RHETORIC VS. REALITY:

The Myth of “Renewable Natural Gas” for Building Decarbonization

EARTHJUSTICE

SIERRA CLUB

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EXECUTIVE SUMMARY

Policymakers seeking to cut emissions and reduce reliance on fossil fuels are increasingly examining energy use within buildings, which account for nearly 40% of carbon emissions globally. One of the largest drivers of these emissions is the burning of fossil fuels like gas for home heating, hot water, and cooking. In 2018, carbon emissions from U.S. buildings increased 10% due to growth in these uses alone.[1]

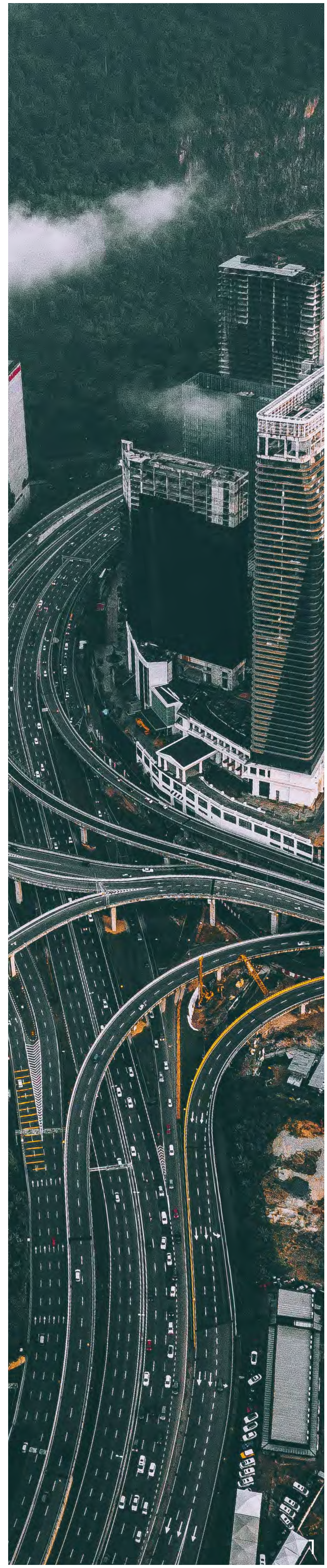
There is growing consensus that electrifying buildings – using electric appliances like heat pumps and induction stoves to replace the need for fuel combustion – is the clearest path to mitigating their pollution. Efficient, all-electric buildings eliminate on-site carbon emissions and methane leakage, and they can eventually achieve net-zero emissions as the grid becomes cleaner. Furthermore, building electrification eliminates the health impacts from burning gas indoors,[2] and reduces the safety hazards from gas leaks and explosions, all while capitalizing on the declining costs of generating electricity from solar and wind power.

Numerous studies indicate that electrification is the lowest-risk and lowest-cost method to reduce greenhouse gas emissions ("GHGs") from buildings, while generating additional societal benefits. And because buildings last for many decades, avoiding gas infrastructure and appliances in new construction is crucial for avoiding lock-in of fossil fuel reliance. As such, many policymakers across the U.S. and globally see electrification as the future of buildings. By early 2020, more than 30 cities and counties in the U.S. passed policies requiring or supporting all-electric new construction.

Gas utilities, which rely on maintaining and expanding fuel delivery infrastructure to buildings to generate revenue, view electrification as an existential crisis. The industry's response has been to pitch fossil gas alternatives ("FGAs") – often marketed as "renewable" natural gas ("RNG") – as an alternative to building electrification.

The argument goes that existing gas infrastructure can continue to operate by replacing today's fuel with a range of biologically and synthetically derived non-fossil gaseous fuels.

This report examines the potential for FGAs to decarbonize buildings and refutes the claim that FGAs are a viable alternative to building electrification.



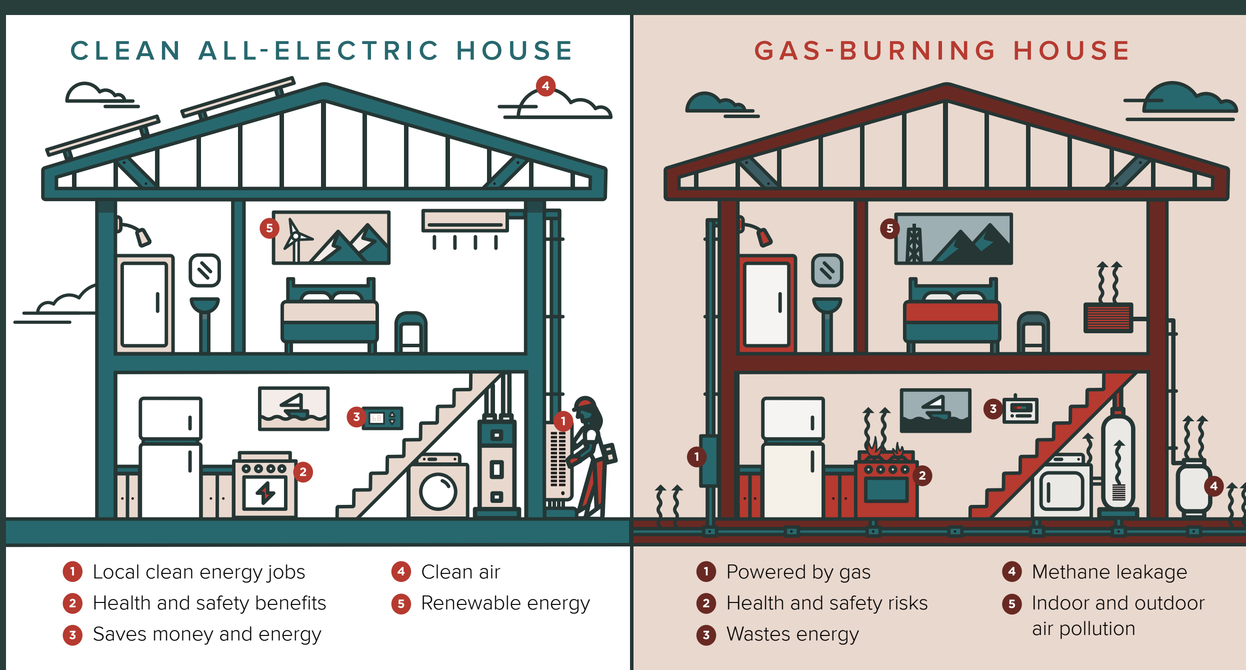
Topline findings include:

- **The potential supply of FGAs is a small fraction of gas demand.** The gas industry's own research found that after two decades of ramping up supply and production, FGAs could only replace 13% of the existing demand for fossil gas. Any strategy to reduce building emissions that relies on FGAs in lieu of electrification would not lead to complete decarbonization and diverts limited FGA supplies from more difficult to electrify sectors.

- **Replacing fossil gas with FGAs is extremely costly.** High production costs mean FGAs range from 4 to 17 times more expensive than fossil gas.

- **FGAs have a mixed environmental record.** Facilities where FGAs are produced can exacerbate air and water pollution impacts in nearby communities. When methane is intentionally produced, leakage throughout the distribution process can result in increased emissions.

- **FGAs perpetuate the health impacts of combustion.** Burning FGAs in homes, offices, and commercial spaces has the same issues inherent to any combustion-based fuels: they produce toxins that harm the health of people living, working, or learning in these buildings and also contribute to local air pollution through continued emissions of NOx and other combustion byproducts.



Through electrification, decarbonizing our buildings is also an opportunity to reduce legacy sources of indoor air pollution.

The report finds that due to the limited supply and high cost of biogas and synthetic gas, and the associated pollution and health impacts, the small and costly amount of FGAs available should be used to decarbonize sectors where there are few or no lower-cost mitigation solutions. Buildings do not meet these criteria.

Nevertheless, gas system incumbents are embarking on a coordinated strategy advocating for the use of FGAs in homes and buildings, irrespective of the fact that low-grade building heat is a poor use case for the limited supply of high-cost, low-carbon FGAs.

The second half of the report looks at both gas industry incumbents' efforts to fight electrification through a well-funded campaign to sway public opinion – often through fake grassroots organizations – and their misleading public rhetoric on the potential use of FGAs as an alternative building electrification.

Claims from utilities like Southern California Gas Company ("SoCalGas") that replacing 20% of fossil gas with FGAs can have the same impact as electrification, or Dominion Energy, that replacing 4% of fossil gas can eliminate the entire carbon footprint of its gas operations, are flawed and misleading given the limited supply of low-carbon FGAs.

These statements positioning FGAs as a clean source of energy make more sense when reviewing internal gas industry documents. The American Gas Association's ("AGA") Clean Energy Task Force developed draft policy principles stating the AGA "supports policies that define the term 'renewable energy' to include RNG on par with other energy sources, such as energy generated from wind or solar resources."[3]

An internal set of AGA meeting notes from March 2018 shows the industry determined FGAs can be used to "mitigate the opposition's fervor" to phase out the burning of gas due to climate concerns.[4]

Another internal document makes clear an awareness of FGAs' limits, coming from an industry source: "[In my opinion], RNG will not sustain our industry at its present size."[5] In another instance, a board member for a gas industry advocacy group told The Guardian on the record: "Dairy biogas is way too expensive" to use in home or businesses – five to 10 times more expensive than fossil gas. "It doesn't pencil out and it doesn't make all that much sense from an environmental standpoint. It's a pipe dream."[6]

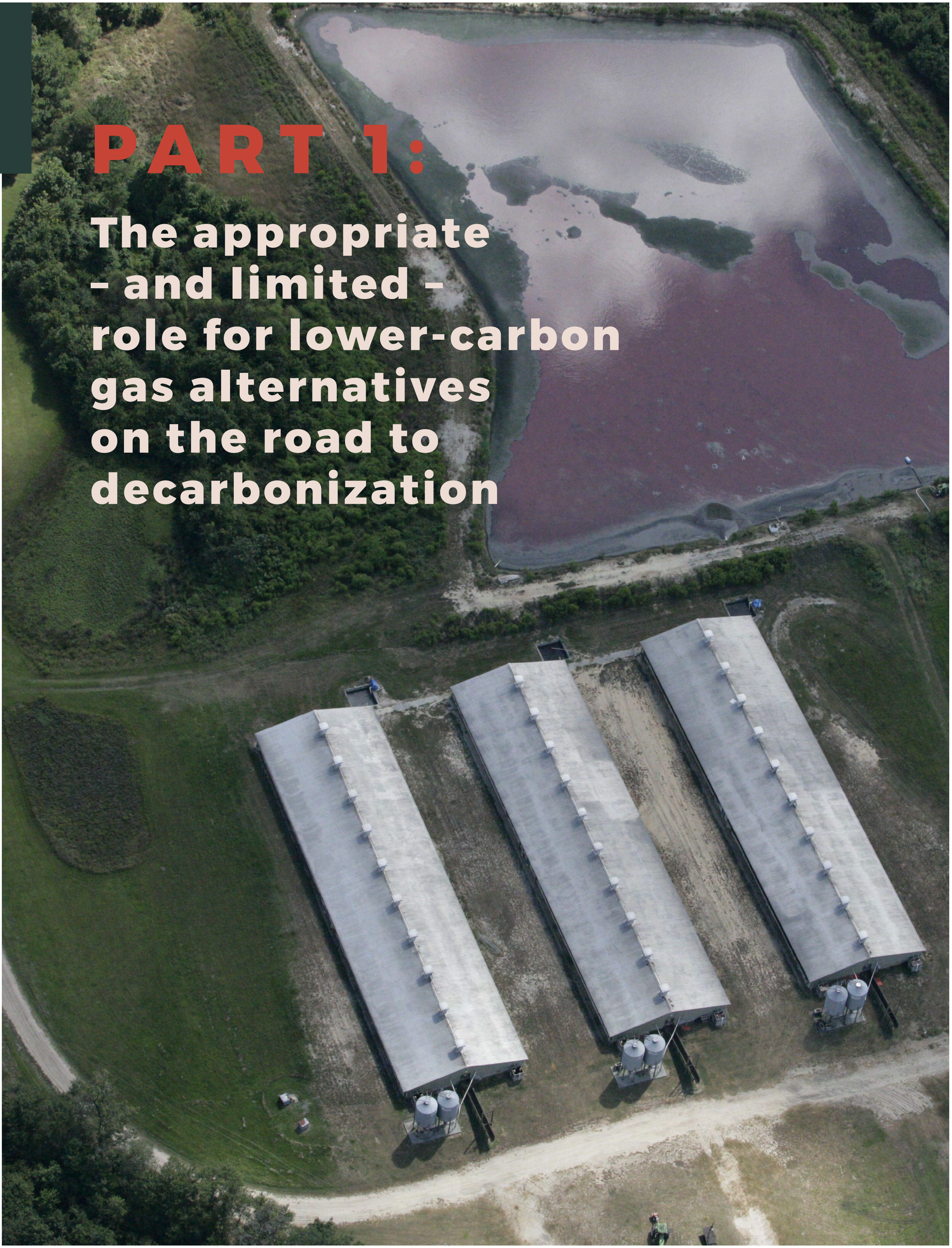
We find a pattern of talking points and lobbying efforts that leverage FGAs as a means of maintaining a gas-based heating system and stalling the transition away from fossil fuels.

This is not unfamiliar territory: The tactics come from the same energy industry playbooks that have dismissed and obfuscated the threat of climate change. In this case, the widespread adoption of a proven and cost-effective means of fighting climate change is being attacked and stalled in order to protect fossil fuel financial interests.

Ultimately, FGAs do not provide a path to decarbonizing the gas grid in line with a net-zero emissions energy system. Policymakers must see beyond the gas industry's rhetoric around FGAs and acknowledge the reality of their high costs, limited supply, and environmental risk. ■

PART 1:

The appropriate – and limited – role for lower-carbon gas alternatives on the road to decarbonization



1. Climate goals require a gas phaseout

To keep global average temperature from rising above 1.5°C and avoid the worst impacts of climate destabilization, the world must achieve net-zero emissions of greenhouse gases by mid-century.[7] This requires us to stop burning fossil fuels as rapidly as possible.[8] **Thus, greenhouse gas emissions from unabated gas use are incompatible with achieving net-zero emissions.**[9] Even aiming for the far less safe 2°C warming scenario would mean keeping more than half of the world's existing gas reserves unused and unburned.[10]

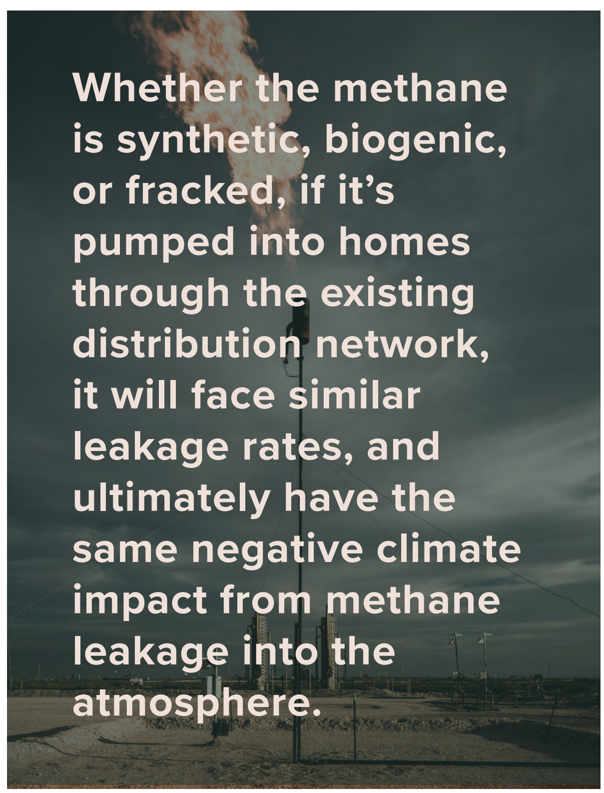
Achieving a net-zero emissions society inevitably means a substantial decline in gas consumption. With gas overtaking coal as the largest source of fossil fuel emissions in the United States, greater focus has been given to its true climate impact.

A growing body of research has highlighted the high global warming potential of methane, the main constituent of gas. Methane's radiative force,[11] which is 36 times more potent than CO2, and its pervasive leakage along the gas supply chain – both of which are proving more severe than previously understood – increase the urgency of its near-term mitigation.

New findings suggest methane leakage throughout the nation's gas delivery system is much more widespread than officials understood just a few years ago. In 2018, research published in the journal Science found the leakage rate in the U.S. gas supply chain equaled 2.3% of U.S. gross gas production, 60% higher than the EPA's official estimate.[12]

A 2019 study expanded the analysis to include leakage in distribution and end-uses, and found observed emissions from local gas distribution to be a factor of two to three times larger than those in the U.S. EPA's inventory.[13] Researchers in California found average home leakage rates to be 0.5%, representing leaks "an order of magnitude larger" than earlier estimates.[14]

Importantly, methane leakage issues are not limited to fossil gas. Whether the methane is synthetic, biogenic, or fracked, if it's pumped into homes through the existing distribution network, it will face similar leakage rates, and ultimately have the same negative climate impact from methane leakage into the atmosphere.



Gas flare at Permian Basin— Eddy County, NM
blake.thornberry, Flickr, CC BY-NC-ND 2.0

2. Different sources of fossil gas alternatives

The term "RNG" is currently used as an umbrella term to describe a range of fossil gas alternatives, most of which fall into two categories: biogas and synthetic gas. Different feedstocks and production methods for either of these alternatives require trade-offs around cost, supply, and social and ecological impact.[15]

BIOGAS

Biogas refers to methane derived from organic sources, such as crops or animal manure. It is produced via two main pathways, anaerobic digestion and thermal gasification. When upgraded and conditioned so it is pipeline-ready, biogas is typically referred to as biomethane.

ANAEROBIC DIGESTION

Anaerobic digestion is the decomposition of wet, organic matter by microorganisms in an oxygen-free environment. Often, anaerobic digestion is used to produce biogas from sources which currently emit methane, including:

- landfill gas;
- animal manure from livestock operations;
- wastewater treatment plants ("WWTP"); and
- organic municipal solid waste ("MSW"), specifically food waste.

THERMAL GASIFICATION

Thermal gasification breaks down dry biomass in a high-heat environment, creating methane from solid matter where none would ordinarily occur. The feedstocks used in this process are mostly lignocellulosic plants – so named because they contain carbon-based polymers – which include:

- agricultural residues, such as the unusable portions of crop stalks, stems, and branches;
- forestry and forest residues, such as sawmill residue and the extraneous wood generated from logging;
- energy crops, grown specifically for the purpose of becoming fuel, such as perennial grasses; and
- inorganic components of MSW, such as construction debris, such as plastic, glass, and textiles.

Lignocellulosic biomass can also be used as a non-gaseous fuel, such as conversion into renewable diesel. While gasification is a well-understood process, thermal gasification of biomass has not yet been proven at scale.


Lima Synthetic Gas Research Center
Ohio Development Services Agency, Flickr, CC BY 2.0

SYNTHETIC GAS

Synthetic gas is produced by converting electricity into a gaseous fuel through a process called power-to-gas, or P2G. It begins with electrolysis – using electricity to split water into hydrogen and oxygen. Hydrogen itself is a gaseous energy carrier, but to match the chemical make-up of fossil gas, it must go through a second step called methanation where carbon dioxide is added to the hydrogen.

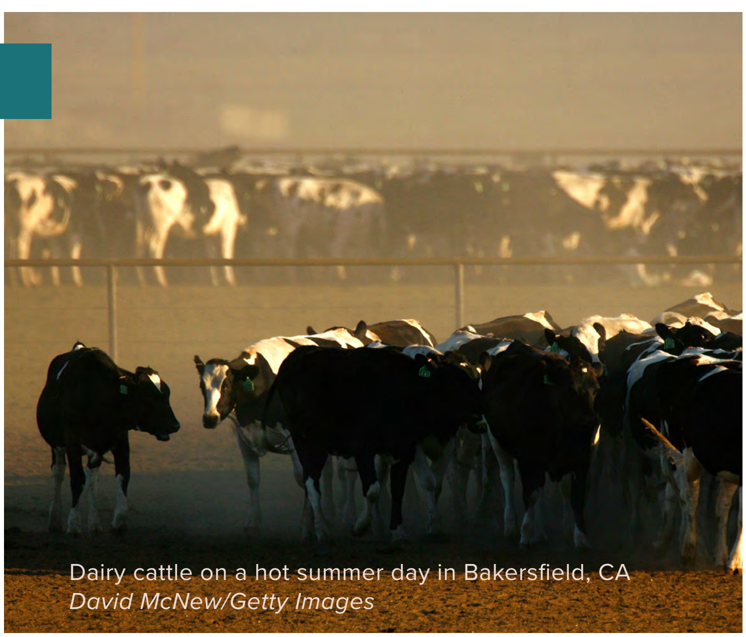
When powered by renewable electricity, this process allows power from sources such as wind or solar to be converted into a gaseous fuel that can be carried by traditional pipelines.

But the substantial amounts of energy and conversion loss needed to turn electricity into hydrogen, and then hydrogen into synthetic methane, wastes much of the renewable power. After electrolysis, only about 67% to 81% of the initial energy remains. Not including the energy required to capture the CO_2, the methanation process leaves only about 54% to 67% of the energy.[16] All else being equal, using renewable electricity to power electrolysis and create synthetic methane that is then used to generate heat is far more costly and energy-intensive than the direct use of renewable electricity through heat pumps.

3. Not all fossil gas alternatives are environmentally beneficial

While estimates for the maximum amount of technically producible FGAs vary, these estimates rarely screen for those FGAs which are actually environmentally beneficial to use. Higher potential volumes of FGAs should not be assumed to be more environmentally beneficial. Because of methane's severe radiative force and the high probability of leakage throughout its lifecycle, generating new sources of methane where none would ordinarily occur can lead to an overall increase in GHGs. A new analysis by the Natural Resources Defense Council estimates that screening out ecologically problematic sources of FGAs would exclude roughly half the total amount of FGAs technically producible.[17]

Recent research highlights the potential for intentionally produced methane to create climatically significant levels of leakage.[18] The analysis shows that FGAs "from intentionally produced methane is always GHG positive unless total system leakage is 0."[19] At leakage levels observed



Dairy cattle on a hot summer day in Bakersfield, CA
David McNew/Getty Images

Biogas from CAFOs

Methane generated from the anaerobic decomposition of manure in lagoons at concentrated animal feeding operations ("CAFOs") has been advanced as a promising source of biomethane production. While often marketed as "sustainable," biomethane capture does not abate the significant harms CAFOs have on already overburdened local communities and ecosystems. For example, dairy CAFOs in the Southern San Joaquin Valley of California are the region's largest source of ozone-forming volatile organic compounds ("VOC") and further damage air quality through significant emissions of ammonia and fine particulate matter.[i] These facilities also contribute to nitrate pollution of drinking water and contaminate waterways, with nitrogen runoff leading to the eutrophication of lakes and streams.[ii] Every well monitored near dairies in the Central Valley Dairy Representative Monitoring Program showed nitrate levels above the maximum contamination limit.[iii]

In addition, while proponents assert that methane from CAFOs manure lagoons would otherwise be emitted into the atmosphere, these emissions are not an inevitable or ordinarily occurring consequence of raising livestock. They are the result of industrial livestock management decisions (namely confinement, concentration, and liquid-based manure storage)[iv] and a regulatory environment that permits these practices to continue despite their significant air and water quality impacts. Were herd sizes maintained at more manageable levels, livestock operations could avoid producing waste in excess of agronomic rates for nearby crops, maintain pasture-based livestock operations, or more feasibly employ dry handling storage systems, thereby avoiding these methane emissions in the first instance.[v] Because the high capital costs of anaerobic digesters make economic sense only for the CAFOs that produce and store large quantities of wet manure, markets and subsidies for biomethane capture reward the largest and most polluting CAFOs, reinforcing and intensifying trends of industry consolidation, with corresponding increases to localized pollution.[vi]

in the existing biogas industry, intentionally produced methane, even from climate-neutral CO_2 sources, has substantial climate impacts.[20] Thus, the climate benefit of FGAs depends on whether they are derived from methane that would otherwise be emitted into the atmosphere. Of the total volume of FGAs technically producible, only a very small portion comes from methane already being emitted to the atmosphere. **The study estimates that capturable waste methane (e.g., from uncontrolled landfills and wastewater treatment plants) is less than 1% of current gas demand.**[21] The rest must be intentionally produced and will pose the risk of additional methane leakage that can offset any potential emission reductions.

Even FGAs that can be produced from methane already emitted into the atmosphere should not automatically be considered environmentally beneficial. As a general rule, proposals to commoditize pollution should be treated with caution. Climate “solutions” that perpetuate or exacerbate local pollution are incompatible with the principles of a just and equitable transition. In fact, creating markets for FGAs that capture methane pollution can perversely incentivize continued reliance on practices that lead to the methane pollution in the first instance. As researchers note, “because biogas and biomethane can generate revenue, it is not only possible but expected to intervene in biological systems to increase methane production beyond what would have happened anyway when there is an incentive to do so.”[22] Before considering capturing and using waste methane as an FGA, decision makers should examine whether the methane emissions could be prevented in the first place through better resource or waste management practices. **A premium should be placed on mitigation strategies that permanently avoid the generation of methane emissions through more sustainable practices.**

In particular, mitigation strategies that address the underlying causes of waste methane are important to consider when these practices are associated with multiple social and environmental harms. Markets that value pollution may become obstacles to policies that can reform inefficient and polluting practices or which may appropriately make polluters responsible for addressing their own emissions. In the graphic below, we illustrate a framework for assessing whether FGAs are actually likely to be environmentally beneficial. The supply of FGAs from genuine and unavoidable waste methane is far more limited than the amount that is technically producible.

A premium should be placed on mitigation strategies that permanently avoid the generation of methane emissions through more sustainable practices.

What Biomethane Sources are Environmentally Suitable?

The supply of biomethane that is environmentally beneficial to produce is substantially smaller than the total maximum potential of biomethane.

Genuine waste methane which cannot be readily avoided and has few other social or environmental harms (e.g., wastewater treatment) may be environmentally beneficial to capture and reuse as biomethane.

Maximum biomethane that is technically producible

Does production require generating new sources of methane where none would ordinarily occur?

YES →

AVOID

Thermal Gasification of:

- Energy crops
- Forest product residue*
- Usable agricultural residue*

RATIONALE

Due to methane's severe radiative force, and the high probability of leakage throughout its lifecycle, it is preferable to avoid generating new sources of methane where none would ordinarily occur.

NO ↓

WHAT'S LEFT:
Biomethane from sources of fugitive methane emissions

Can methane emissions be prevented through alternative resource and waste management?

YES →

AVOID

Anaerobic Digestion of:

- Manure from CAFOs
- Preventable, rescuable or compostable food waste

RATIONALE

A premium should be placed on mitigation strategies that permanently avoid the generation of emissions in the first instance. Biomethane production from these sources can perversely perpetuate poor resource management.

NO ↓

WHAT'S LEFT:
Biomethane where capture-and-use is the optimal mitigation strategy

* While they do not ordinarily generate methane, certain types of lignocellulosic biomass from agricultural or municipal solid waste (e.g., sawmill residue) may be unpreventable and difficult to compost or divert toward other uses. If no superior waste prevention or management strategy exists, it may be environmentally advantageous to redirect these waste streams toward fuel production. Nonetheless, it may be practical to exclude these from estimates of biomethane potential since multiple end-uses beyond current gas demand will compete for the limited supply of sustainable lignocellulosic biomass. Potential renewable fuel sources are generally better devoted to liquid fuels that displace more expensive, GHG-intensive petroleum or to hydrogen production which does not pose the risks of GHG increases from methane leakage or emit pollutants when combusted.

4. Fossil gas alternatives have no clear path to fully decarbonizing the gas grid

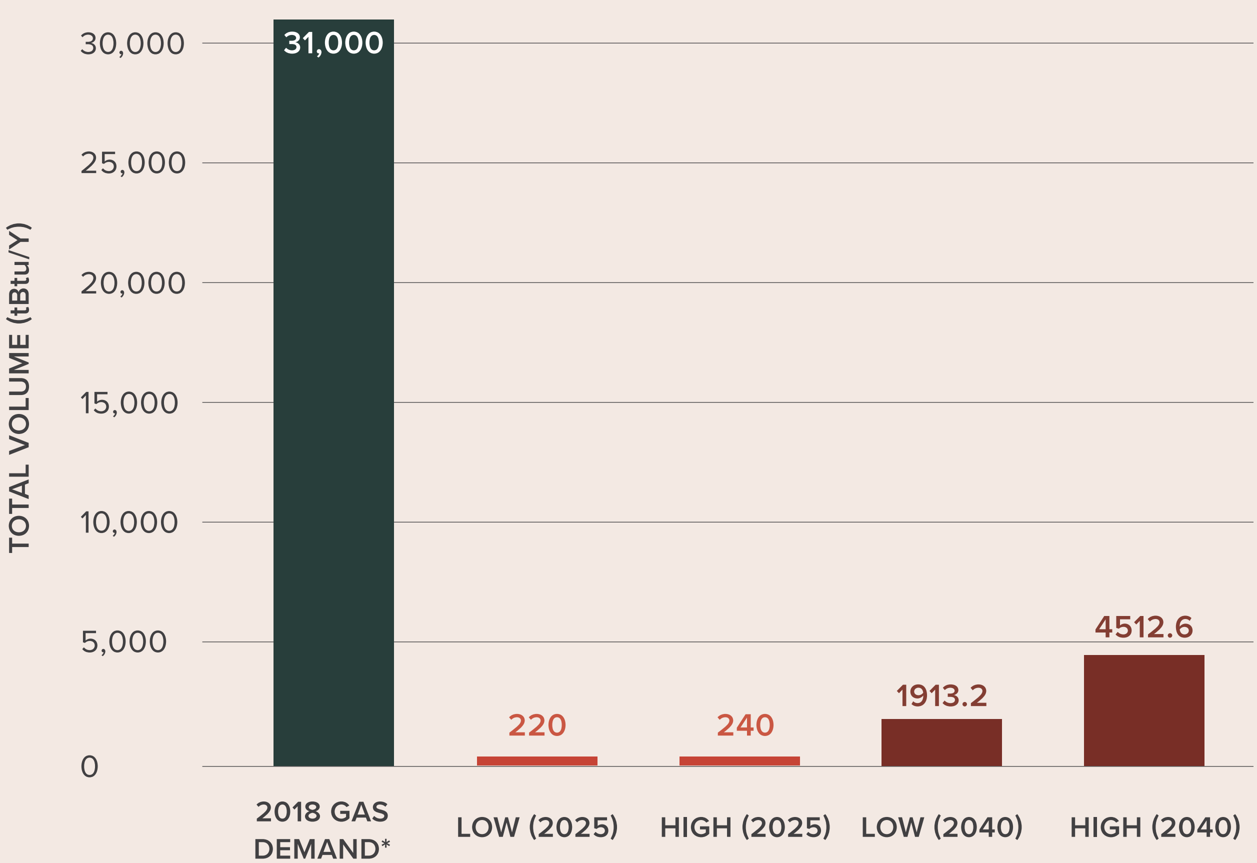
Even the gas industry's own analysis finds there is an insufficient supply of carbon-free gas to meet anything more than a small portion of current gas demand. **According to a study by the American Gas Foundation ("AGF"), even after fully ramping up the production of renewable gas, FGAs could supply between just 6% to 13% of current gas demand,**[23] clearly falling short of the goal of net-zero emissions and requiring fossil gas to make up the difference.

In the AGF study, a proposed high-resource scenario, which would still meet just 13% of U.S. gas demand, relies on significantly increased thermal gasification of energy crops, accelerating production from 123 to 837 tBtu/year (trillion British thermal units a year, a measure of gas production). Expanding reliance on purpose-grown energy crops would introduce serious sustainability risks by diverting arable land from food to energy production. It could drive up the cost of food and drive changes in land-use patterns that would transform forests and grasslands – natural carbon sinks – into agricultural areas for energy crops. According to the U.S. EPA's own assessment, the Renewable Fuel Standard – an existing program that incentivizes biofuel production – has resulted in the conversion of 4 to 8 million acres of land, completely nullifying and overwhelming any climate benefit the program might have had.[24] Thus, additional energy crop incentives are likely to result in a dramatic loss of stored carbon and increased emissions that can make biofuels even more GHG-intensive than fossil fuels.

A limited amount of biogas (363-876 tBtu/year) could come from the residual portions of agricultural and forest products that are not traditionally usable. But some of these forest and crop residues would be more ecologically advantageous to devote to other purposes besides fuel production, such as animal feed or incorporation as a soil amendment into compost. The high-resource scenario also assumes that most or all forest and crop residue would be devoted exclusively to gaseous fuel production as opposed to liquid fuels or power generation, more suitable uses explored later in this report.

Even the most aggressive scenario laid out by the AGF still reflects what would be possible by 2040, after two decades of scaling FGA potential. Mobilizing all these resources toward existing gas demand, which still would only meet 13% of the nation's gas needs, would leave a far smaller amount of biogas and synthetic gas available for more difficult to decarbonize end uses.

FGA RESOURCE POTENTIAL AND CURRENT GAS DEMAND



Source: *American Gas Foundation RNG Report, Dec. 2019*
** U.S. Energy Information Administration*

5. Low-carbon gases are significantly more expensive than fossil gas

Relative to the cost of fossil gas, FGAs are far more expensive to produce. Between 2018 and 2020, fossil gas prices mostly hovered between $2.03-$2.86/MMBtu (one million British Thermal Units).[25] By contrast, the AGF's estimates for landfill gas, typically the cheapest way to produce biogas, range between $10-$20/MMBtu.[26] Dairy manure projects are projected to cost closer to $40/MMBtu. Thermal gasification projects, necessary to achieve higher technical potentials, all begin at even higher production costs.[27]

The AGF concluded that by 2040, half of all low-carbon, non-fossil gas used in their aggressive resource potential scenario could be available at $20/MMBtu. While some low-cost biomethane from landfills and wastewater treatment plants is available, the costs rapidly increase as production is expanded and pushed to more challenging projects.

A report for the California Energy Commission similarly finds: "[e]ven under optimistic cost assumptions, the blended costs of hydrogen and synthetic natural gas are found to be 8 to 17 times more expensive than the expected price trajectory of natural gas."[28] While substantial cost declines are likely to be a decade or more away, synthetic gas from hydrogen (whereby hydrogen is produced from electrolysis and then methanated) is estimated to remain many times more expensive than fossil fuels for decades to come, even assuming aggressive and rapid industry learning. Production costs would be lower if electrolysis is used only to produce hydrogen and avoid the additional step of methanation. But hydrogen can only be injected into existing gas pipelines at minimal volumes before risking dangerous levels of corrosion. Optimistic scenarios estimate that the pipeline system could handle volumes of 7% hydrogen by energy content before requiring costly upgrades.[29]

Thus, each FGAs decarbonization potential for building end uses is limited by supply, cost, or environmental integrity. Synthetic methane is disadvantaged by its conversion inefficiencies and high costs. Biogas, which is limited in supply, could only be made in more substantial amounts by accepting significant environmental risks and higher production costs. While hydrogen production is compatible with net-zero emissions and technically unlimited in supply, its suitability for decarbonizing the existing gas grid are constrained by its effects on the pipeline.[30]

6. Given their limited supply and high costs, fossil gas alternatives are best-suited for use in harder-to-decarbonize segments of society

Injecting FGAs into the gas delivery system hits a dead end well short of complete decarbonization. Even outstanding improvements to the production costs of FGAs are unlikely to alter a fundamental point: **Decarbonized gas is better suited for applications that currently lack a low-cost pathway to direct electrification.**

Even if renewable energy costs decrease and electrolyzer technology improves, lowering the cost of renewable hydrogen and using renewable synthetic gas to decarbonize heating will likely remain far more expensive than running heat pumps on renewable power, an existing and already widely available technology. Changes to this dynamic are limited by basic physics: Using renewable electricity to power electrolysis for the production of gas will result in significant conversion losses. To produce 100% renewable hydrogen, an electrolyzer has to have access to 3 to 3.5 times its installed capacity of solar or wind generation.[31] **Because of this inherent inefficiency, P2G will always be considerably more expensive than directly using electricity.**[32] On top of that, gas-burning appliances such as boilers and furnaces are far less efficient than heat pumps. Direct electrification is therefore far more effective in decarbonizing heat wherever it is possible to use heat pumps. Even for many industrial uses, which require temperatures between 75 to 140°C, heat pumps are the most effective option.[33]

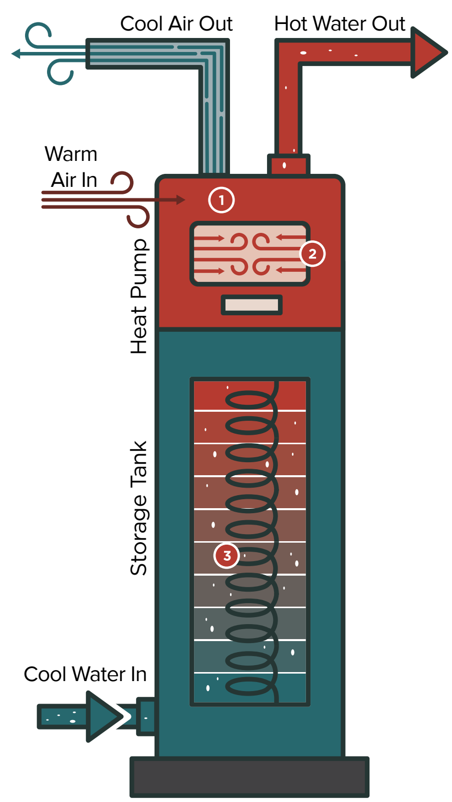
Given the limited availability of economic, sustainable FGAs, their role in a net-zero energy system will necessarily be small. Dedicating FGAs to incrementally lower the carbon intensity of gas heating in buildings is a poor use case, especially given their potential to advance decarbonization in more challenging sectors.

On a cost-effectiveness basis, policymakers should focus on socially optimal use cases for liquid/gaseous renewable fuels, such as delivering high industrial heat for steel production or powering air or marine

HOW DO HEAT PUMPS WORK?

By transferring heat rather than creating it, heat pumps deliver hot water **3-5 times more efficiently** than conventional water heaters.

1. Heat pump pulls warmth from the air.
2. Warm air is compressed, increasing its temperature.
3. Condenser coils transfer heat to the water.



transportation. Biogas and synthetic gas, as well as other renewable liquid fuels, have several advantages over electricity. Though costly, limited, and inefficient to produce, they are energy-dense, can be stored and transported more readily than electricity, and work with existing infrastructure that must rely on combustion. In optimizing their use, the advantages of renewable fuels (e.g., flexible, combustible, dispatchable) should be weighed against their disadvantages (e.g., cost, leakage, limited supply) and the availability of alternatives such as electrification and demand management. Because heat pumps and electric vehicles offer superior efficiency and eliminate end-use air pollution, direct use of electricity should be used to the maximum extent feasible in buildings and transport.

Because heat pumps and electric vehicles offer superior efficiency and eliminate end-use air pollution, direct use of electricity should be used to the maximum extent feasible in buildings and transport.

SOME SUGGESTED USES FOR FGAs:

HIGH-HEAT INDUSTRIAL PRODUCTION

Certain carbon-intensive industrial processes, such as steel production, require sustained temperatures greater than 200°C, which are currently generated by combusting natural gas. While it's possible to use advanced heat pumps to deliver high process heat in some instances, changing industry operations to employ electricity in place of combustion may require expensive logistical changes and facility retrofits.[34] Biogas and synthetic gas could enable decarbonization of these sectors right now, without requiring costly modifications.

DECARBONIZING CHEMICAL PRODUCTION

Hydrogen is required as a feedstock for industrial processes, such as ammonia and iron ore production. Nearly all of the hydrogen currently used to meet these demands is developed through Steam Methane Reformation ("SMR") of fossil gas, an emissions-intensive process. Renewable hydrogen offers a way to provide cleaner feedstocks to these industries.

FUEL FOR HEAVY ROAD, AIR, AND MARITIME TRANSPORTATION

Renewable liquid or gaseous fuels, either from biogenic materials or from power-to-gas/ power-to-liquid pathways, may eventually enable decarbonization of the heavier categories of transportation, such as international air and sea transport.

Even with the current, low-commodity costs of fossil gas, electrification proves to be a cost-effective energy solution for many households. The balance would significantly tilt in favor of electrification if FGAs were used given their extremely high costs.

These findings are not limited to warmer climates such as California. A multifaceted analysis by Evolved Energy Research on pathways to reducing the state of New Jersey's emissions and meeting its 2050 climate goals included a "least cost" option. That scenario, along with numerous other options discussed, required buildings to be 90% electric by 2030.[35]

Nevertheless, gas system incumbents are embarking on a coordinated strategy advocating for the use of FGAs in homes and buildings, irrespective of the fact that low-grade building heat is a poor use case for the limited supply of high cost, low-carbon FGAs.

Moreover, FGAs are not an ideal fuel source for buildings because, just like fossil gas, their combustion harms the health of people living, working, or learning in these buildings. They also contribute to local air pollution through continued emissions of NOx and other combustion byproducts – an avoidable outcome, given the availability of electric, zero-emission solutions. In addition, even after treatment for injection into gas pipelines, the potential residual toxicity of biomethane has yet to be fully understood. A recent study by the California Energy Commission found that using biomethane for home appliances causes DNA damage and mutagenicity, with varying results for fossil gas.[36]

The existential financial risks large-scale electrification present to the incumbent fossil fuel industry – largely responsible for the energy and environmental challenges we now face – should not be a reason to waste precious time and resources and on promoting FGAs for use in buildings. ■

A father prepares a meal with his son on an induction stove. Children who grow up in a home with a gas stove are 42% more likely to develop asthma than those who don't.[37]
Tom Werner/Getty Images

PART 2:

How the reality of fossil gas alternatives differs from gas and industry rhetoric

1. Fossil gas alternatives help preserve the gas utility business model in the face of electrification

Despite the inefficiency of FGAs laid out in this report, the fossil fuel industry hopes that by capitalizing on very low public awareness of the respective cost, supply, and sustainability challenges that exist for broad-scale use of FGAs, they can sell them as an alternative to building electrification.

This section lays out how building electrification challenges the gas industry's business model and profits, and how FGAs rose to prominence within their efforts and tactics to fight electrification.

Like electric utilities, gas utilities profit not by selling the gas itself, but by maintaining infrastructure that delivers energy to homes and businesses within an exclusive service territory. Their businesses are regulated by state public utility commissions, which allow them to earn a rate of return on the money they invest in their gas pipeline networks.

On average, gas utilities generate more than 85% of their gross revenues[38] from their residential and commercial customers. In the last 20 years, gas utilities have added 12.4 million new residential customers,[39] and spent more than $22 billion annually[40] replacing old pipes, averaging a 12% per year increase in capital investment from 2010 to 2016.[41] About 30% of the nation's residential and commercial gas demand is delivered by gas-only utilities, as opposed to those who deliver both gas and electricity, making these organizations that much more dependent on maintaining the status quo.

Any large-scale shift that reduces gas usage, such as electrification, poses an existential threat.

As Sempra Energy, the parent company for California utilities SoCalGas and San Diego Gas & Electric Company ("SDG&E") noted in its annual 10-K Report, increased use of renewable energy and electrification "could have a material adverse effect on SDG&E's, SoCalGas' and Sempra Energy's cash flows, financial condition and results of operations."[42]

Indeed, in a 2014 presentation to senior management, SoCalGas already foresaw the risks of electrification to its business, fighting against higher proposed efficiency standards for water heating in new construction to block the pathway toward highly efficient electric heat pump water heating and more widespread building electrification.

While investors have typically prized gas utilities, valuing them higher than their electric counterparts for many years, signs are emerging that investor confidence in the future of gas may be in question.[43] This has also been visible on recent gas utility quarterly earnings calls, where company executives are increasingly being forced to defend the sustainability of their businesses to the financial community.[44]

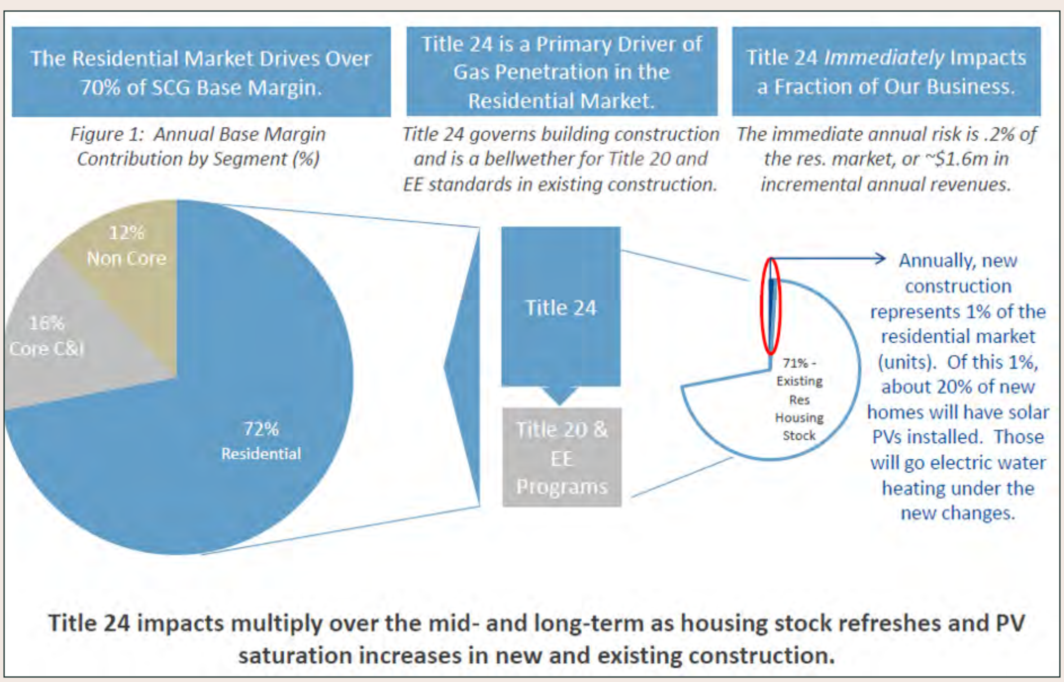
Gas interests are under pressure to both demonstrate they are taking steps to reduce emissions while also illustrating alternative pathways that allow gas infrastructure to continue being "used and useful" and also expanded.

The Longer Term Business Impact Would Be Significant.

» Left unchecked, the proposed changes would have a growing impact on SoCalGas:

- Residential water heating accounts for ~$800m of revenues/year
- **New construction opportunity cost: Up to $12m per year by 2020**
  - Adoption of these proposals would lead to new construction opportunity cost of $1.6m in the first year (2016), as .2% of the market (new construction homes with PV) migrates to electric
  - By 2020, the new construction opportunity cost would be at least $4.8m annually. If PV installations accelerate from 20% to 50% of new construction, the annual opportunity cost would be $12m/year by 2020.
- **Existing construction lost revenues: ~$4.8m per year by 2020**
  - Extrapolated to retrofit standards, the first year replacement rate of gas storage or tankless by electric heat pump would result in an additional $1.6m in lost revenues from current market the first year (2016) (2% of homes have solar PV; of those, 10% will have to replace water heater per year).
  - Assuming average water heater life of 10 years and that homes with solar PV will switch to electric water heating (2% of existing homes are solar), our gas water heating revenues would decline by an incremental $1.6m/year, or up to $4.8m annually by 2020
- Total impact by 2020: Up to $17m in lost revenues and opportunity cost annually
- As gas water heating erodes in new construction, space heating, cooking, clothes drying, etc., are all put at risk due to dominant role of water heating in cost justifying the gas houseline
- The loss of residential water heating revenues will cause rates to rise across other customer segments

In a 2014 presentation to senior management, SoCalGas already foresaw the risks of electrification to its business, fighting against higher proposed efficiency standards for water heating in new construction to block the pathway toward highly efficient electric heat pump water heating and more widespread building electrification.



2. How the gas industry seeks to short-circuit building electrification

The movement towards all-electric buildings, which emerged in 2019 with a wave of measures seeking to replace gas appliances with increasingly efficient and consumer-friendly electric alternatives, poses a new long-term financial threat to the gas industry.

To date, more than 30 communities in California and Massachusetts have passed policies restricting or eliminating the installation of any new gas infrastructure in new buildings, or promoting all-electric building codes. These communities include San Jose, California, the tenth largest city in the U.S., and Brookline, Massachusetts,[45] which became the first local government on the East Coast to adopt its own electrification policy. Dozens of other cities across the country are considering similar measures.

States, too, are beginning to examine how to wind down investment in existing gas distribution networks. California,[46] New Jersey,[47] and New York[48] in particular are updating and modernizing planning processes, gearing them towards a clean energy future that reduces or eliminates the need for future gas infrastructure investment.

Residents Line Up to Speak in Support of Berkeley's All-Electric Building Code

The gas industry quickly mobilized against pro-electrification legislation,[49] using front groups to wage aggressive misinformation campaigns. Prominent examples include:

- SoCalGas set up and continues to fund Californians for Balanced Energy Solutions ("C4BES"), a front group masquerading as a grassroots organization.[50] A filing to the California Public Utilities Commission shows how SoCalGas hired a PR firm to set up and provide ongoing support to this organization.[51]
- The Seattle Times recently exposed a $1 million effort from Washington and Oregon gas companies to form a new group dubbed the Partners for Energy Progress, which launched in May 2020.[52] It is intended to represent a coalition of unions, businesses, and consumer groups specifically to help "prevent or defeat" local electrification initiatives. They received advice from C4BES.

- Hawaii Gas, facing a Honolulu City Council bill that would limit gas water heaters in newly built homes, hired a Seattle-based political consulting firm to create a new front group called Our Energy Choice and fund additional opposition campaigns.[53]
- Before the town of Brookline passed a measure to prohibit new fossil fuel infrastructure in major construction projects, a group called the Massachusetts Coalition for Sustainable Energy unsuccessfully pressed Brookline officials to reject the policy.[54] Despite its name, however, this organization is actually an Astroturf front group formed to promote gas pipeline expansion projects and funded by in-state gas interests and utilities including Enbridge, Eversource, and National Grid.[55]

Recently, gas interests have also turned to a preemption strategy. Industry allies have begun pushing bills in state legislatures that would preempt or prevent cities and towns from enacting local ordinances that would limit or ban the inclusion of gas infrastructure in new buildings. Arizona legislators, at the behest of the utility Southwest Gas,[56] passed the first such measure, soon followed by Tennessee,[57] the second state to enact such a law. Similar bills forbidding gas bans, using near identical language to the Arizona bill, have been introduced in Kansas,[58] Minnesota,[59] Mississippi,[60] Missouri,[61] and Oklahoma.[62] SoCalGas also advocated for a similar law in California. In an email to C4BES Board Members, the Vice President for External Affairs and Environmental Strategy at SoCalGas stated “Regarding the AZ bill, maybe we at C4BES should be looking at that approach here in CA.”

These efforts to stymie building electrification are effectively kneecapping local governments that are serious about meeting their long-term emissions reductions goals, since this sector represents such a significant portion of citywide carbon emissions. Building emissions represent 27% of the greenhouse gas footprint in Berkeley, California,[63] nearly two-thirds in Brookline,[64] and as high as 73% in Washington, D.C.[65]

Community Demonstration at SoCalGas/C4BES Press Conference in Riverside, CA

3. Industry claims about fossil gas alternatives

The gas industry's strategy to prevent electrification by locking in FGAs is framed as a pursuit of a more sustainable future. The pitch consists of oft-repeated statements meant to confuse the public over the value and cost of electric alternatives while promoting FGAs.

At least 10 op-eds from gas industry surrogates, promoting misleading data on the costs related to electrification while pushing FGAs as a better solution, have been published in California and national media between late 2018 and 2020.

Local utilities, eager to continue supplying gas to homes and buildings and provide some justification for their role in a decarbonized future, have been particularly aggressive in pushing and inflating the potential of FGAs.

SOUTHERN CALIFORNIA GAS COMPANY

In March 2019, SoCalGas announced its intent to become the "cleanest natural gas utility in North America." A cornerstone of that strategy is to replace 20% of its fossil gas supply with FGAs by 2030:

> ***"Research shows that replacing about 20% of California's traditional natural gas supply with renewable natural gas would lower emissions equal to retrofitting every building in the state to run on electric-only energy and at a fraction of the cost," a company press release claims. "Using renewable natural gas in buildings can be two to three times less expensive than any all-electric strategy and does not require families or businesses to purchase new appliances or take on costly construction projects."[66]***

As illustrated in Part 1 of this report, the reality is that FGAs can take California only marginally down the path of reducing emissions, and at an extremely high cost, while building electrification can cost-effectively take it to zero. The California Energy Commission, across two reports and three years, has found building electrification is the cheapest and lowest-risk option to decarbonize the state's buildings. SoCalGas's claims and rhetoric run counter to all reputable analyses on the topic, and SoCalGas has been silent on how much replacing 20% of its gas with FGAs would cost its customers.

Emails show that SoCalGas's front group, C4BES, was set up specifically to help spread this inaccurate message. In a welcome letter between Ken Chawkins, a SoCalGas employee, and Matt Rahn, who was recruited by SoCalGas as the chair of the board of C4BES, Chawkins states the purpose of C4BES: "We (C4BES) will tell the public and the media about the importance of natural and renewable natural gas."[67]

DOMINION ENERGY

Dominion Energy, a mixed-fuel utility that supplies gas to seven states, has been actively promoting FGAs as part of its pathway to decarbonization. Dominion announced[68] a goal in February 2020 to reach net-zero emissions by 2050 and plans to meet that goal with FGAs, saying in their statement that capturing the methane from farms will offset "any remaining methane and carbon dioxide emissions from the company's natural gas operations."

Dominion's RNG strategy includes a recently announced $200 million investment[69] with pork conglomerate Smithfield Foods to produce biomethane.

According to their website as of March 26, 2020, "Our goal is to meet 4 percent of our gas utility customers' needs with RNG by 2040. Because RNG captures 25 times more greenhouse gas than it releases, that will offset our customers' carbon footprint by 100 percent!"[70]

The current version of their website makes the following claim:

> ***"[D]id you know renewable energy can also come from our nation's farms? That's right. Thanks to technological innovation, we can capture waste methane from hog and dairy farms and convert it into clean energy that can heat homes and power businesses.***
>
> ***It's called renewable natural gas, or RNG, and it's transforming the future of clean energy. When methane is converted into RNG, it captures 25 times more greenhouse gases from the atmosphere than are released when RNG is used by consumers. That makes RNG better than zero-carbon. It's actually carbon-beneficial!"***[71]

The claim that RNG captures 25 times more greenhouse gases is unsupported, and specious at best. As explained in Part 1, sources of FGAs vary in their carbon intensity. The vast majority of FGAs are not carbon negative, and most, like landfill gas, are not even carbon neutral. Even those FGAs which are sometimes considered "carbon negative," like biomethane from manure, that consideration is based on the presumption these emissions are inevitable, in contradiction to alternative management systems which avoid emissions altogether.

No utility has thus far been forthcoming about the costs of FGAs as an alternative to building electrification, though regulators have been clear. The Minnesota Attorney General's office called the cost of FGAs "unreasonably high"[72] and noted that if a customer used that fuel exclusively, their gas bill would increase by thousands of dollars annually.

4. Despite what it's telling customers, the gas industry knows the shortfalls of fossil gas alternatives

Despite these public statements, many in the gas industry are all too aware of the problems with wide-scale promotion and production of FGAs. Internal documents and communications illustrate how and when the strategy of using FGAs as a defense against building electrification emerged, as well as the cost and feasibility issues around these fuels.

The American Gas Association's Clean Energy Task Force developed draft policy principles for FGAs in January 2018. As stated in the document,[73] the AGA "supports policies that define the term 'renewable energy' to include RNG on par with other energy sources, such as energy generated from wind or solar resources." The principles also discuss FGAs as a way for gas to count towards Zero Net Energy standards for buildings.

An internal set of AGA meeting notes from March 2018 shows the industry's interest in using FGAs to "mitigate the opposition's fervor." After FGAs "piqued the interest of opposition group" Mothers Out Front, a Boston-based nonprofit dedicated to phasing out fossil fuels, the group reached out to National Grid, a gas utility that operates in Massachusetts, to learn more about the fuel. The meeting notes record the following action item in response: "Consider how technologies to decarbonize the pipeline can serve as a conduit to environmental organizations, thereby seeking to mitigate the opposition's fervor against infrastructure expansion."[74]

At the same time as the industry quickly began to outwardly express confidence in the role FGAs can play in "decarbonizing" the gas system, internal documents show there were and are concerns about the costs and supply of these fuels.

In a document obtained by the Climate Investigations Center,[75] Mark Krebs, an energy policy specialist at St. Louis-based Spire Energy, wrote to other gas utility employees, "If CA sees builders use more gas, they will probably clamp down on it; unless it is RNG; hence all the hoopla over RNG. In my opinion, RNG will not sustain our industry at its present size."

Even members of the board of C4BES – the pro-gas industry front group developed and funded by SoCalGas – expressed concerns about the misleading characterization of FGAs. Michael Boccadoro, a lobbyist for California's dairy industry, which stands to benefit from incentives promoting the production of FGAs from large dairies, sat on the board of C4BES at its launch. He told The Guardian, "Dairy biogas is way too expensive" to use in home or businesses – five to 10 times more expensive than fossil gas.

He also stated, "It doesn't pencil out and it doesn't make all that much sense from an environmental standpoint. It's a pipe dream."[76]

Boccadoro raised his concerns about supply and price in emails with the rest of the C4BES board, which were played down by the chairman, Matt Rahn. Boccadoro left the board shortly thereafter. ■

CONCLUSION:

Benefits of building electrification should not be obscured by a fog of gas industry misinformation

The continued evolution of our energy systems and the push towards net-zero emissions require honest accounting of the pros and cons of different energy solutions. State agencies and independent analysis have overwhelmingly concluded that powering the grid with renewable energy and electrifying buildings is one of the quickest, most cost-effective ways to hit emission reduction goals.

Closer scrutiny of the production and distribution challenges of fossil gas alternatives (called "renewable natural gas" by the gas industry) are not, and are unlikely to ever be, a substitute for widespread electrification. Their role, if any, should be specialized and limited to specific industries that can't easily electrify, specifically heavy industry and air or maritime transport. If focused on those specific functions, these fuels can play a potential role in complementing the society-wide energy transition.

The gas industry's well-documented campaign of skewing facts, misleading consumers, and branding fossil gas alternatives as a renewable, sustainable energy source must be recognized for what it is: a PR campaign to protect the industry's financial interests and preserve a business model that is incompatible with achieving a net-zero emissions society. The movement towards building electrification is gaining ground in the United States on a local level because it's the most viable and affordable option for reducing emissions from the built environment. A straightforward reading of the facts and the adoption of existing technology can steer policymakers, consumers, and utilities alike towards a future of cleaner energy. ■

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