SAVINGS VERIFICATION STUDY

OF THE DSM ADMINISTRATOR'S 2010 DEMAND SIDE MANAGEMENT PROGRAMS

MARCH 2011

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Table of Contents

FIGURES

TABLES

DSM SAVINGS VERIFICATION REPORT

I. Executive Summary

This report is a savings verification review conducted by H Gil Peach & Associates LLC for the Nova Scotia Utility and Review Board (Board). It reports on verification of savings estimated by NMR Group, Inc. (NMR), the Independent Evaluator for the Demand Side Management (DSM) Administrator's third year (calendar 2010) programs. The purpose of this report is to review, verify, and if appropriate, recommend adjustments to the savings data and estimates created by evaluation consultants engaged by the DSM Administrator.[1]

The examination is based on careful review of the evaluation for each program in the DSM portfolio, including review of each evaluation design, of evaluation methods and standards employed in each evaluation, and on selected checking of calculations. 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) and selected "due diligence" site visits to check installation counts and quality of work. In addition, the savings verification consultant watches the evolving general standards of practice in DSM and DSM evaluation to highlight best practices.

The purpose of this report is to review, verify, and if appropriate, recommend adjustments to the savings data and estimates created by evaluation consultants engaged by the DSM Administrator

In understanding how DSM works, probably the most important thing is to see it not as any single activity but as a *cycle subject to continuous improvement*. Figure 1 emphasizes the DSM cycle with four parts and with each part contributing knowledge to improve the other parts from cycle to cycle. The arrows in this diagram show the direction of the primary flow of activity within a DSM cycle.

Each step in the cycle feeds information forward to the Planning step, which proceeds continuously but is also implemented in a major planning study every three to five years to use in developing the next set of cycles. The Implementation step in each cycle feeds information forward to Planning, for example, through the records in the program

[1] Nova Scotia Power, Inc. served as DSM Administrator for the 2010 Demand Side Management Programs. Responsibility transferred to Efficiency Nova Scotia Corporation in October 2010.

data tracking system, but also from the development of deep practical knowledge and insights by program administrators into the realities of each type of program implementation. Over a few cycles, the program managers acquire deep and practical knowledge of specific sets of markets, technologies, codes, and common practices.

The Evaluation step should also feed timely information back to the Program Implementation step in order to provide opportunity for program corrections within the same cycle. However, Evaluation is primarily directed toward providing independent program assessments for the next Implementation step and for Planning.

Both the Program Implementation step and the Evaluation step feed information forward to the Savings Verification and Planning steps, for example, through the results of electrical measurements. The Evaluation step adds results of independent measurements of auxiliary variables (such as hours of operation) and results from observations, site inspections, and analysis/calculations.

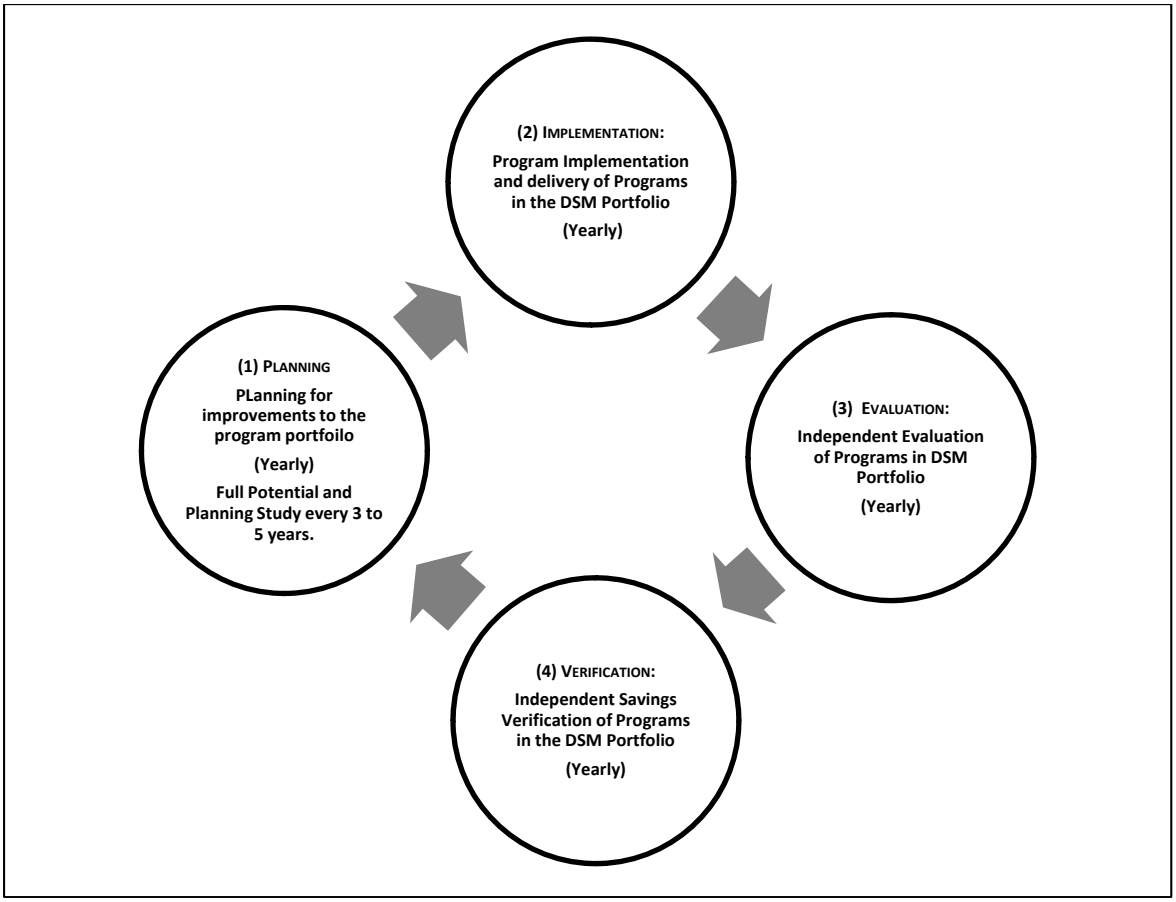

Figure 1: The Demand Side Management Cycle.

In the 2010 program year (the third program cycle), the DSM Administrator operated nine separate programs and two cross-cutting program support areas across customer sectors (Table 1).[2] NMR Group, Inc. (NMR), augmenting its team with co-consultants from KEMA, carried out impact and process evaluations of the nine programs:[3]

Table 1: DSM Portfolio for Program Year 2010.

DSM Portfolio for Program Year 2010		
Commercial & Industrial		
1	Commerical & Industrial Custom Program (C&I)	
2	Prescriptive Rebate Programs	
	2.1	Business Energy Rebates Program (BER)
	2.2	Smart Lighting Choices (SLC)
3	Small Business Direct Install Lighting Solutions (SBLS)	
Residential		
4	Efficient Products - Retail Program - Power Down (PD)	
	4.1	CFL Component
	4.2	Fixtures and Controls Component
	4.3	Appliance Rebates Component
5	Efficient Lighting -- Direct Install (DI)	
6	EnerGuide for Existing Houses Program (EEH)	
7	EnerGuide for New Houses Program (NH)	
8	Appliance Retirement and Replacement Program (ARR)	
	8.1	Appliance Retirement
	8.2	Appliance Replacement
9	Low Income Households - EnerGuide (LIH)	
Multi Sector		
10	Education and Outreach	
11	Development & Research	

[2] In addition, work was carried out to support development of custom new construction.

[3] This Savings Verification study is focused on impact, so also addresses the first nine program areas.

In preparing for this study, which includes review of the NMR impact evaluations, the savings verification team had initial meetings with the Nova Scotia Utility and Review Board (Board) staff and with the DSM Administrator's management, specialists and program managers and staff. The DSM Administrator provided full access to the records of each program, both written and electronic, including data on specific sites. We also met briefly with NMR staff for short discussions and met KEMA staff in the field on some site visits. NMR was helpful in responding to questions as we reviewed the NMR impact evaluations. We also conducted "due diligence" site visit inspections.[4]

In consideration of the fact that the Evaluation Reports for the 2010 series of DSM Programs were completed by NMR Group and filed on February 28, 2011 and the very limited time available to carry out the verification steps and prepare and submit a report in time for adequate availability prior to the UARB hearings in April, the savings verification team focused on review of the input numbers, assumptions, evaluation design, calculating methods, and values obtained or developed by NMR in estimating the energy savings and demand reductions for each program. It was also decided that the approach would be informed and supported by as many on-site check visits by the savings verification as could conveniently be scheduled and consistent with budget. Such visits were sometimes conducted with the DSM Administrator staff, sometimes with NMR or NMR subcontractor staff, and sometimes independently.

The 2010 savings verification approach includes the following steps:

- We reviewed the kinds of information available in the Program Tracking files developed and maintained by the DSM Administrator. During 2010 the new program database was completed by NSPI creating a central location for electronic program records. The new Program Tracking System was not used by most of the programs during 2010, but the data areas within the system were being populated by year-end. We look forward to active use of the new system by program managers beginning in 2011.

- Review of the NMR evaluated estimates provided annual energy savings and demand reductions. We reviewed the fit between program tracking numbers and evaluated results but for 2010 we focused on the evaluated savings. Note that the annual energy saving and demand reduction figures are *annualized values* regardless of what time of the year measures were put into service. They do not represent the "realized" savings for the calendar year of the program, but are the savings that should be realized when each of the projects operates for a full year.

- Reviews were carried out of the process used for each program to determine the values that were used to adjust the estimated savings and demand reductions for free-ridership and spillover impacts.

[4] Due diligence site visits are selected by the savings verification team and do not constitute statistical samples.

- For the 2010 program year, NMR was careful to assess interactive effects (*i.e.,* changes in the energy use of other devices or of a facility which sometimes offset or added to energy savings directly attributable to specific energy conservation measures).

- Finally, we focused this review at the generator level.

Basic Findings and Recommendation

There are two basic findings in this 2010 savings verification study:

Finding 1: All of the 2010 DSM programs were competently administered by the DSM Administrator. This finding is based on the NMR evaluations, our review of program documentation and tracking databases, interviews with the DSM Administrator's management, specialists, program managers, and staff as well as discussions with delivery agents and "due diligence" site visits. Some programs encountered problems and there are some areas in which we suggest improvements for the next cycle with a primary concern for internal program control and the reduction and/or explanation of free-ridership levels.

Finding 2: In general, NMR Program Year 2010 evaluations were conducted within industry accepted evaluation frameworks and within the appropriate professional scope of a firm of seasoned Demand Side Management evaluators, given the time constraints of the regulatory schedule. There is only one decision to meld samples in a single evaluation where this savings verification study differs from the evaluator's technical decision. There are some areas in which we suggest improvements for the next evaluation cycle with a primary concern for more electrical measurement to serve as a replacement for and/or as a correction factor in modeling. We also support NMR's recommendation for a Nova Scotia socket study.

The primary recommendation of this study is to accept almost all NMR results for Program Year 2010:

Recommendation 1: We recommend acceptance of the NMR evaluation results for energy savings and demand reduction for 2010, except for a ten percent (10%) cut for Efficient Products-Direct Install. We also identify some specific areas for improvement for the next DSM cycle.

The overall comparison of savings and demand reductions is shown in Table 2. The overall differences are quite small.

Table 2: Comparison of Energy Savings & Demand Reduction.

Overall Results: Evaluations vs. Savings Verification Study				
DSM Program	**NMR** (GWh)	**SVS** (GWh)	**NMR** (MW)	**SVS** (MW)
RESIDENTIAL PROGRAMS				
Efficient Products Residential*	12.65	12.65	2.71	2.71
EnerGuide for Existing Houses	8.14	8.14	2.17	2.17
Low Income Households	0.90	0.90	0.20	0.20
New Houses	0.68	0.68	0.81	0.81
Residential Total	22.37	22.37	5.89	5.89
C&I PROGRAMS				
Efficient Products - Direct Install	25.23	22.71	5.29	4.76
Smart Lighting Choices	6.25	6.25	1.19	1.19
Business Energy Rebates**	0.50	0.50	0.07	0.07
C&I Custom**	19.41	19.41	2.41	2.41
Small Business Lighting Solutions	11.21	11.21	1.53	1.53
C&I Total	62.60	60.08	10.49	9.96
PORTFOLIO				
Portfolio Total	84.97	82.45	16.38	15.85
*Includes the Power Down (Retail) and Appliance Retirement and Replacement program components				
**Includes Retrofit and New Construction				

Additional findings and recommendations are presented below and in the sections for the individual programs.

Specific Action Items

Improvements in evaluation methods to improve validity (balanced by reasonable cost) as well as some improvements in related areas are listed below as action items. Response to each of the following recommendations should be summarized by the DSM Administrator and progress reported to the NSUARB.

Recommendation 2: Increase Electrical Measurement. We continue to recommend moving measurement more in the direction of electrical measurement and passive (instrumented) monitoring and less in the direction of modeling and social science, though both electrical measurement and social science tools (surveys, interviews, observations, etc.) are important. This will result in some increase in evaluation cost. This year, for the 2010 programs, NMR introduced a rigorous analysis of the Low Income Housing EnerGuide program using energy usage data from the customer information system. This is an important improvement because it creates a factor grounded in the actual usage and billing system with which to correct (EnerGuide) modeled energy savings for the program

The general principle is that the closer DSM programs can be assessed in terms of actual energy usage (whether by short term metering or by use of usage and billing data from the customer information system), the more valid the impact evaluation results. The DSM Administrator or the Evaluator at the direction of the DSM Administrator should advance suggestions for electrical measurement and passive monitoring for each program where movement towards more electrical measurement and passive measurement is possible, and indicate those programs where it is not possible.

For example, the EnerGuide for Existing Houses program should move to a “non-equivalent control group” design. (Note that the “non-equivalent control group” design requires analysis of data from the previous year in order to have a twelve month “post-installation” period and requires access to data from a comparison group of very similar non-participant houses.)

Similarly, the correction factor developed from EnerGuide for Existing Houses “non-equivalent control group” design can be

transferred to EnerGuide for New Housing, assuming the evaluator determines there is enough similarity in the two groups of homes. Since new housing does not have a same house baseline the full "non-equivalent control group" design cannot be used, but the correction factor can be applied to the modeling effort.

Recommendation 3: For the Appliance Retirement and Replacement Program, two hour monitoring should be applied to an adequate sample of retired refrigerators. This will (if with a larger sample) permit a replacement of the "performance degradation factor" and "lab to site factor" in the modeling or (if with a smaller sample) permit development of a correction factor to be applied to the model.

In addition, the delivery agent should be required to capture a digital photo image of the machine label so that its age and energy use can be checked on a look-up table.

Recommendation 4: Where survey information is used to establish hours of use, at least some light loggers should be introduced as a check.

Recommendation 5: NMR has proposed a Nova Scotia socket study. We support NMR's recommendation that a Nova Scotia socket study be conducted. The socket study is essential for understanding the market transformation dimension of CFL and LED measures and will permit a "socket target" to be set for programs. For example, if the socket study shows an average of 45 sockets for a particular housing type or for the average house, the program target might be set to 36 sockets or some other number to be determined by the DSM Administrator.

Recommendation 6: We recommend that the DSM Administrator insure that the evaluator is assigned to make at least some site visits to each program and subprogram each year as a check.

The evaluation principle in this recommendation is that the evaluator should be engaged in the physical materiality of each program through at least a few site visits.

Recommendation 7: We recommend the DSM Administrator direct staff and/or program delivery agents to fully capture relevant baseline information of pre-program equipment tied to exact program replacements. For example, for the Efficient Products Direct

Install program, we recommend that for every tenth site, the delivery agent team be directed to bring back all removed bulbs. On each bulb a permanent magic marker would be used as it is unscrewed at the site to record a symbol for the exact type of CFL or LED used as a replacement. These records would be tallied for the year to support existing record keeping with more exact physical detail.

The evaluation principle here is documentation of physical materiality of exact replacements.

Recommendation 8: The DSM Administrator should direct the evaluator to continue the NMR's current practice of clearly separating reporting of sites finished during the program year and sites committed but not completed during the program year.

A goal of DSM is to treat DSM as a resource equivalent to generation. For that reason, it is essential that the evaluations treat completed work and "committed but not completed" work in separate sections of the evaluation.

Recommendation 9: The DSM Administrator should direct the evaluator to continue and expand NMR's current practice of clearly designating program designs and logic diagrams to indicate if the program is a Resource Acquisition program or a Market Transformation program (or both).

Where a program has measures that are part of a Market Transformation effort, the description of the market, the approximate current point of the product on the product adoption curve and the transformation goal for each measure should be reported.

Recommendation 10: According to NMR's analysis, free-ridership in some of the programs is relatively high. For example, for light fixtures it is sixty percent (60%), for power bars with timers it is seventy-six percent (76%), for indoor light timers it is eighty-four percent (84%), for heavy duty pool/outdoor timers it is sixty-seven percent (67%), for refrigerators it is seventy-two percent (72%), and for clothes washers it is eighty-five percent (85%).

NMR discusses these problems and proposes some solutions such as selecting equipment from higher Energy Star tiers

(within an equipment type meeting a minimum Energy Star standard, there is often very high savings variation). There is also the possibility of using Top Ten (http://www.toptenusa.org/).

The DSM Administrator or the evaluator as directed by the DSM Administrator should construct a table listing all programs and major subprograms, classify them by Resource Acquisition or Market Transformation program (or both), and state the free-ridership rate for each program and major subprogram.

The free-ridership rates should then be discussed in terms of the two DSM paradigms and as to which are low enough to be considered normal overhead, which need to be cut back (with strategies for reducing free-ridership to an acceptable goal), and which may be high due to the current stage of market transformation (along with the plan and time line for transformation of the particular market).

While a free-ridership of 72% or 85% may indicate a problem from a Resource Acquisition perspective, it may be an expected indicator from a Market Transformation perspective. In fact, as the tipping point is approached which will drive the inferior product from the market, program spending on free-riders may increase substantially.

In any case, the DSM Administrator or the Evaluator needs to address all programs and subprograms with high free-rider rates and explain either how the free-rider rates will be reduced or why they are strategically necessary given current context from a Market Transformation perspective.

Recommendation 11: The DSM Administrator should consider whether or not it may be useful to revisit approaches to assessing free-ridership. Currently, NMR is using an improved variant of the Oregon Energy Trust/Research Into Action method. Just as the original multiplicative method used in the first Program Year understated free-ridership, it may be that for certain programs the current method somewhat overstates free-ridership.

Recommendation 12: Beginning with the next set of evaluations, a policy on dual baselines should be stated and implemented for each program. This will require consideration of effective useful life (EUL) and remaining useful life (RUL) for each measure and whether or not a code or customary standard is in place to determine replacements in the absence of a DSM program. Currently savings is valued as the difference in energy use and demand between new equipment and equipment replaced.

The Effective Useful Life (EUL) is "an estimate of the median number of years that efficiency measures installed under a program are still in place and operable." Old equipment (to be replaced) also has an Effective Useful Life.

The Remaining Useful Life (RUL) of a piece of equipment that is replaced by a program is estimated by asking, at the time the equipment was replaced, about how many years were left in its useful life (without major repairs which may have led to replacement). Another way to put this question is, "How long would the old equipment have met the technical and performance needs of the facility? Another way to ask is, "Was the condition of the existing equipment fully functional?"

Generally, if the equipment was replaced on failure (that is, it has no RUL), the incremental savings is the difference between the energy use of the new DSM equipment and either the current code for the old equipment or the common practice replacement for the old equipment. If the equipment replaced has a number of years of RUL when it is changed out (early replacement) then the incremental savings is the difference between the energy use of the new DSM equipment and the old equipment for the duration of the RUL; then it shifts to the difference between the new DSM equipment and either code or common practice in replacement.

This description is an approximation to provide a general outline of considerations of EUL and RUL. The DSM Administrator or the evaluator should put forward a policy to be followed for EUL and RUL in evaluations for each program.

Recommendation 13: To improve presentation, we recommend that the DSM Administrator direct the evaluator to attach worksheets that

support calculations and results for at least one individual example project (reviewed by NMR for uniformity of format and easy interpretation by an external reviewer, and as is normal with project worksheets also signed and dated by the analyst who developed the worksheet). These example work papers would be included as a separate appendix to the 2011 evaluation. This will assist readers in following the calculation steps in the text of each program evaluation.

II. Frameworks for Understanding Demand Side Management

This section of the study sets up the framework for assessment of the programs and the evaluations which follow. There are three paradigms used for structuring Demand Side Management (DSM) effort (Figure 2). In this savings verification review, we make use of two of the three frameworks:

- The first is the resource acquisition framework[5] which draws primarily upon integrated least-cost planning and engineering perspectives.

- The second is the market transformation framework[6] which combines social science, marketing, and community organization perspectives which broaden the approach to resource acquisition.

- The third is the climate change framework. This is a framework which is clearly present and evolving in the background to current DSM in North America, but is not within current terms and conditions for the DSM industry or any of the regulatory jurisdictions, including Nova Scotia.

Sometimes a program and its evaluation may do very well in all three frameworks; sometimes in one or in two, but not the other(s). Each of the three frameworks deploys DSM under different principles and rules. This means that each framework deploys different types of DSM programs and different evaluation methods.

[5] For an overview, see Gellings, Clark & John H. Chamberlin, *Demand-Side Management Planning*. Lilburn, Georgia: The Fairmont Press, 1993.

[6] For a brief overview of this paradigm, 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.

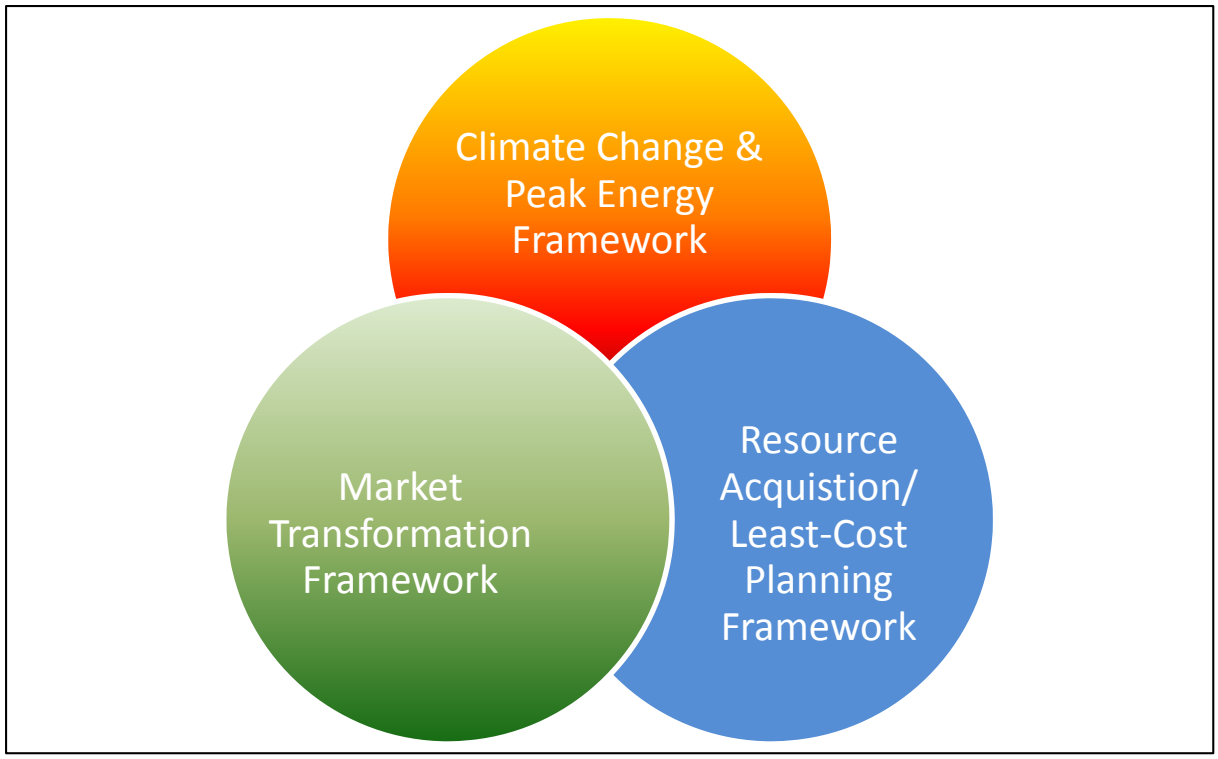

Figure 2: Three Frameworks for Demand Side Management.

The Resource Acquisition Framework

In the resource acquisition framework developed in the late 1970's through the 1980s by Amory Lovins, Roger Sant, and other pioneers of early Demand Side Management (DSM), the basic proposition is that it is often less expensive to conserve a unit of energy at the point of application than it is to generate and transmit it to the point of application.[7] For example, if a 13 Watt CFL can produce the lighting equivalent to that of 60 Watt incandescent bulb, last perhaps six or seven times longer and have a lower lifecycle cost, then it is a good candidate component for a resource acquisition DSM program. DSM is treated as an energy resource equivalent to a power plant and normally resource acquisition DSM program must pass a strict cost test that shows it is less expensive than the least-cost next generation plant (the "marginal plant").
If enough workable programs with strong energy saving and demand reduction components (and lower lifecycle costs) can be assembled and implemented, it is possible for DSM to delay the need for a new power plant, or to displace it entirely.

[7] For the linear programming methods underlying this approach, see Morse, William L. & H. Gil Peach, "Control Concepts in Conservation Supply," *Energy*, Vol. 14, No. 11, Pp. 727-735, 1989.

Because DSM energy savings and demand reduction must compete against the lowest cost new power plant (the "marginal plant" next in line for construction), units of DSM energy savings and units of DSM demand reduction are subject to stringent rules for cost control and for verification:

- These units must be available when needed; this is the analog to dispatch from a power plant.

- The units are also constrained to cost less (in lifecycle costing) than coal, natural gas, or nuclear energy; whichever type of plant offers the least-cost generation alternative.

The Total Resource Cost Test (TRC Test) is designed to insure no DSM project has a unit cost higher (unless a conservation or non-energy benefit adder is included on the demand side or a social discount rate is substituted for the utility discount rate) than the lowest cost of the next alternative generating plant.[8]

Also, in the resource acquisition perspective, energy efficient options face certain barriers to acceptance, and a major goal of program design is to overcome market barriers and increase customer participation.

The Market Transformation Framework

The market transformation framework originated independently in Canada and in Sweden and was later copied and adapted in the US and the EU. It has earlier roots in social science, marketing, and materials procurement; in particular, defense procurement. It can be seen as an extension of the Resource Acquisition approach.

- In the 1980s, BC Hydro designed its DSM incentive programs to facilitate energy efficient practices (for example in new construction) and to promote energy efficient appliances. On the surface, the intent was to get practices and more efficient devices into markets, change practices and build adoption. The deeper strategy was to move adoption forward to the point at which it would be politically possible to secure changes in provincial energy standards. These changes would make the new practices and products the mandatory baseline for the next cycle of development. Then higher efficiency practices and products would be promoted. Today, we regard this kind of strategy as self-evident, but for many years most DSM Administrators in North America were simply running marketing

[8] This is part of the Integrated Least-Cost Planning paradigm.

and promotion and only later was the deeper strategy introduced by BC Hydro understood and widely adopted.

- Meanwhile, in Sweden, a national government agency, NUTEK, was established to identify technologies and products amenable to rapid energy efficiency improvement. In this version of Market Transformation, modeled on WWII defense procurement, a good candidate might be a technology with few producers and a limited number of large institutional buyers. NUTEK staff met with these limited institutional buyer communities to explore favorable characteristics in the product, including energy efficiency, then jointly developed product specifications. Finally, they approached manufacturers with a guaranteed purchase agreement from the buyer group if the collaboratively developed specs were met or exceeded. The specific advantage of this approach was that it required little funding because the inducement to the manufacturers was a guaranteed purchase agreement if all product specifications were met.

Today, Energy Star, European Union directives (http://www.eceee.org/) and "TopTen" (http://www.topten.info/) are three of the forms taken by market transformation DSM. Addition of market transformation perspectives to resource acquisition DSM requires more sophistication in valuing energy savings and demand reduction than is typical for the resource acquisition approach by itself. Also, the program designs and evaluation approaches for market transformation are different than those appropriate for a strict resource acquisition framework. In the market transformation framework, in addition to individual equipment or device lives and lifecycle costing, product diffusion curves (adoption curves) also have to be considered.

These curves often mean that DSM incentive amounts *will not appear in balance with the cost of conventional power plants over periods of a few years to several years*. The balancing occurs later, when energy savings and demand reduction are summed over the adoption curve and product cycle.

To illustrate this difference of delayed savings, a generic diffusion curve is shown in Figure 3, and the Market Transformation multiplier effect is shown in Figure 4.

For the Market Transformation paradigm, Figure 3 shows a rough diagram of a typical product diffusion curve, for example, for regular CFLs. The vertical axis illustrates percentage adoption of household CFLs. The horizontal axis represents time after introduction, with time proceeding to the right. Adoption begins from zero with innovators and early adopters filling the first household sockets with regular CFLs. The first bend in the curve represents a point of inflection where an "early majority" of

households use at least one CFLs. The bend near the top of the curve represents the "late majority" and the final portion of the curve is where the last "laggards" adopt at least one CFL in their homes.

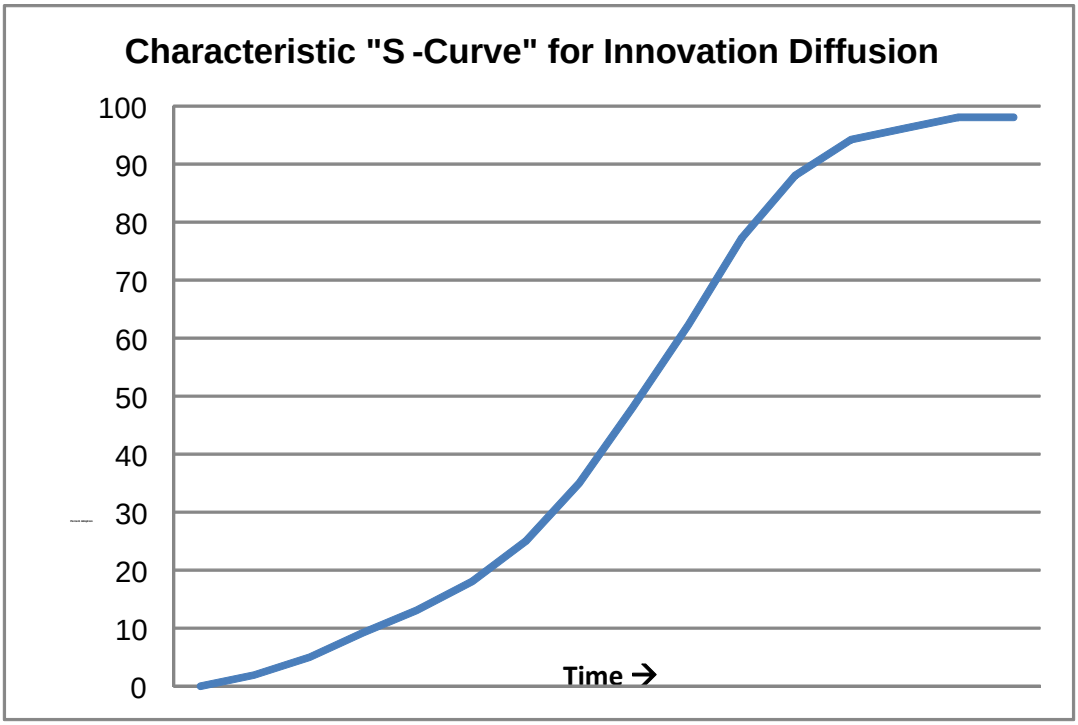

Figure 3: Generic Product Diffusion Curve.

The characteristic “S” curve shown in Figure 3 would have been drawn for introduction of a single CFL per home in the 1980’s. Today, following a socket study to establish a baseline, it would be drawn instead for a target number of sockets per home, for example if an average home or a home of a certain type has forty-four sockets, the target for CFLs and/or LEDs might be thirty-six. This change resets the curve back to zero and each increment along the curve is another home with at least thirty-six energy efficient lighting products installed.

A second Market Transformation diagram is shown in Figure 4. This diagram is taken form a Bonneville Power Administration (Bonneville) study of an upstream market transformation program.[9] In this program, for several years, Bonneville and regional

[9] Peach, H. Gil, C. Eric Bonnyman, Agneta Persson & Anne West, *Pacific Northwest Energy-Efficient Manufactured Housing: A Time of Paradigm Shift and Transition.* Beaverton, Oregon: H. Gil Peach & Associates, August 1997, a report for the Bonneville Power Administration.

investor owned utilities paid a subsidy to regional builders of manufactured homes sufficient to pay down the *full* manufacturer level cost difference between a regular home and a highly energy efficient home.[10] This project was successful in changing how homes were built in the Pacific Northwest region of the US.

As a result of the buy down at the manufacturing level, the cost to home buyers was marked down double the utility subsidy to the manufacturer. As market purchases of the energy efficient homes increased, plants began to stock only energy efficient windows and other components. When the utility payment ended, many plants continued to make the efficient homes, so that the price per unit of energy saved dropped dramatically as measured over the number of homes that received the buy-down plus the ever increasing multiple of that number built to the new standards but without a buy-down. This is the Market Transformation framework market multiplier effect.

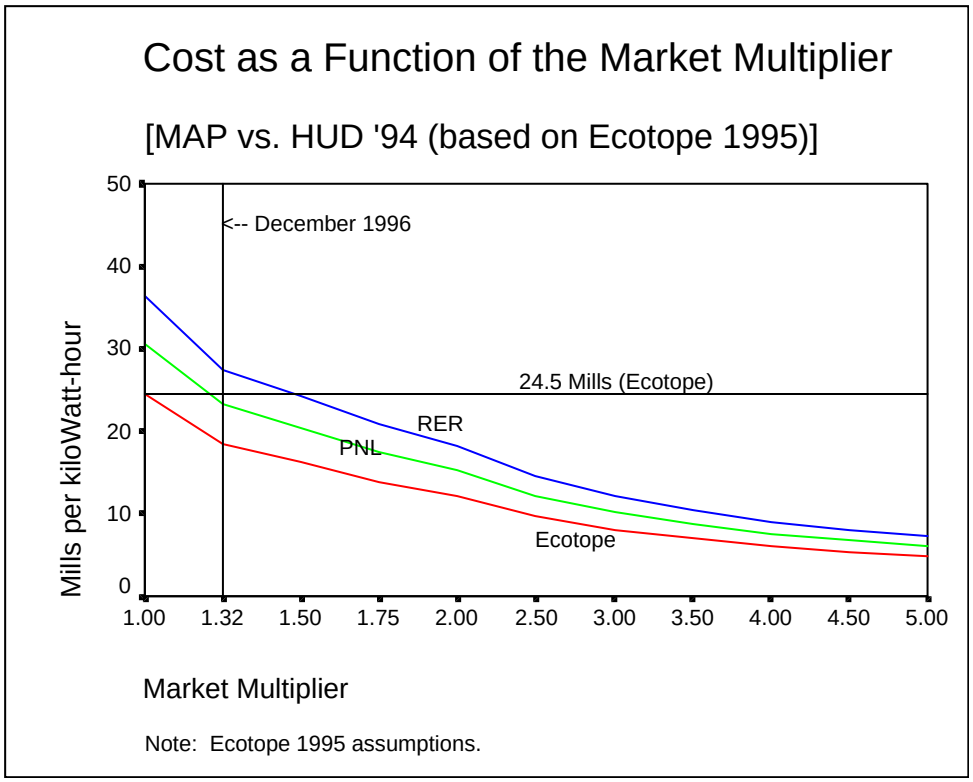

Figure 4: The Market Transformation Multiplier Effect.

[10] The buy-down at the manufacturer level cost approximately one-half of what the same buy-down would have cost at the consumer level. Once manufacturers ordered energy-efficient windows in large quantities, their price dropped substantially and there was limited storage space in the plants so some manufacturers decided it was less expensive and easier just to stock the energy efficient component for installation in all their homes.

The horizontal line at the middle of Figure 4 shows a constant cost as seen from the Resource Acquisition perspective. The three downward sloping lines represent results calculated by three different evaluation studies of the actual cost per kilowatt-hour with the multiplication effect taken into account.

As illustrated in Figures 3 & 4, the Market Transformation perspective requires a deeper understanding of markets than the Resource Acquisition perspective. There are times when the buy-down appears one way from a Resource Acquisition framework[11] and another way from the Market Transformation framework.

As a concrete example, Efficiency Nova Scotia's Smart Lighting Choices (SLC) program which is run through regional lighting distributors is very close to market transformation. If legislation is passed to mandate T-8 bulbs, Efficiency Nova Scotia can redirect this program to another target or withdraw it. In either case, the downward sloping lines of Figure 4 illustrate how the original program investment will have created a return spread over all future sales that will reduce ultimate program cost to a few mills/kWh and ultimately approach zero. This suggests why it is important to vigorously implement Smart Lighting Choices until the legislation is locked in and why any extra cost at this point in the curve will actually be very cost-beneficial when spread across all future units as well as units to date.

The Climate Change Framework

Climate Change provides a third framework for understanding the role of Demand Side Management. This framework is rooted in the second law of thermodynamics (heat energy) in its application on a human scale. In each of our non-renewable fuel contexts, useful heat energy becomes a smaller and smaller quantity, generally obtained at an increasing dollar cost and with an increasing loss of energy invested to energy harvested.

[11] The Smart Lighting Choices (SLC) program which is run through regional lighting distributors is a case in point. If acceptance of T-8 lighting through this program is becoming near universal as a result of the upstream buy-down by Efficiency Nova Scotia, is it worth it to continue the buy-down? The unplanned but perfect experiment which happened when Efficiency New Brunswick discontinued its program while Efficiency Nova Scotia Corporation continued demonstrates the answer. In New Brunswick, without legislation in place, business were found to be approximately 95% motivated by the dollar discount and only about 5% remained green purchasers. Stocking practices reverted to the older less efficient lighting equipment almost overnight. This information is taken from due diligence discussions with lighting distributors.

From an energy perspective, entropy is increasing in ways that directly affect us on a short-term (human) timescale. There are significant practical concerns regarding peak oil, peak gas, peak uranium, and peak coal. These concerns combine with the problem of the increased heating of the planet due to carbon loading of the atmosphere and the related problem of the acidification of the oceans.

The climate framework for DSM draws on the work of environmental and climate sciences.[12] The newest studies note that climate change could have been avoided or very significantly moderated had the world continued the wave of energy conservation and focus on clean energy that were associated with "energy conservation as the moral equivalent of war" in the 1970's. But, with the temporary return of inexpensive oil, social focus on conservation of energy rather quickly dissipated while the physical processes of the real world did not, so we now have to adjust to increasingly major changes in climate (high frequency of "freak" weather so that it becomes normal, rising water levels, melting tundra and undersea ice, loss of glaciations and ice shelves, reduction of world food supply, increasing of temperatures in general but intensification of winters in other areas, animal and plant migrations and die-offs, and the like). In *Eaarth*, Bill McKibben suggests we think of ourselves as having landed on an earthlike but increasingly hostile planet. In *Early Warming*, Nancy Lord relates her work with original peoples as they escape slowly rising ocean levels by moving villages to higher ground, adapt new crops and try to look after the local network of food supplies. In the *Maritime Book of Climate Change*, Richard Zurawski deals with specific impacts over relevant years to Nova Scotia and specifically to Nova Scotia's coastal communities and inland low-level areas.[13] Exactly how DSM should be adapted to these changes is being worked out, and is presumably a part of the pragmatic and ad hoc business of Efficiency Nova Scotia Corporation. Clearly there will be implications for where new buildings should be

[12] In conventional Resource Acquisition and Market Transformation DSM programs, amenity is preserved or enhanced. In the Climate Change paradigm the focus is on doing with less, doing without, localization, mutual cooperation, and community survival. See, for example: Murphy, Pat, *Plan C, Community Survival Strategies for Peak Oil and Climate Change*, Gabriola Island, BC: New Society Publishers, 2008; Odum, Howard T. & Elizabeth C. Odum, *A Prosperous Way Down, Principles and Policies*, Boulder, Colorado: University Press of Colorado, 2001; and Greer, John Michael, *The Long Descent, A User's Guide to the End of the Industrial Age*, Gabriola Island, BC: New Society Publishers, 2008. For an introduction to climate change, see Volk, Tyler, *CO_2 Rising, The World's Greatest Environmental Challenge*, Cambridge, Massachusetts & London, England: MIT Press, 2008. Also, Henson, Robert, *The Rough Guide to Climate Change,* London, England: Rough Guides Ltd, Second Edition, 2008. The major economist who advanced economics as confined within the entropy law and the rules of physics is Nicholas Georgescu-Roegen, *The Entropy Law and the Economic Process*, Cambridge, Mass. & London: Harvard University Press, 1971 & 1999, republished in New York, San Jose, Lincoln & Shanghai by ToExcel

[13] McKibben, Bill*, Eaarth, Making Life on a Tough New Planet*. New York: Times Books, Henry Holt and Company, 2010. Lord, Nancy, *Early Warming, Crisis and Response in the Climate-Changed North*. Berkely, California: Counterpoint, 2011. Zurawski, Richard, *The Maritime Book of Climate Change*: Lawrencetown Beach, Pottersfield Press, Nova Scotia, 2008.

sited and opportunities for improving essential public infrastructure such as police, fire, and medical facilities as well as schools to function well for the duration. The duration is likely to be quite long as problems intensify due to the long lag factor of carbon and methane cycling in the atmosphere plus the tipping points for additional natural release of greenhouse gases from tundra and undersea ice that cannot now be avoided. There are wonderful opportunities for program design in this area – for example, how can we build single family homes and apartments to get us through the greenhouse gas era with near zero energy use? The Swedes and the Germans have such houses and apartments. Can we ramp to that level?

The climate change paradigm for DSM is evolving and is not yet within the established terms and conditions for the DSM industry in any of the jurisdictions, so for now we are limited to the Resource Acquisition and Market Transformation frameworks. But it is a framework to think about; just as the Market Transformation framework was not within the terms and conditions of the original Resource Acquisition framework but is now settled practice, it is clear that a Climate Change framework is coming.

Framework Summary

The three frameworks (resource acquisition, market transformation, and climate change) imply different optimal program portfolios and different approaches to assessing energy savings and demand reduction. For example, resource acquisition DSM deeply discounts the future in keeping with its goal of demonstrating acceptable DSM programs as more attractive from an investment perspective than the marginal power plant and non-renewable fuel. In market transformation DSM, plans for tipping of markets and strategies of linking marketing and promotion to further steps in law and building codes are taken into account so that expenditure per unit may increase as the "lock-in" point for market transformation is approached. This basic reality of markets is something not readily understood in the resource acquisition framework. In the climate change approach, in contrast, policy goals for energy efficiency are set and the future is explicitly not discounted – it is either counted as equal to the present or counted as more important than the present.[14] At the same time, the appropriate cost tests shift towards the Administrator's Cost Test and the BTU/dollar test.

[14] This is, in part, simply a different philosophical perspective in which we wish the future to be better than the present or the past. It is also a perspective based on realistic expectations that energy prices will rise and available resources diminish due to peak oil, peak gas, peak uranium, peak coal and disruptions to food supply, production, and jobs due to climate change. In other words, we may be much more able just now to work with these changes than we will be in the future.

The DSM Industry's and Nova Scotia's current primary framework for savings verification is the Resource Acquisition framework (and usually the TRC Test is the primary cost test), but market transformation is also involved in some of the programs. Assessment of savings for Market Transformation is similar to Resource Acquisition, but, as discussed, deeper strategy is required wherein timing and adoption curves are also taken into account. As we move deeper into Climate Change some programs may be moved into a Climate Change framework (with the Administrator's Cost Test and the BTU/dollar test).[15]

III. The Individual Program Evaluations

The development of the NMR estimates of energy savings and demand reduction attributable to each DSM program was carefully reviewed. Our opinion is that the estimates are reasonable, and are good approximations of actual savings. There is a minor exception for the Efficient Products – Direct Install Program (DI) where the savings verification estimates differ by ten percent from the evaluation estimates.

In this section the programs are discussed, in turn

(1) 2010 Commercial & Industrial Custom Program (C&I)

The Commercial and Industrial (C&I) Custom Program was first implemented in the 2008 program year. The program provides financial incentives to large commercial and industrial customers that complete energy studies and audits, and who implement electric energy efficiency measures and programs at their facilities. The program originated as, and continues to be, a well-designed and well-run program. It benefits from a well-designed sequence of activities and events that must be followed as the project progresses. The program has developed a detailed and well-documented data tracking and recording process, effective policies and procedures designed to screen-out and minimize free-ridership, and a rigorous monitoring and verification approach including a tracking system for maintaining careful watch over the progress of the work and the estimation of energy savings. A centralized data system was implemented in the summer of 2010, and while all of the 2010 projects are in the new system, work remains to be done to smooth and fine-tune various aspects of operation of the data

[15] But note that this will be a new thing, not following a precedent but setting a new pattern on a trial basis.

system. Data tracking and entry procedures will be expanded and enhanced as the system matures.

The C&I Custom program continued its mandate in 2010 to provide large commercial and industrial customers financial incentives to implement the more complex electrical energy saving projects where more detailed study, feasibility assessment, project coordination, savings measurement and verification are all part of the project. The 2010 C&I Custom program recorded one hundred and two (102) projects that received incentive payments for work completed in 2010. The number of projects exceeds the number of participating customers because of instances where more than one project was carried out at a given facility. Partial savings were credited, and incentive payments made, for portions of some 2009 projects that were completed in 2010, or for installations installed in 2010 on projects that will be completed in 2011.

For the process of estimating the energy savings attributable to the projects completed in 2010 the NMR evaluation team used program and project records, telephone survey data from a sample of customers, and data and information obtained through site visits to a sample of the projects. The telephone survey data and information was used to estimate spillover and free-ridership effects.

To determine size and select a sample of projects for the evaluation of savings, NMR used Model-Based Statistical Sampling (MBSS) methodologies. Targeting a $\pm$ 10% relative precision at the 90% confidence interval for energy savings at the program level using MBSS with an error ratio of 0.25 suggested a sample size of 14. Fourteen sites were visited, but one was later removed when it was realized that it had been credited to the 2009 program. NMR deemed that the final sample design remained fairly optimal in capturing greater savings at the larger sites than the smaller ones.[16]

In reviewing the range of types, and frequency, of the equipment that was installed through the 2010 program, and of those in the sample, it was deemed that there was reasonable diversity represented in the selected sample. Lighting measures represented the majority of the sample, and savings from lighting retrofit were also the most substantial among the largest sites in the program population. Non-lighting measures that were reviewed and analyzed included refrigeration, motors, HVAC, and envelope installations.

[16] During the verification process members from the H. Gil Peach & Associates LLC also made visits to twelve of the projects from the 2010 C&I Custom program.

In the range of measure types that were represented in the site visits, the lighting retrofit included a single 'traffic lighting' project, refrigeration included a project where control and operational modifications were made at 19 different locations, motors included a project involving 43 motors, and envelope included a newly constructed facility that NMR characterized as a 'whole building' energy efficiency project as it included HVAC, insulation, and lighting measures.

When visiting project sites the work focused on various tasks, including:

- verifying that the proposed types and quantities of equipment had been installed
- collection of equipment specification data and operating schedules and conditions
- confirming operating schedules, both pre- and post- installation of the new equipment
- identifying areas of facilities served by electric space heating or cooling in order to calculate interactive effects on savings
- verifying that the records of pre-retrofit equipment of fixture types and characteristics are valid

As mentioned above, the sample of sites to be visited as part of the 2010 evaluation included a newly constructed facility, which incorporated HVAC, thermal insulation, and lighting measures. Since both the lighting and insulation measures had a direct effect on the HVAC operation and savings it was necessary to investigate savings for each measure as a combined exercise. To do so, a building simulation modeling approach was used for the analysis. Following completion of the calculation of all measure level savings for each sampled site, NMR developed an estimate of the annual energy savings and peak demand reduction, at the generator level. The site level results were then translated into the program level impacts for the 2010 program year though the use of stratified ratio estimation techniques.

For the C&I Custom program in 2010, the results of the calculations, including interactive effects, show gross installed annual energy savings, at generator-level, of 21,570 MWh, and peak demand reduction of 2,672.8 kW.

None of the participants interviewed reported any additional purchases or installations of the same types of equipment as they had installed through the C&I Custom program. The spillover rate was thus recorded as zero.

Results of the questioning of participants and analysis of responses from the new free-ridership questions and protocol were developed. These were developed subsequent to the DSM Administrator coordinated Free-ridership Symposium held in May 2010, which mirrored the free-ridership calculations developed for the Energy Trust of Oregon by Research into Action, and rendered a free-ridership value of 10%.

It is important to note that three different methods were used to determine the free-ridership percentage for the 2008, 2009 and 2010 program years. In the 2008 year evaluation NMR used an approach and series of questions based on standardized methods outlined by PA Consulting in 2003. The free-ridership value for the 2008 program was determined to be 1%. In the 2009 program year NMR used a similar approach as for 2008, but used an arithmetic mean of two components and a more conservative scoring method for the factors in the calculations. The free-ridership value for the 2009 program was determined to be 6%. For the 2010 program year evaluation NMR completely revised the questions in the survey and mirrored the free-ridership calculations developed for the Energy Trust of Oregon by Research into Action. The free-ridership value for the 2010 program was determined to be 10%.

Applying the values that were determined for spillover and free-ridership, the net-to-gross ratio for the 2010 C&I Custom program is 90% for each of energy savings and peak demand reduction.

Applying the net-to-gross ratio to the estimates of the gross energy savings and peak demand reduction shows the final estimates of net savings for the 2010 C&I Custom program to be 19,413 MWh of energy savings, and 2,405.5 kW of peak demand reduction, at the generator level.

Recommendation: We recommend acceptance of NMR's energy savings and demand reduction results for this program for 2010. The methods used in the analysis were appropriate for the time allotted for the evaluator to complete 2010 program evaluations.

Recommendation: We recommend that the DSM Administrator continue to support the program emphasis on baseline measurement and spot metering.

Recommendation: We recommend that this very successful program be continued into future program cycles.

(2) 2010 Prescriptive Rebate Programs (BER & SLC)

There are two Prescriptive Rebate Programs: Business Energy Rebates and Smart Lighting Choices.

Business Energy Rebates (BER)

The Business Energy Rebates (BER) program was a new program in 2010, launched at the end of June 2010. The BER program provides financial incentives, through prescriptive rebates, to businesses throughout Nova Scotia for the purchase of qualified energy efficient equipment for installation in their premises. Qualified equipment includes: lighting, motors and drives, HVAC equipment, refrigeration equipment, and compressed air equipment.

The BER program was modeled closely after successful prescriptive based DSM programs in other jurisdictions, and more specifically Efficiency Vermont. The technologies targeted for the initial launch of the BER program were recommended by Efficiency Vermont as having best suitability for initial uptake. Efficiency Vermont also provided other information and data to assist in the initial program planning and development, such as eligibility criteria, savings estimates and lists of 'approved products'.

The BER program was initiated as a resource acquisition program. However, long-term focus of the program is to encourage and assist market transformation by influencing the practice of business customers toward consideration and adoption of energy efficient technologies and equipment. In its present form the BER program is somewhat akin to a junior C&I Custom program, and focuses on somewhat more typical applications of smaller energy efficient equipment. The program does not call for a customized approach like the C&I Custom. Participants in the BER program must first purchase and install energy efficient equipment, and only then may apply for a rebate through the program.

In the 2010 program year there were thirteen (13) customers who participated in the BER program and received a rebate from the DSM Administrator.[17] The majority of responders to enquiries by NMR indicated satisfaction with the program. Despite the high level of satisfaction indicated by the responders, they were least satisfied with rebate amounts offered by the program. In spite of the time required to introduce and generate interest in a new program, NMR reported that their findings from participant surveys showed that businesses in Nova Scotia are interested in a program that offers incentives to procure energy efficient equipment.

[17] During the verification process members from H. Gil Peach & Associates made site visits to four of the projects from the 2010 BER program.

To carry out an estimate of savings attributable to the installations of energy efficient equipment completed under the program in 2010, the NMR evaluation drew upon a review of program records, site visits to a sample of participating businesses, and telephone survey data. The telephone data were used to estimate spillover and free-ridership impacts. There were a total of thirteen sites with installations credited to the 2010 program year. Eight of the sites were retrofits, and five were new construction. Rebated measures were divided among three primary measure types: lighting, motors and drives, and HVAC. Site visits were made to eleven of the thirteen sites. Two additional sites were completed and received rebates after the visits had been made. The latter two sites had the two highest estimated savings of the thirteen projects, so the NMR team contacted the participants by telephone and obtained the necessary data to refine and verify their savings estimates. Evaluation activities included a review of the files for each project, and visits to eleven of the thirteen sites. While at the sites various checks were made, quantities and types of equipment verified, and other related data collected. As NMR stated, they "collected the most accurate information available to inform the evaluated savings". The impact evaluation was carried out for each of the three major categories of equipment (lighting, motors and drives, HVAC) individually, then combined and netted out by application of the calculated factors for spillover and free-ridership.

Lighting

The lighting savings that were estimated are those realized from the replacement of older lighting units with new and more efficient units, thereby obtaining comparable or improved lighting levels using less power. In some situations additional energy savings may result from interactive effects, *e.g.* where reduced heat from lighting lessens the cooling load in air-conditioned spaces. For the lighting savings analyses NMR followed recognized and accepted data collection, compilation, and analytical procedures. Data pertaining to interactive savings were collected during site visits. Among the sites visited none had new lighting installed in spaces with electric heating, and two had new lighting installed in air conditioned spaces, so the total energy savings for the lighting projects was the combination of the connected load savings plus the cooling interactive energy savings. After all adjustments were applied for each site, the estimate of total gross electric energy savings at meter level for the lighting measures installed through the BER program for 2010 was 514.9 MWh, and estimated peak demand reduction of 75.5 kW.

Motors and Drives

The only equipment installed under the 'motors and drives' category in the NMR sample of sites was variable frequency drives (VFDs). VFDs adjust a motor's speed to meet the load, thereby reducing the motor's input power. Four projects in the BER program involved installation of VFDs. Three of the four had unique operating conditions, so each was evaluated separately using a load profile, hourly bin analysis approach. The fourth project involved installation of VFDs on supply air and return air fans in an office building. For this project the calculation of energy savings and peak demand reduction used the same methodology as was used by the DSM Administrator to calculate the tracking savings estimates. The estimated gross energy savings at the meter-level for the motors and drives installed through the BER program for 2010 were 345.2 MWh, and estimated peak demand reduction of 47.7 kW.

HVAC

Four of the projects in the BER program in 2010 involved installation of HVAC equipment. Each of the sites had a new high-efficiency air-source heat pump installed. In preparing an estimate of the savings for these four projects the NMR evaluation team carefully reviewed the methodology used by the DSM Administrator to estimate the savings in the tracking system. NMR agreed that the approach used was appropriate, but made a few adjustments to better define and improve the estimation process for the four projects of the BER program. The resultant estimate of gross energy savings at the meter level for the HVAC equipment installed through the BER program for 2010 was 11.8 MWh, and estimated peak demand reduction of 2.9 kW.

Overall Combined Energy Savings and Demand Reductions

Combining the estimates of gross savings for the three categories of equipment installed through the BER program in 2010, and using a factor of 1.069 to calculate the generator level savings from the meter level savings, provides a total gross energy savings estimate of 932.0 MWh, and peak demand reduction of 134.8 kW, at the generator level. Spillover and free-ridership impacts were assessed and calculated from data obtained through telephone interviews with a sample of program participants. Because of the nature of the program, spillover was found to be zero, while the free-ridership level was determined to be a high 46%. As the final calculation for the overall BER program, the net-to-gross ratio of 54% was applied to the gross estimates at the generator level to provide a final figure of net energy savings of 503.3 MWh, and peak demand reduction of 72.8 kW for the Business Energy Rebate (BER) program for 2010.

Recommendation: We recommend acceptance of NMR's energy savings and demand reduction results for this program for 2010. The methods used in the analysis were appropriate for the time allotted for the evaluator to complete the 2010 program evaluations.

Recommendation: We recommend that the program be continued and expanded. The program is new, has been well received, has good potential for meaningful expansion, and fits well beside the C&I Custom program to provide financial incentives to smaller companies for installation of less complex equipment.

Recommendation: As stated above, participants in the BER program must first purchase and install energy efficient equipment, and only then may apply for a rebate through the program. Because of the very nature and sequence of activities of the program, and in view of the high percentage of free-ridership calculated for the 2010 program, we concur with the NMR recommendation that some form and level of screening to reduce free-ridership should be reviewed and implemented into the program protocol.

2010 Smart Lighting Choices Program (SLC)

Smart Lighting Choices had been operated by Conserve Nova Scotia in prior years and in 2009 and 2010 by the DSM Administrator. The Smart Lighting Choices Program is an upstream lighting program that is designed to produce market transformation in the non-residential lighting sector by working through lighting distributors to buy down the price of energy efficient lighting offered by the distributors. This program has been successfully implemented for a sufficient time that its effects can ultimately be coordinated with legislative efforts to require high-efficiency T8 lighting. If this legislation is introduced and becomes law, Smart Lighting Choices will be an example of a successfully completed market transformation.

The program provides financial incentives for units of qualified lighting products (focusing primarily on 4-foot HP T8 fluorescent lighting) sold for installation in non-residential facilities throughout the Province. The incentive is paid to the distributor, with part intended to be retained by the distributor as a fee, and the balance passed on to the end-user in the form of reduced cost. The program is intended as a market transformation program, with the goal of shifting the non-residential market from the traditional T12 fluorescent fixture with magnetic ballast to a high performance T8 fixture with electronic ballast.

The NMR impact evaluation for the 2010 Smart Lighting Choices Program was performed using similar methodologies as in the 2009 evaluation for the same program. The evaluation relied heavily on 2009 program evaluation efforts to augment the 2010 impact evaluation. The impact evaluation consisted of determining replacement watts for installed fixtures, annual hours of operations for installed units and a measure of unit installation rates for the program. NMR analysis consisted of in-person interviews with distributors (4 of 6) and document reviews of sales information for 5 to 15 sales transactions from each distributor. To determine installation rates, on-site verification visits were performed for a number of program participants. A review of sales documentation provided by distributors was also compared with the tracking database information to ensure consistency.

The baseline for this program was developed by NMR by comparison to current market availability for new construction projects. This method of baseline determination is consistent with current evaluation methods. An alternative approach, actual pre-post inspections of a statistically significant sample size would offer better validity and precision and also likely yield greater energy savings results but would significantly increase costs of the overall evaluation. This method of baseline determination assumes that, in absence of the program, non-residential retrofits would install T8 lamps with standard electronic ballasts. This method does not credit the program incentives with creating new retrofit projects. Therefore, the evaluation method is conservative.

Installation rates were determined using verification visits to nine (9) sites and this result was then compared with the 2009 evaluation rates. Since the sample size of the verification efforts was not large enough to yield statistically significant findings, the results of the 2009 program evaluation phone-interviews (11 customers) were averaged with the 2010 findings to produce a final installation realization rate of 93%. The evaluation methods for finding the installation rates of both the 2009 and 2010 programs utilized small sample sizes and neither produced realization rates are of statistically significant value. In addition, since the smart choice lighting program is an upstream program, verification sites were chosen based on distributor sales records and were not taken from completed project sites from installation contractors. The inspection of sites that were still in the process of implementing the program at the time of the evaluation, coupled with the small sample size, may yield an artificially low overall program installation rate than the actual program installation rate. This rate is therefore conservative.

Hours of operations of installed lighting measures were based on the small 2010 verification sample. Comparison was also made with findings of other non-residential lighting program evaluations including the evaluation of the 2009 cycle as well as

comparative studies of other Northeast US region non-residential lighting evaluations and case studies. The determined value for average annual hours of use per fixture of 3,400 hours per year is consistent with previous findings and, given the sample size constraints, is also a conservative yet reasonable value.

The 2010 evaluation of the Smart Lighting Choices program relied completely on the 2009 evaluation determinations of free ridership. It is unclear whether free ridership rates will change year over year for this program. The 2009 evaluation determined a free ridership rate of 16% with no spillover.

Results, including the impact of free-ridership, are 6,242.1 MWh saved at the generator and a peak demand savings of 1,188.9 MW saved at the generator. This is an excellent performance by the Smart Lighting Choices program. The Smart Lighting Choices 2010 evaluation results are conservative but may be considered reasonable given constraints in the evaluation budget necessitating smaller sample sizes for the program evaluation.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be accepted for 2010. The evaluation methodology used was consistent with industry standards and fit within the evaluation budget guidelines.

Recommendation: We recommend that the Smart Lighting Choices program be continued as an effective non-residential DSM and market transformation effort until an upgrade in lighting codes to T-8 occurs. The problem of discontinuing a successful program prior to updating code was recently shown in New Brunswick where funding for a similar program through lighting distributors was dropped and practice almost immediately shifted back to the less efficient products. For this reason the DSM Administrator should continue its focus on development of legislative code for this technology.

(3) 2009 Direct Install (Small Business Lighting Solutions Program – SBLS)

In 2010, the program was expanded to cover Nova Scotia, with six service areas. The program had relatively low levels of free-ridership (about 13% in 2010) which fits well with the general picture that small businesses must focus on the business and have neither the special expertise nor the available time or personnel to learn the lighting area.

Last year NMR recommended that the program focus on performance of Delivery Agents, Electrical Contractors and Materials Vendors as the program expanded.

Customer satisfaction remains quite high, indicating that this focus has worked. However, supply and timing of delivery constraints were experienced with the previous system of a single low-cost materials vendor when the program expanded. So for 2011 the program is to switch to multiple materials vendors with each contractor responsible for securing materials at reasonable price. In 2010 the recycling capability introduced in 2009 was expanded to all six service areas. The program offers lighting retrofits to eligible participants at 20% of installed cost, with the DSM Administrator responsible for the remaining 80% of installed cost. The participant cost can be financed, interest free, for up to two years. Eligible small businesses have an average demand of less than 100 kW and an annual electricity use of less than 300,000 kWh.

NMR approached the impact evaluation to employ a billing analysis but two barriers were encountered. First, it was not possible to develop an adequate non-participant comparison group. Second, it became evident in running trial billing analyses that the DSM Administrator's records did not contain all accounts for each program building so that program effects could not be properly captured. Accordingly, NMR decided that the best option was to conduct the 2010 analysis using data from site work carried out during 2008. For purposes of the Savings Verification study, we agree that NMR chose the best of the available options. For 2011, NMR recommends the evaluation approach be based on on-sites with time of use meeting. For purposes of Savings Verification, we support NMR's recommended approach of on-sites and time of use metering for 2011.

NMR took several steps to compare 2008 activity and results with 2010 activity and results to insure reasonable compatibility. NMR also compared 2008 results for energy savings at the meter and at the generator with result of several other studies from the Northeast region of the US and demonstrated that the DSM Administrator's results for 2008 closely match the expected outcomes based on these other additional studies. Spillover was estimated conservatively (minimizing it to "participant-like" spillover). Free ridership was estimated using an improved variant of the Oregon Energy Trust/Research Into Action method. The final result is 11,210 MWh of energy conserved at the generator and 1,529.9 kW of coincident demand.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be accepted for 2010. The evaluation methodology used was the best method given the time constraint, the evaluation budget, and the problems in the DSM Administrator's data tracking system which made it impossible to link meters with lighting circuits (and also, for the same reason, to establish a reasonably similar non-participant comparison group) so that the original billing analysis approach could not be used.

Recommendation: We recommend that the Small Business Direct Install/Small Business Lighting Solutions Program be continued since its relevance and usefulness for this business sector has been demonstrated across three program and evaluation cycles.

Recommendation: We recommend that the DSM Administrator use 2011 to find a solution to the matching of accounts, meters, and circuits for this program type in a form that is easily retrievable and easily interpreted by the Evaluator from the Data Tracking System.

Recommendation: We support NMR's recommendation to conduct the 2011 evaluation for this program using on on-sites with time of use meeting.

(4) 2010 Efficient Products Retail - Power Down Program (PD)

The Power Down program provides in-store rebates and coupons for the purchase of CFLs, Energy Star appliances (refrigerators and clothes washers), indoor light fixtures and controls (programmable thermostats for baseboard heaters, indoor lighting timers, heavy duty outdoor or pool timers, power bars with integrated times and dimmer switches). Evaluated savings estimates for program measures are consistent with those of a well-designed and marketed program. While free-ridership issues exist for appliances, light fixtures and equipment controllers, these effects are not out of line with similar programs. At the same time relatively high free-ridership can be a signal to modify the program to reduce free-ridership.

CFLs

Absent lengthy and expensive market assessments of Nova Scotia CFL consumption patterns, it can be assumed that significant spillover benefits can be attributed to this successful program. In contrast, recent evidence from the US shows that in states without CFL incentive programs consumers are experiencing year-on-year declines in CFL consumption.[18] Interactive effects for the CFL portion of the Power Down program were estimated by NMR using simplified engineering methods.

[18] Leora Broydo Vestel, "As CFL Sales Fall, More Incentives Urged" *New York Times,* September 28, 2009

Fixtures and Controls

Fixtures and controls included Energy Star indoor light fixtures, outdoor/heavey duty timers, programmable thermostats for electric baseboard heaters, hard-wired indoor light timers, dimmer switches, and power bars with integrated timers. Impact estimates were developed from a review of secondary sources, with primary reliance on a 2010 Ontario Power Authority report.[19] Savings rates associated with programmable thermostat settings for baseboard heating in the NMR evaluation were deemed from a 2010 Ontario Power Authority (OPA) report. It can be reasonably assumed that the rate of annual savings determined by OPA for programmable thermostats coupled with baseboard heaters is accurate for Ontario. The deemed savings rates associated with room heaters for Ontario are likely somewhat lower than actual savings for the same equipment installed in Nova Scotia. While Ontario does experience slightly colder winters on average, the maritime climate of Nova Scotia has significantly cooler summers. This factor should lead to increased heating usage and increased actual savings in Nova Scotia as compared to the Ontario study.

Specialty Bulbs

The decline in specialty bulb sales from 2009 to 2010 indicates that these products are still underutilized in the market. To cite an extreme case, market analysis in California, where there has been many years of CFL promotional campaigns, indicates that the consumer awareness levels of specialty CFL products, especially dimmable CFL bulbs, has not reached levels sufficient to produce a sustainable rise along the product diffusion curve. Last year, Summerhill Group, the Program Delivery Agent, conducted in-store events in 36 locations, including specialty CFL give-aways, torchiere exchanges, and seasonal holiday lights exchanges, but there was less promotional activity during 2010.

Energy Star Appliances

The Power Down appliance rebate opportunity ran from October 1, 2010 through the end of December 2010 and included two appliances: Energy Star refrigerators and Energy Star clothes washers.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be accepted for 2010. Although the spillover results may be high, the baseboard thermostat savings are likely low and the overall result is reasonable for 2010.

[19] Ontario Power Authority, *2010 Prescriptive Measures and Assumptions*, January 2010.

Recommendation: For the next program cycle, we recommend a ramping up of in-store promotions for specialty CFLs.

Recommendation: For the next evaluation cycle, we recommend direct monitoring of a small baseboard heater control sample to establish a Nova Scotia value.

Recommendation: For the next evaluation cycle, we recommend NMR partition spillover between program and other market effects.

(5) 2010 Efficient Lighting - Direct Install (DI)

The Efficient Lighting Products Direct Install Program has exceeded its aggressive target goals by substantial margins for each year since the program's inception in 2008 as a pilot program. This program has produced high customer satisfaction and has increased DSM awareness in the Nova Scotia small business and commercial sectors. This is both a resource acquisition and a market transformation program.

An issue with this program is that in due diligence visits by H. Gil Peach & Associates, we determined a significant percentage of unrealized potential savings were being left in the market. These missed savings in the program were due to the unavailability of dimmable CFLs in the program portfolio. In several sites visited the potential for savings for these bulbs was comparable to the overall site savings realized by the program with non-specialty CFLs. It is recommended that specialty CFLs, especially dimmable CFLs be emphasized in the portfolio for the next cycle.

A second issue occurred with an overstatement of work performed by an implementation team (the problem was confined to a single team, rather than the program). The NMR evaluation report utilized a revised estimate of tracking system savings due to a corrective analysis performed by the implementation contractor. During the evaluation process it was discovered that a specific implementation team had misstated their work. This led to immediate dismissal of the team in December 2010 and the adoption of strict process changes to be put into effect in January 2011:

(1) The program audit coordinator will be responsible for conducting bi-weekly audits on all installers' waiver books vs. Footprints tracking system data to ensure accuracy throughout the program delivery year to identify any discrepancies immediately.

(2) The program audit coordinator will be responsible for checking customer satisfaction calls (25% of total participants) and for on-site spot checks (15% of total participants) to confirm all recorded details of installations.

(3) Installer books will be revised to include three carbon copies (for business participant, installer record, and for program coordinator audit) and a new section will require details and business/installer sign-off if bulbs are left behind for maintenance staff to install (with a requirement to be installed by a particular date).

(4) If bulbs are left behind for installation by maintenance staff due to safety or security reasons, follow-up calls and visits will be conducted for every applicable business by the responsible installers to confirm installation. If installation is not completed by the agreed upon date noted on the waiver sheet, the bulbs will be picked up by the installers and program records will be edited in Footprints.

(5) Summerhill will conduct quarterly reconciliation of invoicing against the Footprints data in order to account for regular quality assurance updates in the Footprints database.

(6) There will be no more cold calls permitted. New prospects identified by in-field teams will be forwarded to the call centre to have a formal appointment booked.

(7) Incentives for special achievements will be converted to team awards and will be subjected to 100% audits.

Immediately on confirmation of the problem, an in-house assessment of all sites for which installation was provided by the suspect implementation team was performed. A small sample of non-suspect sites was also inspected for consistency. The total number of sites included in the special inspection was fifteen percent (15%) of the 2010 program installation sites. The result was to reduce program tracked savings by five and one-half percent (5.5%).

NMR chose to average the energy savings projection from its evaluated sample (using light loggers) with the energy savings projection from the corrected data tracking system. This combination of results from an independent evaluator's sample and a tracking data base sample is not standard practice. NMR's evaluated results were a realization rate of 63.8% and 28,846 MWh at the generator level with a coincident demand savings of 6,048 kW. The averaged results were a realization rate of 78.9%, 32,326 MWh and a coincident demand savings of 6,684 kW.[20] After consideration of in-service rates, spillover and free-ridership NMR net savings at the generator were 25,233 MWh and peak demand reduction of 5,291 kW.

[20] NMR Evaluation of 2010 Efficient Lighting Direct Install Program, Table 3.5, P. 15.

Recommendation: It is recommended that specialty CFLs, especially dimmable CFLs be emphasized in the portfolio for the next cycle.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be adjusted downwards for 2010 by 10%. This is to compensate for the melding of tracking system results with evaluated results.

Recommendation: We recommend that the Power Down Program be continued as an effective non-residential DSM and market transformation effort.

Recommendation: We recommend adoption of the seven process changes developed by the DSM Administrator.

Recommendation: To further tighten accounting for this program, we recommend that each implementation team collect all removed bulbs (for perhaps 10% of sites), having noted with a permanent magic marker the exact type of new bulb inserted into the socket. These are to be sorted and a journal kept of the exact bulbs removed and their exact replacements and reported monthly and at the close of the year.

(6) 2010 EnerGuide for Existing Houses (EEH)

The Program Delivery Agent for EnerGuide for Existing Houses for 2010 was Conserve Nova Scotia. This program helps homeowners to improve the energy efficiency of their houses. Any existing residential home or small multi-unit residential building is eligible. For houses that use electricity as the primary source for space heating, the DSM Administrator pays the provincial government's share of any rebates to the homeowner, plus additional rebates for electricity-related upgrades. For homes without electric heat the DSM Administrator pays for electric measures only.[21] In past years and at the beginning of 2010, the program was funded through the support of Natural Resources Canada, Conserve Nova Scotia and the DSM Administrator. Federal support ended March 31, 2010 for new program participants.

In 2010, a total of 1,516 households in various locations throughout Nova Scotia were served by this program. Although not all homes completed the "pre-test" baseline audit,

[21] For the DSM Savings Verification analysis, joint funding is an important leveraging tool for the DSM Administrator to achieve better results at less per house cost to the DSM Administrator. NMR notes that Natural Resources Canada may also be reporting the savings from this program at the federal level and there may be a possibility of double counting. For the DSM Savings Verification perspective, however, this simply means there are two reporting systems, one for federal purposes and one for Nova Scotia. Specifically, federal support does not introduce a problem of double counting for the DSM Administrator. Rather, under the model of coordinated programs, the joining of resources across organizations common goals is positive leveraging.

the model for this program is to begin with the HOT2000 audit (the D audit, base audit). The energy efficiency improvements are then installed and the installations are then followed by the "post-test" audit, the HOT2000 E audit (the upgrade audit).

The HOT2000 modeling program was developed by CanmetENERGY's engineering experts. It is a powerful and accurate building energy simulation tool. It's use is to measure the energy performance of residential buildings. It provides the ability to produce technical reports for whole-house technical assessments, is used to inform and guide the user in selecting opportunities to improve the energy efficiency of the building, and is applicable to both new and existing houses. The original version, then called HOTCAN 1.0, was released in 1982, and the program has been evolving since that time. The original Microsoft Windows version (v8.0) of the program was released in 1998, and the latest version (v10.40) was released in February 2009.

NMR's impact evaluation of the program was initiated by working with a sample of 71 houses and was based on review of savings using HOT2000 audit information (from D and E audits). This yielded an evaluation ratio of energy savings per EnerGuide point of 1,047 kWh in contrast to the estimate used by the program of 1,032.88 kWh. This sample of 71 houses is then shown by NMR to reasonably represent the set of houses served by the program in 2010.

Using information from a recent Ontario Power Authority study, "2010 Prescriptive Measures and Assumptions" and the 2009 evaluation of the DSM Administrator's Low-Income Program, plus a considered review of individual measures, NMR also constructed values for the prescriptive measures included in the program that contribute savings outside the HOT2000 modeling. For some measures, evaluated savings were larger than program prescriptive values. Evaluation savings were lower for others; and for some measures were about the same. Selected program measure values were excluded from the analysis to prevent double counting and special care was taken with the inclusion and exclusion or measure savings from homes in which fuel switching occurred.

Combining results for modeled and prescriptive measures, NMR found that program and evaluated energy savings were close, within two percent (2%). NMR also found that the program's evaluated savings exceeded the target for the year (nearly double). This savings was based on increased savings per home in comparison with planning estimates since homes served were slightly over one-half of homes planned.

Free-ridership was calculated based on the DSM Administrator's Free-ridership symposium (May 2010). This resulted in a free-ridership estimate of 24% and a net-to-gross estimate of 76%. Results, including the impact of free-ridership are 8,138 kWh saved at the generator and 2,174 kW at the generator. These results compare with the

program goals of 4,930 kWh and 1,410 kW. This is excellent performance by the DSM Administrator's 2010 EnerGuide for Existing Houses Program.

Analysis by NMR is within the scope of acceptable evaluation methods and was competently carried out. The free-ridership analysis was appropriate. In researching HOT2000, we found that it is known to typically overestimate energy savings by about 15% though occasional individual cases can run to 50%.[22] NMR's analysis may have corrected for this known problem with the simulation software.

Recommendation: We recommend acceptance of NMR's energy savings and demand reduction results for this program for 2010. The methods used in the analysis were appropriate for the time allotted for the evaluator to complete 2010 program evaluations.

Recommendation: We recommend that a program in the residential existing houses sector be continued since it is an important sector for achieving effective DSM.

Recommendation: We recommend that future evaluations for this sector use actual kWh rather than modeled kWh. The main issue would be timing since twelve to thirteen months would need to pass following the end of a program year to generate the "post-test" actual energy consumption required for the analysis. This analysis should also include collection of demographic/housing characteristics from an accompanying participant and non-participant survey. The high rigor evaluation method used in the 2010 low-income evaluation is an excellent model to apply for the residential existing houses evaluation.

(7) 2010 EnerGuide for New Houses & Performance Plus Program (NH)

This program offers incentives to homeowners who are constructing new electrically heated homes. The change this year is that the new Nova Scotia building code began to require an EnerGuide rating of 80 for all new houses (or an equivalent based on prescriptive measures). The 2010 EnerGuide for New Houses Program initially continued the older participation requirement from past years of an EnerGuide rating of at least 80. In the fall of 2010, the minimum participation requirement was raised to an EnerGuide rating of at least 83, and the program was given a new name, the PerformancePlus Program.

[22] Simulation software of this type is designed primarily to provide an optimal list of energy saving improvements for a home. The production of energy savings estimates for the home is a secondary purpose, essentially a side effect of running the model. Comparable software in the US, mandated by the US Department of Energy for low income weatherization applications, shows similar strength in recommending an optimal improvement package for a home and a similar weakness in estimation of whole house energy savings.

NMR found that this tends to be a heat pump program, with a free rider rate of 79% for builders and 52% for homeowners. This means that many builders and homeowners have already decided that they want to install an electric heat pump prior to qualifying for the program. From a DSM Savings Verification perspective this is a normal development for a program that has become important to both builders and homeowners over a number of years. Today, and especially with the ease of information access provided by the Internet, almost everyone interested in building a new home will check out any incentives offered by the DSM Administrator as well as any provincial or federal incentives. This is, in fact, an objective of DSM communications and marketing.

At play here is a tension between two views of DSM. One, a cost control perspective, puts primary emphasis on reducing free riders as an overhead cost. The other, which focuses on attaining a goal for the physical characteristics of the housing stock and on a marketing and market transformation perspective, works towards achieving just such a result as reported by NMR, in which homeowners and builders are deciding for heat pumps.[23] In either case, the next challenge after developing a better market pattern is to reduce free ridership while not losing market participation. As NMR suggests, a solution to minimize free ridership is to increase the minimum participation requirement by increasing the minimum required EnerGuide rating for participation. The increase to 83 may have the desired effect. NMR suggests raising the minimum participation requirement to an EnerGuide rating of 85 and perhaps to 90 in two to three years. An alternative suggested by NMR is to replace the program by a system of specific incentives for specific measures.

A total of 260 homes participated in the program during 2010.

- **Modeling:** New construction is an unusual sector in the evaluation of DSM programs because it requires development of a modelled baseline against which to assess home performance. Due to the change in the building code, NMR constructed two baselines using Hot2000:[24] one for homes built prior to the code

[23] In a market transformation perspective, the goal is to transform the housing stock as a whole so rising free ridership may be taken as a signal to increase incentives to consolidate transformation of a market prior to withdrawing a program. The strategy may be to insure the transformation and move inferior products out of participation in the market. More conventionally , rising free ridership is a signal to take action to minimize free ridership, for example by raising minimum participation requirements.

[24] HOT2000 ratings range from 0 to 100; to achieve something close to the 100 rating the house has to be "net zero energy", *i.e.* house and occupants generate adequate heat or other forms of energy to bring overall annual energy use for the home to near zero on an annual basis. A one point change in the HOT2000 rating, for example, for a 2,000 sq. ft. house, moving from a rating of 80 to a rating of 81 represents about 4 to 7.5 Gj of energy savings (1 Gj = 278 kWh). HOT2000 has been tested against other simulation models and has been tested against the BESTEST procedures. Savings per rating

change, and one after. Assuming a six-month lag, the code upgrade baseline home is used for any home built after June 30, 2010.

- **Prescriptive Review:** In addition to the modeling, NMR validated the prescriptive measures offered by the program (outside of the Hot 2000 modeling) using the Ontario Power Authority's "2010 Prescriptive Measures and Assumptions" report and results of the 2009 low-income program. This required adjustment of the prescriptive value of only one of seven measures.

- **Comparison Check:** As an extra check, NMR compared results with results generated using the REM/Rate modeling software and found the results to be essentially equivalent.

NMR selected a sample of 25 homes. For homes built prior to the upgrade in building standards, NMR determined an evaluated result of 1,131 kWh/EnerGuide point. For homes after the upgrade in building standards the result was 1,032 kWh/EnerGuide point.[25] These ratios were then applied, respectively, to the pre-code change and post-code change parts of the total set of homes. Then Prescriptive savings from outside the modelling was added to yield total savings for per home. Finally, taking free ridership into account reduced the energy savings for this program. Savings at the generator were calculated at 680 MWh in comparison with the goal for the year of 2 gWh and 810 kW in comparison with the goal of 640 kW. These results are quite reasonable for the program of this type (new houses) in a year in which an upgraded building code was introduced; also, in view of the high free ridership rate. The high free ridership rate for this program is an indication of the success of marketing and promotion for the program and indicator of the need to modify program design. This is a case in which free rider information is useful and should be acted on to improve program design. For example,

point can range from 3 Gj to 8 Gj, depending on a number of factors, such as location, climatic conditions, size of house, efficiency, and so on. Lower levels of saving per point, say 2.5 to 3 Gj, are generally associated with smaller, efficient homes, 1200 to 1300 sq. ft. HOT2000 is generally recognized as over predicting savings by upwards of 15% (it was mentioned it could be as high as 50%), largely because there are no inputs to 'adjust' for family size and lifestyles. The program uses standard occupant and condition defaults: 0.3 air changes per hour, typical temperatures (19 to 21 degrees C depending on location), a family of two adults and two children, and so on. The program is not set up to modify the standard defaults. HOT2000 predicts well, on a measure-by-measure basis, using the built-in defaults. It provides a good approximation of savings if/when actual conditions in the house are close to the default conditions. However, it does not include considerations for different life styles. At the end of the HOT2000 reports, the following disclaimer appears in bold writing: "The calculated losses and energy consumptions are only estimates, based upon the data entered and assumptions within the program. Actual energy consumption and heat losses will be influenced by construction practices, localized weather, equipment characteristics and the lifestyle of the occupants."

[25] Use of independent modeling and ratios is a reasonable method, especially for new construction.

if the minimum participation EnerGuide score is raised following the NMR recommendations, or if different "deep savings" measures are introduced it will be possible to substantially reduce free ridership. New housing is a critically important sector of residential DSM and this program needs a run of at least five years (and hopefully an upswing in the construction of new homes) to improve both physical performance and program design. NMR found that this program (in contrast to all of the other programs) showed a relatively high proportion of free riders. We agree with NMR's analysis which suggests that this will happen in the early years for this type of program in a market in which there are relatively few new houses being built.

For the 2010 EnerGuide for New Houses program and the successor HomePerformance program, we find that NMR carried out an impact evaluation within the accepted range of alternative evaluation methods and within the proper scope of seasoned expert evaluators.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be accepted for 2010. The methods used in the analysis were appropriate for the time allotted for the evaluator to complete 2010 program evaluations.

Recommendation: We recommend that a program in the new houses sector be continued since it is an important sector for achieving effective DSM.

Recommendation: We recommend that future evaluations for this sector use actual kWh rather than modeled kWh. The main issue would be timing since twelve to thirteen months would need to pass following the end of a program year to generate the "post-test" actual energy consumption required for the analysis. In new construction there is no actual kWh "pre-test" baseline. However, results of the actual usage "true-up" analysis from a high rigor evaluation for existing houses could be applied as a model correction to the new houses program.[26]

Recommendation: In this program type there are separate free rider rate for builders and for homebuyers. We recommend these rates not be arithmethically averaged, but that if a single rate is required a study be performed to determine with the builder or the buyer is the responsible party for each home, and melding occur on that criterion.

[26] This assumes that participants in the two programs are reasonably similar (mostly single-family homes of similar sizes, etc.) or transfer can be developed using stratification and strata weights
.

(8) 2010 Appliance Retirement & Replacement Pilot Program (ARR)

This Appliance Retirement & Replacement Program[27] is a pilot program first introduced in 2010 and was limited to the Halifax regional municipalities and Cape Breton. The program has two components::

- Appliance retirement serves single family household. It involves the pickup and disassembly of old refrigerators, freezers and dehumidifiers. This component of the pilot was originally planned to run from June through September but was extended for a second phase which ran from October through November.

- Appliance replacement serves multifamily residential buildings. It combines provision of new energy efficient refrigerators at low price combined with pickup and disassembly of old refrigerators. This component ran from June through December.

Energy savings for refrigerators and freezers was calculated as follows:

- **Old units** - To determine the energy consumption of old refrigerators and freezers, NMR used data from the Association of Home Appliance Manufacturers (AHAM) to develop an average unit energy consumption value (UEC) to apply to each old refrigerator and freezer retired through the program. For each refrigerator and freezer retired this initial value was adjusted to take account of the degradation of the units over time (degradation factor)[28] and also adjusted to take into account the difference between ratings on lab tests and actual performance of units in homes (Site/Lab factor).[29]

- **Old units** - For old refrigerators picked up from single family households in the retirement component of the program, after the UEC was computed, any partial use was adjusted for. For old refrigerators in the multifamily component of the program, full year-around use as the primary refrigerator for each apartment was assumed, so there was no need for a partial use adjustment.

[27] The program is also referred to as the “Pull the Plug” program.

[28] The degradation factor (an increase in energy consumption of 1.37% per year) was taken from a 1998 Miller and Pratt study of multifamily refrigerators for the New York City Housing Authority.

[29] The lab to site factor (0.79) was developed from a CADMUS study of cool climate zones in California using weighting from that study based on household size for households where the unit was a primary appliance.

- **New units** - For new refrigerators in the multifamily refrigerator replacement component of the program, the energy use of the new refrigerators was taken from the DSM Administrator's tracking system.

- **Used units** – All primary refrigerators in the refrigerator retirement component of the program were assumed to be replaced. The proportion of secondary refrigerators in the retirement component of the program split to a portion that were replaced and a portion that were not replaced. Of all replacements, 95% of refrigerator replacements were by a new refrigerator and 5% by a used refrigerator. For freezers, 86% were replaced by a new freezer and 14% by a used freezer. Used equipment was assumed to have been originally purchased in the year 2000, and AHAM values for that year were used for the original unadjusted Unit Energy Charge for each machine.

This method gives full credit to the single family refrigerators and freezers retired (as adjusted for partial use) by assuming that they are not replaced in the household. For dehumidifiers, it was assumed each unit was replaced by a current Energy Star unit.[30] So for the dehumidifiers, energy savings is the difference between the energy consumption in kWh of the new unit and the old unit. For multifamily refrigerators and freezers replaced, the energy savings is the difference between the energy consumption in kWh of the new unit and the energy consumption of the old unit. Note that 5% of "new" refrigerators and 14% of "new" freezers were used models. As a final step, to calculate net energy savings the free-ridership rate was also taken into account.[31]

NMR also developed annual energy consumption for conventional dehumidifiers, drawing on two previous studies.[32] Nova Scotia weather data was used to determine operating hours for dehumidifiers (1,114 hours). Operating hours, Unit Energy Consumptions for units with different capacities, and market share information were used to develop the estimated weighted yearly energy consumption per dehumidifier picked up for recycling (735 kWh). Using the same method, the estimated weighted yearly energy consumption per new Energy Star dehumidifier was 627 kWh.

[30] This assumption follows from the Maritime climate.

[31] As developed from the participant survey.

[32] Ontario Power Authority, *2010 Prescriptive Measures and Assumptions*, January 2010; PA Consulting and Patrick Engineering, *Dehumidifiers Deemed Savings Review for Targeted Home Performance with ENERGY STAR*, March 19, 2009.

Results from each component and sub-component of this program were totaled by NMR to yield net savings at the generator of 476.4 kW and 2,285.9 MWh.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be accepted for 2010.

Recommendation: This pilot is a promising new program. We recommend exploring ways to continue and expand the pilot.

Recommendation: While the analysis is well constructed for a first year evaluation of a first year pilot program, we recommend that future program evaluations adopt direct appliance metering for a subset of each appliance type. A protocol for metering for multifamily replacement refrigerators from the New York Technical Resource Manual is attached as an appendix to this report. This protocol could serve as a starting point for developing a metering protocol appropriate for Nova Scotia. For the next evaluation of this program there should be enough direct (2 hour) metering to establish correction factors for each appliance (refrigerators, freezers, dehumidifiers). The correction factors could be used to "true-up" modeling procedures. Approximately two hours of monitoring would cover three cycles.

Recommendation: We recommend that a digital picture be taken of the label in each machine and used to determine age using look-up tables.

Recommendation: A potential weak point in recycling programs is that some units might find their way back to the secondary market. Accordingly, we recommend that the evaluator devise an emphasis on spot checks to insure that machines make it all the way through the recycling process.

(9) 2010 Low Income Households Program (LIH)

The Low Income Households Program[33] was administered for the DSM Administrator by Conserve Nova Scotia. Direct installation was carried out by three program delivery agents[34] and twenty homes were inspected by a separate third-party contractor. Energy saving improvements are divided into two groups, Scope I savings and Scope II savings. The program Scope I savings estimate is based primarily on building envelope measures, assessed using the HOT2000 residential building simulation program. The program Scope II savings estimate is based on mainly prescriptive upgrades and

[33] This program is sometimes also called the Residential Energy Affordability Program.

[34] MJM Energy Ltd., Clean Nova Scotia and Trinity Maintenance Solutions

energy savings are estimated using deemed savings. Funding was provided by four sources: Conserve Nova Scotia, ecoNova Scotia, Natural Resources Canada (NRCan), and the DSM Administrator.[35] Electric heated home energy savings, electrically heated hot water energy savings and electricity saving measures in other homes are paid for by the DSM Administrator.[36]

NMR's impact analysis follows a non-equivalent control group design which compares the participant homes to a group of non-participant homes. The 2010 evaluation is based on actual monthly kWh energy use (using weather normalized data), contrasting a "post-test" energy use with "pre-test" energy use to construct the gross change in energy use for both groups. The difference between these two gross savings results (for participants and for non-participants) is the net savings attributable to the program. Since this design requires a year following installations to accumulate a full year of post installation energy use for the "post-test" measurement, the analysis was run on the 2009 program year. The analysis was run on each stratum of a stratification based on annual kWh use in 2009 and 2010 and the results were then used with strata weights to 2010 program year results.

Analysis was carried out four ways, using the Princeton model (PRISM), ordinary least squares regression analysis, weighted least squares regression analysis and an analysis based on a subset of cases for which full tracking system information was available. The PRISM result, the ordinary least squares regression result and the weighted least squares regression result were very close and the PRISM result somewhat higher. The analysis using the tracking system came in much lower (at about one-half of the other results) but it was found that the homes for which full tracking system data was available were a subset not representative of the population of participant homes for 2010.

Net evaluated savings at the generator are 895.4 MWh in comparison with the 2010 goal of 5,260 MWh. Net evaluation kW reduction at the generator is 199.2 kW in comparison with the 2010 program goal of 1,170 kW. These results were compared with other low-income program evaluation results from the US Northeast and found to be comparable.

Recommendation: We recommend that the NMR energy savings and demand reduction results for this program be accepted for 2010.

[35] This model, in which several organizations support a single program, is called a "coordinated program." In a coordinated program each organization treats the other organization's financial support as positive leverage. See Hill, Lawrence J. & Marilyn A. Brown, "Estimating the Cost-Effectiveness of Coordinated DSM Programs," *Evaluation Review*, Volume 19, No. 2, April 1995, Pp. 181-186.

[36] Homes with partial electric heat are eligible for electric heat measures for those rooms heated by electricity.

Recommendation: This evaluation employed a high-rigor evaluation method which corrects for problems in savings estimation inherent in the HOT2000 simulation software. We recommend that the same or a similar PRISM based and/or regression based approach (both of which are used here) be employed in all future impact evaluations for this program type.

Recommendation: We recommend that a whole house program in the low income sector be continued and gradually enhanced year by year with the goal of increasing energy savings per home.

Recommendation: Results should be presented separately for electrically heated homes, homes with partial electric heat, home with electric hot water (but not electric heat), and all other non-electric homes. When all of these types of homes are analyzed together, there is a mixture problem that has a major impact on the result depending on the number of homes with electric heat relative to the number of homes in the analysis. This does not affect the validity of the overall result.

IV. Discussion of Process Evaluation

This Savings Verification study does not focus on the process evaluation. However, we provide the following definition (see text box):

> **Process Evaluation** – A systematic assessment of an energy efficiency program for the purposes of documenting program operations at the time of the examination, and identifying and recommending improvements that can be made to the program to increase the program's efficiency or effectiveness for acquiring energy resources while maintaining high levels of participant satisfaction.
>
> - Northeast Energy Efficiency Partnerships, *Glossary of Terms*, Version 1.0., A Project of the Regional Evaluation, Measurement and Verification Forum, March 2009, Prepared by Paul Horowitz PAH Associates, Facilitated by Northeast Energy Efficiency Partnerships.

NMR conducted an excellent process evaluation of its type, primarily directed to interviews and surveys in support of the impact evaluation. This is an appropriate strategy. However, a traditional DSM process evaluation would be structured to also

cover the following topics, essentially constituting an organizational study with some elements of a management audit:[37]

- Report on program design and planning; Report on whether the program as implemented matches the program design and follows the planned program logic, and where and why it has changed

- Describe program administration and management; Report on administrator policies and procedures

- Report on marketing activity for each program and on program delivery

- Report on the effectiveness of program information materials

- Report on the training of administrator staff, contractors, and any trade allies; Report on whether the administrator is sending key staff to DSM meetings and conferences to keep them in touch with new developments for different program types, and to meet alternative program vendors

- Report on program data tracking system and management reporting system (not in general, but for the specific program)

- Report on adequacy of staffing, budgets, and expenditures, including timeliness

- Report on interdepartmental communication and cooperation

- Describe how appointments are scheduled for each program, provision for customer follow-up, and how well the system is working; Review the application process for each program and how eligibility is correctly and consistently verified

- Review customer complaints, how they are received, if there are gaps in receiving or delaying sending complaints to the attention of management, and how customer complaints are resolved; Assess customer satisfaction with program services

- Review contractor selection and the fairness of bidding processes

[37] This section is developed from Gellings, Clark & John H. Chamberlin, Demand-Side Management Planning. Liburn, Georgia, USA: The Fairmont Press, 1993. See P. 408 & Pp. 428-429.

- Review the technical capability for specifying, ordering, tracking, and installing of equipment

- Review QA/QC procedures

- Report on the accounting and IT support for the programs

The activities of a process evaluation typically include:

- Review of program plans and records to identify the goals and objectives of each program

- Identification of the major functions of and strategy for implementing each program

- Observation of office processes and also in-field program delivery (observe and write-up observation on the steps in the implementation process)

- Interviews, field observations of team work in progress, surveys, focus groups

NMR engaged several of these areas for 2010. In particular, there is an excellent treatment of the data tracking system. There is also consistent attention to program targets and program achievements. Once Efficiency Nova Scotia Corporation has been in full operation for a year, it may be useful to return more fully to an organization study focus for 2012.

V. NMR Executive Summary

Overall Characterization of 2010 Programs

The Executive Summary of the NMR evaluation summarizes the 2010 programs as "generally run well and efficiently."[38] The savings verification study is in agreement with this overall characterization for the DSM Administrator's 2010 programs.

In Table 1-1 of the Executive Summary, NMR shows that the DSM Administrator exceeded the 2010 GWh target by five percent (5%) and very closely approached

[38] Evaluation 2010 DSM Program Executive Summary, P. 1

(98%) the MW target. In the savings verification study we characterize this somewhat differently, noting that 2010 GWh and MW targets were essentially met. This is due to our recommendation to lower GWh and MW achievement of the Efficient Products – Direct Install (DI) program by ten percent (10%). With this reduction although our numbers are somewhat different, the conclusion is the same.

Error Bands

As to small differences in numbers, it is useful to imagine an error band around each program result and a wider error band around the overall portfolio results for GWh and MW for 2010. It is natural to want to take the numbers produced by the evaluations as exact but they are not exact. Instead, they are pretty good approximations. The size of these error bands is unknown because they are not based on statistical estimation. They are due to a number of modeling steps and assumptions (including data borrowed from other jurisdictions). For these reasons, results cannot be characterized by simple statistical error bands. But, conceptually, error bands are present.

More Measurement

One way to narrow errors is to limit modeling steps, limit the number of auxiliary parameters employed and limit the number of assumptions in constructing results. That is why in the savings verification study we emphasize direct electrical measurement (with short term metering or use of annual energy use data as appropriate to type of measurement problem and the program type) as well as and passive (instrumented) monitoring (for example, the use of light loggers). Where modeling and the use of borrowed data is essential to an evaluation, direct measurement can empirically bound model error by providing a correction factor (with which to bound the results produced by the overall model). When electrical measurement can be used directly it eliminates the need for one or more modeled constructions (such as the lab to site factor or the performance degradation factor) which can be open to multiple interpretations.

As a practical illustration, low-income program modeling software is excellent at recommending what measures should be included in a measure package for each home but typically poor in estimating yearly energy savings. In Canadian and US software that does not require entry of the past twelve months of energy use for a home, savings results can be off from fifteen to fifty percent (15% - 50%).[39]

One current tendency is to resolve measurement questions administratively. For example, in California answers to intricate engineering questions regarding custom equipment are being decided through litigation before an Administrative Law Judge. In New York, the Public Service Commission instead is simply insuring the quality of

[39] See footnote 24.

Program Administrator QA/QC procedures, standards for selection of consultants for custom projects and documentation standards. A more common tendency, recommended by the Regulatory Law Project, is the development of Technical Resource Manuals. Several jurisdictions use these for program planning so that utilities will use common calculations and assumptions. In some jurisdictions, partly to streamline evaluations and partly to provide regulatory certainty to Program Administrators, tabled values from TRM-type databases have been mandated for use in evaluations. In Washington State, recently evaluators were instructed to use tabled values from the Regional Technical Forum and only question values for measures not in the regional tables. The concept in use is that many prescriptive measures are so well known that they are to be used both in program planning and in program evaluation. However, both of these tendencies for administrative solutions when applied to evaluation (in contrast to program planning where they may be of some use) curtail the independence and the technical and professional control of the evaluation by the evaluator. Based on experience in which professional independent evaluators are necessary to catch problems, including unanticipated problems, our recommendation is to move in the other direction – toward more electrical measurement and more passive (instrumented) monitoring as primary evaluation approaches.

Problems of High-Performing Programs

NMR then proceeds with a discussion of programs, primarily focused on how well they performed on evaluated energy savings and demand reduction in relation to their targets. Programs they identify as doing well on these indicators are Efficient Products - Residential (Power Down Retail Sales and the Appliance Retirement and Replacement Program), Efficient Products – Direct Install (DI), and EnerGuide for Existing Houses. Yet, as noted by NMR, the CFL component of Efficient Products – Retail represented eighty-eight percent (88%) of energy savings from this program area. It is expected that incandescent bulbs that cannot meet efficiency targets will be phased out starting in January 2012. As NMR notes, Efficient Products – Direct Install, since it is a lighting program, will also be affected by the phase out. Also, Natural Resources Canada withdrew its cooperative federal rebates for existing homes entering the program after March 31, 2010.

Importance of Housing Programs

We suggest, of course, that all of the residential housing programs (existing houses, new houses, and low-income) be continued. These components of the DSM portfolio are too important to drop in terms of the physical need for transformation of energy use characteristics of the Nova Scotia housing stock. They are also important to insure that

customers continue to receive and perceive value for their monthly payments to support DSM.

Directions for Lighting

While CFLs can provide excellent lighting quality, it is quite likely that both efficient halogen and efficient incandescent bulbs will be available from big box home stores in 2012 and after 2012 due to consumer preferences. We will have to see how consumers will select from this mix. Also, within the mix there will be a wide variation in efficiency among bulbs that meet the new standards, so it is quite likely that top range CFL/LED bulbs can continue in the two Efficient Product programs, as alternatives to low range bulbs of different kinds that just meet the new standards.

Lower Performing Programs

The Low Income Households program fell short of target, as did Business Energy Rebates, Smart Lighting Choices, Small Business Lighting Solutions, the New Houses program and the C&I Custom program. As NMR notes, the C&I Custom program almost met its targets. Using the framework applied in the savings verification study in which the evaluation numbers are taken as inherently inexact, we would classify the C&I Custom program as successful. Falling short by three percent (3%) or 0.6 GWh is not meaningful. In addition, the C&I Custom program has an excellent tradition of careful measurement.

Program Data Tracking

The NMR Executive Summary contains an excellent section on the program data tracking system and related data quality issues. We fully support this analysis and NMR's recommendations. For the Savings Verification study, we initially followed the development of the tracking system with interest. However, the status of the system for 2010 was that it was completed and tested. Most of the programs did not actively use the system for 2010 but, instead, had targets for transferring information into the system. We expect to see the system in use in 2011.

Challenges

The NMR Executive Summary notes the challenges faced by Efficiency Nova Scotia Corporation in moving forward to meet goals in a context in which some programs are being affected by new lighting standards and housing codes while federal support is being withdrawn for the Residential Existing Houses program. At the same time, in its discussion of the individual programs, NMR proposes some solutions to deal with these problems and also with the problems of free-ridership in some of the programs.

Methods, Programs and Recommendations

The NMR Executive Summary concludes with a brief summary of evaluation objectives and methods for the impact and process evaluations, summaries of the performance of individual programs, and a convenient summary of all NMR recommendations.

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VII. Appendix

Refrigerators

This section covers replacement of refrigerators with Energy Star models in single family and multi-family dwellings. High-efficiency refrigerators save energy and demand through improved compressor design, better case insulation, improved door seals, and improvements to defrost and anti-sweat heater controls. Both early replacement and normal replacements are covered in this section. The algorithms include an adjustment for the fraction of replaced refrigerators that enter the used appliance market. Programs that cannot demonstrate disabling or recycling of removed refrigerators should includethis adjustment.

The approach for estimating the savings from early replacement of refrigerators is based on measuring/metering actual energy usage of the refrigerator(s) to be replaced. This approach (referred to as early, short term metering) is established because of the wide variance in potential savings from refrigerator replacement programs that are significantly influenced by the conditions associated with the typical participating facility as well as the program implementation approach. Through this early replacement program, annual savings ranging from a low of 300 kWh per unit, to a high of about 700 kWh per unit are expected. Programs that focus their operations on replacing only the most energy inefficient units will achieve savings near the upper end of this estimated savings range. Programs that do not distinguish the replacement need for each individual unit are expected to have savings near the lower end of this range.

The approach for estimating savings for normal replacements relies on Federal Appliance (NAECA) Standards for establishing baseline energy consumption. The baseline consumption for a normal replacement is a refrigerator or freezer that is minimally compliant with NAECA Standards according to the size and features of the new (replacement) unit. Eligibility and energy consumption measurement rules for refrigerator replacements are as follows:

1. Only replacement of refrigerators that are ten years old or older are eligible for savings claims.

2. Units from 10 to 16 years old will be treated as ***early replacements*** and given full savings relative to the existing unit.

3. Units built before 1994, will be considered ***normal replacements*** and will be given incremental savings. Incremental savings are defined as the difference between the annual kWh consumption of a new unit that is minimally compliant with Federal appliance standards (NAECA) and the new Energy Star unit.

Early Replacement Baseline Refrigerator Energy Consumption

To estimate annual consumption of existing units under an early replacement scenario, the program administrators have the option of testing units one-by-one and making replacement decisions for each unit or selecting a sample of units for testing to make replacement decision for the population of units represented in the sample. If the sample approach is chosen, the program administrators will select a representative sample of refrigerator units to be replaced within a participating multi-family facility. The sample should represent the typical type, size and age of the units to be replaced within the facility. The program administrators will then conduct short term metering on a small sample within the participating facility to establish the projected energy savings from that facility. This effort will be completed early in the program participation process prior to replacements being made at the facility. It is up to the program administrators to identify a sample of refrigerators so that the resulting estimated savings can be expected to be representative of the participating facility. The program administrators are free to set the sample size as long as that sample is no less than the size specified in the following table.

Refrigerator short term metering minimum sample size
Number of units expected to be replaced per facility
Minimum short term metering sample (refrigerators sampled separately using same sampling approach)

10 or less	3*
11 to 20	4
21-50	6
51- 100	8
100-150	10
150-200	12
200-300	17
300 or more	20

*If less than 3 units are projected to be replaced in a facility, sample all units projected to be replaced

For facilities that have identical refrigerators (same make, model, year, size) within the facility, the sample can be focused on those units. For facilities that have a wide mix of brands, models, sizes and ages, the sample should be selected to represent that diversity. In these cases the sample size may need to be larger. However, in no case does the sample *need* to be above 20 units for a participating facility. The evaluation efforts will more accurately estimate ex-post savings as the studies are designed, approved by DPS, and implemented. Program administrators are free to increase the sample size if they elect to have a more rigorous sampling and estimation process. However, care should be exercised so that the sampled units can be expected to be representative of the typical unit within the facility that is replaced by the program in terms of unit size, age, and design. Once the sample size and representative units are identified, program administrators will then install short term metering on that sample to obtain a baseline from which savings can be estimated. The metering approach will be conducted in accordance with the following approach. The units to be tested must be functioning within the dwelling (in situ). The program will arrange for a skilled metering professional to conduct the metering test. The metering professional will install a digital power meter directly into the refrigerator's power cord. The metering equipment can be

selected by the program administrator; however it should be able to record both kW (instantaneous demand) and kWh (energy consumption) and record the number of minutes the unit is being metered. The professional should confirm that the meter has been calibrated according to the manufacturer's recommendations.

The meter should be set to zero at the beginning of each test. The test shall be conducted for a period of time no less than 2 hours, which is the required time to allow the units to stabilize and cycle. While more time would allow increased accuracy, 2 hours is enough time to estimate the amount of energy typically consumed by the unit over a year or 8,760 hours. The resulting total kWh consumed over the metering period will be divided by the number of metering hours and then multiplied by 8760 (hours per year). The resulting energy use calculation will be set for the baseline energy consumption for that metered unit.

Similarly, the unit's average operating baseline demand (kW) will be estimated by dividing the accumulated kWh during the test by the duration of the test (in hours). The following steps will be used in the metering approach:

Metering Steps

1. Open door and record the following data:
Brand _____
Model Number _____ Size _____cu ft
Serial Number _____
2. Close Door after compressor comes on and note wattage. (remember to zero the watt meter before starting) Record Running Compression Wattage:
_____ watts
3. Let operate normally for two hours or more with door closed and record the total metering minutes and the kWh reading.
Total Minutes: _____ Total kWh Reading: _____
4. Calculated and record Annual Estimated Energy Consumption ____ kWh
And Average Demand s _____ kW

Normal Replacement Baseline Refrigerator Energy Consumption

Energy consumption for the normal replacement baseline refrigerator shall be determined from the Federal Standard (NAECA) maximum consumption for the type and size of refrigerator purchased. These data are available in the directory of Energy Star qualified refrigerators on the Energy Star website7 according to the make and model of the new (replacement) refrigerator.

Efficient Refrigerator Energy Consumption

Annual energy consumption for the new (replacement) refrigerator shall be determined from the DOE rating for the make and model number of the replacement unit. All new units shall be Energy Star qualified. These data are available in the directory of Energy Star qualified refrigerators on the Energy Star website according to the make and model of the replacement refrigerator.

Annual Energy and Summer Peak Demand Savings
kWs = *see base CF kWh kWh units _ __*

8760 (1 + HVACd)___Fmarket
_kWh = units _ (kWhbase - kWhee) _ (1 + HVACc)___Focc __Fmarket
_therm = _kWh__ HVACg

where:
kW = gross coincident demand savings
kWh = gross annual energy savings
therm = gross annual gas impacts from heating system interactions
units = number of refrigerators installed under the program
kWhbase = annual energy consumption for the replaced unit estimated from short-term test
kWhee = annual energy consumption for the new unit from DOE test
CF = coincidence factor (1.0)
HVACc = HVAC system interaction factor for annual energy consumption
HVACd = HVAC system interaction factor at utility peak hour
HVACg = HVAC system interaction factor for annual gas consumption
8760 = conversion factor (hr/yr)
Focc = occupant adjustment factor
Fmarket = market effects factor accounting for replaced refrigerators that enter the used appliance market

See list of qualified refrigerators on the Energy Star website: www.energystar.gov

Occupant Adjustment Factor
The occupant adjustment factor8 is used to adjust the energy savings according to the number of occupants in the apartment, as shown in the following table:

Number of Occupants Focc
0 occupants 1.00
1 occupant 1.05
2 occupants 1.10
3 occupants 1.13
4 occupants 1.15
5 or more 1.16

Market Effects Factor
An adjustment factor must be applied to account for existing refrigerators that enter the used appliance market when programs do not have a recycling or old refrigerator disabling component. The market effects factor is defined below.

Program Component Fmarket
No recycling or disabling of existing refrigerators 0.8

Recycling or disabling of existing refrigerators can be demonstrated 1.0

Operating Hours
The equations above assume the refrigerator is operating year-round. The cycling of the compressor is considered in the annual energy consumption and compressor duty cycle run time.

HVAC Interactions
Efficient refrigerators reject less heat into the conditioned space, which must be made up by the space heating system, but can also provide savings on cooling loads. Calculations must include space heating interactions with efficient refrigerators. The HVAC interaction factors calculated from the prototypical building DOE-2 models as a function of the building and HVAC system type are shown in Appendix D.

Notes & References
1. The Energy Star website has a directory of Energy Star qualified refrigerators by make and model number. The directory also lists the baseline energy.

The occupant adjustment factor is taken from National Energy Audit Tool (NEAT). Oak Ridge National Laboratory, Oak Ridge, TN. http://weatherization.ornl.gov/national_energy_audit.htm consumption according to NAECA standards for the size and type of refrigerator purchased. See www.energystar.gov.

2. The occupant adjustment factor is taken from National Energy Audit Tool (NEAT). Oak Ridge National Laboratory, Oak Ridge, TN. http://weatherization.ornl.gov/national_energy_audit.htm

3. Mean life for normal sized refrigerators is assumed to be 17 years. See Preliminary Technical Support Document: Energy Efficiency Program for Consumer Products: Refrigerators, Refrigerator-Freezers, and Freezers. U.S. Department of Energy, November 2009.

Revision Number 1

[Note: This Appendix excerpt from the New York TRM is one example of a refrigerator protocol. It is included as an example from which to begin discussion.