Clean Heat Standard Technical Advisory Group
7 March 2024, 9:30-12:30 ET
Agenda

Meeting Link: https://meet.goto.com/263652093

DRAFT

I. Welcome – Chair (5 min)
   a. Initiate recording
II. Review agenda – Chair (10 min)
   a. Introduction of the facilitator and her role
III. Review and approval of 2/16/24 meeting minutes – Vice Chair (5 min)
IV. Updates from the PUC (15 min)
   a. General update
   b. Introduction of technical consultant and SOW
      i. SOW - https://puc.vermont.gov/document/clean-heat-standard-technical-consultant-rfp
V. TAG procedures (20 min)
   a. **Discussion**: Roberts Rules vs facilitated discussion; aspirations for strong majority support; open meeting law as applied to subcommittees[i]
VI. DPS Potential Study – TJ Poor and NV5 (60 min)
   a. **Questions and Discussion**: Next steps
   b. Public Comment (10 min)
VII. PUC workshop on Pacing of Retirements – TAG members (15 min)
   a. Debrief public comments and workshop
   b. **Discussion:** Should TAG develop recommendations on Pacing?
VIII. TAG workplan [ii]and schedule – Chair & Vice Chair (30 min)
   a. Formation of subgroups
   b. Coordinating activities and timelines for TAG, technical and potential study consultants, and PUC proceedings
   c. **Discussion:** TAG comments on overall schedule
IX. Collaboration with Equity Advisory Group - Chair (5 min)
   a. **Discussion:** Suggestions for how to coordinate/collaborate with EAG
X. Other Matters (10 min)
   a. **Discussion:** Agenda topics for next meeting – Thurs., Mar. 21, 9:30 – 12:30
XI. Public Comment (10 min)
XII. Close – Chair (1 min)

[i] As currently interpreted in draft procedures:
The TAG may form subcommittees to effectively delegate the work of the group. Subcommittees fall within the definition of a "public body" [1] and must adhere to the Open Meeting Law.

[2] Subcommittees are responsible for their own scheduling, agendas, and minutes, and must share these materials with Commission staff so that they are posted in accordance with the Open Meeting Law.

[1] 1 V.S.A. § 310(4) "Public body" means any board, council, or commission of the State or one or more of its political subdivisions, any board, council, or commission of any agency, authority, or instrumentality of the State or one or more of its political subdivisions, or any committee of any of the foregoing boards, councils, or commissions, except that "public body" does not include councils or similar groups established by the Governor for the sole purpose of advising the Governor with respect to policy.

[2] 1 V.S.A. § 310(3)(A) "Meeting" means a gathering of a quorum of the members of a public body for the purpose of discussing the business of the public body or for the purpose of taking action.

[ii] Relevant portions of Act 18

§ 8128. Clean Heat Standard Technical Advisory Group

(a) The Commission shall establish the Clean Heat Standard **Technical Advisory Group (TAG)** to assist the Commission in the ongoing management of the Clean Heat Standard. Its duties shall include:

(1) establishing and revising the lifecycle carbon dioxide equivalent (CO2e) emissions accounting methodology to be used to determine each obligated party's annual requirement pursuant to subdivision 8124(a)(2) of this chapter;
(2) establishing and revising the clean heat credit value for different clean heat measures;
(3) periodically assessing and reporting to the Commission on the sustainability of the production of clean heat measures by considering factors including greenhouse gas emissions; carbon sequestration and storage; human health impacts; land use changes; ecological and biodiversity impacts; groundwater and surface water impacts; air, water, and soil pollution; and impacts on food costs;
(4) setting the expected life length of clean heat measures for the purpose of calculating credit amounts;
(5) establishing credit values for each year over a clean heat measure's expected life, including adjustments to account for increasing interactions between clean heat measures over time so as to not double-count emission reductions;
(6) facilitating the program's coordination with other energy programs;
(7) calculating the impact of the cost of clean heat credits and the cost savings associated with delivered clean heat measures on per-unit heating fuel prices;
(8) calculating the savings associated with public health benefits due to clean heat measures;
(9) coordinating with the Agency of Natural Resources to ensure that greenhouse gas emissions reductions achieved in another sector through the implementation of the Clean Heat Standard are not double-counted in the Vermont Greenhouse Gas Emissions Inventory and Forecast;
(10) advising the Commission on the periodic assessment and revision requirement established in subdivision 8124(a)(3) of this chapter; and
(11) any other maters referred to the TAG by the Commission.

(c) The Commission shall hire a third-party consultant responsible for developing clean heat measure characterizations and relevant assumptions, including CO2e lifecycle emissions analyses. The **TAG** shall provide input and feedback on the consultant's work. The Commission may use appropriated funds to hire the consultant.

(d) Emission analyses and associated assumptions developed by the consultant shall be reviewed and approved annually by the Commission. In reviewing the consultant's work, the Commission shall provide a public comment period on the work. The Commission may approve or adjust the consultant's work as it deems necessary based on its review and the public comments received. (Added 2023, No. 18, § 3, eff. May 12, 2023.)

§ **8124. Clean Heat Standard compliance**

(d) Equitable distribution of clean heat measures.

(2) Of their annual requirement, each obligated party shall retire at least 16 percent from customers with low income and an additional 16 percent from customers with low or moderate income.

For each of these groups, at least one-half of these credits shall be from installed clean heat measures 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. Examples shall include weatherization improvements and installation of heat pumps, heat pump water heaters, and advanced wood heating systems. The Commission may identify additional measures that qualify as installed measures.

§ 8127. Tradeable clean heat credits

(b) Credit ownership. The Commission, in consultation with the **Technical Advisory Group**, shall establish a standard methodology for determining what party or parties shall be the owner of a clean heat credit upon its creation. The owner or owners may transfer those credits to a third party or to an obligated party.

ATTACHMENT A – STATEMENT OF WORK

Introduction

The PSD is conducting a Thermal Sector Carbon Reduction Potential Study with the assistance of Optimal Energy, LLC (Contractor). Optimal Energy, LLC will subcontract with Energy and Environmental Economics, Inc. for assistance with the work stated in this contract.

The Contractor will be the prime contractor and overall project manager. The subcontractor will provide analytical and subject matter expertise for renewable and emerging fuels modeling and measure characterization. The Contractor will coordinate with the subcontractor to compile and provide deliverables.

The Contractor is assessing thermal sector carbon reduction potential for the State of Vermont. This information will be used by the PSD in the Public Utility Commission ("PUC") Clean Heat Standard proceeding.

The primary objective of this work is to quantify technical and economic thermal sector carbon reduction potential as well as two types of achievable potential (maximum and program achievable). The results shall include a comparison to the legal obligations of the thermal sector portion of the requirements of the Global Warming Solutions Act ("GWSA"). The study shall also evaluate market conditions for delivery of clean heat measures within the State and workforce needed to meet obligations of the GWSA.

Task 1: Kick-Off Meeting and Revised Work Plan

The Contractor shall coordinate and attend a project kick-off meeting with PSD staff to ensure there is a common understanding of the project's needs, the proposed work efforts, and products. The Contractor's designated representatives will attend this meeting virtually or in person.

The Contractor will prepare a draft agenda for the kick-off meeting for review by PSD staff. The Contractor will prepare detailed notes and action items identified during the kick-off meeting. The Contractor will submit an updated work plan that documents any revisions to the initial project scope that result from the kick-off meeting discussions, as well as an updated detailed schedule for completion of deliverables.

Topics shall include but not be limited to identification of data needs, data sources, and stakeholder engagement needed to effectively carry out the scope of work as well as meet the timelines associated with the work.

Task 1 Deliverables –

The Contractor shall provide a draft of the agenda for the kick-off meeting, meeting minutes and action items, an updated work plan and an updated project schedule based on discussions at the kick-off meeting.

Task 2 – Modeling Inputs and Data Collection

The Contractor shall compile modeling inputs and data collection needed to model and characterize the market and measures. The Contractor shall compile the characterizations to enable modeling of the

carbon reduction potential assessment. Modeling inputs and data collection shall include but not be limited to the areas below.

- Modeling inputs and assumptions
    - Potential study estimates should be provided for a 25-year timeframe, from 2026 through 2050 with an emphasis on near-term years 2026 through 2030.
    - Fuel switching (technologies, markets, and scenarios as needed)
    - Renewable fuels (technologies, markets, and scenarios as needed)
    - Emerging technologies
    - Emerging fuels
    - Program delivery equity in a variety of forms (sector, low and moderate income, energy burden, geographic)
    - Participation estimates
    - Cost effectiveness tests (at a minimum Societal Cost Test)
    - Avoided Costs
        - Fuel and clean heat measure annual and cumulative lifecycle emissions reductions

- Market characterization
    - Natural gas and delivered fuels sales (volume and price) forecasts
        - High, medium, and low forecasts
        - Adjusted for no future efficiency as needed
    - Sales forecast disaggregation
        - By fuel type, sector (residential, commercial/ industrial), end use, and building type (including residential income qualified/non-income-qualified).
    - Customer counts and demographics
    - Baseline market characteristics

- Measure characterization
    - Measure list and interactions
    - Measure adoption rates
    - Measure lifetimes, annual and cumulative energy savings and emissions reductions, O&M impacts, and incremental costs
    - Measure incentive, non-incentive, and administrative costs
    - Insights from past program performance and Vermont specific EM&V results
    - Net to Gross ratios

Task 2 Deliverables –
Summary of modeling inputs and assumptions, natural gas and delivered fuels sales forecasts, characterization of current market, measure database containing the following elements for each measure: a brief measure description, average per unit energy savings, clean heat measure annual and cumulative emissions reduction impacts, incremental and total measure costs, measure lifetimes, and discussion of data needed but unavailable. Presentation of modeling assumptions to the PSD and stakeholders with opportunity for comments, questions, and subsequent revisions based on feedback.

Task 3: Workforce Estimate Analysis
The Contractor shall conduct an assessment of workforce characteristics capable of meeting consumer demand and meeting the obligations of the GWSA. The Contractor shall characterize both the current state of the thermal sector workforce and develop a business-as-usual ("BAU") forecast of capacity. In

addition, the Contractor shall development a thermal sector workforce forecast needed to meet the GWSA.

The GWSA thermal sector workforce forecast should be compared to the BAU forecast and identify any gaps needed to meet GWSA. The Contractor shall include an estimate of costs and pace needed to fill any workforce gaps identified.

Task 3 Deliverables –
The Contractor shall quantify and characterize the current state of the thermal sector workforce and develop a BAU forecast. The Contractor shall conduct an analysis of the BAU thermal sector workforce forecast's ability to meet customer demand and meet the obligations of the GWSA. The Contractor shall quantify and characterize the future state of the thermal sector workforce capable of meeting GWSA compared to the BAU forecast.

Task 4: Technical, Economic, Maximum Achievable, and Program Achievable Potential Analysis
The Contractor shall estimate the following levels of potential for thermal carbon reduction measures.

- Technical Potential
- Economic Potential
- Achievable Potential
    - Maximum Achievable
    - Program Achievable

Task 4 Deliverables –
The Contractor shall develop a summary memo and slide deck describing forecast calibration results and supporting documentation in spreadsheet format; databases showing the inputs and results of the calculations of technical, economic, maximum and program potential, including benefit/cost screening results and annual and cumulative emissions reductions compared to emission reductions required under the GWSA. Presentation of potential study results to the PSD and stakeholders with opportunity for comments, questions, and subsequent revisions based on feedback.

Task 5: Program Achievable Potential At 18 Optimization
Using the program achievable potential assessed in Task 4 as the "base case", the Contractor shall optimize to meet the requirements of Act 18, The Affordable Heat Act of 2023. Optimization shall include but not be limited to the following required by Act 18.

- Assessment of workforce characteristics capable of meeting consumer demand and meeting the obligations of GWSA from Task 3;
- Prioritize customers with low income and moderate income and those households with the highest energy burdens;
- Prioritize residents of manufactured homes, and renter households with tenant-paid energy bills;
- Maximize the use of available federal funds to deliver clean heat measures;
- Disaggregation of potential for multi-unit dwellings, condominiums, rental properties, commercial and industrial buildings, and manufactured homes; and
- Sequencing and pacing of emissions reductions potential to balance equity and workforce objectives meet the targets of the GWSA most cost effectively.

Task 5 Deliverables -
The Contractor shall develop a summary memo and slide deck describing Act 18 optimization results and supporting documentation in spreadsheet format; databases showing the inputs and results of the calculations of Act 18 optimized program potential. The Contractor shall include benefit/cost screening

results, annual and cumulative emissions reductions compared to the other potential scenarios as well as compared to GWSA. Presentation of Act 18 optimized program potential results to the PSD and stakeholders with opportunity for comments, questions, and subsequent revisions based on feedback.

Task 6: Reporting

The Contractor shall develop preliminary and final results memos associated with Tasks 2, 3, 4 and 5. The Contractor shall develop draft final overall report, and final overall report including review processes and incorporation of feedback from the PSD and stakeholders. The Contractor shall participate in PUC proceedings as needed to provide information and presentations of draft results related to Tasks 2, 4, 5 and final results.

Task 6 Deliverables –

The Contractor shall provide status reports as needed, task results memos, and data summaries as needed to develop the analysis. Key deliverables include preliminary and final memos associated with Tasks 2, 3, 4, and 5. The Contractor shall also develop a draft final overall report and final overall report. The Contractor shall also provide presentations as needed as part of the PUC process, including at least one presentation of the final results. Participation in PUC process and presentations may occur virtually or in person. Participation in PUC process and presentations may occur virtually or in person.

In addition, outside the PUC process, the Contractor shall provide up to 3 virtual presentations of the final results to audiences to be determined by the PSD.

Task 7 – General Administration and Management

The Contractor shall designate a project manager that will lead communication with the PSD. Responsibilities shall include regular, bi-weekly (at a minimum) project updates with the PSD project manager, in which the Contractor and the PSD have a conference telephone call to discuss progress on the project.

Task 7 Deliverables –

Expected results should be proposed according to the timeline below.

Key Deliverables	Deliverable
Kick-off Meeting	TBD
Task 2	REDACTED
Tasks 3 and 4	REDACTED
Task 5	REDACTED
Final Report	REDACTED

Performance Measures

Timeliness – Contractor shall complete tasks and submit deliverables as scheduled above, or if a timeframe is not specified, within a reasonable time to allow adequate opportunity for PSD review.

Quality – Contractor shall insure financial and economic analysis, recommendations and written work, including any reports, testimony and discovery, is well-written, clear and thorough without need for significant editing by PSD staff.

Relationships – Contractor shall work well with the PSD staff and other individuals or entities as requested by the PSD.

In the event the work described above is not going to be provided within the time outlined above, Contractor shall contact the PSD to discuss a remedy to resolve the situation. If a mutually acceptable resolution cannot be reached, then the contract shall be terminated.

CLEAN HEAT STANDARD POTENTIAL STUDY ASSUMPTIONS

Technical Advisory Group Meeting – March 7, 2024

NV5

AGENDA

- Team Introductions
- Project Summary
- Modeling Methodology
- Modeling Assumptions
  - Measures and Emerging Technologies
- Emissions Reductions
  - Lifecycle and Non-Lifecycle
- Next Steps
- Measure List (Appendix A)

PROJECT TEAMS

NV5

- National leader in potential studies for last 25 years with projects in PA, NO, NJ, MN and NY.
- Helped VEIC and State of Vermont set up Efficiency Vermont.
- **NV5 will serve as the prime contractor and overall project manager, as well as technical leads for all tasks outside of emerging fuels.**

Energy and Environmental Economics, Inc.

- Xcel Energy, Clean Heat Plan Support.
- PSE, Gas Local Distribution Company Decarbonization Strategy Support.
- Massachusetts Local Gas Distribution Companies, Dept. of Public Utilities Future of Gas Net Zero Strategy.
- **Analytical and subject matter expertise support for renewable and emerging fuels modeling and measure characterization in Task 2.**

PROJECT SUMMARY

Clean Heat Standard:

To support the goals of the Global Warming Solutions Act (GWSA), The Clean Heat Standard is intended to reduce greenhouse gas emissions in Vermont's thermal sector through clean heat credits representing reduced emissions from clean heat measures.

Project Objective:

The potential study will quantify the technical, economic and achievable potential for Vermont thermal sector resources which will inform the price and amount of clean heat measures.

MODELING METHODOLOGY

POTENTIAL SCENARIOS AND OPTIMIZATION

- Technical Potential
  - Full technical potential of each measure
- Maximum Achievable Potential
  - Scenarios based on different market intervention
    - Examples: budget constraints, variable incentives, different adoption curves, technology priorities, GWSA targets
- Economic Potential
  - Cost effectiveness screening
- Act 18 Optimization
  - Optimizing potential results to meet Act 18 policy requirements
    - Program Achievable scenarios
    - Examples: low-and-moderate income, workforce development, manufactured homes, federal funding scenarios

MODELING ASSUMPTIONS

MEASURE OVERVIEW

Standard Measure List

Sector	Measure	Base Fuel	Priority
RES/C&I	Heat Pumps: GSHP, DHP, ASHP	Gas, Oil, Wood, Propane	High
RES/C&I	Water Heat: HPWH, Solar, Utility-Controlled	Gas, Oil, Wood, Propane	High
RES/C&I	Envelope	Gas, Oil, Wood, Propane	High
RES/C&I	Advanced Wood	Gas, Oil, Wood, Propane	High
RES/C&I	Network Geothermal	Gas	High
RES/C&I	Efficient Electric Manufactured Home	Baseline Home	High
C&I	Commercial HVAC: VRF, RTU, Boiler (Advanced Wood)	Gas, Oil, Propane	High
RES/C&I	Advanced Thermostats	Gas, Oil, Wood, Propane	Low
RES/C&I	Low Flow Aerator and Showerheads	Gas, Oil, Wood, Propane	Low
RES/C&I	Induction Stovetops	Gas, Propane	Low

Measure Characterization Categories

- Efficient measure description
- Baseline equipment or practice description
- Measure life
- Incremental cost of the efficient measure over baseline
- Primary fuel saved (electric, natural gas, oil or petroleum fuels, biomass)
- Secondary fuel
- Primary fuel and secondary fuel end uses
- For electric measures: load shape, coincidence factors
- Energy & demand savings relative to baseline
- Early-retirement retrofit inputs (baseline life & age, baseline shift)
- Operation & maintenance (O&M) impacts (cost savings or increased cost)
- Secondary fuel impacts (savings or increased usage)
- Water savings
- Other non-energy benefits including emissions

MODELING ASSUMPTIONS – CLEAN FUELS

MEASURES AND EMERGING TECHNOLOGIES

- E3 will evaluate availability and cost for the following fuels:
  - Renewable natural gas (RNG) from landfills, animal waste, and municipal wastewater
  - RNG from thermal gasification of agricultural and forestry residues and municipal solid and food wastes
  - Renewable fuel oil (RFO) from agricultural and forestry residues and municipal solid and food wastes
  - Woody biomass from forest residues
  - Green hydrogen produced with dedicated renewables
- E3 will not look at some fuels for several different reasons:
  - Dubious environmental benefits: renewable fuels from purpose-grown crops
  - Fuels with low technical readiness: synthetic fuels from low-carbon hydrogen
- E3 will draw upon internal models, parameterized with data from the DOE Billion Ton Update, California Air Resources Board Low-Carbon Fuel Standard, and other sources to estimate availability and costs of each fuel





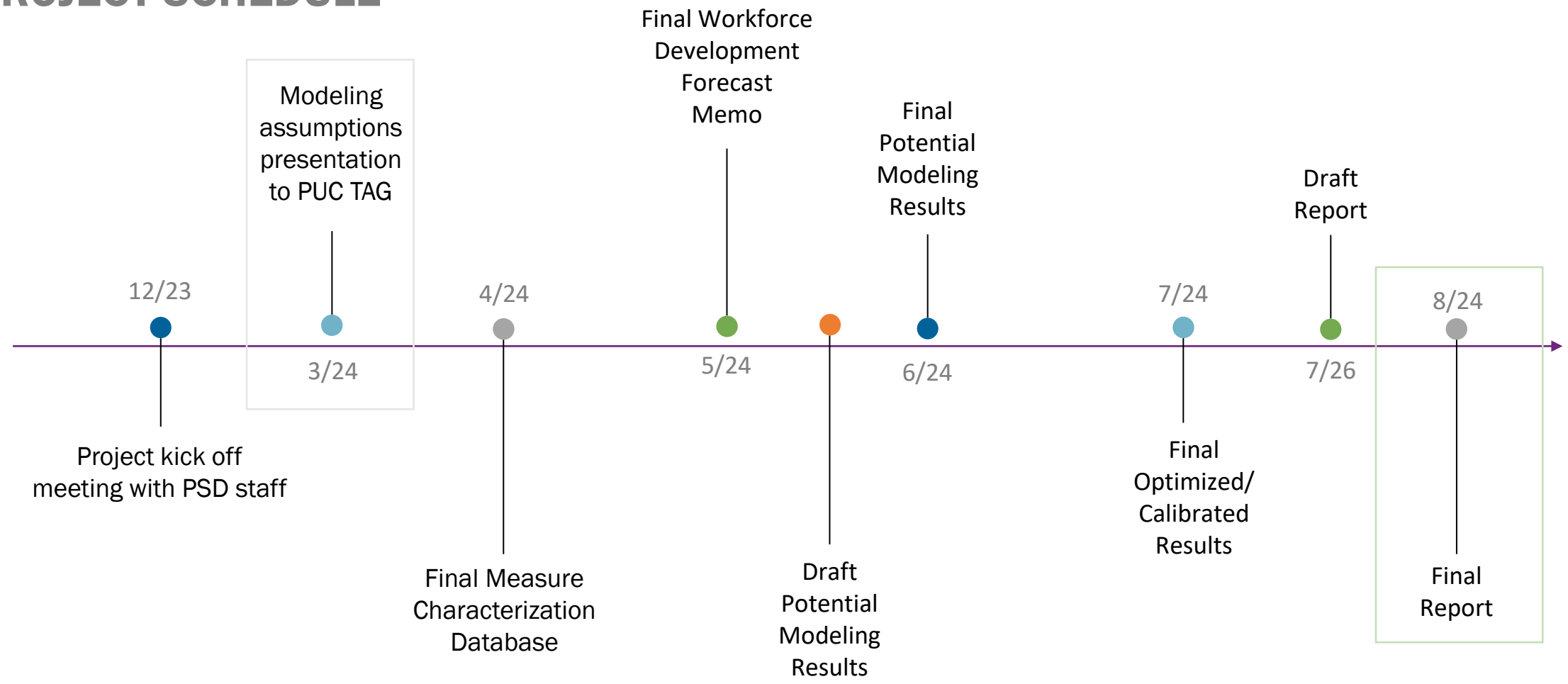

EMISSIONS REDUCTIONS

LIFECYCLE AND NON-LIFECYCLE EMISSIONS

- Clean Heat Standard emissions definition
- Interpretation of Lifecycle (upstream) and non-Lifecycle (combustion)
  - Equipment end-use material embedded carbon out of scope
  - Three sets of emissions for low-carbon fuels:
    1. IPCC-style consistent with VT's GHG inventory
    2. LCA-based excluding biogenic CO2 and avoided counterfactual credits for animal waste and landfill RNG and woody biomass, consistent with ANR Lifecycle Report
    3. LCA-based including biogenic CO2 and avoided counterfactual credits
- Sources for including each into measure characterizations
  - DRAFT ANR Lifecycle Report
  - Vermont Greenhouse Gas Emissions Inventory and Forecast
  - Emerging Fuels
    - DRAFT ANR Lifecycle Report
    - Registered LCFS projects

NEXT STEPS

PROJECT SCHEDULE



APPENDIX A – MEASURE LIST

Sector	Measure	Base Fuel	Clean Heat Standard Measure #	Priority
RES/C&I	Ground source heat pump - Full Replacement†	Gas	2	High
RES/C&I	Ground source heat pump - Full Replacement†	Oil	2	High
RES/C&I	Ground source heat pump - Full Replacement†	Wood	2	High
RES/C&I	Ground source heat pump - Full Replacement†	Propane	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Gas	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Oil	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Wood	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Propane	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Gas	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Oil	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Wood	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Propane	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Gas	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Oil	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Wood	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Propane	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Gas	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Oil	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Wood	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Propane	2	High
RES/C&I	Advanced Thermostats	Gas	1	Low
RES/C&I	Advanced Thermostats	Oil	1	Low
RES/C&I	Advanced Thermostats	Wood	1	Low
RES/C&I	Advanced Thermostats	Propane	1	Low
RES/C&I	Heat Pump Water Heater†	Gas	3	High
RES/C&I	Heat Pump Water Heater†	Oil	3	High
RES/C&I	Heat Pump Water Heater†	Propane	3	High
RES/C&I	Heat Pump Water Heater†	Wood	3	High
RES/C&I	Solar Water Heater	Gas	5	High
RES/C&I	Solar Water Heater	Oil	5	High
RES/C&I	Solar Water Heater	Propane	5	High
RES/C&I	Solar Water Heater	Wood	5	High
RES/C&I	Utility-Controlled Electric Water Heater	Gas	4	Low
RES/C&I	Utility-Controlled Electric Water Heater	Oil	4	Low
RES/C&I	Utility-Controlled Electric Water Heater	Propane	4	Low
RES/C&I	Utility-Controlled Electric Water Heater	Wood	4	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Gas	1	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Oil	1	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Propane	1	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Wood	1	Low
RES/C&I	Induction Stovetop	Gas	6	Low
RES/C&I	Induction Stovetop	Propane	6	Low
RES/C&I	Envelope†	Gas	1	High
RES/C&I	Envelope†	Oil	1	High
RES/C&I	Envelope†	Wood	1	High
RES/C&I	Envelope†	Propane	1	High
RES/C&I	Advanced Wood	Gas	7	High
RES/C&I	Advanced Wood	Oil	7	High
RES/C&I	Advanced Wood	Wood	7	High
RES/C&I	Advanced Wood	Propane	7	High
RES/C&I	Networked Geothermal	Gas	2	High
Res	Efficient and Electric Manufactured Home*†	Baseline Home	11	High
C&I	Variable Refrigerant Flow (VRF)	Gas	2	High
C&I	Variable Refrigerant Flow (VRF)	Oil	2	High
C&I	Variable Refrigerant Flow (VRF)	Propane	2	High
C&I	Rooftop Unit (RTU)	Gas	2	High
C&I	Rooftop Unit (RTU)	Propane	2	High
C&I	Boiler (Advanced Wood Heating)	Gas	2	High
C&I	Boiler (Advanced Wood Heating)	Oil	2	High
C&I	Boiler (Advanced Wood Heating)	Propane	2	High

*https://vermodhomes.com/evt-zem-program/
†low-and-moderate income markets

THANK YOU

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VT PSD Timeline V2	December	January				February				March					April				May					June				July				August					September			
Tasks	wk ending	5	12	19	26	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27
1: Kick-Off Meeting and Revised Work Plan																																								
Kickoff Meeting	12.7																																							
Revised Workplan																																								
2: Modeling Inputs and Data Collection																																								
Summary of modeling inputs and assumptions								NV5	E3																																
Market characterization																																								
Measure database																																								
Modeling assumptions presentation											P																													
Initial Draft																																								
Final Draft																	R																							
3: Workforce Estimate and Job Creation Potential Analysis																																								
Current-state Memo																																								
Workforce Forecast Memo																																								
Initial Draft																																								
Final Draft																	R																							
4: Technical, Economic, Maximum Achievable, and Program Achievable Potential Analysis																																								
Database model workbook																																								
Summary memo and analysis for forecast calibration results																																								
Presentation Draft Results																						P																		
PresentationFinal Results																								P																
5: Program Achievable Potential Act 18 Optimization																																								
Act 18 Model inputs and forecast results																																								
Act 18 Summary memo and analysis for forecast calibration results																																								
Act 18 Presentation of results																													P											
6: Reporting																																								
Final Report Initial Draft																																								
Final Report Draft Review																																	R							
Final Report Final Draft and Presentation																																			P					

P = Presentation

R = PSD Review

NV5 Clean Heat Standard Potential Study Modeling Assumptions

Introduction

This memo summarizes key modeling assumptions for the VT Clean Heat Standard Potential Study. The following assumptions represent the known parameters at the initial phase of the project (February 2024) and are subject to change throughout the duration of the project due to stakeholder feedback and project updates through conversations with Vermont's Public Service Department ("PSD").

Project Summary

The thermal sector potential study supports Act 18 "the Affordable Heat Act" and the Clean Heat Standard. To support the goals of the Global Warming Solutions Act ("GWSA"), the Clean Heat Standard is intended to reduce greenhouse gas emissions in Vermont's thermal sector through clean heat credits representing reduced emissions from clean heat measures. The Clean Heat Standard Potential Study will quantify the technical, economic, and achievable potential for Vermont thermal sector resources.

Modeling Methodology

Technical Potential

Standard efficiency potential studies typically model three-to-four different potential scenarios: Technical, Economic, Achievable and/or Program Achievable; each representing a set or subset of energy efficiency acquisition market conditions. For the Clean Heat Standard Potential Study, Technical Potential for energy efficiency measures (e.g. full market penetration of Air Source Heat Pumps) isn't a useful first scenario because, by definition, it would eliminate all the potential from renewable fuels, wood heating, district heating, and ground source heat pumps. The NV5 team will instead replace the technical potential scenario with additional economic or maximum achievable scenarios that investigates different technology adoption conditions with different factors or policy choices to determine how to prioritize and order different technologies. For example, having both a maximum achievable "heat pump first" scenario and a maximum achievable "renewable fuels first" scenario could give a good sense on how, at a policy or programmatic level, prioritizing different fuel sources may impact costs and emission reductions of the program. If it's determined that a traditional technical potential scenario is required, NV5 would suggest either looking at the full technical potential of each measure, **without considering interactions or mutual exclusivity** or selecting mutually exclusive measures based on maximum GHG reduction.

Achievable and Economic Scenarios

The maximum achievable scenario potential will assume incentives that cover full incremental cost of the measures. As described above, initial examples of different program achievable scenarios would include:

- Budget Constrained Scenario (e.g. based on a maximum desired budget or rate impact).

- Set Incentive or Incremental Cost Scenario (e.g. 50% instead of 100% in the max achievable scenario).
- GWSA Target Scenario (scenario targeting the goals set in the GWSA).
- Adoption Scenarios – (sensitivities looking at the impacts in changes for assumptions in adoption curves and/or program ramp rates).
- Technology Scenario – (prioritizing different sets of technologies or measures).
- Workforce Scenario – (workforce capacity to meet targets).

These scenario examples will continue to be discussed with PSD staff and applicable stakeholders to determine an agreed-upon prioritized scenario list that will be used in the final modeling process.

Economic potential screening removes all non-cost-effective measures by using the Societal Cost Test and will be run as a subset of the different achievable scenarios as described above. The model will segment the market into different categories, each with different costs and application to certain measures. For example, costs of heat pumps in New Construction are going to be lower than the costs of putting one into an existing building. There will likely be some measures that are cost effective in some markets and building types, but not in others.

Act 18 Optimization Potential

The final potential scenario will be optimizing results to meet the specific requirements and general policy priorities in Act 18. This includes low-and-moderate income, workforce development, manufactured homes, and federal funding scenarios. Final optimized scenarios and supporting assumptions will be documented in the draft and final reports.

Workforce Development

A better understanding of Vermont's clean energy sector workforce will be an important step in assessing the future implementation of Vermont's Clean Heat Standard. NV5 will estimate workforce as it relates to our potential study analysis in three areas: current-state workforce conditions, business as usual workforce forecast, and workforce capacity to meet GWSA targets. A quantification of the gaps for each workforce area based on the GWSA potential scenario (described above) will be calculated and intervention strategies will be suggested to fill the workforce gaps to meet GWSA workforce capacity. A memo summarizing current state workforce conditions, business as usual and GWSA forecast results and assumptions and specific workforce gaps between both forecasts will be published in late Q2 2024.

Modeling Assumptions

I. Modeling Timeline

The potential study analysis will be conducted assuming a 25-year timeframe (2026—2050) with an emphasis on the near-term years 2026 through 2030. Act 18 also requires that, to support the long-term planning by obligated parties, "*the Commission shall establish and update annual clean heat credit requirements for the next 10 years*.[1]" Therefore, the NV5 team will emphasize not only the next two 3-year periods, but also the initial 10-year period. As with any 25- year study, input

[1] VT Legislature Act 18. Pg 7.
https://legislature.vermont.gov/Documents/2024/Docs/ACTS/ACT018/ACT018%20As%20Enacted.pdf

parameters, and the corresponding analytical results, for the out years may be more uncertain compared to the near-term. When modeling a thermal energy system with reduced carbon over time, the prevailing opportunities and associated costs can and likely will diverge considerably from current conditions.

II. Measures

All measures included in the potential study will be characterized with respect to GHG emission reductions, energy savings, costs, applicability, effective useful life and building type. Due to the scope and timeline of this project, installed measures will represent what is commercially available in the market today and where supporting baseline and market data exists. The Vermont Technical Reference Manual ("TRM") (December 2018[2]) will be the primary source of the measure characterization effort for traditional measure groups (e.g. insulation, air sealing, heat pumps and heat pump water heaters). This will be supplemented with the Tier III Technical Advisory Group TRM[3] which supports energy transformation measures that reduce fossil fuel consumption and the Vermont Gas TRM where necessary. While the prescriptive savings algorithms presented in these TRMs may be adequate to quantify the savings for some measures, they will not cover all savings opportunities. These measure characterizations will estimate savings potential from a variety of additional sources, including custom site-specific measures (e.g. solar hot water, district heating). NV5 will use our existing library of measure characterizations, including those developed during the measure characterization process for applicable regional forecasting projects and other regional sources, as appropriate. Additionally, the NV5 team will review savings information to ensure savings estimates are calibrated to current Vermont energy codes, equipment standards, and market trends. All measure sources will be identified and documented in the Clean Heat Standard Potential Study draft and final reports. NV5 will also coordinate with the Vermont Public Utility Commission's ("PUC") technical consultant regarding the Clean Heat Standard as needed.

Measure List

A preliminary measure list can be found in Appendix A which identifies the most common measures applicable to the Clean Heat Standard at the time of publication of this memo. Additional measure detail and characteristics will be developed in early Q3 and be available for review on the VT PSD Clean Heat Standard website.

Emerging Technologies

Low-Carbon Fuels

Biofuel feedstock potentials and pathways will be sourced, when possible, from the Department of Energy Billion-Ton Update. The California Energy Commission's Challenge of Retail Gas in California's Low Carbon Future report[4] will be used to support the green hydrogen production analysis. The following low-carbon pathways will be modeled:

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[2] VT Technical Reference Manual. December 2018. https://puc.vermont.gov/document/ev-technical-reference-manual
[3] Vermont Act 56 Tier III Technical Advisory Group. Submitted to the Public Utility Commission on behalf of the Technical Advisory Group by VEIC. 2023 Annual Report.
[4] The Challenge of Retail Gas in California's Low Carbon Future. California Energy Commission. https://www.energy.ca.gov/publications/2019/challenge-retail-gas-californias-low-carbon-future-technology-options-customer.

- Renewable natural gas (RNG) from anaerobic digestion of animal waste, landfill waste, municipal solid waste, or food waste
- RNG from gasification of food, agricultural, or forestry waste
- Renewable diesel (RD) from Fischer-Tropsch of agricultural, forestry, or municipal solid waste.
- Green hydrogen from grid or emission-free electricity

The costs for low-carbon fuels today are often influenced by California's Low-Carbon Fuel Standard (LCFS) and the national Renewable Fuel Standard (RFS) markets. Costs for low-carbon fuels will be derived from the publicly available LCFS 2023 Standardized Regulatory Impact Assessment[5] and from internal review of the RFS credit market.

Networked Geothermal Heat Pumps

Networked geothermal heat pump systems connect ground source heat pumps via an underground shared water-loop pipe network to meet diverse heating and cooling loads across residential and commercial buildings.

The technical feasibility screening for networked geothermal will be defined based on household density thresholds, informed by a HEET and Buro Happold 2019 Geothermal Networks Feasibility Study[6]. Population, land use, and housing data sourced from the Vermont Data Portal[7] will be used to develop estimates of household density and thus networked geothermal feasibility across the state.

Costs of networked geothermal systems are uncertain, given the nascency of this technology. Utility pilot project budgets from existing pilots in the Northeast will be used to inform the total installation costs and energy impacts of these measures.

Other Emerging Technologies

Act 18 identifies an extensive list of eligible clean heat measure categories which will be documented and later characterized in Q3 for those emerging technologies not described above. This list will be supplemented with additional research on emerging technologies, leveraging the work of bodies such as the Emerging Technologies Coordinating Council[8], reviewing recent clean heat and electrification potential studies in other jurisdictions, and reviewing research reports from leading Energy Efficiency and decarbonization programs. These emerging technologies will then be screened for those measures with well-documented, defensible costs and savings estimates and non-negligible market potential. A summary of emerging technologies that were reviewed but not included in the final model will be also documented in the draft and final reports.

III. Cost Effectiveness

[5] Low Carbon Fuel Standard 2023 Amendments: Standardized Regulatory Impact (SRIA). California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/appc-1.pdf
[6] Geothermal Network Feasibility Study. https://assets-global.website-files.com/649aeb5aaa8188e00cea66bb/656f8ad67bbc7df081e3fe17_Buro-Happold-Geothermal-Network-Feasibility-Study.pdf
[7] Vermont Data Portal. https://data.vermont.gov/
[8] California State-Wide Emerging Technologies Program. https://ca-etp.com/

Each applicable Clean Heat Standard measure will be subjected to the Vermont Societal Cost Test using the most recent PUC approved 2021 New England Avoided Energy Supply Costs ("AESC") values as the avoided cost inputs[9]. These avoided costs represent the latest VT PUC approved avoided cost vintage which were used in the most recent January 2023 Vermont Public Service Department Vermont Energy Efficiency Market Potential Study[10]. NV5 will also model scenarios for economic potential based on increases or decreases in avoided costs. The cost effectiveness screening tool also performs a full measure life analysis of costs and benefits for all possible measure permutations including technology, sector, building type, and market.

IV. Emissions Reductions - Annual and Cumulative Lifecycle

Pursuant to Clean Heat Standard section § 8124 (a)(1):

> "The Commission shall establish the number of clean heat credits that each obligated party is required to retire each calendar year. The size of the annual requirement shall be set at a pace sufficient for Vermont's thermal sector to achieve lifecycle carbon dioxide equivalent (CO2e) emission reductions consistent with the requirements of 10 V.S.A. § 578(a)(2) and (3) expressed as lifecycle greenhouse gas emissions pursuant to subsection 8127(g) of this title."

NV5 will model measures using upstream lifecycle emissions values in compliance with Clean Heat Standard credit policy. The Clean Heat Standard Potential Study defines lifecycle emissions as the values sourced from the Vermont Agency of Natural Resource's latest Vermont Energy Sector Life Cycle Assessment report which calculates upstream emission factors (e.g. raw material extraction, processing, transportation, etc.) by major GHG species, for each VT energy pathway and total emissions estimates based on activity data for 1990-2020. These values only include emissions within the state as upstream emissions occurring outside of the state borders are not included.

Lifecycle emissions for fuel pathways not covered by the Vermont Agency of Natural Resource's report, such as renewable diesel or gasification-based biomethane, will be sourced from existing projects registered in the California Low Carbon Fuel Standard program[11]. NV5 will also use the California Air Resources Board LCFS GREET model[12] for estimating avoided methane emissions for landfill gas and animal waste RNG. The team will continue to research best sources for biogenic emissions factors from woody biomass as proxy state or regional modeling outside of Vermont will not be representative of the state's specific forestry feedstocks.

NV5 also intends to model measure scenarios to be consistent in meeting the requirements of the Global Warming Solutions Act (GWSA) targets which use non-lifecycle emissions values. These non-lifecycle emissions values will be sourced from the Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990 – 2020 report published by the Vermont Air Quality and Climate Division in April

[9] Vermont PUC Case No. 21-2436-PET. Final EEU Avoided Costs. https://epuc.vermont.gov/?q=downloadfile/615689/160095
[10] Vermont Public Service Department Vermont Energy Efficiency Market Potential Study. GDS Associates Inc. January 2023. https://publicservice.vermont.gov/efficiency.
[11] Current Pathways All. California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/current-pathways_all.xlsx
[12] CARB LCFS Life Cycle Analysis Models. https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-models-and-documentation.

2023[13]. These emissions values represent estimates of anthropogenic (energy-related activities from combustion of fossil fuels in the utility sector) gas emissions within the state of Vermont annually for the years 1990 – 2020.

Based on our interpretation of the Clean Heat Standard, emissions from measure end use materials (e.g. heat pumps or weatherization) are outside of the scope of this potential study. NV5 will continue to coordinate with PSD staff on availability or inclusion of these emission factors if this changes.

[13] Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990 – 2020. Vermont Agency of Natural Resources Climate Action Office. https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory

Appendix A – Preliminary Measure List

Sector	Measure	Base Fuel	Clean Heat Standard Measure #	Priority
RES/C&I	Ground source heat pump - Full Replacement†	Gas	2	High
RES/C&I	Ground source heat pump - Full Replacement†	Oil	2	High
RES/C&I	Ground source heat pump - Full Replacement†	Wood	2	High
RES/C&I	Ground source heat pump - Full Replacement†	Propane	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Gas	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Oil	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Wood	2	High
RES/C&I	Ductless air source HP - Full Replacement†	Propane	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Gas	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Oil	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Wood	2	High
RES/C&I	Ductless air source HP - Partial Replacement†	Propane	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Gas	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Oil	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Wood	2	High
RES/C&I	Air Source heat pump - Full Replacement†	Propane	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Gas	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Oil	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Wood	2	High
RES/C&I	Air Source heat pump - Partial Replacement†	Propane	2	High
RES/C&I	Advanced Thermostats	Gas	1	Low
RES/C&I	Advanced Thermostats	Oil	1	Low
RES/C&I	Advanced Thermostats	Wood	1	Low
RES/C&I	Advanced Thermostats	Propane	1	Low
RES/C&I	Heat Pump Water Heater†	Gas	3	High
RES/C&I	Heat Pump Water Heater†	Oil	3	High
RES/C&I	Heat Pump Water Heater†	Propane	3	High
RES/C&I	Heat Pump Water Heater†	Wood	3	High
RES/C&I	Solar Water Heater	Gas	5	High
RES/C&I	Solar Water Heater	Oil	5	High
RES/C&I	Solar Water Heater	Propane	5	High
RES/C&I	Solar Water Heater	Wood	5	High
RES/C&I	Utility-Controlled Electric Water Heater	Gas	4	Low
RES/C&I	Utility-Controlled Electric Water Heater	Oil	4	Low
RES/C&I	Utility-Controlled Electric Water Heater	Propane	4	Low
RES/C&I	Utility-Controlled Electric Water Heater	Wood	4	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Gas	1	Low

RES/C&I	Low Flow Faucet Aerator and Shower Heads	Oil	1	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Propane	1	Low
RES/C&I	Low Flow Faucet Aerator and Shower Heads	Wood	1	Low
RES/C&I	Induction Stovetop	Gas	6	Low
RES/C&I	Induction Stovetop	Propane	6	Low
RES/C&I	Envelope†	Gas	1	High
RES/C&I	Envelope†	Oil	1	High
RES/C&I	Envelope†	Wood	1	High
RES/C&I	Envelope†	Propane	1	High
RES/C&I	Advanced Wood	Gas	7	High
RES/C&I	Advanced Wood	Oil	7	High
RES/C&I	Advanced Wood	Wood	7	High
RES/C&I	Advanced Wood	Propane	7	High
RES/C&I	Networked Geothermal	Gas	2	High
Res	Efficient and Electric Manufactured Home*†	Baseline Home	11	High
C&I	Variable Refrigerant Flow (VRF)	Gas	2	High
C&I	Variable Refrigerant Flow (VRF)	Oil	2	High
C&I	Variable Refrigerant Flow (VRF)	Propane	2	High
C&I	Rooftop Unit (RTU)	Gas	2	High
C&I	Rooftop Unit (RTU)	Propane	2	High
C&I	Boiler (Advanced Wood Heating)	Gas	2	High
C&I	Boiler (Advanced Wood Heating)	Oil	2	High
C&I	Boiler (Advanced Wood Heating)	Propane	2	High

*https://vermodhomes.com/evt-zem-program/
†low-and-moderate income markets