Verification Review of Program Year 2018 Evaluation Results

Report for the Nova Scotia Utility and Review Board

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Verification Review

Of Program Year 2018 Evaluation Results

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Towards contextually sound and practical measurement, analysis, and reporting…

I. Introduction & Overview

This report is a savings verification review for Calendar Year 2018 conducted by H. Gil Peach & Associates, LLC for the Nova Scotia Utility and Review Board (Board). The report is focused on verification of electricity energy savings and demand reduction as measured, modeled and estimated by Econoler, the Independent Evaluator for Efficiency Nova Scotia's Demand Side Management (DSM) energy savings and demand reduction programs.

This report reviews, verifies, and if appropriate, recommend adjustments to the savings data and estimates created by evaluation consultants engaged by Efficiency Nova Scotia.[1] For this reason it is focused on impact evaluation. The report also provides limited comments on other parts of the evaluation, including process evaluation.

The examination is based on careful review of the evaluation for each program component or initiative in the DSM portfolio, including review of each evaluation's explicit or implicit design, of evaluation methods and standards, and/or evaluation protocols used in each evaluation. It is also based on review of the program data tracking system, on discussions with staff and delivery agents concerning program procedures and methods for program Quality Assurance/Quality Control (QA/QC). It is also based on selected "due diligence" site visits to check installation counts and quality of work.

In addition, where appropriate, we reference the evolving standards of practice to highlight "better practices" and the fit between the evaluations and evolving standards of practice.

A. Demand-Side Management as Continuous Improvement

It can be useful in approaching evaluation to review how DSM works and where evaluation and savings verification fit.[2] DSM is a *cycle of repeated activities with the*

[1] Nova Scotia Power, Inc. served as the DSM Administrator for calendar years 2008 and 2009. Responsibility transferred to Efficiency Nova Scotia Corporation in October 2010. Calendar year 2011 represented the first full program cycle with Efficiency Nova Scotia as the DSM Administrator. This is the eleventh program year from the 2008 start and the eighth year with full administration by Efficiency Nova Scotia. All programs (except new pilots) are mature programs in 2018.

[2] This initial discussion is to set context for new readers.

goal continuous process improvement.[3] Figure 1 shows the DSM cycle with four main centers of focus designated by circles.[4]

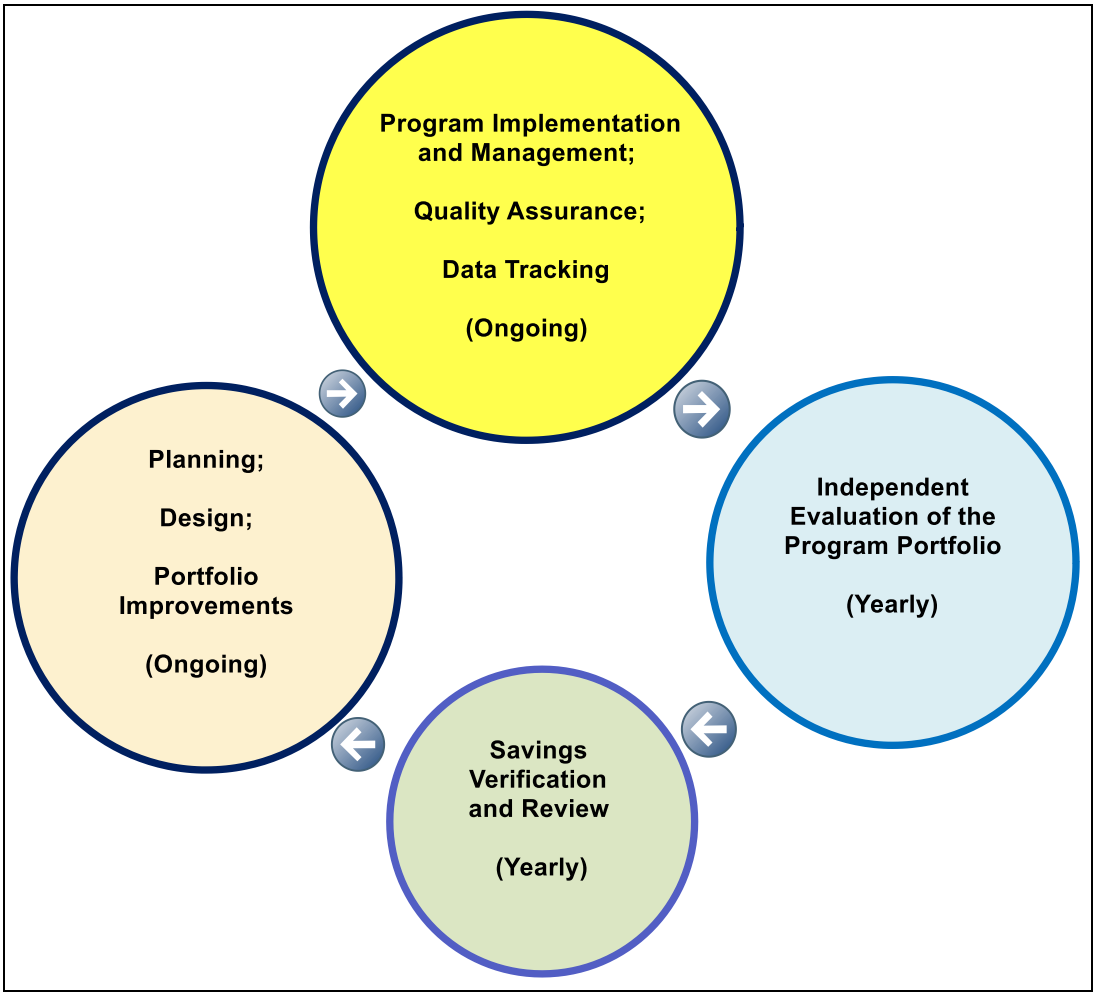

Figure 1: Continuous Improvement: The DSM Cycle.

The arrows in Figure 1 show the clockwise direction of the primary flow of effort within a single DSM cycle. Each step in the Demand-Side Management Cycle feeds

[3] Morse, William L. & H. Gil Peach, "Control Concepts in Conservation Supply," Energy, Vol. 14, No. 11, Pp. 727-735, 1989; Gellings, Clark W. & John H. Chamberlin, *Demand-Side Management Planning Concepts & Methods*, Second Edition, Liburn Georgia: The Fairmont Press, 1992; Gellings, Clark W. & John H. Chamberlin, *Demand-Side Management Planning*, Liburn, Georgia: The Fairmont Press, 1993.

[4] There are other parts not shown. Some of these are: periodic potential studies, other special studies such as socket studies, development of measurement protocols and the development and use of the Technical Reference Manual, determination of effective useful life (EUL) and benefit/cost testing.

information forward to the Planning step, and planning proceeds continuously both for longer-term planning and adjustment to realities as they are encountered. In addition, every three to five years there is an intensified major planning effort that sets the pattern for developing the program portfolio until the next major planning effort.

1. Planning

The function of the Plan is to develop program plans and to provide estimates, while incorporating new knowledge, much of which is moved forward from other steps in the process. The Plan provides a high-level blueprint for Implementation in the form of a program portfolio, the results of benefit/cost tests and specific program plans.

2. Implementation

The Implementation step in each cycle feeds information forward to Planning through the development of practical knowledge gained by program managers and delivery agents. Program implementation and results are recorded in the data tracking system. Work in Implementation means being "at the edge" encountering emergent realities that require constant alertness, pattern recognition and identification of anomalies. From time to time it requires quick adaptation based on new information.

In this way, the programs are adapted from planning perspectives to field realities, moving programs forward through (usually incremental) changes to adapt to encountered situations. The focus of implementation is to implement the portfolio of programs as planned and to modify quickly in relation to the development of internal and contextual forces and limits that could not have been anticipated in the planning step.[5] All of the steps in the DSM cycle provide support to Implementation.

3. Evaluation

The Evaluation step produces independent results assessment for the full portfolio of programs in a yearly formal evaluation report. Evaluation also should feed timely

[5] For an early article on this point, see Keating, Kenneth M., Ruth L. Love, Terry V. Oliver, H. Gil Peach & Cynthia B. Flynn, "The Hood River Project; Take a Walk on the Applied Side," Pp. 112-118, *The Rural Sociologist*, Vol.5, No. 2, May 1985.

information back to the Implementation step throughout the year to provide information for in-progress program corrections without waiting for the full evaluation report.

Evaluation produces independent measurements, observations, site inspections, surveys, interviews, literature reviews and analyses (for example, of electrical measurements, hours of operation, interaction effects, the assessment of free-riders and spillover effects). Evaluation develops program baselines and program results. Sometimes there are also special studies to support the evaluation process.

4. Savings Verification

Both the Implementation step and the Evaluation step feed information forward to the Savings Verification. This information includes selection of methods, analysis plans, program documents, tracking records, electrical measurements and evaluation results. Savings Verification confirms and, when necessary, questions the Evaluation data, methods and reported results.

B. Evaluated Net Demand Reduction at the Generator

Efficiency Nova Scotia conducts a portfolio of six programs which, taken together, include eleven program components. Econoler also separately evaluates Codes & Standards, which is considered outside the portfolio and for which Efficiency Nova Scotia receives no credit.[6] In Table 1, evaluated values for net peak demand reduction at generator are shown for DSM portfolio programs and for program components, as well as for Codes & Standards.

Econoler reports a DSM portfolio net peak demand reduction of 25.542 MW at the generator. In addition, Econoler reports a net peak demand reduction of 4.008 MW at the generator for Codes and Standards. The total net peak demand reduction is 29.550 MW.

As shown in Table 1, net demand reduction at the generator (MW) is split about 44% to the Residential sector and 56% to the business, non-profit and institutional program sector (BNI).

[6] Although Efficiency Nova Scotia supports Codes and Standards, Codes and Standards are seen as coming primarily from the federal or provincial levels.

For 2018, about 86% of net demand reduction at the generator comes from the DSM portfolio and about 14% from Codes & Standards.

Table 1: Net Demand Reduction at Generator.

2018 Net Evaluated Peak Demand Reduction (at Generator)				
Program	**Portfolio Residential Component**	**Demand Reduction (MW)**		**Program**
Rebates	Appliance Retirement	0.378	2.95	**Rebates**
	Instant Savings	2.572		
Existing	Home Energy Assessment	1.600	7.105	**Existing**
	Green Heat	4.042		
	Efficient Product Installation	1.463		
New	New Home Construction	1.278	1.278	**New**
	Residential Subtotal	11.333		
Program	**Portfolio BNI Component**	**Demand Reduction (MW)**		**Program**
Rebates	Business Energy Rebates	11.327	11.327	**Rebates**
Custom Incentives	Custom	1.200	1.441	**Custom Incentives**
	Energy Management Information Systems	0.051		
	Strategic Energy Management (SEM)	0.190		
Direct Installation	Small Business Energy Solutions	1.441	1.441	**Direct Installation**
BNI Subtotal		14.209		
Overall DSM Portfolio Total		25.542		
Codes & Standards		4.008		
Total (DSM Portfolio plus Codes & Standards		29.550		
Table Notes				
Source: Data from Table 6: 2018 Evaluated Results and Tracked Peak Demand Savings at the Generator, P. 16 in *2018 DSM Program Evaluation Executive Summary, Final Report* , March 18, 2019.				

In Figure 2, the DSM program components from Table 1 are sorted by amount of net peak demand reduction. MW values are presented at the left in the graph and the components are listed in rank order from low to high. The top three portfolio components (Business Energy Rebates, Green Heat and Instant Savings yield 17.941 MW of demand reduction at the generator, or about 71% of the 25.542 MW first year portfolio net demand reduction.[7]

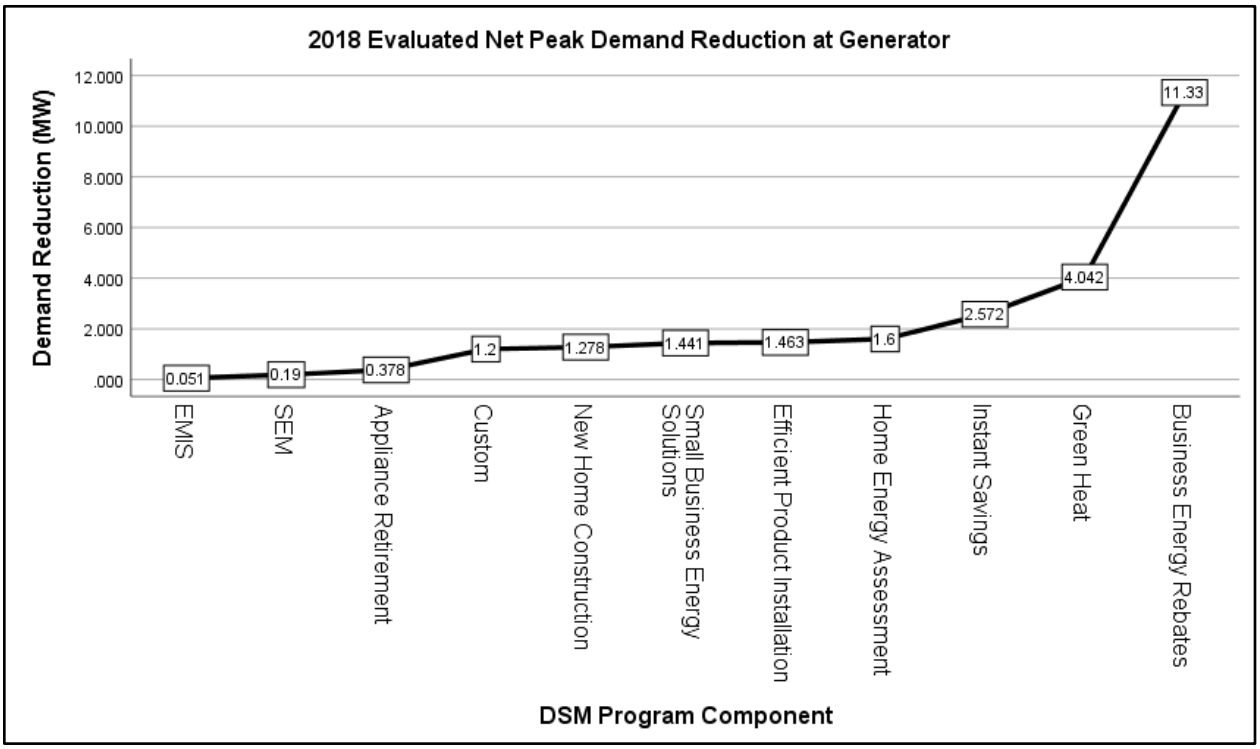

Figure 2: Rank Order of Program Components for Net Peak Demand Reduction.

C. Evaluated Net First-Year Energy Savings at the Generator

In Table 2, evaluated values for net energy savings (GWh) at generator are shown for DSM portfolio programs and for program components, as well as for Codes & Standards.

[7] In rough percentages, the top 27% of DSM portfolio components produce about 71% of 2018 net peak demand reduction.

Table 2: First-Year Net Energy Savings at Generator.

2018 Net Evaluated Energy Savings (at Generator)				
Program	**Portfolio Residential Component**	**Annual Net Savings (GWh)**		**Program**
Rebates	Appliance Retirement	2.657	24.587	**Rebates**
	Instant Savings	21.930		
Existing	Home Energy Assessment	5.724	22.728	**Existing**
	Green Heat	4.227		
	Efficient Product Installation	12.777		
New	New Home Construction	4.515	4.515	**New**
	Residential Subtotal	51.830		
Program	**Portfolio BNI Component**	**Annual Net Savings (GWh)**		**Program**
Rebates	Business Energy Rebates	75.298	75.298	**Rebates**
Custom Incentives	Custom	11.603	14.674	**Custom Incentives**
	Energy Management Information Systems	1.616		
	Strategic Energy Management (SEM)	1.455		
Direct Installation	Small Business Energy Solutions	9.589	9.589	**Direct Installation**
BNI Subtotal		99.561		
Overall DSM Portfolio Total		151.391		
Codes & Standards		23.809		
Total (DSM Portfolio plus Codes & Standards		175.200		
Table Notes				
Source: Data from Table 5: *2018 Evaluated Results and Tracked Energy Savings at the Generator* , P. 15 in 2018 DSM Program Evaluation Executive Summary, March 18, 2019.				

Econoler reports a DSM portfolio net energy savings of 151.393 GWh at the generator. In addition, Econoler reports a net energy savings of 23.809 GWh at the generator for Codes and Standards. The total net energy savings for 2018 is

175.201 GWh.[8] As shown in Table 2, the DSM portfolio net energy savings at the generator (GWh) is split about 34% to the Residential sector and about 66% to the business, non-profit and institutional program sector (BNI).

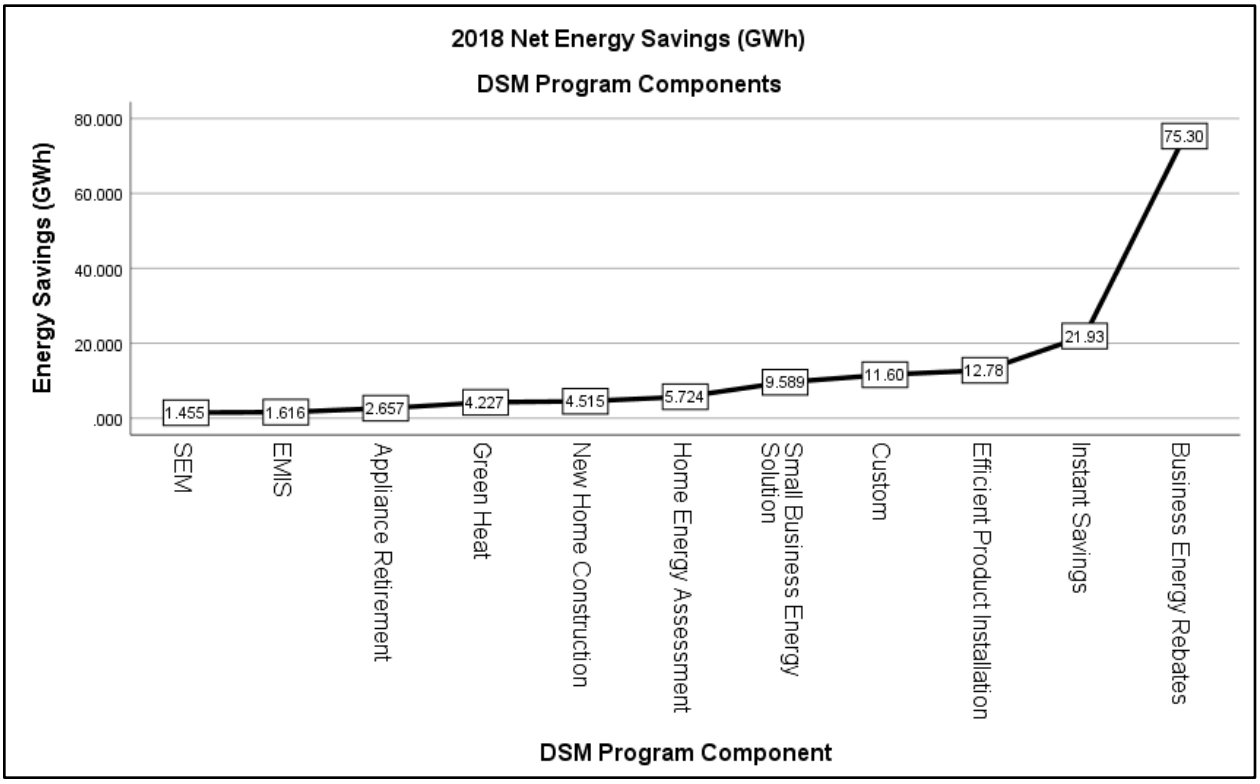

Figure 3: Rank Order of Program Components for Net First-Year Energy Savings.

Using the information from Table 2, the DSM components are ranked by net first year energy savings (GWh) as Figure 3. On a first-year net energy savings basis, the top three program components are Business Energy Rebates, Instant Savings and Residential Efficient Product Installation. For the portfolio, these top three program components yield 110.005 GWh or about 73% of the 151.393 GWh net portfolio energy savings at the generator.

[8] Tables in this report may contain small rounding errors and so not exactly match Econoler tables. These differences are not important.

D. Evaluated Lifetime Net Energy Savings at the Generator

Econoler lifetime evaluated net energy savings at the generator is shown in Table 3. These estimates of DSM component lifetime net energy savings take into account the savings-weighted measure lives within component. A comparison of lifetime and first year net energy savings at generator is shown in Table 4..

Table 3: Net Evaluated Lifetime Energy Savings at Generator (GWh).

Net Evaluated Lifetime Energy Savings (at Generator)				
Program	**Portfolio Residential Component**	**Annual Net Savings (GWh)**		**Program**
Rebates	Appliance Retirement	19.822	209.158	**Rebates**
	Instant Savings	189.336		
Existing	Home Energy Assessment	114.488	298.768	**Existing**
	Green Heat	76.292		
	Efficient Product Installation	107.988		
New	New Home Construction	135.671	135.671	**New**
	Residential Subtotal	643.597		
Program	**Portfolio BNI Component**	**Annual Net Savings (GWh)**		**Program**
Rebates	Business Energy Rebates	852.117	852.117	**Rebates**
Custom Incentives	Custom	156.077	164.097	**Custom Incentives**
	Energy Management Information Systems	3.655		
	Strategic Energy Management (SEM)	4.365		
Direct Installation	Small Business Energy Solutions	118.794	118.794	**Direct Installation**
BNI Subtotal		1,135.008		
Overall DSM Portfolio Total		1,778.605		
Table Notes				
Source: Data from Table 8: *2018 Evaluated Net Lifetime Energy Savings at the Generator* , P. 26 in 2018 DSM Program Evaluation Executive Summary, March 18, 2019.				

Table 4: Lifetime Multiple (%) and Lifetime Additional Net Energy Savings (GWh).The top four lifetime net energy at generator components are Business Energy Rebates, Instant Savings, Custom and New Home Construction. These top four program components contribute 1,333 net lifetime GWh to the overall DSM portfolio total of 1,778 GWh, or about 75% of the total. The comparison is show in the graph of Figure 4 with the components listed along the y-axis in order of size from smallest to largest.

Table 4: Lifetime Multiple (%) and Lifetime Additional Net Energy Savings (GWh).

DSM Component	Net		Lifetime Multiple	Lifetime Additional
	Annual	Lifetime		
	(GWh)	(GWh)	(%)	(GWh)
Appliance Retirement	2.657	19.822	746%	17.165
Instant Savings	21.930	189.336	863%	167.406
Home Energy Assessment	5.724	114.488	2000%	108.764
Green Heat	4.227	76.292	1805%	72.065
Efficient Product Installation	12.777	107.988	845%	95.211
New Home Construction	4.515	135.671	3005%	131.156
Business Energy Rebates	75.298	852.117	1132%	776.819
Custom	11.603	156.077	1345%	144.474
Energy Management Information Systems	1.616	3.655	226%	2.039
Strategic Energy Management	1.455	4.365	300%	2.910
Small Business Energy Solutions	9.562	118.794	1242%	109.232
Total	151.364	1778.605	1175%	1,627.241

Source: Annual 2018 Net Energy Savings from Table 2; Lifetime 2018 Net Energy Savings from Table 3. The lifetime savings multiple is shown to the nearest percent.

The evaluation of net lifetime energy savings developed by Econoler is useful in understanding the full results of the DSM program effort. A Technical Brief from Lawrence Berkeley Laboratory (LBL)[9] puts the specific concerns this way:

[9] Hoffman, Ian M., Steven R. Schiller, Annika Todd, Megan A. Billingsley, Charles A. Goldman, Lisa C. Schwartz, "Energy Savings Lifetimes and Persistence: Practices, Issues and Data." Berkeley, California: Lawrence Berkeley National Laboratory, Electricity Markets & Policy Group Technical (hereinafter "LBL Technical Brief"), May 2015, P. 1. (https://emp.lbl.gov/sites/all/files/savings-lifetime-persistence-brief.pdf)

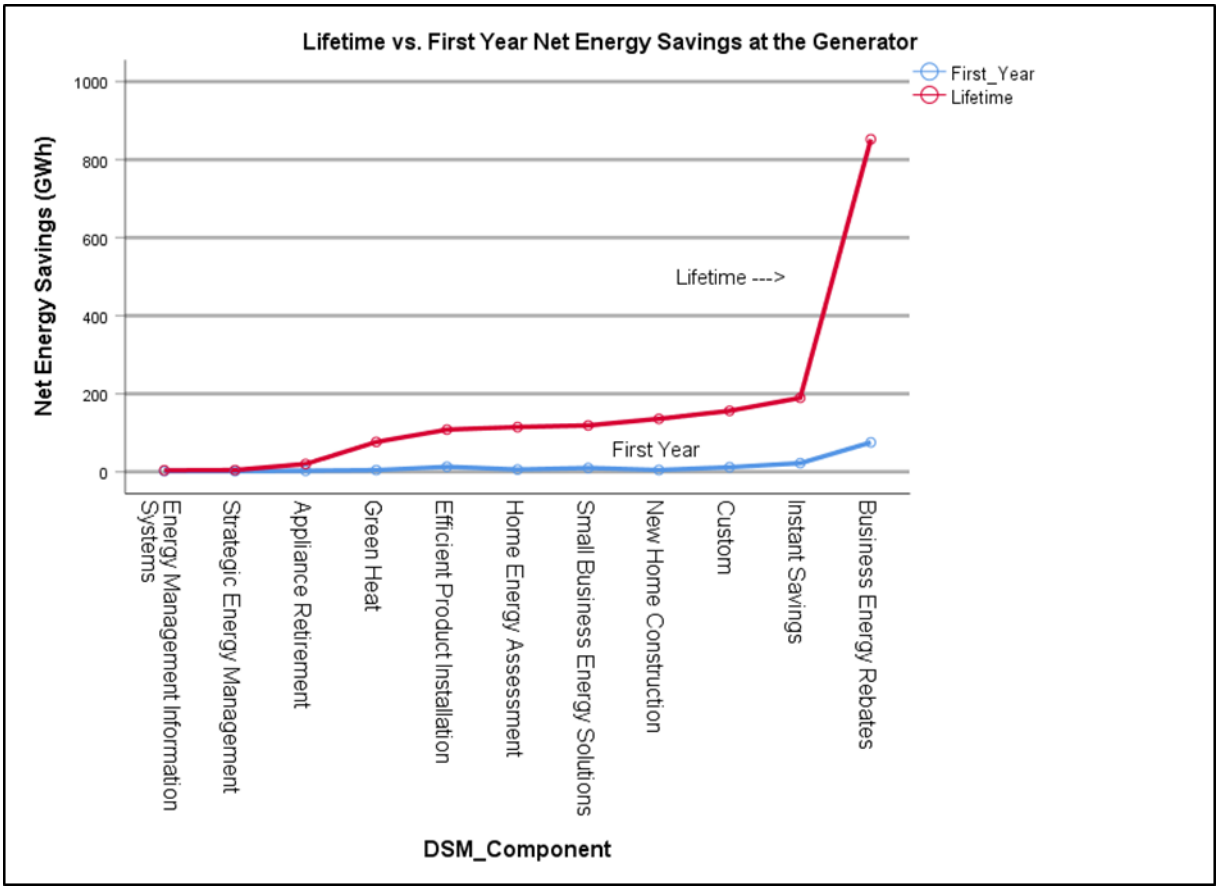

Figure 4: Rank-Ordered Lifetime Net Energy Savings for DSM Program Components.

> [U]nderstanding how long measures, programs and portfolios last (lifetimes) – and the degree to which savings change over time (persistence) – is critical to estimating the benefits of efficiency, calculating cost effectiveness and prioritizing long-term vs. short-term efficiency actions.

As the brief points out, "program administrators use these factors."[10] They are used in the Planning step of the DSM Continuous Improvement Cycle (Figure 1). In fact, when measures, programs and portfolios leave the Planning step and are moved to Implementation the *ex-ante* values for these factors have already been estimated. Together, they form the basis for passing (or failing) the internal screening test required to move a proposed program from Planning to Implementation.

[10] LBL Technical Brief, P. 1.

Understanding net lifetime energy savings supports a deeper valuation and introduces the concept of shifting our sense of time for an eventual shift of valuation systems. This shift is a dialectical change within a mathematical framework.[11] There is a jump in understanding when the time dimension is added. *This is important because appreciation of the true value of a program component occurs over the lifetime of the program component, and as the social and economic context changes, while cost currently occurs in the first year for almost all measures and programs (bundles of measures)*. Program performance is not a single year performance. For customer value and value in resource planning, DSM components engage the future.

E. Evaluation of Market Transformation/Market Evolution

Evaluation of market transformation[12] has two parts. First, analysis of resource acquisition programs that, over time, develop market effects that develop into possible market transformation. This involves measures cost-justified for direct first-year energy savings, but that happen to develop market transformation possibilities over time. The second part of evaluation of market transformation can be centered on analysis of programs planned from the start as market transformation programs.

In the 2018 Evaluation, Econoler developed analysis of market transformation for three selected measures that have been offered in resource acquisition program components by Efficiency Nova Scotia for several DSM cycles:

- Instant Savings: Residential LED lamps
- Business Energy Rebates: Commercial LED Lighting
- Green Heat: Mini-Split Heat Pumps

[11] According to the principles of dialectics as summarized by Mario Bunge, "Every quantitative change ends up in some qualitative change and every new quality has its own new mode of quantitative change." (P. 42). "…[I]n every process a stage comes when some new property emerges, which has in turn its own mode of quantitative variation" (P. 55). Bunge, Mario, *Scientific Materialism*. Dordrecht, Boston & London: D. Riedel Publishing Company, 1981. See also: Mitroff, Ian I. & Richard O. Mason, *Creating a Dialectical Social Science*, Theory and Decision Library, Volume 25. Dordrecht, Boston & London: D. Reidel Publishing Company, 1981. We assert that when included in a single mathematical diagram, these paradigm jumps can take the form of step functions.

[12] For a brief overview of the market transformation approach, see Chapter 5: A Market Transformation Perspective, in International Energy Agency, *Creating Markets for Energy Technologies*. Paris: Organization for Economic Cooperation and Development/International Energy Agency, 2003.

In this review, we note that Econoler selected the correct measures and conducted careful and considered analysis, testing the maturity of these three markets. For these reasons, the market transformation analysis in the Econoler evaluation is useful and fully adequate or the 2018 program year.

The Econoler evaluation does not analyze market transformation implicit in the forward edge of new construction program components, for example in promotion of types of aggressively energy efficient residential houses such as Passive House. The small numbers of these homes being constructed is edge technical work. This work cannot be done on a mass basis with current funding and cost tests but can be explored on a limited pilot basis. Simply because new construction has this kind of forward edge, in this area Efficiency Nova Scotia is doing limited innovation that implicitly reaches towards development of explicit market transformation programs. A constraint, of course, is that standard cost tests don't work for edge programs.[13]

F. Addressing Climate Mitigation & Climate Adaptation

Evaluation of climate change aspects of DSM has two parts. First, evaluation of the role of program components in climate mitigation. Second, evaluation of the role of program components in climate adaptation and resiliency.

For 2018, the Econoler evaluation develops the climate mitigation value stream in terms of reduction of greenhouse gas emissions for the DSM program components.[14] Within a DSM perspective, climate mitigation (lowering emissions of greenhouse gases) is not the most important value stream (we focus primarily on first year energy and demand reduction impacts), but it is a situationally meaningful value stream that derives from the implementation of DSM programs and plays into the contextual

[13] In Robert S. Kaplan & Robin Cooper, *Cost & Effect, Using Integrated Cost Systems to Drive Profitability and Performance*, practical cost structures for new product development (applied research & development) are made explicit. To get to viability, you build and gradually improve the product and run pilots. The key insight is that no new products would get to the stage of market viability if all costs associated with the product were allocated back to the product as a cost center. Instead, companies allocate costs of new products under development to other cost centers, such as a generic product development budget under corporate administration. The argument can be made that for four or five Passive House homes per year, a more creative cost center could be developed by moving certain costs out from the current costing model to provide higher incentives. It seems also reasonable that the savings weighted measure life for edge housing might be more like 150 or 300 years. That is part of the point of it. Passive House is a place where energy efficiency and climate resilience come together.

[14] See Econoler, *2018 DSM Programs Evaluation Executive Summary,* Table 9, Evaluated Avoided GHG Emissions, P. 29.

social valuation of DSM accomplishments. The Econoler evaluation computes this value stream by documenting emissions that are offset by the programs. For this reason, the mitigation analysis in the Econoler 2018 is useful and fully adequate.

The Econoler evaluation does not analyze climate adaptation. That is appropriate since climate adaptation is not within defined scope in 2018. Even though it haunts our consciousness in all technical work and seems to be the remote endpoint of all effort, climate adaptation is not operationally expressed within the terms and conditions for DSM program components or evaluation. Yet, climate adaptation is a potential value stream within DSM, just as DSM is a value stream within climate adaptation. Time scales are different: the value stream from climate adaption aspects of DSM *is inherently intergenerational,* while DSM can function well on a short-term time horizon due to limited measure lives.[15] The climate adaptation value stream is more similar to the value of disaster preparedness and the value of keeping civil infrastructure functional under stressed conditions.[16] Also, it appears that all DSM measures except new construction or aggressively extensive whole building retrofit have no institutional or behavioral climate "lock-in" problems.[17] These "lock-in" problems occur when a technical choice is inherently a long-term commitment that may produce desired results but, at the same time, also produces long-term negative consequences.[18]

G. Highlighted Evaluation Standards

In this section we highlight five guidelines or standards for evaluation: independence, avoiding the risk of circularity in using automated evaluation,

[15] The "look-ahead" for a DSM Integrated Resource Plan is often 20 or 30 years, while the "look-ahead" for climate adaptation is easily 220-600 years.

[16] The integration of a DSM value stream for climate adaptation is not a formal recommendation but is a matter for thought.

[17] Űrge-Vorsatz, Diana, Cynthia Rosenzweig, Richard J. Dawson, Roberto Sanchez Rodriguez, Xuemei Bai, Aliyu Salisu Barau, Karen C. Seto and Shobhakar Dhakal, "Locking in Positive Climate Responses in Cities." *Nature Climate Change*, March 2018, 8:3, Pp. 174-177.,

[18] A useful insight from using a climate adaptation perspective is that it highlights the risk in adoption of "low-hanging fruit" type program strategies, because in a longer time perspective fast returns can prevent deeper savings when the low-hanging fruit is gone. See Űrge-Vorsatz, Diana, op. cit., P. 174. In other words, one would structure program priorities and evaluations differently if one had a 220 to 600-year time horizon than if one had a 30-year or one- year time horizon. An example of a lock-in from on the generation side is the decision of a US utility to move to oil-fired generation due to a decline in oil prices that made oil look least cost for a few years. With decisions made and plants built, there was a lock-in of the wrong technology at a time when coal would have been the better economic choice.

transparency, avoiding the risk of circularity in using a Technical Resource Manual, and the desirability of familiarity with current evaluation guidelines.

1. Independent Evaluation

The primary standard in Demand Side Management evaluation is that evaluation must be conducted by an independent evaluator to guarantee the integrity of reported savings and prevent conflict of interest. There has always been a separation of function between program implementers and program evaluators and a concern to place a wall between them.

> The standard in Demand Side Management evaluation is that evaluation must be conducted by an independent evaluator, who has control over method and measurement approaches, to guarantee the integrity of reported savings and to prevent conflict of interest.

In response to problems encountered and as DSM programs began to mature, regulators across jurisdictions required evaluation to be conducted by outside independent evaluators. By 1992, the requirement for independent evaluations was a general regulatory requirement.[19] The Econoler evaluation is an independent evaluation that meets this standard.

2. Automated M&V vs. Automated Evaluation

Automated M&V and Automated Evaluation are different concepts with very different implications. Today, and looking forward, there is a financial interest and technical interest in the development of semi-automation of program directed M&V. For example, to facilitate "going to scale" by attracting private capital (as opposed to ratepayer funding), there are experiments with "M&V 2.0"[20]. At the same time, some jurisdictions are

[19] A DSM Administrator will always have an evaluation manager and may have a few evaluation staff because it is necessary to maintain technical competence to choose evaluators and to manage evaluations.

[20] Studies of whole building approaches suggest that M&V improvement is possible. See, for example, Granderson, J., Price, P., Jump, D., Addy, N., Sohn, M. (2015).

talking about the prospect of "going to scale" with energy efficiency driven by climate concerns rather than the current least cost planning model.[21] There is also a technical interest being able to do more precise analysis with better data, and potentially automating much of the process.

A promising series of applied research projects at Lawrence Berkeley Laboratory is exploring possibilities for automating M&V for whole building approaches.[22]

> Streamlined or Automated M&V strategies provide a means to estimate savings for whole building energy efficiency approaches. There is a growing recognition that whole building approaches to energy efficiency hold promise for realizing deep energy savings in commercial buildings.

Automated metering infrastructure with at least hourly data (and preferably sub-hourly data) would be required.[23] To work well, some form of Energy Management Information System would also be preferable. However, if extended from M&V ("M&V 2.0") to evaluation ("Evaluation 2.0") robotic approaches, while they may be valuable to develop insights, may also create collateral damage. They may miss problems of data and analysis that professional evaluators deal with; and, further, we assert that that much care must be taken to insure such approaches are not easily gameable (to invite unchecked misstatement of energy savings).[24]

Automated Measurement and Verification: Performance of Public Domain Whole-Building Electric Baseline Models. Applied Energy 144:106-13 (http://eis.lbl.gov/pubs/lbnl-187596.pdf).

[21] For jurisdictions, the need to go to scale is rooted in a climate adaptation perspective, but this is often in the background and the focus is more on capital efficiency of electric systems (including both sides of the meter).

[22] Lawrence Berkeley Laboratory, Building Energy Information Systems and Performance Monitoring Tools, 2014-2016 Assessment of Automated M&V Methods, Summary of Work (http://eis.lbl.gov/auto-mv.html).

[23] Some vendors will claim that they have proprietary and confidential methods based on engineering models, perhaps combined with big data analytics, that enable development of results without automated metering infrastructure. However, as a general principle, whenever an evaluation approach is put forward as proprietary and confidential it should be ruled out. Evaluation has the purpose of validation and validation requires a transparent process open to inspection by all parties.

[24] Peach, H. Gil, Pam Brandis, Michael J. Maranda, Ryan Miller, Anne West & Howard Reichmuth, "Evaluator as Fool, Reducing Uncertainty Through Evaluation", Brooklyn, New York: International Energy Program Evaluation Conference, August 2005. http://www.iepec.org/conf-docs/papers/2005PapersTOC/papers/031.pdf)

The future will likely be a synthesis including pieces of new approaches. But in evaluation, we assert that the goal is truth in measurement, and methods must be based on physical measurement, where possible.[25] It will be important to preserve the independence of the evaluator, including the evaluator's independence in control of methods of analysis for evaluation.

The 2018 Econoler evaluation has no problems of this kind.

3. Transparency

DSM evaluation plans and reports are made public and are open to inspection by any party. Third party review of evaluations helps insure objectivity and promotes credibility, and, when necessary, revision of evaluation results. The 2018 evaluation process is well structured and complete. The 2018 Econoler evaluation has no transparency problem.

4. Technical Resource Manual

Most jurisdictions eventually develop a Technical Resource Manual (TRM) in which calculation methods, assumptions and (in some cases) default unitary values for energy savings and/or components used in the construction of energy savings and demand-reduction are curated and open for inspection by all parties. Efficiency Nova Scotia has constructed an electronic TRM (eTRM). We have reviewed the eTRM and find it to be a useful technical advance for program purposes. Econoler uses the eTRM while independently inspecting measure values (such as unitary savings and effective useful life). It will be important to continue this independent check to avoid circularity based on the eTRM. The 2018 Econoler uses the eTRM appropriately.

[25] Separate financial evaluation is not a problem; the problem is the desire to streamline M&V and evaluation to remove actual project energy performance – as independently measured – from surety of financial return.

5. Evaluation Guidelines

Many jurisdictions also have a set of evaluation guidelines.[26] Econoler has demonstrated thorough knowledge of the Uniform Methods Project evaluation guidelines and other protocols that form the most current sets of generally accepted guidelines for DSM program evaluation (although discussion continues, and the process of refining protocols is open ended). These replace older guidelines issued by the California Public Utilities Commission, the Oak Ridge National Laboratory and the Electric Power Research Institute.

6. Process Evaluation

Table 5, from Econoler, provides a picture of the evaluation effort for 2018.[27] In this table "C" indicates a complete evaluation and "R" indicates a reduced evaluation. In reviewing the assignment of level of effort, the process evaluation area is weak compared with market and impact evaluation. Accordingly, we recommend that Efficiency Nova Scotia and Econoler increase the process evaluation effort for the next evaluation.

Overall, however, the evaluator's decision to put primary focus on impact evaluation is appropriate. The secondary focus on market evaluation is relevant to understanding program component impacts. The tertiary focus on process evaluation runs a risk of not detecting relevant changes in program definition, delivery and environments. It would useful for the process evaluator to include a sociological type of process evaluation with participant observation. In this approach, which differs from a business model or an audit model, the process evaluator would work along with staff and delivery agents for at least one or two program components each year to produce a well-grounded full process evaluation of the component(s).

[26] For example, the New York evaluation guidelines are at: http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/$FILE/NY_Eval_Guidance_Aug_2013.pdf.

[27] This is a copy of Table 1 from P. 4 in Econoler, *2018 DSM Program Evaluation Executive Summary,* March 18, 2019.

Table 5: Evaluation Effort for 2017 & 2018.

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R

* The process evaluation specifically targets the Retrofit service of the Custom program component.
** The process evaluation specifically targets the New Construction service of the Custom program component.
*** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.

II. Savings Verification Approach

The savings verification review was conducted as follows:

- During the year, we conducted a set of due diligence site visits for each program component except Appliance Retirement. These provide an independent view of each program and of any obvious problems. During the year, the site visits provide opportunity to call attention to anything that needs to be explained or potentially fixed. We keep the Nova Scotia Utility and Review Board aware of any problems encountered.

- During the year we discussed use of the tracking system with Efficiency Nova Scotia staff. This provides an independent sense of how the tracking system is working in practice. It is working well.

- During the year, we read electronic Technical Resource Manual (eTRM) materials reviewed the eTRM.

- In review of the evaluations, we focused on the "installed" annual energy savings and demand reductions. [These are the annualized value of savings and demand reductions from the measures installed, regardless of what day of the year they were put into service. They do not represent the "realized" savings for the calendar year but are the savings that should be realized when each of the projects operates for a full year.] These numbers come from the tracking system and from the evaluator's adjustments.

- Generally, we did not check the evaluator's mathematical calculations, but did carefully check the evaluator's presentation of method for each program analysis. We reviewed the interaction, free-ridership, spillover and net-to-gross approaches.

III. General Findings

There is one general finding for this Savings Verification study:

SVF-1: All 2018 evaluations conducted by Econoler are within accepted industry frameworks and evaluation standards.

- Each program evaluation is comprehensive: The structure and format of each impact evaluation is consistent and useful. Each has an Executive Summary that accurately reports the contents of the evaluation. Each provides key definitions of terms and acronyms up-front. Each has a good table of contents. Each has an explanatory methodological model diagram, followed by specification and discussion of methods employed in the evaluation. Citations throughout the evaluations to other studies are relevant. For each evaluation for which it applies there is an appendix with a careful and clear delineation of calculation methods, surveys, and other core material used in the evaluation.

- Econoler has appropriately developed savings-weighted measure life analysis for net energy savings at the generator for all program components reporting energy savings for 2018. This lifetime analysis is useful in understand the full value of the programs.

- Market transformation/evolution of LEDs has emerged over the past few years, raising the question of the maturity of the markets for different types of LEDs. The evaluation appropriately includes focus on market evolution, analyzing these developments.

- Climate mitigation in terms of emissions offsets are appropriately analyzed by Econoler.

- Econoler conducted an appropriately independent evaluation.

- The 2018 evaluation does not rely on automated analysis or any other type of analysis outside the direct choice and control of the evaluator.

- All elements of the evaluation are open to mutual inspection and the evaluation report provides appropriate transparency.

- Since Econoler takes responsibility not to use the eTRM uncritically, there is no circularity in the evaluation results.

- Econoler has demonstrated command of the currently accepted evaluation guidelines, while taking independent responsibility for design of evaluation and for methods employed.

IV. General Recommendations

1. **Savings Verification Recommendation No. 1:** The Savings Verification study recommends acceptance of the 2018 evaluation results for energy savings and for demand-reduction for all programs.

   SVR-1: The Savings Verification study recommends acceptance of the 2018 evaluation results for energy savings and for demand-reduction for all programs.

2. **Savings Verification Recommendation No. 2: Process Evaluations.** Process evaluation is a good check on the extent to which the program as

planned by Efficiency Nova Scotia corresponds to the way the program is implemented and how it functions in practice. Necessarily, programs often adjust to realities that cannot be anticipated in program planning. First-line program delivery staff often have a better understanding of how a program works than an administrator who works out of an office and may only have had direct experience with operations in an earlier program era (with the same program in an earlier incarnation or with a different program).

Process evaluation can also be the one place in which process evaluator direct interaction and participant observation can catch "outside the box" patterns that may be unplanned, illogical, but fully operative.[28] Process evaluators are also useful in spotting possibilities for program improvements.

SVR-2: The Savings Verification study recommends increase in the level of effort in process evaluation for the next evaluation to include participant observation by the process evaluator of one or two program components and development of a full process evaluation report.

While the process evaluations included in the 2018 evaluation studies are very useful and bring added dimensionality to understanding of the impact of program approaches in comparison with the similar programs of other DSM administrators (and, also provide better understanding of impact results),

[28] If we think about the current problem with the 737 Max aircraft, we see that a special automatic control system was installed but aircraft pilots were not alerted to the change, nor were they trained in the change. That an AI would override pilot control in responding to sensors was not a part of the pilots' understanding. The pilot and the crew thought the pilot was in control. Further, both the indicator that would show the state of the sensors and control system and the mechanism to easily disconnect the control system were not built into the aircraft; but were made optional cost adders. This is like the Arthur C. Clarke novel and film directed by Stanley Kubrick, *Space Odyssey*, in which a computer named HAL is given information not given to the crew of a spacecraft. HAL functioned exactly as it should as a background AI, just as the 737 Max aircraft control system functioned correctly as a background AI. In both cases, the AI took command without the crew being aware. Process evaluators, although they will not find an AI operating in the background controlling programs, are there to spot these kinds of outside the box discrepancies and "wild cards". For physical systems we would be talking about resilience engineering. For programs, the process evaluator should be looking for discrepancies and tipping points. See: Dekker, Sidney, *Drift into Failure*, From Hunting Broken Components to Understanding Complex Systems. Farnham, Surrey England & Burlington Vermont: Ashgate Publishing, 1988

adding participant observation to future evaluations would strengthen the depth of understanding of Efficiency Nova Scotia programs as administered and implemented.

V. Individual Program Component or Initiative Review

Econoler conducted evaluations of eleven DSM components across the residential and BNI sub-portfolios, plus Codes & Standards which is outside the DSM program portfolio (Table 6). For the Savings Verification study, we focus on impact evaluation.

Table 6: List of Individual Evaluations.

DSM Portfolio Program Components	
1	Appliance Retirement Program
2	Instant Savings
3	Home Energy Assessment
4	Green Heat
5	Residential Efficient Product Installation
6	New Home Construction
7	BNI Energy Rebates
8	BNI Custom
9	BNI Energy Management Information Systems (EMIS)
10	BNI Strategic Energy Management (SEM)
11	BNI Small Business Energy Solutions
Codes & Standards	
12	Codes and Standards

1. Appliance Retirement Program

The Appliance Retirement Program provides a small incentive to pick-up appliances. It provides environmentally sound disposal and recycling of components of household refrigerators, freezers, room air conditioners and small refrigerators or freezers. The program also educates customers about the relatively high energy use of older appliances.

The Appliance Retirement Program does not replace appliances. However, another

component, HomeWarming, is rolled up within reporting for the Appliance Retirement Program. HomeWarming, a low-income program which is partially supported by the Province, replaces existing appliances with energy efficient appliances.
Also, for the first three months of 2018, a pilot project was continued with the Halifax Regional Centre for Education (HRCE). This pilot is also rolled up for reporting within the Appliance Retirement Program. It picks up appliances owned by schools. Energy savings from HomeWarming and HRCE are included in the Appliance Retirement Program.

The 2018 evaluation approach includes documentation review, an interview with the program manager, one visit to the recycling facility, a participant survey (n=200) and a unitary savings review. Based on survey results, free-ridership and secondary market impacts were assessed. Econoler has focused in 2017 and 2018 on improving measurement of results for this program. For metering in 2018, it was found that that since the measurement room had been relocated to an area near a large loading bay door, temperature fluctuations affected measurement results. For this reason, 2017 measurements were used as a basis for the 2018 evaluation.

For the 2018 evaluation, Econoler implemented the updated Uniform Methods Project Refrigerator Recycling evaluation protocol.[29] Evaluation results include free-ridership, secondary market impacts, and internal spillover. Electric interactive effects were included.

In this evaluation, the embodied decisions on method and analytic approach are fully within the scope of performance by an independent evaluator. Impact results were somewhat lower than planned targets yet within a reasonable range. Customer satisfaction with this program is very high, corresponding to the customer very high satisfaction that is typical of this service.[30] This is an excellent evaluation in that it is complete and transparent; and, in that it caught the measurement problem associated with temperature.[31] The evaluation provides recommendations to

[29] Keeling, J.; Bruchs, D. (September 2017). Chapter 7: Refrigerator Recycling Evaluation Protocol. The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68563 (http://www.nrel.gov/docs/fy17osti/68563.pdf). This version supersedes the 2013 version of the protocol.
[30] As the updated refrigerator recycling protocol notes, this high satisfaction and the effectiveness of program outreach for this type of program should make the program a useful vehicle for cross-program marketing and promotion. Ibid.
[31] Also, the evaluation continues a focus on improving metering, a goal called for in the updated refrigerator recycling protocol. Ibid.

continue careful metering activity while insuring the protocol is followed and to develop and implement a protocol for using the heat gun.

2. Instant Savings

Instant Savings is administered by Efficiency Nova Scotia as an in-store discount program for energy-efficient products.[32] The program is implemented through a delivery agent and participating retailers throughout Nova Scotia. People encounter the program through marketing and promotional messages and/or when making purchases in stores. Several types of stores are included in the program and the range of products is wide. There are campaigns for most products in the spring and fall, while appliance rebates are offered throughout the year.

For 2018 there was a complete impact evaluation and a complete market evaluation. The impact evaluation is based on document review, an interview with the program manager, interviews with nine retailers, and an intercept survey (n=194). Econoler also conducted a unitary savings review to validate and, where necessary, revise energy savings values. Expected Useful Life (EUL) values from 2017 were used for the 2018 evaluation

Savings results exceeded program goals; and the evaluator reports that the program is showing successful diversification to new products as the market evolves. The market evaluation includes an innovation adoption curve and an S-curve that are useful in understanding market evolution of LEDs. Lighting evaluation follows the Uniform Methods Project protocol.[33] In this evaluation, the included decisions on analytic approach, methods and quantitative values are fully within the scope of an independent evaluator. The analytic detail and coverage of the evaluation of this program is complete within this context. This is an excellent evaluation.

The evaluator provides two recommendations, the first for a socket study and the second to continue monitoring LED market indicators. It seems reasonable, given the evolution of the lighting market that a socket study is needed to bring information current and the relative maturation of A-type bulbs and the introduction of new types

[32] A list of rebates by product is provided on P. 33 of the Residential Efficient Product Rebate Program evaluation.

[33] Dimetrosky, S.; Parkinson, K.; Lieb, N. (2017). Chapter 6: Residential Lighting Evaluation Protocol, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/ SR-7A40-68562. (http://www.nrel.gov/docs/fy17osti/68562.pdf). This version supersedes the 2013 and 2015 versions of the protocol.

of bulbs indicate the importance of directing resources to the continued monitoring of LED market indicators.

3. Home Energy Assessment

Home Energy Assessment (HEA) provides financial incentives in the form of rebates or zero-interest financing to homeowners to reduce consumption of energy. HEA is focused on shell insulation measures, better electric space-heating systems or certain "green" substitutes or additions (wood or pellet stoves or heat pumps) and water-heating systems (solar domestic water heaters and heat pump water heaters). It also includes mechanical ventilation systems. The HEA is employed to optimize a package of measures to reduce the need for grid-supplied electricity for space and/or water-heating. To measure performance, it incorporates "test-in/test-out" ("D" and "E") residential audits which include blower door testing. These assessments are conducted by delivery agent energy advisors.[34]

For 2018, the evaluation includes a documentation review, an interview with the program manager, four on-site visits with simulation review, a billing analysis and a savings calculation review. This program uses HOT2000 simulations for the "D" and "E" audits. Water heating results are developed using unitary savings values. Free-ridership and spillover are included, as are interactive effects. The 2018 billing analysis was used to develop a new 2018 overestimation ratio (OR), which was used in space heating savings calculations.[35] This is a correction factor that adjusts Hot 2000 simulations to actual billing data. "Unconverted D Assessment Spillover" (households that started in the program with the "D" audit, made improvements, but did not continue for the "test-out" "E" Audit) were included. For 2018 there was a reduced impact evaluation and no market evaluation or process evaluation.

The method, decisions and calculations performed by the evaluator are appropriate to this program type and within the scope of an experienced independent evaluator. Although this is a reduced evaluation, viewed in the context of work in prior years

[34] Beginning July 10, 2018, HEA has received funding for non-electrically heated households from the federal government Low Carbon Economy Fund (LCEF) via the government of Nova Scotia. Savings associated with measures that displace non-electrical energy consumption are reported separately to the Province of Nova Scotia.

[35] A new analysis was required because a new version of HOT2000 is being used. The 2015 overestimation ration was calculated for the previous version of HOT2000.

which grounds approaches to the 2018 evaluation, this is an excellent evaluation that “trues-up” HOT2000 simulation results to energy use of homes as recorded in billing data.

For the next DSM cycle, Econoler recommends a more complete billing analysis and further improvement in developing the overestimation ratio, to include sub-analysis for a set of more focused research questions. Econoler also recommends sharing evaluation findings with the Energy Auditors. This is a training recommendation to improve the accuracy of data collection and project review.

4. Green Heat

The Green Heat Program focuses on replacement and supplementation of heating systems by installation of equipment that uses fuel derived from renewable resources. The new equipment may either fully replace or supplement existing heating equipment. Incentives are available for central heating systems, as well as to supplement electrical heat with an area heater. The following categories of heating system are rebated:

- Biomass: Wood stove, Pellet stove, Wood furnace or boiler
- Solar: DHW solar system, Solar-air-space-heating system
- Heat Pump: Air-source heat pump, Ground-source heat pump, Mini-split heat pump, Heat pump water heater

Since July 2018, non-electrically heated homes have been eligible for Mini-spit heat pump (MSHP) incentives under the federal government Low Carbon Economy Fund (LCEF) through the Province of Nova Scotia. Nova Scotia Power offers on-bill financing for customers who purchase a heat pump, including MSHPs.

In its methodological approach, Econoler reviewed unitary and calculated savings values for each type of equipment category based on information in the tracking system, conducted site visits (n=25), a participant survey (n=90) and interviews with distributors (n=6). Econoler also conducted a literature review. Interactive effects and free-ridership were taken into account. Billing analysis was conducted on a sample of homes with a centrally-ducted Air Source Heat Pump (ASHP) installed in previous years. The billing analysis compared energy consumption as a function of heating degree days for one year prior to installation of a new heat pump and for one heating season following installation. There was a complete impact evaluation and a complete market evaluation in 2018, but not process evaluation. The market evaluation includes an innovation adoption curve and S-curve for the market

evolution of Mini-split heat pumps.[36]

The methods and calculations performed by the evaluator are appropriate to this program type and within the scope of an experienced independent evaluator.

Econoler provides two recommendations for Green Heat. The first is to correct a critical problem with the tracking sheet for heat pumps. The second is to continue to monitor barriers to the adoption of high-efficiency Mini-split heat pumps, while continuing to incent high-efficiency models.

5. Residential Efficient Product Installation

The Residential Efficient Product Installation program component provides free of charge direct installation of energy-efficient lighting and domestic hot water-heating products. The program is available to both home owners and renters.

Econoler's methodological approach includes program documentation review, an interview with the program manager, a survey (n=100) and a unitary savings review. Interactive effects, free ridership and participant spillover were included. There was a full market evaluation and a reduced impact evaluation.

The products for 2018 were:

- Light Emitting Diode (LED) lamps (A-type, reflector and chandelier
- LED holiday lights (an exchange, in February and October to December)
- LED nightlights
- Faucet aerators
- Low-flow showerheads
- Pipe insulation
- Hot water tank wraps
- Smart power controllers for audiovisual equipment
- Programmable thermostats
- Nest thermostats (for non-electrically heated low-income households)
- Thermostatic shower valves
- Clotheslines (from July to November)

The methods and calculations performed by the evaluator are appropriate to this

[36] 2018 Existing Residential Program Efficiency Nova Scotia, Figure 15, P. 62.

program type and they are within the scope of an experienced independent evaluator. This is an excellent evaluation, more complex than it might appear.

The evaluator provides one recommendation – that the new measure, thermostatic shower valves, be better explained to customers.

6. New Residential Program

The New Residential Program includes New Home Construction and a Passive House pilot. There were 682 completions in 2018 in the New Home Construction Program including 7 in the Passive House pilot. The program is designed to encourage homeowners and builders to exceed building code requirements for energy efficiency in new homes. Participation involves review of home plans using HOT2000 simulation software. Results are provided to the builder or the homeowner with recommendations to meet program eligibility requirement. The built home is inspected by an energy advisor, and a blower door test is included.

The program steps are:

- Review home plans HOT2000 simulation software;
- Provide the builder or homeowner with a report
- Once the home is built, have an energy advisor (EA), hired by an NHC delivery agent (DA), conduct a final inspection and an air-tightness (blower door) test to verify the energy efficiency level of the new home.

The program can offer three certifications: Energy Star, R-2000 and Passive House.

For NHC, participants' gross energy savings were calculated by determining the difference between the to-code and the as-built modelled energy consumption values. Since the primary calculation tool for this program type is simulation, initial results were corrected using an overestimation ratio (OR), depending on the heating system. The ORs used in 2018 were borrowed from the HEA analysis since the number of NHC participants with enough available billing data and who used the new version of HOT2000 did not allow for such an analysis. Passive house analysis used the methods and parameter values used for the 2017 analysis.

For 2018, there was a complete process evaluation and a complete impact evaluation, but no market evaluation. Econoler conducted evaluation using a program documentation review, an in-depth interview with the program manager, and a jurisdictional review that drew insights and perspectives from five other new home construction programs (with staff interviews). Econoler also conducted analysis of ten of the homes consisting of an on-site visit and review of the HOT2000 simulations

and a savings calculation review. Free-ridership and spillover were analyzed. The methods and calculations performed by the evaluator are appropriate to this program type and within the scope of an experienced independent evaluator.

The evaluator provided five recommendations for this program. One of these is to conduct a billing analysis to review overestimation ratios (ORs) when enough NHC participant sample becomes available. Another is to ensure the tracked savings are accurate (since there were problems with the 2018 tracking data, though most variances were within a reasonable range)

An effective useful life of 30 years is used by the evaluator to calculate lifetime energy savings for this program, and this number is used in other jurisdictions also. However, the number is not demonstrated in the evaluation. There are two Savings Verification recommendations:

> SVR-3: In the Appendix or in the text of the next New Residential Homes evaluation, explain the concepts of expected useful life (EUL) and savings weighted measure life for the program. Show the derivation of the 30-year estimate used in the calculation of lifetime energy savings. Also calculate a separate EUL estimate for the Passive House pilot homes.

> SVR-4: It can be observed that a well-built house itself can easily last 100 or 200 years, while components of the house such as appliances, shingles and windows require periodic replacement. Also, maintenance requirements are typically not conceptualized and included in DSM programs. Consider and report on the possibility of improving EUL (a) by taking maintenance requirements into account and (b) explain if a materials science or engineering approach to quality and longevity of components could improve EUL at reasonable cost.

7. BNI Efficient Product Rebates

This program serves the business, non-profit and institutional sector (BNI sector). The Efficient Product Rebates program for 2018 is the same as Business Energy Rebates (BER). The program has two components, Instant Rebates at point-of-sale and Mail-in rebates. This program provides prescriptive rebates or financing. The point-of-sale rebates are provided through electrical product distributors throughout Nova Scotia. The Mail-in rebates require an application submitted to Efficiency Nova Scotia. In 2018, the mail-in approach covered 366 projects by 257 participants. Electrical distributors provided 506,533 product rebates.

The prescriptive measures for mail-in rebates are grouped into 13 categories: agricultural, commercial lighting, commercial refrigeration, commercial laundry, commercial kitchen, compressed air, heating, IT & datacenters, variable frequency drives, water heating, solar thermal, pumping and pool equipment. To be included, a measure must meet minimum efficiency/efficacy values for its category as well as industry standards (such as Energy Star® performance levels or standards of the DesignLights Consortium and the National Electrical Manufacturers Association.

For 2018, complete market, process and impact evaluations were conducted. Econoler's evaluation approach included an interview with the program manager, a phone survey of mail-in participants (n=70), and Instant Rebate participants including contractors (n=20) and end users (n=30). There were on-site visit project reviews to Mail-in rebate participants (n=78), interviews with electrical distributors (n=11) and interviews with Mail-in contractors (n=15). There was also a savings review to insure tracked savings were consistent with recommended values from the 2016 evaluation. Interactive effects, free-ridership and spillover were calculated. The free-ridership approach made use of a combination of distributor and participant interviews, which is a current "better practice" approach. Econoler also conducted effective useful life (EUL) review. A brief jurisdictional review was conducted of business DSM programs in Canada (BC Hydro, Energy Efficiency Alberta, Manitoba Hydro, the Independent Electricity System Operator, New Brunswick Power and Newfoundland Power. An Innovation Adoption Curve and S-Curve are developed to show current market evolution for commercial LED lighting.[37]

In its study of variables associated with market evolution for this program component, Econoler note that "[d]istributors reported that the market for LED linear lamps and

[37] Econoler, et al, *Efficient Product Rebates Program, 2018 DSM Evaluation, Efficiency Novia Scotia, Final Report*, P. 62.

general-use and decorative LEDs is nearing maturity, with continued price decreases, as well as increased accessibility of measures and customer awareness.…" However, the market for downlights and linear fixtures is not as mature.[38]

The evaluation of BNI Efficient Products Rebates, including methods and calculations performed by the evaluator are appropriate to this program type and within the scope of an experienced independent evaluator. This is an excellent evaluation.

The evaluator provides four recommendations, each derived from the process evaluation.

8. BNI Custom Incentives Program

For 2018, the BNI Custom Incentives Program includes three primary components: (1) Custom, (2) Energy Management Information Systems (EMIS) and (3) Strategic Energy Management (SEM). EMIS and SEM evaluation will be examined separately, with Custom reviewed here.

The Custom program has three primary components: (a) retrofit, (b) new construction and (c) building optimization. Retrofit helps with technical and financial support for scoping and feasibility studies, then helps implement technical changes using a customized and flexible approach. New construction provides incentives for new buildings, additions to buildings and major renovation of existing buildings. Building optimization provides a recommissioning process and supports implementation of low-cost/no-cost efficiency improvements.

Retrofit is the biggest contributor to net energy savings, providing over three-quarters of custom savings (77%) in 2018. For retrofit, Econoler conducted a technical review of project documentation and on-sites for twenty-five projects. Econoler notes that introduction of a new quality assurance notebook made it easier to follow changes in savings values. However, opportunities for improvement remain, including capturing adjustments for changes in operating conditions and getting to complete documentation for all projects. Free-ridership and spillover were measured.

For new construction, five projects were completed in 2018. Econoler conducted an examination of four of these. This included detailed technical review, site visit and review of simulations. There was also a process evaluation and a market evaluation.

[38] Ibid., P. xv.

For building optimization, six projects were competed in 2018. Econoler conducted in-depth technical review and on-sites for three of these. Econoler found errors in the expected energy savings modeling and calculations. Corrections were applied only to the three buildings examined.

The evaluation of the Custom components of the BNI Efficient Products Rebates, including methods and calculations performed by the evaluator are appropriate to this program type and within the scope of an experienced independent evaluator. This is an excellent evaluation.

The evaluator provides two recommendations

Noting that in small samples the evaluator does not extrapolate corrections to unexamined cases from the cases analyzed, the Savings Verification recommendation is to expand analysis.

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> SVR-5: When three of six cases are examined and there are modeling and/or calculation errors in each examined case, the evaluator should examine the remaining cases also. Errors should trigger additional examinations.

9. BNI Energy Management Information Systems (EMIS)

Energy Management Information Systems (EMIS) provide real-time energy consumption data from metered systems and enable businesses and institutions to make real-time energy decisions. The EMIS program provides funding to audit EMIS systems (EMIS audit), develop an EMIS implementation plan (EMIS implementation plan) and to install the metering and monitoring equipment (EMIS implementation). This program provides training and organizational support for implementing management information systems and processes. There were two EMIS projects for 2018.

Econoler conducted a program component documentation review, interviews with the program manager and carried out a desk review for the two projects (including a phone or site visit interview with both projects). Free-ridership and spillover were assumed to be zero so for this program component net savings are gross savings

are identical.

The evaluation of EMIS is appropriate to this program type and within the scope of an experienced independent evaluator.

Econoler provides one recommendation with six parts, concerning adjusting program delivery to better equip participants to better understand and fully master energy performance tracking methods (this recommendation applies to both EMIS and SEM). The other parts of the recommendation have to do with SEM baselines, SEM tracking, the SEM net-to-gross ratio (NTGR), SEM Net Savings and an EMIS 2017 recommendation for tracking that has not been fully implemented.

10. BNI Strategic Energy Management (SEM)

Strategic Energy Management is an approach for integrating energy management into business practice – so that a focus on continually advancing energy-efficiency becomes an integral aspect of workplace awareness and cooperative activity. This kind of approach has previously been used to uplift awareness and attention to quality assurance and in workplace safety campaigns. Generically, SEM focuses on changes in daily operations with management support that engage staff of an organization in energy efficiency thought, alertness and activities as they perform cooperative work. In a specific project it may be that only certain categories of workers are designated by management to be involved, such as engineers. It is a socio-technical approach to production that orients a production process to energy-efficiency goals. The origin of Canadian and US SEM programs is attributed to the Japanese Kaizen (continuous improvement) programs which assume that every process can be cooperatively improved and that with management support, intentional self- and corporate-discipline and awareness improvements can continue over time, indefinitely.[39]

For 2018, there were four SEM projects generating energy savings.

The evaluation approach includes a documentation review, an interview with the program manager and a savings review for each project. Econoler conducted an on-site visit with each project. Each project developed a regression approach to determining energy savings. The evaluator developed peak energy savings for each project. It was necessary for the evaluator to clean non-SEM energy savings from the ENS tracking system, although the project level information was sound. Based

[39] See https://www.investopedia.com/terms/k/kaizen.asp.

on project longevity, savings were assigned an expected useful life (EUL) of three years. Free-ridership and spillover were confirmed to be zero. Projects were found to be unlikely to continue tracking or to maintain continuous improvement without outside support.

The evaluation of SEM is appropriate to this program type and within the scope of an experienced independent evaluator.

Econoler provides one recommendation with six parts, concerning adjusting program delivery to better equip participants to better understand and fully master energy performance tracking methods (this recommendation applies to both EMIS and SEM). The other parts of the recommendation have to do with SEM baselines, SEM tracking, the SEM net-to-gross ratio (NTGR), SEM Net Savings and an EMIS 2017 recommendation for tracking that has not been fully implemented.

The curtailment of SEM and EMIS absent the service provider suggests that these efforts at technically and behaviorally oriented awareness, work engagement and monitoring systems are suffering the same fate as is common to related collective efforts that begin through mediation of an external community organizer when the organizer (change agent) leaves. Even though oriented to continuous improvement and a permanent change in collective sociotechnical behavior, they fail to become long-term when the organizer (an inspirational and technically able cultic exemplar) is withdrawn. Accordingly, it looks like some form of socio-technical circuit rider is required to keep sociotechnical corporate effort viable.

SVR-6: For SEM and EMIS, experiment with provision of a circuit rider to maintain contact and occasional sociotechnical engagement projects to help maintain technologies and self- and corporate discipline when the service provider is no longer available to a project. A pragmatic rule of thumb is that changes stay in place if they can be maintained for over five years and through at least one change of lead personnel.

11. BNI Direct Installation Program

The BNI Direct Installation Program is identical with Small Business Energy Solutions (SBES), available to businesses that use less than 350,000 kWh annually. There are

two paths within the program, the audit path and the do-it-yourself path. For 2018, there were 28 projects on the audit path and 501 projects on the DIY path. The DIY path includes 4 participants in the Affordable Multifamily Housing (AMH) pilot, which has an eligibility basis in affordable housing though it provides SBES-type measures.

Businesses that desire and qualify for the audit path are offered a free energy audit. Those that do not qualify may pay for an energy audit. Participants that follow the DIY path are provided quotes and invoice guidelines, product worksheets and referral to the Efficiency Trade Network (ETN). Participants can select measures or chose to employ a contractor to help with the decision on which measures to install. The application process was simplified for 2018.

The evaluation approach included an interview with the program manager and conducted 50 on-sites visits (for DIY, n=40; for Audit n=10). The on-sites were used to confirm that measures listed as implemented in the tracking system and the CIRx screening tool were in place. Additionally, hours of operation, information on characteristics of old and new equipment, and operating conditions were validated. Econoler conducted a full impact evaluation and a reduced market evaluation (there was no survey in 2018). The evaluator also reviewed and revised when necessary effective useful life (EUL) values for lighting measures for which baseline changes are expected during measure lifetimes. The net-to-gross-ratio (NTGR), free-ridership and spillover were assessed.

The evaluation of the Direct Installation Program is appropriate to this program type and within the scope of an experienced independent evaluator. The evaluation is complete and shows careful attention to detail.

Econoler does not provide specific recommendations for this program, and instead refers the general recommendations in the Overall Evaluation Executive Summary for all ENS program components.

This is the final program for which savings are credited to Efficiency Nova Scotia. Though Efficiency Nova Scotia supports Codes and Standards, Codes and Standards are viewed as primarily the responsibility of the federal government and the Province of Nova Scotia.

12. Codes and Standards

Energy savings and demand reduction impacts of Codes and Standards are evaluated by Econoler but are accounted outside the DSM Administrator's DSM

portfolio. Savings from Codes and Standards do not overlap with savings from programs and program components in the Efficiency Nova Scotia DSM portfolio. Savings associated with DSM programs represent increased savings relative to regulated minimum efficiency standards. Activity in Codes and Standards modify the regulated minimum efficiency standards and so affect program savings.
To improve energy efficiency, Natural Resources Canada (NRCan) implements minimum energy efficiency standards through amendments to the Energy Efficiency Regulations. In 2006 Canada established a Clean Air Regulatory Agenda. Three recent amendments to the Energy Efficiency Regulations aim "to deliver energy, greenhouse gas (GHG) and air pollutant reductions". The most recent amendment (Amendment 13) was published on December 28, 2016 and came into force on June 28, 2017.

In addition, Nova Scotia applies MEPS to street lights (Nova Scotia is the first province in Canada to make LED roadway lighting a minimum requirement). Nova Scotia also enforces an Energy Code applicable to houses, small buildings, large buildings, condos and apartments.

The 2018 Codes and Standards evaluation includes:

- Incandescent Lamps
- LED street lights
- New building energy code for houses and small building
- New building energy code for large buildings, condos and apartments.
- Clothes washers
- General service incandescent reflector lamps
- General service fluorescent lamps
- Fluorescent lamp ballasts

For 2018, the evaluation approach was secondary data analysis. First, data sources were selected. The data was collected from the Electro-Federation Canada (lamp-related shipment data, the Association of Home Appliance Manufacturers (AHAM Canada), NRCan, Nova Scotia Municipalities (street light stock data), the Canada Mortgage and Housing Corporation (building statistics) and Statistics Canada (building permit data and international imports of clothes washers). There were also interviews with retailers and manufacturer associations. Relevant studies were consulted and reviewed. Unitary savings and interactive effects were developed and reviewed. For each product, market size was estimated. Analysis of Codes and Standards requires relevant data plus wide knowledge and understanding of the context and workings of specific markets. Impacts are estimated as net energy savings and net peak demand reduction.

The evaluation methods employed, and analysis developed for Codes and Standards are within the scope of an experienced and professional independent evaluator.

Econoler provides two recommendations, both of which are practical:

(1) Consider removing houses and small buildings from the scope of the 2019 Codes and Standards evaluation because code in this area, as determined by the evaluator, has had a negligible impact on energy efficiency.[40]

(2) Consider removing incandescent lamps (40W, 60W, 75W & 100W) from the scope of the 2019 Codes and Standards evaluation since other technologies provide a more realistic baseline. Instead, the focus would be on more recent lighting regulations.

Energy savings and demand reduction from Codes and Standards are appropriately accounted outside the DSM Administrator's portfolio. Although Efficiency Nova Scotia is active in relation to Codes and Standards, energy impacts for Codes and Standards are seen driven by the federal government and by the Province of Nova Scotia.

[40] This would remove the 2015 National Building Code (NBC) affecting houses and small buildings from the scope of the 2019 evaluation. In contrast, the National Energy Code for Buildings (NECB) would be kept, since there are energy efficiency impacts for large buildings, condos and apartments.

VI. Summary of Findings

SVF-1: All 2018 evaluations conducted by Econoler are within accepted industry frameworks and evaluation standards. (Page 26)

VII. Summary of Recommendations

SVR-1: The Savings Verification study recommends acceptance of the 2018 evaluation results for energy savings and for demand-reduction for all programs. (Page 27)

SVR-2: The Savings Verification study recommends increase in the level of effort in process evaluation for the next evaluation to include participant observation by the process evaluator of one or two program components and development of a full process evaluation report. (Page 28)

SVR-3: In the Appendix or in the text of the next New Residential Homes evaluation, explain the concepts of expected useful life (EUL) and savings weighted measure life for the program. Show the derivation of the 30-year estimate used in the calculation of lifetime energy savings. Also calculate a separate EUL estimate for the Passive House pilot homes. (Page 36)

SVR-4: It can be observed that a well-built house itself can easily last 100 or 200 years, while components of the house such as appliances, shingles and windows require periodic replacement. Also, maintenance requirements are typically not conceptualized and included in DSM programs. Consider and report on the possibility of improving EUL (a) by taking maintenance requirements into account and (b) explain if a materials science or engineering approach to quality and longevity of components could improve EUL at reasonable cost. (Page 36)

SVR-5: When three of six cases are examined and there are modeling and/or calculation errors in each examined case, the evaluator should examine the remaining cases also. Errors should trigger additional examinations. (Page 39)

SVR-6: For SEM and EMIS, experiment with provision of a circuit rider to maintain contact and occasional sociotechnical engagement projects to help maintain technologies and self- and corporate discipline when the service provider is no longer available to a project. A pragmatic rule of thumb is that changes stay in place if they

can be maintained for over five years and through at least one change of lead personnel. (Page 41)

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IX. Appendix: Some Questions to ask of DSM Evaluations

(1) Is the evaluator free of conflicts of interests?

(2) Does the independent evaluator have control over methods and measurement approaches?

(3) Is the evaluation oriented to the goal of truth in measurement?

(4) Is the evaluation open, well documented and transparent?

(5) If the evaluator uses a Technical Resource Manual, are values and calculation methods critically reviewed?

(6) Are appropriate evaluation guidelines or protocols cited and used?

(7) Is impact evaluation supported by process and market evaluation?

(8) Is market evolution critically developed and well reported?

(9) Does the evaluator engage with program administration and program technical staff in the design of the evaluation?

(10) Does the evaluation make use of literature reviews and/or consultation with experts, where appropriate?

(11) Are problems identified by the evaluator during fieldwork reported to program managers on a timely basis?

(12) Does the evaluator follow up to check implementation of recommendations in the next program cycle and include follow-up in the next evaluation report?

(13) In a complex evaluation, does the evaluator include a list of abbreviations and definitions?

(14) In a complex evaluation, is method and measurement approach explained?

(15) For surveys, are the survey questions presented in an appendix to the evaluation?

(16) Is statistical confidence and statistical precision reported for surveys or interview sets?

(17) For programs that require on-sites, are there enough on-site visits?

(18) Are there careful project file reviews?

(19) Are there critical unitary savings reviews?

(20) Is analysis of metered energy data carried out correctly and used when it is relevant?

(21) Is there critical review of simulation models, when simulation models are used in a program and/or for evaluation?

(22) When metering is done, are potential problems with the accuracy and/or precision of metered results explored and reported?

(23) Is effective useful life (EUL) well estimated?

(24) Are avoided GHG emissions calculations conducted correctly?

(25) Is the method of calculation of free-ridership and spillover carefully reported and clarified?

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