BEFORE THE
NEW YORK STATE
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Central Hudson Gas & Electric Corporation for Electric Service	)))))	Case Number: 17-E-0459
Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Central Hudson Gas & Electric Corporation for Gas Service	)))))	Case Number: 17-G-0460

DIRECT TESTIMONY TESTIMONY OF BOB WYMAN

November 21, 2017

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Introduction

Q. What is your name?

A. I am commonly known as Bob Wyman. My formal name is Robert Mark Wyman.

Q. Mr. Wyman, have you previously testified before the Commission?

A. On several occasions, I've given verbal testimony at PSC public hearings, however, I have never before offered written testimony such as this in a rate case.

Q. What is your background?

A. I am a New York City-based advocate for renewable energy and Beneficial Electrification with a focus on geothermal heat pumps. I am a member of NY-GEO (New York Geothermal), the Renewable Thermal Alliance, and of the International Ground Source Heat Pump Association (IGSHPA) on whose Advocacy Committee I serve. I am a founder of, and sometimes consultant to, Dandelion Energy, the Google X spin-off company that currently installs geothermal heat pump systems within Central Hudson's franchise area. I am also a member of the DPS' three VDER Working Groups (Low and Middle Income, Value Stack, and Rate Design).

Although most of my career was spent in the computer software business, during which I worked for a variety of companies, including Digital Equipment Corporation, Microsoft, Google, Medio Multimedia, and Pubsub Concepts, I have been advocating on energy related issues for almost 45 years, having first given public testimony in hearings concerning Pres. Nixon's "Project Independence" in 1973.

Purpose of Testimony

Q. What is your purpose in submitting this testimony?

A. I wish to comment on several of the EAM proposals made by Central Hudson in Case 17-E-0459 and to ask consideration of the creation of rates which address the needs of those who adopt Beneficial Electrification. I also wish to comment on the Gas Expansion plans described in Case 17-G-0640.

Q. What is "Beneficial Electrification?"

A. One often quoted definition is: "The use of electricity in end-uses that would otherwise be powered by fossil fuels (natural gas, propane, fuel oil, or gasoline) to reduce greenhouse gas (GHG) emissions."[1] However, the benefits usually extend beyond merely reducing GHG emissions. Depending on the particular Beneficial Electrification technology, the benefits can include reduction of non-GHG emissions (pollution), reduction of peak demand, smoother grid utilization profiles, etc.

Case 17-E-0459

Q. Before addressing the specific EAM proposals, do you have general comments you'd like to make?

A. I have some concerns with the proposed EMS, some of which are discussed in this testimony. However, as a general statement, I think that more should be done to encourage the ends of these EAMS.

[1] Dennis, Lazar and Colburn, More is Less: Environmentally Beneficial Electrification (EBE), 30 Nov 2016

As discussed in the EAM Panel Testimony, and elaborated upon below, adoption of Beneficial Electrification measures (such as electric vehicles and heat pumps) can help in accomplishing several of the goals addressed by the proposed EAMs. Depending on the particular technology chosen, Beneficial Electrification can reduce carbon emissions, reduce peak demand, and increase energy efficiency.

I am particularly concerned that current rate structures tend to result in excessive collection of delivery charges from those who adopt Beneficial Electrification measures and I suggest that, in addition to pursuing the EAMs as proposed, the impact of current rates on the lifetime costs of Beneficial Electrification measures should be carefully considered. My belief is that with better rate design, we could see great improvement in the rate of adoption of Beneficial Electrification and thus more easy accomplishment of the EAM goals.

Excessive Delivery Charges

Q. Why do you believe that adopters of Beneficial Electrification pay "excess delivery charges?"

A. It may be easiest to explain this using the example of a single-family home with and without a geothermal heat pump system:

Current electric rates are designed with the average home in mind. Today, the average home uses a fossil fuel furnace for heat during the winter and an electrically powered air-coupled “air conditioner" for cooling during the summer. In addition to the energy used for heating and cooling, the home will also use electricity to power appliances, communication or computing devices, lighting and other equipment.

When a home replaces its fossil fuel furnace with an electrically powered geothermal

heat pump, the result will be an increase in that home's total consumption of electricity over the year, by the amount needed to power the heat pump during the winter, as well as a decrease in the home's summer peak demand since a geothermal heat pump system will cool more efficiently than any air-cooled system. The home's consumption of electricity for non-heating and cooling applications would not be expected to change. This means that the home, once converted to a geothermal heat pump system, will be reduce its demand for electricity during the peak period which causes most of the utility's costs while increasing demand for electricity during the off-peak period when there is a great deal of essentially "free" spare grid capacity. Such a home would also produce dramatically fewer GHG emissions than one heated by fossil fuel combustion.

Even though a home, by converting to a geothermal heat pump system, reduces the utility costs that delivery charges are intended to recover, given current rate designs, that home would be forced to pay higher delivery charges over the course of a year since it will have consumed more electricity during that year and because delivery charges are assessed per kWh consumed rather than strictly in proportion to cost causation. (Note: Of course, the home will also pay more in energy or supply charges, but that is as it should be. The issue here is with delivery charges.)

The amount by which a home's actual annual delivery charges exceed the actual delivery-related costs that are caused by that home's electricity usage is what I call "excess delivery charges."

At the risk of over-simplification, delivery rates are generally set by first determining the expected costs of serving the needs of a particular rate class and then dividing that cost by the number of kWh's which are expected to be consumed by that rate class. When one or more members of a rate class pay excess delivery charges, the long-term

impact is that delivery rates will be lowered in future rate cases for all members of the rate class since the number of kWh's sold will increase while the actual costs of service stay the same or decline.

Thus, homes which adopt geothermal heat pumps and pay excess delivery charges tend to subsidize the rates paid by all other ratepayers in their class, including those who continue to use fossil fuel furnaces. Because delivery charges are over 50% of the average electric bill, the size of this forced subsidy of others contributes significantly to the operating cost of the geothermal heat pump system and often results in increasing those costs so high that homeowners are discouraged from adopting such systems. The result is that peak demand remains higher than it might otherwise be and emissions of various kinds are higher than they might be.

The problem is that homes that adopt geothermal heat pumps cause lower than average costs for the utility even though they consume higher than average amounts of electricity while still paying average per kWh rates for their consumption. The result is excess delivery charges.

Q. Do buildings with air-source heat pumps also pay excess delivery charges?

A. Yes. By replacing fossil fuel furnaces with air-source heat pumps, one tends to consume an above average quantity of electricity. However, that above average consumption occurs primarily during the winter and during off-peak periods when there is plenty of spare delivery capacity. On the other hand, air-source heat pumps are generally no more efficient at cooling than are air-coupled air conditioners, so one would not expect a reduction of summer peak demand as a result of ASHP adoption. Nonetheless, excess delivery charges are paid for the above average off-peak consumption for the purposes of heating.

Q. What about other kinds of Beneficial Electrification such as electric vehicles?

A. Except when electric vehicles are charged during peak periods, they consume above average quantities of electricity, primarily during low-cost off-peak periods. Thus, they are much like ASHP systems that do not contribute to peak reduction even though they increase demand during periods when costs are low.

Q. Should we dramatically reduce delivery rates for all off-peak electricity consumption?

A. No. In traditional cases, without either Beneficial Electrification or the use of TOU rates, there is usually a high correlation between off-peak and on-peak consumption. Larger and less efficient buildings tend to consume more during both on- and off-peak periods. Smaller or more efficient buildings tend to consume less during both on- and off-peak periods. Thus, it normally makes sense to spread the delivery costs across both on- and off-peak periods to reduce the variability of monthly charges. However, Beneficial Electrification often increases off-peak usage while, in the case of geothermal heat pumps decreasing on-peak usage, or in the case of air-source heat pumps, not significantly effecting on-peak usage. Thus, the degree of correlation between on- and off-peak usage is significantly reduced by many of the Beneficial Electrification technologies. This loss of correlation makes it more reasonable to consider specific reductions of off-peak delivery rates for Beneficial Electrification adopters.

Q. What about electric resistance heating? It also increases off-peak usage of electricity.

A. Electric resistance heating is not an example of Beneficial Electrification. Its use increases electrical consumption dramatically while providing no benefit, such as reduced emissions, to other ratepayers or to the utility. If electric resistance heating was provided with low rates, and if substantial numbers of customers switched from

fossil fuels to electric resistance heat, the result would be increased emissions as well as more rapid development of annual consumption peaks occurring during the winter.

Q. What should be done to address excess delivery charges for Beneficial Electrification?

A. As long as Beneficial Electrification (e.g. electric vehicles and heat pumps) is relatively uncommon, users of these measures should be included in a distinct rate class and rates for them should be set according to normal utility cost causation principles. Over time, we can expect that this rate class will grow substantially while the traditional rate class will shrink until a time, perhaps in several decades, when Beneficial Electrification technologies become “normal" and the traditional rate class may be eliminated.

Q. What problems might this cause and how might they be addressed?

A. One problem that might come from creating a “Beneficial Electrification" rate class with a single rate for all electricity use including normal use, even if a TOU rate, is that recognizing the lower costs of Beneficial Electrification would, of necessity, also mean that rates for normal electricity use would be reduced. The availability of this lower rate might discourage customers from attempting to increase the efficiency of their normal electricity use. Thus, the creation of the class, while tending to encourage Beneficial Electrification, might discourage energy efficiency in other applications.

This problem could be addressed by allowing for the separate metering of electricity used for Beneficial Electrification. A home might have two meters. One meter would record the use of electricity for normal purposes. A second meter, with a distinct rate, would then record just the use of electricity used by heat pumps, electric vehicles and

other types of Beneficial Electrification.

Certainly, the requirement for separate meters would create higher metering costs. Nonetheless, it is quite possible that even with those higher costs, the reduction in delivery charges would still be high enough to encourage people to convert to Beneficial Electrification.

EAM Funding

Q. How will the incremental costs and incentives associated with the EAMs be funded?

A. As detailed in the EAM Panel Testimony[2] Central Hudson proposes that "all incremental costs and incentives except for those associated with energy efficiency programs be recovered through the Miscellaneous Charges Factor of the Company's Energy Cost Adjustment Mechanism."

Q. Do you have concerns with this source of funds?

A. As discussed previously, the adoption of Beneficial Electrification will often result in the payment of delivery charges in excess of a customer's fair share of the actual costs which the delivery charges pay for – as determined by applying reasonable principles of accounting for cost causation. In fact, given a Rate Impact Metric (RIM) value greater than one, the impact of collecting such excess payments from adopters of Beneficial Electrification will tend to be a reduction of the rates paid by all ratepayers. Such a reduction of rates, since it benefits all ratepayers, not just those who pay the costs of adopting Beneficial Electrification, acts as a subsidy of non-adopters by those who do adopt.

[2] EAM Panel Testimony at 12.

While I would prefer that the collection of such excess delivery payments was eliminated or at least reduced by the creation of more just rates, if such rates are not provided, then I suggest that the excess delivery charge payments should be calculated and used to offset at least some of any need for levying additional charges to pay the costs and incentives of the Carbon Reduction Program. The amount of excess payments used in this manner should be no less than that which would be required to reduce the RIM to a value no higher than one.

Carbon Intensity EAM and Carbon Reduction Program

Q. Is the Carbon Intensity EAM appropriate?

A. Yes, with some exceptions. Central Hudson should be complimented for recognizing that although great effort has been put into finding ways to increase the production of electricity from non-emitting sources such as solar and wind, it is time that we begin to address the problem of reducing carbon emissions from the end-use of energy. It is particularly good that Central Hudson recognizes the value that Beneficial Electrification can provide to carbon reduction programs.

Q. Explain, in more detail why Beneficial Electrical is important.

A. It is inevitable that as non-emitting generation displaces emitting generation, the marginal benefit of each additional kWh of non-emitting supply will be reduced. Each additional kWh of electricity generated from solar, wind, etc. results in a slightly smaller reduction of carbon emissions than did the immediately previous kWh. Eventually, once all emitting sources of generation have been displaced by non-emitting generation, additional non-emitting generation will increase electricity supply but will displace no additional carbon emissions.

On the other hand, the marginal contribution of Beneficial Electrification to carbon emission reduction increases as the carbon intensity of the consumed electricity decreases. Unlike the case with non-emitting generation, the marginal contribution of Beneficial Electrification is maximized when the supplied electricity is 100% emissions free.

Q. Can you illustrate these comparative marginal benefit effects?

A. Yes. In the graph below, "Emissions Impact of Heat Pumps Replacing Oil," I compare the marginal benefit of one kWh of emissions-free generation with the marginal benefit of an additional kWh of electricity consumed by a specific Beneficial Electrification measure: the replacement of an oil furnace with a geothermal heat pump at various COP values.

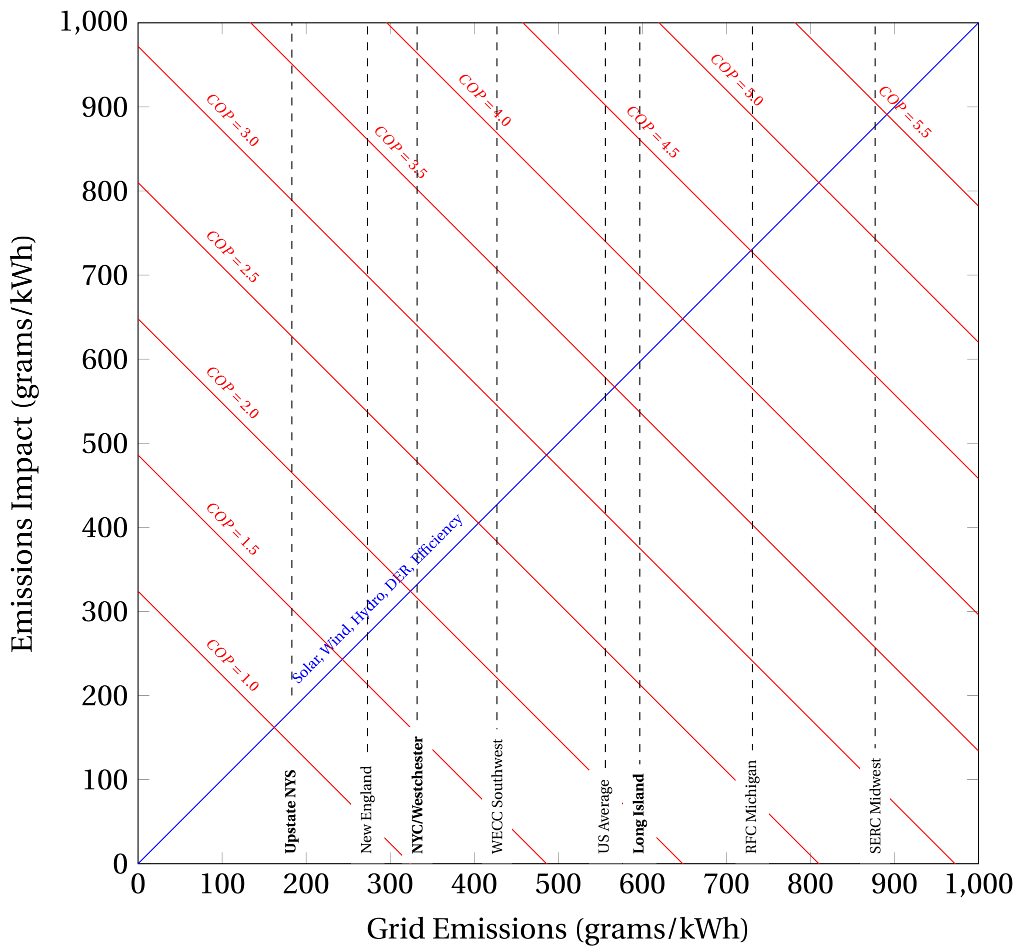
With lines ascending from the X-axis, I show the eGrid emissions reported for various eGrid subregions in the United States. Central Hudson's franchise area is within "Upstate New York" region shown by the first vertical line on the left. The "Upstate New York" region is assumed to have an emissions factor of about 183 grams of carbon per kWh, according to eGrid data and adjusting for losses.

The diagonal line rising from left to right shows that for each additional kWh of emission free generation the avoided emissions are essentially equal to the emissions factor for the grid at that time and in that area.

The various diagonal lines descending from left to right show the amount of emissions that are displaced by each additional kWh of electricity consumed by a geothermal heat pump, replacing an oil furnace, for COP values at each of the grid emissions factors. In this graph, I assume that the emission factor for an average installed oil furnace is about 324 grams per kWh of useful heat output. As should be clear, the

amount of displaced emissions increases as the grid's emissions factor decreases and reaches a maximum when the grid emissions are zero.

Emissions Impact of Heat Pumps Replacing Oil



Q. How is this graph relevant to the Carbon Reduction Program?

A. If carbon emission reduction is a priority, it is useful to compare the expected emissions reduction from one kWh of additional non-emitting production to the emissions reduction that will be the result of one additional kWh of consumption. On the graph, at any point on the X-Axis when the red "COP" line is higher on the Y-Axis than the blue line, one additional kWh of consumption will result in a greater reduction of carbon emissions than would an additional kWh of non-emitting generation. Thus,

if costs were not a factor, one who prioritizes carbon emission reductions should prioritize efforts to increase consumption whenever the red line is higher than the blue line.

Given that Central Hudson is in the Upstate NYS eGrid subregion, one can say that an additional kWh of consumption caused by the replacement of oil furnaces with heat pumps whose COP is greater than about 1.2 should be preferred to the generation of an additional kWh of non-emitting electricity. Given that geothermal heat pumps typically operate with a COP much higher than three, one can be assured that additional consumption by a geothermal heat pump in Upstate New York will result in greater carbon emission reductions than would an additional kWh of non-emitting generation.

Q. How can these values calculated without reference to the graph?

A. The COP value at which the use of a heat pump will result in greater carbon emissions than non-emitting generation can be easily computed using a two-step process.

First, one needs to calculate the “Break Even COP" at which the heat pump will produce fewer emissions than the alternative fuel being replaced. This can be done by dividing the emissions factor of the grid by the emissions factor of the alternative fuel. (i.e. $BreakEvenCOP = \frac{GridEmissions}{FossilFuelEmissions}$) For Upstate New York, the Break Even COP for a geothermal heat pump replacing an average oil furnace is $\frac{183}{324} = 0.6$. Thus, in Upstate New York, any geothermal heat pump, operating at a COP higher than 0.6 will produce fewer carbon emissions than an oil furnace.

Once the Break Even COP has been calculated, the COP at which the emissions reductions from increased consumption will equal those from non-emitting generation can be found simply by multiplying the Break Even COP by two. Thus, in Upstate New

York, any geothermal heat pump which is replacing an oil furnace and operates at a COP higher than $2x0.6 = 1.2$ will cause carbon emissions to be reduced by a greater amount per kWh consumed than would an additional kWh of non-emitting generation.

Q. Are you suggesting that we should always prefer increased consumption to increased non-emitting generation?

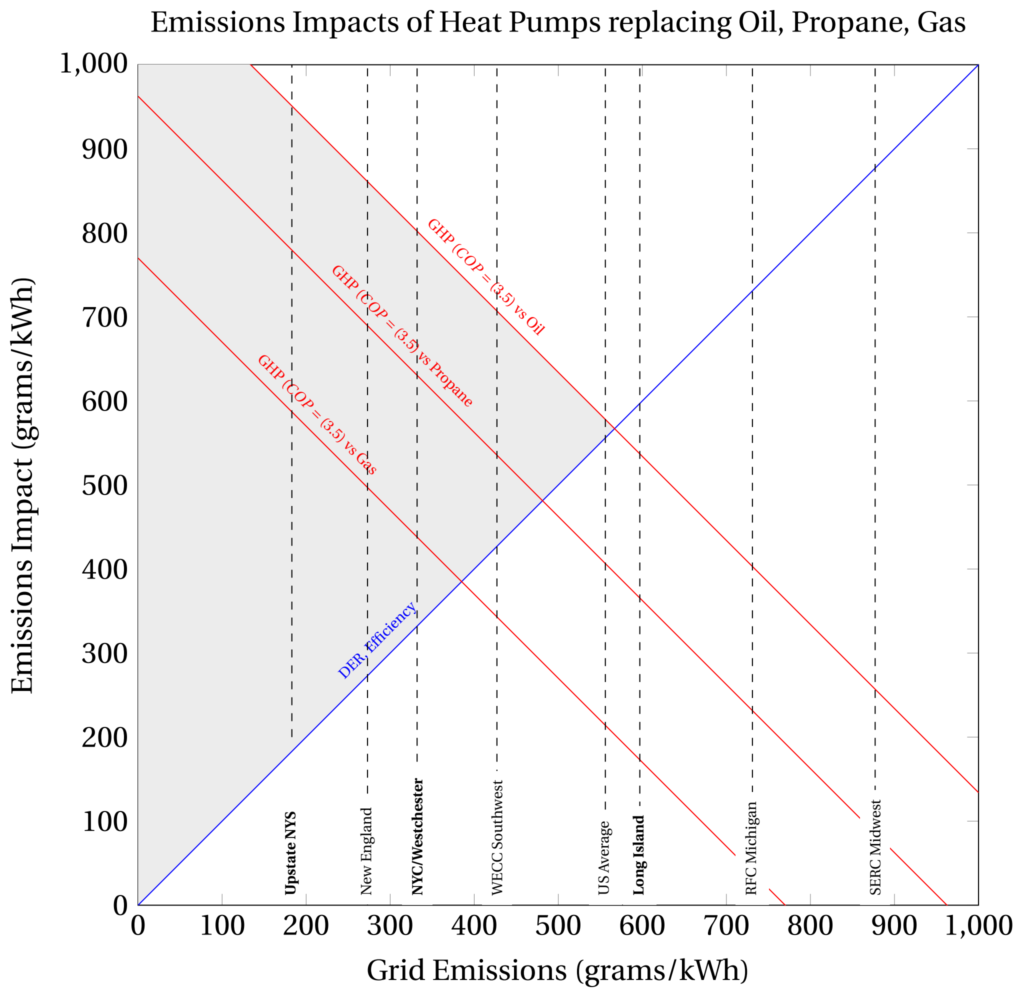
A. No. The reason that the Break Even COP for geothermal heat pumps is so low in the Upstate New York eGrid subregion is because there is such a large quantity of low- or non-emitting generation. Efforts should continue to ensure the continued growth of non-emitting generation at the same time that Beneficial Electrification is encouraged.

Q. Can similar graphs be shown for fuels other than oil?

A. Yes, see the graph below entitled “Emissions Impacts of Heat Pumps Replacing Oil, Propane, Gas." On this graph, I assume that the heat pump's COP is 3.5, which is the COP of a moderately efficient geothermal heat pump. Emissions from average installed propane furnaces are estimated to be 275 grams per kWh of useful heat and emissions from average installed gas furnaces are estimated to be 221 grams per kWh (without consideration of methane gas leaks).

Q. Do you have any other comments on the proposed Carbon Reduction Program?

A. Yes. I feel strongly that the program should not provide benefits to those who convert to using natural gas. Given a Break Even COP of $\frac{183}{221} = 0.8$ when heat pumps replace average installed natural gas furnaces, it should be clear that the carbon reductions from conversions to heat pumps will be dramatically higher than those from conversions to natural gas. Additionally, as will be discussed in more detail in my comments



on Case 17-G-0460, any efforts to increase the usage of natural gas will only serve to make it harder for us to meet our long-term carbon reduction goals. It is best that we curtail or reduce natural gas expansion as soon as possible. Given that we have available technologies that produce much higher carbon reductions than come from conversions to natural gas, we should prioritize those technologies.

Energy Efficiency ("EE EAM")

Q. Is the Energy Efficiency EAM, as proposed, well designed?

A. No. While it is appropriate to incent Central Hudson to encourage energy efficiency, the proposed "MWh Reduction Metric" is an inappropriate, indirect measure of energy efficiency and may lead to unintended negative consequences. In some cases, it is possible that reliance on this metric will tend to discourage the adoption of measures that would otherwise lead to higher energy efficiency. It should also be noted that the EE EAM is in conflict with the Carbon Intensity EAM.

Q. Why is the "MWh Reduction Metric" not an appropriate measure of improved energy efficiency?

A. As described in the EAM Panel Testimony, "the MWh Reduction metric is designed to directly measure and incent Central Hudson's efforts resulting in the reduction of customer energy usage as measured by megawatt hours ("MWh")."[3]

The "MWh Reduction Metric" would be appropriate and useful if electricity consumption and energy use were always positively correlated. If this were the case, then a reduction in electricity consumption would always imply a reduction in energy use. However, electricity consumption and "energy use" are not always positively correlated. (i.e. A reduction in electricity consumption does not always imply a reduction in energy use and an increase in electricity consumption does not always imply an increase in energy use.)

Thus, while a "MWh Reduction metric" may "measure and incent" reductions in electricity consumption, it is not a good measure for reductions in "customer energy use." Reliance on a "MWh Reduction metric" will tend to discourage reductions in energy use which are the result of increased electricity consumption.

Q. When would increases in electricity consumption lead to lower customer energy use?

[3] Central Hudson EAM Panel Testimony at 23, lines 6-9.

A. Beneficial Electrification results in both an increase in electricity consumption as well as a decrease in energy use. (In other words, electricity consumption and energy use are negatively correlated.) The increased electricity usage is inevitable since the fuel-switching which distinguishes Beneficial Electrification implies the substitution of electricity for some alternative non-electric energy source, typically fossil fuels. (The substitution of electricity for fossil fuels results in increased electricity consumption.) The reduced energy use results from the higher efficiency of electrical systems when compared to those powered by fuel combustion.

For example: If one assumes that electricity is being produced only by natural gas powered generators, less gas must be burned to produce the electricity needed to power a modern geothermal heat pump than would be burned to produce the same amount of useful heat output from an on-site furnace. So, replacing on-site gas heat with a modern geothermal heat pump system will result in increased electricity consumption but less natural gas consumption and thus less energy usage.

Similarly, an electric vehicle consumes much less energy, per mile traveled, than does a traditional ICE[4] vehicle. Thus, increased adoption of electric vehicles will increase MWh consumption while reducing energy consumption.

Q. Does the use of heat pumps always result in increased electricity consumption?

A. No. When geothermal heat pump systems replace existing electric resistance heating systems, there will be a dramatic reduction in electricity consumption. While an electric resistance heating system will produce useful heat at close to 100% efficiency (i.e. $COP = 1$),[5] a geothermal heat pump system will usually produce useful heat with a COP of 3 or higher. Thus, while an electric resistance heating system will produce

[4] ICE: Internal Combustion Engine
[5] COP: Coefficient of Performance

one unit of useful heat for every one unit of electricity consumed, a geothermal heat pump system will produce three or more units of useful heat for every unit of electricity consumed. Clearly, replacing electric resistance heating systems with geothermal heat pump systems will dramatically reduce both electricity consumption and energy usage. When replacing electric resistance heating with geothermal heat pump systems, reductions in electricity consumption are positively correlated with reductions in energy usage.

Note: Air-source heat pump systems, although less efficient than geothermal heat pump systems, will still usually result in decreased energy consumption relative to that of electric resistance heating systems. At times when the outside air temperature is particularly low, air-source heat pumps often fall-back to resistance heating and thus do not reduce either electricity consumption or energy use relative to electric resistance systems, however, such conditions only occur infrequently in the typical year. Air-source heat pump systems will usually operate more efficiently than electric resistance heating systems.

Q. Does the use of heat pumps always result in increased energy efficiency?

A. If properly designed and installed, heat pumps will provide the most efficient handling of a building's heating and cooling load. While sometimes the best method of reducing a building's energy consumption is to take measures, such as insulation or other envelope improvements, that reduce the building's heating and cooling load, heat pumps will usually be most efficient at serving whatever thermal load remains after such methods are exploited.

Given products available in the market today, we can expect that electric resistance heating systems will produce useful heat at an efficiency close to 100%. Natural gas

systems have the potential to reach an efficiency of 95%, but most installed systems run at lower efficiency. The best oil and propane systems have an efficiency of about 90%, however, most installed systems operate at about 80% efficiency. Geothermal heat pump systems typically produce at least three units of useful heat for each unit of electrical energy that they consume. Commonly installed geothermal systems produce as much as five units of useful heat for each unit of electricity consumed. Thus, one often hears the odd statement that geothermal heat pumps operate at 300% to 500% efficiency (when efficiency is defined as $\frac{OutputEnergy}{InputEnergy}$). Air source heat pumps are less efficient than geothermal heat pumps, yet they still commonly produce useful heat at about 240% or higher efficiency.

While research into new methods of providing heating/cooling continues, I am aware of no evidence that a technology more efficient than heat pumps will become available any time in the near or even mid-term.

Q. How will use of the "MWh Reduction metric" produce negative results?

A. The EAM mechanism provides powerful financial rewards to utilities when they accomplish defined goals. We should expect that EAMs will significantly influence the behavior of utilities – otherwise, it would not be sensible to provide them. Given that the EE EAM rewards reductions in electricity consumption, it must be expected that the utility will be motivated to discourage otherwise beneficial adoption of technologies when such adoption results in increased electricity consumption.

It should also be recognized that the EE EAM, since it relies on the MWh Reduction metric, conflicts with the Carbon Intensity EAM. The EE EAM, as defined, discourages the utility from encouraging Beneficial Electrification while the Carbon Intensity EAM encourages Beneficial Electrification. At this time, we cannot predict which

of the two EAMs will be seen by the utility as providing the greatest motivation to act. However, we can be sure that the conflict will result in less than optimal pursuit of one or both of the two conflicting EAMs, as they are currently defined.

Q. Would the EE EAM, as currently defined, lead to any positive results?

A. Yes. If the utility decides to pursue the EE EAM, in spite of its conflict with the Carbon Intensity EAM, their efforts would probably result in greater efficiency for existing uses of electricity. The problem with the EE EAM's current design exists primarily with its tendency to discourage Beneficial Electrification; measures for which electricity consumption and energy use are negatively correlated.

Q. How can the MWh Reduction metric be modified to avoid discouragement of Beneficial Electrification?

A. The MWh Reduction metric, as proposed, would be useful in measuring the results of efforts to increase the efficiency of existing electricity usage but it is flawed in that it also discourages Beneficial Electrification. Thus, the key to an improved MWh Reduction metric is to compute it in such a way that it is independent of the electricity consumption increases that result from Beneficial Electrification.

The MWh Reduction metric would be improved significantly by establishing a mechanism to offset changes in electricity consumption by the amount, or an estimate of the amount, of increased consumption that is a consequence of Beneficial Electrification. Doing so would ensure that the utility's ability to achieve the EE EAMs goals was not reduced by efforts to encourage Beneficial Electrification. Such a process would also eliminate the existing conflict with the Carbon Intensity EAM which will encourage additional Beneficial Electrification.

Admittedly, it may be hard to properly measure the precise amount by which elec-

tricity consumption is increased by Beneficial Electrification. To do so with precision would probably require that installations considered to be "Beneficial Electrification" were metered separately from traditional electricity consumption.

However, given that the Carbon Intensity EAM is proposed, it is likely that most, if not all, those who adopt incremental Beneficial Electrification measures within the utility's franchise area will seek to exploit the Carbon Reduction Program incentives. Thus, the record keeping for the Carbon Intensity EAM could be adjusted to ensure that expected increases in electricity consumption are estimated in addition to expected reductions in carbon emissions. The expected increases in electricity consumption resulting from pursuit of the Carbon Intensity EAM could then be used in calculating an offset for the EE EAM's MWh Reduction metric. In this way, the conflict between the EE EAM and the Carbon Intensity EAM would be eliminated and the utility would be more likely to be motivated to put its full efforts behind accomplishing the requirements of both EAMs.

Q. How could the impact of Beneficial Electrification on the EE EAM and similar programs be better understood?

A. Hopefully, my testimony will make clear that the impact of Beneficial Electrification on electricity consumption and energy use will be significant in coming years. This impact is likely to be felt by any effort that attempts to reduce or control electricity consumption. However, the scale of these impacts is not well known and planning processes do not currently take these impacts fully into consideration. Thus, I propose that the EE EAM be expanded to include a requirement that a detailed report be written, submitted to the PSC and published to the public, that describes both the full technical potential for Beneficial Electrification within the utility's franchise area as well as appropriate estimates of the likely impact of Beneficial Electrification given

appropriate scenarios and assumptions.

By "full technical potential" I mean the replacement of all use of non-electric fuels or energy sources with electricity for at least transportation and heating applications. Ideally, the Beneficial Electrification Potential Report would also consider the potential for electrification in industrial and other applications. Of course, the full technical potential is unlikely to be met in the near term, thus, it would be appropriate to provide estimates of achievable electrification under various scenarios such as "Business as Usual," "Aggressive Adoption," etc. The study horizon for the report would ideally extend to at least the year 2050.

Q. How else might the EE EAM be improved?

A. While the adoption of heat pumps as replacements for electric resistance heating systems may receive an incentive under the Carbon Reduction Program, such adoption will also help achieve the EE EAMs goals. However, there appears to be nothing in the EAM Panel Testimony that suggests that the "EE" value provided by such adoptions would be rewarded or compensated for the benefits they provide. Thus, it appears that the utility's shareholders would profit (via the EE EAM) from the "EE" benefits of such measures while those homeowners and businesses who paid the costs of achieving those benefits would not. This does not seem fair.

It would be appropriate to provide an incentive, in addition to that provided by Carbon Reduction program, for the adoption of heat pumps as replacements for electric resistance heating systems. More generally, measures at least partially paid for by utility customers, which help achieve the EE EAM's goals, should be provided with an "EE"-specific incentive in addition to whatever other incentives they may receive as part of programs associated with other EAMs. (Note: Most Beneficial Electrifica-

tion measures would not be eligible for such an incentive since, as noted, Beneficial Electrification usually results in increased electricity consumption.)

I also suggest that the utility adjust its "behavioral energy efficiency program design"[6] to encourage those customers who are known users of electric resistance heating systems to convert to heat pumps.

[6] EAM Panel Testimony at 25.

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Gas Expansion

Q. Is the proposed Gas Expansion plan appropriate?

A. No. It is becoming increasingly clear to most observers that in order to achieve necessary GHG emissions reduction goals, we must dramatically reduce the burning of fossil fuels. Knowing that the need to restrict GHG emissions will only increase in the future, now is the time to put an end to natural gas expansion. We should at least require a gas expansion moratorium in order to allow careful public consideration of how best to manage the transition from dirty fossil fuel combustion to cleaner electrically powered systems.

While some may argue that natural gas combustion is "clean," since its burning produces fewer GHG emissions than does the burning of oil, coal or other alternatives, it is well established that heat pumps in the Central Hudson franchise area today produce GHG emissions at a rate much lower than that of even the most efficient natural gas furnaces. Also, unlike natural gas furnaces, electrically powered heat pumps do not rely on prone to leak gas pipes that emit methane even before the gas arrives at the point of combustion. In the future, as continued efforts to reduce the carbon intensity of electricity generation bear fruit, the relative emissions advantage of electrically powered heating solutions over natural gas will only increase while the carbon intensity of natural gas burning is essentially fixed at today's levels.

As shown in the EAM Panel's Exhibit EAMP-2, GHG emissions from heating applications in the Central Hudson franchise area are greater than the total emissions from all electricity consumption in the same area. Additionally, natural gas currently ac-

counts for approximately 45% of those heating-related GHG emissions. Given that only 24% of the area's GHG emissions are attributed to the use of electricity, the bulk of emissions reductions will have to come from reductions arising from the adoption of electric vehicles and electrically powered heating systems. Thus, if we are to reach commonly accepted goals, such as an 80% reduction in GHG emissions by 2050, it is essential that fossil fuel consumption, including natural gas consumption, be curtailed.

The gas expansion plan proposes that ratepayers fund an expensive effort dedicated to convincing new customers to convert to a method of heating which is inferior to readily available alternatives and which will become increasingly more inferior as time passes. This does not seem appropriate.

Q. Is the proposed Gas Expansion plan prudent?

A. In their Business Development Panel testimony, the utility states that they have established "a gas capital budget associated with customer additions of $64.9 million for the period 2018-2022." Of course, the cost of this capital budget will be born by all ratepayers, whether or not they benefit from these new capital investments, while providing the utility with a guaranteed rate of return. This investment in customer additions might be prudent if it could be shown that sales to those who benefit from it would pay off the full costs before the increasingly growing pressure to reduce fossil fuel usage depletes the paying customer base. However, given the long time that it takes to amortize utility infrastructure investments, it is quite likely that significant amounts of customer defection from natural gas to electrically powered, cleaner alternatives will occur before the proposed costs will have been recovered through gas sales. Thus, it is likely that at least some of this new investment will create stranded assets whose costs will burden ratepayers in the future.

It should also be noted that the adoption of gas heating requires significant expenditure of customer funds as well as utility funds. Today, the expected lifetime of customer funded gas heating equipment is on the order of 20 years and customers purchasing new heating equipment typically consider this expected lifetime when making their own decisions. Thus, customers will expect that systems installed today will continue to be used until at least 2038 to 2042, if not longer. However, given the growing pressure to reduce fossil fuel use as well as the inevitable reduction in heat pump cost that will result from continued research and development, it is likely that some number of customers will be surprised and disappointed to discover that they will need to, or be best advised to, replace their natural gas furnaces before their expected end of life.

Thus, it appears that the proposed investment in new customer additions bears the risk of creating stranded assets and of burdening customers with systems that they may desire to replace before those systems' expected end of life. Given these factors, it appears that additional investment in customer additions would not be prudent.

Q. Have expenditures on customer additions been prudent in the past?

A. Certainly, there was a time during which at least some expenditures on customer additions were prudent. However, Central Hudson has, in past years, testified before the PSC that at least some of the customer addition programs included in the current plan did not pay for themselves. For instance, they testified that "Often times the tariff requirement of installing 100 feet of main and 100 feet of service is not supported by the revenue received on such an extension."[7]

When investments are not "supported by the revenue received" and when they run

[7] Case 12-G-0297 - Proceeding on Motion of the Commission to Examine Policies Regarding the Expansion of Natural Gas Service, Comments of Central Hudson Gas & Electric Corporation, page 4 (August 5, 2013)

the risk of creating stranded assets while increasing the difficulty of meeting Carbon Reduction goals, the costs of those investments should not be levied on the ratepayers.

Q. How should Central Hudson respond to customers who request new natural gas service?

A. If continued conversion to natural gas is permitted, it must be recognized that at least some customers may request new natural gas service in spite of the risks, both financial and environmental, that such additions will cause. In such cases, the principle of “Costs must follow benefits" should be employed and the full costs of gas expansion should be borne by those specific customers who request and benefit from that gas expansion. New customers should also be clearly informed that due to the potential need to curtail gas delivery in the future, long-term commitments to provide gas supply cannot be made.

Ratepayers who do not directly benefit from investments in customer additions should not bear the costs of those investments.

Q. Do the gas expansion plans conflict with other utility proposals?

A. Yes. The gas expansion plans conflict with the utility’s proposed Carbon Reduction Program as described in the EAM Panel testimony for Case 17-E-0459. In that proposal, the Company proposes to establish a program to encourage conversions from fossil fuels to electrically powered heat pumps. Thus, it would appear that in at least some cases, there is likely to be competition between one part of the Company which seeks to convert customers to natural gas service and another part which seeks to convert the same customers from fossil fuels to electrically powered heat pumps. It is quite possible that such competition might be reduced by internal agreements, po-

tentially informal, to reduce the vigor of efforts to convert to heat pumps those customers that are sited close to existing gas lines. Thus, it is likely that the resolution of the internal competition will result in some customers receiving unequal treatment and thus a risk that some customers will make decisions that are not in their best long-term interest.

Q. How might the shareholders of Central Hudson pursue earnings from the thermal energy sector if customer additions are ended?

A. Central Hudson might consider redefining its goal from one of delivering natural gas to one of providing for customers' thermal energy needs. One possible avenue to explore would be that of emulating the efforts of Enbridge, a supplier of natural gas in Ontario, who have recently begun to explore augmenting their existing natural gas delivery business by expanding into the geothermal heat pump business.[8]

[8] Jennifer Runyon, *Canadian-Based Enbridge Embarks on Geothermal Plan*, Renewable Energy World, April 18, 2017, http://www.renewableenergyworld.com/articles/2017/04/canadian-based-enbridge-embarks-on-geothermal-plan.html