Advancing the Clean Energy Future
Acadia Center
31 Milk Street, Suite 501
Boston, MA 02109
617.742.0054
acadiacenter.org

Via Email

December 8, 2021

Poppy Milliken
ERM, on behalf of the Future of Gas
1 Beacon Street,
Boston, MA 02108

RE: Considerations for LDC and Consultant D.P.U. 20-80 Draft Scenario Analysis Modeling

Dear Future of Gas Consultants:

Acadia Center appreciates the opportunity to participate in and comment on the D.P.U. 20-80 process, an investigation into the role of gas local distribution companies (LDCs) as the Commonwealth works to achieve its mandated 2030 and target 2050 climate goals. As a non-profit research and advocacy organization committed to advancing the clean energy future, Acadia Center is at the forefront of efforts to build clean, low-carbon, and consumer-friendly economies throughout the Northeast – and remains very interested in decarbonizing the economy of Massachusetts in compliance with the Global Warming Solutions Act and Next Generation Climate Roadmap targets.

Acadia Center has several concerns stemming from the most recent Massachusetts Future of Gas Stakeholder meeting held on December 3, 2021. Based on our participation in the stakeholder process to date, Acadia Center is concerned that several of the key modeling decisions by the LDCs and their consultants related to biomethane assumptions could jeopardize the value of the ultimate outputs of the analysis. These concerns include a modeling approach that:

1. Assumes that all forms of biomethane are completely carbon neutral
2. Underestimates future national competition and costs of obtaining biomass feedstocks
3. Does not account for the opportunity cost of using limited biomass feedstocks to generate (theoretically[1]) carbon neutral biomethane versus using these same feedstocks to generate negative emissions that are desperately needed to achieve net-zero targets

[1] Assuming sustainable sources of biomass feedstocks and significantly reduced levels of methane leakage across the biomethane supply chain

Acadia Center encourages the LDCs and their consultants to modify their scenario analysis to fully account for these factors that could undercut the validity of the study's results. We would be happy to discuss our concerns further, either directly or in a smaller, technical session regarding draft scenario results.

A Heavy Reliance on Biomethane to Decarbonize Buildings in Modeled Scenarios

All of the scenarios presented in the Draft Scenario Analysis rely on some "low-carbon fuels": biomethane (commonly referred to as RNG), hydrogen, and synthetic natural gas (SNG). Biomethane, in particular, is a presented as a key tool for decarbonizing heating in buildings across multiple scenarios. For example, by 2050 in the "Hybrid Electrification" scenario with "optimistic biomethane supply assumptions", biomethane appears to account for over 60% of the total energy delivered through the gas distribution system.[2] Given the strong reliance on biomethane to decarbonize the building sector in many scenarios, including the "Hybrid Electrification" scenario, it's important that the assumptions related to biomethane be available to stakeholders and that these assumptions be reviewed with a discerning eye. To date, stakeholders have received limited information on assumptions related to biomethane.

Biomethane is Not a Carbon Neutral Fuel Just Because the MA GHG Inventory Treats it as One

One of the key limitations of Massachusetts' greenhouse gas inventory is that it treats biogenic emissions as an informational item and does not consider the impact of biogenic emissions on overall statewide emissions totals. This is a gross simplification of a complex issue, particularly in instances where biogenic emissions come from the production, processing, and transportation of biomethane. The scenario analysis conducted by E3 mimics this flawed approach, simply assuming that biomethane derived from upgraded biogas is carbon neutral in all instances. This assumption ignores a number of critical, and complex, nuances related to GHG accounting for biomethane that need to be taken into account.

Energy crops, sometimes referred to as "intentionally produced biogas", are the most problematic biomethane feedstock for a number of reasons. Acadia Center commends E3's approach of completely excluding energy crops from consideration as a biomethane feedstock in their analysis. However, even excluding energy crops, many of the pathways for producing biomethane via biogas are problematic from a GHG emissions perspective.

Typically, biogas produced at facilities, including wastewater treatment plants and landfills, is either vented or flared. Venting is a controlled release of biogas into the atmosphere during production, while flaring is controlled burning during biogas production using a dedicated flare to ignite the methane (CH_4). While both processes release GHG emissions, flaring is much more preferable from a GHG emissions perspective since it converts CH_4, a GHG over 80 times more potent than carbon dioxide (CO_2) over a 20-year time period, to CO_2 prior to being released into the atmosphere.[3] This is one of the reasons California requires all municipal waste landfills to install gas collection and control systems. Once captured, landfill gas in California can either be flared or used to generate electricity and heat,

[2] Estimated based on graph on slide 11 of 11/30/21 Draft Scenario Analysis presentation: https://thefutureofgas.com/content/downloads/2021-11-30/11.16.21.%20DRAFT%20Scenario%20Analysis.pdf

[3] Greenhouse Gas Protocol "Global Warming Potential Values" https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

but both processes must have a "CH_4 destruction efficiency", essentially the rate at which CH_4 is converted to CO_2, of at least 99%.[4] Alternatively to venting or flaring, biogas can be captured and processed to produce biomethane.

When biomethane is produced from biogas that has been diverted from flaring, even relatively small levels of methane leakage in the biomethane supply chain (including processing, transporting, storing, and end uses phases) can result in net positive GHG emissions. This is the case because the GHG intensity of producing biomethane via biogas diverted from flaring must be measured against the counterfactual – in this case, flaring the biogas. Even assuming relatively low biomethane supply chain leak rates, simply capturing and flaring "waste biogas" (e.g. from landfills) often produces less GHG emissions than the emissions arising from CH_4 leaks occurring in the biomethane supply chain.

Research suggests that total supply chain CH_4 leakage from biomethane intended for pipeline injection typically ranges from 2.8-4.8%, but can be as high as 15.8%.[5] The same study assumed a reasonable fossil natural gas (FNG) supply chain leak rate of 2.8%.[6] Assuming an average 3.8% biomethane supply chain leak rate, a 2.8% FNG supply chain leak rate, and using 20-year global warming potential (GWP) values, the **methane leakage GHG footprint of biomethane derived from waste biogas that is diverted from flaring is 33% of the combustion plus methane leakage GHG footprint of FNG.**[7] **Under a scenario where the biomethane supply chain leak rate exceeds 6.8% for biomethane produced using biogas diverted from flaring, the biomethane GHG footprint exceeds that of FNG.**[8] Given this information, sensible policy aimed at minimizing GHG emissions from biogas would require facilities that currently vent biogas to either flare the biogas or combust the biogas in combined heat and power (CHP) plants on site.

The Massachusetts Greenhouse Gas Inventory, and in turn the scenario analysis conducted by E3, ignores this important distinction and treats all biomethane as carbon neutral – regardless of whether the biomethane is produced using true "waste methane" that can't reasonably be captured and either flared or used productively in a CHP power plant.

Acadia Center requests that E3 conduct a sensitivity analysis that accounts for the increase in net GHG emissions resulting from diverting biogas from flaring to produce biomethane. This sensitivity analysis should account for methane leaks resulting from the processing, transporting, storing, and end uses phases of biomethane and account for methane leaks along the supply chain regardless of whether they occur within or outside the borders of Massachusetts.

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[4] California Air Resources Board Final Regulation Order: Methane Emissions from Municipal Solid Waste Landfills. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2009/landfills09/landfillfinalfro.pdf

[5] Grubert, Emily. 2020. "At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates" https://iopscience.iop.org/article/10.1088/1748-9326/ab9335

[6] Ibid.

[7] Ibid.

[8] Ibid.

Future Competition for Biomass Feedstocks is Likely to Drive Up the Cost of Low-Carbon Fuels Higher than E3's Model Assumes

There are two main production pathways for biomethane: 1) Anaerobic digestion and 2) Gasification. Feedstocks for biomethane produced via anaerobic digestion include landfill gas, wastewater, animal manure and municipal waste. Feedstocks for gasification include agricultural residues, municipal solid waste, and forest residues. The feedstocks required for biomass gasification can be used to produce a variety of fuels that will be critical for decarbonizing various hard-to-electrify end uses including shipping, aviation, heavy-duty trucking, various industrial end uses, and "clean firm" power generation.[9]

Many of the scenarios developed by E3 are highly reliant on the gasification of biomass to produce biomethane for eventual consumption in residential and commercial buildings in Massachusetts. For example, in the "Efficient Gas" scenario with "optimistic biomethane supply assumptions", biomass gasification is responsible for producing approximately 60% of the biomethane consumed in buildings by 2050. However, reliance on the nation's limited supply of sustainable biomass feedstocks to produce biomethane to be blended into the gas distribution system in New England does not come without a massive opportunity cost. Most notably, this strategy will 1) Use limited biomass resources that should instead be diverted to the hardest-to-electrify sectors of the U.S. economy and 2) Drive up the cost of these limited biomass resources, making it even more challenging for the hardest-to-electrify sectors to achieve decarbonization.

E3's model attempts to account for this dynamic by modeling competition for biomass feedstocks across heating, industrial, and transportation sectors. However, E3's approach is to allocate a "population-weighted" share of biomass feedstocks to each state– in other words, allocating a "fair share" of biomass feedstocks based strictly on population. Since Massachusetts makes up approximately 3% of the "East of the Mississippi" population of the U.S., the model assumes that Massachusetts can responsibly consume approximately 3% of all biomass generated by this group of states. [10]

This population-weighted methodology for allocating biomass feedstocks fails to account for that critical point that states with a disproportionate concentration of industry and other hard-to-electrify sectors will require a much higher share of biomass feedstocks, beyond the levels apportioned using a population-weighted approach, to have any reasonable chance of achieving net-zero emissions by 2050. To illustrate this point, consider the state of Louisiana. Louisiana has a population of 4.65 million people, about two thirds the population of Massachusetts. Using E3's population-weighted approach, Louisiana would receive about two thirds as much biomass feedstocks as Massachusetts. However, **industrial sector GHG emissions in Louisiana are over 35 times industrial sector**

[9] Clean firm power generation is zero-carbon power that can be relied on whenever it is needed for as long as it is needed and serves to compliment intermittent renewable energy resources including wind and solar.
[10] This 3% assumption and explanation of how biomass competition was modeled was shared verbally by E3 staff during the 12/3/21 stakeholder meeting but has not been described in writing to stakeholders.

emissions in Massachusetts.[11] Put another way, industrial sector emissions alone in Louisiana in 2018 were over 67% higher than the entire Commonwealth's emissions from all sectors in the same year.[12] States with heavy concentrations of industry, like Louisiana, already face the most challenging path to achieving decarbonization without states with relatively light concentrations of industry, like Massachusetts, competing for biomass feedstocks that are used to generate low-carbon fuels for a sector (buildings) that is relatively easy to decarbonize through electrification. The Commonwealth has a moral imperative to ensure that the path it pursues to achieve net-zero emissions does not directly conflict with the efforts of other states (and in the bigger picture, heavily industrialized countries) to achieve net-zero emissions and the scenario modeling efforts should accurately reflect this imperative.

Acadia Center also has significant concerns related to how E3 has chosen to model competition across various low-carbon fuels (biomethane, hydrogen, and synthetic natural gas) included in their analysis. The analysis assumes that there are up to five distinct market clearing prices[13] for these fuels.[14] For example, in the "Efficient Gas" scenario assuming "conservative biomethane supply" in 2050 the biomethane resources that are cheapest to produce are assumed to have a market clearing price below $10/MMBtu, while the most expensive synthetic natural gas (SNG) resources are assumed to have a market clearing price over six times higher, at $60/MMBtu. The end products in both instances, biomethane and SNG, are chemically identical products. **If the market is willing to pay $60/MMBtu for SNG, the market would also be willing to pay $60/MMBtu for biomethane.** The market clearing price should be identical for both low-carbon fuels in scenarios where the more expensive SNG is modeled to be part of the low-carbon fuel blend used in Massachusetts.

The analysis also appears to assume that the market clearing price of hydrogen is completely independent of the clearing price for either RNG or SNG. For example, in the "Efficient Gas" scenario assuming "conservative biomethane supply" in 2050 the clearing price for hydrogen is around $24/MMBtu, while the most expensive SNG resources are assumed to have a market clearing price more than double that at over $60/MMBtu.[15] While hydrogen and SNG are very different fuels chemically, production of both fuels will require competition for the same feedstocks or "intermediate fuels". For example, biomass can either be purchased on the market for the purpose of producing hydrogen via gasification or for the purpose of producing SNG via gasification.[16] Similarly, hydrogen produced via electrolysis can either be sold as a "final fuel" (e.g. to be used in hydrogen fuel cell trucks) or sold as an intermediate

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[11] U.S. Energy Information Administration, "Energy-Related CO2 Emission Data Tables" Table 4 https://www.eia.gov/environment/emissions/state/

[12] MassDEP Emissions Inventories, https://www.mass.gov/lists/massdep-emissions-inventories

[13] The market clearing price is the equilibrium monetary value of a traded asset determined by the interaction of supply and demand forces

[14] Slide 98 of 11/30/21 Draft Scenario Analysis presentation: https://thefutureofgas.com/content/downloads/2021-11-30/11.16.21.%20DRAFT%20Scenario%20Analysis.pdf

[15] Ibid.

[16] While the E3 analysis makes the simple assumption that hydrogen consumed in Massachusetts is produced only via electrolysis and not via biomass gasification, it is realistic to assume that some hydrogen will be produced via gasification in the U.S. (as modeled in Princeton Net-Zero America among other studies), further driving up demand for biomass feedstocks needed to produce RNG and SNG.

fuel that, combined with captured CO_2, produces SNG (e.g. to be used in gas pipelines). The market clearing price for hydrogen will be directly impacted by the market clearing price of SNG and RNG due to competition for feedstocks and competition for hydrogen as an intermediate fuel in many of the scenarios E3 has modeled, but this dynamic is not currently being captured based on Acadia Center review of the information that has been provided to date.

Acadia Center requests that E3 :

- Share more detailed assumptions on how competition for biomass feedstocks across industries and across states is being modeled.
- Share what level of decarbonization in hard-to-electrify sectors is assumed to be achieved by 2050 in states outside of Massachusetts, how these levels of decarbonization are being achieved (e.g. biomass gasification, hydrogen electrolysis, electrification, etc.), and how the assumed levels of decarbonization are modeled to impact the market clearing price of biomass feedstocks.
- Provide a detailed explanation of why the population-weighted approach to biomass allocation was selected and why an approach that considers the unequal concertation of hard-to-electrify sectors (e.g. industrial) across states is not more appropriate.
- In all scenarios where SNG is assumed to be part of the low-carbon fuel blend, the market clearing price of RNG should be adjusted so that it is identical to the market clearing price of SNG.
- In all scenarios where synthetic natural gas from biomass (SNG-bio) is assumed to be part of the low-carbon fuel blend, the market clearing price of hydrogen should be adjusted to account for SNG-bio driving increased demand for biomass feedstocks (that could be used to produce either hydrogen or SNG-bio).
- In all scenarios where synthetic natural gas from direct air capture (SNG-DAC) is assumed to be part of the low-carbon fuel blend, the market clearing price of hydrogen should be adjusted to account for SNG-DAC driving increased demand for hydrogen.

Massachusetts and the U.S. Will Need Negative Emissions by 2050 and Using Biomass to Produce Biomethane for Consumption in Buildings is Directly at Odds with Negative Emissions Pathways

There is scientific consensus among experts that negative emissions, accomplished through capturing and storing CO_2 by various means, will be needed to achieve global climate targets by 2050. The Massachusetts Executive Office of Energy and Environmental Affairs ("EEA") acknowledged this need for negative emissions when it set a target of 85% reduction of gross emissions by 2050. This gross emissions reduction target relies on the assumption that the last 15% of gross emissions will be "netted out" via sequestration.

Both the Massachusetts Roadmap and the D.P.U. 20-80 scenario analysis conducted by E3 modeled a 90% reduction in gross emissions by 2050 and assumed the final 10% of emissions would be netted out by sequestration, but neither modeling effort has conducted rigorous analysis to demonstrate how the 10% sequestration level could realistically and cost-effectively be achieved. The Roadmap limited its analysis to enhancing the carbon sequestration potential of Massachusetts' forests and soils and found that their potential for sequestration (~ 5 $MMTCO_2e$) is well short of the 10% sequestration needed (~9.4 $MMTCO_2e$), never mind the 15% established by state mandate (14.1 $MMTCO_2e$).[17] E3's modeling makes a simple assumption that 10% sequestration will be needed and the Commonwealth will achieve that level of sequestration, but the model does not investigate how or at what cost.

Many reputable studies investigating the most cost-effective route to achieving negative emissions at scale point to the critical role of biomass. For example, one of the key conclusions of the Princeton Net Zero-America modeling effort was that, by far, the most valuable and cost-effective use of limited biomass feedstocks was the production of hydrogen (H_2) via biomass gasification with carbon capture and sequestration.[18] Biomass gasification with carbon capture and sequestration to produce hydrogen has a two-birds-one-stone advantage: It both 1) Results in negative emissions 2) Generates a *net negative-emissions fuel* that can be used to decarbonize hard-to electrify sectors (e.g. industrial, aviation, maritime, clean firm power generation).

As a result, the Princeton study's "High Electrification" pathway found that by 2050, about 68% of all biomass feedstocks nationally were used to produce net negative-emissions hydrogen. The "Less-high Electrification" pathway reached a similar conclusion with about 61% of all biomass feedstocks allocated to production of net negative-emissions hydrogen.[19] Critically, Princeton found overwhelmingly that the most cost-effective use of the H_2 generated via biomass gasification was for direct "demand side" uses (e.g. transport, production of chemicals, direct-reduced iron, process heat in various industries) and production of synthetic liquid fuels for use in non-electrified transportation. In both the "high electrification" and "less-high electrification" pathways less than 5% of all H_2 produced nationally in 2050 was allocated to pipeline gas blending.[20] **Biomass gasification and pyrolysis plays a lynchpin role in achieving negative emissions in the Princeton study: In the "high electrification scenario" biomass accounts for approximately 70% of captured carbon and in the "less-high electrification" scenario (where higher levels of negative emissions are required) it accounts for approximately 40% of captured carbon.[21]**

This is a critical point. Biomass gasification to produce biomethane for eventual consumption in commercial and residential buildings will at best be a carbon neutral fuel. [22] **Using limited biomass feedstocks to produce (theoretically) carbon neutral biomethane for consumption in a relatively easy-to-electrify sector (buildings), as is assumed in many of the scenarios developed by E3, directly inhibits the ability of Massachusetts, and the U.S. as a whole, to produce net-negative emissions fuels that are needed to both generate negative emissions and**

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[17] Massachusetts 2050 Decarbonization Roadmap, https://www.mass.gov/doc/ma-2050-decarbonization-roadmap/download

[18] Princeton University Net-Zero America Potential Pathways, Infrastructure, and Impacts Final Report. Slide 172. https://netzeroamerica.princeton.edu/the-report

[19] Princeton University Net-Zero America Potential Pathways, Infrastructure, and Impacts Final Report. Slide 175. https://netzeroamerica.princeton.edu/the-report

[20] Princeton University Net-Zero America Potential Pathways, Infrastructure, and Impacts Final Report. Slide 194. https://netzeroamerica.princeton.edu/the-report

[21] Princeton University Net-Zero America Potential Pathways, Infrastructure, and Impacts Final Report. Slide 206. https://netzeroamerica.princeton.edu/the-report

[22] Assuming sustainable sources of biomass feedstocks and significantly reduced levels of methane leakage across the biomethane supply chain

decarbonize hard-to-electrify sectors. E3's modeling approach completely ignores this tradeoff by making a blanket assumption that the Commonwealth will assume 10% sequestration in all scenarios without modeling how or at what cost.

Acadia Center requests that E3 :

- Quantitatively incorporate into the scenario analysis the trade-off of:
  - 1) Using limited biomass feedstocks to produce (theoretically) carbon neutral biomethane for consumption in a relatively easy-to-electrify sector (buildings) with
  - 2) Using biomass feedstocks to produce net-negative emissions fuels that are needed to both "net out" remaining gross emissions and decarbonize hard-to-electrify sectors, within and outside the borders of Massachusetts.
- Quantitatively assess how the above tradeoff analysis is impacted by assuming 10% vs. 15% sequestration of remaining emissions by 2050 in Massachusetts.
- Explain how the anticipated national demand for negative emissions via biomass gasification and/or pyrolysis is assumed to impact the price of biomass feedstocks and biomethane by 2050.

Conclusion

Acadia Center urges the consultants to adjust their modeling approach to accommodate the three key concerns identified in this letter and allocate more time in the 20-80 stakeholder process for answering technical questions in a live discussion format. Acadia Center looks forward to continuing to work with the LDCs and their consultants as an interested stakeholder to reach a safe, sustainable, and economic clean energy transition.

Sincerely,

Ben Butterworth
Senior Manager, Climate & Energy Analysis
bbutterworth@acadiacenter.org
617.742.0054 ext.111