July 1, 2022

New York Climate Action Council
New York State Department of Environmental Conservation
625 Broadway
Albany, New York
12233-001

Coalition for Renewable Natural Gas - Feedback on New York Draft Scoping Plan

Dear Climate Action Council Members,

The Coalition for Renewable Natural Gas (RNG Coalition) submits the following comments in response to the New York Climate Action Council's (CAC or Council) Draft Scoping Plan (Draft or Draft Plan) and related documents.[1]

We commend the extensive work of the Council, the Advisory Panels, and the dedicated staff at New York's key agencies tasked with drafting this important plan and addressing climate change—including the leadership of the New York Department of Environmental Protection (DEC), New York State Energy Research and Development Authority (NYSERDA), and the Public Service Commission (PSC). Once complete, the Final Scoping Plan (Final Plan) will be the state's most comprehensive document aimed at providing a pathway toward reducing greenhouse gas (GHG) emissions and achieving the broader social and environmental goals required by the Climate Leadership and Community Protection Act (CLCPA).[2]

The Draft Plan contains several key strategies related to the use of renewable gases (e.g., biomethane and renewable hydrogen) as a climate change mitigation tool for use across all sectors. These strategies will increase the use of RNG as a clean fuel; capture and utilization of methane emissions from organic waste streams; and circularity of New York's economy through recycling, the creation of bioproducts, and carbon sequestration.

While we strongly appreciate the inclusion of renewable gases in the various sections in the Draft Plan, we hope that the attached comments from our Coalition will allow the Final Plan to go further and outline a comprehensive vision for the near- and long-term sustainable production and use of renewable gases as a key tool toward New York's greenhouse gas reduction goals.

The most critical policies that will drive RNG development quickly are a Clean Fuel Standard (CFS) in the transportation sector and utility procurement of renewable gases through either a

[1] https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan

[2] https://www.nysenate.gov/legislation/bills/2019/S6599

Renewable Gas Standard (RGS) or Clean Heat Standard (CHS). We strongly recommend swift adoption of such policies.

Sincerely,

/s/

Sam Wade
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Renewable Gas is a Fundamental Part of the Solution to Climate Change

The Role of Renewable Gas in Decarbonization

Renewable gases, including renewable natural gas[3] (RNG) and renewable hydrogen, are an important near-term decarbonization strategy for all applications which currently utilize fossil-derived fuels and, in the long-term, renewable gas use will be necessary in applications that have certain reliability requirements, or which are not well-suited to electrification.[4]

Incorporating the use of renewable gases as part of New York's Final Scoping Plan will result in compound benefits through (1) the displacement of anthropogenic carbon dioxide (CO_2) emissions from the combustion of fossil fuels, (2) the critical near-term greenhouse gas (GHG) benefits of increased methane capture and destruction, and (3) additional environmental benefits that result from the improved management of organic waste.

To achieve these outcomes, New York should target the development of renewable gases in tandem with the other technologies that will be required to fully decarbonize the state.[5] RNG should be given significant attention in the near-term, based on both the well-proven technology readiness level of various methods of making RNG today—such as Anerobic Digestion (AD)—and the flexibility provided by RNG's fungibility with all conventional gas applications.

In the mid- to long-term, hydrogen produced from renewable feedstocks such as clean electricity and waste biomass should also be viewed as an essential part of New York's renewable gas mix. In a similar manner to RNG, waste-biomass-derived hydrogen is poised to contribute to New York's circular bioeconomy as a pathway for recycling resources which are not suitable for AD. Furthermore, the use of carbon capture and sequestration (CCS) technologies such as geologic storage or biochar will produce negative-GHG outcomes when paired with RNG and hydrogen derived from waste biomass. These technologies will provide a necessary pathway to *remove* emissions from the atmosphere,[6] creating an important pathway to carbon neutrality and, ultimately, carbon negativity.

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[3] Sometimes called biomethane or refined biogas.

[4] Bataille et al., *A Review of Technology and Policy Deep Decarbonization Pathway Options for Making Energy-Intensive Industry Production Consistent with the Paris Agreement.* https://www.sciencedirect.com/science/article/abs/pii/S0959652618307686

[5] Including, for example, end-use electrification and geothermal resources. RNG Coalition does not oppose electrification or deployment of any other low-GHG technology.

[6] Sequestration of the biogenic carbon contained in waste feedstocks from RNG and biomass-derived renewable hydrogen can be a carbon-negative process that removes carbon from the atmosphere. This benefit is separate from the methane destruction potential of RNG, which can lead to additional carbon-negative outcomes on a lifecycle basis relative to existing environmental control baselines.

Over time, these resources can be directed toward the end-uses which are best served by the use of gaseous fuels, serving in tandem with technologies that require time to scale and achieve production cost reductions (e.g., electrolytic hydrogen, heavy duty electric vehicles) or that involve the turnover of long-lived capital stock (e.g., electrification of building space and water heating).

The portion of renewable gas serving New York's gas system will increase even as total system throughput declines, eventually leading to a smaller gas system which transports only 100% clean fuels[7] to targeted end uses. Given expected declines in gas system throughput, the use of renewable gas need not lead to net pipeline expansion, beyond connecting these new supply sources to existing load.

Further, many long-term studies of decarbonization agree that the use of renewable gases is essential but disagree about which sector will most need RNG to decarbonize in the long run.[8] Because of these facts, in these comments we attempt to articulate a nimble vision of how RNG in New York can best help with decarbonization in the near-, mid-, and long-terms as shown in Figure 1.

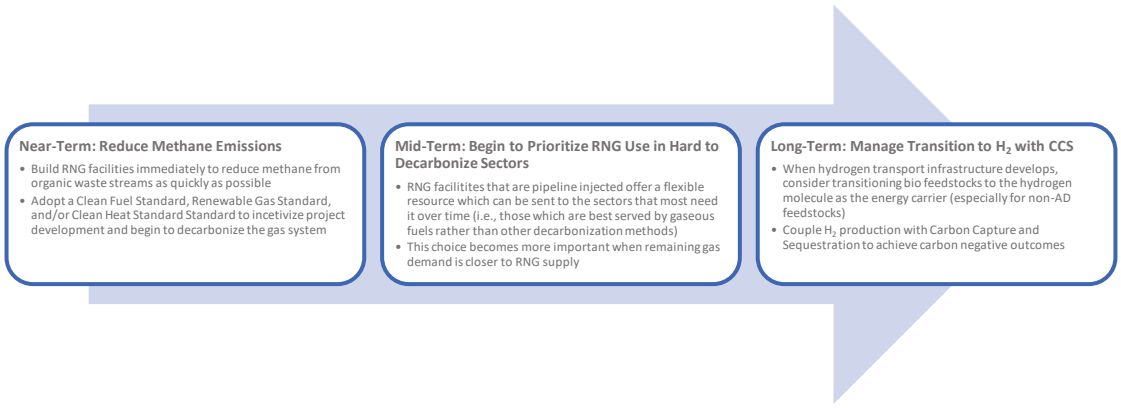

Figure 1. New York's Priorities for RNG Deployment Will Likely (and Should) Shift Over Time

Navigating these complex but necessary changes will require state agencies, utilities, and other stakeholders to fully consider all possible renewable gas end-uses in the near-term, and to develop a framework to determine what end-uses may be most appropriate in the mid- to long-term. With this need in mind, we note with concern that the Draft does not clearly articulate what policies should be used to incent the development and use of renewable gases. As outlined below, based on existing policies and consensus surrounding gas decarbonization

[7] https://www.nationalgrid.com/document/146251/download

[8] WRI 2020, Renewable Natural Gas as a Climate Strategy: Guidance for State Policymakers https://static1.squarespace.com/static/53a09c47e4b050b5ad5bf4f5/t/60ad57a35aaa6563fbc3e508/1621972901032/2020_Dec+World+Resources+Institute_Renewable-natural-gas-climate-strategy.pdf

strategy in other jurisdictions, we believe that New York should incorporate a Renewable Gas Standard (or Clean Heat Standard), along with a Clean Fuel Standard, as part of a broad gas decarbonization strategy.

Reducing Methane Emissions and Improving Organic Waste Management

Complementary to their role as a method of zero-fossil-carbon energy supply, RNG and other waste-derived resources are unique in their near-term ability to reduce methane—a short-lived climate pollutant that, when assessed over a 20-year timeframe, is up to 80 times as potent as a greenhouse gas as carbon dioxide[9]—and to serve as a catalyst for improving organic waste management practices.

Society's waste streams create significant methane that must be dealt with quickly. Using this methane from organic wastes productively as a resource, rather than flaring it, provides greater impetus toward implementing and improving methane capture and organic waste management systems. The need to target methane emissions immediately as part of any GHG reduction strategy is substantiated by leading organizations focused on climate change mitigation, including the Intergovernmental Panel on Climate Change (IPCC), as described below. Indeed, the potency of methane as a greenhouse gas and, by association, the urgency of addressing methane emissions is rightfully recognized by New York, which is planning to assess GHGs using a 20-year global warming potential (GWP).[10]

As shown in Figure 2, comparing the International Energy Agency's (IEA) estimated cost of reducing methane emissions through the creation of RNG[11] to the Social Cost of Carbon (SCC) assessed by New York,[12] RNG is likely to be a cost-effective GHG reduction strategy. Inclusion of methane reduction benefits in such a calculation is important. Factoring methane capture and destruction into the lifecycle GHG impact shows the true cost-effectiveness of RNG facilities, even using a 100-year GWP. Comparatively, using a 20-year GWP, which is required by the CLCPA and is more consistent with the timeframe under which we must reduce GHG emissions to address climate change,[13] would further and significantly increase this cost effectiveness given the outsized impact of addressing methane emissions.

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[9] The Global Warming Potential for non-fossil methane is 27 on a 100-year basis and 80 on a 20-year basis according to the most recent IPCC assessment. See Table 7.15 directly from Chapter 7.6 of the Sixth Assessment Report (Working Group 1: The Physical Science Basis). https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07.pdf

[10] https://www.dec.ny.gov/energy/99223.html

[11] https://iea.blob.core.windows.net/assets/03aeb10c-c38c-4d10-bcec-de92e9ab815f/Outlook_for_biogas_and_biomethane.pdf

[12] New York estimates that the societal benefit of reducing one ton of carbon dioxide is $125 per ton (lower central discount rate, for a 2020 reduction): https://www.dec.ny.gov/regulations/56552.html

[13] Sam Abernethy and Robert B Jackson, *Global Temperature Goals Should Determine the*

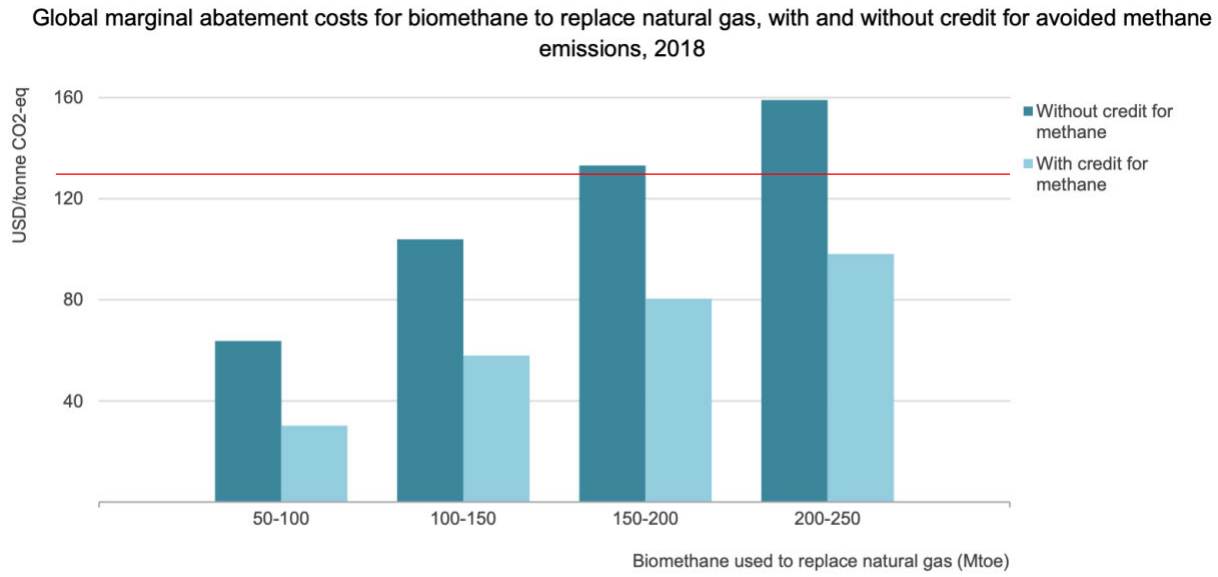

Figure 2. Comparing the IEA's Biomethane Abatement Costs to New York's Social Cost of Carbon (red line), most RNG is cost effective even using 100-year GWPs. Recognizing methane benefits (especially if using 20-year GWP) helps improve cost effectiveness further.

In creating a policy framework designed to improve the GHG performance of the organic waste sector it is important to consider that, globally, municipal solid waste is expected to grow 69% from 2.01 billion metric tons (BT) in 2018 to 3.4 BT in 2050 (around 50% of which is organic waste).[14] Moreover, these trends are underpinned by an expected 25% population increase of 2 billion people between now and 2050.[15] As a jurisdiction leading in waste generation[16] and population,[17] and considering the state's ambitious GHG reduction goals, New York needs to help pioneer the development and commercial deployment of viable technologies to address these challenges.

New York's Food Donation and Food Scraps Recycling Law[18] is designed to support anaerobic digestion as a waste reduction strategy. This is consistent with the Food Recovery Hierarchy developed by U.S. EPA, which ranks industrial use—inclusive of conversion to energy through

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Time Horizons for Greenhouse Gas Emission Metrics, 2022 Environ. Res. Lett. 17 024019 https://iopscience.iop.org/article/10.1088/1748-9326/ac4940/pdf

[14] https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

[15] https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html

[16] According to the Draft, New York generated approximately 18 million tons of Municipal Solid Waste in 2018.

[17] According to the U.S. Census, New York ranks 4th in population among U.S. states. https://www.census.gov/popclock/

[18] https://www.dec.ny.gov/chemical/114499.html

anaerobic digestion—as the 4th highest use after source reduction and repurposing edible food to humans and animals.[19]

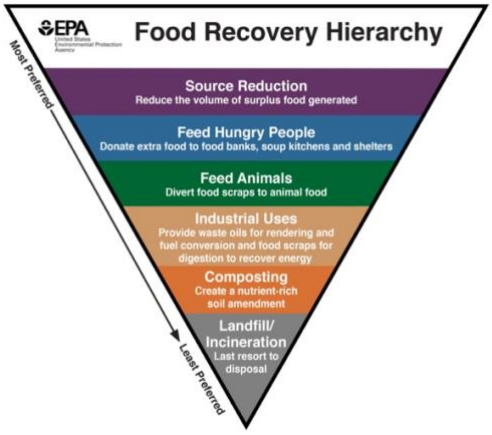

Figure 3. U.S. EPA Food Recovery Hierarchy

RNG production through anaerobic digestion of materials such as food waste, animal manure, and wastewater also yields valuable by-products. After the elimination of pathogens, digested solids can be recycled for productive uses such as animal bedding,[20] and AD converts nutrients into a form more accessible by plants than raw manure, allowing for an effective organic fertilizer.[21] Processing digestate using pyrolysis and other technologies to create biochar is also an option, resulting in a soil amendment which supports plant growth, can eliminate harmful perfluoroalkyl and polyfluoroalkyl substances (PFAS), and can achieve carbon-negative outcomes. Overall, recycling and using the by-products of waste through AD for RNG production processes creates a more environmentally responsible and sustainable circular economy.

RNG Coalition generally supports current language in the Waste section of the Draft Plan surrounding the productive use of biogas as a GHG mitigation strategy. However, the Draft does not properly consider RNG as a thermal decarbonization strategy. For example, that a study surrounding RNG use should "stress the use of fuel cells for electricity in lieu of generators or pipeline use, [etc.]"[22] does not account for the benefits of replacing geologic natural gas, better utilizing existing natural gas infrastructure, or the long-term need for gaseous thermal resources in certain sectors.

Furthermore, the Draft is not clear as to what policies or strategies will be used to promote methane capture from these sources if RNG is not incented. Simply requiring organic waste

[19] https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy

[20] U.S. EPA. *The Benefits of Anaerobic Digestion* (2020, August 18) https://www.epa.gov/agstar/benefits-anaerobic-digestion

[21] Id.

[22] See Draft pg. 251

aggregators to capture and flare emissions is not a good outcome from a local criteria pollutant perspective, and will not incent methane capture to the fullest extent possible. Studies from both the United States Environmental Protection Agency[23] (U.S. EPA) and the California Air Resources Board (CARB)[24] have shown that pipeline injection of biomethane reduces criteria air pollutants both on site (relative to a case where the biogas is flared or used in most on-site power generation equipment) and on a lifecycle basis (with additional emission reductions possible depending on end use).[25]

As described in further detail below, and given that combustion of RNG and biogas do not appear to be permitted as electricity generation resources under the CLCPA, the Council should incorporate a CFS and a RGS (or a CHS) as part of the Final Plan. Jurisdictions leading the way[26] on GHG reduction have implemented such programs as part of their strategy for simultaneously decarbonizing the energy and organic waste sectors.

RNG Supply Potential

Based on a 2019 study conducted by ICF which outlines the supply potential for RNG in the United States,[27] we estimate that RNG from AD feedstocks will be able to supply at least 1,425.3 tBtu/year by 2040.[28] Based on U.S. natural gas consumption in 2021, this would cover approximately 30.6% of residential demand, 43.7% of commercial demand, or 17.4% of industrial demand nationally.[29]

Comparatively, NYSERDA recently published a study prepared by ICF that specifically outlines the potential for RNG production in New York.[30] According to the NYSERDA report, RNG potential from anaerobic digestion feedstocks ranges from 24.2 tBtu/year in a "Limited Adoption" scenario to 83.9 tBtu/year in a "Maximum Growth" scenario. We believe that the

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[23] https://nepis.epa.gov/Exe/ZyPDF.cgi/P100QCXZ.PDF?Dockey=P100QCXZ.PDF

[24] https://ww2.arb.ca.gov/sites/default/files/2020-07/dairy-emissions-matrix-113018.pdf

[25] For example, when low-NOx natural gas vehicles displace emissions from diesel vehicles.

[26] Jurisdictions which have historically been leaders in climate and environmental policy—such as California, Oregon, Washington, Canada, and the EU—have policies in place to promote renewable gases as part of their waste management and GHG reduction strategies.

[27] ICF, *Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment.*

https://gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf

[28] Based conservatively on the "High" production scenario, using landfill gas, animal manure, wastewater, and food waste feedstocks.

[29] https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm

[30] ICF, *Potential of Renewable Natural Gas in New York State.*

https://www.nyserda.ny.gov/-/media/Files/EDPPP/Energy-Prices/Energy-Statistics/RNGPotentialStudyforCAC10421.pdf

"Optimistic Growth" scenario is, in fact, conservative, projecting a 44.4 tBtu/year potential which would cover approximately 3.3% of New York's natural gas demand as of 2019.[31] This report provides a reasonable lens through which to view the "lowest-hanging fruit" within the RNG universe, however, there are key assumptions made by ICF which result in the exclusion of a portion of RNG supply.

First and foremost, the study does not account for organic waste which is not landfilled in New York. According to the Draft, 27% of New York's MSW is exported.[32] This waste should ultimately be diverted and processed in-state given waste diversion laws; otherwise, New York is simply exporting their waste management and methane emissions problems. Furthermore, the study does not model future growth and decline of landfilled waste based on existing or forthcoming policies such as the Food Donation and Food Scraps Recycling Law—effectively assuming that the same amount of waste will continue to be exported indefinitely. Finally, the food waste potential is largely limited to an analysis of commercial and industrial sources—excluding significant amounts residential food waste generated in the state. In short, if New York aims to divert food waste away from landfills, in-state RNG potential would be higher.

Although the RNG industry's focus has traditionally been limited to feedstocks which are well-suited to AD, it is also important to consider the additional potential of RNG produced via gasification of feedstocks such as agricultural residue, forestry and forest product residue, and energy crops. According to the NYSERDA study's "Optimistic Growth" scenario, New York's gasification feedstocks (excluding MSW) have the potential to add 71.1 tBtu/yr to RNG supply, which could cover an additional 5.4% of the states 2019 gas demand.

Although gasification/pyrolysis feedstocks do not have the benefit of capturing and reducing methane emissions, potential benefits incentivizing the improved management of these feedstock streams deserves additional attention in the Final Plan. In California, for example, the recently enacted RNG mandate requires the development of pilot gasification facilities for forestry waste as a wildfire control mechanism. Furthermore, potential energy crops should not be dismissed without additional analysis on a feedstock-by-feedstock basis. Research by the Climate and Applied Forest Research Institute at the State University of New York's College of Environmental Science and Forestry,[33] suggests that feedstocks such as willow can sequester more carbon in the soil than emitted over the plants' lifetime, potentially leading to carbon-negative outcomes even before the employment of CCS. Despite the need for more caution with gasification/pyrolysis feedstocks,[34] if incentivized carefully these resources have the

[31] https://www.eia.gov/state/print.php?sid=NY

[32] See Draft Plan pg. 233

[33] http://cafri-ny.org/wp-content/uploads/2021/01/Greenhouse-Gas-Balance-of-Willow.pdf

[34] We understand and appreciate the concerns of environmental groups related to intentionally creating methane through biomass gasification and agree that it is especially important to employ strong lifecycle accounting for such projects to guard against pathways that would produce a high-carbon outcome.

potential to drive numerous environmentally beneficial outcomes throughout New York's bioeconomy.

Finally, when determining the total potential for RNG in New York, the Council should consider using their population-weighted share of regional RNG resources that could be imported. New York's gas demand is currently served by pipelines which transport conventional natural gas, extracted in other states, many miles. While some parts of the gas infrastructure are slated to decline, these larger transport arteries will need to be maintained to support fossil natural gas use for some time, and could eventually transport 100% clean fuels as part of a smaller gas system. For example, ICF estimates that nationally, in a "High" production scenario, (analogous to the "Optimistic Growth Scenario" in the New York-specific study) states east of the Mississippi River[35] could produce 756.1 tBtu/y from AD feedstocks and 582.1 tBtu/y from gasification feedstocks (excluding MSW) in 2040.

Studies and Existing Programs Highlighting Capturing Methane from Organic Wastes Streams with Productive Energy Use as a Key Near-term Climate Strategy

The complementarity of RNG and renewable hydrogen with other decarbonization strategies—such as electrification and energy efficiency—is well-substantiated by climate change mitigation studies and strategies conducted in various states, including New York, as well as by leading universities, government entities, and environmental organizations.

New York's broader energy and waste decarbonization strategies should include renewable gases in a manner that reflects the most current thinking and best modeling of pathways to reach carbon neutrality by 2050 while also remaining focused on the need to drive substantial near-term GHG reductions. Indeed, with respect to the use of low-carbon fuels, Scenario 2 and Scenario 4 in the Plan—targeting RNG at proportions of 9% and 7%, respectively[36]—are most in line with gas decarbonization policies already in place in leading jurisdictions.

New York should target the most ambitious GHG reduction schedule possible and use all tools to try to achieve that schedule. The diversity of technologies proposed in Scenario 4 best reflects that approach. However, the Final Plan should still explicitly state the need to promote the use of renewable gaseous fuels. The following are leading examples of studies outlining the role of RNG in economywide decarbonization, all of which substantiate the necessity of including renewable gases in strategies that reach deep GHG cuts. We recommend that similar statements be included and reinforced in the Final Plan.

Intergovernmental Panel on Climate Change

[35] Including the New England, Middle Atlantic, South Atlantic, East North Central, and East South Central regions.

[36] Draft Scoping Plan Section 9.2: *Scenario Design*

The Intergovernmental Panel on Climate Change (IPCC) calls methane capture and recovery from solid waste management "a short-term 'win-win' policy that simultaneously improves air quality and limits climate change."[37] Furthermore, the 2021 IPCC Working Group I report recommends that "strong, rapid, and sustained reductions in CH_4 emissions" should be a first priority for policymakers.[38]

In its most recent approved draft report on GHG mitigation, entitled *Climate Change 2022, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change,*[39] the IPCC states that:

> *"Sustainable biofuels, low emissions hydrogen, and derivatives (including synthetic fuels) can support mitigation of CO_2 emissions from shipping, aviation, and heavy-duty land transport but require production process improvements and cost reductions."* Page SPM-41
>
> *"Because some applications (e.g., aviation) are not currently amenable to electrification, it is anticipated that 100% renewable energy systems will need to include alternative fuels such as hydrogen or biofuels."* Page TS-54
>
> *"Several biomass conversion technologies can generate co-benefits for land and water. Anaerobic digestion of organic wastes (e.g., food waste, manure) produces a nutrient-rich digestate and biogas that can be utilised for heating and cooking or upgraded for use in electricity generation, industrial processes, or as transportation fuel. The digestate is a rich source of nitrogen, phosphorus and other plant nutrients, and its application to farmland returns exported nutrients as well as carbon."* Page 12-102, line 36 (citations removed)
>
> *"Scaling up bioenergy use will require advanced technologies such as gasification, Fischer-Tropsch processing, hydrothermal liquefaction (HTL), and pyrolysis. These pathways could deliver several final energy carriers starting from multiple feedstocks, including forest biomass, dedicated cellulosic feedstocks, crop residues, and wastes."* Page 6-40, line 7
>
> *"Most production routes for biofuels, biochemicals and biogas generate large side streams of concentrated CO_2 which is easily captured, and which could become a source of negative emissions."* Page 11-32, line 12

[37] See page 6-91 of: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_06.pdf

[38] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf, pg. 27

[39] https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf

Environmental Protection Agency

The U.S. EPA has long supported biogas recovery for use as RNG under programs such as the Landfill Methane Outreach Program (LMOP),[40] AgSTAR,[41] and the Renewable Fuel Standard.[42] The LMOP website, for example, notes the benefits of RNG as a resource which utilizes existing infrastructure, supports local economies, provides local air quality benefits compared to fossil fuel resources such as diesel and conventional natural gas, and reduces GHG emissions through methane destruction and fossil fuel displacement. In the agricultural sector AgSTAR has, for more than 20 years, promoted covered lagoons and digesters as the top solutions for manure management.[43] More recently, EPA added Renewable Natural Gas as an explicit opportunity within the Methane Challenge program, noting that, "as a substitute for natural gas, RNG has many end-uses, including in thermal applications, to generate electricity, for vehicle fuel, or as a bio-product feedstock."[44]

Canada

Canada has made several climate commitments backed by concrete plans and policies. They have stated that:

> *"To meet our new 2030 and 2050 net-zero goals, Canada's economy will need to be powered by two equally important energy sources—clean power and clean fuels. Electrification—clean power—provides a near-term pathway for emissions reductions in many sectors including personal transport and the built environment. But clean fuels (low-carbon fuels that typically consist of clean hydrogen, advanced biofuels, liquid synthetic fuels, and renewable natural gas) are expected to play a critical role in 'hard-to-decarbonize' sectors such as industry and medium- and heavy-duty freight.*
>
> *Even in a scenario with ambitious electrification, it is estimated that 60 percent or more of national energy demand in 2050 could need to be met with clean fuels to meet a net-zero goal."*[45]

[40] https://www.epa.gov/lmop/renewable-natural-gas

[41] https://www.epa.gov/agstar

[42] https://www.epa.gov/renewable-fuel-standard-program

[43] https://www.epa.gov/sites/default/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf

[44] https://www.epa.gov/system/files/documents/2022-05/MC_BMP_TechnicalDocument_2022-05.pdf

[45] Natural Resources Canada, "Clean fuels – fueling the future," 2022. https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/clean-fuels-fueling-the-future/23735

In its 2030 Emissions Reduction Plan released on March 29, 2022, the Government of Canada adds that economy-wide strategies to reduce GHG emissions, inclusive of clean fuels and methane emissions reduction, will enable Canada to meet its climate targets in the most flexible and cost-effective way.[46]

Canada also has strong methane emission reduction targets. In November 2021, Canada joined the Global Methane Pledge, which has been signed by over 100 countries, to reduce anthropogenic methane emissions across all sectors by at least 30% below 2020 levels by 2030. The measures outlined in the 2030 Emissions Reduction Plan may result in a reduction in waste-sector GHG emissions of 49% by 2030 against 2005 levels.[47]

European Union

Europe has long supported RNG under the broad Renewable Energy Directive (RED) framework.[48] Recent revisions known as the "Hydrogen and Decarbonized Gas Package"[49] reinforce support for renewable gases as a key greenhouse gas reduction strategy in the context of RED updates and the "Fit for 55"[50] strategy, which is essentially the EU's Scoping Plan analogous process.

Individual European Union member states have very high biomethane blend rates. For example, Denmark's proportion of RNG injected into its system was almost 25% of total demand as of the end of 2021. Denmark hopes to be able to meet 75% of its gas demand from RNG by 2030. By 2034, RNG production is expected to cover all Danish gas consumption on an annual basis.[51]

Russia's recent military aggression against Ukraine has massively disrupted Europe (and the world's) energy system. It has caused hardship due to high energy prices and it has heightened energy security concerns, bringing to the fore the EU's over-dependence on gas, oil, and coal imports from Russia. As a result, on March 8, 2022, the European Commission called for a rapid phase out of Russian fossil fuels and an acceleration of the European Green Deal in its Communication "REPowerEU: Joint European Action for More Affordable, Secure and Sustainable Energy".[52] This action plan calls for Europe achieving 35 billion cubic meters (bcm)

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[46] Environment and Climate Change Canada, *2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy* (2022), page 23 (pdf page 25). https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/Canada-2030-Emissions-Reduction-Plan-eng.pdf

[47] Ibid, page 90 (pdf page 92)

[48] https://www.europeanbiogas.eu/renewable-energy-legislation/#:~:text=In%20general%2C%20the%20Directive%20is,border%20trade%20of%20biomethane%20easier

[49] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6682

[50] https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/

[51] https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/natural-gas/011022-denmark-hikes-proportion-of-biogas-in-grid-to-25-grid-operator

[52] https://ec.europa.eu/commission/presscorner/detail/en/qanda_22_3132

of annual RNG production by 2030. The European Biogas Association states that this target represents over 20% of the current EU gas imports from Russia and that by 2050, this potential can triple, growing to well over 100 bcm and covering 30-50% of the future EU gas demand.[53] The EU has also joined the Methane Pledge targeting a 30% reduction by 2030.[54]

International Energy Agency

The International Energy Agency's (IEA) *Net Zero by 2050* report from May 2021 projects that, to reach carbon neutrality, global RNG use needs to increase seven times from 2020 levels by 2030 and over 27 times 2020 levels by 2050, leading to a blend rate in gas networks of above 80%. The report also notes that a key advantage of RNG is ability to "use existing natural gas pipelines and end-user equipment",[55] continuing that "[t]he share of low-carbon gases (hydrogen, biomethane, synthetic methane) in gas distributed to buildings rises from almost zero to 10% by 2030 to above 75% by 2050",[56] and that "[g]overnments should prioritise the co-development of biogas upgrading facilities and biomethane injection sites by 2030, ensuring that particular attention is paid to minimizing fugitive biomethane emissions from the supply chain."[57] These statements surrounding the timeline and trajectory for RNG development and use align with our vision for the future of the RNG industry in New York and North America.

California

In May 2022 the California Air Resources Board (CARB) released their Draft 2022 Scoping Plan,[58] which outlines the state's pathway to carbon neutrality by 2045—one of the most ambitious GHG reduction targets put forth by any jurisdiction in the world. The plan identifies increasing methane capture at landfills and dairy digesters as a key GHG abatement strategy. Specifically, strategies for the dairy and livestock sector include, "[Installing] state of the art anaerobic digesters that maximize air and water quality protection, [maximizing] biomethane capture, and [directing] biomethane to sectors that are hard to decarbonize or as a feedstock for energy".[59] Strategies for reducing methane emissions include, "[maximizing] existing infrastructure and [expanding] it to reduce landfill disposal, with strategies including

[53] https://www.bioenergy-news.com/news/biomethane-will-deliver-20-of-current-eu-gas-imports-from-russia-by-2030/

[54] https://www.state.gov/joint-u-s-eu-statement-on-the-global-methane-pledge/

[55] Id., pg. 78

[56] Id., pg. 146

[57] Id., pg. 112

[58] https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents

[59] Id., pg. 214

composting, anaerobic digestion, co-digestion at wastewater treatment plants, and other non-combustion conversion technologies."[60]

California's strategy also includes the use of RNG across different sectors. In the buildings sector, for example, "This transition must include the goal of trimming back the existing gas infrastructure so pockets of gas-fueled residential and commercial buildings do not require ongoing maintenance of the entire limb for gas delivery. Blending low-carbon fuels, such as hydrogen and biomethane, into the pipeline further displaces fossil gas".[61] In the industrial sector, "Decarbonizing industrial facilities depends upon displacing fossil fuel use with a mix of electrification, solar thermal heat, biomethane, low- or zero-carbon hydrogen, and other low-carbon fuels to provide energy for heat and reduce combustion emissions".[62] And finally, in the transportation sector, "In addition to building the production and distribution infrastructure for zero-carbon fuels, the state must continue to support low-carbon liquid fuels during this period of transition and for much harder sectors for ZEV technology such as aviation, locomotives, and marine applications. Biomethane currently displaces fossil fuels in transportation and will largely be needed for hard-to-decarbonize sectors but will likely continue to play a targeted role in some fleets while the transportation sector transitions to ZEVs".[63]

California's Integrated Energy Policy Report (IEPR) is the California Energy Commission's (CEC) leading document aimed at comprehensively addressing the state's evolving energy trends in the context of climate change and other environmental issues. CEC 2021 IEPR Volume III was entitled *Decarbonizing the State's Gas System*.[64] This document recognizes the role renewable gas can play in decarbonization of the gas system and encourages the use of renewable gases to achieve a variety of important environmental benefits. Notably, the report states that "there is increasing awareness that to fully decarbonize the gas system, there is a need for clean fuels or molecules in addition to clean electricity." The hydrogen section of the report also acknowledges that renewable organic waste feedstocks can be used to produce renewable hydrogen in a beneficial manner.

[60] Id., pg. 216

[61] Id., pg. 197

[62] Id., 192

[63] Id, 179

[64] California Energy Commission, *2021 Integrated Energy Policy Report, Volume III: Decarbonizing the State's Gas System*

https://efiling.energy.ca.gov/GetDocument.aspx?tn=242233

Columbia University

Columbia University's School of International and Public Affairs Center on Global Energy Policy conducted a study[65] focused on the use of the existing gas system in a carbon neutral world. Notably, the authors state that:

> *"[R]etrofitting and otherwise improving the existing pipeline system are not a choice between natural gas and electrification or between fossil fuels and zero-carbon fuels. Rather, these investments in existing infrastructure can support a pathway toward wider storage and delivery of cleaner and increasingly low-carbon gases while lowering the overall cost of the transition and ensuring reliability across the energy system. In the same way that the electric grid allows for increasingly low-carbon electrons to be transported, the natural gas grid should be viewed as a way to enable increasingly low-carbon molecules to be transported."*

World Resources Institute

The role of RNG as a decarbonization strategy was also recently examined by the World Resources Institute, who published a paper illustrating how RNG fills an important niche as part of a broader low-carbon technology portfolio.[66] The authors state that:

> *"RNG has the potential to reduce methane emissions from organic wastes and provide fuel for applications that lack other low-carbon alternatives, such as heavy-duty freight or existing building and industrial heat sources."*
>
> *"The report emphasizes the importance of considering RNG as a complementary fuel in applications where natural gas or other energy sources are currently used. In this way, RNG can be seen as a flexible, low-carbon fuel source that can potentially be deployed in a variety of applications, even as other vital strategies such as electrification are pursued in parallel."*

Furthermore, WRI's analysis *How Methane Emissions Contribute to Climate Change* identifies "improving efficiency [in agricultural production practices, including manure management]",

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[65] Blanton et. Al, *Investing in the US Natural Gas Pipeline System to Support Net-Zero Targets* https://www.energypolicy.columbia.edu/research/report/investing-us-natural-gas-pipeline-system-support-net-zero-targets?utm_source=Center+on+Global+Energy+Policy+Mailing+List&utm_campaign=38d4ab05a7-EMAIL_CAMPAIGN_2019_09_24_06_19_COPY_01&utm_medium=email&utm_term=0_0773077aac-38d4ab05a7-102456873

[66] World Resources Institute, *Renewable Natural Gas as a Climate Strategy: Guidance for State Policymakers.*

https://www.wri.org/publication/renewable-natural-gas-guidance

"separating organics and recycling", and "capturing landfill gas and reducing energy" as key methane abatement strategies. [67]

Previous New York Modeling of Pathways to Carbon Neutrality

The analysis conducted for New York by the consulting firm Energy and Environmental Economics' (E3) in June of 2020 identified switching to low-carbon fuels as one of the four pillars of decarbonization "critical to achieving carbon neutrality" in New York State, with scenarios including an 8-18% pipeline blend of RNG,[68] showing widespread RNG use across sectors. This is consistent with E3's high-electrification scenarios conducted in other jurisdictions, which show significant demand for gaseous fuels remaining in 2050.[69]

The New York City Mayor's Office of Sustainability, in collaboration with Con Edison and National Grid, published a study outlining three pathways by which New York City can achieve carbon neutrality by 2050.[70] All three pathways in the report—including the pathway with highest electrification—outlined the use of renewable gases as an essential part of this goal. Even in the case where it is possible to convert approximately 60% of New York City's building stock to all-electric applications by 2050, this study shows that RNG has a role to play. A key finding applicable to all scenarios was that, "in addition to providing a solution for buildings that do not electrify, a low carbon gas network improves overall system reliability by offering optionality and flexibility within the energy system."[71]

This key framing of the role of RNG in the above New York analyses is consistent with studies conducted for other jurisdictions—including California,[72] Minnesota,[73] Oregon and

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[67] https://www.wri.org/insights/methane-gas-emissions-climate-change

[68] See slide 5 of E3's "New York State Decarbonization Pathways Analysis," presented to the Climate Action Council on June 24, 2020. https://climate.ny.gov/-/media/Project/Climate/Files/2020-06-24-NYS-Decarbonization-Pathways-CAC-Presentation.pdf

[69] For an example from other similar E3 work, see pg. 35 of the California Energy Commission report entitled *The Challenge of Retail Gas in California's Low Carbon Future,* which finds that natural gas in California's residential, commercial, and industrial sectors is still ~1,000 tBtu in 2050 in the high-building-electrification case: https://ww2.energy.ca.gov/2019publications/CEC-500-2019-055/CEC-500-2019-055-F.pdf

[70] New York City Mayor's Office of Sustainability, *Pathways to Carbon-Neutral NYC: Modernize, Reimagine, Reach.* https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/Carbon-Neutral-NYC.pdf

[71] Id., xvii

[72] *Achieving Carbon Neutrality in California.* https://ww2.arb.ca.gov/sites/default/files/2020-10/e3_cn_final_report_oct2020_0.pdf

[73] Great Plains Institute & Center for Energy and Environment, *Decarbonizing Minnesota's Natural Gas End Uses.* https://e21initiative.org/wp-content/uploads/2021/07/Decarbonizing-NG-End-Uses-Stakeholder-Process-Summary.pdf

Washington,[74] Colorado,[75] and Maryland,[76] among others. Simply put, RNG is a necessary decarbonization strategy, even in high-electrification scenarios.

Building RNG Supply Quickly to Capture Methane from Organic Wastes is More Important in the Near-term than Debating the Sector that is the Long-Run Best Use

We believe the body of literature presented above shows that renewable gas has a clear role within any of New York's GHG reduction scenarios. However, the same literature also shows that there is diversity of opinion about the best targeted long-term uses of RNG. The RNG industry does not claim to be able to solve the daunting challenge of eliminating all organic waste methane emissions and decarbonizing the entire gas system alone, however, we believe that deciding on the best long-run end use is less important in the near term relative to ensuring that renewable gas represents a key component of New York's GHG strategy to reduce methane and begin to decarbonize gas supply.

As well stated by the World Resources Institute work referenced above:

> *"The viability of RNG as a decarbonization strategy will vary depending on regional context, and ultimately the role that it plays in decarbonization and how it complements other key strategies may shift over time. However, through careful consideration of the factors included in the preceding discussion, policymakers can explore and identify opportunities for targeted RNG production and use that can meaningfully contribute to GHG reduction goals. Overall, the flexibility of RNG, along with the methane emissions reductions associated with its production, mean that it can play a dynamic and complementary role in decarbonization in the long term."*[77]

Therefore, as summarized above in Figure 1, in the near-term the Final Plan should focus on new policy to deploy RNG quickly. Doing so does not preclude adjustments to its end use as the gas system transition takes place—an effort which will take significant time and require thoughtful infrastructure planning to determine the targeted long-run applications best served by clean gaseous fuels. Our industry remains open minded to those varying possibilities, and we

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[74] *Pacific Northwest Pathways to 2050*. https://www.ethree.com/wp-content/uploads/2018/11/E3_Pacific_Northwest_Pathways_to_2050.pdf

[75] *Colorado GHG Reduction Roadmap Technical Appendix.* https://drive.google.com/file/d/1215j7zfCsgE50msF_ZJt6ZUj0iG7Th3V/view

[76] *Maryland Building Decarbonization Study.* https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/E3%20Maryland%20Building%20Decarbonization%20Study%20-%20Final%20Report.pdf

[77] World Resources Institute, *Renewable Natural Gas as a Climate Strategy: Guidance for State Policymakers. (*See page 37).

https://www.wri.org/publication/renewable-natural-gas-guidance

look forward to working with the Council and other New York stakeholders as the long-term vision for RNG use in New York evolves.

Economy-wide Carbon Pricing Strategies are Helpful, but Sector-specific Tradeable Performance Standards Have a Better Track Record of Motivating RNG Buildout

Building on Existing Successful Tradeable Performance Standards

In determining which policies and programs to recommend in the Final Plan, New York should look to other jurisdictions which have made considerable progress toward similar decarbonization goals. We believe that Tradeable Performance Standards (TPS) have proven to be very effective tools in motivating RNG buildout specifically, and "fuel switching" through clean energy and infrastructure deployment more generally, toward decarbonizing the supply side of the transportation, gas, and electric sectors. New York should build on the success of the Clean Energy Standard in the power sector by developing an analogous Clean Fuel Standard in the transportation sector and a Renewable Gas Standard or Clean Heat Standard to decarbonize the gas system.

In general, a TPS sets a standard of technology performance but leaves technology choice to the program participants (e.g., clean technology companies and compliance entities). It increases the relative costs of technologies with undesirable GHG performance characteristics and lowers the costs of technologies with desirable GHG characteristics.

Clean Fuel Standard

A Low Carbon Fuel Standard (LCFS) or Clean Fuel Standard is the leading transportation "fuel switching" policy which holistically addresses the need to both decarbonize existing transportation modalities and build the infrastructure for the energy carriers of the future. While many climate-focused states, including New York, have prioritized funding zero emission vehicles (ZEVs) fueled by electricity and hydrogen, combustion fuels will remain a part of the transportation mix for the foreseeable future, and should also be decarbonized expediently using clean fuels, to the fullest extent possible. Indeed, focusing only on future technologies while ignoring the near- and mid-term options to displace the use of fossil fuels is not compatible with serious GHG reduction planning. Establishing a Clean Fuel Standard in New York will incentivize the production of clean fuels in conventional vehicles while also directly financing the buildout of infrastructure for ZEVs.

Jurisdictions leading on climate change—California, Oregon, Washington, British Columbia, and the Canadian Federal Government—have all implemented or are in the process of implementing Clean Fuel Standards as a primary means of decarbonizing their transportation sectors. Such programs are technology neutral and provide credits relative to a declining

benchmark that requires improvements relative to the lifecycle carbon intensity (CI) of the closest fossil fuel alternative. Entities which supply fossil fuels are required to purchase an amount of credits proportional to the GHG impact of the fossil fuels they sell. The amount of this requirement increases over time based on the total GHG reduction goal, making this a form of performance standard with a revenue-neutral funding mechanism. For clean energy technology providers, revenue generated from credit sales is spread throughout their energy and infrastructure supply chains, resulting in additional investment in, for example, EV charging infrastructure.

In California, the LCFS is responsible for a very significant share of in-state GHG reductions in the transportation sector to-date. As shown in Figure 4 below, California has an established target of 20% reduction in CI by 2030, based off 2010 levels. Per the 2021 data, California is ahead of schedule to meet that goal.[78]

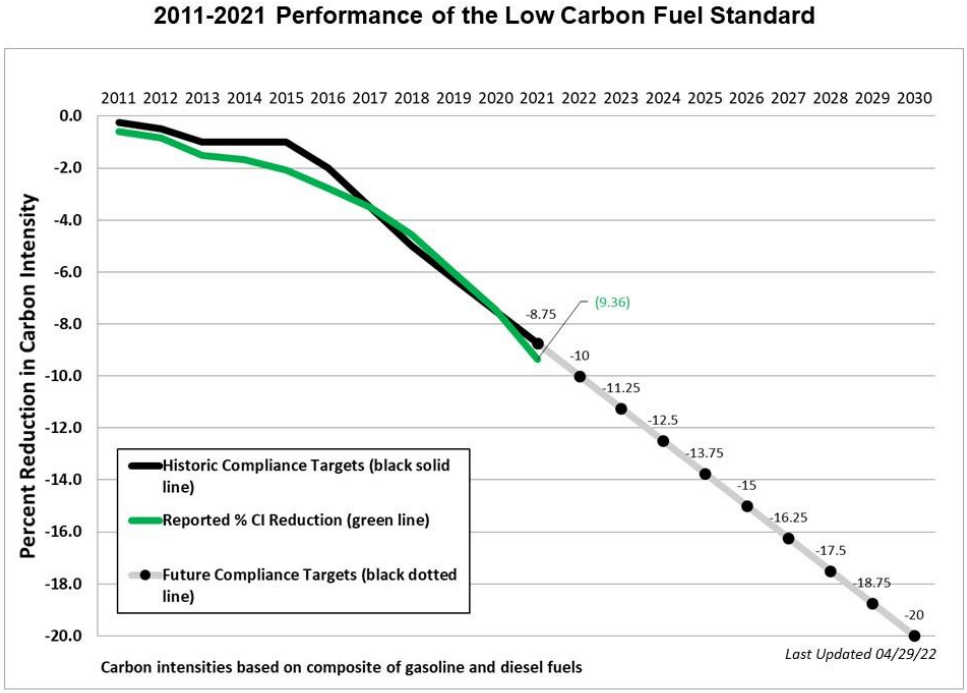

Figure 4. Performance of California LCFS To-Date

Figure 5 provides a visualization of existing certified CI scores in the program for each transportation energy type.[79] Here it is important to note that biogas-to-ZEVs and RNG are responsible for the lowest CI scores in the electricity, hydrogen, bio-CNG, and bio-LNG

[78] California Air Resources Board, *LCFS Data Dashboard*:

https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard

[79] Id.

categories.[80] Programs in Oregon,[81] Washington,[82] and Canada[83,84] are modeled after the California program.

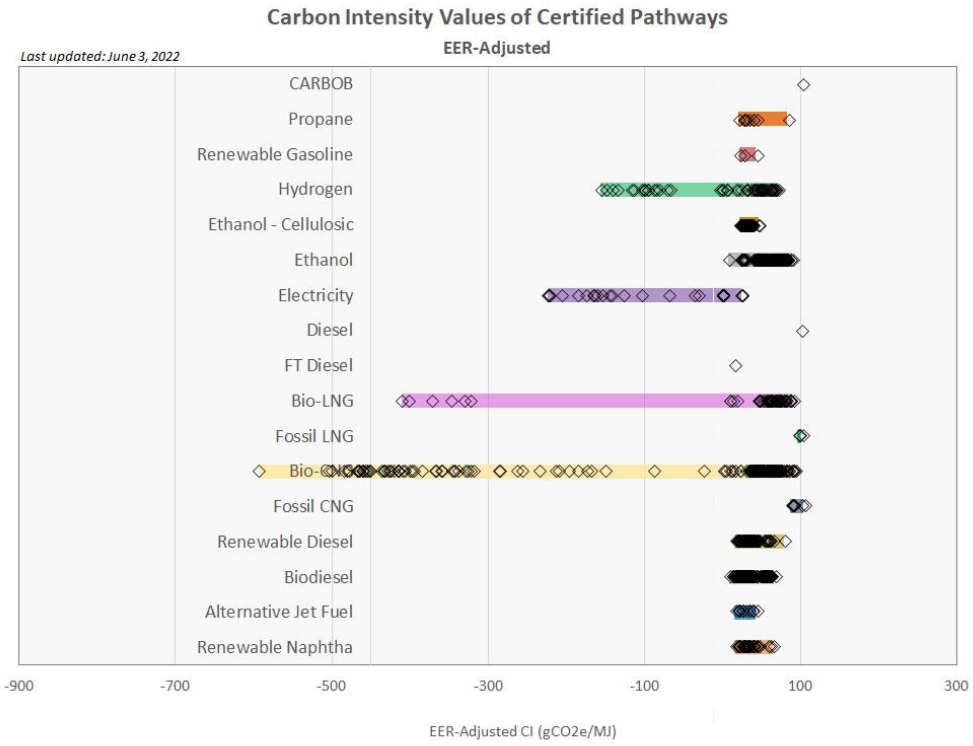

Figure 5. Current Certified Pathways Under California LCFS

In addition to their ability to reduce GHG emissions immediately both within and beyond the transportation sector, clean fuels have been shown to drive air quality benefits in disadvantaged communities, and are expected to increase that near-term effect. This is exemplified by a recent study from UC Davis modeling Oregon's planned expansion of their CFS target to 20% by 2030 and to 37% by 2035,[85] which concludes that the program would reduce

[80] Biogas and RNG are increasingly used as feedstocks to produce electricity and renewable hydrogen.

[81] https://www.oregon.gov/deq/ghgp/cfp/Pages/default.aspx

[82] https://ecology.wa.gov/Air-Climate/Climate-change/Reducing-greenhouse-gases/Clean-Fuel-Standard

[83] https://www.canada.ca/en/environment-climate-change/news/2022/06/government-of-canada-supports-innovation-in-the-fuel-industry-with-final-clean-fuel-regulations.html

[84] https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels

[85] https://www.oregon.gov/deq/rulemaking/Documents/cfp2022pnp.pdf

air pollution deaths and avoid $84.4B and $87.7B in healthcare costs per year due to reductions in $PM_{2.5}$, respectively, compared to a business-as-usual scenario.[86]

Despite the focus on promoting ZEV adoption as quickly as possible, the Draft Plan correctly identifies that, "Given the service life of current vehicles and equipment under the most aggressive scenarios identified for transitioning to zero-emission technologies, fossil fuels are expected to constitute most of the fuel mix until the mid- or late-2030s". Furthermore, it should be emphasized that, "Substituting sustainable renewable fuels for a portion of this remaining fossil fuel combustion will reduce GHGs and other emissions" and that, "For harder to electrify vehicles and equipment, the scenarios identified for meeting the Climate Act GHG emission reduction requirements rely, in part, on the increased use of lower carbon renewable fuels, including renewable diesel, renewable jet fuel, and/or green hydrogen."[87]

As a proven policy which establishes and promotes a targeted decline in transportation GHG emissions using all possible means, the Final Plan should require a Clean Fuel Standard as part of New York's transportation decarbonization strategy.

Renewable Gas and Clean Heat Standards

Jurisdictions focused on gas sector decarbonization have employed two primary types of policies aimed at incenting clean energy supply and infrastructure. Specific to gas supply only, a Renewable Gas Standard establishes targets for total renewable gas throughput, potentially including both RNG and renewable hydrogen, which increase over time.

Alternatively, a Clean Heat Standard can be used to incentivize clean heat resources more broadly, often including electrification and geothermal infrastructure alongside renewable gases. We believe that including one of these strategies in the Final Plan will be crucial to meeting both near- and long-term decarbonization goals in New York.

As part of California's gas sector decarbonization strategy, the California Public Utilities Commission (CPUC) voted unanimously to adopt a RGS in early 2022. Establishing a 12.2% procurement mandate for utilities' core gas customers by 2030, with a smaller mid-term target in 2025, this program is also viewed by the state as an important component of their methane reduction and landfill diversion strategies, with the near-term RNG requirement being largely based on potential from organic waste diversion projects.[88]

In addition to reducing methane emissions and replacing fossil-derived natural gas, the program is designed to facilitate the broader environmental benefits of RNG development. This is

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[86] Murphy et. Al, *Modeling Expected Air Quality Impacts of Oregon's Proposed Expanded Clean Fuels Program*. https://escholarship.org/content/qt6pz348mc/qt6pz348mc_noSplash_35bd521866d4290a1a8755f4af0d281a.pdf

[87] Draft at pg. 118.

[88] https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-sets-biomethane-targets-for-utilities

accomplished by prioritizing facilities which include carbon sequestration to further reduce emissions and achieve carbon negativity; prioritizing facilities which use their waste byproduct to create soil amendments such as a compost and biochar; requiring the buildout of pilot facilities which use wood waste feedstocks in gasification applications to reduce forest fire risk; and prioritizing facilities which use zero or near-zero emission trucks. These provisions exemplify the potential of RNG to contribute to broader environmental goals, including strengthening and circularizing the state's bioeconomy.

In May of 2022, the Minnesota Public Utilities Commission (MPUC) voted unanimously to adopt a carbon intensity (CI) and cost-benefit analysis (CBA) framework pursuant to the *Natural Gas Innovation Act*—a first-of-its-kind Clean Heat Standard in North America.[89] This program allows the state's gas utilities to propose investments in a variety of clean energy resources and infrastructure, including RNG, renewable hydrogen, electrification, geothermal, and energy efficiency, among others. Each resource mix must be compared based on cost-effectiveness, which includes lifecycle CI scoring for RNG and renewable hydrogen. Clean Heat policies such as this are significant because of their ability to incent the full spectrum of resources that are shown to be necessary for gas sector decarbonization. Jurisdictions which have adopted either a RGS or CHS include British Columbia,[90] California, Colorado,[91] Minnesota, New Hampshire,[92] Oregon,[93] and Quebec.[94]

The Gas System Transition section of the Draft Plan rightfully acknowledges that the transition away from fossil natural gas—particularly given the potential for electrification of many residential and commercial customers who underly current business models for gas distribution utilities—needs to be conducted deliberately and carefully to avoid an unbalanced system for remaining gas customers. Furthermore, planning for gas sector decarbonization must take into account the time required for fuel-switching, where feasible, as well as the continued need for gaseous fuels in certain applications. It is likely that this transition will require changes in rate design for gas utilities, which deserves more deliberate consideration under New York's "Gas System Planning" proceeding.[95]

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[89] https://www.revisor.mn.gov/bills/text.php?number=SF0421&session=ls92&version=latest&session_number=0&session_year=2021

[90] https://news.gov.bc.ca/releases/2021EMLI0046-001286

[91] https://leg.colorado.gov/sites/default/files/2021a_264_signed.pdf

[92] https://legiscan.com/NH/text/SB424/id/2528713#:~:text=New%20Hampshire%20Senate%20Bill%20424&text=Bill%20Title%3A%20Relative%20to%20renewable%20energy%20and%20natural%20gas.&text=AN%20ACT%20relative%20to%20renewable%20energy%20and%20natural%20gas.&text=This%20bill%20authorizes%20the%20recovery,of%20the%20public%20utilities%20commission.

[93] https://olis.oregonlegislature.gov/liz/2019R1/Measures/Overview/SB98

[94] https://www.legisquebec.gouv.qc.ca/en/pdf/cr/R-6.01,%20R.%204.3.pdf

[95] See New York State Public Service Commission Case 20-G-0131.

Allowing gas utilities to invest broadly in renewable thermal infrastructure such as renewable gas supply (with a goal of ultimately achieving 100% of supply from renewable sources), dedicated hydrogen infrastructure, geothermal energy, and electrification could provide a pathway for the development and maintenance of the spectrum of sustainable energy infrastructure required to serve all of New York's thermal needs in the future.

Furthermore, as discussed in more detail below, allowing some thermal customers to qualify under a CFS, or even creating an economy-wide Clean Energy Supply Standard, could more broadly spread costs and encourage clean technology adoption, especially given the fungibility of clean fuels in common liquid and gas applications. This concept was considered by Canada as part of their federal CFS development process.[96]

RNG Coalition Supports the Use of Economy-Wide Policies

A Clean Energy Supply Standard (or a Set of Sector-Specific Tradeable Performance Standards) Would be Complementary to Modest Carbon Pricing

Chapter 17 of the Draft Plan explores the use of broad, economy-wide climate policies. Carbon Pricing, Cap-and-Invest, or Clean Energy Supply Standards could all create the correct signals to drive significant investment by RNG developers. Because of the success of sector-specific TPSs in motivating RNG buildout, a Clean Energy Supply Standard would be our first preference, should the Council feel that an economy-wide program should be developed. However, we believe that moderate economy wide carbon pricing could also be used to motivate some demand-side GHG reductions while raising revenue to address priority non-climate environmental issues, such as racial and social equity.

Carbon Pricing and Cap-and-Invest programs create incentives for both output reduction and technology change, while TPS programs do not fully internalize the costs of emissions, resulting in lower price effects on products and raising the total cost of emissions reductions compared with carbon pricing. However, a TPS provides stronger incentives for upstream innovation and technology transformation. TPS programs are generally additive to the effects of carbon pricing, therefore, these policies can be combined without sacrificing the efficiency properties achieved by pricing.[97]

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[96] https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/clean-fuel/regulations/CFR_CG_II_RIAS_Unofficial_Version_EN_2022-06.pdf

[97] *Tradable Performance Standards in the Transportation Sector*, Resources for the Future, Sonia Yeh, Dallas Burtraw, Thomas Sterner, and David Greene. Working Paper 20-18 October 2020. https://media.rff.org/documents/Tradable_Performance_Standards_in_the_Transportation_Sector_v3.pdf

Either Carbon Pricing or Cap-and-Invest Could be Helpful for RNG Development

We conceptually support both economy-wide Carbon Pricing (using the Draft's terminology to mean a fixed carbon price) and Cap-and-Invest policies. However, our experience in other jurisdictions is that, in practice, these two policies create similar incentives that, historically, have not yet been strong significant drivers of RNG development.

We have a mild preference for Cap-and-Invest because, as the Draft points out, emissions certainty is an important feature around which to construct economy-wide policies. Achievement of strong long-run GHG abatement goals, in line with the best science, must be prioritized. However, in practice, when prices in Cap-and-Invest are range-bound with appropriate floors and ceilings, emissions certainty must be traded-off slightly to offer a range of price certainty.

Although it is somewhat simpler for the RNG investor when the regulator sets a fixed and stable carbon price, retaining some flexibility for GHG prices to fluctuate, as do other commodity prices, can increase consumer acceptance. For example, if macro drivers (such as the recent war in Ukraine) create dramatic impacts on conventional diesel and gas prices, allowance prices in Cap-and-Invest systems will decline, all else equal, which can have net benefits for energy consumers. A Carbon Pricing system would remain fixed, potentially leading to unacceptably high consumer energy prices and real (or manufactured) political backlash against the program.[98]

Efficient Carbon Pricing Will Have a Bigger Immediate Impact on Consumer Energy Prices than Would a Clean Energy Supply Standard

As described by the RFF article cited above, Carbon Pricing (inclusive of Cap-and-Invest) is designed to create noticeable consumer price impacts, with a goal of changing energy consumption and consumer behavior. The conceptual argument is that "pricing the bad" (e.g., GHG emissions) motivates people to stop consuming the fuels and products that produce the bad. In Carbon Pricing systems, every GHG emission is priced at the marginal abatement cost (MAC), which should theoretically align with the Social Cost of Carbon (SCC) to drive the socially optimal outcome. New York has assessed the 2020 central value of the social cost of carbon dioxide to be $125 per ton.[99]

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[98] When conventional energy prices increase rapidly opponents of carbon pricing/cap-and-invest programs will attempt to scapegoat/scrap these policies, even when other factors are the primary true drivers of overall increases. For examples see: https://www.dailybulletin.com/2014/07/03/stop-the-hidden-cap-and-trade-tax-on-fuel-guest-commentary/, https://www.taxpayer.com/newsroom/hidden-gas-taxes-driving-up-pump-price-report , https://financialpost.com/opinion/franco-terrazzano-provide-real-relief-at-the-pump-cut-gas-taxes

[99] Many studies of the MAC of technologies required to reach net zero GHGs include technologies that currently cost more than $125 per ton. For example, see Exhibit 6 of *Navigating America's Net-zero Frontier: A Guide for*

In practice, the MAC in many existing GHG carbon pricing systems has remained well below New York's Estimate of the SCC, due to political concerns preventing policymakers from setting carbon prices at the socially optimal level. For example, the Regional Greenhouse Gas Initiative price at the June 1, 2022 auction was $13.90 per (short) ton,[100] and the California/Quebec Cap-and-Trade May 2022 auction price was $30.85 per (metric) ton.[101] The Transportation and Climate Initiative CO_2 credit reserve trigger price would have started at only $12 per ton.[102] This issue is not unique to Cap-and-Invest programs; the BC carbon tax (a fixed carbon price) is currently $CAN 50 per metric ton.[103] We believe that the lack of carbon pricing programs with MAC at social optimal levels is due to concerns about negative public reaction to changes in consumer prices for conventional energy. Unfortunately, as shown in Figure 2, the vast majority of RNG projects cannot be built and operated at such low carbon prices.

In Tradeable Performance Standards each unit of required emission reduction is priced at the MAC. Emissions are always larger than emission reductions at the beginning of such programs, thus TPSs have less impact on energy prices and can still justify investments in technologies with higher MAC in line with the SCC. At the outset of such programs, when the amount of emission reductions called for is modest relative to remaining emissions, these programs have pricing impacts that are undetectable to the consumer (and even to sophisticated regression analyses),[104] even when the MAC in the program is high.

Thus, in practice, regulators have found that it is expedient to motivate the more expensive forms of GHG abatement (up to the socially-efficient MAC) with TPS programs. Investors, such as RNG Coalition members, also prefer TPS programs relative to low-priced carbon pricing systems because they can provide the needed value to allow socially-optimal investment in renewable power, fuels, and vehicles to be cost effective.

If economy-wide tools are to be used, the Final Plan should rely on TPSs to motivate higher MAC abatement and modest economy-wide pricing to raise funds and address equity concerns. We believe this will help motivate other regional actors to follow.[105] Unfortunately, even socially-optimal carbon pricing—if implemented in New York alone—will not solve the climate

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Business Leaders, McKinsey & Company, May 2022, https://www.mckinsey.com/business-functions/sustainability/our-insights/navigating-americas-net-zero-frontier-a-guide-for-business-leaders

[100] https://www.rggi.org/auctions/auction-results/prices-volumes

[101] https://ww2.arb.ca.gov/sites/default/files/2022-05/nc-may_2022_summary_results_report.pdf

[102] https://www.transportationandclimate.org/sites/default/files/TCI-P-Model-Rule.pdf

[103] https://www2.gov.bc.ca/gov/content/environment/climate-change/clean-economy/carbon-tax#:~:text=On%20April%201%2C%202022%2C%20B.C.,%2450%20per%20tCO2e.&text=To%20align%20with%20the%20change,child%20effective%20July%201%2C%202022.

[104] https://www.bateswhite.com/media/publication/226_BW%20LCF%20Report%20-%20April%202022.pdf

[105] Motivating action by other jurisdictions is a critical goal, as discussed on page 262 of the Draft Plan.

crisis, which underscores the need for New York to serve as a leader in developing policies which can be replicated by other states.

The GHG Accounting Method Developed Thus Far as Part of the NY GHG Inventory Will Not Motivate Optimal Biofuel Outcomes, is Not Required by Statute, and Should Not Be Used for Any Policy that Includes Biofuels

Point Source Accounting vs. Lifecycle Accounting

There are two distinct GHG emission accounting approaches commonly used in regulatory programs for bioenergy today: the "point-source biogenic CO_2 emissions are carbon neutral" approach and the "lifecycle" approach. Programs built on lifecycle analysis are more likely to produce better incentives for biofuels and bioenergy.

The Draft's underlying analytical work relies upon a unique third approach that is not required by statute, is unproven relative to the two approaches discussed above, and is unlikely to be helpful for creating the correct incentives for maximizing global greenhouse gas reductions associated with bioenergy. This third approach is a fractured/incomplete lifecycle analysis that incorporates upstream emissions from fossil fuels, but not from biofuels, and ignores the netting of biogenic emission sinks and other upstream benefits from RNG production, such as methane capture.

When using a point-source approach, GHG emissions from bioenergy are assessed only at the point of use—such as in a home, business, vehicle, power plant, or industrial facility. When determining these point-source GHG emissions, the biogenic carbon dioxide produced from the combustion of a biomass-derived input is often assumed to be counteracted by the carbon dioxide that was recently removed from the atmosphere when the biogenic material was grown, and thus netted out of any final compliance obligation.[106] The use of such a point-source framework is appropriate if it is expected that the upstream emissions (e.g., pipeline leakage) and upstream GHG sinks and avoided emissions (e.g., methane emissions from organic waste) will be accounted for by other jurisdictions under analogous programs.

A lifecycle approach[107] (LCA) accounts for GHG emissions generated from a fuel's production through its end-use—the full life of the fuel.[108] The lifecycle approach for GHG emission

[106] For example, the Regional Greenhouse Gas Initiative uses this approach.

[107] Lifecycle analysis is well established as the leading way to holistically compare greenhouse gas abatement options. It is frequently used for bioenergy (inclusive of biofuels), but also has a role in comparing many other types of GHG abatement. The term "life cycle" appears 143 times in the IPCC's *Climate Change 2022, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_Chapter10.pdf

[108] https://www.epa.gov/renewable-fuel-standard-program/lifecycle-analysis-greenhouse-gas-emissions-under-renewable-fuel

accounting for biofuels can also be referred to as a "well-to-wheels" or "full fuel cycle" approach. This approach accounts for all of the GHG emissions produced or avoided from the production, collection and processing, transmission and delivery, and ultimate use of a fuel (including upstream sinks and final point-source emissions).

When determining the lifecycle GHG emissions factor or carbon intensity, the GHG emissions are summed across each stage, and the end user of the fuel is responsible for all emissions. A full lifecycle approach is appropriate if other jurisdictions do not have programs to account for these upstream sources and sinks, or simply if the jurisdiction's goal is to create the proper incentives to reduce global emissions across an entity's entire biofuel or bioenergy supply chain.

New York Should Consider More Complete Inventories for both Production and Consumption Effects

We interpret the inventory approach that New York is implementing as an incomplete initial attempt to monitor some, but not all, consumption effects. Doing so is not unprecedented at the state level. For example, Oregon's GHG inventory is split into two portions and attempts to include both sector-based (primarily in-state point sources) and consumption-based (a form of LCA) emissions for the entire economy.

Specifically, the sector-based assessment accounts for in-state emissions from Oregon's agricultural, industrial, residential, commercial, and transportation sectors—including electricity and natural gas usage, and waste attributed to each sector. The consumption-based inventory accounts for the lifecycle emissions produced throughout the full supply chain of goods and services in the state, categorized by those which occur within the state, within the United States, and globally.[109]

For Oregon, "[m]ore than half of the consumption-based emissions occur in other states or nations and are not included in the sector-based inventory."[110] Accounting for out-of-state upstream and downstream impacts in this manner is an attempt to monitor and take responsibility for the full environmental impact of the state's economy. It is a helpful viewpoint to have for any state working to lead on climate action.

As previously discussed, according to the Draft, 27% of New York's MSW is exported.[111] Based on New York's current GHG inventory approach, it is likely that this significant amount of the state's waste emissions will go unmonitored. This current approach will also limit the ability to assess the benefits of technologies, such as RNG, which are designed to eliminate emissions from organic waste and improve waste management—in line with the state's organic waste

[109] See Oregon emission assessment, PDF pg. 11: https://www.oregon.gov/deq/FilterDocs/OregonGHGreport.pdf

[110] https://www.oregon.gov/deq/mm/pages/consumption-based-ghg.aspx

[111] See Draft Plan pg. 233

diversion laws—because those emissions are effectively treated as non-existent in the current inventory if the waste is exported.

Even Oregon's inventory is simplified—it treats biofuels as carbon neutral at the point of combustion in both the sector-based and consumption-based inventories. However, Oregon's Clean Fuel Program fully accounts for the upstream benefits and disbenefits of all fuels and thus sets the proper GHG reduction incentives. New York should similarly consider a focused LCA accounting method for any policy designed to promote the use of low carbon fuels.

Ignoring Upstream GHG Benefits and Disbenefits from Biofuels will Not Create the Correct Incentives

Fundamentally, it is appropriate to track biogenic carbon dioxide emissions from use of biomass and biofuels as a line item in any point source emission accounting, and to appropriately "net out" CO_2 biogenic emissions or sinks as a step in any accounting of such fuels. Conversely, it is not appropriate to treat biogenic CO_2 from the use of biomass and biofuels as identical to CO_2 from fossil fuels (thus ignoring the upstream sink as the biogenic material is grown). The analytics conducted for the Draft Plan's scenario analyses choose to do so and thus significantly understate the true GHG benefits of bioenergy across all scenarios.

If the accounting framework used in the Scoping Plan analytics was also used in future GHG reduction policies that are inclusive of biofuels or bioenergy as a compliance option, it will not create the correct incentives to source and use the least-emitting biofuels and biomass. For example, biofuels that have demonstrated dramatic upstream GHG disbenefits—such as deforestation due to expansion of palm oil plantations—would be treated identically to fuels derived from the circular use of organic waste streams (biodistillates derived from used cooking oil, renewable gas derived from wastewater treatment, etc.).

If such an accounting framework were used in regulatory policies and New York still consumes a significant amount of biofuels, as predicted in all of the Scoping Plan scenarios, it will lead to a "race to the bottom" across biofuel feedstocks. This outcome would be counter to the intent of the New York stakeholders that have expressed skepticism about biofuels—which has potentially unintentionally created the unfortunate framework currently used in the inventory. New York should not "go it alone" and attempt to create a unique new framework for biofuel GHG accounting. Instead, New York should rely on proven LCA tools, such as the Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model (GREET) from Argonne National Labs, that are supported by more than 25 years[112] of research and peer review.[113]

[112] https://www.epa.gov/system/files/documents/2022-03/biofuel-ghg-model-workshop-biofuel-lifecycle-analysis-greet-model-2022-03-01.pdf
[113] https://greet.es.anl.gov/

Including Smart Biofuel Policy Offers Greater Certainty in Emissions Reductions, Will be Less Expensive Compared to Forced Scrappage of Working Vehicles and Equipment

We respectfully assert that the Draft Plan's integration analysis overstates likely GHG reductions associated with policies requiring forced scrappage (early retirement) of working vehicles and equipment. The natural gas vehicle industry (which overlaps with the RNG industry) has extensive real-world experience[114] with existing programs that require scrappage of heavy-duty diesel trucks. In trying to motivate action under such programs we have found uptake of incentives with a scrappage requirement to be more challenging than programs without a scrappage requirement. When scrappage requirements are poorly constructed, consumers and fleets simply choose not to participate in such programs at high volumes. Therefore, scrappage requirements often do not function well and are, at times, a barrier to deployment of new low-emitting vehicles.[115]

In the Draft Plan's analysis, the level of forced scrappage of vehicles and heating equipment used in each scenario is not transparent. For example, the Draft Plan's assumptions figure for "Scenario 3: Accelerated Transition Away from Combustion" states only that there is some level of "early retirement of old vehicles" and "early retirement of old heating systems" without specifying what volume of such retirement is required and for what specific ages of equipment.[116] Without greater transparency as to total assumed rates of early retirement, programmatic details of how such scrappage would be motivated, and what funding would be required to effectuate such scrappage, we feel that the challenges of driving such retirement have been understated (and thus certainty of associated emission reductions is overstated) in the Draft Plan.

Based on prior examples of such programs, it will likely be hard to motivate individuals to replace functional vehicles and appliances in a meaningful and cost-effective way. For example, a 2010 study[117] of the "Cash for Clunkers" program[118] showed that efforts to motivate early retirement of aging combustion vehicles with more efficient combustion vehicles had implied costs of over $450 per ton of carbon dioxide equivalent. The program only modestly shifted purchases in time (likely by less than a year) and had high reversal rates (because fewer autos

[114] For example, the California Carly Moyer Program requires vehicle scrappage. See: https://ww2.arb.ca.gov/sites/default/files/2022-05/Carl_Moyer_Program_Chapter_4_Updated_040722.pdf

[115] https://www.act-news.com/news/overcoming-funding-barriers-to-meet-immediate-fleet-sustainability-goals/

[116] Draft Plan, Figure 8.

[117] Knittel, Christopher R., *The Implied Cost of Carbon Dioxide Under the Cash for Clunkers Program* (August 31, 2009). Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1630647

[118] Cash for Clunkers is listed as an example policy informing how early vehicle retirement is modeled in slide 6 of E3's Workshop presentation: https://ww2.arb.ca.gov/sites/default/files/2022-03/SP22-Model-Results-E3-ppt.pdf

were purchased in the period after the program expired).[119] The average age for a vehicle retired under that program was 14 years old.[120] There is little from this example that implies that a more aggressive version of such a policy, focused on transition to zero emission vehicles, deserves to be a cornerstone of any scenario under consideration by New York in the Plan. In an opinion piece in Scientific American, Professor Jeffrey D. Sachs of Columbia University went as far as to call Cash for Clunkers "a cautionary tale for the future of climate change control."[121]

Similar results have been found for appliance scrappage programs. For example, a large-scale appliance replacement program in Mexico from 2009 to 2012 helped 1.9 million households replace their old refrigerators and air conditioners with energy efficient models. However, the ex-post energy savings was much less than predicted by ex-ante analyses and the researchers found that the program is an expensive way to reduce externalities from energy use, reducing carbon dioxide emissions at a program cost of over $500 per ton.[122]

Convincing consumers to undertake early retirement of working vehicles and appliances—especially those that are relatively new and still in good working order—is extremely difficult to accomplish in practice. Consequently, either emissions reductions from such retirement is overstated, or costs are understated, in the aggressive "early retirement" strategies required in Scenario 3. Therefore, Scenario 3 may not, in fact, be lower cost than the other scenarios.

If aggressive early retirement as considered in Scenario 3 were to be pursued, New York must not ignore the resulting increase in global emissions due to accelerated vehicle and appliance production (sometimes called embodied emissions from premature manufacturing and/or premature disposal), which can be significant, especially for vehicles,[123,124] and may occur outside of New York as a form of emissions leakage.[125]

This critique of Scenario 3 should not be read to imply that we oppose the swiftest possible action to reduce greenhouse gases—only that we oppose poorly crafted policy solutions that do not consider the full universe of abatement strategies, do not maximize abatement certainty, and do not attempt to minimize total societal costs. The other Scenarios in the Draft

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[119] Atif Mian & Amir Sufi, 2012. "The Effects of Fiscal Stimulus: Evidence from the 2009 Cash for Clunkers Program," The Quarterly Journal of Economics, Oxford University Press, vol. 127(3), pages 1107-1142. https://ideas.repec.org/a/oup/qjecon/v127y2012i3p1107-1142.html

[120] https://www.everycrsreport.com/files/20100303_R40654_31334bf7ef7706220966685afd51009808cb82de.pdf

[121] https://www.scientificamerican.com/article/a-clunker-of-a-climate-policy/

[122] Davis, Lucas W., Alan Fuchs, and Paul Gertler. 2014. "Cash for Coolers: Evaluating a Large-Scale Appliance Replacement Program in Mexico." *American Economic Journal: Economic Policy*, 6 (4): 207-38. https://www.aeaweb.org/articles?id=10.1257/pol.6.4.207

[123] https://iopscience.iop.org/article/10.1088/1748-9326/5/4/044003

[124] https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf

[125] Another reason to consider a consumption-based inventory would be to try to catch such effects.

Plan that employ a broader suite of technology options are more likely to succeed. An aggressive strategy which creates opportunities for all available technologies—and employs proven strategies such as focusing on reducing organic waste methane emissions as quickly as possible—will provide the best opportunity to mitigate the most harmful effects of climate change.

Renewable Natural Gas Creates Green Jobs and Provides a "Just Transition" for the Gas Sector Workforce

Ensuring a just transition away from traditional energy sources and industries is an important aspect within the Scoping Plan and has been identified as a key concern for workers and community voices participating in the Climate Action Plan development process. Indeed, it is likely that many of the technologies considered by the Council will lead to the eventual obsolescence of some existing oil and gas *extraction* infrastructure as fossil fuel use declines. However, the Council must consider how certain necessary components of the state's GHG reduction strategy, such as renewable gas and liquid biofuels, will support the long-term use of a subset of the existing *distribution* infrastructure and associated jobs in a beneficial manner, in addition to the important opportunity to promote high-quality manufacturing jobs in New York from emerging technologies.

The process of decarbonizing all sectors which currently utilize fossil natural gas will involve increasing renewable gas supply while systematically pruning portions of the gas system subject to electrification. From an employment standpoint, the utility gas industry currently provides well-paying union jobs for skilled workers across New York. Therefore, it is important to consider apprenticeship opportunities and high-road pathways to green jobs provided by renewable gases, which in turn will advance the state's goals of broadening access to middle-class jobs while resolutely addressing the climate crisis.

While gas industry jobs have historically fallen under the fossil fuel industry umbrella, those which are retained will become green jobs as the pipeline system transitions to a clean fuel system and RNG methane capture projects begin to employ this skilled labor. With this in mind, New York should study which portions of the pipeline are expected to be needed for renewable gas delivery over different timeframes, and should map employment expectations and gaps accordingly.

RNG Coalition best understands the employment benefits at the RNG facilities themselves. As the state moves forward with its organic waste recycling mandates, new facilities will be needed to process the additional quantities of organic waste, stimulating employment in the sustainable waste management and industrial building construction industries, among others. For comparison, California is projected to create 11,700 permanent jobs based at more than 80

new or expanded compost or anaerobic digestion facilities based on CalRecycle's organic waste recycling goals.[126]

The RNG industry currently has more RNG plants under construction or substantial development than in existence. Therefore, RNG contribution to jobs and the economy will inevitably increase. This represents an important opportunity for employment in New York given that RNG jobs are high paying, the vast majority of which fall well above the national average personal income. In 2021, the RNG industry contributed 22,600 Jobs and $2.6B in GDP to the U.S. economy, and could contribute 200,000 jobs by 2030 if the U.S. is on track to achieve carbon neutrality by 2050. Every $1 million spent on RNG production in 2021 created approximately 12 jobs.[127]

Conclusion

The Draft Plan's current recommendations regarding renewable gases are extremely helpful. However, additional clarification could be added in the Final Plan to crystalize New York's strategy for developing and using RNG and renewable hydrogen. Based on extensive research, modeling, and experience from existing policies aimed at achieving carbon neutrality, RNG has demonstrated it can play a key role in reaching deep decarbonization goals in New York and globally.

To achieve methane reductions, RNG should be generally incentivized for use in any application to displace fossil fuels in the near-term, including those which may ultimately be electrified. There remains such a large demand for conventional fuels, and the RNG industry is still so nascent, that there is no need to determine the ultimate end use of the sustainable RNG resources immediately. In the long-term, renewable gases should be targeted toward applications that are not suitable for electrification. With this framework in mind, we urge the Council to develop a Final Plan which includes the use of a Clean Fuel Standard for transportation, a Renewable Gas Standard (or Clean Heat Standard) for thermal decarbonization, and that sends clear signals about New York's vision for the use of renewable gases.

Our industry stands ready to deploy renewable gas technologies which will reduce methane emissions, displace fossil fuel supply, improve organic waste management, produce useful soil amendments, and ultimately sequester carbon in New York. We commend the Council, New York's agencies, and all stakeholders for your significant work throughout this process and look forward to continued collaboration toward the state's GHG reduction goals.

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[126] https://www.nrdc.org/sites/default/files/green-jobs-ca-recycling-report.pdf

[127] https://static1.squarespace.com/static/53a09c47e4b050b5ad5bf4f5/t/61ba25c889b4fb7566404e6c/1639589328432/RNG+Jobs+Study.pdf