assumptions made to generate the input. Assumptions should be clearly identified. Typical assumptions include: time horizon of program; future cost of energy; future cost of carbon; and program effectiveness or penetration rates.
- As with the other methods outlined, an understanding of the assumptions, approach, and limitations of the approach is required to accurately interpret and present the results.

Need for specialized expertise:

- Specialized expertise is needed for analysis of a full CEP. Standard input-output models, which represent inter-industry relationships within an economy, must be customized to the region under analysis. These models are specialized and may not be available for all regions, and are often proprietary to academic researchers or consulting firms.
- City staff can run NRCan's District Energy Economic Model analysis tool for District Energy themselves, if they have the feasibility study for the proposed project and some technical expertise. This tool has been designed for engineering professionals, planners, and other municipal technical personnel involved in the development and operation of district energy systems.

Approximate cost and level of effort (full CEP, adapting a model developed for another economic sector in the region):

- 40 person days of internal staff time, primarily invested in collecting data on expenditures on machinery, construction, energy, and labour for proposed programs, and researching similar projects for data for assumptions.
- Consultant fees of $15,000-$20,000.

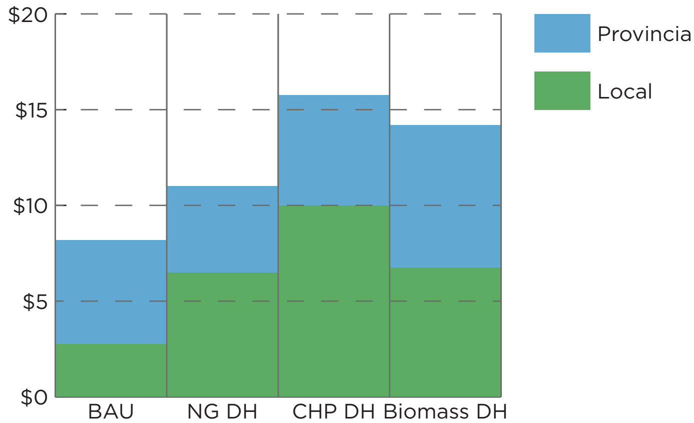
[13] Sustainability Solutions Group, ND. Municipality of North Cowichan Climate Action & Energy Plan. http://www.northcowichan.ca/assets/Departments/Engineering/PDFs/NC%20CAEP%20final%20report%20v5_reduced.pdf

Approximate cost and level of effort (district energy project):
1-10 person days of internal staff time for a typical analysis depending upon complexity, and depending on whether a feasibility study has already gathered expenditure information for the proposed project.

Data requirements:
- Baseline data: baseline energy source, energy consumption and unit cost of energy disaggregated by target sectors (e.g., building units, daily trips by transport mode).
- Direct program investment: Estimates of expenditures on machinery, construction, energy, and labour for proposed programs.
- Assumptions derived from similar projects for financial life cycle, proportion of capital cost or labour from local suppliers, energy impacts (saved or produced), terms of financing, payback periods, participation or penetration rates, and use of dollars from energy saving over time of analysis.
- Economic and technical databases published by Statistics Canada. For example:
  — Inter-provincial input-output tables
  — Employment by sector
  — Taxes by type and level of government
  — Prices of products
  — Energy used in physical and monetary units
  — Location quotients.

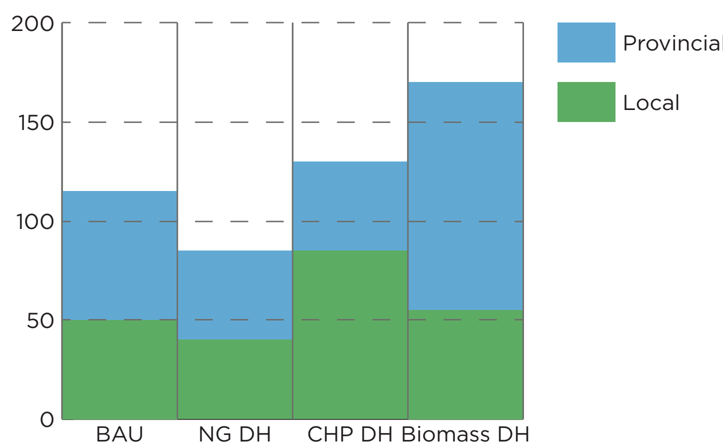
Example: District Energy Economic Model (DEEM) for Calgary
NRCan conducted a DEEM analysis comparing different types of district energy systems with a business as usual case of natural gas space heating from in-building boilers and provincial grid electricity for power. Three district energy systems, with installed capacities between 10 MWt and 12.5 MWt were analyzed: natural gas boilers, gas-fired combined heat and power supplemented with gas-fired boilers, and biomass-fueled boilers. The results, in Figure 6-8, calculate direct and indirect economic benefits only, for the city of Calgary.[14]

Figure 6 – Net present value of GDP increase, 2015-2039 (CAN$ millions)



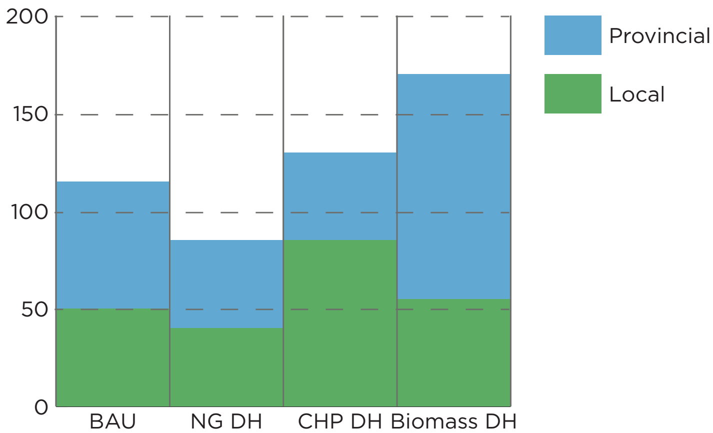
Source: Church, Ken. 2016. District Energy, Second Quarter 2016.

Figure 7 – Employment potential by technology choice, 2014–2039 (person years).



Source: Church, Ken. 2016. District Energy, Second Quarter 2016

Figure 8 – Tax revenue benefit by technology choice, 2014-2039 ($Can)



Source: Church, Ken. 2016. District Energy, Second Quarter 2016

Example: Regional Municipality of Durham, Ontario

The Regional Municipality of Durham's Local Action Plan outlines how the Durham community could achieve its GHG emissions reduction targets, improve the air quality in the community, and diversify and broaden the community's employment and social structures. They commissioned analysis to quantify the likely economic impacts of the 13 mitigation and adaptation strategies in the Local Action Plan, with an interest in understanding the economic benefits that these programs could generate through employment creation, income augmentation and expanding the local fiscal base.

A standard economic impact methodology was used with a unique regional impact model that captures the economic impact of different activities at the local level, the provincial level, and the national level. The study examines Durham's suite of strategies and assesses their costs, savings and contributions to the economy of the Region of Durham and to Ontario as a whole. It looked at economic impacts over 10 years in constant 2013 dollars.

Table 3 and Figure 9 show the findings for one of the strategies, comprehensive residential retrofits, with an 80 percent participation rate from 194,225 units over a ten year period. The study used baseline energy consumption data from NRCan and constant energy costs, and assumed average investments of $9,600/unit for an annual average savings of $865/year, an 11 year average payback period, and 25 percent of energy savings redirected to spending. It was estimated that participants in this program would spend $1.5 billion on their retrofit, and another $192,500 from energy savings.

Looking at the direct, indirect, and induced impacts, or how a dollar spent in the local program circulates and re-circulates in the economy, the study calculated:

- *Participant expenditures:* the initial, direct expenditures for the comprehensive residential retrofits;
- *Value added:* the net output generated by these participant expenditures in the province;
- *Employment:* total person years (full-time equivalent jobs) employment generated;
- *Taxes:* tax revenue generated by these impacts, by level of government; and
- *Imports:* goods and services acquired from outside the Durham Region or the province.

[14] Church, Ken. 2016. Quantifying the real value of district energy: Canada develops a model for demonstrating socioeconomic benefits to the community. District Energy, Second Quarter 2016. International District Energy Association.

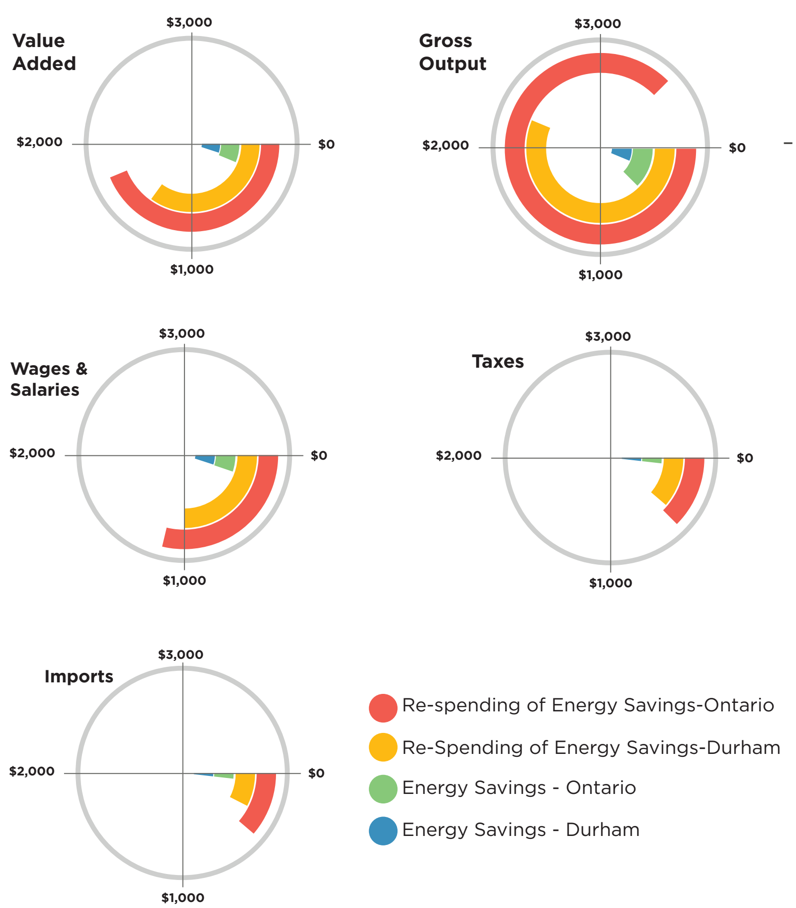
Total income (GDP) for Ontario would increase by about $2.1 billion, of which about $1.7 billion would be in Durham. Total wages and salaries would augment by $1.5 billion across Ontario, with $1.2 billion as Durham's share. Over 27,396 person years of employment would be generated across Ontario over the 10 year period, of which 23,544 would be in Durham. A total of $631 million in tax revenue would be collected by all three levels of government, $50.6 million of which would be collected by the Durham Region's municipal governments.[15]

Table 3[SC5] – Economic Impacts of Comprehensive Residential Retrofits, Regional Municipality of Durham

	Durham			Ontario		
	Participants Expenditures	Re-spending of Energy Savings	Total	Participants Expenditures	Re-spending of Energy Savings	Total
Participants Expenditures	$1,490,890	$192,484	$1,683,374	$1,490,890	$192,484	$1,683,374
Value Added						
Direct	$709,210	$117,063	$826,263	$934,116	$125,267	$1,059,383
Indirect & Induced	$835,561	$12,440	$848,001	$954,774	$97,997	$1,052,771
Total	$1,544,771	$129,493	$1,674,264	$1,888,890	$223,264	$2,112,154
Multiplier	1.04	0.67	0.99	1.27	1.16	1.25
Gross Output						
Direct	$1,490,890	$192,484	$1,683,374	$1,490,890	$192,484	$1,683,374
Indirect & Induced	$1,121,563	$15,992	$1,137,555	$2,108,177	$224,467	$2,332,644
Total	$2,612,453	$208,476	$2,820,929	$3,599,067	$416,951	$4,016,018
Multiplier	1.75	1.08	1.68	2.41	2.17	2.39
Wages & Salaries						
Direct	$613,459	$60,100	$673,559	$754,875	$64,889	$819,764
Indirect & Induced	$514,311	$9,488	$523,799	$582,107	$59,796	$641,903
Total	$1,127,770	$69,588	$1,197,358	$1,336,982	$124,685	$1,461,667
Employment						
Direct	$11,313	$1,063	$12,376	12,730	$1,132	$13,862
Indirect & Induced	$10,665	$503	$11,168	12,182	$1,353	$13,534
Total	$21978	$1,566	$23,544	24,912	$2,485	$27,396
Multiplier	1.94	1.47	1.90	1.96	2.19	1.98
Taxes						
Federal	$251,684	$14,623	$266,307	$314,097	$34,253	$348,350
Provincial	$160,528	$9,537	$170,065	$195,659	$22,167	$217,826
Local	$47,773	$2,838	$50,611	$58,228	$6,597	$64,825
Total	$459,985	$26,998	$486,983	$567,984	$63,017	$631,001
Imports						
From Other Provinces	$212,446	$11.789	$224,235	$320,445	$29,057	$349,502
From Other Countries	$90,598	$5,861	$96,459	$129,015	$14,797	$143,812
Total	$303,044	$17,650	$320,694	$449,460	$43,854	$493,314

Source: Econometric Research Limited, 2012. The Economic Impacts of Action Plan Concepts for the Regional Municipality of Durham.

Figure 9 – Economic Impacts of Comprehensive Residential Retrofits, Regional Municipality of Durham (Millions of 2013 dollars)



Source: Econometric Research Limited, 2012. The Economic Impacts of Action Plan Concepts for the Regional Municipality of Durham.

Further resources:

- Natural Resources Canada. District Energy Economic Model. Spreadsheet analysis model to quantify the community benefits of district energy system investment in terms of employment and employment income, taxes, and GDP. *While the model has been developed in good faith, Natural Resources Canada accepts no responsibility for any project or financial decisions made from the results of any analysis using the tool.* Available by request from Raymond Boulter, CanmetENERGY, NRCAN — raymond.boulter@canada.ca
- U.S. Environmental Protection Agency. 2011. Assessing the Multiple Benefits of Clean Energy: A Resource for States. Chapter 5: Assessing the Economic Benefits of Clean Energy Initiatives. EPA-430-T-11-014. At https://www.epa.gov/sites/production/files/2015-08/documents/epa_assessing_benefits.pdf

[15] Econometric Research Limited, 2012. The Economic Impacts of Action Plan Concepts for the Regional Municipality of Durham.

3.6 – PROFILE: COST BENEFIT ANALYSIS

Best for:
screening and prioritizing measures, programs, or portfolios to identify if benefits over time exceed initial costs, and for identifying a portfolio of measures that maximize the economic, environmental, and social benefits from CEP implementation.

What is it?
Assessments of the cost benefits of a CEP are used to evaluate the economic and financial performance of possible programs within comprehensive, long term plans. They look at the cost of the investment relative to the benefits arising from the investment over time, and can analyze both energy and non-energy impacts, such as environmental, health, and community economic costs and benefits. These assessment methods are useful in screening, prioritizing, and fine-tuning possible measures into a portfolio designed to be economically favourable to both public and private stakeholders. They are also helpful in determining whether an energy or emission reduction target is economically achievable. Their analysis integrates several of the other methods described above.

The analysis can be conducted at the level of a specific measure, program or full CEP portfolio. Testing on a measure-by-measure basis identifies those measures for which the benefits outstrip the costs. Testing on a program or portfolio basis allows cost-effective actions to subsidize non-cost-effective actions, as long as the overall program or portfolio nets out positive. Several scenarios are typically modeled to test sensitivity to economic assumptions (e.g., discount rates, cost of energy, cost of carbon) or program portfolios.

These approaches take into account that costs and benefits are not evenly distributed between the public sector, households, and business. For example, a program administrator will have different costs and benefits than a program participant, and these are again different for a non-participating local taxpayer. Conducting the analysis from several perspectives helps to inform how to balance costs and benefits appropriately across stakeholders, for better program design.

Cost-benefit analysis monetizes the benefits into common monetary units and in doing this, is well suited to assessing net present value of an investment: the value in the present of benefits accruing over one or more decades compared to the cost of investments made in the immediate term. A closely related method, cost-effectiveness analysis, measures outcomes in their customary units of measure, for example vehicle-km, kWh, or hospital admissions, and is better suited to assessing benefits than are difficult to quantify. Both approaches can be adapted to consider anticipated future cost of carbon.

Considerations:
- Unlike the simpler forms of financial analysis described above, this method provides the ability to look at economic impacts over long time periods. The timespan for analysis should align with the dates in any targets established in the CEP, such as energy efficiency or emission reduction targets.
- An assiduous scoping of objectives is critical in determining the type of modeling, scope and detail of the analysis. The consultant should be closely involved in helping to define the objectives.
- The longer the timespan of analysis, the more sensitive the results to the assumptions used. The client should thoroughly understand and support the choice of assumptions used in the analysis.
- Shaping the analysis to provide results at interim dates, aligned with local government budget cycles, will allow programs to be broken into phased steps coordinated with governance cycles, while maintaining the flexibility for adaptive management.
- Spreadsheets, and training in how to use these, should be among the contract deliverables in order to give local authorities the internal capacity to run models for iterative program design and adaptive management.

Need for specialized expertise:
- Considerable. A consultant with expertise in cost-benefit analysis constructs a model tailored to the specific objectives of the analysis and populates it with local data. Staff may need to provide some of this data if the community does not have a baseline energy inventory at the level of detail appropriate to the analysis objectives.
- Staff should be trained in how to use the model themselves, and how to interpret and present results.

Approximate cost and level of effort:
- These methods require expert economic support along with dedicated internal staff time to thoroughly define scope and objectives, understand the assumptions, and build internal capacity on how to use the model, interpret, and present the results.
- Consulting services to build the economic model from scratch, typically done for larger communities, and populating it with data are in the $25,000-$75,000 range. An existing model can often be used for smaller communities, in which case the populating it with data would be $10,000-$30,000.

- The level of effort for staff will depend on number of staff involved, and what existing data is available. A small community with only one staff person involved in the analysis might invest about 5 person days in data gathering, project scoping, data interpretation and communication of results, and training in how to use the model. In a larger community with a well-developed data set, and staff with strong economic backgrounds, the level of effort would be similar. A community involving several staff in the project, and needing to gather new data might invest about 12 to 15 days.

Data requirements and sources:

- The baseline energy use inventory required for previously-described methods of analysis. This is the basis for all subsequent steps, such as the greenhouse gas inventory, business as usual projections, and the various program scenarios.
- Detailed program assessment and design requires granular data (broken into subclasses of residential, commercial, industrial, transportation use and capital stock characteristics), but high-level analysis can be done with less granular data.
- Description of potential programs, including public and private costs, expected effectiveness, and program length.
- The expert consultant supplies the other data needed.

Example: Edmonton, Alberta

Edmonton's Community Energy Transition Strategy modeled the economic performance of ten possible energy efficiency and renewable energy programs to achieve a greenhouse gas emission reduction of 35 percent below 2005 levels by 2035. They found that, in all cases, administrative and financial incentives would be required from government, but that the long-term public and private benefits would exceed long-term public and private costs. A combined public and private investment of $274 million over four years is expected to deliver a net present value of approximately $2.5 billion in public and private benefits (Table 4). It is even greater—$3.37 billion—if greenhouse gas reductions are valued at $51/tCO_2e$, their estimated cost to society (public cost).

The Strategy recommended a phased approach to program implementation, starting with programs with benefit/cost ratios equal to, or greater than 2.5 in a first four year period, and programs with lower, but still positive benefit cost ratios in a second four year period.[16]

[16] City of Edmonton, 2015. Edmonton's Community Energy Transition Strategy, Retrieved from https://www.edmonton.ca/city_government/documents/EnergyTransitionStrategy.pdf

Table 4: Summary of Edmonton's Community Energy Transition Strategy Cost-Benefit Modelling Results

Program	Potential Lifetime Reduction kt CO_2	Potential Lifetime Energy Saving TJ	Net Present Value to 2035		Benefit / Cost Ratio	Program Costs (2018–2021) $million (undiscounted)
			Private $million	Public $million		
Participants Expenditures						
Energy efficiency —new homes	18,500	177,00	$675	$860	2.4	$103
Renewable energy —new homes*	400	9,000	$70	$70	3.2	$3
Energy efficiency —existing homes*	10,300	82,000	$265	$500	6.3	$27
Renewable energy —existing homes	600	12,000	$130	$120	2.4	$8
Large (ICI) Building Programs						
Energy efficient —new buildings*	15,500	50,000	$230	$625	4.1	$16
Renewable energy —new buildings*	500	11,000	$90	$90	3.6	$4
Energy efficiency —existing large / ICI buildings	2,100	40,000	$125	$85	1.3	$16
Renewable energy —enxisting large / ICI buildings*	1,600	33,000	$320	$320	3	$15
Industry Programs						
Energy efficiency —industrial facilities and processes*	5,100	99,000	$575	$645	5.1	$44
Vehicles Program						
Purchase of electronic vehicles*	900	7,00	$40	$55	2.6	$1
Total	**55,500 kt**	**120,000 TJ**	**$2,520M**	**$3,370M**		**$237M (over 4 years) $60M a year**

* Program is recommended for community-scale implementation beginning 2018 based on B/C ratios greater than 2.5.

Source: City of Edmonton, 2015. Edmonton's Community Energy Transition Strategy.

Further resources:

- CRA International. 2007. Overview of Cost-Benefit Analysis and its Applications in Public Policy Decisions. At http://www.ieso.ca/imoweb/pubs/consult/mep2/MP_WG-20070607-Overview-of-Cost-Benefit-Analysis.pdf
- Transportation Research Board. n.d. Transportation benefit-cost analysis. At http://bca.transportationeconomics.org/home
- Victoria Transport Policy Institute. 2016. Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications. At http://www.vtpi.org/tca/

Section 3

Summary

Different methods of economic analysis serve different purposes, and provide different information. The varied purposes of the six major methods for measuring the economics of CEPs, introduced above, illustrate the importance of selecting a method whose purpose aligns with the community's approach to CEP development, and a careful appraisal of the objectives of the analysis:

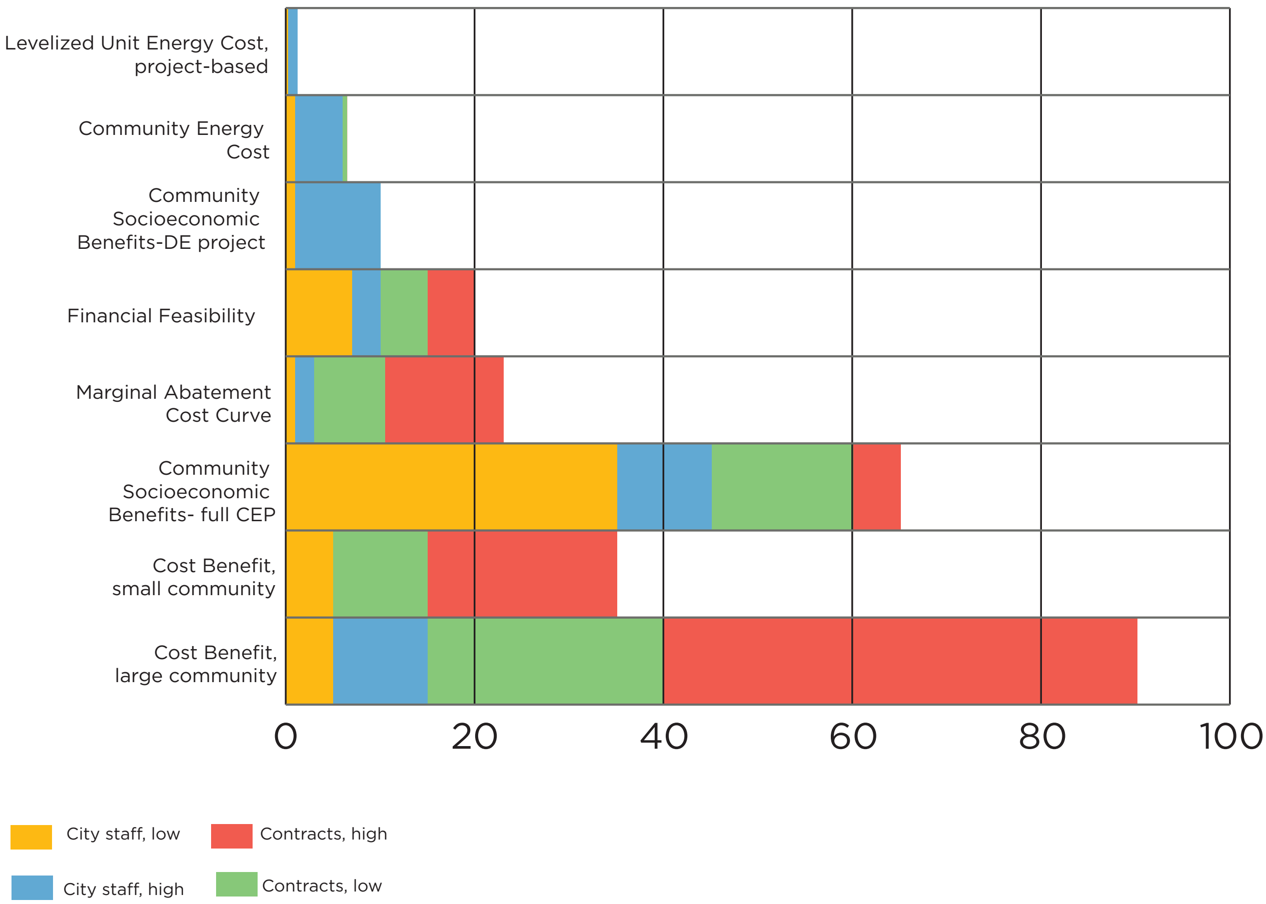
- The community energy cost uses the total cost of energy spend in a community as a metric through which everyone can readily understand the 'size of the prize', and how shaving that spending through a CEP can offer economic benefit to the community. The cost profile monetizes this data to understand the total cost of energy in the community, the profile of energy costs across sectors, and the profile of energy revenue within the community, regional and larger economies. This information can be used to identify opportunities to reduce these costs and/or keep dollars in the community, and to track savings from CEP implementation.
- Financial feasibility assessments evaluate whether, and under what conditions, the investment in a specific measure, program, or portfolio will break even. These calculations can be used to rank specific measures and programs under consideration, and to do so under multiple energy and/or carbon price-forecast scenarios. They can also identify what level of government subsidy would be needed to encourage the desired household and business investments.
- A levelized unit energy cost analysis compares the overall competitiveness of different generating technologies, considering the full range of building and operating costs across the design lifetime of a generating asset, on the basis of real dollars per kWh. This allows for like-to-like comparisons of technologies such as solar, wind, cogeneration, combined cycle gas, etc., which have very different profiles for capital costs, fuel costs, operation and maintenance costs, cost of capital, and utilization rates.
- A marginal abatement cost curve (MACC) summarizes GHG emission reduction options in a graphical format that makes it easy to compare the cost per tonne CO_2e reduced, and to see the potential volume of reductions from each option. It is useful for initial prioritization of options, and can also be used to identify what level of subsidy, or what carbon price, would make specific options break even.
- Calculations of community socioeconomic benefits measure how a dollar spent on an action within a CEP changes the local economy. This includes how spending circulates and re-circulates within the whole community, for example through changes in economic output (GDP), employment, household income, and government tax revenues. This type of analysis allows the investment needs for a CEP to be considered on an equivalent basis to other major community investments.
- Assessments of the cost benefits of a CEP look at the cost of the investment relative to the benefits arising from the investment over long time periods, and can analyze both energy and non-energy impacts, such as environmental, health, and community economic costs and benefits. These methods are useful in screening, prioritizing, and fine-tuning possible measures into a portfolio designed to be economically favourable to both public and private stakeholders. They are also helpful in determining whether an energy or emission reduction target is economically achievable.

Just as there are a range of CEP approaches, from a project specific focus, to year-by-year plans, to more comprehensive, long term plans (Table 1), economic methods range in the breadth, depth, and complexity of information they provide (Figure 10). More complex models require more experience to identify assumptions and interpret results, and community energy managers will benefit from the professional judgment of experts in these methods. More complex models also require more experience in communicating results. For example, return on investment (ROI) to analyze financial feasibility, is a concept that is likely familiar to most people, and easy to communicate. However, methodologies that provide fuller portrayals of jobs or of long term economic benefits are more likely to be new to many, and therefore more challenging to communicate. Community energy managers need to carefully consider how to support the interpretation needs of those who are making the key decisions on the CEP, and how to present analysis results in ways tailored to their level of economic knowledge.

A final consideration in selecting a method for measuring the economics of CEPs is what resources will be required for the analysis: staff time and/or budgets for consultants. The foundation for any of these methods of measurement is a community energy inventory, and the estimates of resource needs in this report are additional to the resources for the inventory. Resources may involve staff time only, for simpler methods, or budgets for consultants specializing in these methods of analysis, for more comprehensive methods.

Measurement methods that provide more thorough portrayals of full economic impacts also yield more breadth, depth, and complexity of information, and require more expertise and resources to complete and interpret. In the latter case, staff are encouraged to invest time in working closely with the consultant to understand and support assumptions, and to include spreadsheets, and training in how to use these, among contract deliverables in order to build internal capacity for iterative program design.

Figure 10 – More thorough portrayal of economic impacts requires more expertise, data, and resources.



* Range of effort: staff days + consulting days @ $1,000/day
** Assumes a community-wide energy inventory exists
*** Varies based on number of scenarios requested.

The choice of economic method needs to align with a community's approach to CEP development, which will guide the objective of the economic analysis, and to be aware of the knowledge base of the audience. While the economic analysis should only go as broad and deep as is needed to gain support from senior decision makers and elected officials, greater analysis may also lead to better informed choices. But, more comprehensive analysis is more resource-intensive and more complex to develop, interpret and communicate. A thoughtful balance needs to be struck between informed decision-making and analysis paralysis. More complex analysis is not correlated with buy-in for all decision-makers, and the Community Energy Manager needs to assess which method is sufficient for the local situation. The economic analysis to support a CEP should only go as deep as is needed to gain support from senior decision-makers and elected officials.

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