

Health Impacts and Considerations for the Clean Heat Standard

Relevant Language from CHS Statute

- § 8121. INTENT
Pursuant to 2 V.S.A. § 205(a), **it is the intent of the General Assembly that the Clean Heat Standard** be designed and implemented in a manner that achieves Vermont's thermal sector greenhouse gas emissions reductions necessary to meet the requirements of 10 V.S.A. § 578(a)(2) and (3), minimizes costs to customers, **protects public health**, and recognizes that affordable heating is essential for Vermonters. It shall enhance social equity by prioritizing customers with low income and moderate income and those households with the highest energy burdens. The Clean Heat Standard shall, to the greatest extent possible, maximize the use of available federal funds to deliver clean heat measures.
- § 8127. TRADEABLE CLEAN HEAT CREDITS
(h) Review of consequences: **The Commission shall biennially assess harmful consequences** that may arise in Vermont or elsewhere from the implementation of specific types of clean heat measures and shall set standards or limits to prevent those consequences. Such consequences shall include environmental burdens as defined in 3 V.S.A. § 6002, **public health**, deforestation or forest degradation, conversion of grasslands, increased emissions of criteria pollutants, damage to watersheds, or the creation of new methane to meet fuel demand.
- § 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:
 - (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.
 - (8) **calculating the savings associated with public health benefits** due to clean heat measures.

Questions for TAG Consideration

1. If the TAG is required to “periodically” assess and report to the Commission on the sustainability of the production of clean heat measures, on what cadence should this occur? Should it be done biennially to meet the requirement for the Commission to biennially assess harmful consequences?
2. Should the first review of consequences occur prior to implementation of the CHS to inform the Commission, so it can set standards or limits to prevent harmful consequences? For example, if certain potential clean heat measures are determined to have high risks of negative consequences for human health or the environment, could they be screened out upfront?
3. What additional information regarding potential public health impacts would be helpful? What form should that information take? What (if any) formal decisions should the TAG make related to public health considerations and their application in this process? Doing a systematic and quantifiable analysis of health impacts seems beyond the capacity of the TAG to take on directly without dedicated consultant support. The available scientific evidence may also not support such an analysis, particularly for emerging fuels and technologies.
4. There is fairly solid information on the human health impacts of various clean heat measures, as detailed below. It’s less clear how to evaluate environmental impacts and impacts on food costs for clean heat measures. How should the TAG assess carbon sequestration and storage, land use changes, ecological and biodiversity impacts, impacts on groundwater and surface water, and water and soil pollution? What about impacts on food costs?

Initial Review of Public Health Impacts of Clean Heat Measures

This section provides a high-level summary of potential human health impacts and considerations for several groupings of clean heat measures, based on a non-exhaustive review of peer-reviewed scientific evidence. It also notes the degree of confidence in the conclusions based on the availability of scientific literature on related human health impacts. Unless otherwise noted, the focus of this analysis was on health impacts relating to end use at a residence, not to impacts from upstream in the life cycle.

Home weatherization (positive health benefits, high confidence)

- Reduced combustion emissions; improved temperature control and indoor air quality; reduced humidity, mold, and pest intrusion; money saved on fuel often directly supports better health; opportunities for other health and safety improvements.
 - [OEO estimated in 2024](#) an average household savings of \$1,026 per year from reduced fuel demand.
 - [VDH estimated in 2018](#) \$1,302 per year in public health savings per year from reduced outdoor air emissions and reduced resident impacts from cold, heat, and asthma.
- Need to ensure sufficient ventilation and treatment of indoor air pollutants after weatherization.

Electric heating and appliances (positive health benefits, high confidence)

- Compared to conventional liquid or solid heating fuels: avoided combustion emissions; avoided indoor exposure to nitrogen dioxide and other air toxics ([particularly from gas cook stoves](#)); avoided risk of carbon monoxide poisoning.
- Heat pumps provide health co-benefits such as increasingly necessary air conditioning and dehumidification.

Wood heating (negative health benefits, high confidence)

- Residential wood heating emits substantially more fine particulate matter and air toxics than other non-woody residential fuels. Fine particulate matter (PM_{2.5}) is a critical pollutant of concern due to decades of research establishing significant associations with human mortality and morbidity.
 - This is true for all wood fuel types and heating equipment, though there is a spectrum from most -> least polluting per heat output (uncertified wood stove -> EPA-certified wood stove (nuncatalytic) -> EPA certified wood stove (catalytic/hybrid) -> pellet stove or boiler). There is a wide range of other whole-house wood-fueled systems (boilers or furnaces using cordwood or wood chips) that are hard to place in this spectrum due to a lack of scientific emissions data.
- From 2022 VDH analysis using EPA Co-Benefits Risk Assessment (COBRA) tool:
 - 97% of the monetizable health impact from residential heating emissions in Vermont is attributable to wood fuel combustion.
 - Monetizable health impact of residential wood heating in Vermont is \$105M-\$238M (about 30x greater than for all other residential fuels combined).
 - Pollution from wood heating is associated with 10-22 early deaths (about 20x greater than for other residential fuels).

- Cancer risk from wood heating pollution is 2.5 per million (about 20x greater than for other residential fuels).
- Replacing fossil fueled heating with wood heating, especially cordwood, would likely have a harmful impact on human health as a result of increased air pollution emissions. The magnitude depends on what type of wood heating equipment is used and what is being replaced.
 - Replacing cordwood stoves and boilers with pellet stoves or boilers has the potential to provide a substantial public health benefit. Pellet stoves are very low emitting for everything except trace metals of health concern (Pb, Cd, As). In general, emissions from pellet heating systems are a much lower concern than cordwood emissions with respect to health impacts. Compared to cordwood emissions, pellet emissions have very low particulate matter, black carbon, volatile organics (including carcinogenic VOCs), and de minimus polycyclic aromatic hydrocarbons (PAHs).
- Manually operated wood stoves can continue providing heat in the event of power loss.

Biofuels and hydrogen (mixed findings, low confidence due to limited research available)

- Research on air quality and health impacts of liquid biofuels is limited. Most of that limited research is focused on analyzing biofuels v. conventional transportation fuels (diesel or gasoline). Findings differ by characteristics of the biofuel (e.g., feedstock, blend), engine type, consideration of part or all of the lifecycle impacts, etc.
- Some fairly consistent findings across the review literature include:
 - Health benefits of biofuels compared to conventional fuels include reduced particulate matter and carbon monoxide.
 - Negative health impacts of biofuels compared to conventional fuels include increased nitrogen oxides, sulfur dioxide, formaldehyde, and overall toxicity.
 - Mixed findings about polycyclic aromatic hydrocarbons (PAHs).
 - Health impacts are typically more of a concern with biofuel blends >20%.
- Research on air quality and health impacts of hydrogen fuels is extremely limited.
 - Combustion of hydrogen alone or hydrogen blended into natural gas generates more nitrogen oxide emissions than natural gas alone.
 - Other concerns seem to be related to the method of production, with harmful health effects associated with fossil-fueled production methods.
- If possible, outside expertise could help clarify health concerns related to biofuels and hydrogen.

Other considerations

- Equity considerations: Ensuring equitable access to health benefits and protection from health harms.
- Lifecycle impacts: Extraction, production, transportation, etc. impacts on emissions, environmental health; impacts related with upstream electricity generation.
- Fuel/technology used for backup power: For example, battery backup versus fossil-fueled generator.
 - Accidental CO poisoning has caused about 50 ED visits / year and 1-2 deaths / year in Vermont over the past 10 years. Common causes of accidental CO poisoning include improper generator use or the malfunction or improper use of heating equipment, cooking equipment, or other combustion-fueled appliances.