STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Case No. 22-2230-PET

Petition of Vermont Gas Systems, Inc., Pursuant to 30 V.S.A. § 248(i), for approval of An out-of-state renewable gas purchase contract With a term exceeding five years	

DIRECT TESTIMONY OF EMILY GRUBERT, PhD

September 2, 2022

Exhibit EG-1: Emily Grubert 2020 *Environ. Res. Lett.* **15** 084041
Exhibit EG-2: Supplementary Data File S1: Grubert 2020
Exhibit EG-3: Diana Burns and Emily Grubert 2021 *Environ. Res. Lett.* **16** 044059
Exhibit EG-4: The Gas Index

Summary of Testimony

Based on the description in this petition, the renewable natural gas (RNG) purchase contract will reduce Vermont Gas Systems' greenhouse gas emissions by about 4% of its 2030 emissions in 2030. This emissions reduction pace is not commensurate with statewide emissions reductions requirements of 40% by 2030 and 80% by 2050, relative to a 1990 baseline, and there is no guarantee the RNG will actually displace fossil gas or lead to real emissions reductions. The GHG analysis is inappropriate for evaluating impact under Vermont Law and misinterprets key issues related to GHG impacts, including by assuming that possible future carbon capture and storage at the landfill from which RNG will be secured will affect the RNG's carbon intensity. Whether the source landfill will remain open past 2025 is a matter of significant contention in New York State, and the petition does not describe this as a risk factor for the contract. The primary argument in favor of the contract is to contribute to a large share of VGS' planned greenhouse gas emissions reductions: as described, the contract provides essentially negligible emissions reductions while reinforcing a high emitting pathway. As such, it does not effectively progress Vermont's climate requirements.

DIRECT TESTIMONY OF
EMILY GRUBERT
ON BEHALF OF CATHERINE BOCK

Q1. **Please state your name.**

A1. My name is Emily Grubert.

Q2. **Please describe your relevant education and professional experience.**

A2. I am an energy systems expert with a focus on infrastructure systems and the US decarbonization transition, particularly related to fossil fuel infrastructure, life cycle assessment, and methane. I am an Associate Professor of Sustainable Energy Policy at the University of Notre Dame and previously served as the Deputy Assistant Secretary for Carbon Management at the US Department of Energy. I hold a PhD from Stanford University, an MA and MS from The University of Texas at Austin, and a BS from Stanford University and am a registered professional engineer in the State of Georgia. I also had a temporary role at Pacific Gas and Electric focused on capital allocation for natural gas transmission pipeline projects.

Q3. **On whose behalf are you testifying in this case?**

A3. I am testifying on behalf of Catherine Bock.

Q4. Have you testified previously before the Vermont Public Utility Commission?

A4. No.

Q5. What is the purpose of your testimony?

A5. The purpose of my testimony is to offer an expert perspective on selected issues associated with renewable natural gas ("RNG"), specifically related to effects on greenhouse gas emissions.

Q6. Have you previously testified to any other state's boards or commissions?

A6. Yes. I have previously submitted testimony or comments to the California Air Resources Board regarding the mine methane capture carbon offset protocol (2014) and the use of 20-year global warming potentials for methane in the draft Aliso Canyon methane leak climate impacts mitigation program (2016). I have also submitted testimony to the New York State Public Service Commission regarding the Niagara Mohawk Power Corporation's application to incorporate RNG into its natural gas distribution system (2020).

Q7. Have your professional analyses appeared in peer-review journals in your field?

A7. Yes. I have authored 60 peer-reviewed journal papers either in print (56) or in press (4).

Q8. Have you published in peer-reviewed journals broadly read by researchers spanning diverse areas of science?

A8. Yes. Many of my papers appear in broadly read interdisciplinary journals, including *Science*, *Environmental Research Letters*, and *Environmental Science & Technology*.

Q9. Has your opinion been sought and quoted in articles appearing in national news publications?

A9. Yes. Among other publications, I have been interviewed for and quoted in articles appearing in the *New York Times*, *Los Angeles Times*, *Chicago Tribune*, and the *Wall Street Journal*.

Q10. What is the purpose of your testimony?

A10. I bring an expert perspective on climate impact issues related to renewable natural gas (RNG) to Vermont Gas Systems, Inc.'s ("Company's") petition for approval of an out-of-state renewable gas purchase contract with a term exceeding 5 years, from the Seneca Meadows Landfill RNG plant in Waterloo, New York. The purpose of this testimony is to evaluate the climate impacts of securing the

RNG resource in this petition, and to evaluate the petition's consistency with Vermont's Global Warming Solutions Act of 2020. I discuss climate impacts, analytical approaches, and energy system needs for decarbonization.

Q11. What factors are important to consider when weighing the climate implications of using RNG in a fossil natural gas (FNG) system?

A11. There are several factors that must be evaluated to assess the climate implications of using RNG in an FNG system. First, the absolute life cycle GHG emissions of the RNG must be determined. These are typically dominated by methane emissions over the life cycle, with further emissions associated with GHG-producing inputs to the production, processing, transportation, and use of RNG – e.g., combustion of fossil natural gas to compress RNG for pipeline transport. Next, counterfactuals for the fate of the methane used to produce RNG must be evaluated to assess the net GHG impact of using the methane for RNG rather than some other purpose. For example, landfill-derived biomethane might have otherwise been burned in a flare, or synthetic methane (i.e., methane derived from CO_2 and hydrogen) might not have existed. Counterfactuals for providing the service for which the RNG is used are also necessary. For example, if RNG is used for home heating, the GHG impact depends on how else the home might have been heated, for example via zero-GHG electricity in a heat pump, district geothermal, or fossil natural gas. Notably, counterfactuals should account for policy and other dynamics: for example, it would be inappropriate to assume that unabated fossil natural gas would be used in place of RNG if a legal requirement to eliminate or dramatically reduce GHG emissions is in place. Finally, it is important to ensure that any GHG reductions associated with RNG are not being counted more than once.

Beyond the basic factors required for calculating the GHG impact of using RNG, it is also critical to assess how the use of RNG might affect broader infrastructure system dynamics. For example, if investing in RNG prolongs the life of fossil gas systems (e.g., through pipeline investments, delay in conversion of gas appliances, etc.), the induced GHG impacts could be very large. In general, given a policy emphasis on GHG mitigation and net zero emissions, considering whether any investment (including RNG) enables the achievement of complete or near complete decarbonization of the service it facilitates is important. That is, if an investment does not have a path to zero GHG emissions but long-term efforts require achieving zero GHG emissions, the investment will eventually need to be replaced with an alternative that does have that path.

Q12. Are these factors quantifiable?

A12. Yes. Life cycle assessment and scenario analysis are common quantitative tools used to evaluate the factors I described above. When the goal is to understand absolute emissions, the relevant factors can be directly measured. When interested parties wish to claim benefits associated with "net," "displaced," or "avoided" emissions, it is necessary to establish counterfactuals that cannot be directly measured (because they by definition did not happen), but such counterfactuals can be and are commonly quantitatively modeled.

Q13. Your article,"At scale, renewable natural gas systems could be climate intensive: The influence of methane feedstock and leakage rates" was published in the journal *Environmental Research Letters vol 15, August 2020* and is submitted for the record as Ex. EG-1. Are any of the conclusions of that paper subject to revision based on new information that has become available since its publication?

A13. No. That paper *(Ex. EG-1)* and accompanying model *(Ex. EG-2)* concludes that the GHG impacts of using RNG are variable based on production pathway and use case, and that truly zero- or negative-GHG RNG is extremely rare. As such, most RNG likely contributes to climate change. Methane emissions associated with RNG that would not otherwise have occurred are likely, and claims of GHG benefits must be carefully validated. The petition at hand describes RNG with a carbon intensity roughly in the middle of the range that I evaluated based on literature estimates.

Q14. Informed by your analysis, would the contract for RNG from the New York landfill presently under consideration contribute to reducing Vermont's greenhouse gas emissions commensurate with the pace of statewide reductions required by the State's 2020 Global Warming Solutions Act?

A14. No. The 2020 Global Warming Solutions Act requires a 40% reduction in GHG emissions by 2030 and an 80% reduction by 2050, relative to a 1990 baseline. That is, the Act requires absolute emissions reductions, not a reduction in carbon intensity. The largest GHG impact contemplated in the current petition, at about 10% replacement of fossil natural gas by RNG from Seneca Energy by 2030, *(PFT Murray 6/13/22, inferred from p4 line 17, p4 line 20, footnote 4, and p5 line 13)* amounts to a 4% reduction in the Company's 2030 emissions relative to its 2030 baseline (10% replacement of fossil natural gas with a carbon intensity of 79 g/MJ by RNG with a carbon intensity of 45 g/MJ). Note that even if the RNG had no GHG emissions, which is highly unlikely *(Ex. EG-1)*, the overall impact would be to reduce emissions by the percent share (i.e., 10% emissions reductions at 10% of the volume and no GHG footprint) and does not account for the potential for natural gas demand to increase.

Specifically, the petition does not describe how the Company will ensure that RNG is displacive (i.e., actually results in lower fossil natural gas demand) rather than additive, particularly relative to an absolute baseline. Vermont's natural gas-related CO_2 emissions have doubled since 2012 after a long period of being nearly flat (methane emissions are not readily available).[1] Petroleum-related CO_2 emissions (the only other fossil-related CO_2 emissions reported by the Energy Information Administration for Vermont) remained essentially flat during the recent period where natural gas emissions have been rising,[2] suggesting that the natural gas is not displacing more emissions-intensive fuels on an absolute basis. It is unclear that the RNG in this petition will be displacing fossil gas emissions, and it is unlikely that the RNG will be reducing rather than adding to emissions relative to a 1990 baseline.

It is likely technically possible for Vermont to meet its Global Warming Solutions Act requirements without meaningful reductions in GHG emissions from natural gas systems, but the very small reduction implied by this petition (which does not seem to assume a large reduction in natural gas use) is not commensurate with the Act's statewide requirement. Natural gas accounted for 13% of Vermont's energy-related CO_2 emissions in 2019, up from 6% in 1990 (noting that the natural gas share of overall GHG emissions is likely higher given the more

[1] Energy Information Administration, Fuel specific emission tables by state, Vermont: https://www.eia.gov/environment/emissions/state/excel/states/vermont.xlsx. Date last checked: 9/2/22

[2] Ibid.

significant role of methane emissions in natural gas' GHG footprint relative to petroleum), and 2019 emissions were higher than 1990 emissions.[3]

Separately, even this small planned reduction in emissions relies on assumptions about RNG availability that in my view have not been sufficiently justified. Namely, the petition notes a 14.5 year supply of RNG sourced from the Seneca Meadows landfill, with the potential to extend for 5 years. Given that the landfill's permit currently expires in 2025 and that a permit extension beyond 2025 could violate a law in the neighboring community of Seneca Falls, New York, a description and evaluation of this risk is warranted.

Q15. VGS uses GREET model carbon intensity scoring to estimate the potential for GHG emissions reduction of the present contract. ***(VGS Response to 1st set of DPS Discovery Requests, pp 21-23)*** **Is this an adequate method for assessing the GHG emissions reductions under this contract?**

A15. No. Although the use of the carbon intensity score provisionally approved in 2021 for Seneca Energy RNG under California's Low Carbon Fuel Standard (LCFS) is adequate and likely required for evaluating potential LCFS credit quantity and value, it is not adequate for assessing GHG emissions reductions for the purpose of assessing actual impacts for Vermont, particularly in the context of Vermont's Global Warming Solutions Act of 2020. The California carbon

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[3] Energy Information Administration, Fuel specific emission tables by state, Vermont: https://www.eia.gov/environment/emissions/state/excel/states/vermont.xlsx. Date last checked: 9/2/22

intensity score assumes the Seneca Energy RNG is physically transported to California. Further, the California carbon intensity score assumes the RNG is converted to compressed natural gas.[4] This estimate is a hypothetical for use in a very specific market setting: in practice, the actual emissions will reflect very different conditions that could mean higher or lower greenhouse gas emissions. For example, the transportation distance for Seneca RNG is likely lower in practice, and thus likely results in lower transmission pipeline-stage methane emissions (although note that this is not necessarily true, as pipeline leaks are caused by many factors). Similarly, CNG compression is likely not relevant for most of the Company's planned use cases. By contrast, distribution, metering, and end-use emissions could be higher in the Company's use context than in a California CNG context, as these life cycle stages might not be relevant for RNG conversion to CNG for transportation. I note that I do not have access to the full calculations and thus cannot comment on what is and is not included.

Similarly, as the stated greenhouse gas benefit of using this RNG resource presumes displacement of fossil natural gas, it is also important to estimate the specific carbon intensity of fossil natural gas used in Vermont. The Company uses a carbon intensity of 79 g/MJ for conventional natural gas. *(A.DPS.VGS.1-5)* Based on my work on the impact of methane emissions on fossil and renewable

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[4] California Air Resources Board, LCFS Pathway Certified Carbon Intensities, Current Fuel Pathways table. https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/current-pathways_all.xlsx. Date last checked: 9/2/22

natural gas carbon intensities *(Ex. EG-2)* and on the methane intensity of fossil natural gas consumption by state, *(Ex. EG-3, p6 (Figure 5))* this estimate is similar to what might be expected in California, with a state-average methane emissions rate of 2.8% methane emitted per unit of methane withdrawn for consumption – roughly 76 g/MJ. For Vermont, with an estimated state-average methane emissions rate of 0.9% methane emitted per unit of methane withdrawn for consumption (largely driven by lower emissions at the fossil gas production stage, which would not translate to RNG the way that better pipeline or end use performance would), fossil natural gas has an estimated carbon intensity of 61 g/MJ. Assuming the Seneca RNG carbon intensity is 45 g/MJ, adjusting the fossil gas carbon intensity to the expected Vermont level suggests a GHG reduction of only 26% per unit of fossil gas displaced by Seneca RNG, rather than the Company's estimate of a 43% reduction. Even these seemingly minor analytical changes have a significant impact on estimated emissions. As such, both the fossil natural gas and Seneca RNG carbon intensities are unlikely to match those estimated for use in California's LCFS and need to be calculated relative to realistic conditions for use in Vermont to assess GHG emissions reductions under this contract, and preferably measured with ongoing monitoring and verification.

A broader, overall point is that as the GHG intensity of RNG considered in this petition is positive, it will continue to contribute to climate change. Further, any net benefit is only realized if the true counterfactual scenario (i.e., what would have happened otherwise) has higher emissions than this RNG supply, and even that benefit is only to slow rather than stop or reverse ongoing contributions to climate change. With Vermont's strict legislative greenhouse gas emissions reductions requirements, it is my opinion that ongoing direct use of fossil natural gas at the scale currently observed is not an appropriate counterfactual, and that it is possible or likely that the RNG in this petition has higher climate impact than a more realistic counterfactual. That is, a future that complies with the Global Warming Solutions Act would likely require heavy use of pathways capable of achieving zero greenhouse gas emissions to provide the services currently provided by natural gas, such as electrification and further efficiency upgrades. The resource proposed by the Company has a stated estimated carbon intensity more than half that of fossil natural gas with no clear pathway to reduction.

Q16. What measurements would be necessary to make an assessment in this particular case?

A16. A desktop study could likely proceed with existing information about regionally specific methane emissions from fossil natural gas production and processing (e.g., my work on state-level methane attribution *(Ex. EG-3)*), combined with information about natural gas transportation and use infrastructure that both RNG and fossil gas would use. For example, *The Gas Index*, a project that I advised but did not lead, estimates city-level methane emissions from US gas systems (including for Burlington, Vermont*) (Ex. EG-4)*. Direct measurements of methane emissions from Seneca Energy's RNG production and processing, and methane emissions from the flare where the gas would otherwise have been burned, would likely be the minimum necessary empirical measurements. Ideally, empirical measurements of methane leakage along the full supply chain – something likely to be facilitated by the methane provisions of the federal Inflation Reduction Act – would be used to assess and adjust the program.

Q17. Archaea expects that carbon capture and sequestration (CCS) could come online at the Seneca Meadows landfill by 2027. (VGS Responses to 2nd set of DPS Discovery Requests) *(Ex. EG-5, pp. 2-3)* Would the addition of CCS alter the greenhouse gas emissions impact of the present contract?

A17. No. Archaea's potential Seneca Meadows CCS project, which would capture and sequester biogenic CO_2 that is also produced at the landfill, is irrelevant for the GHG footprint of RNG, which is biogenic methane. CCS captures and sequesters CO_2, not methane, and RNG does not produce CO_2 until it is combusted. In fact, to the extent that the CCS project affects the GHG balance of this RNG project, it could be to increase the net emissions relative to a counterfactual: if the alternative fate of the biomethane were combustion in some form on the landfill property (e.g., for power or in a flare) and the landfill were able to capture and store those emissions as part of its CCS project, the overall emissions could be substantially lower than emissions from selling the biomethane as RNG for combustion without CCS.

For the CCS project to affect the greenhouse gas emissions of the RNG in this petition from an attribute ownership perspective, the Company would need to arrange to purchase or otherwise receive the environmental attributes of Archaea's sequestered CO_2. Based on the documentation I had access to, there does not appear to be any right to these attributes in the present contract. Note that sequestration of biogenic CO_2 like that generated at landfills can generate extremely valuable "negative emissions," as a form of carbon dioxide removal. For context, the US Department of Energy's highly ambitious target is to reduce the cost of such activities to less than $100/tonne of net CO_2e removed[5] – the current market value is much higher for projects with durable storage. As such it is unlikely that these credits would be made available to the Company for free.

Q18. VGS uses the avoided cost of carbon compared to the cost of RNG and the rate impacts of this contract to determine the contract's cost effectiveness and affordability (VGS Responses to 2nd Set of DPS Discovery Requests) ***(Ex. EG-5, pp. 2-3)*** **What do you consider to be the best means for assessing the cost effectiveness of GHG emissions reduction strategies?**

A18. In my view, particularly in a setting where the long-term goal is to reach and maintain net zero emissions – a goal that Vermont has noted as one it is committed to[6] – the best means for assessing the cost effectiveness of GHG emissions reduction strategies is to constrain solutions to those that can deliver

[5] US Department of Energy, Carbon Negative Shot. https://www.energy.gov/fecm/carbon-negative-shot. Date last checked: 9/2/22

[6] Vermont General Assembly, Vermont Global Warming Solutions Act of 2020, https://legislature.vermont.gov/Documents/2020/Docs/ACTS/ACT153/ACT153%20As%20Enacted.pdf. Date last checked: 9/2/22

zero emissions systems by 2050 and compare the cost of alternatives that present a path to zero. In my view, cost effectiveness on the basis of GHG reductions alone should be one of several factors that informs the actual decision, recognizing also that issues of justice, implementability, robustness in the face of climate and technological uncertainty, and non-GHG socioenvironmental impacts are core to the choice of emissions reduction strategy given the deep embeddedness of emissions in society. In particular, pure marginal evaluations like per-ton social cost/avoided cost of carbon metrics can lead to highly suboptimal decision making, particularly when they lead to decisions that enable cost-effective GHG reductions that are fundamentally limited. For example, this petition describes a plan to reduce GHG emissions from Vermont's gas system by about 4% by 2030, which is not consistent with reaching zero GHG emissions unless very thoughtfully paired with aggressive alternative investments that are supported by rather than competitive with this approach. In my opinion, this petition does not sufficiently demonstrate why this investment is an effective use of ratepayer funds for climate mitigation.

Q19. In your expert opinion, what are the long-term climate risks associated with expanding the 'nascent' RNG market?

A19. The principal risk of expanding the RNG market is committing funding and infrastructure to a system that fundamentally cannot provide services without GHG emissions. In practice, RNG is very rarely, if ever, climate neutral or carbon negative on an absolute basis. Investing in RNG both prolongs the use of fossil gas by preserving and investing in its infrastructure and likely slows the implementation of alternatives with an actual path to zero GHG emissions due to limitations on time, regulatory effort, ratepayer funding, and other resources. Further, when markets exist for RNG, they also tend to counteract efforts to reduce biogenic methane production (e.g., food scrap diversion, alternative agriculture, etc.). Ultimately, RNG systems will need to be replaced with an alternative that is capable of providing services without GHG emissions, so the risk of requiring ratepayers to fund multiple transitions is relatively high. Particularly because RNG is rarely considered as a sole fuel, but rather a blended fuel, it is fundamentally tied to ongoing use of fossil gas in many proposals.

Q20. Is the climate impact of supplying RNG to Vermont Gas customers affected negatively, positively or neutrally by the proposed secondary trading of bio-methane attributes?

A20. Legally, the climate impact of secondary trading of bio-methane attributes on supplying RNG to Vermont Gas customers is likely neutral. In practice, multiple entities claiming or implying ownership of the benefits associated with RNG with severed attributes is fairly common, which tends to increase climate impact. Because the sale of RNG attributes is not a trade – that is, someone selling the benefit of RNG does not receive the disbenefit of diesel in return – attribute trading in offset contexts can also lead to stranded emissions that no entity is ultimately responsible for eliminating, thus potentially increasing climate impact.

Q21. In your opinion, does this contract promote the general good of the state of Vermont?

A21. From a greenhouse gas perspective, this contract does very little to advance Vermont's ambitious climate mitigation requirements in a critical decade for deep structural change. Given that climate is the primary motivation for the contract, in my opinion, this contract does not effectively promote the general good of the state of Vermont. Given the inherent dependence of RNG blending on the ongoing use of fossil gas, it is also unclear that this contract does not create harm relative to a counterfactual that is aligned with Vermont's legislated mitigation requirements.

Q22. Does this conclude your direct testimony?

A22. Yes.