Four Global Energy Leaders Commit to Climate Goals

Developing renewable gases (RG) is essential to advancing energy sector decarbonization. That's the conclusion of the International Energy Agency (IEA) in its April 2020 Outlook for biogas and biomethane.[1]

Southern California Gas Co. (SoCalGas), Énergir, GRDF and GRTgaz, gas infrastructure sector leaders in California, Quebec and France, respectively, have collaborated for over two years on viable solutions and associated technologies to leverage the potential of gas grids to support the energy transition. A key objective has been to facilitate RG production and injection into gas networks.

These four energy leaders believe that RG offers solutions to meet enhanced climate targets from short- to long-term. This reflects a commitment to advancing natural gas sector decarbonization and supporting cost-effective, strategic development of RG in their respective countries.

To achieve these goals, the four energy leaders:

- **Facilitate the development and use of RG**, including biomethane and hydrogen[2], leveraging existing local production where feasible.
- **Leverage the potential of gas grids as an enabler of the energy transition** in a unified, cross-continental approach to achieve climate-neutrality.

[1] Outlook for biogas and biomethane. Prospects for organic growth, IEA, April 2020

[2] In this paper, renewable gas (RG) is used as an umbrella term that includes biogas, biomethane and hydrogen. Biomethane is biogas that has been upgraded to be eligible for injection into natural gas pipelines. Biomethane is often called renewable natural gas or RNG.

Facilitating the development of renewable gases

Renewable gases are fuels with much lower lifecycle carbon dioxide equivalent (CO2e) emissions – they can even be carbon-negative in some instances- than geological natural gas, derived from biogenic or other renewable sources.

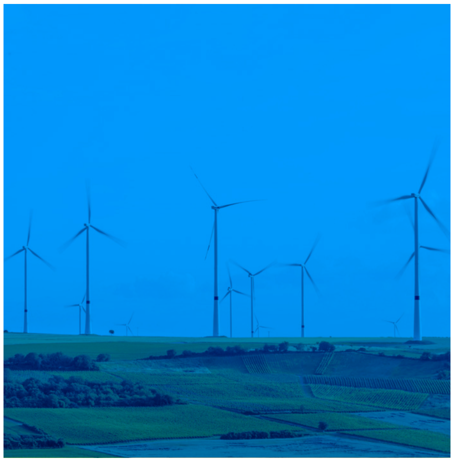
In addition to biogas and biomethane, the term “renewable gases” also includes hydrogen produced using renewable electricity to split water into hydrogen and oxygen through electrolysis. Biogas can also be used to create renewable hydrogen by removing the methane from biogas to create hydrogen, also called biogas reforming.
There are currently three primary technologies to produce renewable gases in various stages of commercialization **that hold the potential to significantly decarbonize natural gas consumption in the immediate future and beyond.**

Three different technologies to produce renewable gases

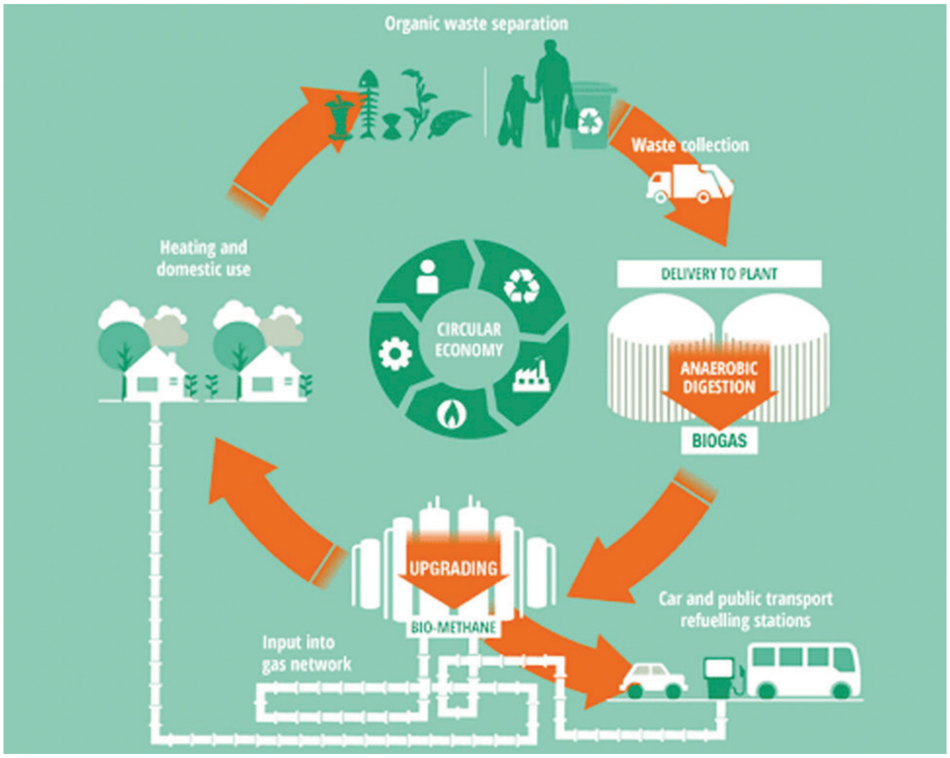
Anaerobic Digestion

Gasification

Electrolysis



Anaerobic Digestion



The first technology, biogas, can be produced from **anaerobic digestion**[3] of organic waste, primarily from agricultural waste, organic waste diverted from landfills and sewage sludge.

The biogas produced from anaerobic digestion is then cleaned to produce biomethane to meet specifications for injection into existing gas grids. Or biogas can be used as a feedstock to produce hydrogen.

This technology is mature, and its deployment is currently accelerating across Europe, Canada, the United States and the rest of the world.

For instance, France reached two terawatt hours (TWh) of installed biomethane capacity at the end of 2019, with 24 TWh[4] of additional projects currently at different development stages. This represents 6 percent of final gas consumption presently in this country. Québec now has a production capacity of 1.5 TWh, and many other projects are in development. Quebec's total potential for biomethane is estimated at 40 TWh. California is projected to have 160 biogas production facilities by 2024, producing over 15.8 million MMBTUs (or 4.6 TWh) annually[5] and has the potential to produce approximately 282 million MMBTU (or 83 TWh) per year by 2040.[6]

Producing biogas helps to increase the overall renewable energy supply and **reduces waste sent to landfills.** Biogas also **provides a substitute for chemical fertilizers** through the digestate it co-produces, supporting rural areas by bringing additional revenues to farmers. **Biogas production advances the circular economy** since it is collected and produced from waste locally. It has beneficial uses as a clean fuel for local heavy-duty trucking, heating systems and industry. Thus, biogas is a solution that allows municipalities to manage their waste streams and support the production of renewable thermal energy to help achieve climate goals.

[3]Anaerobic digestion is the natural process in which microorganisms break downorganic materials. In this instance, "organic" means coming from or made of plants or animals. Anaerobic digestion happens in closed spaces where there is no air (or oxygen) https://www.epa.gov/anaerobic-digestion/basic-information-about-anaerobic-digestion-ad

[4]In France and Quebec RG is measured in terawatt hours (TWh). 1 TWh equals 3.41 x 106 MMBtu.

[5]An Assessment: California's In-State RNG Supply for Transportation 2020-2024 https://www.gladstein.org/gna_whitepapers/an-assessment-californias-in-state-rng-supply-for-transportation-2020-2024/

[6]Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment, High Resource Potential Scenario, P. 66 https://gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf

Gasification

The second renewable gas production technology is non-combustion thermal conversion[7] (i.e., **gasification**) of waste biomass such as agricultural residue and the biogenic portion of municipal solid waste. Once processed, the resulting biomethane or hydrogen can be injected into existing gas grids or delivered to other end users. In California, gasifying waste biomass into hydrogen with simultaneous capture of the process CO2 emissions holds the greatest potential for negative emissions at the lowest cost, according to a recent study by Lawrence Livermore National Laboratory.[8]

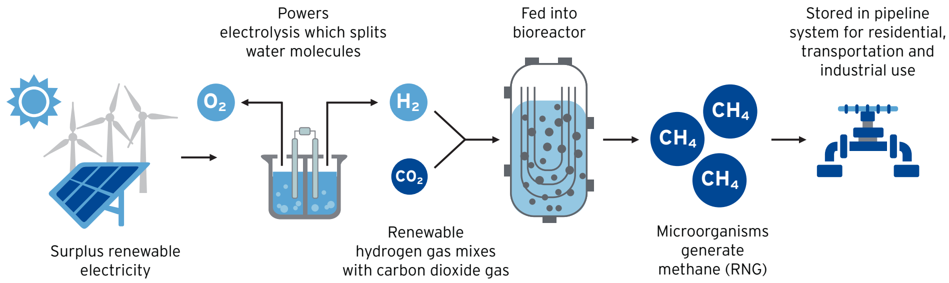
This technology is under development, with pilot projects at different scales emerging around the world. For instance, in 2016, Energir participated in a project that gasified wood waste with favorable results. This example could be replicated elsewhere to commercialize this technology more quickly.

[7]A non-combustion thermal conversion is the thermal degradation at high temperature of solid waste in the absence of oxygen. It produces a combination of solid char and gas (hydrogen and carbon monoxide)

[8]Getting to Neutral: Options for Negative Carbon Emissions in California, Lawrence Livermore National Laboratory, August 2020, https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf

Electrolysis

The third technology is **electrolysis** whereby renewable electricity is converted into gaseous fuel. This process uses electricity to split water into hydrogen and oxygen. The resulting renewable hydrogen can (1) be blended with natural gas and injected into gas grids.
(2) It can be used directly in transportation or industry or (3) combined with carbon dioxide and converted to synthetic methane using a methanation reaction[9] and injected into the gas grid.



Of these three primary ways to use hydrogen, two can leverage existing natural gas grids, positioning gas infrastructure as a key enabler to help develop the hydrogen economy.

In other words, existing natural gas infrastructure can create a demand-pull and grow the P2G industry.

Many electrolysis pilot projects are currently underway around the world. For example, GRTgaz has launched the JUPITER 1000 project. This is the first industrial demonstration project with a power rating of 1 MW for electrolysis and a methanation process with carbon captured from industrial processes close to the demonstration site. Another example is the GRHYD project, a consortium in which GRDF participated. This project was designed to test the effects, if any, on pipelines and residential appliances when hydrogen is blended into a natural gas distribution network in a newly built residential community of around 200 homes. This pilot tested blends from 6 to 20 percent hydrogen and did not find significant effects on the gas infrastructure or on customers' gas appliances.

We expect this trend of electrolytic hydrogen development, which creates a bridge between the electricity grid and the gas grid via the hydrogen vector, to accelerate across the world in the coming years, with several governments putting in place specific strategic industrial plans. For instance, the French government decided in September 2020 to allocate 7 b€ to its national hydrogen strategy to support the installation of 6.5 GW of electrolysers to produce approximately 20 TWh of zero-carbon hydrogen by 2030. At the EU level, major gas transmission operators, including GRTgaz, collaborated to create a strategy to build the backbone of a future hydrogen grid[10], supporting European ambition into hydrogen.

[9]Methanation reaction converts hydrogen (H^2) and carbon dioxide (CO^2) to produce methane (CH^4)

[10]European Hydrogen Backbone: https://gasforclimate2050.eu/sdm_downloads/european-hydrogen-backbone/(CH^4)

Significant potential for renewable gases

Several studies published in the last couple of years confirm significant potential to develop high volumes of renewable gases in different regions of the world, as the table below illustrates.

IEA[11] estimates the biomethane that could be sustainably produced globally can increase up to 12,000 TWh (or 40 000 million MMBTU) by 2040. It represents 30 percent of the current natural gas consumption worldwide.

Supplies are abundant, and since renewable gases are pivotal to achieving Paris Agreement climate targets, they should be developed accordingly.

Geography	Horizon	Renewable Gas	Volume (in TWh)	Volume (in 106 MMBTU)	Source
France	2050	Biomethane	320	1,100	ADEME[12]
		Hydrogen	140	480	
EU	2050	Biomethane	1,150	3,900	Trinomics, for European Commission
		Hydrogen	7,900	27,000	
Quebec	2030	Biomethane	40	135	Quebec Ministry of Environment
California	2040	Biomethane	83	282	ICF Study for the American Gas Foundation
Worldwide	2040	Biomethane	12,000	40,100	IEA[13]

The global energy system currently relies more heavily on "molecules" than electrons, with more than 75 percent of final energy demand produced from biomass, coal, oil or natural gas. While certain end uses, such as home heating and passenger vehicles, can be fueled by electricity, some critical end uses are hard to electrify. These include certain types of manufacturing, high heat industrial processes and long-haul applications for freight, marine and aviation.

Consequently, developing renewable gases, such as biomethane and hydrogen, will be critical to reaching carbon neutrality by 2050. This is especially true in Quebec, where electricity already accounts for 40 percent of the stationary energy use mix. Furthermore, many end-uses that can be easily electrified already use this form of energy and further conversion is limited to a small subset of applications.

[11]See [1]

[12] Gas independence in France in 2050: A 100% renewable gas mix in 2050?, ADEME, January 2018

[13] See [1]

Reducing GHG

From a public policy standpoint, RG is an efficient and economical way to reduce greenhouse gas (GHG) emissions. A recent study commissioned by the Quebec Ministry of Environment found that RG was the most cost-effective measure to implement in terms of cost and tons of avoided GHG emissions.

In California, the Air Resources Board (ARB) found that the Dairy Digester Research and Development program that supports biomethane production is a highly cost-effective GHG reduction measure at $9 per metric tonne of CO2e (MTCO2e).[14] In the American Gas Foundation RNG Supply Study, ICF estimates that most of the RNG produced in the high resource potential scenario is available in the range of $7-20 MMBtu, which is equivalent to $55/ MTCO2e to $300/MTCO2e in 2040.

The cost-effectiveness of RG as a GHG mitigation strategy is competitive with and, in many cases, lower than the costs per ton associated with other strategies to reduce GHG emissions. For instance, electrification is at $572-806/ MTCO2e.[15]

This is why countries are increasingly establishing binding targets of RG production and procurement. France has set a target of ten percent RNG use in 2030, with a goal of nearly 100 percent by 2050. By the end of 2021, 1 percent of Quebec's gas consumption will be renewable, with a target of five percent for 2025 and 10% by 2030. California has GHG and methane reduction goals that support the development of the renewable gas industry. These goals include:

These goals include:

- A requirement to reduce greenhouse gas emissions 40 percent below 1990 levels by 2030.
- Reduce methane emissions from organic sources by 40 percent by 2030
- Achieve economy-wide carbon neutrality by 2045.

Finally, from an economic perspective, developing biomethane and hydrogen **supports local companies, regional industry and sustainable job creation that can't be replicated elsewhere.** This will be particularly important in helping communities begin to recover from the economic impacts of COVID19. **Consequently, it is essential to include the production and use of renewable gases in local, regional and national recovery plans.**

[14] https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/auctionproceeds/2020_cci_annual_report.pdf Table ES-2, p xiv.

[15] Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment, P. 62
https://gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf

[16] SB 1383 (Lara 2016) requires a 40% reduction in methane emissions by 2030; In 2019 Governor Brown issued an executive order creating a new statewide goal to achieve carbon neutrality as soon as possible, and no later than 2045, and achieve and maintain net negative emissions thereafter.

Recomendations

SoCalGas, Énergir, GRDF and GRTgaz recommend:

- **Climate laws must define RG targets.** Targets should be set at state, regional or national levels considering supply potential and carbon neutrality goals for 2050. Production targets, based on the injection of RG into the grid, will allow for the decarbonisation of gas networks, better maximize production volumes and optimize end uses.

- **RG should be supported through existing and new fiscal mechanisms** to foster the development of these technologies and support local companies. In addition to **recognizing and valuing all environmental and economic benefits** linked to RG production and use, supportive tax policy and production incentives are needed to ensure RG is **sustainable and affordable for governments and consumers.**

Leverage the potential of gas grids to accelerate the energy transition

Three key areas can help unlock the tremendous potential of RG as we advance. While these three areas are not without their unique challenges, strategically devoting resources may yield significant results towards lower carbonization.

Cost-competitive energy systems | Existing gas grids | Sustainable transportation

Cost-competitive energy systems

Natural gas is one of the most cost-competitive energy solutions for heating in buildings and industry. RG is an immediate and efficient solution to replace more carbon-intensive fuels such as coal and fuel oil. **Maintaining sustainable and resilient solutions for households and industry is one of the main challenges in achieving a fair, cost-effective, socially accepted and gradual energy transition. The efficient use of natural gas plays a key role.**

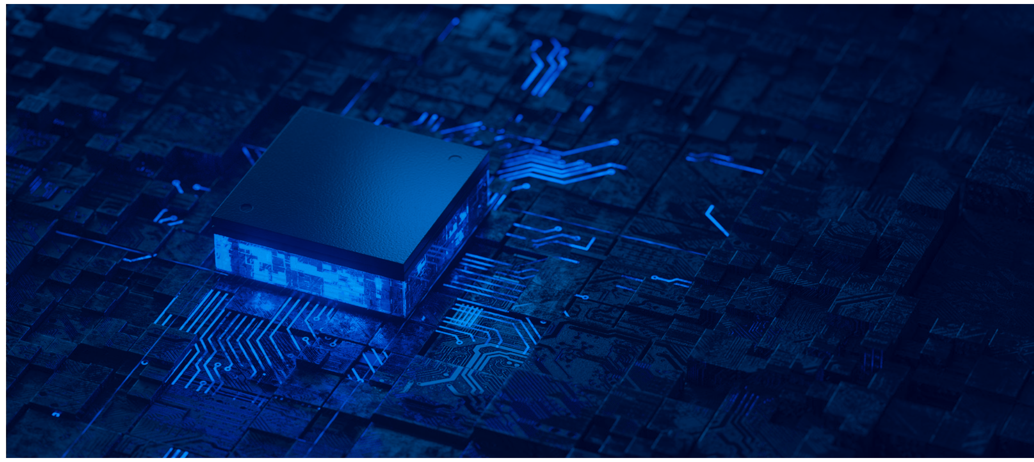
Energy efficiency should be prioritized for reducing energy consumption, which includes moving away from older energy endpoints to newer, more efficient ones. For instance, there is significant potential for energy savings by replacing old gas boilers with high-efficiency ones, as demonstrated in Quebec in recent years. Similarly, in California, energy efficiency programs have delivered 77 million tonnes of CO2 reductions since 2016, equivalent to taking 12 million cars off the road.[17]

[17] SB 1383 (Lara 2016) requires a 40% reduction in methane emissions by 2030; In 2019 Governor Brown issued an executive order creating a new statewide goal to achieve carbon neutrality as soon as possible, and no later than 2045, and achieve and maintain net negative emissions thereafter.

Existing gas grids

Existing gas infrastructure brings essential flexibility and supply security for energy systems. Gas grids provide a safe, secure and predictable energy supply.

By design, they are flexible and offer a cost-effective and reliable way to store renewable energy for long periods and dispatch it to meet peak demand.



Gas is the optimal complementary energy technology to balance intermittent renewable electricity such as wind and solar, which will significantly increase in electricity mixes worldwide in the coming decades while more carbon-intensive power plants will close.

Through **electrolysis and the broader concept of sector coupling** between gas and electricity markets, existing gas infrastructure, with its large storage capabilities, can support renewable energy integration. It can also help eliminate wasteful power curtailment practices, enable energy storage-related financial instruments, and reduce the need for large new investments in electricity grids while enhancing renewable energy assets' economic viability.

Gas-electricity sector coupling is also key at the end-use level in different sectors.

For instance, replacing an old gas boiler with a hybrid heat pump — essentially coupling an electric heat pump with a high-performance gas boiler — **significantly reduces energy demand and CO2 emissions. It further reduces stress on the electric grid** during winter peak periods, thereby increasing energy reliability. This type of coupling reduces overall gas use, which further supports decarbonization.

New storage capacity can be gained through using existing gas infrastructure as long-term energy storage (imagine the gas pipeline system as a giant flow battery).

These efforts support increasing electricity from wind and solar resources that can enable further coupling between energy and financial sectors through various value-enhancing forward market arbitrage instruments.

Biomethane and hydrogen production can be used in difficult areas to decarbonize, such as older facilities, transport and industry. The many climate benefits and positive externalities offer a strong case for integration in those areas.

Gas grids are valuable assets in the transition to a hybrid energy system designed for climate neutrality.

Sustainable transportation

Decarbonizing the transportation sector — one of the largest GHG emitters today — is challenging but crucial to reaching carbon neutrality in 2050. **Natural gas and renewable gases complement electricity and gradually allow light-duty and heavy-duty transportation to transition from diesel and gasoline.** They are especially well-suited for fueling heavy-duty trucks, buses and coaches because of limitations in battery technology.

NGV Trucks, France

Natural gas vehicles (NGV) and hydrogen fuel cell electric vehicles (FCEVs) reduce air pollution, a common public health problem in cities worldwide, as well as GHG emissions. Also, using biomethane as a fuel (bioNGV) generates lower and sometimes negative GHG lifecycle emissions, depending on the feedstock used for fuel generation. Consequently, developing NGV, bioNGV, and FCEV solutions and refueling infrastructure today in the transportation sector provides a pathway to tackle significant emission sources in on-road and off-road transportation, alongside electric solutions.

Conclusion & Recommendations

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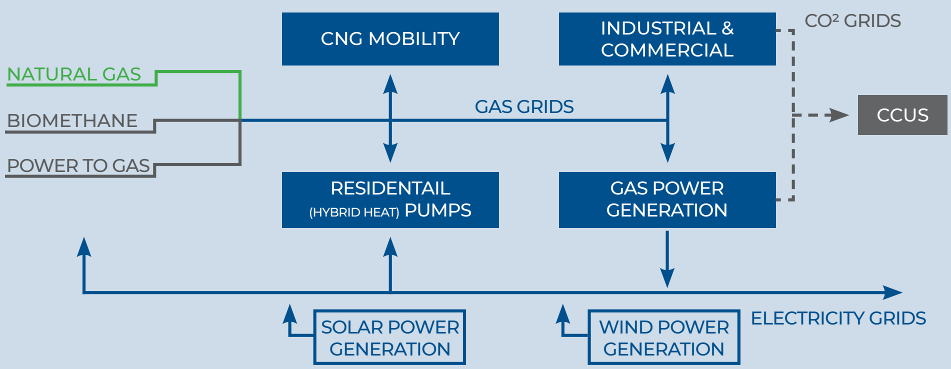

In a global and integrated approach, gas grids, transporting biomethane and hydrogen, and electricity grids, transporting renewable electricity, will be increasingly interconnected. Connecting both the production side — through P2G and gas power generation — and at the end-use level will result in efficient decarbonization of all economic sectors.

Climate change is one of our greatest and most urgent global challenges that must be addressed. Tackling the impact of climate change without impeding economic growth or increasing energy poverty requires a integrated approach where all low and zero-carbon energy sources have a role to play. Renewable gas and gas grids offer key solutions for the energy sector, the environment and the global economy.

- Promoting a **global approach** in energy system planning by **leveraging existing gas grids with sector coupling solutions.**
- **Identifying and implementing policy and regulatory changes needed to ensure gas infrastructure can be maintained and developed to continue to support the energy transition and energy system resilience.**
- **Considering conventional natural gas and renewable gases, including hydrogen, solutions for mobility (transportation sector) as equitable pathways to low-carbon battery-electric solutions,** based on the adoption of a **Life Cycle Assessment methodology**.
- **Ensuring social recognition and acceptance** that NGV, Bio-NGV, and hydrogen fuels are relevant alternatives to conventional fuels through continued public education efforts and focused communications.
- **Integrating conventional gas and renewable gas in road, rail and marine transportation** in forthcoming sustainable transportation planning, as well as **supporting the deployment of public recharging, refueling points and related low-carbon infrastructure investments.**