NY RENEWS

FALSE SOLUTIONS

Gas and trash: how the fossil fuel industry is holding back a just transition

FALSE SOLUTIONS

This report was prepared by the NY Renews Policy Committee and written by Lew Daly. NY Renews is a coalition of over 250 environmental, justice, faith, labor, and community based organizations fighting for policy that promotes climate, jobs, and justice in New York State.

Our Steering Committee includes: 32BJ SEIU, ALIGN - Alliance for a Greater New York, Catskill Mountainkeeper, Center for Working Families, Citizen Action of New York, Communications Workers of America District 1, Environmental Advocates of New York, GreenFaith, Long Island Progressive Coalition, NYC Environmental Justice Alliance, NY State Nurses Association, Our Climate, People's Climate Movement New York, PUSH Buffalo, Sierra Club, THE POINT CDC, and UPROSE.

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EXECUTIVE SUMMARY

In 2019, New York State became the nation's climate leader with the enactment of the Climate Leadership and Community Protection Act (CLCPA). This landmark law requires an economy-wide zero greenhouse gas emissions mandate by the year 2050, encompassing electricity, transportation, buildings, industry, and agriculture. Unlike "net zero" or "carbon neutral" approaches that include significant flexibility for polluters to avoid directly reducing emissions, the CLCPA explicitly establishes a "hard" mandate of 85 percent direct emissions reductions across the economy. New York is the first state in the country to have such comprehensive and binding emissions mandates.

While the CLCPA establishes firm emissions mandates for the state, as well as critical commitments on equity and environmental justice for the most impacted communities, the law leaves many of the specific policy choices for achieving the emissions targets in the hands of a public decision-making structure and planning process bringing together government, advocacy, and private-sector stakeholders over a 2-year period. This public decision-making process helps to ensure that New Yorkers have a say in our clean energy future and the transition off of fossil fuels that will impact all of our lives.

New Yorkers all have a stake in this process. All New Yorkers are promised new jobs, cleaner air, and greater investment in creating a livable future. Environmental justice communities, who bear the worst burdens of pollution and the climate crisis, are especially impacted by this process. Yet, an array of other interests are poised in this moment to get in the way of real progress, often in the name of being "clean" or "renewable" or otherwise part of the solution. The fossil fuel industry, including and especially natural gas interests are fighting to protect the status quo and their ill advised investments.

In the following report, we examine a particular set of “false solutions” to the climate crisis, each of which is marketed, often by fossil fuel interests themselves, as a “renewable” or “clean” or “low-carbon” alternative to fossil fuels. These false solutions are the wrong direction for our state.

First, production of these alternative fuels is often carbon-intensive--compared to fossil fuels, some of these false solutions literally add more greenhouse gas emissions than they reduce. Second, many of these fuels must be combusted to produce energy, which leads to more local pollution. Environmental justice communities will not see adequate reductions in toxic pollution, and thus adverse public health impacts, as long as we continue to combust fuels for energy. Third, some of the alternative fuels with a legitimately cleaner footprint are not economically viable for even marginally replacing fossil fuels in our economy. Fourth, reliance on “bioenergy” diverts land use from food to energy, depletes the earth’s ability to recycle carbon, and contributes to water pollution. Finally, the production of some of these fuels is water intensive and could contribute to severe water stress.

“Bioenergy”—energy extracted from organic matter and implicating specific land-uses—is at the heart of many of these false solutions. As a replacement for fossil fuels, bioenergy raises no less serious and troubling questions about how we are using natural resources for human needs. Bioenergy can divert land use from food to energy production, particularly for populations in the Global South. It may also deplete the earth’s power of carbon recycling, which is urgently needed to slow and reduce atmospheric warming. Producing these fuels also requires intensive water needs and use of pesticides, leading to further concerns about how we use our planet’s land and resources.

We cannot let the CLCPA become a vehicle for wrong or inadequate answers to the “how” of getting to zero emissions, because it will soon be too late if implementation of our climate laws falls short of what was promised to the people.

The False Solutions

The report includes five sections, each covering a different false solution. Several of the categories are closely interrelated and sometimes interchangeable in terminology. But we have devised a categorical breakdown as follows:

- Biofuels—primarily liquid fuels used for transportation, derived from a variety of plant matter including grains, grasses, tree fiber, and vegetable oils.
- Biomass—raw feedstocks of biofuels, primarily woody matter, which are burned directly for energy instead of being processed into liquid fuels.
- Biomethane, termed "renewable natural gas"—biogenic gas captured from breakdown of waste materials in landfills and livestock operations, and processed into nearly pure methane for blending with fossil gas.
- "Green" Hydrogen—technically not a biofuel, hydrogen gas for energy is produced from methane gas or water and primarily used as a heat source in industrial processes.
- Waste-to-Energy—incineration of biogenic municipal waste (food, paper, cloth, wood) to reduce waste volume and recover energy for electricity and/or heat.

Key Findings

BIOFUELS

Biofuels, especially for transportation, have long been promoted as "carbon neutral" by industry. But the most common biofuels in use or development today are not carbon neutral if accounted for on a life-cycle basis including direct and indirect land-use changes, disruption of carbon recycling, processing and transport emissions, and end-use emissions. Biofuels of different types are net contributors to atmospheric emissions for between 52 and 167 years. **In other words, it takes at least 5 decades before biofuel emissions are reabsorbed by regrowing plants and restoring land-uses. This puts biofuels on a collision course with current timeframes for mitigating the climate crisis.**

BIOMETHANE (RENEWABLE NATURAL GAS)

Biomethane—methane captured from landfills and other waste streams or potentially gasified from waste materials or energy crops—is being proposed as a clean, "decarbonizing" substitute for burning fossil gas for electricity, heating, transportation, and industrial processes. This "renewable natural gas," like fossil gas, is nearly pure methane; if produced and distributed into the existing gas network, it will add to methane leakage and related serious warming effects, as well as local environmental health harms. **Promotion of renewable gas is also arguably—indeed self-identified as—a strategic bid to buffer the fossil gas industry from policy and market changes that threaten its very existence.** Further, such an effort raises serious concerns about expansion of carbon-intensive land-uses to grow feedstocks necessary to "green" the fossil gas system, **as existing feedstock capacity is only sufficient to replace between 6 and 13 percent of current gas demand** (according to the industry's own analysis).

BIOMASS ENERGY

Biomass energy—particularly involving direct combustion of woody matter—is expanding, causing climate and environmental justice harms. Markets for woody biomass, primarily in Europe for the replacement of coal, are driving deforestation and local pollution in the Southern United States. Biomass energy is another false solution said to be carbon neutral. In fact **it is acutely disruptive of carbon neutrality, because carbon recycling from the atmosphere by regrowing trees takes decades even as wood burning for energy is copiously adding emissions today.** Further, side by side studies of biomass plants and gas plants, drawing on actual air permit data, find **dramatically higher rates of local pollution from biomass.**

GREEN HYDROGEN

The concept of green hydrogen is taking hold in clean energy discussions. But often, the potential climate benefits of hydrogen can be far outweighed by potential harms. Targeted, potentially beneficial uses for energy storage and hard-to-electrify niche sectors could be positive. Larger scale substitution of hydrogen for fossil fuels, especially for electricity, buildings, and light-duty vehicles, ring alarm bells.

Blending or substituting hydrogen into the fossil gas network reinforces gas combustion and gas infrastructure as part of our economy, while also raising fuel costs and facing multiple technical challenges. Turning hydrogen into a fuel is extremely resource intensive. **More than 95 percent of hydrogen in use today—mostly for industrial heat processes—is produced using fossil fuels, with the perverse emissions effects of using dirty energy to produce clean energy.** At the same time, the prospect of "green" hydrogen—produced by electrolysis of water using renewable electricity—raises a host of other concerns. Diversion of renewable electricity to produce energy instead of power cars and buildings could have **perverse effects of grid destabilization and slowing economy-wide decarbonization.** Producing hydrogen is also water intensive, and severe water stress, already a significant issue in some parts of the country, is another potential harm. Producing 1kg of hydrogen via electrolysis uses 18.04 kg of water, in addition to the water lost in the distillation process, which nearly doubles that amount. Combustion of hydrogen for electricity, heating, and industrial processes also raises serious environmental justice concerns, threatening significant emissions of ozone-forming nitrogen oxides that contribute to respiratory distress.

WASTE TO ENERGY

Waste-to-Energy, which recovers energy for electricity and heating by burning municipal solid waste, is considered a renewable energy source in multiple states (not including New York State). Compared to burning coal, local pollutant emissions and GHG emissions from waste incineration are generally higher. From a GHG perspective, life-cycle analyses counting reduced landfill emissions as a net improvement of incinerator emissions show mixed results. But carbon neutral analyses of waste incineration that ignore local pollution raise serious environmental justice concerns. For one or more pollutants, **seven of New York State's waste incineration facilities are counted among the 12 most polluting such facilities across the United States.** New York's waste incineration facilities perform significantly worse on cancer-causing hazardous air pollutants compared to other power plants in the state. In 2018, New York City shipped 12 million tons of its own municipal solid waste to landfills and incinerators in other places, often in or near low-income communities. Burning waste is an acutely unhealthy, racially inequitable, false solution to waste management problems that require much bolder solutions such as waste reduction and recycling.

BIOFUELS

LAND FOR PLANET, NOT FOR POWER

What are Biofuels?

Biofuels come in many varieties, but all varieties have the common trait of turning organic matter into sources of heat energy. Although originally promoted as a way to secure “energy independence” from foreign oil, today biofuels are almost exclusively marketed as a climate-friendly “clean” alternative to fossil fuels.

Biofuel uses include transportation, heating, and generating electricity. As with fossil fuels, biofuels are almost always combusted to release their energy. Some biofuels are more than nominally “cleaner” than fossil fuels in terms of raw carbon content; the most prevalent, such as ethanol, are not. But in other respects, such as cultivation of their feedstocks and related land-use changes, displacement of food production, soil and water contamination, carbon-intensive fuel processing methods, and non-GHG pollutants and local pollution, biofuels introduce new problems that only compound a climate crisis demanding more fundamental changes in the energy system and the economy it powers [1].

Biofuels introduce new problems that only compound the climate crisis.

Destructive effects of biofuel markets and production in the global South are well-documented and incisively critiqued in environmental justice scholarship, but here we focus more narrowly on domestic aspects and specific questions facing policymakers in New York State [2].

Most commercial biofuels are liquid fuels used in transportation and interchangeable with refined petroleum fuels such as gasoline or diesel fuel; the term “biofuels” commonly refers to liquid fuels for transportation. Gas energy derived from decomposing organic matter is also processed as a biofuel, termed biogas or biomethane (biomethane is discussed elsewhere in this report). Gas biofuel is often marketed as a cleaner blend for heavy transportation and gas-fired electricity, but it is increasingly being promoted for residential uses such as heating. Hydrogen is another—and much touted--alternative to fossil gas, but it is not a biofuel, as it is not derived from organically stored energy (so-called “green hydrogen” is discussed elsewhere in this report).

“Conventional” biofuels, the most common of which is corn ethanol, are derived from fermented grain sugars. Ethanol is typically blended with gasoline, at a rate of 10 percent. In 2019, New York State approved a marginally “cleaner” 15 percent ethanol blend (E 15), after a multi-year lobbying campaign by the industry [3].

Biofuels derived from vegetable oils, cooking grease, and animal fats are used in diesel engines. These fuels are termed biodiesel and are likewise used as a blending fuel, particularly for public fleets and other trucking, as well as home heating.

“Second generation” biofuels are cellulosic, deriving from fibrous agricultural and forest residues, from intentionally planted energy crops such as perennial grasses and short-cycle trees, as well as from biogenic municipal waste. These fuels are sometimes called “advanced” in contrast with the “conventional” grain alcohol fuels. They are generally known to have somewhat less carbon content and cleaner emissions when combusted, but even today they are not commercially viable because of high production and processing costs. Federal mandates setting production ratios between different types of biofuels reflect the considerable challenges facing advanced biofuels. The ratio of cellulosic biofuels production to gasoline and diesel production is mandated at well under 1 percent (.34) under the federal Renewable Fuel Standard rules of 2020 (see below) [4].

Some biofuel feedstocks ("biomass”) are not processed into liquid fuels but rather are combusted directly in solid or gasified forms to generate direct biomass energy, with uses such as electricity and heating as well as transportation in very limited forms (biomass energy is assessed elsewhere in this report).

Biofuels are not a friend to environmental justice: they are not commercially viable and have little to no impact on improving air quality in truck-clogged communities and high exposure workplaces.

Industry narratives sometimes frame biofuels as a friend to environmental justice. At a minimum, this story ignores the fact that the least polluting biofuels are not commercially viable and currently have little or no impact on improving air quality in truck-clogged communities and high-exposure workplaces. The industry’s response is to seek policy regulatory advantages and long-term subsidies, but this flies in the face of environmental justice critiques of precisely such policies both within and beyond our national borders [5].

Energy Footprint of Biofuels

Contemporary biofuels were first heavily promoted in the United States as a source of energy independence in response to the fuel shortages and foreign conflicts of the 1970s. Environmental benefits have since become a staple argument of the biofuels industry, and today they are promoted as both “renewable” and “carbon neutral” energy sources and as an antidote to climate change. This “green” narrative is often oversimplified and in fact harbors troubling implications as a matter of both pollution control and climate policy.

The national energy footprint of biofuels is substantial but varying significantly by class. A significant fraction of the gasoline supply at the pump is 10 percent ethanol, and 38 percent of corn cultivation was for ethanol as of 2019.

Environmental impacts on land-use and water resources are well-known. Among other things, ethanol feedstock demand is a significant source of chemical run-off into the Mississippi River. This pollution flows into the Gulf of Mexico and has created a massive hypoxic dead zone measuring roughly 6,000 square miles in area on a five-year average [6].

The United States and Brazil produced approximately 84 percent of global ethanol in 2019. All other biofuels combined comprise less than 5 percent of primary energy in the United States. Biomethane, primarily from landfills, generated 0.3 percent of utility scale electricity in the U.S. in 2019 [7].

Legislation passed in 2005 and expanded in 2007 established a federal Renewable Fuel Standard (RFS) to increase biofuel penetration in the country's fuel-energy mix, requiring a projected 36 billion gallons by 2022--equal to roughly 20 percent of national gasoline consumption. Federal requirements were not met in the first decade of the program, and EPA initially waived the standards and within three years was forced to lower the standards.

The RFS legislation also required quantified greenhouse gas reductions: compared to gasoline emissions, ethanol had to attain a 20 percent reduction and a variety of advanced biofuels had to attain an average reduction rate of roughly 50 percent. According to the Government Accountability Office, the program had little to no effect on GHG emissions as of 2019 and this will remain the case through 2022, the program's next statutory deadline. Some observers argue that the primary reason biofuels have fallen short on GHG reductions is that advanced biofuels, theoretically assumed to have greater carbon reduction potential, had little growth under the program compared to ethanol, which is the weakest biofuel from a carbon reduction perspective. As noted, high production and processing costs are a major reason advanced biofuels are not yet widely available [8].

Deeper and more concerning criticism has been mounting, however. As biofuels have become more integral to transportation in the United States, their carbon footprint has been subject to increasing scrutiny drawing on more robust modeling.

As will see in more detail below, the industry framing of biofuels as a climate-friendly alternative to gasoline (supported early on by major environmental groups) is now in serious question, and significant policy changes may be coming.

The biofuel production footprint in New York State is generally small. New York ranks 16th in ethanol production, with about 4 million barrels produced annually as of 2018 (about 1 percent of total national production) [9]. New York has almost no biodiesel production, but fairly significant biodiesel consumption, about 1.7 million gallons in 2018--still only a small fraction of the roughly 1.5 billion gallons of petroleum diesel consumed in the state [10]. As of 2018, home heating oil sold for use in New York City and Nassau, Suffolk, and Westchester Counties had to be blended with 5 percent biodiesel, and the state also has a tax credit for purchases of B6 diesel (6 percent biodiesel) for use in space and water heating within New York.

Low Carbon Fuel Standard legislation in the New York State Legislature has support from gas and biofuel interests, but no environmental justice groups are behind this effort.

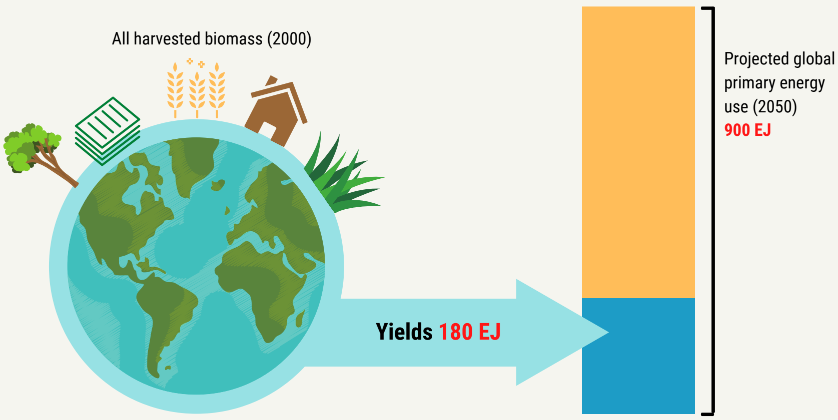
Under New York's Climate Leadership and Community Protection Act, biofuels are excluded from eligibility for the law's strictly limited carbon offset program (15 percent of emissions on a path to zero emissions economy-wide by 2050); further, biomass energy is excluded from the state's program for advancing renewable energy under its Clean Energy Standard. But that leaves a vast swath of the economy, particularly in the transportation, buildings, and agricultural sectors, potentially open to more biofuels as "low carbon" or "renewable" alternatives to fossil fuels. In fact, an important push in this direction, seeking to establish a Low Carbon Fuel Standard (LCFS) in the state, is already making its way through the New York State legislature. The legislation has support from gas and biofuel interests that stand to benefit, along with a handful of environmental groups. But no environmental justice groups are part of the coalition behind this effort [12].

"LOW CARBON" DOES NOT MEAN LESS POLLUTION OR GREENHOUSE GAS EMISSIONS

As noted, biofuels depend on combustion to provide energy, with resulting pollution. Biofuel pollution compared to fossil fuel pollution is a disputed topic, but it is a mistake to assume that the label “lower carbon” often applied to biofuels means less pollution. All marketed biofuels have some level of carbon emissions upon combustion and in their production process as measured on a life-cycle basis, and they all contain non-GHG pollutants that are released during production and combustion (and sometimes before combustion in an evaporative state). Yet biofuels are often framed as “carbon neutral,” on the assumption that they have no net emissions because these emissions are offset by carbon “uptake” (absorption) in the organic feedstocks used to produce the biofuels. In fact, this is a deeply contested and often disproven assumption:

- Research led by Timothy Searchinger modeled how the diversion of U.S. land for biofuels would affect GHG emissions over a 30-year period. Previous GHG emissions research had largely failed to account for land-use changes associated with biofuel production. Far from being carbon neutral, he found that conventional biofuels nearly double emissions compared to gasoline over 30 years, and switchgrass emissions were 50 percent higher [13]. Ethanol is not carbon neutral for 167 years, and for switchgrass the carbon neutral timeline is 52 years. Such timelines for carbon neutrality are of course alarming because controlling GHG emissions is a matter of utmost urgency even within the next 10-15 years. In addition to not being safe from a climate perspective, biofuel energy is also simply unsustainable, ecologically and socially. As Searchinger calculates, using the entirety of human plant harvests in 2000 to produce energy would only meet 20 percent of global energy demand by 2050 [14].

Using All of the World's Harvested Biomass for Energy Would Provide Just 20% of the World's Energy Needs in 2050 (Exajoules per year)

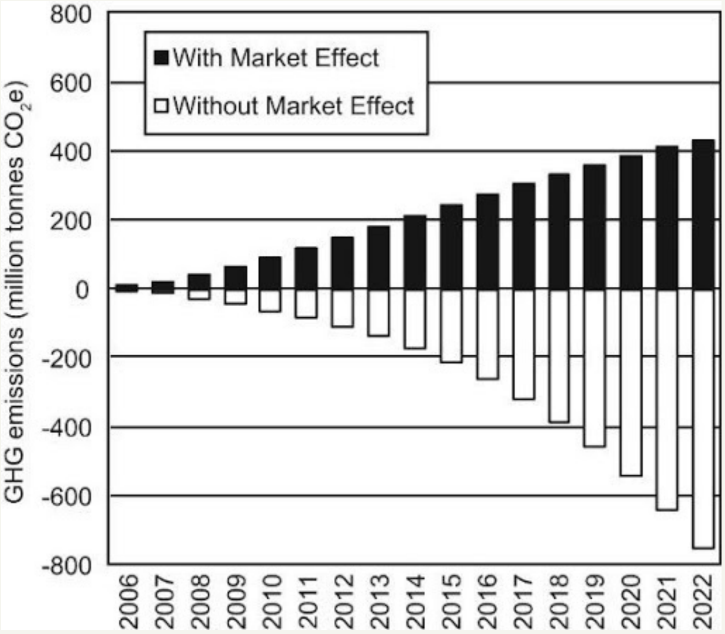


World Resources Institute, see bit.ly/1K5FCSr

Switchgrass is not carbon-neutral for 52 years; ethanol isn't carbon neutral for 167 years. That's a timeline we just can't afford.

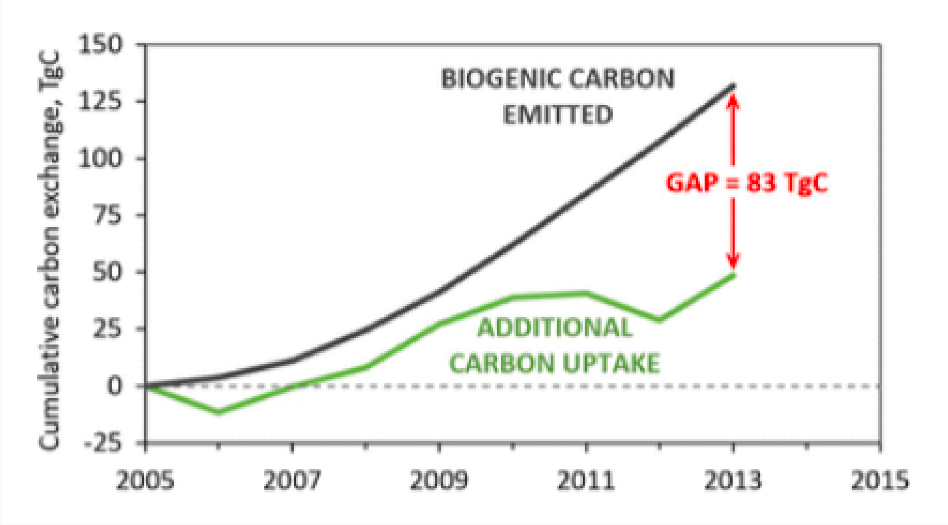
- As U.S. biofuel mandates sextupled biodiesel production between 2008 and 2016, land and forest conversion and industrial palm fruit operations in Indonesia drove a measurable spike in global GHG gas emissions and caused a social and environmental catastrophe that drew worldwide attention to biofuels' perverse logic and outcomes. Although biodiesel in the U.S. is not now reliant on palm oil,this highlights the dangers of treating land and forests as willing feedstocks for global energy markets. The biodiesal market has provoked huge controversies and resistance in Global South development circles and Indigenous human rights movements, along with sharp criticism from climate change researchers and policy critics of the biofuels industry [15].
- Through the 2010s, federal incentives appeared to pit biofuels against fossil fuels, with many climate and environmental experts (not all) decrying both [16]. The debate is not completely settled, but the assumption of "carbon neutral" biofuels has been completely upended and today and we have (and should use) a much more systemic understanding of the net destructive effects of biofuels, considering multiple factors in addition to emissions upon combustion: agronomically and socioeconomically significant land-uses changes, direct and indirect; carbon-intensity of cultivating, processing, and transporting the fuels; end-uses from a place-based exposure perspective; environmental impacts of the production chain and end uses; market-mediated effects on energy production and consumption.

- Research assessing the market effects of the Renewable Fuel Standard found extensive "rebound" effects, where biofuels only partially displace gasoline usage and fuel prices drop overall because of excess supply. As a result of these market effects, even when biofuels meet EPA's GHG emissions intensity standards, the federal biofuels mandate actually drives up GHG emissions due to market rebound effects [17].



- One major study found that, between 2005 and 2013, cumulative carbon uptake from planting biofuel feedstocks was only sufficient to offset 37 percent of total emissions from biofuels' production and consumption. What has been touted as a climate-friendly substitute for fossil fuels is in fact a net contributor to the problem [18].

- Although biodiesel generally has lower carbon content than other biofuels, biodiesel production from vegetable oils is a net contributor to GHG emissions, primarily due to direct and indirect land-use changes. Only biodiesel made from waste fats appears to be less carbon intensive than fossil fuels [19].



BIOFUELS POLLUTE COMMUNITIES

Co-pollutant emissions of biofuels vary compared to gasoline, but biofuels are by no means so much cleaner than gasoline that we should not be concerned about, and expect more research on, local pollution effects of burning biofuels.

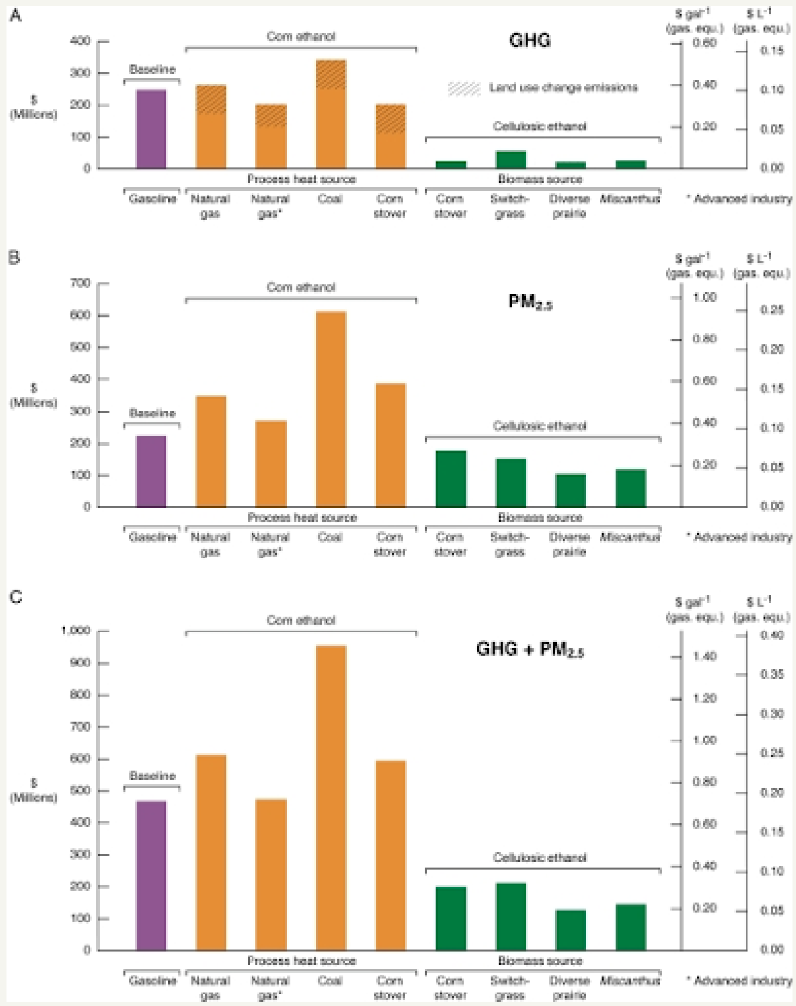
- In a major study, the atmospheric scientist Mark Jacobson found that ethanol emissions are associated with higher rates of ozone formation—a major source of respiratory illness, particularly in low-income communities of color [20].
- According to the same study, ethanol is also no better than gasoline in terms of carcinogenic potential, and it is much quicker to evaporate pre-combustion, increasing pollution inside of vehicles and around the gas pump and gas tank [21].
- Compared to powering electric or hydrogen vehicles with renewable energy, which produces zero deaths per year, powering vehicles with corn ethanol, cellulosic ethanol, or gasoline results in at least 10,000 deaths per year for each of the three fuels [22].

Ethanol is no better than gasoline in terms of carcinogenic potential, and actually increases pollution inside vehicles and around the gas pump and gas tank.

- Advanced biofuels are considered to have lower carbon content compared to gasoline, but less is known about co-pollutants of these cellulosic fuels (which in any case comprise only a small fraction of biofuel production). However, a study published by the National Academy of Sciences sheds further light on fuel combustion health impacts by assessing the combined effects on GHG emissions and fine particulate matter (PM 2.5) attributable to three different fuels. Based on one million gallons produced and combusted in the United States, the study found climate and health damages equal to $469 million for gasoline, $472-952 million for corn ethanol, and $123-208 million for various cellulosic biofuels. Corn ethanol, the most prevalent biofuel, is the most damaging of the three fuel types, and while certain advanced biofuels appear to be less harmful, clearly none of them are without some adverse impacts on climate and people's health [23].

- Biomethane (processed biogas captured from waste streams) is promoted as a clean fuel especially for buses and moderate- and heavy-duty trucks. Compared to natural gas, biomethane is considered to have fewer upstream emissions, because the gas is captured from decomposing waste streams and thereby prevented from escaping into the atmosphere. However, biomethane and fossil gas have virtually the same chemical composition and both emit similar levels of nitrogen oxides upon combustion.

For this reason, biomethane is not considered any cleaner from an environmental justice perspective. A broader problem is that available waste feedstocks for biomethane production are extremely limited, enough to meet only about 4 percent of natural gas demand. Expanding the supply of "clean" gas would therefore require expanding the acreage for energy crops to supply more methane, with potentially perverse effects on overall emissions (the section on renewable natural gas examines these issues in greater detail).



Because biomethane and fossil fuels both emit similar levels of nitrous oxide upon combustion, biomethane is not considered any "cleaner" from the perspective on environmental justice communities plagued by highways and traffic.

- Natural gas transportation fuels, such as liquified natural gas, are promoted as cleaner alternatives to petroleum fuels, and particularly diesel fuels for trucking. An influential 2019 study from The Netherlands comparing actual tailpipe emissions of diesel and gas trucks found precisely the opposite: Urban LNG trucks emitted 2-3.5 times more NOx than the least polluting diesel trucks. This would also be true if the LNG trucks were fueled with biomethane, the authors asserted based on gas chemistry (but they did not test this assertion). It should be noted that the study was criticized by truck manufacturers, and the authors rebutted the criticism. It should also be noted that some manufacturers are working to develop low-NOx truck engines [24].
- While marketed as a cleaner gas fuel, like other biofuels biomethane is a blend stock the commercial viability of which depends on the pipelines and other infrastructure of the larger fossil gas supply chain. Thus, increasing the supply of biomethane will only serve to further lock-in gas infrastructure, while putting a misleading cleaner stamp of approval on the gas industry's vast and harmful extractive enterprise [25]. Cleaner gas cannot replace fossil gas; it can only perpetuate it. However, most critics agree that limited development of biogas for hard-to-electrify uses such as shipping and aviation is a good idea.

Increasing the supply of biomethane will only serve to further lock-in gas infrastructure.

- Compared to highly toxic petroleum diesel, biodiesel may be less harmful to air quality and health, but the evidence is quite mixed. Biodiesel tailpipe studies generally find higher nitrogen oxide emissions (NOx) and lower emissions of fine particulate matter (PM 2.5). From a health perspective, however, the more important issue may not be the relative toxicity of the two types of diesel fuel but rather rates of exposure to diesel exhaust. Effects of high exposure, particularly in specific work environments and heavily trucked neighborhoods, likely outweigh the health benefits of biodiesel as a cleaner blend-stock in diesel engines [26].

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RENEWABLE NATURAL GAS

A PIPE DREAM FOR THE PLANET

What is Renewable Natural Gas

Renewable natural gas (RNG) is a processed form of "biogas," meaning gas generated from naturally decomposing human, animal, and plant waste. Biogas is distinguished from "fossil" gas (the main form of what is generally termed "natural gas") by the way it is formed and by its sources. Both, however, are similar in chemical makeup, and when biogas is processed to remove impurities, the resulting "biomethane," like fossil gas, is almost 100 percent methane. Methane is a greenhouse gas (GHG) nearly 90 times more powerful than carbon dioxide.

Nitrous oxide is a GHG "super-pollutant" 300 times more powerful than carbon dioxide.

Unlike fossil gas, which is extracted from underground hydrocarbon deposits formed over millions of years, biogas is generated by decomposition of waste matter still on the surface, in a process termed anaerobic digestion (breakdown without oxygen). Landfills, food and animal waste, and waste-water, as well as low-lying ecosystems such as bogs and marshes, are sources of biogas. Dry waste such as forest and agricultural residues and certain other biomass feedstocks can also produce biogas with the application of heat at low oxygen levels ("thermal gasification"). Prior to processing, biogas composition is primarily methane along with carbon dioxide. Other polluting elements in biogas vary by source, such as hydrogen sulfide (landfills) and nitrous oxide (animal waste and fertilized soil). The latter, emitted primarily by the agricultural sector, is a GHG "super-pollutant" 300 times more powerful than carbon dioxide [1]. Biogas methane, with its four hydrogen atoms, can also be used to produce hydrogen fuels, which is a focus elsewhere in this report.

Once it is “captured” from waste sources by engineered methods, biogas, as noted, can be “upgraded” to nearly pure methane by reduction of other elements in the biogas. The resulting product is termed biomethane or Renewable Natural Gas (RNG), which must meet pipeline standards of chemical purity to be deliverable for consumer energy uses. In most gas uses, including electricity, heating and appliances, and transportation, RNG and fossil gas are interchangeable and depend on the same pipeline and delivery infrastructure for reaching end-users. RNG is considered renewable on a very malleable definition: the supply can be renewed as long as there is human, animal, and plant waste that is technologically accessible for methane capture.

RNG's Energy Footprint

While natural gas, overall, supplies about one third of primary energy consumption in the U.S., and likewise about one third of electricity generation, RNG is currently a small fraction of natural gas consumption, likely no more than 2-3 percent [2]. Estimates of total RNG potential based on existing waste streams do not go substantially higher: The gas industry itself projects that only between 6 and 13 percent of natural gas consumption can be replaced by RNG from fully harnessing biogas resources over 20 years; notably, the higher potential scenario includes thermal gasification of dry waste such as agricultural and forest residues, a technology that is not yet viable for commercial applications [3]. Utilizing screening criteria for “ecological soundness” of biogas feedstocks, the National Resources Defense Council estimates that only about 7 percent of fossil gas can be replaced by RNG over 20 years [4]. Yet, in 2020, National Grid released its Net Zero Grid plan, elevating RNG and hydrogen as key resources for “decarbonizing” the gas network, a top business priority.

Flying in the face of their own estimates of RNG potential, gas industry executives are bargaining on a big push to market RNG as a clean—even carbon negative—alternative to fossil gas or other fossil fuels, on par with renewables such as solar and wind. Residential and commercial uses in particular are a focal point because buildings are by far the largest sector for natural gas delivery infrastructure and revenues (see below).

The electricity sector, too, could also continue to be an incumbent sector for fossil gas with the promotion of RNG and other types of low-carbon fuels. This is a live question in New York City, where environmental justice groups reached an agreement in 2020 with the New York Power Authority to transition 6 natural gas “peaker plants” (which are highly polluting and mainly located in low-income communities) to renewable energy and battery storage [6]. RNG is being considered as a fossil gas blend or replacement in the peaker plant transition. More generally, fossil fuel power plant owners are quickly getting attuned to the realities facing them under the CLCPA and publicly discussing how they can stay in business by substituting “clean” gas alternatives such as hydrogen or RNG [7].

A coalition of bio-energy businesses and advocates, including supporters of biomethane for vehicles, is actively promoting biomethane for use in heavy-duty trucks, farm equipment, and other harder-to-electrify uses. This coalition is lobbying the New York State legislature to establish a Low Carbon Fuel Standard (LCFS) to incentivize transportation biofuels, following in the footsteps of California. Biomass Magazine has surveyed how LCFS policy and other state policies are driving rapid growth in RNG production for transportation fuel and other gas markets [8].

But residential and commercial uses are the largest revenue source for gas utilities in New York State. Thus, to a significant degree, the gas industry’s economic future in New York will hinge on various strategies to maintain its very large residential and commercial customer base for gas delivery despite state policies that threaten to greatly curtail gas combustion under GHG reduction mandates. It is fair to say that the only scalable, effective, and ultimately lawful climate solution in the buildings sector, building electrification, poses an existential threat to the gas industry. The RNG push is one way of trying to ward off this accelerating threat and maintain gas’s foothold in the energy system. Further, the stark mismatch between feasible supply of RNG and overall natural gas demand points to other potential problems. For example, stark supply limits could lead to “induced” demand for RNG—demand driven by intentionally created methane supplies—with troubling implications, discussed below.

New York State Gas Profile

New York State is the sixth largest consumer of natural gas in the United States, generating more than $5.5 billion in sales for gas utilities, and more than $1.3 billion for gas industry transportation, in 2019 [9]. Roughly 40 percent of electricity in New York is generated from natural gas. Nearly 60 percent of households across the state are heated with natural gas, and more than 99 percent of gas utility sales in New York are for residential and commercial uses [10]. The gas system's large financial footprint in residential and commercial uses and related gas infrastructure stands in stark tension with the fact that fuel combustion for buildings is the second largest source of GHG emissions in New York, at 30 percent of total emissions (and approximately 70 percent in New York City) [11].

Fuel combustion in buildings is the second largest source of GHG emissions in New York, and 70 percent of total emissions in New York City. Natural gas is on a collision course with New York State's emission reduction mandates.

This reality puts natural gas in New York State on a collision course with GHG reduction mandates of the Climate Leadership and Community Protection Act, which went into effect in 2020. By 2040, gas-fired electricity must be eliminated from the state's power grid, and by 2050 natural gas for heating and appliances and other residential and commercial uses, as well as industrial processes, must be greatly curtailed if the state is to meet its legal mandate of achieving economy-wide net-zero emissions. This includes an 85 percent reduction in direct emissions, along with a 15 percent carve out for indirect emissions reductions (allowing carbon neutrality, mainly in the form of limited carbon offsets, for the most challenging abatement scenarios, such as industrial processes that cannot be feasibly electrified). Clearly, however, most natural gas uses—and the vast majority of gas combustion—will have to be eliminated under the 85 percent direct emissions reduction mandate [12].

The gas industry’s hype machine and policy attack for derailing electrification and promoting RNG and other alternative gas fuels has been ramping up since the mid-2010s, as statewide and municipal renewable energy standards and fossil fuel restrictions started gaining traction [13]. Among other major initiatives in this market and policy push for gas alternatives is the $100 million Low Carbon Resources Initiative (LCRI). Launched last year by the Electric Power Research Institute and the Gas Technology Institute, with support from National Grid and other large utilities, the LCRI will support research and policy development promoting large-scale deployment of RNG, bioenergy, and low-carbon fuels [14].

What's Wrong With RNG?

CLIMATE NEGATIVE, NOT CARBON NEGATIVE

RNG is described as carbon neutral or even carbon negative. In fact, only one available source of RNG—dairy manure waste operations—has the potential to be carbon negative. Most sources, like landfill gas, are not necessarily carbon neutral, particularly if distributed into the gas network. A fair number of waste-water treatment plants have digesters on site to process gas from waste solids. As of 2012, only a very small fraction of waste-water gas was being processed and distributed into the gas system [15]. This is a critical choice for maintaining carbon neutrality or achieving carbon negativity in capturing biogas from waste streams.

Indeed, RNG is being broadly marketed on the idea that, since it involves capture of methane that would otherwise be emitted into the atmosphere by waste sources, it should be considered to have an attribute of carbon negativity, or net reduction of GHG emissions [16]. As such, capture of waste biogas should receive financial and other benefits of policy. This rosy picture of a “win-win” scenario for waste biogas operations and climate change alike is in fact highly misleading, however, for several major reasons:

TOO MUCH LEAKAGE

While RNG can prevent methane from escaping biogas sources into the atmosphere, it changes nothing about significant leakage of methane from biogas capture and processing, pipelines, building hookups, and residential and commercial boilers, appliances, and other equipment [17]. At least 2-3 percent or more of gas in the supply chain escapes as so-called fugitive methane leakage, and the amount of leakage may be much greater than previously estimated. A 2019 study of 5 East Coast cities estimated methane leakage to be almost 900,000 tons, the vast majority of which—750,000 tons--came from residences, businesses, and facilities rather than from waste sources such as landfills. This localized gas leakage was more than twice the amount estimated previously for roughly the same region by the Environmental Protection Agency, and more than three times EPA estimates for leakage from gas fields in the Bakken shale [18]. Replacing fossil gas with RNG does not address fugitive methane and this is a major reason why most biogas sources, while less carbon intensive than extracted fossil gas or oil and coal—are in fact not carbon negative or even carbon neutral, as noted above. In fact, RNG produced on any significant scale will likely worsen the leakage problem by adding new processing and supply points to the existing leak-prone gas delivery system.

LIMITED POTENTIAL

RNG's carbon-negative reputation is conceptually incoherent and deceptive for another, even more troubling reason. As an alternative to fossil gas, RNG potential can only replace up to 13 percent of demand over a 20-year period (according to the gas industry itself, as noted earlier). Therefore, the only way to more than marginally match RNG supply with gas demand, thus making significant progress in "greening" the gas system, would be to "induce" RNG demand by intentionally creating a lot more biomethane to capture, process, and deliver for end uses. Preventing intentionally created methane from escaping into the atmosphere cannot be considered a carbon negative solution in the energy system, because it is only a solution to a GHG problem of its own making [19].

PERVERSE INCENTIVES

The induced demand problem raises a more specific troubling issue. Given relative inelasticity of human and animal waste streams accessible for methane capture, only large new supplies of energy crops could produce the methane needed to replace extracted fossil gas with RNG. The perverse land-use effects of energy crop expansion for intentional methane production may render RNG even more carbon-intensive than fossil gas. Further, other large sources of methane such as industrial scale livestock operations are major sources of local air and water pollution.

The perverse land-use effects of energy crop expansion for intentional methane production may render RNG even more carbon-intensive than fossil gas.

THROWING MONEY DOWN THE DRAIN

The tremendous sunk costs of climate-polluting gas infrastructure will only be further “locked in” financially by mixing RNG in the fossil gas supply chain, with negligible climate benefits compared to electrification. Further, the high costs of RNG production and processing will, in addition to raising consumer costs for energy (see below), divert investment from the massive solar and wind deployment that will be necessary to comply with the CLCPA and other GHG reduction mandates such as Local Law 97 for NYC building emissions, also passed in 2019.

RAISING CONSUMER COSTS

RNG will also cost significantly more than fossil gas at current prices, somewhere in the range to 3 to 15 times higher by 2040, according to a 2019 analysis prepared for the American Gas Foundation [20]. Rising gas costs will worsen significant home energy affordability gaps faced by low-income New Yorkers [21].

INDOOR AIR POLLUTION

Finally, the high volume of residential gas combustion for heating and appliances is a significant problem for indoor and outdoor air quality, and combusting RNG instead of fossil gas does not eliminate these problems. As noted, substantial methane leakage is occurring “back of the meter,” in and around residences and other buildings and infrastructure in urban areas. Gas cooking appliances, moreover, emit co-pollutants known to cause health problems, such as nitrogen dioxide, carbon monoxide, and fine particulate matter. Lower income people with smaller, less well-ventilated apartments and older appliances are the most vulnerable to indoor air pollution from gas appliances; further, one major study estimated that approximately 27,000 tons of carbon monoxide and nitrogen dioxide emitted from gas appliances actually polluted outdoor air in California in 2018 [22].

Beneficial Uses of RNG

Capturing and processing landfill gas and waste-water solids gas for on-site or nearby uses like heating or powering equipment is beneficial and even carbon negative compared to biomethane produced for distribution in the gas system. Capture of livestock manure biogas for on-site uses would also have significant GHG reduction benefits, but most livestock gas comes from concentrated animal feeding operations (CAFOS) that generate multiple environmental harms along with the biogas. Fashioning gas capture systems for these large animal product operations may only serve to reinforce this resource-intensive and highly polluting model and give it a green stamp of approval. Potential climate benefits should be weighed against other harms of these industrial feeding operations.

Other potentially beneficial uses for RNG might also include industrial processes requiring high heat, such as steel production; transportation that will be difficult to fully electrify (aviation, shipping); and backup generation support for grid reliability as we transition to 100 percent renewable electricity.

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BIOMASS ENERGY
RENEWABLE CARBON BOMBS

What is Biomass Energy?

Biomass is organic raw material for generating energy. Biomass “feedstocks” are often processed into liquid and gas “biofuels,” for transportation, heating, and industrial uses (as discussed elsewhere in this report). Woody biomass in particular is sometimes burned directly, like fossil fuels. In the clean energy debate, some consider biomass energy to be renewable and even “clean” compared to fossil fuels. This framing rests on three fundamental fallacies.

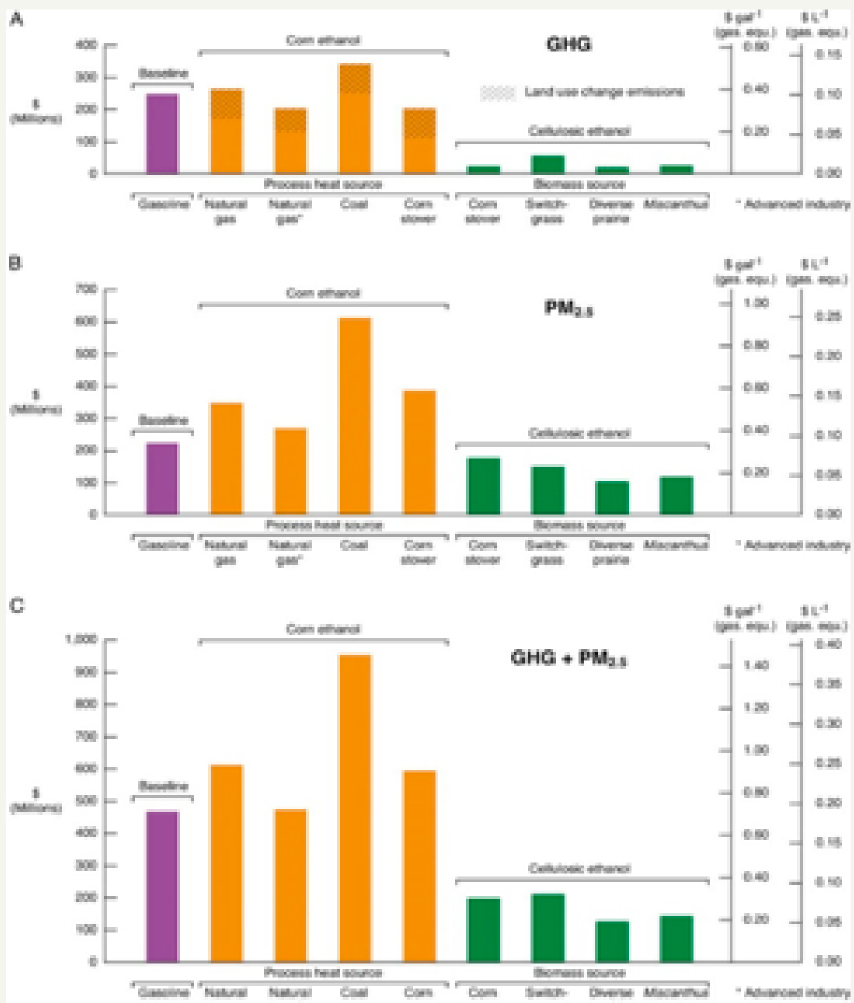
First, biomass energy is considered “renewable” simply because plants and trees cultivated for energy can be replanted. But plants and trees cannot replant themselves, and energy history has little to recommend itself from a standpoint of enlightened land use. More pointedly, harvesting and processing forest materials releases emissions, which add to the emissions released upon combustion.

Energy history has little to recommend itself from a standpoint of enlightened land use.

Second, biomass is also thought to be “carbon neutral,” because the GHGs released when biofuels are combusted are offset by carbon absorbed in the biomass material as it grows back. In fact, as we review elsewhere in this report, many types of bioenergy can be net contributors to GHG emissions for decades before the carbon is reabsorbed, and this will not allow for repair of the carbon cycle until it is too late. Additionally, reliance on the generation of biofuels from organic wastes such as food scraps, leaf litter, or wood chips incentivizes the furtherance of waste production, rather than goals higher on the waste hierarchy such as prevention, composting, or donation.

Describing fuels generated from food and other organic waste products as "carbon neutral" also ignores GHG emissions from inputs such as nitrogen fertilizers, petroleum for plastic packaging, and various fuels used in transport and refrigeration.

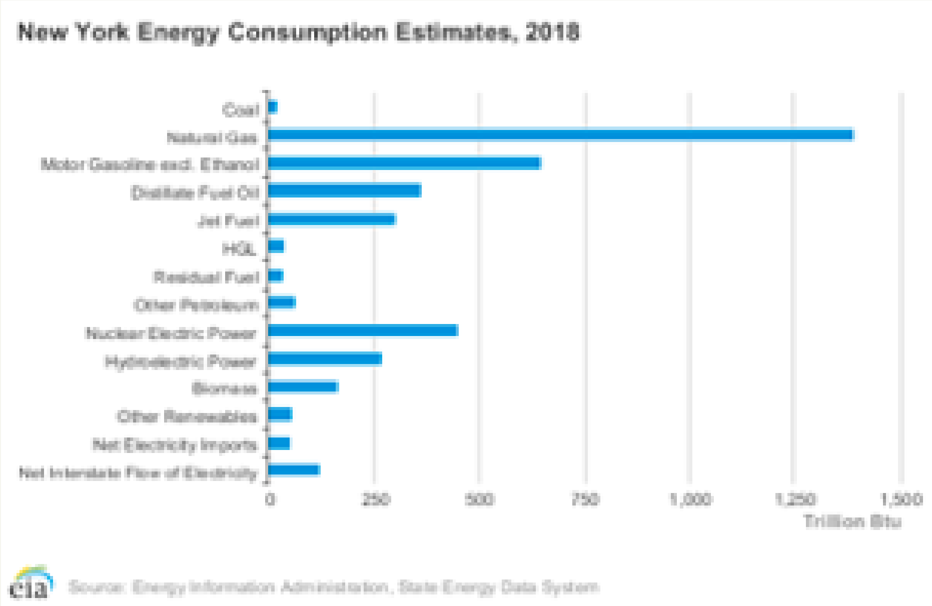
Last is the question of "clean" biomass energy, which depends on many factors: What are the feedstocks (corn, energy crops, vegetable oil, waste streams, wood)? How are they utilized to provide energy (processed into fuels, directly combusted, captured from waste streams, injected into pipelines, etc.)? Some biofuels are more polluting than gasoline. Research comparing ethanol to gasoline (see the figure below) found that ethanol has similar or higher GHG emissions, depending on how it is produced. It also has significantly higher particulate matter emissions, which, in turn, are concentrated in vehicle- and industry-heavy areas disproportionately populated by low-income people and people of color.



So-called advanced biofuels (cellulosic) appear to be less polluting, but some are not much better than gasoline on particulate matter [1]. Many of their promoters do not even consider local pollution when touting the climate benefits of biomass energy. The bizarre practice of burning wood at utility scale as a substitute for fossil fuels may be the clearest example of what's wrong with biomass energy in general.

Biomass's Energy Footprint

In 2019, combined use of forest, agricultural, and waste resources for energy comprised approximately 5 percent of total primary energy use in the U.S. Wood supplied 46 percent of this bioenergy and biofuels (primarily ethanol) supplied 45 percent. Biogenic waste resources supplied the remaining 9 percent of biomass energy in the U.S. The industrial sector consumed the most biomass energy, at 46 percent, including many forest product and paper plants that burn biomass for combined heat and power in their own operations. Transportation accounted for another 28 percent of biomass consumption, primarily in the form of biofuels. Electricity generation consumed about 9 percent, and wood-burning for residential heat about 11 percent. [2]



While biomass's imprint on New York State is relatively small, it is larger than that of all other non-hydro renewables combined.

In 2018, New York generated about 160,000 megawatt hours in utility-scale electricity from biomass, 128,000 of which were generated by Independent Power Producers [2]. New York has three wood-burning, utility-scale generating facilities providing about one-fourth of the state's biomass electricity. Many smaller landfill gas generating facilities provide about one-fourth of the state's biomass generating capacity. The state also has seven wood pellet plants, for use in home heating and power generation [4]. New York ranks among the top 10 states in particulate matter emissions from residential wood burning, with neighboring Vermont being at the top of the per capita list [5].

In the state's Clean Energy Standard, biomass is excluded from eligibility under Tier One, covering new renewable energy capacity—a good policy choice. Existing biomass facilities that were operational before 2015 are included in Tier Two for "maintenance resources," but expansion of Tier Two facilities appears to be allowed under certain circumstances [6]. Whether biomass generating capacity is likely to grow in New York based on existing facilities is unclear. But it is notable that biomass wood-burning has become a major battlefield in the legal and policy conflicts over what, if anything, qualifies as renewable or carbon neutral in the full spectrum of biomass energy. In 2018, Congress and then the Trump Administration attempted to mandate that wood-burning be included in the federal Renewable Fuel Standard program for promoting biofuels, but this reclassification was never made permanent.

The RFS itself, and biofuels writ large, are facing serious scrutiny, from both a climate perspective and an environmental perspective. The end or wind-down of the program and related subsidies may indeed be looming. The legal and policy obfuscations boosting biofuels for decades now are falling apart, and they are increasingly a battleground for dirty energy producers facing climate mandates and financial pressures that threaten to stop them in their tracks or put them out of business for good. A case in point, and perhaps a cautionary example for New York advocates fighting for just and equitable implementation of the CLCPA, is the 10-year battle over Palmer Renewable Energy, a large wood-biomass generation facility proposed in Springfield, Massachusetts. This major permitting fight was recently disrupted by the state legislature when it put a 5-year hold on a legislative proposal to include biomass in the state's renewable energy program [7].

Yet, across the country, at least 115 new biomass combustion facilities are in various stages of permitting, and a significant number of coal plants are considering how to re-tool for co-firing with biomass. It is important to recognize, further, that biomass is not just about generation, it's also about producing the wood and other feedstocks. Remarkably, the Southeast region of the United States has become an epicenter for production of wood pellets for heat and power, mostly for export to Europe. Although little noticed in the U.S., wood biomass energy is now the single largest source of "renewable" energy in the United Kingdom and parts of Europe, creating a new and expanding market for U.S. wood feedstocks. Dozens of wood pellet factories dotting the South are driving up local pollution, largely in and around low-income communities of color. Southern forests are under attack to provide wood feedstocks for a surging European bioenergy market. The resulting feedstocks then create even more pollution when they are combusted overseas by wood-burning power plants often converted off of coal [8].

What's Wrong with Biomass?

Promoters of wood-biomass energy have tried to follow the standard script for all bio-energy: the “bio” in biomass and the fuels or direct energy derived from it means “carbon neutral.” Substituting biomass for fossil fuels is good for the climate because combusting it is part of a carbon cycle. The plants you burn for energy grow back and effectively reabsorb their own previous carbon emissions. By contrast, combusting fossil fuels releases carbon permanently into the atmosphere.

As reviewed in the biofuels section of this report, as early as the mid-to-late 2000s, scientific modeling was already casting doubt on this theory by incorporating impact variables previously left out of carbon emissions analyses—most importantly effects of direct and indirect land-use changes. Multiple studies found that liquid biofuels in particular generated net emissions increases, thus worsening climate change. If not a new consensus, a strong critique took shape, which has continued to gain ground.

Burning the wood is effectively a carbon bomb for climate change, the fallout of which is only partially reabsorbed by replanting the trees, even after decades.

Today’s growing focus on wood-biomass has sharpened one key aspect of this critique, the question of time. Simply put, when you burn wood for energy you add GHGs to the atmosphere immediately and push cumulative emissions ever closer to catastrophic tipping points. Carbon uptake of the trees you replant, however, begins slowly and does not fully lock-in until decades later, when the trees are full grown. Burning the wood is effectively a carbon bomb for climate change, the fallout of which is only partially reabsorbed by replanting the trees, even after decades. Studies accounting for this factor of carbon “payback” time find that wood biomass 1) generates more emissions than burning coal, and 2) these emissions are net contributors to the climate crisis as potentially irreversible impacts arise while we are waiting for the biomass emissions to be fully reabsorbed by new trees [9].

Biomass emissions are net contributors to the climate crisis as potentially irreversible impacts arise while we are waiting for biomass emissions to be fully reabsorbed into new trees.

The biomass industry also has a very serious environmental justice problem. As with burning fossil fuels, burning biomass such as wood pellets and forest residues releases copious amounts of co-pollutants into local air space. According to the Partnership for Policy Integrity, a respected environmental research organization, these pollutants include nitrogen oxides, sulfur dioxide, carbon monoxide, and particulate matter, in addition to acidic gasses and other hazardous air pollutants. Burning “urban wood,” from construction debris and demolitions, adds heavy metals into the toxic combustion mix [10].

PFPI’s research examines actual air permit data to compare biomass energy emissions with fossil plant emissions. In the table on the following page, a biomass plant in Gainesville, Florida, is compared to a diesel-gas plant in Westfield, Massachusetts. Dramatic gaps between the two plants are shown at the right. Biomass energy is far more polluting than fossil fuel energy, according to air permit data. Likewise, as we see in the second table below, cofiring coal with biofuels only makes the coal worse, sharply so with hazardous air pollutants. A review of emissions inventory data from the California Air Resources Board similarly found that Humboldt County’s three biomass plants generated criteria air pollutant emissions at rates far in excess of emissions from a much larger natural gas plant in the county [11].

The 100 MW Gainesville Renewable Energy biomass plant will emit dramatically more pollution than a 431 MW gas/diesel plant in Massachusetts, both as total tons, and as lb per MWh	GREC: 100 MW biomass: tons per year	GREC biomass lb/MWh	PVEC: 431 MW nat gas/diesel: tons per year	PVEC: nat gas/diesel lb/ MWh	GREC rate as % PVEC rate
Nitrogen oxides	416.4	0.95	91.9	0.05	1953%
Carbon monoxide	713.8	1.63	59	0.03	5214%
Particulate matter	249.8	0.57	49.1	0.03	2193%
Sulfur dioxide	243.9	0.56	16.7	0.01	6295%
Volatile organic compounds	77.3	0.18	23.8	0.01	1400%
Hazardous air pollutants	24.7	0.06	5.1	0.003	2087%
Carbon dioxide	1,232,225	2,813	1,432,825	759	371%

An investigation of 21 wood pellet mills by the Environmental Integrity Project found a pattern of violations including pollution exceeding permitted levels and evasion of pollution control technologies required under the Clean Air Act [12].

The health impacts of toxic air pollution from fuel combustion--and racial disparities in these health impacts—are well-known and have continued to cause harm for too long. The bioenergy industrial complex has been making things worse for people and planet alike all along. Their false solutions are also simply getting in the way of the real changes we need. It’s time we brought this failed experiment to an end, giving the power back to our one and only planet.

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Boiler #2 (B001)

Pollutant	PTE - Coal only tpy	PTE - Coal/biofuel tpy
Particulate (total filterable)/PE	2,596	2,596
PM_{10} (filterable)	1,843	1,843
$PM_{2.5}$ (direct)	1,324	1,324
SO_2	31,158	31,158
NO_X	18,175	18,175
CO	2,596	3,895
VOC	70.1	88.3
Lead	0.45	0.43
Sulfuric acid (H_2SO_4)	38.9	38.9

Pollutant	PTE - Coal only tpy	PTE - Coal/biofuel tpy
POM (reported as PAH)	0.02	0.20
Acetaldehyde	0.66	1.71
Benzene	1.51	6.89
Formaldehyde	0.28	5.98
Toluene	0.28	1.46

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GREEN HYDROGEN

DON'T BELIEVE THE HYPE

What is "Green" Hydrogen?

Hydrogen is abundant in many compounds, such as water, natural gas, and organic matter and waste. In gaseous form, it is an energy carrier that can power fuel cell electric vehicles, hold and dispatch backup energy in a renewable electricity system, and reduce the carbon footprint in industrial processes. Hydrogen is not naturally prevalent in gaseous form, however, so it must be processed to separate hydrogen atoms from the compounds containing them–most abundantly water and methane. So-called “green” hydrogen refers to hydrogen produced without using fossil fuels. If produced by carbon-free means and used for limited but essential energy purposes, hydrogen can be valuable in the energy mix of a decarbonizing economy. However, the current footprint of hydrogen production and proposed usage points in the opposite direction: gas industry survival by other, counterproductive if not dangerous means, and a lot of corporate hype [1].

"Green" Hydrogen's Energy Footprint

The hydrogen gas market is growing markedly, at a rate of about 8.1 percent annually. But hydrogen remains a small faction of gas production, at roughly 60 million tons globally, compared to more than 700 million tons of natural gas consumed in the United States alone in 2018 [2]. By 2050, however, global hydrogen production could grow to as much as 650 million tons per year [3].

California has the largest hydrogen footprint in the U.S., but it is still relatively small even compared to battery electric vehicles. The state has about 7500 hydrogen vehicles on the road, but it projects that number to grow to 50,000 (especially light-duty vehicles), with support from 1000 fueling stations, by the second half of the decade [4].

In New York State, hydrogen uses are in their infancy; there are only a handful of hydrogen fueling stations across much of the Northeast. But the NY-based Plug Power, which primarily makes fuel-cell systems for forklifts and "material moving," was able to raise over $1 billion in capital last fall for developing fuel cell infrastructure and expanded production [5]. Hydrogen is also gaining a foothold in the power sector in New York. The Danskammer peaker plant, in Newburgh, New York, is seeking state approval for a $500 million expansion for natural gas generation and promising to run on 100 percent green hydrogen by 2040 (this is the state's deadline for decarbonizing its electricity system). A few of the dirtiest power plants in the state, among New York City's peaker plants, are also proposing a transition to natural gas made cleaner with hydrogen or renewable natural gas [6]. Further, the gas and electric utility National Grid, with millions of customers in New York City, Long Island, and parts of Upstate, announced last fall its intention to "decarbonize" the gas network by blending hydrogen and renewable natural gas into its fossil gas delivery system—potentially a landscape-shifting and deeply problematic proposal we examine in more detail in the section on renewable natural gas [7].

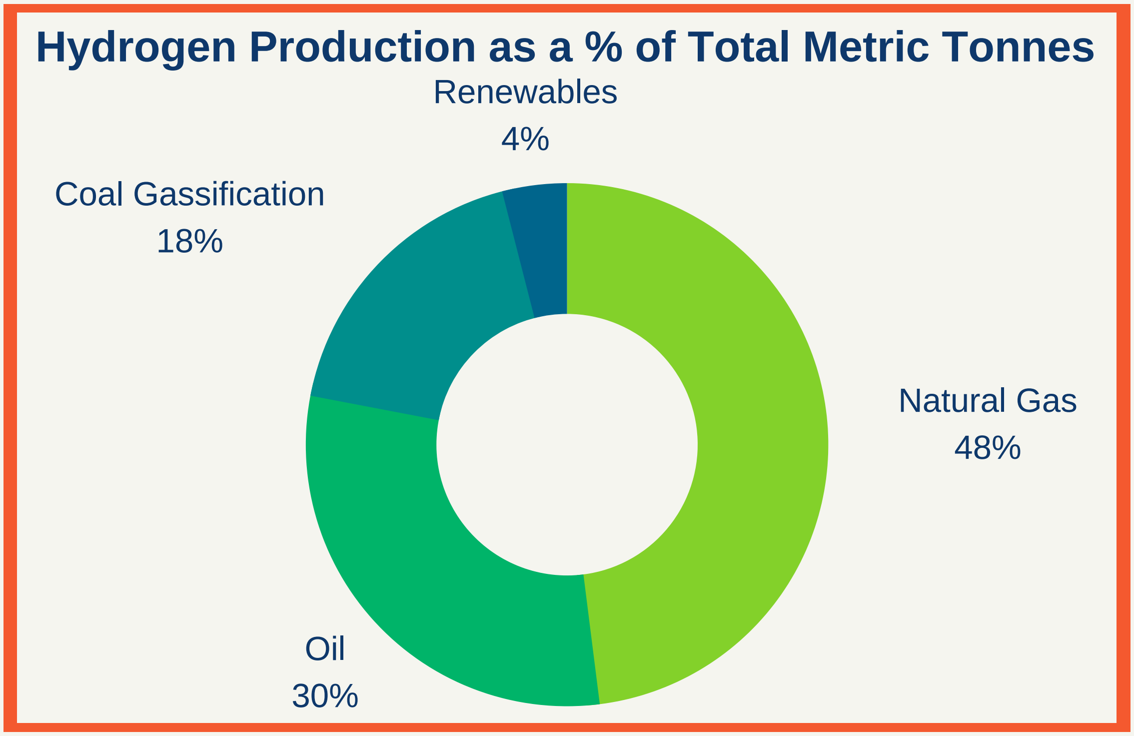
The growing market for hydrogen energy in the buildings sector, the power sector, and transportation, marks a decisive shift from historic uses in the industrial sector, where hydrogen can be substituted for fossil fuels as a process heating agent. It's important to understand how this shift into other sectors hides some troubling realities. As explained by the Rocky Mountain Institute, "the abatement impact of hydrogen is determined by the combination of the CO2 footprint of how it is produced and the emissions from the activity in which the hydrogen is being used" [8]. As noted, today, and in its development to this point, most hydrogen gas is used as a chemical feedstock in industrial processes such as petroleum refining and producing ammonia for fertilizer. Other emerging applications include steel and cement production and heavy transportation such as shipping.

Hydrogen's main climate benefit with these applications is to reduce the carbon-intensity of on-site industrial production processes, which require high temperature heat typically generated by fossil fuels. More than one quarter of global emissions come from on-site industrial processes involving fossil fuels; thus, hydrogen is potentially an impactful source of emissions abatement. The problem is that hydrogen production itself is carbon intensive. Ninety-six percent of hydrogen gas currently available is produced with fossil fuels, and only 4 percent is produced with renewable energy [9].

96% of hydrogen gas is produced with fossil fuels.

The contradiction of using fossil fuels to produce clean fuels is self-evident and well-understood by observers of industry. Using hydrogen for scenarios of industrial heat, shipping, and steel production, for example, is estimated to abate carbon emissions by factors of 7-12, 14, and 32, respectively [10]. However, if the hydrogen is produced with fossil fuels—as is overwhelmingly the case today—hydrogen's carbon abatement effect in industrial processes is effectively negated [11].

Any proposal for "greening" buildings or power or transportation with hydrogen energy faces a massive logistical obstacle—namely that green hydrogen essentially does not exist. In fact, there are reasons to believe we will be better off without it, except for important but limited uses that truly add value or cannot be implemented otherwise.



What's Wrong with Green Hydrogen?

Nearly all hydrogen gas available today is what's known as "gray" hydrogen, which is produced by "steam methane reforming (SMR)," a carbon-intensive, fossil-fuel fired method by which hydrogen can be separated from methane in natural gas. A variation called "blue hydrogen" attempts to utilize carbon capture and storage technology to reduce emissions from gray hydrogen production. Green hydrogen production, which employs no fossil fuels directly, uses electricity to split ordinary water molecules into hydrogen and oxygen, in a process called electrolysis. In each approach, hydrogen production is rife with contradictions or perverse effects:

- SMR makes little sense from a climate perspective. While hydrogen is obviously carbon free, producing it with SMR is carbon-intensive. Substituting hydrogen for fossil fuels in hard-to-abate industrial processes, where it is mostly used today, reduces carbon emissions. But these reductions typically do not exceed emissions generated to produce the hydrogen itself. On a net basis, then, SMR hydrogen should not be considered a clean substitute for fossil fuels.

Carbon Capture and Storage is grossly ineffective for reducing GHG emissions and may also make local air pollution worse, while its high costs divert resources away from renewables.

- SMR plus Carbon Capture and Storage technologies (CCS)—producing so-called blue hydrogen—is a favorite "alternative" for the gas industry. But, despite unproven claims of near total emissions abatement, CCS is in fact grossly ineffective for reducing GHG emissions and also makes local air pollution worse, while its high costs divert resources away from renewables [12]. For the gas industry, ignoring the realities of CCS while hyping blue hydrogen gives them cover to claim that they can provide cleaner fuel for gas power and gas buildings even as new emissions upstream in their supply chain of hydrogen will be adding to the climate crisis.

- Green hydrogen uses large amounts of electricity to produce hydrogen from water, and so by definition it is only as “green” as the power grid from which it draws. This can mean either that green hydrogen drives up GHG emissions from a dirtier grid, or it diverts substantial renewable electricity from a cleaner grid. In fact, intensive power demand may be the single biggest barrier to green hydrogen. For example, the International Energy Agency (IEA) finds that hydrogen demand in the European Union will require 3,600 TWh of renewable electricity, almost equal to total current electricity demand in the region [13]. Heavy draw-down of renewable electricity for green hydrogen electrolysis is especially concerning given that the renewable power supply will likely need to grow by 100 percent or more in the first place--to support electrification of other major sectors such as transportation and buildings. This is not even to mention that green hydrogen is water-intensive as well, for electrolysis, and the water needs to be distilled. Producing 1kg of hydrogen via electrolysis uses 18.04 kg of water, in addition to the water lost in the distillation process, which nearly doubles that amount [14]. For those who are promoting a larger-scale transition from fossil fuels to hydrogen, the likelihood of severe water resource stress should be a red flag.

Hydrogen is only as "green" as the power grid it draws from.

- Hydrogen also brings a host of drawbacks in terms of transmission and distribution. Among the most concerning is that, at higher concentrations, it can cause embrittlement of metal pipes and containers. Leakage and safety risks in the gas distribution system may also be elevated with blending of hydrogen. Hydrogen also has a lower energy conversion rate than fossil gas, which means that more gas will be needed to meet energy demand if hydrogen is blended at high ratios in the gas system [16].
- Thermal gasification of dry waste or energy crops is another, even more nascent, approach for producing hydrogen. But, as with renewable natural gas and other biofuels, net emissions effects of gasified hydrogen—positive or negative—depend on the carbon intensity of feedstocks producing the hydrogen. Expanding cultivation of bioenergy feedstocks to meet market demand for hydrogen, for example, does not seem auspicious from a net emissions perspective.

HYDROGEN ENERGY: MORE GAS COMBUSTION & MORE LOCAL POLLUTION

The many detrimental production issues surrounding hydrogen are amplified by the gas industry's heavy emphasis on blending hydrogen into the existing gas system over other uses such as fuel cells for energy storage [17]. Using hydrogen for energy storage is increasingly considered to be a critical feature in models of 100 percent renewable electricity (i.e. without any gas); trying to sell policymakers and the public on a "greener" gas system, in contrast, is economically and environmentally antithetical to a renewable energy future and to the CLCPA's goal of achieving a zero emissions economy. Additionally, environmental health impacts of burning hydrogen are increasingly getting public attention but have yet to be fully studied or even acknowledged in the hydrogen hype [18].

Green hydrogen helps the gas industry put a climate-friendly patina on its infrastructure and delivery system for fossil gas.

Despite these growing health concerns, blending hydrogen with natural gas for combustion heating and other building uses certainly helps the gas industry put a climate-friendly clean patina on its infrastructure and delivery system for fossil gas. The result, whether sincere on climate or not, is to prop up fossil gas for residential and commercial uses as well as industry—a very large fraction of utility gas sales. As we examined in the section on renewable natural gas, National Grid's "net zero grid by 2050" plan puts gas system "greening"" with renewable natural gas and hydrogen near the top of its list of strategic priorities. Add to this industry promises of cleaning up dirty power plants with clean gas alternatives, and the strategy is hard to misunderstand. The gas industry faces an existential threat under policies like the CLCPA, namely economy-wide electrification of energy use to hit a zero emissions target by 2050. Hydrogen energy, even if it could be greened in its production, is a fossil fuel alternative that just happens to depend on, and will perpetuate, the fossil gas infrastructure that delivers not just trillions of cubic feet of gas every year but billions in customer sales, including nearly $6 billion for New York's gas utilities alone [19].

Equally troubling, environmental justice concerns arise from mounting evidence that combustion of hydrogen is a potent source of local pollution, particularly oxides of nitrogen (NOx). Power plants burning a blend of gas and hydrogen may emit higher levels of NOx than with fossil gas alone, depending on the fuel mix [20]. Indoor air quality already compromised by gas appliances may be further compromised by gas and hydrogen fuel mixes put into the residential gas delivery system. At least two studies also point to escalated NOx emissions in industrial settings powered by gas and hydrogen fuel blends, potentially exposing workers to health risks. Health effects associated with NOx, which is also a precursor element to fine particulate matter and ozone, primarily include respiratory problems, including asthma attacks [21].

Power plants burning a blend of gas and hydrogen may emit higher levels of NOx than with fossil gas alone.

Beneficial Uses of Green Hydrogen

If produced in limited quantities for specific uses, and if kept out of the gas system as a fuel for power and heating, renewably sourced hydrogen could have several valuable uses in the climate transition. The first and most important beneficial use is to power a fuel cell infrastructure to durably store excess renewable power when it is available. This can prevent curtailment of power and provide for flexible dispatch when demand runs high. Select industrial uses with substantial abatement effects—again, if the hydrogen is renewably sourced—may also be particularly beneficial. Steel and cement production are good examples. Select transportation uses could be appropriate for hydrogen power, particularly heavy trucks, barges, and port equipment. For passenger vehicles, it remains to be seen if fuel cell electric vehicles will ever be able to overtake battery electric vehicles, but hydrogen's inclusion in California's Low Carbon Fuel Standard appears to have given FCEV's a fighting chance in the country's largest automobile market [22]. Hydrogen vehicles are more dangerous than battery vehicles, but fueling them is much more convenient and typically they have longer range.

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WASTE TO ENERGY
A CURE WORSE THAN THE DISEASE

What is Waste-to-Energy (Wte)?

Waste to energy is just what it sounds like: a waste management approach that generates energy from processing solid waste. Processing the waste usually involves incineration that reduces it to ash, which is deposited at a landfill at greatly reduced volume. In most WtE facilities, steam generated by burning the waste powers turbines that produce electricity and/or heat. Some are just incinerators and do not recover energy, but it's important to understand that energy is not the primary purpose of any of these facilities. The primary purpose is waste management by incinerating waste.

Other waste streams, such as decomposing landfill waste and waste-water solids, are also sometimes processed to produce fuels or energy. But WtE primarily refers to incinerating municipal solid waste for reduction and energy recovery, in facilities designed for that purpose.

WtE requires combustible waste, which includes biogenic waste (food, trimmings, leaves, paper, wood) and non-biogenic waste (plastics and other petroleum-based synthetics). Non-combustible waste such as metals and glass is managed separately.

The waste is not always combusted directly. Thermochemical techniques with low oxygen can be applied to chemically transform the waste into gas or biofuel or a solid fuel product, which are used on site or sometimes sold for a variety of purposes. The low-oxygen thermal technique of pyrolysis is one such technique, and one resulting product is "biochar," a majority plant-based relative of charcoal. Biochar is mostly used as a soil amendment, but its use is limited by very high costs compared to compost. Another technique is hydrolysis, where garbage is immersed in acids and fermented into an alcohol fuel.

WtE's Energy Footprint

The U.S. generates close to 300 million tons of solid waste annually, the majority of which is paper, food, and yard trimmings. Half is landfilled and about 12 percent is combusted for energy. In 2019, there were approximately 67 WtE power plants in the U.S., which burned about 25 million tons of garbage to generate about 13 billion kilowatt hours of electricity [1].

New York State currently has 10 active waste incineration facilities, four of which are located on Long Island. Several do not include energy recovery. In addition, there is 1 active thermal facility and three fuel combustion facilities with on-site storage. Hospital waste facilities and pet crematories are regulated separately and generally exempted from waste incineration regulations [2]. New York also ships municipal solid wastes to waste incineration facilities in other states.

What's wrong with WtE?

WtE is a false solution, but it is important to be clear that there is a larger problem, one of its own making. Namely, there is too much waste in the supply chain to begin with, and too little recycling of the existing waste. Waste prevention policy and extended producer responsibility for waste impacts of goods and services are part of the solution; another is much higher rates of recycling. But even absent these more structural changes toward a "circular" economy, WtE is not a good answer to waste management problems.

First and foremost, 80 percent of the incinerators are located in environmental justice communities or areas largely populated by low-income households and people of color [3]. Although New York City finally closed its last waste incinerator in 1999—there were 22 across the city at their peak—the garbage formerly burned in city neighborhoods is now shipped off for incineration or landfilling in other cities and often to low-income neighborhoods and communities of color in those places. In 2018, twelve million tons of New York City garbage went to Newark and other places as far away as South Carolina and Ohio. Failure to prevent excess waste generated to begin with, and the city's abysmal 18 percent recycling rate, are significant reasons for this [4].

80% of incinerators are located in environmental justice communities and areas largely populated by low-income households and people of color.

The specific health toll of the incinerators is hard to isolate, as many are sited in areas afflicted by other sources of pollution and health vulnerability. But the incinerators seem to stand out. They are dirtier than coal plants when it comes to local pollution, emitting (among other pollutants) an estimated 14 times more mercury, 5 times more carbon monoxide, and nearly 7 times more nitrogen dioxide per megawatt hour, according to New York State's Department of Environmental Conservation [5]. Studies of incinerators in France and Italy have found facility- and pollutant-specific effects including high incidence of non-Hodgkins lymphoma (dioxins) and miscarriage (PM.10) [6]. Dioxins, which come from plastics, electronic equipment, batteries, and fuel oil, among other things, are particularly toxic and can cause cancer as well as reproductive and immunological impairment.

Waste incineration is also worse for climate compared to coal plants, producing 68 percent more GHG emissions per unit of energy put into the grid [7]. Life-cycle analysis of waste incineration, counting avoided methane leakage from landfilling as an incinerator benefit, has shown mixed results of climate benefit or harm, depending on waste composition and other factors [8].

Six of New York State's ten incinerators are among the twelve most polluting in the country on at least one major pollutant. Together these twelve facilities expose populations totaling 1.6 million people.

- Oswego County Energy Recovery ranks 3rd in nitrogen oxide emissions.
- Niagara Falls Energy Resource ranks 8th in sulfur dioxide emissions
- Babylon Resource Recovery ranks 1st in mercury emissions.

- Wheelabrator Hudson Falls ranks 1st in lead emissions, 3rd in mercury emissions, and 3rd in carbon monoxide emissions.
- Dutchess Country Resource Recovery ranks 7th in mercury emissions and 5th in carbon monoxide.
- MacArthur Waste-to-Energy ranks 11th in mercury emissions.
- Four of the six high-polluting New York incinerators are located in environmental justice communities [9].

Six of New York's incinerators are among the dozen most polluting in the country.

In a study of New York State's energy facilities, Yale University researchers found a clear general pattern in comparing waste incinerators with other power plants. Incinerators emit more oxides of nitrogen and cancer-causing hazardous air pollutants, while performing better on fine particulate matter. Out of eleven New York power plants emitting the most hazardous air pollutants, 7 are waste incinerators [10].

Pyrolysis and other thermal reduction techniques to recover fuel energy from solid waste do not pollute communities like waste combustion, but they are not free of health and environmental risks. Conversion, transportation, and application of biochar can release fugitive emissions. These are carbon-intensive particulate emissions, with climate and health effects similar to those of fossil fuel particulates [11].

Waste incinerators create additional pollution from the modes of transportation that waste haulers use to bring the garbage. An average incinerator would require a waste hauling fleet of approximately 186 trucks per day, emitting hundreds of thousands of pounds of pollutants at ground level annually [12].

Waste incineration is a cure that is worse than the disease. Burning garbage is a very unhealthy way to manage a major public health problem—too much garbage. It is also, often, just one major health burden among multiple sources of pollution, and people of color are often the most affected. We should stop burning garbage and start reducing it.

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