Testimony of Bob Amelang

before House Committee on Natural Resources, Fish and Wildlife

January 26, 2018

My name is Bob Amelang. I am retired after working 26 years for CVPS, and after the merger, for GMP as an electric power engineer. During my career I have gained broad experience in the electric utility sector, including renewable energy generation, Canadian hydro-electric imports, transmission and distribution, and air emission from utility power supply sources. After retirement I have done limited private consulting work for the Town of New Haven, related to proposed solar generation and a proposed electric transmission line to import renewable energy to Vermont.

I am a member of the Climate Action Commission's Technical Advisory Committee, but I have not been asked to perform any work for that committee until now. Thank you for asking me to testify on the proposal to conduct a Carbon Pricing Study.

In summary, I think that any attempt to institute carbon pricing on a statewide basis would have undesirable, unintended consequences for Vermonters. Any such carbon pricing plan would not solve the Climate Change problem our planet faces. Rather than providing a shining example for other government bodies on how to limit carbon emissions, it's likely that Vermont would show that carbon tax programs do not work. Thus, I recommend that Vermont not do a Carbon Pricing Study and any associated work, such as drafting a bill for the ESSEX plan.

I respect all the hard work done to develop the ESSEX plan. I share with its proponents the idea that government policy should address the carbon problem. But I think that a Vermont carbon pricing plan of any kind is the wrong thing to do, for the many following reasons.

A Vermont carbon pricing plan is like Vermont establishing a college to train Olympic athletes as a solution to a nationwide health problem, when Vermonters already greatly exceed national health standards. The new college has elaborate, lengthy programs to take the small number of students to the highest level of athletic prowess. Tuition cost is high and many students drop out because the program is so difficult. But the national problem is due to students in all other states who are overweight and don't exercise much. From a resource allocation perspective, it would be more efficient to develop simpler programs to limit junk food intake and promote exercise for the rest of the country, rather than turn Vermonters into Olympic athletes.

Vermont is already extremely fit in terms of low carbon emissions. If other states are like couch potatoes, we are like marathon runners. Evidence of our low carbon emissions is in a report used by carbon pricing proponents. VPRIG commissioned a Washington DC think tank called REMI to study carbon pricing:

REMI Study on VPIRG web site, "*The Economic, Fiscal, Emissions, and Demographic Implications from a Carbon Price Policy in Vermont*", dated 11-13-2014.

http://www.energyindependentvt.org/wp-content/uploads/2015/04/REMI_Final.pdf

Page 39 of that report, footnote 52 has a link to a US Energy Information Administration table of the Vermont State Electricity Profile for 2015 (EIA updates its data annually, so REMI study would have used 2013 data).

https://www.eia.gov/electricity/state/vermont/

Rather than show you the whole table, I will point out a few statistics that shows Vermont's standing among states. Vermont had the highest rank, meaning the lowest Carbon Dioxide Emission rate for electric generation (pounds per megawatthour). In 2015 Vermont's CO2 statistic is 12 lbs/MWh, a rank of 51 (D.C. is considered the 51st state). That means our state that year had the lowest level of carbon emissions to generate electricity. We were also ranked lowest (51) for total CO2 emissions in tons. By contrast, Texas has a rate of 1,190 CO2 lbs/MWh, 100 times higher than Vermont. Massachusetts has a 920 CO2 lbs/MWh rate.

These statistics are for electricity production only, not for transportation or heating. I have shown these statistics for two reasons: first, to show that Vermont already has the lowest carbon emissions for electric generation and second, to illustrate the faulty logic used by carbon pricing advocates, which is a point I make later. Any new electrical usage for heat pumps and electric cars would be generated on a New England wide basis, incrementally, not by the clean Vermont sources on an average historic basis.

Annette Smith's testimony provides US Energy Information Administration data that shows Vermont is ranked second lowest (50 out of 51) for carbon dioxide emissions in tons, for all energy uses in 2014. Thus, from a common sense standpoint, it seems unwise to have our legislature allocate its limited time and resources to reduce Vermont's already minimal carbon emissions. It will take considerable resources to debate a bill, cause headaches for all Vermonters after passage, and have minimal impact on the nation and the world.

A response to the "Vermont is too small to matter" argument is that Vermont can set an example for the country to follow. But I expect that after a year or two, we will be the poster child state for what not to do to limit carbon. We could possibly discourage any government program to limit carbon by setting a bad example. Also, Vermont is not a state that represents the nation as a whole.

Any carbon pricing method would be complicated and costly to set up and administer. One can easily see implementation problems that would soon occur. Vermonters would buy gasoline and even heating oil from adjacent states with no carbon pricing. Mistakes or intentional deception could occur with the complex accounting needed to assign carbon pricing to fossil fuel, allocate carbon tax revenues and reduce electric rates. Vermont has better things to do and bigger fish to fry.

The idea of subsidizing electric rates is problematic. Electric rates are rising due to the impact of net metering and increased capacity costs (capacity costs are opposite of variable, energy based costs such as generator fuel--- they are based on the capital and maintenance costs of electric utility infrastructure), per GMP's explanation of it latest 5 % rate increase. Utilities need to address the issue of increasing costs on their own, without the help of carbon tax revenues. And the ESSEX plan does not penalize excessive electricity consumption. To select an extreme example, the ESSEX plan could result in lower electric rates that encourage more hot tubs. Wealthy residents and visitors with mansions will have lower electric bills due to payments by working class Vermonters.

The carbon pricing model in Vermont seems to be based on the misconception that most of the new electrical energy from heat pumps and electric cars will come from clean, renewable sources, and that more electric energy consumption is a social good. Neither is correct.

The Vermont Natural Resources Council posting on the ESSEX Plan, dated November 15,2017

https://vnrc.org/the-essex-plan-pricing-pollution-to-boost-vermonts-economy/

states that: “The proceeds [of carbon taxes] would be directly applied to lowering the cost of electricity. Fuel prices would be higher, but electric power would be cheaper. And it would encourage a shift toward electricity, which would help Vermont meet its policy goals [low carbon emissions from renewable energy], because much of the state’s electricity comes from renewable sources.”

The logic that appears to justify carbon pricing is that since some electric energy is generated by renewable generation, when oil heat is replaced with electricity using a heat pump, much of that energy will come from renewable energy. So how much is “much”? I believe that carbon pricing advocates exaggerate how “much” renewable energy contributes to additional electric usage incentivized by carbon pricing.

The assumption that renewables provide much of our electricity ignores four phenomena of how our electric energy is generated: (1) our electric energy comes from the New England regional grid, not Vermont’s mostly green generation; (2) the average historical energy source mix is not the same as the new, incremental source mix that will supply the needs for new heat pumps and electric cars; (3) the mismatch in time periods during which electricity is used for heat pumps and renewable energy is generated reduces carbon reduction benefits; and (4) there are major technical problems with installing large amounts of renewable generation that are just now being understood by decisionmakers.

Electric energy is provided in New England based on the operation of the New England power grid as a whole, not on a statewide basis. Vermont buys a considerable amount of energy from Hydro Quebec, which is about 96-99% supplied by large hydro-electric stations. GMP has in-state hydro generation and energy purchases from nuclear generators and other out of generating units with low or no carbon emissions. Thus, electric energy generated either in Vermont physically or purchased by Vermont utilities is historically low in carbon, relative to the rest of the country. But it is wrong to say that the electricity needed for new electric cars and heat pumps will be provided by the same mix of green generation sources Vermont has had on a historic average basis.

If Vermonters install collectively enough heat pumps to add 1,000 kilowatts of new electric load and run it for an hour, that produces an additional one megawatthour of electric load. That 1 MWh of load will be provided by one or more generators in New England or in some cases, from nearby regions that have transmission ties to New England. Those generators will not be the same as historic average Vermont generation, and most likely will not be as green as those of the Green Mountain State.

Renewable generation is predominately provided by sources that cannot increase output to serve new load on a minute to minute basis. When Vermont turns on its new heat pumps and needs that extra megawatthour in the morning when we wake up, chances are one or more natural gas fired generators will increase their output. Renewable generation will not automatically increase. Hydro units and purchases under Hydro Quebec contracts for the most part, are already operating on fixed schedules. Wood and refuse generators generally operate near maximum output whenever possible. Energy from wind and solar is obviously being generated based on the weather, and cannot be controlled or dispatched to higher levels. So the lack of control (“dispatchability”) of renewable generators is a limit to providing energy for heating and transportation.

Even when one accepts that New England’s grid is operated as a single entity, there is a myth that needs to be exposed about generation source mix for new electric load. New England’s electric energy supply recently has been relatively green. There are few coal plants, oil-fired plants are not operated much (on annual basis, but at high levels during cold winter periods), while there are relatively large amounts of energy from carbon free sources: nuclear plants, small hydro, wood and refuse fired plants and Hydro Quebec imports. But average historic source mix cannot be applied to new, incremental generation needed to serve new load from heat pumps and electric cars.

Similar to the situation I described above, on a minute to minute basis, when generators dynamically increase output as load increases, there is the same problem over a longer period of up to several years. If Vermont load increases by X% from 2018 to 2019, there will not be automatic increases in Hydro Quebec contracted quantities. All existing renewable plants will generate up the same maximum levels in 2019 as in 2018. In fact, one of the New England's four nuclear plants (Pilgrim) is expected to shut down in 2019, so there will be more need for fossil fueled generation in New England, until a substantial amount of new renewable generation is installed.

It's true there will be new some new solar and wind generation in 2019, but these sources have problems providing energy for heat pumps, due to the third ignored phenomenon and for all new load due to the fourth ignored phenomenon. On my third point, it matters greatly what time of day or year in which the new electric load or generation occurs. Here I will talk only about time of year temporal problems related to heat pumps, and generation from natural gas and solar generation units.

Simply put, heat pumps require energy at times of the year when it's cold, which is when solar generation is at its lowest and it's more likely that natural gas fired generation units cannot obtain fuel because of pipeline constraints. There is some correlation between sunny winter days and cold nights. But because of shorter daylight in winter, solar generation is lower at those times when heat pumps operate. Snow cover is another problem, which this winter has had a significant impact on solar generation. Rooftop, net metered solar generation is probably the worst case for snow impact. A Rutland solar net metered installation, for which I have GMP customer detailed data access, provides a good example. For 17 of the 45 days starting December 10, 2017, the rooftop solar generation for this customer was either 0 to under 1 % of possible output (based on maximum daily generation).

About 38% over the time, for a month and a half this winter, solar generation at this Rutland house was unavailable, due to snow. I often walk in Rutland and have seen many homes whose solar panels were covered with snow. I also saw snow covering panels at the 2 megawatt solar project at the corner of Highway 7 and 103 south of Rutland. It's likely that most of the solar generation in Vermont, as well as other parts of New England, had the same problem.

[intentional blank space for following table]

This table shows the range of average solar generation for the sample Rutland house:

Example Rutland Solar Net Metered Solar Rooftop System
Average Solar Generation Compared to Maximum Possible

	kilowatts	% of highest
highest 15 minute period on 5/12/2017	3.64	100%
average over various periods		
Day with highest output, 4/14/2017	0.94	26%
August, month of highest output	0.59	16%
Winter to date, 11/1/17 - 1/23/18	0.15	4%
45 days ending 1/23/18	0.08	2%
17 days with at or zero generation	0.00	0%

Another example of the impact of the timing of heat pump usage affecting the generating fuel source needed to serve that load is also from the most recent winter period. We experienced some record cold weather from late December to early January, which caused New England electric load to reach near record high levels. New England does not have enough natural gas pipeline capacity to run all the natural gas fired generation needed at very low ambient temperatures. Some of these generators switch to fuel oil in these conditions. While natural gas generation using relatively new jet engine (gas turbine) technology is the most efficient and cleanest fossil fuel generation source, oil based generation is not so much.

The article below shows that New England electric generating plants burned almost two million barrels (54 million gallons) of oil during the 15 day period ending January 9, 2018. This oil usage is more than those plants burned during the rest of 2017 and all of 2016 combined. It is also about the annual amount burned by Vermont's residential oil heating users.

https://commonwealthmagazine.org/energy/generators-burned-2m-barrels-oil-15-days/

There is more I'd like to talk about concerning the problem of serving more winter electric load, due to limited natural gas pipeline capacity. But my time is limited, the material is complex and I have a few other points to cover. But I will say that the gas pipeline problem is one more reason we should be cautious about encouraging more electricity use from electric cars, and especially heat pumps.

Wind energy data is more difficult to obtain and analyze for its temporal relationship to heat pump load. But wind energy also has problems like solar energy where maximum energy generated does not occur when maximum electric heat load occurs. And both wind and solar energy have a problem providing renewable energy to the grid in some cases, due to operational problems I alluded to previously-- the fourth ignored phenomenon.

The fourth phenomenon is a very technical issue, which I'll try to describe simply and provide two Vermont examples. This phenomenon is the problem from thermal overload and low voltage situations that can occur because there is too much renewable generation compared to nearby load.

From my experience working for the Town of New Haven, there are distribution circuits in the New Haven area that are expected to have so much solar generation capacity installed that there will be overloads on those distribution circuits and the associated substation. On sunny spring days, solar generation will be at or near maximum levels, while loads can be near minimum levels. The load can be much lower volume than that generated on a distribution circuit. This can cause too much power to flow on the lines, transformers and other devices in the reverse direction. Power normally flows from the grid to the distribution circuits. The opposite is reverse power flow. Too much power flow creates heat. The wires and equipment can get so hot that damage can occur. Utility operators get hot around the collar just thinking about the possibility of this situation.

Another example is in northern Vermont, where the Kingdom Community and Sheffield Wind generation projects are located. The two wind projects have had to reduce output about 20% of the time since mid 2016, because there is too much generation in that area and power operation rules were changed. Output from small hydro generating stations can also be curtailed. Thus, renewable generation is wasted. E.g. there is enough wind to generate 60 megawatthours but the wind project is forced to generate 40 MWh.

The so-called curtailment problem has become important enough that a new PUC Case was set up to discuss solutions to the problem in a public forum. The PUC Case 17-5219-INV was established to deal with the problem of generation curtailments in the northern Vermont region defined by the Shefield-Highgate Export Interface.

Below is the public workshop notice in PUC Case 17-5219-INV (access requires ePUC login)

https://epuc.vermont.gov/?q=user/login&destination=downloadfile/242784/127927

Transcript of that Workshop held Jan. 11, 2018 is below:

file:///C:/Users/Bob/Downloads/5927795783949151onbase-unity_5811492539225860590599.PDF

Not all renewable energy projects are subject to curtailment, but such problems will be more common as more and more renewable generation is connected to the grid. The northern Vermont problem is an extreme case but it illustrates what can happen when too much renewable generation is added too fast, without considering all the impacts. The transcript of the workshop includes discussions of possible reductions in Hydro Quebec renewable energy imports, because the Highgate transmission tie from Quebec to Vermont is a part of the area defined with the curtailment problem. Hydro Quebec deliveries over the Highgate tie occur generally around the clock, 24x7. We may have to rob Peter to pay Paul, by reducing renewable hydroelectric energy to allow more renewable wind energy generation.

There are solutions to the curtailment problem, and a plan to find solutions was described at the workshop. The cost to solve the problem is not known yet, but it's likely to be significant. Who pays the costs is also unknown. This issue is yet another reason to wait before we embark on a program to put a price on carbon.

Aside from the electric utility issues I described, there will be local operational problems from installing large numbers of heat pumps in Vermont. I have experience from friends and acquaintances with heat pumps and have done research on heat pump cost and operation in New England. The oil company workers who maintain my home boiler have told me about fixing pipes that froze and broke because of heat pumps not providing enough heat.

Assumptions used to promote heat pumps are overly optimistic, both for cost savings and carbon reduction impacts. Burlington Electric Department, for example, is reducing 2018 incentives for new heat pumps because projections of cost savings to customers were about twice that of a recent study. More information is available at this web site: http://vermontfuel.com/heatpump/