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October 4, 2024

Holly R. Anderson
Clerk of the Public Utilities Commission
112 State Street
Montpelier, Vermont 05620-2701

Re: Case No. 23-2221-INV, Proceeding to design the potential Clean Heat Standard
Comments on the potential study of September 1, 2024
Topic Tag 9, Other

Dear Ms. Anderson:

These comments are in response to the report on the potential study, "Assessment of Thermal Sector Carbon Reduction Potential in Vermont", NV5, September 1, 2024, including appendices A through H and supplemental documents made available on the Clean Heat Standard pages of the Department of Public Service.

The short message here is that I find much in the potential study to be non-credible. The results are unverifiable. The assessment is a true black box. Some of the input has been revealed to us. The output has been presented to us. How the input is manipulated to achieve the output is neither revealed nor explained.

The analysis is based on what I consider to be flawed assumptions and unsubstantiated numbers.

Unsubstantiated Numbers

The assessment, including its appendices, contains many unsubstantiated numbers. The appendices are included in a spreadsheet available at the Clean Heat Standard pages of the Department of Public Service. The spreadsheet has more than 2,000,000 cells. Yet it lacks basic information and references. That lack means one cannot determine the basis on which each number was developed and whether the number is applicable to the requirements of the Clean Heat Standard. The department placed two additional documents on its pages that do not provide sufficient information to verify many of the numbers.

Vermont Baseline Studies (page 6) The assessment fails to note how one can find the Vermont Baseline Studies. One cannot then determine what those values are or how they apply to NV5's assessment. The Sales Disaggregation spreadsheets (posted September 27, 2024 by the Department at my request) do refer to specific tables in the studies in some cases. They also do not provide sources for the spreadsheets.

Societal Cost Test (page 3 and elsewhere, including appendices *Ex).* The assessment still does not reference a document that explains what the societal cost test is. Nor does it provide details of how the societal cost has been calculated. Nor does it explain what the listed components of the societal cost test are. It provides a reference (page 5) to a PUC order (21-2436-PET a proceeding to update avoided costs and other screening values) from 10/10/2022 as a source of the avoided costs component of the Societal Cost Test (page 5). That order refers to various testimony submitted in that case, without any indication in the NV5 assessment which testimony are actually relevant to the Societal Cost Test. The reference to the order is user inimical.

The omission of a clear reference to the Societal Cost Test particularly inimical because I had asked that NV5 "Provide a better explanation of the Vermont Societal Cost Test and a specific source and title of the document. The request was on page 4 of my comments to the PUC (23-2221-INV) on July 31, 2024. Those comments were on the final draft results presentation presented to the Technical Advisory Group on July 25, 2024.

The assessment lists the components included in the societal costs and benefits (table 1, page 4). The assessment provides a chart showing present values of cumulative societal costs and benefits by category, 2049 (Figure 12, p. 43).

The components shown in Table 1 do not align with the components shown in Figure 12. So it is not clear whether all components in Table 1 are actually included in Figure 12.

The derivations of the values in figure 12 are not provided in either the report or the appendices. Appendix E3 provides total costs and total benefits for each measure. There are no breakouts of the components of costs and benefits. The Societal Cost Test is discussed more below.

Appendices The appendices are not well documented. I was curious why energy efficiency has such a small share of total emissions reductions. So I looked into the air sealing measure in the appendices. Air sealing is shown on lines 254 through 280 of appendices A through E. I have been unable to determine how the numbers are derived. For example, there are 15,384 housing units on line 254 of Appendix A. The penetration on line 254 of Appendix B3 is only 7,574 housing units. I cannot derive 7,574 from the numbers given in the appendices. I would think it could be derived from some combination of numbers in Appendix A. Not so.

Those who have looked carefully at the spreadsheets have seen that there are no formulas in the spreadsheet. Apparently all formula results were created in some spreadsheet not provided to us. Those formula results apparently have been given to us in the Appendices as a glorified set of tables rather than as results of calculations.

Also, many of the values are not clear as to what they are. The various appendices lack footnotes that could clarify how the numbers were obtained. The footnotes could define the various headings and could provide sources for the numbers.

Deliverables The scope of services for the study requires a number of deliverables. The Department of Public Service has made the scope of services available on its Clean Heat

Standard pages. The scope has seven tasks. Each task has deliverables. I asked the Department for all deliverables On August 27, 2024. The Department made two more of the deliverables available on its Clean Heat Standard pages on September 27, 2024. I appreciate the co-ordination that Matthew Bakerpoole's work to make two of NV5's spreadsheets available. The spreadsheets helped me understand NV5's final report of September 1, 2024. These spreadsheets are:

Measure Parameters
https://publicservice.vermont.gov/sites/dps/files/documents/NV5 - VT Act 18 Clean Heat Standard Potential Study Measure Parameters_FINAL_R1.xlsx

Sales Disagregation and Measure Applicability
https://publicservice.vermont.gov/sites/dps/files/documents/NV5 - VT Act 18 Clean Heat Standard Potential Study Sales Disaggregation and Measure Applicability_FINAL.xlsx

However, all documents on the Department's internet site have been insufficient to resolve the lack of data pointed out above in this section.

A key component of a deliverable from task 2 has not been provided. This deliverable is part of the modeling inputs and assumptions, particularly the "Cost effectiveness tests (at a minimum Societal Cost Index). We have received the combined cost effectiveness in Appendices E1, E2, and E3 of the report. However we have received no information on the components of the benefit cost analysis. I'll cover this in more detail later in these comments.

Conclusion: The validity of the findings in the assessment is questionable. This is because so many of the numbers are unverifiable. They are unverifiable because sources are not provided in many instances and because the calculations and components are unknown. The assessment also contains a number of flawed assumptions, discussed in the next section.

Flawed Assumptions

The assessment is based on many assumptions. The validity of the findings is based on the accuracy of the assumptions. I find several assumptions that I believe to be flawed. The validity of the assumptions, or the effect of the assumptions could have been tested with a sensitivity analysis which varied the parameters of the assumptions. The assessment did not indicate that such a sensitivity analysis had been performed.

Decommissioning existing fossil fuel heating systems

> "we assume once someone electrifies their thermal loads, they decommission their existing fossil fuel heating system and do not switch back to fossil heat in the future." (page 3)

The flaw here is the assumption that people decommission their existing heating system. Heat pumps are not yet robust enough to serve as the only heat source in winter. Many people who have installed a ductless heat pump system use it for air conditioning in the summer and heating in the spring and autumn. They retain their existing heating system for use in the winter. Perhaps by 2050 the winter low temperature will be high enough that existing heat pumps can function as heat pumps all winter long. Or perhaps by 2050, heat pump technology will have changed so that the co-efficients of performance of heat pumps will be high enough at Vermont's minimum winter temperatures to allow removal of the existing heating system. Until heat pumps may be used year-round, individuals will not decommission their existing heating systems.

Conclusion: The potential study overestimates the emissions reductions from heat pumps used for heating.

New construction (page 6) NV5's assessment contains two unrealistic assumptions on new construction.

a. "For this analysis, we forecast the amount of new construction based on past trends"

Housing, housing, housing; we need more housing" has been the mantra the past four years. The intent of the mantra is to double, triple, or more the rate of construction of housing units. Thus, basing new construction on past building trends is at variance with the state mantra and is a flawed assumption.

b. "We assume that any new construction building receiving clean heat credits will be all-electric, and thus not add any fossil fuel load."

There is no requirement in the building energy standards that new buildings be all-electric. (Residential Building Energy Standards and Commercial Building Energy Standards, available at publicservice.vermont.gov/efficiency/building-energy standards/residential-building energy-standards and publicservice.vermont.gov/efficiency/building-energy standards/commercial-building energy-standards. Both became effective July 1, 2024.).

The assessment shows that clean fuels are a viable alternative to fuel switching (figure 14). The assessment also shows that 24 % of the emissions reductions of the optimal potential are clean fuels and that about 37 % of the emissions reductions of the optimal potential are uneconomical fuel switching (figure 14 and appendix D3). Thus there is no reason to believe that all new construction will be all-electric. Clean fuels have carbon emissions as shown by the carbon intensities in its appendix F.

The assessment itself contradicts this all-electric assumption. The optimal penetration of clean heat measures involving new housing construction is only 810 units per year over the first four years (2026 through 2029). And then no emissions from increased electric or fossil fuel use from new construction beyond that. (Appendix B3). The assessment does not explain why this is so.

The Vermont Housing Finance Agency reported that Vermont has added about 3500 permitted housing units per year in the years 2022 through 2024. More units are built that do not require permits, so more than 3500 units are being built each year. The Agency provides no estimate of the number of units built that do not require permits. ("Vermont Housing Needs Assessment: 2025-2029", Vermont Housing Finance Agency, June 2024, Figure 1-2, page 6). This means that over 2700 units would be built each year that do not qualify as clean heat measures. Many of those units likely will meet their thermal loads with other than electricity. These other fuels will generate greenhouse gas emissions that do not appear to be accounted for in NV5's assessment.

Conclusion: The potential study fails to account for the increased greenhouse gas emissions generated by the majority of new construction that is not all-electric. Thus the assessment overestimates the emissions reductions from new construction.

Omitted costs

> "costs associated with electric upgrades to support fuel switching were excluded from the analysis" (page 7)

The assessment uses the term "pre-electrification for these costs. It estimates costs of $1900 to $4400 for these costs, with the cost increasing as the income of the occupants decreases (page 54). The same is true for pre-weatherization costs (also on page 54). The assessment does not indicate how the decision to exclude the costs of pre-electrfication and pre-weatherization has reduced the potential of measures that will require electric upgrades.

A major pre-weatherization barrier is the presence of vermiculite insulation. Some vermiculite contains asbestos, the testing for asbestos in vermiculite is unreliable, and the weatherization programs must combine with other, more difficult to obtain, funding to deal with the vermiculite. The estimate is that 10% of homes that would benefit from weatherization are prohibited from being weatherized because of the lack of funding to deal with the vermiculite.

Conclusion: This is a trade-off. Potentially fewer fuel switching projects in the optimized potential if the incentive does not make the upgrade eligible *vs.* potentially more fuel switching if the incentive covers the upgrade. The potential study underestimates the individual costs of those measures that increase the demand of electricity to satisfy a thermal load. And it underestimates the emissions reductions available if those costs are included as part of an incentive package. This will be covered in more detail in the section on "Who Pays", below.

The assessment indicates it cannot achieve the required emissions reductions in homes of those with low incomes. We cannot tell if increasing funding to include pre-electrification and pre-weatherization costs would allow the optimized potential to achieve those required reductions.

Loading order (also known as measure hierarchy)

> "Within the category of efficiency, we generally assume that lower-barrier, less capital-intensive measures, such as smart thermostats, are installed before more expensive measures, such as air sealing and insulation."

The share of energy efficiency's GWSA emissions reductions is surprisingly low in the optimized potential by 2050 (figure 14, page 45). Vermont's weatherization programs reduced average fuel usage by 25% in weatherized residences in 2022 (2024 Annual Energy Report, Department of Public Service, January 18, 2024 page 81). Part of the low percentage in the potential study has to do with the loading order assumed in the assessment.

> "This loading order is defined as efficiency first, then fuel switching, and then clean fuels" (page 16, for the maximum potential).

Air sealing and insulation first is the most effective order, as I pointed out to the Commission on January 19, 2024 and to the Department on March 15, 2024.

<u>To the Commission, 23-2221-INV DDA obligations, January 19, 2024</u>

> I foresee essentially every building, every process thermal load having to have installed measures in the next 25 years. And the most important is the top of the list in §8127(d): thermal energy efficiency improvements and weatherization. I foresee that if thermal energy efficiency improvements and weatherization are not done in every building, we'll never be able to meet the reduction of at least 80% of greenhouse gas emissions required by the end of 2049.
>
> <u>Energy efficiency improvements and weatherization come first</u>
> The most important of the measures is the first in the statutory list: thermal energy efficiency improvements and weatherization. It should be the required go-to measure for a default delivery agent.

<u>To the Department, 23-2221-INV Potential Study March 15, 2024</u>

> **<u>Measure hierarchy</u>**
> The most important two measures are thermal energy efficiency improvements and weatherization (1) and replacement of manufactured homes (11). They are most important because they reduce thermal loads. All the others merely convert thermal loads from one fuel to another. without reducing the thermal load. I use thermal load here to mean the amount of heat and rate of heat moving from the heated space to the outdoors. And conversely for cooling loads, the amount of heat and rate of heat moving from the outdoors into the cooled space. Without reductions in thermal loads, we are wasting energy. We are building too many, unnecessary solar panels, converting too much land unnecessarily for solar panels. We are using too much energy and too many materials for the solar panels. Too much energy and too many materials for the heat pumps that will be oversized when the thermal efficiency improvements and weatherization are completed.
>
> All the other measures, should only receive credits for the reductions that they would provide in a building that is fully weatherized and has fully implemented thermal energy efficiency improvements. Designing to existing energy codes does not meet the

> definition of "fully weatherized and has fully implemented energy efficiency improvements". The thermal improvements mean that the doors and windows are all replaced; the insulation is all done to the maximum for the building. A new building is at least to Passive House standards.
>
> Recommendation: Evaluate:the potential of measures as if they were installed in buildings that are fully weatherized and have fully implemented energy efficiency improvements.

However, the assessment found that the order within efficiency makes a difference.

> "Within the category of efficiency, we generally assume that lower-barrier, less capital-intensive measures, such as smart thermostats, are installed before more expensive measures, such as air sealing and insulation" (page 16).

This is a flawed assumption as the assessment later points out.

> "The Maximum Achievable potential assumes a measure loading order of efficiency first, then fuel switching, then clean fuel to cover the remaining fuel load. This allows for the maximum GHG reductions in a relatively cost-efficient way. However, due to differences in the cost per ton of GHG reduced, the Act 18 Optimized scenario relies significantly, but not entirely, on clean fuels. In practice, in the future this will necessitate efficiency and fuel switching on homes that are already using clean fuels with low (but non-zero) emissions. The clean heat credits for these situations will look more expensive on a cost per ton of carbon reduced basis" (page 52).

This is the reason that I urged that emissions reductions for non-fossil fuels be set as if all efficiency measures and all appropriate fuel switching had been done before the delivery of non-fossil fuels.

Conclusion: The loading order has a large effect on the cost effectiveness of measures. Taking care of the low-hanging fruit (*e.g.*, advanced thermostats) reduces the cost effectiveness of insulation and air sealing. That makes it less likely that the insulation and air sealing will ever be done. And when insulation and air sealing are not done, then the overall system is not affordable, because the larger quantities needed of alternative fuels are unregulated commodities, with prices subject to the whims of the market. And renewable electricity will become more expensive, as the utilities have successfully argued before the Commission regarding net metering at all scales over the last decade or so.

Emissions do not increase after the end of the measure life: air sealing

The assessment assumes that emission reductions continue after the end of the measure life.

Installed measures used in the assessment have lives of 5, 10, 12, 15, 16, 18, 20, 21, or 30 years (Appendix A, column P). That means that many installed measures will have reached the ends of their lives before 2050. I'll use air sealing as an example.

Air sealing has a measure life of 20 years (Appendix A, column P). The full installed cost of air sealing remains constant at $3,000.00 per household during all years 2026 through 2050 (Appendix A, rows 254 through 280). The annual number of installed units on row 254 (for those of low income burning oil in single family homes) is 316 in all years from 2026 through 2049 (Appendix B3, row 254). The GWSA annual emissions reductions are 96,517 kg CO_2e in all years through 2049. The GWSA cumulative emissions reductions in the year 2049 are merely the annual emissions times 24 years (Appendix D3, row 254). There is no reduction in emissions to account for the deterioration of the air sealing. Nor does the installed cost appear to include resealing after the end of the measure life.

Analysis: The units installed in 2026 reach the end of their measure life in 2046. Measure life is not defined. Deterioration of the air sealing material likely will have begun along some kind of distribution before 2046. (The deterioration might occur along a normal distribution, bell-type curve, or maybe some other distribution curve). Many buildings will need to be air-sealed again before by 2050. In the example using row 254, possibly all 316 buildings will need to be resealed by 2046.

Conclusion: The potential study fails to account for the increase in emissions at the end of an installed measure's life. Nor does it appear to provide a cost for resealing. Thus, the potential study overestimates the emissions reductions. Resealing units at the end of their lives should not be given credits.

Carbon intensities of liquid and gaseous fuels

There seems to be some confusion about the difference between the use of "carbon intensity" and the "life cycle emissions" as used in the Clean Heat Standard.

> "While Act 18 explicitly deems the carbon intensity value of No. 2 fuel to be 100, this analysis interprets the requirements to be relative to the lifecycle emissions value for No. 2 fuel oil assumed in this study" (page 16, footnote 32).

Conclusion. This is an appropriate assumption only if NV5's assessment applies the value of 100 only when determining whether liquid or gaseous clean heat measures are eligible to earn clean heat credits.

Carbon intensities are used for different purposes than life cycle greenhouse gas emissions in the Clean Heat Standard, so they are not synonymous. Carbon intensities are used only for non-fossil liquid or gaseous fuels and only when determining those fuels' eligibility to earn clean heat credits. Those carbon intensities are a percentage of life cycle emissions of those fuels to the life cycle emissions of No. 2 fuel oil delivered in 2023.

The Clean Heat Standard differentiates between carbon intensity and life cycle emissions. Carbon intensity is used only in three places in the Clean Heat Standard (30 V.S.A. Chapter 94).

"'Carbon intensity value' means the amount of lifecycle greenhouse gas emissions per unit of energy of fuel expressed in grams of carbon dioxide equivalent per megajoule (gCO2e/MJ)". (§8123 (1)).

Carbon intensity value is different from lifecycle greenhouse gas emissions, because the term "Fuel pathway" is used in the calculation of both "carbon intensity value and lifecycle greenhouse gas emissions of each fuel" (§8123(10)). If the two were synonymous, the definition would not have listed both terms.

Carbon intensity is next (and last) mentioned in §8127(f) when used to determine the eligibility of liquid or gaseous clean heat measures. Carbon intensities may be no larger than specified values. And, for purposes of §8127 (tradeable clean heat credits) only, "the carbon intensity values shall be understood relative to No. 2 fuel oil delivered into or in Vermont in 2023 having a carbon intensity value of 100. Carbon intensity values shall be based on fuel pathways." This actually means that carbon intensities of liquid or gaseous clean heat measures are percentages of the lifecycle greenhouse gas emissions of those fuels compared to the lifecycle greenhouse gas emissions of no. 2 fuel oil delivered in 2023. (Has that specific value of life cycle greenhouse gas emissions been determined yet?)

Thus, the statutory value of 100 for no. 2 heating oil (30 V.S.A. §8127(f)(1)) applies only when determining whether a non-fossil liquid or gaseous fuel is eligible as a clean heat measure.

Life cycle emissions of no. 2 fuel oil are typically calculated to be around 90 g CO_2e / MJ. Let's consider some non-fossil liquid or gaseous fuel that has lifecycle greenhouse gas emissions calculated at 56. For determining eligibility to earn clean heat credits, the other fuel would have a carbon intensity of (56 / 90) = 62 %. Thus the other fuel would not be eligible to earn clean heat credits in 2030 and later.

Costs versus Benefits of the Optimized Potential

Conclusions: The assessment asks us to take this entire benefit versus cost analysis on faith. There is no information on how it is calculated. The numbers are merely given to us in various combinations and in various locations with no back-up data. Thus the entire benefit / cost analysis is not credible. And the numbers purporting to show the same thing can be different from one location in the assessment to another.

Credibility
The assessment shows net benefits of $2,100,000,000 through 2049 (Figure 12, page 43). The components of the costs and benefits are shown in table 1 (page 4).

Many of the costs are incurred when the measures are provided. Many benefits are not achieved until years after the costs are incurred. Figure 12 shows five costs and five benefits. These costs and benefits are not cross-linked with those in Table 1.

The assessment shows $1,600,000,000 of the net benefit comes from estimated reduced energy costs. Figure 12 shows $4,200,000,000 in increased energy costs (wood, electricity biofuels, and renewable fuels). The figure shows avoided fuel costs of $5,800,000,000 (fuel oil, propane, and natural gas. Of course, this savings occurs over time, while the energy efficiency and equipment costs occur initially.

The claimed upfront costs total $6,600,000,000 (incremental measure costs and non-incentive program costs). The delayed benefits are $7,100,000,000 (non-energy benefits, deferred replacement credit, and avoided social economic and environmental damages. This leaves a net benefit of only $500,000,000 from non-fuel costs and benefits.

The claimed upfront costs of $6,600,000,000 are offset by $1,600,000,000 of reduced fuel costs. This means that those who pay for the upfront costs and receive the benefits of reduced fuel costs are out a net of $5,000,000,000. If much of the upfront costs are borne by society at large: (tax payers, electric utilities, electric customers) then the fuel benefits accrue to those who pay for the fuel. Society in general receives unspecified benefits of $7,100,000,000.

The biggest claimed benefits in Figure 12 are avoided social economic and environmental damages. Yet we do not know what these benefits are, how much they are, and who receives the benefits. Nor do we know how accurate these claimed benefits might be.

The cumulative program spending is estimated to be about $8,200,000,000 by summing the incremental bars (figure 13, page 44). Yet Figure 12 shows the incentive costs as about $5,700,000,000. If figure 13 has the correct amount of incentives, then the present value is actually a net cost of $400,000,000. And the text above figure 13 states that the "Present value incentive costs over the analysis period total $6.4 billion." This yields a present value net benefit of $1,400,000,000. Three different values on two consecutive pages. The different values show a large variation in the benefit / cost ratio and casts the benefit / cost ratio analysis into doubt.

This does not even mention the unknowns in the unspecified "Avoided social economic and environmental damages" in figure 12.

Cost effectiveness
"Overall, the results demonstrate that in 2049, 62% of the identified Act 18 Optimized emissions reductions are cost-effective." (pages 45, 46, and 47). Conversely, this means that 38% of the

emissions reductions are not cost effective. It is not clear why a building owner or tenant would accept a measure that is not cost effective. Thus it is not clear that non-cost-effective measures should be included in the potential.

Who pays and how much?

The Clean Heat Standard appears likely to have incentives to encourage individuals and property owners to switch away from fossil fuels in the thermal sector (heating and cooling and cooking and process loads (like coffee roasting and pottery kilns and breweries and lots more). One open question is how much will the incentives be?

> "Obviously a program only paying half the cost would see significant savings compared to a program paying 100% of incremental cost. In reality the amount of the incentive coverage that is necessary will depend on 1) the eagerness of Vermonters to install the measure 2) the amount of c;lean heat credits required, and 3) the opportunity cost of getting clean heat credits via other measures" (page 50)

> "Over the analysis period, relatively flat incentive budgets are spread over decreasing volumes of remaining baseline fuel sales" (page 56).

In any event, the money will come from Vermonters, through some combination of taxes, electric and gas (not gasoline) bills, fuel bills, and installation costs. The money will also have to cover the administrative costs of the program.

The cost of incentives is about $4 / gal. when the existing thermal loads are met by fuel oil (table 28, page 56). The table presents four incentive scenarios covering three fuels. The scenario doesn't really matter. The total cost of $4 / gallon is the same; the scenarios merely split the cost differently among taxpayers, building owners, fuel users, for example.

There will also be costs of perhaps $2,000,000 per year to administer a clean heat standard. This is the amount of money in Act 18 for the Commission and Department to create the clean heat standard. The Commission and Department will have ongoing expenses of about that amount through annual registrations and credit verifications, and through triennial updates.

Spreading the costs over a declining tax base means the fuel surcharge for the clean heat standard will rise significantly over the years. I had argued against this in my comments on the funding report on December 4, 2023.

In addition, the assessment makes certain necessary costs of some measures ineligible for incentives. "Pre-weatherization and pre-electrification barriers, such as knob-and-tube wiring and the need for electrical panel upgrades, represent potentially significant and uncertain costs in the pursuit of widespread decarbonization." (page 54). The costs of these barriers will have to be borne 100% by the property owners (or tenants) or the measures will be have to be forgone for those buildings.

Conclusion: The costs of providing measures will remain relatively the same, no matter who pays. The administrative costs will be about the same, too, no matter who pays, because of the required tracking and updates.

Failure to determine which measures will lower heating bills for those with low or moderate incomes

The assessment states that it did not determine whether any measures will actually lower heating bills for those with low or moderate incomes.

> "As the low-income target was not achieved in the model, the bill impact requirement was not considered" (page 49).

The Clean Heat Standard requires that specified percentages of measures provided to customers with low or moderate income be those "that require capital investments in homes, have measure lives of 10 years or more, and are estimated by the Technical Advisory Group to lower annual energy bills." (330 V.S.A. §8124 (d)(2))

Not considering whether any of the measures will lower annual energy bills of those with low incomes or moderate incomes fails to provide us with necessary information. We now have no idea whether any measures (installed or delivered) will actually reduce energy bills. If no installed measures in homes of those with low or moderate incomes actually reduce energy bills, then the clean heat standard fails to live up to the billing of Act 18 as the Affordable Heat Act.

Conclusion:
- Thus, if it should come about, through changes of assumptions, that the emissions reductions can be achieved by the optimized potential, we have no idea whether or not the measures will lower annual energy bills.
- The study does not indicate that alternatives were evaluated that might have allowed the optimized potential to meet the requirements of the Clean Heat Standard.

Overall conclusion.
Conclusions on individual topics are provided throughout these comments.

The overall conclusion, stated at the beginning, is that the report on the potential study is vague about many important aspects. Thus I find much in the report to be not credible.

Sincerely,
Thomas Weiss, P. E.