



CITY OF BURLINGTON, VERMONT
CITY COUNCIL TRANSPORTATION, ENERGY & UTILITIES COMMITTEE

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Transportation, Energy and Utilities Committee of the City Council
Tuesday August 1st, 2023 – 5PM

Sharon Bushor Conference Room
149 Church St, Burlington, VT 05481
Masks Optional

Join via Zoom, <https://zoom.us/j/92670661614>

To call into the meeting, including to speak during public comment:

Phone number: 312-626-6799, Webinar ID: 926 7066 1614

If you prefer to attend in person, you may join us at City Hall in the Sharon Bushor Conference Room

–DRAFT AGENDA–

- 1. Agenda**
- 2. Minutes of 7.25.23**
- 3. Public Forum**
- 4. Ordinance on Carbon Fee**
 - Councilors, Darren Springer
- 5. Councilors' Update**
- 6. Next Meeting 8/22/23**
- 7. Adjourn**



S.5

Kate Logan <KLogan@leg.state.vt.us>

Wed, Apr 12, 2023 at 10:34 AM

To: Pike Porter <pikeporter@gmail.com>, "info@progressiveparty.org" <info@progressiveparty.org>, Tanya Vyhovsky <TVyhovsky@leg.state.vt.us>, Emma Mulvaney-Stanak <EMulvaneyStanak@leg.state.vt.us>, Brian Cina <BCina@leg.state.vt.us>, Troy Headrick <THeadrick@leg.state.vt.us>, Taylor Small <TSmall@leg.state.vt.us>

Dear Pike,

Thanks so much for joining us yesterday and following up with this helpful email. I will be sure to generate conversation regarding district heat in our *final* bill markup in the Committee today, and appreciate your suggested amendment.

I will speak for myself when I say that I will not be recommending that we add solid biofuel to the carbon intensity requirement. As I'm sure you are aware, this would effectively eliminate the possibility of advanced wood heating as a clean heat measure, since biomass is a particularly inefficient source of heat. While we haven't had a lot of discussion regarding biomass in our Committee conversation on S.5, there has been a significant amount of discussion about biomass elsewhere relevant to S.5 and biomass was included the way it has been very intentionally. Briefly, locally sourced forest byproducts are of such low quality that they aren't appropriate for much else besides compost and incineration/use as a heat source. Further, biomass heating is **extremely affordable** and we have significant **local capacity** to use forest byproducts as heating fuel, and advanced wood heat could provide a non-fossil fuel-derived backup heat source in the coldest weather for homes that are otherwise weatherized and heated by electrical heat sources.

There is no need to include language to instruct the PUC and the TAG to assume that biomass combustion is not carbon-neutral, because S.5 requires that each fuel used as a clean heat measure be subjected to a rigorous lifecycle emissions analysis that includes emissions from "biogenic and geologic sources, including fugitive emissions and loss of stored carbon."

Finally, I want to ensure you that McNeil will be given thorough consideration when we take up the Renewable Energy Standard, as you and I discussed yesterday.

Thanks once again for doing your due diligence as a citizen and climate activist. S.5 would truly not be a piece of legislation that I would support if it had not been for improvements that were made as a result of the advocacy of folks like yourself.

All my best,
Kate

Vermont State Rep. Kate Logan
Chittenden-16, Burlington
House Committee on Environment and Energy

From: Pike Porter <pikeporter@gmail.com>

Sent: Tuesday, April 11, 2023 4:19:20 PM

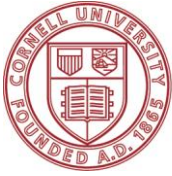
To: info@progressiveparty.org <info@progressiveparty.org>; Tanya Vyhovsky <TVyhovsky@leg.state.vt.us>; Emma Mulvaney-Stanak <EMulvaneyStanak@leg.state.vt.us>; Brian Cina <BCina@leg.state.vt.us>; Kate Logan <KLogan@leg.state.vt.us>; Troy Headrick <THeadrick@leg.state.vt.us>; Taylor Small <TSmall@leg.state.vt.us>

Subject: [External] S.5

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Cornell University

Department of Ecology and Evolutionary Biology

Statement of

Robert W. Howarth, Ph.D.

The David R. Atkinson Professor of Ecology & Environmental Biology
Cornell University, Ithaca, NY 14853 USA

Hearing on Senate Bill 5

Committee on Natural Resources and Energy
Vermont State Senate

February 8, 2023

My name is Robert Howarth. I am an Earth systems scientist with a B.A. from Amherst College and a Ph.D. from MIT and the Woods Hole Oceanographic Institution. I have been a tenured faculty member at Cornell University in Ithaca, NY since 1985 and an endowed professor at Cornell since 1993 (*the David R. Atkinson Professor of Ecology & Environmental Biology*). I have also served as an Adjunct Senior Scientist in the Ecosystems Center of the Marine Biological Lab in Woods Hole, MA for the past 23 years. For decades, I have worked on the consequences of global climate change, on emissions of methane from the oil & gas industry as a driver of climate change, on the production and use of hydrogen, and on alternative energy policies. I have published over 200 peer-reviewed papers, and these have been cited more than 79,000 times in other peer-reviewed literature, making me one of the most highly cited environmental scientists in the world.

Throughout my career, I have been engaged in energy and environmental policy, and I have given briefings and testimony at the White House, at the U.S. Congress and to committees of the US Senate, to the Canadian Senate, to the European Parliament, to the Irish Parliament, to the Senate and Assembly of the State of New York, and in New York courts. I have served on many committees of the US National Academy of Sciences and the International Council of Science, having chaired several of these. Currently, I am one of 22 members of the New York State Climate Action Council, which is the body charged by law with the development of the implementation blueprint ("Scoping Plan") for New York's progressive climate law, the Climate Leadership & Community Protection Act of 2019.

Today, I want to address the proposal that "clean heat credits" be given by the State of Vermont for green hydrogen and for renewable natural gas. In my professional opinion, it would be unwise for Vermont to encourage the use of either hydrogen or renewable natural gas for heating of homes and commercial buildings. These uses were debated extensively by the New York Climate Action Council and its advisory panels and sub-groups over the past 2 to 3 years. In our final Scoping Plan from the Council (passed by a strong 19-3 vote on December 19, 2022), the Council fully rejected the use of hydrogen for heating homes, and put aside the issue of RNG saying it needed further study. Renewable natural gas was certainly not endorsed, though, and I note that renewable natural gas is not mentioned at all in the Executive Summary of the Scoping Plan.

Let me first address renewable natural gas (RNG). RNG is made by processing biogas, making a fuel that is composed mostly of methane and that can be mixed with fossil natural gas in gas pipeline systems. Biogas is a mixture of methane and carbon dioxide as well as other impurities that is produced from anaerobic digesters (including some wastewater treatment plants as well as farm-based systems using manure) and can be captured from landfills. The biogas can itself be used as a fuel, for instance to

generate electricity or heating, but biogas is not suitable for use in pipeline distribution systems. In the final Scoping Plan for the New York Climate Action Council, we specified that whenever possible, biogas should be used directly at the site of production, and preferably used in fuel cells rather than burned to generate electricity. Our plan further stated that the use of biogas as biogas was to be preferred to processing it into RNG. There are two reasons for this: 1) it takes energy to process biogas into RNG, and so this is inherently inefficient and increases greenhouse gas emissions; and 2) the latest peer-reviewed science shows that methane emissions from processing biogas into RNG can be substantial, as shown in a review paper published last year (see: [Bakkaloglu, Cooper, and Hawkes. 2022. Methane emissions along biomethane and biogas supply chains are underestimated. *One Earth* 5: 724-736, doi:10.1016/j.oneear.2022.05.012](#)). Converting biogas into renewable natural gas is wasteful and further contributes to greenhouse gas emissions, with no benefit other than to allow the gas to be pumped into the traditional fossil gas distribution systems.

Please let me note that Vermont Gas Systems currently has contracted to buy RNG from the Seneca Meadows Landfill in central-western New York State, with an expectation of a significant increase in purchase in coming years. This gas is not actually delivered to Vermont, nor will it ever be: rather, the gas enters a general pipeline system moving gas to the west, away from Vermont. Vermont Gas Systems apparently gets financial credits for this scheme through trading mechanisms established by the California Air Resources Board (CARB). The CARB's policy on RNG is based on old, out-of-date science. They simply are wrong that there is any greenhouse-gas benefit from using RNG, and in fact the use of RNG may lead to greenhouse gas emissions that exceed those from using fossil natural gas. The State of New York will now be discouraging the production of RNG such as that from Seneca Meadows Landfill, based on the Climate Action Council's final Scoping Plan. I respectfully ask that the State of Vermont not encourage a policy that runs counter to the policy of New York, and do so based just on paper credits without even any actual delivery of any RNG to Vermont. California started a bad policy in this area, and one that we in New York hope to reverse at least within our State. This issue is close to my heart, as I live only 40 miles from the Seneca Meadows Landfill, the largest active landfill still active in New York, and an environmental travesty with a height of 28 feet over 400 acres. I hate to think that Vermont citizens who buy gas from Vermont Gas Systems will continue to contribute to our environmental problems in the Finger Lakes of New York.

Second, let me address hydrogen. I am pleased to see that Vermont is apparently not favoring any hydrogen made from fossil natural gas, even if with carbon capture. In 2021 I published the first peer-reviewed analysis showing why that is a bad idea for climate when methane emissions are considered (see: [Howarth and Jacobson. 2021. How green is blue hydrogen? *Energy Science and Engineering* 9: 1676-1687, doi: 10.1002/ese3.956](#)).

The "clean heat credit" being considered in this bill by Vermont is for green hydrogen, that is hydrogen made from 100% renewable electricity using electrolysis to break water into hydrogen and oxygen. Green hydrogen has a far lower greenhouse gas impact than does the hydrogen made from fossil fuels, but it is still significant: hydrogen gas is the smallest molecule in the Universe, and as such is very hard to retain and keep from leaking. And while hydrogen is not itself a greenhouse gas, when more hydrogen is leaked to the atmosphere it does significantly increase global warming through prolonging the time methane stays in the atmosphere and adding more water vapor to the stratosphere (See: [Ocko and Hamburg. 2022. Climate consequences of hydrogen emissions. *Environmental Science & Technology* 22: 9349-9368, doi.org/10.5194/acp-22-9349-2022](#)).

In addition to the role of hydrogen as an agent of global warming, there are many reasons not to put hydrogen into gas pipeline systems and use hydrogen for heating homes and commercial buildings. These are summarized in the table below which I produced for the New York State Climate Action

Council in my final statement accompanied my “yes” vote for our the Scoping Plan we adopted on December 19, 2022. That full statement is appended at the end of my testimony below and includes detailed referencing to support the table. These reasons against hydrogen include safety concerns, greenhouse gas emissions, inefficiencies, and high costs to consumers. With regard to safety, there is widespread recognition that most current pipelines designed and built to deliver fossil natural gas are simply not suitable for carrying hydrogen except at very low blends with the fossil gas. Exactly what level of blending is safe remains unknown, but based on a study they commissioned from the University of California at Riverside, the California PUC recommends that no more than 5% hydrogen be blended with 95% fossil natural gas (see: [Pearl. 2022. Hydrogen blends higher than 5% raise leak, embrittlement risks for natural gas pipelines: California PUC. Utility Dive, https://www.utilitydive.com/news/hydrogen-blends-higher-than-5-percent-raise-leak-embrittlement-risks/627895/](#)). With regard to inefficiencies, green hydrogen should be viewed as a precious and expensive resource made from renewable electricity, and using the electricity directly to heat homes with high-efficiency heat pumps generates 6 to 10 times more heat than does the green hydrogen can produce.

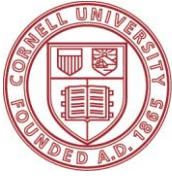
Concerns with Blending Hydrogen into Gas Pipelines that Serve Homes & Apartments

- Hydrogen is very leaky, much more so than methane, and hydrogen leakage from pipelines will contribute to global warming.
- Only small quantities of hydrogen can be blended with fossil gas in distribution pipelines, since hydrogen makes pipelines more brittle, potentially increasing methane emissions and leading to greater catastrophic risk.
- Most existing gas appliances in homes and apartments (furnaces, cooking stoves, water heaters, dryers) are not designed to burn hydrogen-methane blends, and increasing the hydrogen content can decrease the efficiency of combustion and lead to increased air pollution, particularly of nitrogen oxides.
- Most engineering studies indicate greatly increased risk of mixing more than 20% hydrogen into fossil gas systems, and the California Air Resources Board has concluded that no more than 5% hydrogen should be blended until further study shows higher amounts are sufficiently safe.
- The energy density of hydrogen is far less than for methane, so blending 20% hydrogen into a fossil-fuel distribution pipeline reduces the combustion emissions of carbon dioxide by only 7%.
- Hydrogen is significantly more expensive than fossil gas, and so blending any hydrogen into the distribution system increases costs.
- Using renewable electricity to produce green hydrogen which is then used to heat homes and apartments diverts this electricity from more efficient uses, such as using heat pumps. For the same quantity of electricity, a heat pump can deliver 6 to 10 times more heat in a home than could burning green hydrogen.
- Inefficient uses of renewable electricity drive up costs and slow the transition from fossil fuels, since renewable electricity will remain a relatively scarce and precious commodity for the next few decades.

Of note, all independent studies have argued against using hydrogen for home heating, including peer-reviewed papers as well as reports from the International Energy Agency and the UN’s Intergovernmental Panel on Climate Change (see: [Rosenow. 2022. Is heating hydrogen with homes all](#)

[but a pipe dream? An evidence review. Joule. doi :10.1016/j.joule.2022.08.015](https://doi.org/10.1016/j.joule.2022.08.015)). This includes 33 different studies as of today. Only studies funded by or carried out on behalf of industry groups with a vested interest in promoting hydrogen have ever suggested the use of hydrogen for heating. Based on this science, the New York State Climate Action Council strongly recommended against delivery of green hydrogen through the gas pipeline system to heat homes in our final Scoping Plan (see Chapter 18, <https://climate.ny.gov/resources/scoping-plan/>).

In conclusion, I urge the State of Vermont to not promote issue “clean heat credits” that would promote the use of renewable natural gas and hydrogen for home heating and use in gas delivery systems.



Cornell University

Department of Ecology and Evolutionary Biology

Statement of
Robert W. Howarth, Ph.D.

The David R. Atkinson Professor of Ecology & Environmental Biology
Cornell University

and

Member of the New York Climate Action Council

by appointment of the Honorable Carl Heastie, Speaker of the Assembly

December 19, 2022

I fully support the Scoping Plan enacted today by the Climate Action Council, and I am honored and proud to have served on the Climate Action Council since its inception. I thank Speaker Carl Heastie and other members of the Assembly for this opportunity to have served. In my comments that follow, I speak as a member of the Council and as an Earth systems scientist and faculty member at Cornell University who has worked for over 40 years on issues of global change. My comments should not be construed as official positions taken by my employer, Cornell University.

Assembly Person Steven Englebright was hugely instrumental in the passage of the Climate Leadership & Community Protection Act that established the Climate Action Council. I thank him for his leadership on this, and particularly for his support of the progressive approach on greenhouse gas emissions that is a central part of the CLCPA. I originally proposed this to Assembly Person Englebright in 2016, and he enthusiastically endorsed and supported it through multiple versions of the bill that finally led to passage of the CLCPA in 2019. In this accounting for greenhouse gases, a major government for the first time ever fully endorsed the science demonstrating that methane emissions are a major contributor to global climate change and disruption. Further, in passing the CLCPA New York recognized that consumption of fossil fuels (and not simply geographic boundaries) is what matters in addressing the climate crisis. New York wisely banned the use of high-volume hydraulic fracturing ("fracking") to develop shale gas in our State. But since the time of that ban, the use of fossil natural gas has risen faster in our State than any other in the Union. Methane emissions from this use of shale gas are high, but much of that occurs outside of our boundaries in the nearby states of Pennsylvania, West Virginia, and Ohio. Through the CLCPA, the citizens of New York are taking responsibility for these out-of-state emission caused by our use of fossil fuels, particularly for fossil natural gas. The way to reduce these emissions is to rapidly reduce our use of fracked shale gas.

The Assembly and Senate specified in the CLCPA that many of the agency heads of New York's government be members of the Climate Actions Council, and also stated that the Council take input from a set of advisory panels. Both of these requirements led to the leadership of the State being heavily engaged and invested in the implementation of the CLCPA. And the panels brought in a large number of experts and key stakeholders who worked diligently to advise the Council on our Scoping Plan. The Plan benefitted immensely from their efforts and input, and all New Yorkers owe them our thanks.

In the well over one hundred meetings of the Council, advisory panels, and working groups since March of 2020, all viewpoints have been respectfully heard and debated. The tone set by our co-Chairs,

NYSERDA President Doreen Harris and DEC Commissioner Basil Seggos was a critical part of this. I thank them and all of the members of the Council for our sense of community through deliberations in which we often had major differences of opinion. I also thank the staff who contributed so much to the background information provided to the Council and to the drafting of our final report. A large number of individuals participated and contributed in major ways, but I want to particularly thank and acknowledge our Council Executive Director Sarah Osgood, Maureen Leddy and Jared Snyder from DEC, Carl Mas from NYSERDA, and Jessica Waldorf of DPS.

I further wish to acknowledge the incredible role that Prof. Mark Jacobson of Stanford has played in moving the entire world towards a carbon-free future, including New York State. A decade ago, Jacobson, I and others laid out a specific plan for New York (Jacobson et al. 2013). In that peer-reviewed analysis, we demonstrated that our State could rapidly move away from fossil fuels and instead be fueled completely by the power of the wind, the sun, and hydro. We further demonstrated that it could be done completely with technologies available at that time (a decade ago), that it could be cost effective, that it would be hugely beneficial for public health and energy security, and that it would stimulate a large increase in well-paying jobs. I have seen nothing in the past decade that would dissuade me from pushing for the same path forward. The economic arguments have only grown stronger, the climate crisis more severe. The fundamental arguments remain the same.

Our final Scoping Plan from the Climate Action implicitly endorses the vision of the Jacobson et al. paper and is quite clear: we can meet the goals of the CLCPA and we can and will do so in way that is affordable and that will benefit all New Yorkers. Our State will be stronger as this plan is implemented, the health and well being of our citizens improved. Economic uncertainties and vulnerabilities will be reduced. Energy security will be enhanced. Our plan is also clear that the #1 priorities are to continue to move towards wind, solar, and hydro as our source of electricity; to move rapidly towards beneficial electrification as a source of heating and cooling in our homes and commercial buildings; and to move rapidly towards beneficial electrification in our personal and commercial vehicles.

Although I strongly support our final Scoping Plan, I have some disappointments. Chief among these is the decision to postpone the dates by which the State will move away from fossil fuel use for construction of new homes and commercial buildings, which are now one year later than in our draft plan passed in December 2021. For single family homes, for example, our final Scoping Plan calls for the prohibition of fossil fuels in new construction in 2025, not the 2024 specified in the draft plan. The building sector is the largest single source of greenhouse gas emissions, as I discuss further in the next paragraph below. Therefore, the greatest priority for meeting the goals of the CLCPA should be to reduce emissions from the building sector. I urge the Assembly and Senate to act to mandate that the State move away from fossil fuels more quickly than called for in the Council's Scoping Plan., using the guidance from the December 2021 draft Scoping Plan.

Exactly how important are emissions from the building sector in New York State? The Scoping Plan states this sector is the single largest emitter, accounting for 32% of the total (closely trailed by transportation at 28%). However, I believe the Plan understates the importance of the building-sector emissions for two reasons. First, methane emissions from the operations of the fossil natural gas industry in New York are included as part of the "industry" sector in the Scoping Plan, whereas they should have been included in the building and electric sectors according to the accounting specified in the CLCPA (these emissions would not occur if the fossil natural gas were not being used in our buildings and electric power plants). Making this correction, the building sector is seen to contribute 36% of all emissions, followed by 28% for transportation, 14% for electricity, 12% for waste, 6% for agriculture, and only 4% for industry. Second, the greenhouse gas inventory for the State released by the DEC in December 2021 understates methane emissions from the use of fossil natural gas, in my professional

opinion, using an emission factor of 2.49% of gas production. The preponderance of peer-reviewed literature reviewed in my recent paper suggests the factor should be 4.8% (Howarth 2022), a value that is 1.9-times greater than that used by the DEC. Correcting by this factor, I estimate that the building sector is responsible for more than 40% of all greenhouse gas emissions in New York State.

The Scoping Plan strongly calls for beneficial electrification with heat pumps as the best way forward to reduce greenhouse gas emissions from the building sector in New York. I completely agree, but I feel the Plan could have made an even stronger case by including several recent papers and reports. Further, the Plan tends to favor air-sourced heat pumps over ground-sources heat pumps. While the initial cost of the air-sourced pumps is less, they have higher energy and maintenance costs. One recent study examining heat pumps for new home construction in the context of New York State concluded that ground-sourced heat pumps are actually less expensive when these energy and maintenance costs are included (Shron et al. 2022). This was true across the State, in both the coldest and warmest regions. The study also concluded that both air-sourced and ground-sourced heat pumps are almost always less expensive than building new homes heated by fossil natural gas or propane, although air-sourced heat pumps cannot quite out compete fossil natural gas (at average prices over the past decade) in the warmest part of the State, Long Island, according to this report. However, the Long Island Power Authority (2022) has produced a brochure arguing that air-sourced pumps are cost effective for new homes over fossil natural gas on Long Island. And of course the cost of fossil natural gas has increased dramatically since these studies were produced, and may well stay high indefinitely into the future according to many energy economists. If so, anyone building a new home in 2023 or 2024 using natural gas for heating will soon wish they had instead built a fossil-fuel-free home with heat pumps. Further, these costs are from the perspective of the new home owner. I have repeatedly urged in meetings of the Climate Action Council over the past 18 months that we consider the entire energy system when considering the question of heat pumps: ground-sourced heat pumps require far less electricity during peak winter heating times, meaning that encouraging their use over air-sourced pumps lessens the need for electricity storage and for total renewable generating capacity, which could benefit consumers immensely.

As a Council, we spent a disproportionate amount of time in debating what I believe are side issues such as renewable natural gas (RNG) and hydrogen for heating of homes. The oil & gas industry globally has pushed such ideas very heavily as a way to keep their massive fossil-gas pipelines system profitably in operation (Lowes and Cebon 2022). At the Climate Action Council, we have regularly heard suggestions that pipelines in the future can deliver hydrogen and RNG. I and others on the Council have pushed back with objective, scientifically based evidence. In the end, the Council fully rejected the use of hydrogen for heating homes, and somewhat put aside the issue of RNG saying it needed further study. I am pleased to say that RNG is not mentioned at all in the Executive Summary of the Scoping Plan, and hydrogen is mentioned only once, in this case appropriately in the context of its use with fuel cells (not combustion) in transportation (not home heating or use in pipelines).

While the Scoping Plan does not endorse the use of hydrogen for heating or in pipelines, it also does not fully explain the reasons for this decision. And in some places in the text, there is a suggestion for more research on hydrogen. In fact, there is a large amount of information that clearly demonstrates why hydrogen for delivery to homes for heating is a bad idea (Kurmayer 2021; Rosenow 2022; Pearl 2022; Prieto and Henchen 2022; Collins 2022; Lowes and Cebon 2022). There simply is no need for further research on this bad idea. Some of the major reasons for rejecting the use of hydrogen for heating for homes are outlined in the following table.

Concerns with Blending Hydrogen into Gas Pipelines that Serve Homes & Apartments

- Hydrogen is very leaky, much more so than methane, and hydrogen leakage from pipelines will contribute to global warming.
- Only small quantities of hydrogen can be blended with fossil gas in distribution pipelines, since hydrogen makes pipelines more brittle, potentially increasing methane emissions and leading to greater catastrophic risk.
- Most existing gas appliances in homes and apartments (furnaces, cooking stoves, water heaters, dryers) are not designed to burn hydrogen-methane blends, and increasing the hydrogen content can decrease the efficiency of combustion and lead to increased air pollution, particularly of nitrogen oxides.
- Most engineering studies indicate greatly increased risk of mixing more than 20% hydrogen into fossil gas systems, and the California Air Resources Board has concluded that no more than 5% hydrogen should be blended until further study shows higher amounts are sufficiently safe.
- The energy density of hydrogen is far less than for methane, so blending 20% hydrogen into a fossil-fuel distribution pipeline reduces the combustion emissions of carbon dioxide by only 7%.
- Hydrogen is significantly more expensive than fossil gas, and so blending any hydrogen into the distribution system increases costs.
- Using renewable electricity to produce green hydrogen which is then used to heat homes and apartments diverts this electricity from more efficient uses, such as using heat pumps. For the same quantity of electricity, a heat pump can deliver 6 to 10 times more heat in a home than could burning green hydrogen.
- Inefficient uses of renewable electricity drive up costs and slow the transition from fossil fuels, since renewable electricity will remain a relatively scarce and precious commodity for the next few decades.

As with hydrogen, the Scoping Plan does not endorse any widespread use of RNG. In fact, the Plan specifies that it is generally preferable to use biogas (the unrefined mixture of methane and carbon dioxide produced in anaerobic digesters and landfills) directly and at the site of production rather than refining the biogas to produce RNG. However, the Plan does not fully explain the strong science behind this conclusion. Briefly, it takes energy to refine RNG, and this comes either from fossil natural gas with the associated greenhouse gas emissions or from using some of the biogas to power the refining (resulting in a loss of some useful energy, and a lower overall efficiency of using the energy of the biogas). Further, biogas itself can have substantial methane emissions, and the refining of biogas into RNG can substantially increase these methane emissions (Bakkaloglu et al. 2022). In a memorandum I wrote to the Alternative Fuels Working Group of the Climate Action Council in July 2022, I calculated that using the CLCPA accounting methodology and mean emissions from the Bakkaloglu et al. study, methane emissions for RNG are 156 g CO₂-equivalents/MJ, or 1.7-times greater than the combined methane and carbon dioxide emissions for fossil natural gas. Unless these methane emissions can be greatly reduced, New York should clearly discourage the use of RNG.

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Emission Factors for Greenhouse Gas Inventories

Last Modified: 4 April 2014

Red text indicates an update from the 2011 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO₂e). Gases are converted to CO₂e by multiplying by their global warming potential (GWP). The emission factors listed in this document have not been converted to CO₂e. To do so, multiply the emissions by the corresponding GWP listed in the table below.

Gas	100-year GWP
CH ₄	25
N ₂ O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. See the source note to Table 9 for further explanation.

Table 1 Stationary Combustion Emission Factors

Fuel Type	Heating Value mmBtu per short ton	CO ₂ Factor kg CO ₂ per mmBtu	CH ₄ Factor g CH ₄ per mmBtu	N ₂ O Factor g N ₂ O per mmBtu	CO ₂ Factor kg CO ₂ per short ton	CH ₄ Factor g CH ₄ per short ton	N ₂ O Factor g N ₂ O per short ton	Unit
Coal and Coke								
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40	short tons
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40	short tons
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28	short tons
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23	short tons
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34	short tons
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32	short tons
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42	short tons
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36	short tons
Coal Coke	24.80	113.67	11	1.6	2,819	273	40	short tons
Fossil Fuel-derived Fuels (Solid)								
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42	short tons
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126	short tons
Plastics	38.00	75.00	32	4.2	2,850	1,216	160	short tons
Tires	28.00	85.97	32	4.2	2,407	896	118	short tons
Biomass Fuels (Solid)								
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35	short tons
Peat	8.00	111.84	32	4.2	895	256	34	short tons
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44	short tons
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63	short tons
	mmBtu per scf	kg CO ₂ per mmBtu	g CH ₄ per mmBtu	g N ₂ O per mmBtu	kg CO ₂ per scf	g CH ₄ per scf	g N ₂ O per scf	
Natural Gas								
Natural Gas (per scf)	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010	scf
Fossil-derived Fuels (Gaseous)								
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.000002	0.000009	scf
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.000060	scf
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833	scf
Propane Gas	0.002516	61.46	0.022	0.10	0.15463	0.000055	0.000252	scf
Biomass Fuels (Gaseous)								
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306	scf
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000413	scf
	mmBtu per gallon	kg CO ₂ per mmBtu	g CH ₄ per mmBtu	g N ₂ O per mmBtu	kg CO ₂ per gallon	g CH ₄ per gallon	g N ₂ O per gallon	
Petroleum Products								
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09	gallon
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07	gallon
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06	gallon
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06	gallon
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08	gallon
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08	gallon
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08	gallon
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09	gallon
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04	gallon
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03	gallon
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09	gallon
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06	gallon
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06	gallon
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08	gallon
Kerosene-type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08	gallon
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06	gallon
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09	gallon
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08	gallon
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08	gallon
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07	gallon
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08	gallon
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07	gallon
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08	gallon
Petroleum Coke	0.143	102.41	3.0	0.60	14.64	0.43	0.09	gallon
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05	gallon
Propylene	0.091	65.95	3.0	0.60	6.00	0.27	0.05	gallon
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08	gallon
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09	gallon
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08	gallon
Still Gas	0.143	66.72	3.0	0.60	9.54	0.43	0.09	gallon
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08	gallon
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08	gallon
Biomass Fuels (Liquid)								
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01	gallon
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01	gallon
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.88	0.14	0.01	gallon
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01	gallon
	mmBtu per gallon	kg CO ₂ per mmBtu	g CH ₄ per mmBtu	g N ₂ O per mmBtu				
Steam and Hot Water								
Steam and Hot Water		66.33	1.250	0.125				mmBtu

Source:

Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA: 40 CFR Parts 86, 87, 89 et al. *Mandatory Reporting of Greenhouse Gases; Final Rule*, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA: 40 CFR Part 98, *Mandatory Reporting of Greenhouse Gases; Final Rule*, 17Dec10, 81 pp. With Amendments from Memo: Table of Final 2013 Revisions to the Greenhouse Gas Reporting Rule (PDF) to 40 CFR part 98, Subpart C. Table C-1 to Subpart C—Default CO₂ Emission Factors and High Heat Values for Various Types of Fuel and Table C-2 to Subpart C—Default CH₄ and N₂O Emission Factors for Various Types of Fuel.

Steam and Hot Water: EPA (2009) *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance - Indirect Emissions from Purchases/Sales of Electricity and Steam*. Assumption: 80% boiler efficiency and fuel type assumed natural gas. Factors are per mmBtu of steam or hot water purchased.

<http://www.epa.gov/ghgreporting/documents/pdf/2013documents/memo-2013-technical-revisions.pdf>

<http://www.epa.gov/ghgreporting/reporters/subpart/c.html>

Table 2 Mobile Combustion CO₂ Emission Factors

Fuel Type	kg CO ₂ per unit	Unit
Aviation Gasoline	8.31	gallon
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.0545	scf
Diesel Fuel	10.21	gallon
Ethane	4.05	gallon
Ethanol (100%)	5.75	gallon
Jet Fuel (kerosene type)	9.75	gallon
Liquefied Natural Gas (LNG)	4.46	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Methanol	4.10	gallon
Motor Gasoline	8.78	gallon
Propane	5.72	gallon
Residual Fuel Oil	11.27	gallon

Source:

Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2. Table of Final 2013 Revisions to the Greenhouse Gas
LNG sourced from: EPA (2008) Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance - Direct Emissions from Mobile Combustion Sources, Table B-5.
Methanol sourced from: The Climate Registry (2013). General Reporting Protocol for the Voluntary Reporting Program Version 2.0, Default Emission Factors, Table 13.1 US Default CO₂ Emission Factors for Transport Fuels.

Table 3 Mobile Combustion CH₄ and N₂O Emission Factors for On-road Gasoline Vehicles

Vehicle Type	Year	CH ₄ Factor (g / mile)	N ₂ O Factor (g / mile)
Gasoline Passenger Cars	1973-74	0.1696	0.0197
	1975	0.1423	0.0443
	1976-77	0.1406	0.0458
	1978-79	0.1389	0.0473
	1980	0.1326	0.0499
	1981	0.0802	0.0626
	1982	0.0795	0.0627
	1983	0.0782	0.0630
	1984-93	0.0704	0.0647
	1994	0.0531	0.0560
	1995	0.0358	0.0473
	1996	0.0272	0.0426
	1997	0.0268	0.0422
	1998	0.0249	0.0393
	1999	0.0216	0.0337
	2000	0.0178	0.0273
	2001	0.0110	0.0158
	2002	0.0107	0.0153
	2003	0.0114	0.0135
	2004	0.0145	0.0083
	2005	0.0147	0.0079
	2006	0.0161	0.0057
	2007	0.0170	0.0041
	2008	0.0172	0.0038
	2009-present	0.0173	0.0036
Gasoline Light-duty Trucks (Vans, Pickup Trucks, SUVs)	1973-74	0.1908	0.0218
	1975	0.1634	0.0513
	1976	0.1594	0.0555
	1977-78	0.1614	0.0534
	1979-80	0.1594	0.0555
	1981	0.1479	0.0660
	1982	0.1442	0.0681
	1983	0.1368	0.0722
	1984	0.1294	0.0764
	1985	0.1220	0.0806
	1986	0.1146	0.0848
	1987-93	0.0813	0.1035
	1994	0.0646	0.0982
	1995	0.0517	0.0908
	1996	0.0452	0.0871
	1997	0.0452	0.0871
	1998	0.0391	0.0728
	1999	0.0321	0.0564
	2000	0.0346	0.0621
	2001	0.0151	0.0164
	2002	0.0178	0.0228
	2003	0.0155	0.0114
	2004	0.0152	0.0132
	2005	0.0157	0.0101
	2006	0.0159	0.0089
	2007	0.0161	0.0079
	2008-present	0.0163	0.0066
Gasoline Heavy-duty Vehicles	<1981	0.4604	0.0497
	1982-84	0.4492	0.0538
	1985-86	0.4090	0.0515
	1987	0.3675	0.0849
	1988-1989	0.3492	0.0933
	1990-1995	0.3246	0.1142
	1996	0.1278	0.1680
	1997	0.0924	0.1726
	1998	0.0641	0.1693
	1999	0.0578	0.1435
	2000	0.0493	0.1092
	2001	0.0528	0.1235
	2002	0.0546	0.1307
	2003	0.0533	0.1240
	2004	0.0341	0.0285
	2005	0.0326	0.0177
	2006	0.0327	0.0171
	2007	0.0330	0.0153
	2008-present	0.0333	0.0134

Source: EPA (2014) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. All values are calculated from Tables A-101 through A-105.

Table 4 Mobile Combustion CH₄ and N₂O Emission Factors for On-road Diesel and Alternative Fuel Vehicles

Vehicle Type	Vehicle Year	CH ₄ Factor (g / mile)	N ₂ O Factor (g / mile)
Diesel Passenger Cars	1960-1982	0.0006	0.0012
	1983-1995	0.0005	0.0010
	1996-present	0.0005	0.0010
Diesel Light-duty Trucks	1960-1982	0.0011	0.0017
	1983-1995	0.0009	0.0014
	1996-present	0.0010	0.0015
Diesel Medium- and Heavy-duty Vehicles	1960-present	0.0051	0.0048
	1960-1995	0.0899	0.0087
Gasoline Motorcycles	1996-present	0.0672	0.0069
CNG Light-duty Vehicles		0.7370	0.0500
CNG Heavy-duty Vehicles		1.9660	0.1750
CNG Buses		1.9660	0.1750
LPG Light-duty Vehicles		0.0370	0.0670
LPG Heavy-duty Vehicles		0.0660	0.1750
LNG Heavy-duty Vehicles		1.9660	0.1750
Ethanol Light-duty Vehicles		0.0550	0.0670
Ethanol Heavy-duty Vehicles		0.1970	0.1750
Ethanol Buses		0.1970	0.1750

Source: EPA (2014) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. All values are calculated from Tables A-104 through A-106.

Table 5 Mobile Combustion CH₄ and N₂O Emission Factors for Non-road Vehicles

Vehicle Type	CH ₄ Factor (g / gallon)	N ₂ O Factor (g / gallon)
LPG Non-Highway Vehicles	0.50	0.22
Residual Oil Ships and Boats	0.11	0.57
Diesel Ships and Boats	0.06	0.45
Gasoline Ships and Boats	0.64	0.22
Diesel Locomotives	0.80	0.26
Gasoline Agricultural Equip.	1.26	0.22
Diesel Agricultural Equip.	1.44	0.26
Gasoline Construction Equip.	0.50	0.22
Diesel Construction Equip.	0.57	0.26
Jet Fuel Aircraft	0.00	0.30
Aviation Gasoline Aircraft	7.06	0.11
Biodiesel Vehicles	0.57	0.26
Other Diesel Sources	0.57	0.26
Other Gasoline Sources	0.50	0.22

Source: EPA (2014) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. All values are calculated from Table A-107.
Note: LPG non-highway vehicles assumed equal to other gasoline sources. Biodiesel vehicles assumed equal to other diesel sources.

Table 6 Electricity Emission Factors

eGRID Subregion	Total output emission factors			Non-baseload emission factors		
	CO ₂ Factor (lb CO ₂ /MWh)	CH ₄ Factor (lb CH ₄ /MWh)	N ₂ O Factor (lb N ₂ O/MWh)	CO ₂ Factor (lb CO ₂ /MWh)	CH ₄ Factor (lb CH ₄ /MWh)	N ₂ O Factor (lb N ₂ O/MWh)
AKGD (ASCC Alaska Grid)	1,256.87	0.02608	0.00718	1,387.37	0.03405	0.00693
AKMS (ASCC Miscellaneous)	448.57	0.01874	0.00368	1,427.76	0.05997	0.01180
AZNM (WECC Southwest)	1,177.61	0.01921	0.01572	1,210.44	0.02188	0.00986
CAMX (WECC California)	610.82	0.02849	0.00603	932.82	0.03591	0.00455
ERCT (ERCOT All)	1,218.17	0.01685	0.01407	1,181.70	0.02012	0.00763
FRCC (FRCC All)	1,196.71	0.03891	0.01375	1,277.42	0.03873	0.01083
HIMS (HICC Miscellaneous)	1,330.16	0.07398	0.01388	1,690.72	0.10405	0.01912
HIOA (HICC Oahu)	1,621.86	0.09930	0.02241	1,588.23	0.11948	0.02010
MROE (MRO East)	1,610.80	0.02429	0.02752	1,755.66	0.03153	0.02799
MROW (MRO West)	1,536.36	0.02853	0.02629	2,054.55	0.05986	0.03553
NEWB (NPCC New England)	722.07	0.07176	0.01298	1,106.82	0.06155	0.01207
NWPP (WECC Northwest)	842.58	0.01605	0.01307	1,340.34	0.04138	0.01784
NYCW (NPCC NYC/Westchester)	622.42	0.02381	0.00280	1,131.63	0.02358	0.00244
NYLI (NPCC Long Island)	1,336.11	0.08149	0.01028	1,445.94	0.03403	0.00391
NYUP (NPCC Upstate NY)	545.79	0.01630	0.00724	1,253.77	0.03683	0.01367
RFCE (RFC East)	1,001.72	0.02707	0.01533	1,562.72	0.03593	0.02002
RFCM (RFC Michigan)	1,629.38	0.03046	0.02684	1,744.52	0.03231	0.02600
RFCW (RFC West)	1,503.47	0.01820	0.02475	1,982.87	0.02450	0.03107
RMPA (WECC Rockies)	1,896.74	0.02266	0.02921	1,808.03	0.02456	0.02289
SPNO (SPP North)	1,799.45	0.02081	0.02862	1,951.83	0.02515	0.02690
SPSO (SPP South)	1,580.60	0.02320	0.02085	1,436.29	0.02794	0.01210
SRMV (SERC Mississippi Valley)	1,029.82	0.02066	0.01076	1,222.40	0.02771	0.00663
SRMW (SERC Midwest)	1,810.83	0.02048	0.02957	1,964.98	0.02393	0.02965
SRSO (SERC South)	1,354.09	0.02282	0.02089	1,574.37	0.02652	0.02149
SRTV (SERC Tennessee Valley)	1,389.20	0.01770	0.02241	1,873.83	0.02499	0.02888
SRVC (SERC Virginia/Carolina)	1,073.65	0.02169	0.01764	1,624.71	0.03642	0.02306
US Average	1,232.35	0.02414	0.01826	1,520.20	0.03127	0.01834

Source: EPA Year 2010 eGRID 9th edition Version 1.0 February 2014.

Note: Total output emission factors are used for quantifying emissions from purchased electricity. Non-baseload emission factors are used for quantifying the emission reductions from purchased green power.



This is a representational map; many of the boundaries shown on this map are approximate because they are based on companies, not on strictly geographical boundaries.

Source: EPA Year 2010 eGRID 9th edition Version 1.0 February 2014.

Table 7 Business Travel Emission Factors

Vehicle Type	CO ₂ Factor (kg / unit)	CH ₄ Factor (g / unit)	N ₂ O Factor (g / unit)	Units
Passenger Car ^A	0.368	0.018	0.013	vehicle-mile
Light-duty Truck ^B	0.501	0.024	0.019	vehicle-mile
Motorcycle	0.197	0.070	0.007	vehicle-mile
Intercity Rail (i.e. Amtrak) ^C	0.144	0.0085	0.0032	passenger-mile
Commuter Rail ^D	0.174	0.0084	0.0035	passenger-mile
Transit Rail (i.e. Subway, Tram) ^E	0.133	0.0026	0.0020	passenger-mile
Bus	0.058	0.0007	0.0004	passenger-mile
Air Travel - Short Haul (< 300 miles)	0.275	0.0091	0.0087	passenger-mile
Air Travel - Medium Haul (>= 300 miles, < 2300 miles)	0.162	0.0008	0.0052	passenger-mile
Air Travel - Long Haul (>= 2300 miles)	0.191	0.0008	0.0060	passenger-mile

Source:
CO₂, CH₄, and N₂O emissions data for highway vehicles are from Table 2-15 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012. Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2012.
Fuel consumption data and passenger-miles data for rail are from Tables A.14 to A.16 and 9.10 to 9.12 of the Transportation Energy Data Book: Edition 32. Fuel consumption was converted to emissions by using fuel and electricity emission factors presented in the tables above.

Notes:

^A Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

^B Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

^C Intercity rail: long-distance rail between major cities, such as Amtrak

^D Commuter rail: rail service between a central city and adjacent suburbs (also called regional rail or suburban rail)

^E Transit rail: rail typically within an urban center, such as subways, elevated railways, metropolitan railways (metro), streetcars, trolley cars, and tramways.

Table 8 Product Transport Emission Factors

Vehicle Type	CO ₂ Factor (kg / unit)	CH ₄ Factor (g / unit)	N ₂ O Factor (g / unit)	Units
Medium- and Heavy-duty Truck	1.456	0.018	0.011	vehicle-mile
Passenger Car ^A	0.368	0.018	0.013	vehicle-mile
Light-duty Truck ^B	0.501	0.024	0.019	vehicle-mile
Medium- and Heavy-duty Truck	0.296	0.0036	0.0022	ton-mile
Rail	0.026	0.0020	0.0007	ton-mile
Waterborne Craft	0.042	0.0004	0.0027	ton-mile
Aircraft	1.301	0.0000	0.0400	ton-mile

Source:
CO₂, CH₄, and N₂O emissions data for highway vehicles are from Table 2-15 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012. Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2012.
CO₂e emissions data for non-highway vehicles are based on Table A-116 of the U.S. Greenhouse Gas Emissions and Sinks: 1990–2012, which are distributed into CO₂, CH₄, and N₂O emissions based on fuel/vehicle emission factors.
Freight ton-mile data for non-highway vehicles are from Table 1-50 of the Bureau of Transportation Statistics, National Transportation Statistics for 2012.

Notes:

Vehicle-mile factors are appropriate to use when the entire vehicle is dedicated to transporting the reporting company's product. Ton-mile factors are appropriate when the vehicle is shared with products from other companies.

^A Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

^B Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

Table 9 Global Warming Potentials (GWPs)

Gas	100-year GWP
CO ₂	1
CH ₄	25
N ₂ O	298
HFC-23	14,800
HFC-32	675
HFC-41	92
HFC-125	3,500
HFC-134	1,100
HFC-134a	1,430
HFC-143	353
HFC-143a	4,470
HFC-152	53
HFC-152a	124
HFC-161	12
HFC-227ea	3,220
HFC-236cb	1,340
HFC-236ea	1,370
HFC-236fa	9,810
HFC-245ca	693
HFC-245fa	1,030
HFC-365mfc	794
HFC-43-10mee	1,640
SF ₆	22,800
NF ₃	17,200
CF ₄	7,390
C ₂ F ₆	12,200
C ₃ F ₈	8,830
c-C ₄ F ₈	10,300
C ₃ F ₁₀	8,860
C ₃ F ₁₂	9,160
C ₃ F ₁₄	9,300
C ₁₀ F ₁₈	>7,500

Source:

100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. IPCC AR4 was published in 2007 and is among the most current and comprehensive peer-reviewed assessments of climate change. AR4 provides revised GWPs of several GHGs relative to the values provided in previous assessment reports, following advances in scientific knowledge on the radiative efficiencies and atmospheric lifetimes of these GHGs and of CO₂. Because the GWPs provided in AR4 reflect an improved scientific understanding of the radiative effects of these gases in the atmosphere, the values provided are more appropriate for supporting the overall goal of organizational GHG reporting than the Second Assessment Report (SAR) GWP values previously used in the Emission Factors Hub. While EPA recognizes that Fifth Assessment Report (AR5) GWPs have been published, in an effort to ensure consistency and comparability of GHG data between EPA's voluntary and non-voluntary GHG reporting programs (e.g. GHG Reporting Program and National Inventory), EPA recommends the use of AR4 GWPs. The United States and other developed countries to the UNFCCC have agreed to submit annual inventories in 2015 and future years to the UNFCCC using GWP values from AR4, which will replace the current use of SAR GWP values. Utilizing AR4 GWPs improves EPA's ability to analyze corporate, national, and sub-national GHG data consistently, enhances communication of GHG information between programs, and gives outside stakeholders a consistent, predictable set of GWPs to avoid confusion and additional burden.

Table 9b GWPs for Blended Refrigerants

ASHRAE #	100-year GWP	Blend Composition
R-401A	16	53% HCFC-22 , 34% HCFC-124 , 13% HFC-152a
R-401B	14	61% HCFC-22 , 28% HCFC-124 , 11% HFC-152a
R-401C	19	33% HCFC-22 , 52% HCFC-124 , 15% HFC-152a
R-402A	2,100	38% HCFC-22 , 6% HFC-125 , 2% propane
R-402B	1,330	6% HCFC-22 , 38% HFC-125 , 2% propane
R-403B	3,444	56% HCFC-22 , 39% PFC-218 , 5% propane
R-404A	3,922	44% HFC-125 , 4% HFC-134a , 52% HFC-143a
R-406A	0	55% HCFC-22 , 41% HCFC-142b , 4% isobutane
R-407A	2,107	20% HFC-32 , 40% HFC-125 , 40% HFC-134a
R-407B	2,804	10% HFC-32 , 70% HFC-125 , 20% HFC-134a
R-407C	1,774	23% HFC-32 , 25% HFC-125 , 52% HFC-134a
R-407D	1,627	15% HFC-32 , 15% HFC-125 , 70% HFC-134a
R-407E	1,552	25% HFC-32 , 15% HFC-125 , 60% HFC-134a
R-408A	2,301	47% HCFC-22 , 7% HFC-125 , 46% HFC-143a
R-409A	0	60% HCFC-22 , 25% HCFC-124 , 15% HCFC-142b
R-410A	2,088	50% HFC-32 , 50% HFC-125
R-410B	2,229	45% HFC-32 , 55% HFC-125
R-411A	14	87.5% HCFC-22 , 11% HFC-152a , 1.5% propylene
R-411B	4	94% HCFC-22 , 3% HFC-152a , 3% propylene
R-413A	2,053	88% HFC-134a , 9% PFC-218 , 3% isobutane
R-414A	0	51% HCFC-22 , 28.5% HCFC-124 , 16.5% HCFC-142b
R-414B	0	5% HCFC-22 , 39% HCFC-124 , 9.5% HCFC-142b
R-417A	2,346	46.6% HFC-125 , 5% HFC-134a , 3.4% butane
R-422A	3,143	85.1% HFC-125 , 11.5% HFC-134a , 3.4% isobutane
R-422D	2,729	65.1% HFC-125 , 31.5% HFC-134a , 3.4% isobutane
R-423A	2,280	47.5% HFC-227ea , 52.5% HFC-134a ,
R-244A	2,440	50.5% HFC-125 , 47% HFC-134a , 2.5% butane/pentane
R-426A	1,508	5.1% HFC-125 , 93% HFC-134a , 1.9% butane/pentane
R-428A	3,607	77.5% HFC-125 , 2% HFC-143a , 1.9% isobutane
R-434A	3,245	63.2% HFC-125 , 16% HFC-134a , 18% HFC-143a , 2.8% isobutane
R-500	32	73.8% CFC-12 , 26.2% HFC-152a , 48.8% HCFC-22
R-502	0	48.8% HCFC-22 , 51.2% CFC-115
R-504	325	48.2% HFC-32 , 51.8% CFC-115
R-507	3,985	5% HFC-125 , 5% HFC-143a
R-508A	13,214	39% HFC-23 , 61% PFC-116
R-508B	13,396	46% HFC-23 , 54% PFC-116

Source:

100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. See the source note to Table 9 for further explanation. GWPs of blended refrigerants are based on their HFC and PFC constituents, which are based on data from <http://www.epa.gov/ozzone/snap/refrigerants/refblend.html>.

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June 29, 2023

By Certified Mail, Return Receipt Requested and Email

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**Re: New Source Performance Standards for Residential Wood
Burning Heaters – Notice of Intent to Sue Pursuant to 42 U.S.C.
§ 7604(b)(2)**

Dear Administrator Regan,

The Attorneys General of New York, Alaska, Illinois, Maryland, Massachusetts, Minnesota, New Jersey, Oregon, Vermont, and Washington, and the Puget Sound Clean Air Agency (collectively, the States), provide notice of their intent to sue the United States Environmental Protection Agency (EPA) for failing to timely review and revise the New Source Performance Standards (performance standards) for Residential Wood Heaters (wood heaters) under the Clean Air Act (the Act). EPA must review the 2015 performance standards to determine if they are adequate to protect the public health. This letter provides 60-days' notice pursuant to section 304(a)(2), 42 U.S.C. § 7604(b)(2), of the Act of the States' intent to file a lawsuit for EPA's failure to perform a mandatory duty under the statute.

1. *Background*

Section 111(b)(1)(A) of the Act requires EPA to list categories of stationary sources that “cause, or contribute significantly to, air pollution which may reasonably be anticipated to endanger public health and welfare.”¹ EPA must review and, as appropriate, revise, the standards for stationary sources at least every eight years based on the best technological system of continuous emission reduction.²

¹ 42 U.S.C. § 7411(b)(1)(A).

² *Id.* § 7411(b)(1)(B).

In 1988, EPA issued the first emissions standards for particulate matter for new wood heaters.³ In 2013, New York, Connecticut, Maryland, Massachusetts, Oregon, Rhode Island, Vermont, and the Puget Sound Clean Air Agency sued EPA to update these standards. In 2014, the parties entered into a partial consent decree, in which EPA agreed to issue updated performance standards by dates certain.

On March 16, 2015, EPA issued a final rule with two sets of updated performance standards for wood heaters.⁴ That rule had an effective date of May 15, 2015, on which the first set of updated standards went into effect.⁵ The second, more stringent set of the 2015 standards, with lower levels of particulate matter emissions, went into effect on May 15, 2020.⁶

The same day that EPA issued the final performance standards, a wood heaters trade association challenged the rule in the D.C. Circuit.⁷ The association later limited its challenge to EPA's compliance audit testing provisions.⁸

In response, the states of New York, Alaska, Connecticut, Illinois, Maryland, Minnesota, New Jersey, Oregon, Rhode Island, Vermont, and Washington, and the Puget Sound Clean Air Agency filed an amicus brief in support of EPA.⁹ In that brief, amici described the negative health impacts of wood smoke on residents of amici states.¹⁰ Amici argued that the audit testing was necessary because, as determined by the Alaska Department of Environmental Conservation, the majority of certifications had inaccurate data and non-representative testing methods.¹¹ These errors allowed wood heaters to receive certifications without gaining the real benefits

³ 40 C.F.R. Part 60, Subpart AAA.

⁴ 80 Fed. Reg. 13,672 (Mar. 16, 2015).

⁵ *Id.* at 13,676.

⁶ *Id.* 13,680.

⁷ See Petition at 1, *Hearth, Patio & Barbecue Ass'n. v. EPA*, No. 15-1056, (D.C. Cir. Mar 16, 2015), ECF No. 1544461.

⁸ See Petitioner's Brief at 1, *Hearth, Patio & Barbecue Ass'n. v. EPA*, No. 15-1056, (D.C. Cir. June 25, 2020), ECF No. 1849004.

⁹ See Corrected Amicus Brief at 1, *Hearth, Patio & Barbecue Ass'n. v. EPA*, No. 15-1056, (D.C. Cir. Sept. 21, 2020), ECF No. 1862523.

¹⁰ *Id.* at 12–15.

¹¹ *Id.* at 21–23.

of stricter emissions limits. The D.C. Circuit upheld the regulations.¹² While knowing of these issues, EPA has failed to take steps to review and update its standards, despite the requirements of 42 U.S.C. § 7411(b)(1)(B).

2. *Public Health Hazards from Wood Smoke*

As EPA acknowledged in the 2015 performance standards, wood smoke contains fine particulate matter (PM_{2.5}), carbon monoxide, polycyclic aromatic hydrocarbons, and other toxic air pollutants.¹³ All of these compounds negatively impact public health.¹⁴

Of direct relevance to the performance standards, wood smoke contains PM_{2.5}, which causes an array of adverse health impacts. Acknowledging those harmful impacts, EPA recently proposed to strengthen the National Ambient Air Quality Standards (NAAQS) for PM_{2.5}.¹⁵ In doing so, EPA documented a causal relationship between PM_{2.5} exposure and mortality and cardiovascular effects.¹⁶ Multiple studies also confirm adverse health impacts of PM_{2.5} exposure, including on cancer rates,¹⁷ dementia rates,¹⁸ and childhood lung function.¹⁹

¹² *Hearth, Patio & Barbecue Ass'n v. EPA*, 11 F.4th 791, 796 (D.C. Cir. 2021).

¹³ 80 Fed. Reg. 13,672, 13,673 (Mar. 16, 2015).

¹⁴ Agency for Toxic Substances and Disease Registry, *Case Studies of Environmental Medicine, Toxicity of Polycyclic Aromatic Hydrocarbons (PAHs)* at 31, 34, 38 (July 1, 2009), available at: https://www.atsdr.cdc.gov/csem/polycyclic-aromatic-hydrocarbons/information_sources.html; Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Carbon Monoxide* at 10-20 (July 2012), available at: <https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=1145&tid=253>.

¹⁵ 88 Fed. Reg. 5,558 (Jan. 27, 2023).

¹⁶ 88 Fed. Reg. at 5,609.

¹⁷ William Hill, et al., *Lund Adenocarcinoma Promotion by Air Pollutants*, 616 *Nature* 159–167 (2023), available at: <https://www.nature.com/articles/s41586-023-05874-3>

¹⁸ Elissa Wilker, et al., *Ambient Air Pollution and Clinical Dementia: Systematic Review and Meta-Analysis*, 2023 *BMJ* 381 (2023), available at: <https://www.bmj.com/content/381/bmj-2022-071620>.

¹⁹ Hsiao-Hisen Hsu, et al., *Prenatal Ambient Air Pollutant Mixture Exposure and Early School-age Lung Function*, 2023 *Environmental Epidemiology* 7(2) (2023), available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10097575/>.

Further, PM_{2.5} exposure is particularly harmful to environmental justice communities.²⁰ As the 2015 Rule acknowledged, “[r]esidential wood smoke can contribute to unhealthy levels of PM_{2.5} in many neighborhoods nationwide, including in minority and low-income neighborhoods[.]”²¹ Environmental justice communities are exposed to higher levels of air pollution,²² and may be more susceptible to its ill effects.²³ Congress mandated that EPA review, and as necessary, revise the standards every eight years to ensure that these communities do not have to bear the pollution burden of ineffective standards.²⁴

3. *EPA’s Ineffective Wood Heater Testing and Certification Program*

In addition to failing to timely review and update the performance standards for PM_{2.5}, EPA’s wood heater testing and certification program to implement the performance standards is failing to ensure that new wood heaters comply with emission limits.²⁵ As explained below, the current program does not provide reasonable assurance that wood heaters are properly tested and certified before reaching consumers.²⁶ Revising the 2015 performance standards for wood heaters

²⁰ See Executive Order 12898, 59 Fed. Reg. 7,629 (Feb. 16, 1994) (identify and address disproportionately high and adverse human health or environmental effects of their policies on minority populations and low-income populations).

²¹ 80 Fed. Reg. at 13,673

²² Bongki Woo, et al., *Residential Segregation and Racial/Ethnic Disparities in Ambient Air Pollution*, 11 Race & Social Problems 60 (2019), available at: <https://pubmed.ncbi.nlm.nih.gov/31440306/>.

²³ Kevin Josey, et al., Air Pollution and Mortality at the Intersection of Race and Social Class, 388 New England Journal of Medicine 1396 (2023), available at: <https://www.nejm.org/doi/full/10.1056/NEJMs2300523>.

²⁴ See 42 U.S.C. § 7401(b) (stating the Act’s purpose is “to protect and enhance the quality of the Nation’s air resources so as to promote the public health and welfare and the productive capacity of its population”).

²⁵ Northeast States for Coordinated Air Use Management, *Assessment of EPA’s Residential Wood Heater Certification Program*, at iii (Mar. 2021), <https://www.nescaum.org/documents/nescaum-review-of-epa-rwh-nsps-certification-program-rev-3-30-21.pdf>.

²⁶ U.S. EPA Office of Inspector General, *The EPA’s Residential Wood Heater Program Does Not Provide Reasonable Assurance that Heaters Are Properly Tested and Certified Before Reaching Consumers*, At a Glance (Feb. 28, 2023),

presents an important opportunity for EPA to set clear testing and reporting expectations for wood heaters to address this pervasive problem.

Following initial concerns that EPA's wood heater certification program was not well functioning, the Northeast States for Coordinated Air Use Management²⁷ and the Alaska Department of Environmental Conservation coordinated review of over 250 certified wood heaters.²⁸ The study evaluated EPA's compliance program with the 2015 performance standards.²⁹

The study identified deficiencies in all reviewed test reports.³⁰ Manufacturers must seek certification of compliance with the performance standards for each model line, based on a test report from a designated laboratory.³¹ Many of the wood heater models did not have publicly available certification test reports, violating the regulations implementing the performance standards.³² The study did not find any of the other reports to be complete and in full compliance with regulatory requirements.³³

Based on this review, the Northeast States for Coordinated Air Use Management and the Alaska Department of Environmental Conservation found that EPA's certification program did not assure that new wood heaters, subject to the 2015 performance standards, are cleaner than devices sold under the 1988 performance

https://www.epa.gov/system/files/documents/2023-03/epaoig_20230228-23-E-0012_2.pdf.

²⁷ Northeast States for Coordinated Air Use Management is a nonprofit association that provides scientific, analytical, and policy support to air quality agencies in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Northeast States for Coordinated Air Use Management (NESCAUM), *About Us*, <https://www.nescaum.org/about-us> (last visited May 16, 2023).

²⁸ Northeast States for Coordinated Air Use Management, *Assessment of EPA's Residential Wood Heater Certification Program* (Mar. 2021).

²⁹ *Id.* at xiii, 71.

³⁰ *Id.* at 71.

³¹ 40 C.F.R. §§ 60.533, 60.5475.

³² Northeast States for Coordinated Air Use Management, *Assessment of EPA's Residential Wood Heater Certification Program* (Mar. 2021) at 71.

³³ *Id.*

standards.³⁴ The study found that EPA’s failures stem from unclear test methods, an ineffective third-party certification review process, and a lack of audits.³⁵ As a result, the program cannot ensure that wood heaters satisfy the 2015 performance standards.³⁶ If newer wood heaters do not meet cleaner standards, then programs to change out old wood heaters may provide little health benefits at significant public cost.³⁷

EPA’s Office of Inspector General corroborated the study’s findings, determining that “EPA’s residential wood heater program does not provide reasonable assurance that wood heaters are properly tested and certified before reaching consumers.”³⁸ It found that EPA lacks internal controls to ensure that certification tests are appropriately conducted because it lacks procedures to review test reports, does not conduct audit tests, does not have standard templates for test reports, does not use staff with appropriate expertise, and has not exercised oversight authority.³⁹

Furthermore, the Inspector General found that the 2015 performance standards have unclear expectations for test procedures and documentation, which leads to testing labs and manufacturers using their own interpretations, like obscuring failing test runs as invalid and not reporting them.⁴⁰ “[C]ertification test methods also contain vague language,” create “imprecise expectations” for what fuel must be used during testing, “and do not represent real-world conditions.”⁴¹

Indeed, EPA itself has withdrawn multiple test methods after they were demonstrated to be ineffective.⁴² But, because of EPA’s interpretation of the 2015

³⁴ *Id.* at 72.

³⁵ *Id.* at 68.

³⁶ *Id.* at 72.

³⁷ *Id.* at iii.

³⁸ U.S. EPA Office of Inspector General, *The EPA’s Residential Wood Heater Program Does Not Provide Reasonable Assurance that Heaters Are Properly Tested and Certified Before Reaching Consumers*, At a Glance (Feb. 28, 2023).

³⁹ *Id.* at 13.

⁴⁰ *Id.* at 13–14.

⁴¹ *Id.* at 13.

⁴² *Id.* at 13–14.

performance standards, wood heaters certified with those tests continue to have valid certificates of compliance that will not be reevaluated until those certificates expire, as late as 2027.⁴³ Those wood heaters remain available for sale, and could remain in homes—causing harm to residents of nearby communities—for decades.⁴⁴

In response to the Inspector General Report, EPA acknowledged deficiencies in its program.⁴⁵ Apart from updated training, the creation of additional certification information, and lists of wood heaters certified with withdrawn tests, EPA does not plan to start implementing regulatory revisions until 2024.⁴⁶ EPA outlines a serial process of updating test methods, starting in 2024, but does not plan to finalize new performance standards until November 30, 2027.⁴⁷ Even these timelines may be optimistic as EPA has stated that it “do[es] not have hard deadlines for reaching these milestones[.]”⁴⁸ EPA’s uncommitted proposal will take years longer than its statutory deadline, does not explain why EPA cannot work on some of the regulatory updates, such as testing requirements, in parallel, and continues to allow the sale of wood heaters with flawed certifications and certification of improperly tested devices, in the meantime.

In sum, as currently implemented, EPA’s program allows continued sale of high-emitting wood heaters.⁴⁹ Many of these devices will be installed in communities that are overburdened by environmental harms and other inequities, further exacerbating environmental justice issues.⁵⁰ EPA must address the systemic problems with its wood heater certification program when revising the 2015 performance standards.

4. *Notice of Intent to Sue*

⁴³ *Id.* at 14, 25.

⁴⁴ *Id.* at 25.

⁴⁵ U.S. EPA, Response to Office of Inspector General Final Report (April 28, 2023) at 1-2.

⁴⁶ *See id.* at 2-8.

⁴⁷ *Id.* at 6-8.

⁴⁸ *Id.* at 7.

⁴⁹ NESCAUM, *Assessment of EPA’s Residential Wood Heater Certification Program*, at iii (Mar. 2021).

⁵⁰ *See id.*

As discussed above, section 111(b)(1)(B) of the Act requires EPA to undertake a notice-and-comment rulemaking to “review and, if appropriate, revise” each performance standard at least once every eight years, and take into account “emission limitations and percent reductions achieved in practice,” in cases where those emission reductions exceed those required by existing performance standards. Although the current emission standards for wood heaters have been in place since May 2015, EPA has not even started the required notice-and-comment rulemaking proceeding to review the scope or stringency of those standards and make the necessary revisions to ensure they result in actual emissions reductions. EPA is required to review, and as appropriate, revise its regulations to ensure the best technological system of continuous emission reduction.⁵¹ Without accurate testing and certification, there is no way to ensure that the wood heaters meet these standards.

The States’ accordingly request that EPA promptly propose and finalize revised performance standards for wood heaters under 40 C.F.R. Part 60, Subpart AAA, QQQQ. The States also request that EPA promptly revise the testing and certification process for those wood heaters. This letter constitutes notice from the States, pursuant to section 304 of the Clean Air Act and Title 40, Part 54 of the Code of Federal Regulations, of their intent to commence a civil action to enforce the Act due to EPA’s failure to undertake these non-discretionary duties.

Respectfully submitted,

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⁵¹ 42 U.S.C. § 7411(b)(1)(B).

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Why Burlington's Thermal Energy Ordinance Should Not Incorporate Language from the State's Affordable Heat Act (S. 5)

- The City's Ordinance and the State's law are fundamentally different and address different issues.

-The Affordable Heat Act directs the Public Utility Commission to establish by regulation a system of tradeable clean heat credits whereby fuel dealers must earn clean heat credits by delivering clean heat measures to their Vermont customers. § 8122.

The Act defines the clean heat measures eligible for clean heat credits as including:

(1) thermal energy efficiency improvements and weatherization; (2) cold-climate air, ground source, and other heat pumps, including district, network, grid, microgrid, and building geothermal systems; (3) heat pump water heaters; (4) utility-controlled electric water heaters; (5) solar hot water systems; (6) electric appliances providing thermal end uses; (7) advanced wood heating; (8) noncombustion or renewable energy-based district heating services; (9) the supply of sustainably sourced biofuels; (10) the supply of green hydrogen; (11) the replacement of a manufactured home with a high efficiency manufactured home and weatherization or other efficiency or electrification measures in manufactured homes; and (12) line extensions that connect facilities with thermal loads to the grid (§ 8127(d)); as well as "renewable natural gas," if certain requirements are met. (§ 8127(e)).

The amount of credit that can be earned by providing each type of eligible clean heat measure will be determined by the Public Utility Commission, based on a life-cycle analysis of greenhouse gas emissions, through a public notice and comment rulemaking process. § 8127. Thus, the result will be a sliding scale of credits based on the greenhouse gas emission reductions expected from each clean heat measure. If the PUC determines installation of a heat pump will reduce greenhouse gas emissions more than use of "sustainably sourced biofuels," then more clean heat credit would result from sale of a heat pump.

The Act is designed to comprehensively cover the sale of all heating fuels in the State. It applies to sale of fuels to older, poorly insulated homes which present a challenge for heat pumps and weatherization alone to satisfy all heating needs during winter. The legislature was concerned with the costs that would be borne by Vermonters in drafty old homes currently heated by natural gas, fuel oil, propane and wood, and was apparently seeking to promote measures that might affordably be used by such Vermonters, including fuels that can be used in their existing heating systems- biofuels can be used in existing fuel oil heating systems and "renewable" gas can be used in existing gas heating systems.

-In contrast, Burlington's thermal energy Ordinance applies only to installation of new systems in new construction or in existing commercial, institutional or industrial buildings of 50,000 square feet or more. And, unlike the Affordable Heat Act, the

proposed Ordinance does not provide for a sliding scale of fees or credits. It imposes a fee on installation of a fossil fuel heating system based on anticipated lifetime greenhouse gas emissions, and imposes no fee or charge whatsoever on any other type of system. Compared to the Affordable Heat Act's sliding scale it is all or nothing.

Due to these differences, there are three fundamental flaws with incorporating language of the Affordable Heat Act into the Burlington Ordinance:

- New construction can be sufficiently weatherized to permit use of the systems with the lowest greenhouse gas emissions- electrification, with heat pumps or geothermal energy. There is no reason to permit or incentivize installation of systems in new construction that will result in higher greenhouse gas emissions (and higher emissions of other harmful pollutants such as particulate matter), including "advanced" wood heating, "renewable" gas, biofuels, or McNeil "district" heat.

- As the Ordinance applies only to new systems, there is no potential cost advantage for fuels that can be used in existing systems.

- The all or nothing character of the fee ordinance is incompatible with the Affordable Heat Act's sliding scale. Indeed, it would be compatible with the Affordable Heat Act to make all of the eligible "renewable" fuels subject to the carbon impact fee with the fees set based on the relative carbon intensity of the various fuels.

Additional Reasons for Not Incorporating Language of the Affordable Heat Act

- The legislature in the Affordable Heat Act has simply designated measures that are eligible for clean heat credits. It is now up to the PUC to determine, through public notice and comment rulemaking, the amount of credit, if any, that should be provided for each type of eligible measure. The PUC is required to present its final proposed rules to the legislature on or before January 15, 2025, and the rules must then be approved by the legislature before becoming effective. The City of Burlington should not get ahead of the PUC and the legislative process by incentivizing various measures before the PUC has considered the clean heat credits, if any, that will be allowed for them, and the legislature has approved the PUC's final rule.

- The legislature appears to have designated a number of fuels/systems, including advanced wood heating, renewable gas, biofuel, and McNeil "district" heat, as eligible for clean heat credits based on wrongfully assuming that biogenic emissions need not be counted. This is contrary to current science, and may well be corrected during the rulemaking process. The legislature has so far gotten it wrong. The City of Burlington must do better.

- The GREET model referenced in both the Ordinance and the Affordable Heat Act, was developed to evaluate "energy and emission impacts of advanced vehicle technologies and new transportation fuels." <https://greet.es.anl.gov/homepage2> It was never intended to be used with regard to biomass. Further, it's use is inappropriate because it does not account for biogenic CO2 emissions, contrary to current science.

-There was discussion at the July 25, 2023 TEUC meeting about § 8-77(c) of the proposed Ordinance which permits disqualification of any “renewable fuel” that is subsequently deemed by the Public Utility Commission not to satisfy the carbon intensity requirements of a State of Vermont Clean Heat standard or any similar state thermal energy policy.” This provision is inadequate because the carbon intensity requirements of the Clean Heat Standard apply only to “a liquid or gaseous clean heat measure,” and do not apply to biomass.

-Advanced wood heating, with its emissions of particulate matter and other harmful air pollutants, is especially inappropriate in an urban area such as Burlington. Permitting and incentivizing it is contrary to the City’s efforts to facilitate development of denser, more pedestrian and public transit- oriented neighborhoods.

-Unlike residents of much of the State, natural gas is available to Burlington residents. Any rationale, based on costs, lack of alternatives, etc., for permitting and incentivizing, biofuels, advanced wood heating or biomass-based district heat is less compelling in Burlington, where natural gas is available.

Nick Persampieri,
Ward 2
nickpersamp@yahoo.com

Ashley Adams

Comments to TEUC 8.1.23

RE: Ordinance on Carbon Fee

Thank you for your careful attention to the carbon fee ordinance, and for convening an additional meeting with time for public comment.

The predicament this ordinance has created began with the extremely misleading Ballot Question 2, which a number of people fought against, myself included. It passed because voters believed the carbon impact fee would reduce GHG emissions. In fact, that was its stated purpose: **“to reduce greenhouse gas emissions in the City.”** However, due to a widely misunderstood word, many of us are here again tonight attempting to stop the city from incentivizing greenhouse gas intensive and otherwise harmful sources of heat. That word is “renewable.” Governments and utilities everywhere use the word “renewable” because they know the public mistakes it for “climate friendly.” They use it in an effort to promote combustion-based heat and energy. Burlington Electric and Vermont Gas are just two examples.

As every climate scientist will tell you, we need zero carbon heat and energy, not renewable. We know through physics and chemistry that all combustion-based sources of heat and energy, whether they are renewable in 40 years, 100 years, or 1,000, will continue to pump greenhouse gases into the atmosphere. We also know that combustion-based sources come with a host of other harmful impacts, including to biodiversity. Please do not forget that if by some miracle, we succeed in salvaging a habitable climate, we may still be taken down by mass extinction (look no further than to the collapse of insect populations if you doubt this is on the near horizon). You need not listen to me- there is ample scientific evidence available. No further study is needed. You need only listen to the scientists.

I implore you to first to DO NO HARM. Please do not incentivize the use of combustion-based heating systems in our city through this carbon impact fee. If you do so you will be increasing the use of polluting and damaging heat sources. Furthermore, you would be deceiving Burlington voters who passed Ballot Question 2. They voted yes, not because they wanted to incentivize dirty sources of heat, but because they believed in the spirit of the proposed ordinance: that it would result in a reduction of greenhouse gas emissions in the City. If you pass this ordinance as written, you are doing nothing short of defying the intent of Burlington voters who want and deserve real action on climate and preservation of the living world.

Delete line 35, replace with:

"thermal energy from exclusively renewable, non-fossil fuel sources such as:"

Delete lines 52-65.

Correct typo of the word "receives" in line 68.

Amend line 73 as follows:

"greenhouse gas emission ~~listed above~~ from being eligible to satisfy the requirements of ~~this~~ section 8-78 for fuels that reduce greenhouse emissions if such"

Delete lines 146-154 and replace with:

"fuel or a renewable fuel that reduces greenhouse gas emissions, an applicant shall demonstrate compliance by providing a contract that shows (a) that the renewable fuel that reduces greenhouse gas emissions is being delivered directly to that building's thermal energy system for the life of that thermal energy system and (b) the estimated quantity of renewable fuel that reduces greenhouse gas expected to be delivered to that building's thermal energy system."

I am also intrigued with the annual certification system but am interested in not building up the administrative burdens and costs associated with such a system so have not proposed it yet.

Delete lines 156-160.

Amend line 163 by adding:

"except those funds needed to administer this ordinance," after the word "proceeds" and before the word "shall".

Delete line 191.



CITY OF BURLINGTON, VERMONT
CITY COUNCIL TRANSPORTATION, ENERGY & UTILITIES COMMITTEE

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Councilor Gene Bergman, Ward 2
Councilor Hannah King, Ward 8

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Transportation, Energy and Utilities Committee of the City Council
Tuesday August 1st, 2023 – 5PM

Sharon Bushor Conference Room
149 Church St, Burlington, VT 05481
Masks Optional

Meeting begins 5:07 PM.

–DRAFT MINUTES–

1. Agenda

Councilor King moves to approve the agenda. Chair Barlow amends to postpone Item 2 and seconds as amended. All in favor, passes unanimously.

~~2. Minutes of 7.25.23~~

3. Public Forum

Luce Hilman – Executive Director Facilities management at UVM. In support of wood fuel in ordinance.

Ashley Adams – Confusing vote initiative. Need Zero Carbon, not just renewable. Combustion based sources have harmful impacts and should not be permitted.

Nick Persampieri – Ordinance as written does not adequately address greenhouse gas and other impacts of ‘renewable’ sources. Advanced Wood heating has harmful impacts. Current ordinance needs adjusted language.

Catherine Bock – Carbon impact of heating fuels needs to be honest. Combustion based fuels need to be considered in ordinance not just fossil fuels.

Councilor Gene Bergman – arrives at 5:20PM

Dylan Gambatista – Director of Public Affairs for VGS. VGS has long term objective for Net Zero with efficiency, access to latest technology, and fossil fuel displacement with low or no carbon-based alternatives. Fully regulated Utility. Following state guidance. S5 State guidance is the most environmentally friendly low carbon robust climate policy in the country. Important to consider how policy locally fits into overall state goals. Looking to affordable transition to cleaner energy. Ordinance provides flexibility which will help with the state and utilities working with customers to best implement this. Will still benefit our shared climate goals.

Jack Hanson – Sent proposed amendments. Shouldn’t confuse this particular ordinance with larger mission to decarbonize every building in the city as quickly as possible. This ordinance specifically targets new systems being installed. Electrification is preferred method; this should be the focus for this policy. Geothermal is another low impact fuel.

Pike Porter – Plant based fuels are not better than fossil fuels.

Peter Duval – This ordinance needs to be rewritten entirely. Reinforces biomass and dependency on McNeil. All new construction should be low carbon and zero emission. Using FIA 0 complaint.

Peter Sterling – Executive Director of Renewable Energy Vermont – supports action as approved by voters. Encourage City Council to support this. Will reinforce Burlington's leadership role in decarbonizing and set an example for others.

Cheryl Joy Lipton – S5 is only a study at this point, weary of using this. We need to be carbon negative right now. Advanced wood heating should not be encouraged. Need old growth forests.

Public Forum ends 5:43PM

4. Ordinance on Carbon Fee

- Councilors, Darren Springer

Darren Springer – Supportive of policy as it currently stands. Appreciate the alignment with the States policy. Disagree with comments about renewable fuels not being sustainable. Fee on fossil fuels is bottom line to align with voter's support. Large building and City buildings are also included in this ordinance, not just new construction. Carbon price added to that calculation for new construction and major investment in City and large buildings.

Chair Mark Barlow – We have authority to do this for fossil fuels, not for anything else mentioned due to the voters' charter action. Renewable gas we may have some say over. I would like to be aligned with what the State does. Burlington doing things alone can make it less competitive as it could make it harder to live here.

Councilor Hannah King – Need to be aligned with the state. Need time to look at proposed amendments.

Councilor Gene Bergman – Section 48 of Burlington Charter in sub section 66 gives us authority to look at other fuel types based on GHG emission. The fee is where we are limited to fossil fuels based on voters.

S5 is in preliminary stages of its implementation. They key things that we are looking into will not even come into draft form until next fall. We can align with the spirit of the state legislation but we should not get ahead of that. The renewable fuel definition gets too far ahead of what the states system is doing.

Councilors and Darren Springer go through amendments as proposed by Councilor Gene Bergman.

MB – like simplifying renewable section.

Delete lines 52-65 - don't think we have authority over regulating these, though renewable gas is different from others.

Delete lines 146-154 – we need administrative framework. How would this grow with people as their fuel mixture becomes more renewable as VGS offers new options. If not meant to be annually then we wouldn't be able to regulate. Like the idea to simplify but need to keep intent.

DS - Don't think the mix of fossil fuels would be eligible here. Only annual certification would ensure every year the person is getting renewable. Get rid of lifetime to simplify. Track renewable through credits. This is for existing buildings that don't have the option to go electric but can buy credits for renewable fuel.

Delete lines 156-160 – idea is to encourage early action and incentive to do things beyond what is required through this. Would be beyond new, existing large, and city buildings – for encouraging early action for those who have multiple buildings.

Nick Prethensieri – line 175 – should be limited to sites located in Burlington. Concerned about 35 language proposed. Comments on proposed amendments.

MB – Think fleet subsidy option should stay. Open to it but would rather see money spent on winterizing building and helping low-income folks.

GB – One alternative is to have it be a fourth section and if there are no low-income Burlington residents and no others identified above to be eligible, then we can use it to subsidize City's fleet cost.

August 15th, meet to discuss and then take this to ordinance committee.

5. Councilors' Update

None.

6. Next Regular Meeting 8/22/23

Next Special Meeting – August 15th 5PM at BED to discuss Carbon Fee Ordinance

7. Adjourn

Adjourn at 7:01PM

Jack Hanson
Tuesday, August 1, 2023 11:11 AM
Proposed Carbon Fee Ordinance Amendments

Delete line 35, replace with:

"thermal energy from exclusively renewable, non-fossil fuel sources such as:"

Why? The ballot item gave us the authority to put a fee on fossil fuels. It didn't give us the authority to put a fee on renewables. We can't redefine fossil fuels as renewables, nor renewables as fossil fuels. But we can provide examples of widely accepted renewable thermal energy options that achieve compliance with the ordinance.

Delete lines 52-65.

Why? There is no reason to list exemptions (or even examples, if my previous amendment is accepted) for fuels that have high greenhouse gas emissions. If applicants want to make the argument that these fuels are renewable and reduce GHGs, they can make that argument per lines 67-70. Let's stick with exemptions/examples of fuels that we feel confident about their renewability and emissions reductions (which are listed above).

Delete lines 146-154 and replace with:

"fuel or a renewable fuel that reduces greenhouse gas emissions, an applicant shall demonstrate compliance by providing a contract that shows (a) that the renewable fuel that reduces greenhouse gas emissions is being delivered directly to that building's thermal energy system and (b) the estimated quantity of renewable fuel that reduces greenhouse gas expected to be delivered to that building's thermal energy system."

Why?

Our goal as a city, laid out in the Net Zero Energy roadmap and elsewhere, is to reduce greenhouse gas emissions and fossil fuel use right here in Burlington, not to pay for reductions elsewhere. A building that is consuming fossil fuels here but paying a fee to a fossil fuel company in hopes that they will reduce fossil fuel use elsewhere is a system that is much harder for the City to regulate than simply requiring actual physical reductions of fossil fuel use at the building here in Burlington. Furthermore, the health and safety benefits for Burlington residents are only achieved through physical changes here, not through payments to support changes elsewhere.

Delete lines 156-160.

Why? These lines undermine the intended impact of this ordinance, which is to reduce fossil fuel use and greenhouse gas emissions in buildings. Building owners who have already taken steps to reduce fossil fuels use and greenhouse gas emissions will reap the benefits of doing so -- they do

not need to be permitted to increase pollution going forward. To allow them to do so undermines the intent of the policy while providing no tangible benefits to our community or climate. On the rebate side, we give incentives to people who *switch* from fossil fuels to electric heating, not to those who *already have* electric heating. Let's use the same logic on the regulatory side.

Delete line 191.

Why? This policy is intended to accelerate building decarbonization. We need stronger policies to decarbonize transportation --- but those should not be *at the direct expense of* building decarbonization. Let's instead develop stronger policy on transportation decarbonization that does not negatively impact building decarbonization.