MANITOBA PUBLIC UTILITIES BOARD

Efficiency Manitoba
2020/23 EFFICIENCY PLAN SUBMISSION

Testimony of

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For

Consumers' Association of Canada (Manitoba) and Winnipeg Harvest

("the Coalition")

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I. Introduction and Summary

Efficiency Manitoba filed its three-year 2020/2023 Efficiency Plan with the Manitoba Public Utilities Board (hereafter referred to as "the Board") on October 25, 2019. The plan was submitted pursuant to the Efficiency Manitoba Act which established Efficiency Manitoba, the annual and long-term efficiency savings targets Efficiency Manitoba is expected to achieve, and the funding and regulatory framework for oversight of Efficiency Manitoba's work.

This report addresses the intersection between Efficiency Manitoba's filed plan and building electrification. It focuses particular attention on the following topics:

- The importance of building electrification as one of the critical pathways for achieving the kind of substantial reductions in greenhouse gas emissions necessary to stabilize the global climate;
- Why it is important to consider building electrification as part of efficiency plans – not just because electrification measures are often efficiency measures too, but also because decisions on which efficiency measures to include in efficiency plans can have major implications for residential and business customers' readiness and ability to electrify in the future;
- Shortcomings in the way Efficiency Manitoba's filed plan addresses electrification opportunities over the next three years and – perhaps more importantly – in how its proposed mix of measures and programs does not do enough to enable future electrification; and
- How the structure of Efficiency Manitoba's savings goals, as well as how the organization is proposing to treat the impacts of electrification on those goals, may create perverse disincentives to pursuing electrification.

The report aims to help frame Efficiency Manitoba's efficiency plan in the broader context of the province's energy landscape, as well as to address (A) the reasonableness of Efficiency Manitoba's proposed sources of electric and gas savings for meeting the statutory savings targets; and (B) the appropriateness of the methods used by

Efficiency Manitoba to select or reject efficiency options for its plan, including whether it adequately addressed residential savings opportunities, particularly for low income customers, as well as whether it adequately considered the value of developing emerging technologies that could play important roles in future efficiency plans.

II. Qualifications

Chris Neme, the author of this report, is a Co-Founder and Principal of Energy Futures Group (EFG), a clean energy consulting firm based in Hinesburg, Vermont with additional offices in New York and Massachusetts. Mr. Neme has more than thirty years analyzing markets, programs and policies for energy efficiency, demand response, strategic electrification and other distributed energy resources. He has worked for regulators, other government agencies, utilities, efficiency advocates, and/or consumer advocates in five different Canadian provinces, more than 30 U.S. states and several European countries. His work has addressed a variety of topics including the robustness of energy efficiency, demand response and other clean energy goals; the structure of performance incentives for achieving those goals; the design of programs for achieving the goals; the cost-effectiveness of energy efficiency and other distributed resource investments; the bidding of efficiency resources into electric capacity markets; the potential for non-wires and non-pipe alternatives to cost-effectively defer transmission and distribution system investments; and the economic and environmental impacts of strategic electrification. Mr. Neme has filed expert witness testimony on his work in nearly sixty different cases/dockets before regulators in Ontario (on more than twenty occasions), Quebec and ten different U.S. states.

More information on Chris' experience can be found in the discussion of his qualifications in Appendix A – which also summarizes his duties in this case – as well as in his curriculum vitae which is attached as Appendix B.

III. The Importance of Electrification for GHG Reductions

Ten years ago, the G8 countries – including Canada – pledged to reduce their greenhouse gas emissions (GHGs) by 80% by 2050 in order to limit global warming to just 2 degrees Celsius,[1] a level that scientists believed at the time would avoid the most damaging effects of climate change. However, scientists are now recommending that warming be limited to just 1.5 degrees Celsius and suggesting that global emissions of greenhouse gases will need to be completely eliminated (i.e. be at "net zero") by mid-century in order to achieve that goal.[2]

Over the past decade, numerous studies have assessed options for achieving greenhouse gas emission reductions on the order of 80% or more by 2050. A common theme of those studies is that the use of natural gas and other fossil fuels used to provide space heating, water heating and other energy end uses in buildings will need to be dramatically reduced – if not eliminated. Another common theme is that the most realistic and/or most cost-effective path to very large reductions or elimination of fossil fuel use in buildings is to fuel-switch to electricity provided by a decarbonized grid (i.e., one in which electricity is produced by renewable energy and/or other carbon free fuel sources).

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[1] https://www.reuters.com/article/us-g8-summit-environment/g8-agrees-to-limit-global-warming-china-india-resist-idUSTRE5653PW20090708

[2] Intergovernmental Panel on Climate Change, 2018 Special Report: Global Warming of 1.5º C, Summary for Policy Makers (https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf)

These themes appear in studies in both North America[3] and Europe.[4] They also apply to a wide range of climates from California[5] to the northwestern U.S.[6] to Canada. A recent Canadian report, published by the David Suzuki Foundation, is particularly notable.[7] The report is based on "an extensive review of global and Canadian decarbonization models and studies." It highlights ten GHG reduction strategies that "a wide range of experts agree will be front and centre in any credible effort to zero out Canada's emissions by the middle of this century." One of those ten strategies is summarized as (and has its own chapter titled) "Electrify Just About Everything". The report makes clear that this applies not only to transportation, but to buildings as well, stating that "in the buildings sector we can move from natural gas furnaces and boilers to electric heat pumps."

IV. How Electrification Relates to Efficiency Planning

A. Intersections Between Electrification and Efficiency

There are at least three reasons why building electrification can be impacted by efficiency program planning:

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[3] Gowrishankar, Vignesh and Amanda Levin, America's Clean Energy Frontier: The Pathway to a Safer Climate Future, published by the Natural Resources Defense Council, September 2017 (https://www.nrdc.org/sites/default/files/americas-clean-energy-frontier-report.pdf).

[4] European Roadmap 2050 project reports at http://www.roadmap2050.eu/project/roadmap-2050.

[5] Mahone, Amber et al. (Energy and Environmental Economics), California PATHWAYS: GHG Scenario Results, updated April 6, 2015 (https://www.ethree.com/wp-content/uploads/2017/02/E3_PATHWAYS_GHG_Scenarios_Updated_April2015.pdf).

[6] For example, see Haley, Ben et al. (Evolved Energy Research), Deep Decarbonization Pathways Analysis for Washington State, December 16, 2016 (http://www.governor.wa.gov/sites/default/files/Deep_Decarbonization_Pathways_Analysis_for_Washington_State.pdf).

[7] Green, Tom, Zeroing in on Emissions: Canada's Clean Power Pathways – A Review, published by the David Suzuki Foundation, 2019 (https://davidsuzuki.org/wp-content/uploads/2019/05/zeroing-in-on-emissions-canadas-clean-power-pathways-review.pdf).

1. **Some electrification (fuel-switching) measures are also efficiency measures**. For example, high efficiency electric heat pumps installed to displace natural gas heating can reduce total energy consumption while reducing GHG emissions. These measures can be promoted through Efficiency Manitoba's efficiency programs.
2. **Some relatively new technologies that will likely be central to future electrification efforts can be installed today as electric efficiency measures**. For example, the new generation of efficient cold climate air source heat pumps can be installed to displace a significant portion of inefficient electric resistance heat in homes or businesses. By promoting such new technologies as electric efficiency measures today, Efficiency Manitoba's programs could not only generate short-term electric savings, but also help develop the market for the technology so that it is better positioned (greater contractor familiarity, lower costs, etc.) for both additional electric efficiency savings and any future electrification efforts.
3. **Some natural gas efficiency investments today can better enable future electrification efforts**. For example, insulating and tightening up homes and businesses could help facilitate future electrification by reducing heating loads and therefore the size and cost of possible future heat pump installations. In contrast, measures that simply increase the efficiency of gas heating equipment (i.e. meeting the same heating load more efficiently rather than reducing the heating load itself) do nothing to support future electrification efforts. Thus, Efficiency Manitoba's choices regarding the mix of gas efficiency measures and programs to achieve a given level of savings – specifically, the level of emphasis its plan places on reducing gas use through building envelop improvements – has important implications for potential future electrification efforts.

The extent to which Efficiency Manitoba's proposed efficiency plan addresses each of these opportunities is discussed below in Section V of this report.

B. Basis for Considering Efficiency Plan Impacts on Electrification

The primary objective of Efficiency Manitoba's plan is to achieve its statutory savings targets of 1.5% annual electricity savings and 0.75% annual gas savings. That is an obvious and eminently reasonable starting point for a planning process. However, there are literally hundreds of different efficiency measures that efficiency programs can promote and numerous program and portfolio design options that efficiency planners can choose to utilize to promote them. Thus, there are myriad of combinations of efficiency measures and programs that could meet Efficiency Manitoba's savings goals. The choices regarding which combination of measures and programs to pursue should be guided by relevant policy objectives.

Both the statute and the regulations identify a number of criteria that should be considered when developing (and when the Board is deciding whether to recommend approval of) Efficiency Manitoba's efficiency plans. For example, the statute makes reference to ensuring efficiency initiatives are "accessible to all Manitobans",[8] to mitigating rate increases related to capital investments in "major new generation and transmission projects",[9] to assessing "environmental benefits, economic development opportunities and enhancements to energy security",[10] to achieving and analyzing reductions in greenhouse gas emissions,[11] and to laying the foundation for meeting future savings targets.[12] The regulations provide additional specificity on some criteria, including serving low income customers,[13] using private-sector enterprises and non-governmental organizations to deliver programs,[14] and consideration of "new and emerging technologies that may be included in a future efficiency plan".[15]

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[8] 4(3)(c)

[9] 4(1)(c)

[10] 9(g)(iii)

[11] 4(1)(a) and 9(e)

[12] 9(i)

[13] 11(c)

[14] 11(i)

[15] 11(j)

Several of these criteria clearly relate to the intersections between efficiency plan choices and electrification that were discussed in the previous subsection. For example, the multiple references in the Act to greenhouse gases – including requirements to quantify impacts of Efficiency Manitoba's programs on GHG emissions – suggests that mitigating the province's contributions to climate change is an important factor underpinning Efficiency Manitoba's mandate. While actually producing GHG emission reductions over the three-year plan horizon is one obvious and important way to gauge progress towards that objective, building the foundation for future GHG emission reductions – including reductions that could accrue through future building electrification efforts – should be another. Put another way, if Efficiency Manitoba's savings goals could be met in multiple ways, some of which advance electrification more than others and/or enable future electrification better than others, then all other things being equal, there should be a preference for the efficiency program combinations that further advance electrification over the next three years and/or better enable future electrification. Of course, all other things are rarely "equal", so it will likely be necessary to consider trade-offs between objectives. The point here is simply that impacts on current and future electrification should be part of such trade-off considerations.

In addition, there is significant overlap between the reference in the regulations to considering whether the current plan is adequately helping to develop new and emerging technologies that could play bigger roles in future efficiency plans and what will be necessary to enable future building electrification considerations. For example, consider the new generation of cold climate air source heat pumps which offer great potential as both an important electric efficiency measure – in a province in which approximately 40% of all homes heat with electricity,[16] mostly inefficient electric resistance heating systems[17] – and an important electrification measure. As discussed in more detail below,

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[16] Manitoba Hydro, 2017 Residential Energy Use Survey, p. 26.

[17] Electric resistance heat – most commonly in the form of electric baseboards or electric furnaces – has a co-efficient of performance (COP) of 1.0. That means that for every unit of energy input (in the form of electricity) it produces one unit of energy output (in the form of heat). In contrast, heat pumps can

this technology has been successfully deployed in both electric efficiency and electrification initiatives in numerous other jurisdictions, particularly in the northeastern and northwestern parts of the U.S. However, the technology that enables performance in cold climates is evolving, as are efforts to develop and deploy controls to optimize the operation of the heat pumps and any back-up heating systems that may be needed when outdoor temperatures become too cold for the heat pumps to meet heating needs by themselves. Also, anecdotal experience suggests that the cost of these heat pumps is higher in regions that have historically not promoted them relative to the regions where they have been actively promoted.[18] Thus, if Efficiency Manitoba were to promote their installation as electric efficiency measures in its current three-year plan, it could gain experience with the technology, help local HVAC contractors and other trade allies gain experience with it, and lay the foundation for more substantial uptake and electric efficiency savings in future plans – all of which would better enable future electrification efforts.

Finally, because the measures that would electrify building space heating in the current three-year plan (e.g., heat pumps) and those that would enable electrification in the future (e.g., heat pumps, as well as building envelop improvements in gas heat homes and commercial buildings) are relatively long-lived measures, their inclusion in Efficiency Manitoba's plan would increase (relative to alternative shorter-lived measures) the amount of savings persisting 15+ years from now. While it appears as if the statute

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have seasonal average COPs of 2.0 to 4.0, depending on the type of heat pump, climate and other factors. In other words, heat pumps are typically two to four times more efficient than electric resistance heat.

[18] For example, in the latter half of 2017 I helped Commonwealth Edison, the electric utility serving the Chicago area, to develop a pilot program to install and test the performance of cold climate ductless heat pumps in approximately 80 low income apartments across seven different multi-family buildings. Though data on the costs of the heat pumps are confidential, I can say that they were higher than I expected given my own experience with installing the identical product in my home in Vermont (where they have been actively promoted for years) as well as cost data I have seen for other parts of New England (where they have also been actively promoted). While there are undoubtedly a variety of reasons why the Chicago heat pumps were more expensive, the region's lack of experience and familiarity with the products is likely one of them.

simply requires that the sum of incremental annual savings over the first fifteen years of Efficiency Manitoba's efforts equal 22.5% electric and 11.25% gas savings – i.e., it does not appear to specify an amount of annual savings that is *persisting* fifteen years from now – other policy objectives would appear to suggest a preference for longer-lived savings (e.g., statutory references to interests in GHG reductions, other environmental benefits, displacing capital investments on the grid, and enhancing energy security).

C. Time is of the Essence

As discussed above, there is a scientific consensus that we are facing a "climate crisis" with little time left to make the truly fundamental changes in our energy systems necessary stabilize global warming at levels (i.e., 1.5º C) that would avoid the most damaging effects of climate change.[19]

Furthermore, we know from experience that it is very difficult to change the existing building stock quickly. Indeed, a report published by the Regulatory Assistance Project several years ago documented that the most successful home retrofit efforts in the industrialized world – notably Ontario in the 2009-2010 fiscal year and Great Britain for the two-year period end in March 2010 – had only succeeding in partially treating building envelop and/or HVAC system efficiency opportunities in 3-4% of homes per year; no jurisdiction in the industrialized world had succeeded in comprehensively improving the building envelop and HVAC efficiency of more than 2% of the residential housing stock per year.[20] I am not aware of any more recent evidence of programs that have exceeded those market penetration rates. Put simply, if Manitoba is to tackle its contribution to climate change – and recent news reports suggest the Premier considers

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[19] https://www.nytimes.com/interactive/2018/10/07/climate/ipcc-report-half-degree.html

[20] Neme, Chris, Meg Gottstein and Blair Hamilton, Residential Efficiency Retrofits: A Roadmap for the Future, published by the Regulatory Assistance Project, May 2011 (https://www.raponline.org/knowledge-center/residential-efficiency-retrofits-a-roadmap-for-the-future/).

this important[21] – it cannot afford to miss or defer opportunities to advance electrification and/or the enabling of future electrification during the next three years.

V. Efficiency Manitoba's Plan

A. Electrification During 2020/21 through 2022/23 Program Years

It appears as if Efficiency Manitoba's planned support for electrification in the next three years is negligible. For example, Efficiency Manitoba appears to be forecasting that its programs will help only three residential customers and only six business customers to fuel switch from natural gas to electricity over the next three years.[22] It is not clear that it is expecting any other gas to electricity fuel-switches in any of its other programs.

The extremely limited number of forecast gas to electric fuel-switching projects is not surprising given the cost of fuel-switching and the comparative costs of electricity and gas today. However, it appears as if Efficiency Manitoba may be missing an opportunity to promote electrification of buildings using unregulated fuels such as propane or fuel oil. Manitoba Hydro estimates that fuel-switching from propane or fuel oil to ground source heat pumps would cut average annual residential heating costs by 62% to 82% - or roughly $1200 to $2200 per year.[23] Electrification of propane and/or oil heated buildings is permitted for customers who would qualify for the Affordable Energy Fund.[24] Indeed, Efficiency Manitoba recognizes that it could fund "the conversion of a home heating system from propane or fuel-oil to electric" through its Income Qualified,

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[21] Dickson, Janice, "Manitoba Premier Brian Pallister meets with Trudeau, says fighting climate change is a 'unifying project'," The Globe and Mail, November 8, 2019 (https://www.theglobeandmail.com/politics/article-manitoba-premier-brian-pallister-meets-with-trudeau-says-fighting/).

[22] EM's response to Daymark 13(d) shows only 3 ground source heat pumps and no air source heat pumps funded by natural gas incentives provided through its Home Renovation program; it also shows

[23] Manitoba Hydro, "Wondering about your energy options for space heating?" (https://www.hydro.mb.ca/your_home/heating_and_cooling/space_heating_costs.pdf)

[24] Efficiency Manitoba Regulation 6.

Indigenous or Home Renovation programs.[25] However, none of the information provided by Efficiency Manitoba suggests it is expecting any such projects in the Income Qualified or Indigenous programs.[26]

B. Building the Heat Pump Market through Electric Efficiency

As previously noted, nearly 40% of Manitoba's residential customers already heat with electricity. Furthermore, as Table 1 shows, the average annual electricity consumption for those electrically-heated customers (nearly 24,000 kWh) is nearly 13,000 kWh per year higher than for gas-heated customers (about 11,000 kWh).[27] Manitoba Hydro data also suggest that customers with electric heat consume 20.3 kWh per year per square foot compared to 8.5 kWh per year per square foot for gas heated homes.[28] These data suggest that electric heating is by far the largest component of electrically-heated customers' energy bills. If heating represents about half of the electrically-heated residential customers' consumption,[29] electric space heating would

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[25] Efficiency Manitoba 2020/23 Efficiency Plan, Section 2, p. 24.

[26] For example, when asked for the list of measures from which it plans to obtain savings from its Income Qualified program in Coalition I-103, EM referred to its response to Coalition I-91c for a listing of each measure, incentive costs and savings per measure. The table provided in response to Coalition I-91c does not include reference to any heat pump measures in the Income Qualified, First Nations Insulation and Direct Install Offers, Indigenous Small Business Offers or Metis Income Qualified programs. Geothermal heat pumps are listed as the measure under the Community Geothermal program. However, Efficiency Manitoba describes the objective of the Community Geothermal program as helping First Nations convert homes using electric furnaces to geothermal heat pumps (i.e., entirely an electric efficiency measure).

[27] Manitoba Hydro, 2017 Residential Energy Use Survey, p. 27.

[28] Manitoba Hydro, 2017 Residential Energy Use Survey, p. 28.

[29] Without additional data, it is difficult to say exactly what portion of electrically-heated customers' electricity consumption is related to their electric heat. Though they consume more than twice as much electricity as gas heat customers, some of that may be attributable to other electric end uses, particularly water heating. Also, it is possible that geographic location – and related climate differences – could be a factor. Further, gas heated customers also consume some electricity for heating in the form of fans or pumps to move warm air or hot water around the home. That all said, 50% appears to be a reasonable "ballpark" estimate of the portion of consumption attributable to electric heat.

account for about 30% of total residential electricity consumption in the province (even though 60% of residential customers heat with other fuels). Put simply, electric heat is almost certainly the largest residential electric end use in the Province.

Table 1: Electric Heat as % of Total Residential Electricity Sales

	Electric	Gas	Other	Shared	Total
Customers	191,639	249,938	6,945	36,289	484,811
Avg kWh	23,742	10,976	13,940	3,478	
Total GWh	4,550	2,743	97	126	7,516
% Heating	50%				
Heating GWh	2,275				
% Total Res Sales	**30%**				

Moreover, more than 95% of those electrically-heated customers rely on inefficient electric resistance heat.[30] Both geothermal heat pumps and cold climate air source heat pumps – including ductless mini-splits – offer the potential for substantial reductions in electricity consumption relative to electric resistance heating systems. For example, a 2009 Manitoba Hydro study found that the seasonal average co-efficient of performance (COP) of ten ground source heat pumps in the province was 2.8.[31] That is nearly three times as efficient as common electric resistance heating (which has a COP of 1.0), resulting in savings on the order of 65%. Put simply, high performance heat pumps could have a bigger impact on the energy bill of an electrically-heated Manitoban home than any other single efficiency measure. Moreover, by more aggressively promoting them over the next three years Efficiency Manitoba could help to significantly increase customer and contractor familiarity with them, potentially driving down costs and therefore helping to enable their use in both future efficiency plans and future electrification efforts.

Unfortunately, Efficiency Manitoba is not planning a significant heat pump promotion. Indeed, it is forecasting that it will provide only 135 geothermal heat pump

[30] EM response to Coalition I-59b

[31] Andrushuk, Rob et al., Performance of Ground Source Heat Pumps in Manitoba, June 2009 (https://www.hydro.mb.ca/docs/regulatory_affairs/pdf/gra_2012_2013/Appendix_38.pdf).

incentives and only seven air source heat pump incentives through its Home Renovation program over the next three years. That is an average annual market penetration rate of just 0.02% of electrically-heated residential customers.[32]

It is also worth noting that Efficiency Manitoba is not planning on promoting any kind of heat pumps to low income customers because of their high up-front costs and "the observed demographics of the lower income market (i.e. predominantly gas available areas)." That argument is puzzling. First, low income efficiency programs typically do not require customers to pay any of the cost of installed efficiency measures. Thus, it is unclear why Efficiency Manitoba would consider their up-front costs a barrier. It would simply mean that Efficiency Manitoba's budget for its low income program would need to increase. Second, Efficiency Manitoba's conclusion that low income customers are not good candidates for heat pumps because they are in predominantly "gas available" areas appears to be contradicted by data from Manitoba Hydro's 2017 Residential Energy Use Survey which actually suggests that lower income households are much more likely to be electrically-heated than non-low income households. For example, while 39.5% of all households are electrically-heated, 52.4% of households with annual incomes below $25,000 are electrically-heated – or twice the percentage of households with annual incomes above $100,000 (25.1%).[33]

A number of other jurisdictions have begun to run the kind of aggressive promotion of cold climate heat pumps that Efficiency Manitoba appears to have declined to consider. For example, as shown in Figure 1 below, the Northwest Energy Efficiency Alliance (NEEA), an organization that promotes energy efficiency market transformation in the northwestern U.S. states of Washington, Oregon, Idaho and western Montana, provided financial incentives for nearly 70,000 ductless heat pumps in three target

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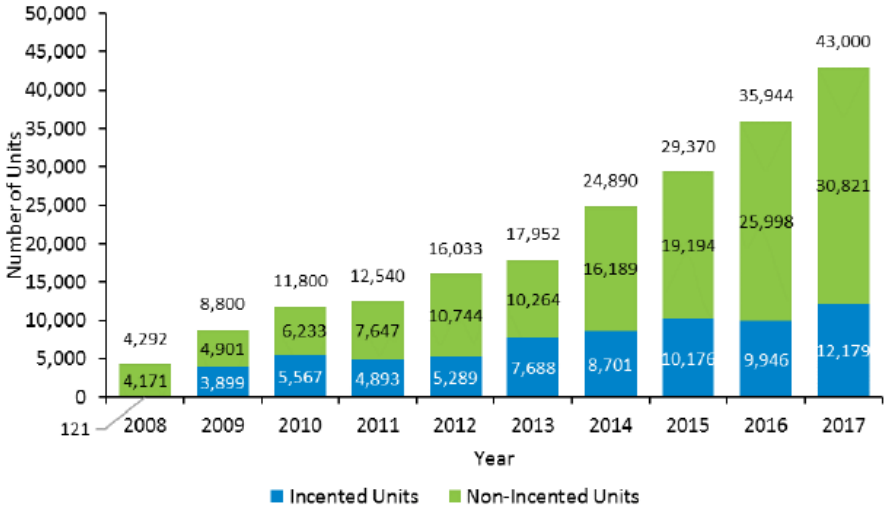
[32] According to Manitoba Hydro's 2017 Residential Energy Use Survey, there are approximately 192,000 electrically-heated customers, approximately 182,000 of which have electric resistance heat (p. 30). Thus, the 135 units Manitoba Hydro forecasts it will rebate over the next three years represents approximately 0.07% of existing electric resistance-heating customers, or approximately 0.02 % per year.

[33] Manitoba Hydro, 2017 Residential Energy Use Survey, p. 26.

markets between 2008 and 2017. An even larger number of non-incentive units – over 130,000 have been sold in other parts of the region over the same time period. The vast majority of the heat pumps have been installed in single family homes with zonal heating (e.g. electric resistance baseboard heating). NEEA's goal is to achieve 65% saturation of ductless heat pumps in such homes by 2039; as of 2017 the market penetration rate had grown to 14%.[34]

Figure 1: NEEA Estimated Ductless Heat Pump Sales[35]



Similarly, the Efficiency Maine Trust – a non-profit entity charged with running efficiency programs for the state of Maine – recently reported that it had reached "a milestone of promoting more than 46,000 high-performance heat pumps installed over the past seven years."[36] That is in a state with approximately 550,000 residential

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[34] Lee, Hanna et al., Northwest Ductless Heat Pump Initiative: Market Progress Evaluation #7, NEEA Report #E18-374, September 20, 2018 (https://neea.org/img/documents/DHP_MPER_7_Report_FINAL_CC.pdf).

[35] Ibid. Copy of Report's Figure 1, p. 13.

[36] Efficiency Maine, FY2019 Annual Report (https://www.efficiencymaine.com/docs/FY19-Annual-Report_final.pdf).

customers[37] – or about 10% more than Manitoba. The state legislature also recently established a goal of installing 100,000 new high-performance heat pumps over the next five years.[38]

While portions of the NEEA territory and Maine are very cold, those states are generally not as cold as Manitoba. Thus, any Manitoba initiative that promoted cold climate ductless heat pumps as an electric efficiency measure would likely need to ensure that the electric resistance heating system remained as a back-up system to address needs during the coldest days of the year. Such an initiative should also ideally be promoted in concert with promotion of building envelop improvements to enable the heat pumps to meet as much of the heating load as possible. Finally, any such initiative should assess the heat pumps' seasonal efficiency and other aspects of its performance to identify modifications to the program that may be warranted in the future.

C. Enabling Future Electrification by Improving Buildings

As previously discussed, investments in natural gas efficiency that are focused on reducing heating loads through improvements to building envelopes (increased insulation, reduced air leakage, etc.) can also enhance the prospects of future electrification efforts. Efficiency Manitoba's plan suggests that its Home Renovation program will produce more than half of its residential savings (excluding codes and standards),[39] with almost all of those savings coming from building envelope measures (insulation, air sealing, doors and windows).[40] Efficiency Manitoba is also forecasting that close to 60% of the gas savings from its Income Qualified program will come from

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[37] U.S. Census data ("Quick Facts") suggest there were an average of 554 thousand households from 2013 through 2017.

[38] Efficiency Maine, FY2019 Annual Report (https://www.efficiencymaine.com/docs/FY19-Annual-Report_final.pdf).

[39] Efficiency Manitoba 2020/23 Efficiency Plan, Attachment 3 – Technical Tables ["Annual Natural Gas Energy Savings (millions m^3)"]

[40] Table Attached to response to Daymark I-13.

building envelope measures.[41] Those percentages suggest an appropriate prioritization of building envelope efficiency improvements within its portfolio of residential programs. On the other hand, because Efficiency Manitoba is planning to achieve the vast majority of its savings from codes and standards (28%) and business (commercial, industrial and agricultural) programs (52%), the Home Renovation program and Income Qualified program savings collectively represent only about 14% of Efficiency Manitoba's total gas savings[42] (other residential and emerging technology programs provide the balance of the savings). Thus, there may be room for expansion of efforts to improve residential building envelope efficiency within the current plan.

VI. Concerns on Accounting for Electrification in Goals

For its 2020/23 plan, Efficiency Manitoba has suggested that the entire reduction in natural gas consumption associated with electrification projects be counted as savings for determining achievement of its gas savings target and the entire increase in electricity consumption be treated as negative savings (i.e. as a penalty) when assessing whether it achieved its electric savings goals.[43] Given the way that Efficiency Manitoba's savings goals are structured, with separate electric and gas savings targets, that proposal has the potential to create perverse incentives. For example, if Efficiency Manitoba is behind on its electric savings goal and on target for achieving its gas savings goal, it would have a disincentive to pursue electrification projects even if they were otherwise good projects to pursue. This potential perverse incentive is not likely to have a material effect on Efficiency Manitoba during the upcoming plan period given the extremely small number of electrification projects Efficiency Manitoba is forecasting for the next three years (three residential and six business fuel switches to heat pumps). However, in the event that its plan is modified, or in case there are significantly more opportunities for

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[41] Table Attached to response to Daymark I-13.

[42] Per Efficiency Manitoba 2020/23 Efficiency Plan, Attachment 3 – Technical Tables ["Annual Natural Gas Energy Savings (millions m^3)"], total 3-year savings from Residential, Income Qualified and Indigenous programs is 6.05 million m^3. The total 3-year savings from the portfolio, excluding interactive effects, is 43.27 million m^3.

[43] Efficiency Manitoba Efficiency Plan 2020/23, Appendix A, Section 2, p. 19.

electrification than Efficiency Manitoba is forecasting, this policy proposal should be modified.

There are several better alternatives for accounting for the effects of electrification measures and projects in Efficiency Manitoba's goals, several of which are discussed in the Dunsky memo on Cost Allocation Methods for Fuel-Switching Programs that Efficiency Manitoba commissioned and included in Attachment 4 to its plan.

The first option would be to change the way goals are expressed to a fuel-neutral metric, such as gigajoules of site energy savings. For example, in their 2019-2021 efficiency plan filing, the Massachusetts utilities proposed to report total MMBtu savings, which would include the net energy effects of electrification measures, as well as total electric savings excluding the effects of electrification.[44] That approach would appear to require a statutory change in Manitoba.

A second option would be to establish separate "efficiency only" and electrification goals. That is – indirectly – the way goals are structured in Vermont, where Efficiency Vermont has energy savings goals it must reach and individual electric utilities have separate targets for helping their customers reduce direct consumption of fossil fuels, much of which they plan to achieve through promotion of electrification of building space heating, water heating and industrial processes. The utilities coordinate their delivery of electrification initiatives with Efficiency Vermont's efficiency

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[44] The utilities proposed to convert both electric efficiency impacts and the impacts of increased electricity consumption from electrification to BTUs on a site savings basis (i.e. one kWh equals 3413 kWh) but proposed to convert impacts from combined heat and power projects based on source savings [Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan, 2019-2021, filed in BPU Dockets 18-110 to 18-119, October 31, 2018, p. 16 (http://ma-eeac.org/wordpress/wp-content/uploads/Exh.-1-Final-Plan-10-31-18-With-Appendices-no-bulk.pdf)]. Some concerns were expressed by other parties about the proposed methodologies. Ultimately, the state's regulators instructed the utilities to "further study and proposed a more refined method to account for the conversion of electric savings to MMBtu savings." [Massachusetts Department of Public Utilities Final Order in DPU 18-110 to 18-119, January 29, 2019, p. 157 (http://ma-eeac.org/wordpress/wp-content/uploads/2019-2021-Three-Year-Energy-Efficiency-Plans-DPU-Order_01.29.19.pdf)].

initiatives. This concept of separate goals for efficiency and electrification would also appear to require a statutory change in order to be adopted in Manitoba.

A third option, which may be implementable without any statutory changes, would be to treat electrification measures in two steps: (1) an electrification step to a standard efficiency electric technology (e.g., electric resistance heating); and (2) an efficiency step that counts electric savings relative to that step 1 baseline (e.g., from electric resistance heat to high performance heat pumps). This is the conceptual approach currently being used in the state of Illinois.[45] It is also conceptually the same at the approach used in Vermont when there is overlap between the utilities' electrification initiatives and Efficiency Vermont's promotion of high performance, cold climate heat pumps as an efficiency measure.[46]

A fourth option, which may also be implementable without any statutory changes, would be to express site energy savings (e.g. the difference between the reduction in gigajoules consumed at the customers' gas meter for its furnace before the fuel switch and the increase in gigajoules consumed at the customer's electric meter after the fuel switch) in kWh equivalents and treat them solely as contributions towards the electric savings goal. This is essentially the method adopted by California.[47]

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[45] See, for example, the Illinois Technical Reference Manual savings algorithms for heat pumps (https://s3.amazonaws.com/ilsag/IL-TRM_Effective_01-01-20_v8.0_Vol_3_Res_10-17-19_Final.pdf).

[46] In such cases, the utilities count fossil fuel reductions from electrification relative to a switch to a standard air source heat pump (this is important because the utilities are required to de-rate the fossil fuel savings from electrification at their customers' premises by the amount of fossil fuel that would be consumed to provide the electricity for the new heating, water heating and/or industrial process equipment) and Efficiency Vermont counts electric efficiency savings equal to the difference in consumption between a standard air source heat pump and the high performance heat pumps they rebate.

[47] Note that the California rule also would treat the reduction in natural gas as a reduction in gas sales, thereby producing a modest reduction in gas savings goals equal to the sales reduction from electrification measures divided by total sales (e.g. if electrification reduced gas sales by 1%, the gas savings goal would go down by 1%). [see Dunsky memo on Cost Allocation Methods for Fuel-Switching Programs that Efficiency Manitoba commissioned and included in Attachment 4 to its plan]

VII. Conclusions and Recommendations

Based on the analysis and discussion above, I make the following recommendations to the Board:

1. Direct Efficiency Manitoba to consider the long-term climate benefits of both current electrification and better enabling of future electrification when making implementation decisions for its programs over the next three years as well as when planning for subsequent three-year program cycles.
2. Direct Efficiency Manitoba to increase its emphasis on heat pumps as an electric efficiency measure promoted through its Home Renovations program. That should include increased financial incentives.
3. Direct Efficiency Manitoba to offer heat pumps as an electric efficiency measure for electrically heated low income customers eligible to participate in its Income Qualified program. Such measures should be offered at no cost to the participating low income customers. Furthermore, efforts should be made to ensure that such measures are installed in both single family and multi-unit residential buildings.
4. Direct Efficiency Manitoba to offer incentives for heat pumps to customers who currently (A) use propane or fuel oil for space heating and (B) qualify for the Affordable Energy Fund.
5. Direct Efficiency Manitoba to change the way it counts impacts of electrification measures to one that is conceptually similar to what is currently done in Illinois and Vermont. Specifically, impacts on gas (or other fossil fuel) consumption should not be counted towards gas savings goals and electric savings should be computed as the difference between a standard electric efficiency technology (e.g., electric resistance heat) and the more efficient electric technology promoted by Efficiency Manitoba's programs (e.g., a high performance heat pump).
6. Consider providing feedback to legislators on the merits of either (A) establishing energy savings targets in a fuel neutral way and/or (B) establishing separate efficiency and electrification goals.

Appendix A – Statement of Qualifications and Duties

A. Qualifications

Chris Neme, the author of this report, is a Co-Founder and Principal of Energy Futures Group (EFG), a clean energy consulting firm based in Hinesburg, Vermont with additional offices in New York and Massachusetts. EFG designs, implements and evaluates programs and policies to promote investments in energy efficiency, renewable energy, demand response, other distributed resources, and strategic electrification.

Chris has more than thirty years of experience in the energy industry, particularly with energy efficiency, demand response, and strategic electrification policies and programs. He has worked for regulators, other government agencies, utilities, efficiency advocates, and/or consumer advocates in five different Canadian provinces, more than 30 U.S. states and several European countries. Chris has filed expert witness testimony on his work in nearly sixty different cases/dockets before regulators in Ontario (on more than twenty occasions), Quebec and ten different U.S. states.

Chris' work has addressed a variety of topics including the robustness of energy efficiency, demand response and other clean energy goals; the structure of performance incentives for achieving those goals; the design of programs for achieving the goals; the cost-effectiveness of energy efficiency and other distributed resource investments; the bidding of efficiency resources into electric capacity markets; the potential for non-wires and non-pipe alternatives to cost-effectively defer transmission and distribution system investments; and the economic and environmental impacts of strategic electrification. Examples of current or recent projects include:

- Representing the Natural Resources Defense Council (NRDC) in both informal consultations and contested regulatory proceedings in Michigan, Illinois and Ohio on energy efficiency and demand response program designs, cost-effectiveness analyses, evaluation and shareholder incentive structures; distribution system planning and non-wires alternatives; strategic electrification planning; and integrated resource planning;

- Serving as an appointed expert on the Ontario Energy Board's Evaluation and Audit Committee for gas demand-side management;
- Helping the National Association of Regulatory Utility Commissioners and the Michigan Public Service Commission assess the relative merits of alternative approaches to defining savings goals for utility efficiency programs (focusing on lifetime savings);
- Co-Authoring the *National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources* (published May 2017) as well as a new Manual to be published in 2020 that will address cost-effectiveness assessment for all types of distributed energy resources;
- Drafting a white paper for the Alberta Energy Efficiency Alliance on how treatment of "efficiency as a resource" could be institutionalized in the province;
- Helping Green Mountain Power to develop forecast of strategic electrification potential in its Vermont service territory, as well as to develop its initial plan for compliance with Vermont's requirement that the state's electric utilities help their customers reduce direct consumption of fossil fuels (including through strategic electrification);
- Analyzing and then testifying before the Vermont Public Service Board (on behalf of the Vermont Public Interest Research Group) on the economic and environmental impacts of fuel-switching from oil or propane heating to either natural gas or efficient, cold climate heat pumps; and
- Helping the Toronto Atmospheric Fund assess efficiency potential from retrofitting of heat pumps into electric resistance-heated multi-family buildings in Ontario.

More information on Chris' experience can be found in his curriculum vitae, attached as Appendix B.

B. Duties

The Public Interest Law Centre retained Mr. Neme to assist the Consumers Coalition with its participation in the Public Utilities Board review of the 2020/23 Efficiency Plan on issues relating to:

1. An assessment of the reasonableness of the projected savings in Efficiency Manitoba's 3-year plan, including an assessment of the methodology used to determine the net savings;
2. An examination of Efficiency Manitoba's proposed plan to reach the savings target, including:
    a. the appropriateness of the methodologies used by Efficiency Manitoba to select or reject demand-side management initiatives;
    b. whether the plan adequately considers the interests of residential customers;
    c. the accessibility of initiatives in the plan to residential customers, including low-income and other hard-to-reach or vulnerable groups, including but not limited to, Indigenous customers, rural customers, customers with disabilities, newcomers, renters and residents of multi-units residential buildings and older customers;
    d. an examination of the use of long-term versus short-lived initiatives;
    e. whether the efficiency plan adequately considers new and emerging technologies that may be included in a future efficiency plan.
3. An analysis of Efficiency Manitoba's proposed evaluation framework;
4. The impact of decarbonization and electrification on the way Efficiency Manitoba savings goals are defined, and the role Efficiency Manitobacould/should play in supporting decarbonization and electrification, including a discussion of best practices and trends in other jurisdictions.

Mr. Neme's testimony focuses primary on the fourth of these topics – the role electrification could/should play in Efficiency Manitoba's plan – though he addresses aspects of the second topic in doing so. Mr. Neme's Energy Futures Group colleague, Jim Grevatt (a Managing Consultant with Energy Futures Group), focuses primarily on the first three issues.

Energy Futures Group's duties included:

- Review Efficiency Manitoba 2020/23 Efficiency Plan;
- Draft information requests;
- Review responses to information requests;
- Prepare briefing notes and attend meetings with clients and legal team, where necessary; and
- Prepare independent expert evidence relating to the issues under examination.

Energy Futures Group's retainer letter includes that Mr. Neme's and Mr. Grevatt's duties are to provide evidence that:

1. is fair, objective and non-partisan;
2. is related only to matters that are within their area of expertise; and
3. to provide such additional assistance as the Public Utilities Board may reasonably require to determine an issue;

Energy Futures Group's retainer letter also specifies that Mr. Neme's and Mr. Grevatt's duties in giving evidence is to help the Public Utilities Board. This duty overrides any obligation to CAC Manitoba. By signing the letter of retainer, Mr. Neme confirmed that he will comply with this duty.

Appendix B: Chris Neme CV

Chris Neme
Principal

ENERGY FUTURES GROUP

Professional Summary

Chris specializes in analysis of markets for energy efficiency, demand response, renewable energy and strategic electrification measures and the design and evaluation of programs and policies to promote them. During his 25+ years in the clean energy industry, Mr. Neme has worked for energy regulators, utilities, government agencies and advocacy organizations in nearly 30 states, 5 Canadian provinces and several European countries. He has defended expert witness testimony before regulatory commissions in eleven different jurisdictions; he has also testified before several state legislatures. Chris has also authored or co-authored numerous reports and papers regarding energy efficiency policies and programs, including the first edition (Spring 2017) of the National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources and several reports on non-wires alternatives.

Experience

2010-present: Principal, Energy Futures Group, Hinesburg, VT

1999-2010: Director of Planning & Evaluation, Vermont Energy Investment Corp., Burlington, VT

1993-1999: Senior Analyst, Vermont Energy Investment Corp., Burlington, VT

1992-1993: Energy Consultant, Lawrence Berkeley National Laboratory, Gaborone, Botswana

1986-1991: Senior Policy Analyst, Center for Clean Air Policy, Washington, DC

Education

M.P.P., University of Michigan, 1986

B.A.., Political Science, University of Michigan, 1985

Selected Projects

- Natural Resources Defense Council (Illinois, Michigan and Ohio). Critically review multi-year efficiency, demand response, electrification, distribution system investment and integrated resource plans filed by Illinois, Michigan & Ohio utilities. Draft/defend regulatory testimony on critiques. Represent NRDC in regular stakeholder-utility processes developing efficiency policy manuals, annual TRM updates, annual NTG updates, evaluation plans and other work. Also represent NRDC in collaborative development of non-wires alternative pilots. Supported development of Illinois clean energy bill adopted in late 2016. (2010 to present)
- Ontario Energy Board. Serve on provincial gas DSM Evaluation Advisory Committee. Work includes input on multi-year evaluation plans, input on scopes of work for evaluation studies, serving on OEB teams that review and score proposals submitted in response to evaluation RFPs,

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and critical review and input on independent evaluator assessments of utilities' annual gas savings claims. Also serve on advisory committees on gas and electric efficiency potential studies and advisory committee on carbon price forecast studies. (2015-present)

- E4TheFuture. Co-authored first edition (Spring 2017) of the National Standard Practice Manual (NSPM) for cost-effectiveness analysis of energy efficiency. Presenting the NSPM for EE to a wide variety of audiences across the U.S. and Canada; helping several to assess how to use it to refine current practices. Co-authoring updated NSPM (expected June 2020) that will expand focus from just EE to address all distributed energy resources. (2016 to present)
- New Jersey Board of Public Utilities. Serve on management team responsible for statewide delivery of New Jersey Clean Energy Programs. Lead strategic planning; support regulatory filings, cost-effectiveness analysis & evaluation work. (2015 to present). Served on management team for start-up of residential and renewables programs for predecessor project. (2006-2010)
- Regulatory Assistance Project - U.S. Provide guidance on efficiency policy and programs. Lead author on strategic reports on achieving 30% electricity savings in 10 years, using efficiency to defer T&D system investments, & bidding efficiency into capacity markets. (2010 to present)
- Regulatory Assistance Project - Europe. Provide on-going support on efficiency policies and programs in the United Kingdom, Germany, and other countries. Reviewed draft European Union policies on Energy Savings Obligations, EM&V protocols, and related issues. Drafted policy brief on efficiency feed-in-tariffs and roadmap for residential retrofits. (2009 to present)
- Energy Efficiency Alberta. Assisting EEA in providing input to Alberta Utilities Commission on the role efficiency resources can play in reducing electric system costs. (2019 to present)
- Citizens Action Coalition of Indiana. Critically reviewing how energy efficiency resources are being modeled in IRPs of several Indiana electric utilities, as well as the design of energy efficiency program portfolios. (2018 to present)
- Efficiency Vermont. Provided technical support in review of avoided cost assumptions, as well as related policies on cost-effectiveness analyses of efficiency resources (2019).
- Earth Justice and Southern Alliance for Clean Energy. Assisted in critically reviewing Florida utilities' efficiency potential studies and proposed and energy efficiency savings targets for 2020 through 2024. (2019)
- Green Mountain Power (Vermont). Support development and implementation of GMP's compliance plan for Vermont RPS Tier 3 requirement to reduce customers' direct consumption of fossil fuels, with significant emphasis on strategic electrification strategies. Also developed 10-year forecast of sales that could result from three different levels of policy/program promotion of residential electric space heating, electric water heating and electric vehicles. (2016 to 2018)
- Alberta Energy Efficiency Alliance. Drafted white paper how treatment of "efficiency as a resource" could be institutionalized in Alberta. The paper followed several presentations to government agencies and others on behalf of the Pembina Institute. (2017 to 2018)

- Green Energy Coalition (Ontario). Represent coalition of environmental groups in regulatory proceedings, utility negotiations and stakeholder meetings on DSM policies (including integrated resource planning on pipeline expansions) and utility proposed DSM Plans. (1993 to present)
- Southern Environmental Law Center. Assessed reasonableness of Duke Energy's historic efficiency program savings claims, as well as the design of their efficiency program portfolios for 2019. Filed expert witness testimony on findings in North Carolina dockets (2018).
- Toronto Atmospheric Fund. Helped draft an assessment of efficiency potential from retrofitting of cold climate heat pumps into electrically heated multi-family buildings (2017).
- Northeast Energy Efficiency Partnerships. Helped manage Regional EM&V forum project estimating savings for emerging technologies, including field study of cold climate heat pumps. Led assessment of best practices on use of efficiency to defer T&D investment. (2009 to 2015)
- Ontario Power Authority. Managed jurisdictional scans on leveraging building efficiency labeling/disclosure requirements and non-energy benefits in cost-effectiveness screening. Supported staff workshop on the role efficiency can play in deferring T&D investments. Presented on efficiency trends for Advisory Council on Energy Efficiency. (2012-2015)
- Vermont Public Interest Research Group. Conducted comparative analysis of the economic and environmental impacts of fuel-switching from oil/propane heating to either natural gas or efficient, cold climate electric heat pumps. Filed regulatory testimony on findings. (2014-2015)
- New Hampshire Electric Co-op. Led assessment of the co-op's environmental and social responsibility programs' promotion of whole building efficiency retrofits, cold climate heat pumps and renewable energy systems. Presented recommendations to the co-op Board. (2014)
- National Association of Regulatory Utility Commissioners (NARUC). Assessed alternatives to first year savings goals to eliminate disincentives to invest in longer-lived measures and programs. (2013)
- California Investor-Owned Utility. Senior advisor on EFG project to compare the cost of saved energy across ~10 leading U.S. utility portfolios. The research sought to determine if there are discernable differences in the cost of saved energy related to utility spending in specific non-incentive categories, including administration, marketing, and EM&V. (2013)
- DC Department of the Environment (Washington DC). Part of VEIC team administering the DC Sustainable Energy Utility (SEU). Helped characterize the DC efficiency market and supporting the design of efficiency programs that the SEU will be implementing. (2011 to 2012)
- Ohio Sierra Club. Filed and defended expert witness testimony on the implications of not fully bidding all efficiency resources into the PJM capacity market. (2012)
- Regulatory Assistance Project – Global. Assisted RAP in framing several global research reports. Co-authored the first report – an extensive "best practices guide" on government policies for achieving energy efficiency objectives, drawing on experience with a variety of policy mechanism employed around the world. (2011)
- Tennessee Valley Authority. Assisted CSG team providing input to TVA on the redesign of its residential efficiency program portfolio to meet aggressive new five-year savings goals. (2010)

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- New York State Energy Research and Development Authority (NYSERDA). Led residential & renewables portions of several statewide efficiency potential studies. (2001 to 2010)
- Ohio Public Utilities Commission. Senior Advisor to a project to develop a web-based Technical Reference Manual (TRM). The TRM includes deemed savings assumptions, deemed calculated savings algorithms and custom savings protocols. It was designed to serve as the basis for all electric and gas efficiency program savings claims in the state. (2009 to 2010)
- Vermont Electric Power Company. Led residential portion of efficiency potential study to assess alternatives to new transmission line. Testified before Public Service Board. (2001-2003)
- Efficiency Vermont. Served on Sr. Management team. Supported initial project start-up. Oversaw residential planning, input to regulators on evaluation, input to regional EM&V forum, development of M&V plan and other aspects of bidding efficiency into New England's Forward Capacity Market (FCM), and development and updating of nation's first TRM. (2000 to 2010)
- Long Island Power Authority Clean Energy Plan. Led team that designed the four major residential programs (three efficiency, one PV) incorporated into the plan in 1999. Oversaw extensive technical support to the implementation of those programs. This involved assistance with the development of goals and budgets, development of savings algorithms, cost-effectiveness screening, and on-going program design refinements. (1998 to 2009)

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Selected Publications and Reports

- *National Standard Practice Manual for Assessing Cost-Effectiveness of Distributed Energy Resources*, (with Tim Woolf and others), forthcoming Summer 2020
- *Recommendations for Accelerating Adoption of Heat Pumps in the Ontario eMURB Sector*, Toronto Atmospheric Fund, forthcoming in 2018 (with Devon Calder, Brian Purcell and Judy Simon)
- *National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources*, Edition 1, Spring 2017 (with Tim Woolf, Marty Kushler, Steven Schiller and Tom Eckman)
- *The Next Quantum Leap in Efficiency: 30% Electricity Savings in 10 Years*, Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings, Volume 9, pp. 1-14 (with Jim Grevatt, Rich Sedano and Dave Farnsworth)
- *The Next Quantum Leap in Efficiency: 30% Electricity Savings in Ten Years*, published by the Regulatory Assistance Project, February 2016 (with Jim Grevatt)
- *Energy Efficiency as a T&D Resource: Lessons from Recent U.S. Efforts to Use Geographically Targeted Efficiency Programs to Defer T&D Investments*, published by Northeast Energy Efficiency Partnerships, January 9, 2015 (with Jim Grevatt)
- *Unleashing Energy Efficiency: The Best Way to Comply with EPA's Clean Power Plan*, Public Utilities Fortnightly, October 2014, pp. 30-38 (with Tim Woolf, Erin Malone and Robin LeBaron)
- *The Resource Value Framework: Reforming Energy Efficiency Cost-Effectiveness Screening*, published by the National Efficiency Screening Project, August 2014 (with Tim Woolf et al.)
- *U.S. Experience with Participation of Energy Efficiency in Electric Capacity Markets*, Regulatory Assistance Project, August 2014 (with Richard Cowart)
- *The Positive Effects of Energy Efficiency on the German Electricity Sector*, IEPEC 2014 Conference, September 2014 (with Friedrich Seefeldt et al.)
- *Final Report: Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges*, prepared for the Michigan Public Service Commission, September 13, 2013 (with Optimal Energy)
- *Energy Efficiency Feed-in-Tariffs: Key Policy and Design Considerations*, Proceedings of ECEEE 2013 Summer Study, pp 305-315 (with Richard Cowart)
- *Can Competition Accelerate Energy Savings? Options and Challenges for Efficiency Feed-in-Tariffs*, published in Energy & Environment, Volume 24, No. 1-2, February 2013 (with Richard Cowart)
- *An Energy Efficiency Feed-in-Tariff: Key Policy and Design Considerations*, published by the Regulatory Assistance Project, March/April 2012 (with Richard Cowart)
- *U.S. Experience with Efficiency as a Transmission and Distribution System Resource*, published by the Regulatory Assistance Project, February 2012 (with Rich Sedano)

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- *Achieving Energy Efficiency: A Global Best Practices Guide on Government Policies*, published by the Regulatory Assistance Project, February 2012 (with Nancy Wasserman)
- *Residential Efficiency Retrofits: A Roadmap for the Future*, published by the Regulatory Assistance Project, May 2011 (with Meg Gottstein and Blair Hamilton)
- *Is it Time to Ditch the TRC?* Proceedings of ACEEE 2010 Summer Study on Energy Efficiency in Buildings, Volume 5 (with Marty Kushler)
- *Energy Efficiency as a Resource in the ISO New England Forward Capacity Market*, in Energy Efficiency, published on line 06 June 2010 (with Cheryl Jenkins and Shawn Enterline)
- *A Comparison of Energy Efficiency Programmes for Existing Homes in Eleven Countries*, prepared for the British Department of Energy and Climate Change, 19 February, 2010 (with Blair Hamilton et al.)
- *Energy Efficiency as a Resource in the ISO New England Forward Capacity Market*, Proceedings of the 2009 European Council on an Energy Efficient Economy Summer Study, pp. 175-183 (with Cheryl Jenkins and Shawn Enterline)
- *Playing with the Big Boys: Energy Efficiency as a Resource in the ISO New England Forward Capacity Market*, Proceedings of ACEEE 2008 Summer Study Conference on Energy Efficiency in Buildings, Volume 5 (with Cheryl Jenkins and Blair Hamilton)
- *Recommendations for Community-Based Energy Program Strategies, Final Report*, developed for the Energy Trust of Oregon, June 1, 2005 (with Dave Hewitt et al.)
- *Shareholder Incentives for Gas DSM: Experience with One Canadian Utility*, Proceedings of ACEEE 2004 Summer Study on Energy Efficiency in Buildings, Volume 5 (with Kai Millyard)
- *Cost Effective Contributions to New York's Greenhouse Gas Emission Reduction Targets from Enegy Efficiency and Renewable Energy Resources*, ACEEE 2004 Summer Study Proceedings, Volume 8 (with David Hill et al.)
- *Opportunities for Accelerated Electric Energy Efficiency Potential in Quebec: 2005-2012*, prepared for Regroupement national des conseils regionaux de l'environnement du Quebec, Regroupement des organisms environnementaux energie and Regroupement pour la responsabilite sociale des enterprises, May 16, 2004 (with Eric Belliveau, John Plunkett and Phil Dunsky)
- *Review of Connecticut's Conservation and Load Management Administrator Performance, Plans and Incentives*, for Connecticut Office of Consumer Counsel, October 31, 2003 (with John Plunkett, Phil Mosenthal, Stuart Slote, Francis Wyatt, Bill Kallock and Paul Horowitz)
- *Energy Efficiency and Renewable Energy Resource Development Potential in New York State*, for New York Energy Research and Development Authority, August 2003 (with John Plunkett, Phil Mosenthal, Stave Nadel, Neal Elliott, David Hill and Christine Donovan)
- *Assessment of Economically Deliverable Transmission Capacity from Targeted Energy Efficiency Investments in the Inner and Metro-Area and Northwest and Northwest/Central Load Zones", for Vermont Electric Power Company, Final Report: April 2003* (with John Plunkett et al.)

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- *Residential HVAC Quality Installation: New Partnership Opportunities and Approaches*, Proceedings of ACEEE 2002 Summer Study Conference on Energy Efficiency in Buildings, Volume 6 (with Rebecca Foster, Mia South, George Edgar and Put Murphy)
- *A Modified Delphi Approach to Predict Market Transformation Program Effects*, Proceedings of ACEEE 2000 Summer Study Conference on Energy Efficiency in Buildings, Volume 6 (with Phil Mosenthal et al.)
- *Using Targeted Energy Efficiency Programs to Reduce Peak Electrical Demand and Address Electric System Reliability Problems*, published by the American Council for an Energy Efficient Economy, November 2000 (with Steve Nadel and Fred Gordon)
- *Energy Savings Potential from Addressing Residential Air Conditioner and Heat Pump Installation Problems*, American Council for an Energy Efficient Economy, February 1999 (with John Proctor and Steve Nadel)
- *Promoting High Efficiency Residential HVAC Equipment: Lessons Learned from Leading Utility Programs*, Proceedings of ACEEE 1998 Summer Study Conference on Energy Efficiency in Buildings, Volume 2 (with Jane Peters and Denise Rouleau)
- *PowerSaver Home Program Impact Evaluation*, report to Potomac Edison, February 1998 (with Andy Shapiro, Ken Tohinaka and Karl Goetze)
- *A Tale of Two States: Detailed Characterization of Residential New Construction Practices in Vermont and Iowa*, Proceedings of ACEEE 1996 Summery Study Conference on Energy Efficiency in Buildings, Volume 2 (with Blair Hamilton, Paul Erickson, Peter Lind and Todd Presson)
- *New Smart Protocols to Avoid Lost Opportunities and Maximize Impact of Residential Retrofit Programs*, in Proceedings of ACEEE 1994 Summer Study on Energy Efficiency in Buildings (with Blair Hamilton and Ken Tohinaka
- *Economic Analysis of Woodchip Systems* and *Finding Capital to Pay for a Woodchip Heating System*, Chapters 6 and 8 in Woodchip Heating Systems: A Guide for Institutional and Commercial Biomass Installations, published by the Council of Northeastern Governors, July 1994
- *PSE&G Lost Opportunities Study: Current Residential Programs and Relationship to Lost Opportunties*, prepared for the PSE&G DSM Collaborative, June 1994 (with Blair Hamilton, Paul Berkowitz and Wayne DeForest)
- *PSE&G Lost Opportunities Study: Preliminary Residential Market Analysis*, prepared for the PSE&G DSM Collaborative, May 1994 (with Blair Hamilton, Paul Berkowitz and Wayne DeForest)
- *Long-Range Evaluation Plan for the Vermont Weatherization Assistance Program*, prepared for the Vermont Office of Economic Opportunity, February 1994 (with Blair Hamilton and Ken Tohinaka)
- *Impact Evaluation of the 1992-1993 Vermont Weatherization Assistance Program*, prepared for the Vermont Office of Economic Opportunity, December 1993 (with Blair Hamilton and Ken Tohinaka)

- *Electric Utilities and Long-Range Transport of Mercury and Other Toxic Air Pollutants*, published by the Center for Clean Air Policy, 1991
- *Coal and Emerging Energy and Environmental Policy*, in Natural Resources and Environment, 1991 (with Don Crane)
- *Acid Rain: The Problem*, in EPA Journal, January/February 1991 (with Ned Helme)
- *An Efficient Approach to Reducing Acid Rain: The Environmental Benefits of Energy Conservation*, published by the Center for Clean Air Policy, 1989
- *The Untold Story: The Silver Lining for West Virginia in Acid Rain Control*, published by the Center for Clean Air Policy, 1988
- *Midwest Coal by Wire: Addressing Regional Energy and Acid Rain Problems*, published by the Center for Clean Air Policy, 1987
- *Acid rain: Road to a Middleground Solution*, published by the Center for Clean Air Policy, 1987 (with Ned Helme)

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