

The Strategic Role of Off-Grid Renewable Gases



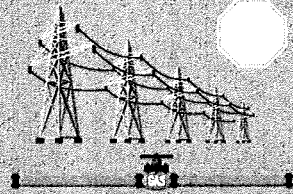
Challenges of Off-Grid Decarbonisation



There are **49.2 million rural households in the EU** and most of them are not connected to a gas grid. These buildings primarily use fossil fuels for heating, these are generally higher carbon footprints.¹



Rural building stock is often old, 36% of building stock in the EU was built before the first thermal regulations in 1978.²



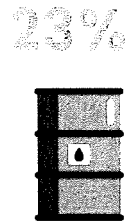
Gas and electricity networks are less developed in rural areas, so the choice of fuels and energy solutions remains limited.⁴



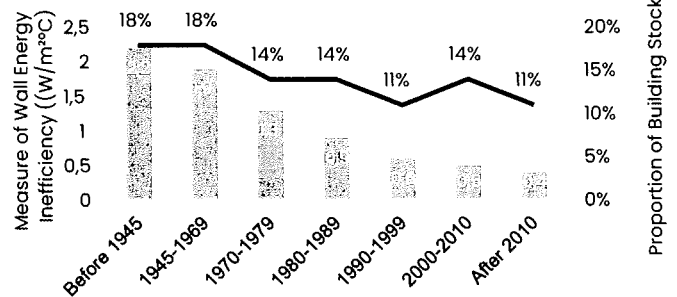
Heat demand varies significantly more than renewable electricity generation throughout the year. Electrification requires constant balancing of supply and demand which will be challenging to meet with intermittent renewable energy.



7% of off grid homes **heat with coal**³ and a further 23% **with fuel oil**³. These fuels have high air pollution and greenhouse gas emissions.



Old Buildings are Common and Less Energy Efficient



Building Stock Diversity and Prominence of Hard-to-Treat Buildings



There is a broad variety of building types and ages in the EU. Generally, older buildings are less energy efficient, as shown on the bar chart above⁵, these hard-to-treat buildings are common in rural areas and require more investment to decarbonise.

There is a broad mix of heating technologies in the EU, heating oil and coal are widely used for dwellings not connected to the gas grid³. These fuels have high carbon and air pollution emissions.

Different buildings and consumers require different energy solutions suited to their needs and circumstances, as there is no 'one size fits all' solution. Consumers should be provided with a choice to ensure rapid decarbonisation and a just energy transition.

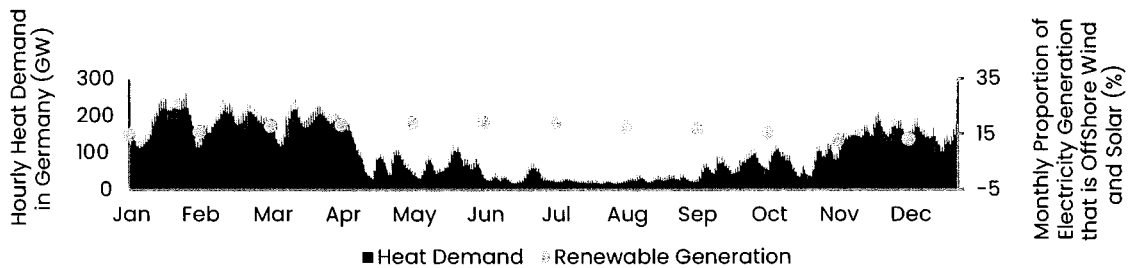
¹ Eurostat (2022) Number of households by degree of urbanisation
² Eurostat (2019) Share of fuels in the final energy consumption in the residential sector for space heating
³ FRAUNHOFER ISI (2021) Space heating market summary 2017
⁴ ECOFYS (2018) Rural energy in Europe
⁵ European Commission (2020) EU Buildings Database



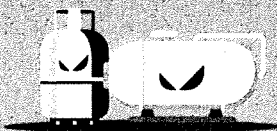
Energy Security and Flexibility

Heating demand varies significantly throughout the year with much higher winter consumption than in summer, as shown on the graph for Germany below⁶. Increasing electrification and penetration of intermittent renewable energy significantly increases the difficulty of operating a reliable electricity grid and managing supply and demand, particularly in off-grid areas which generally have the worst reliability⁷. The graph below shows renewable electricity generation dropping in winter^{8,9} as heat demand is highest. Decarbonisation must be achieved in a way that peak demand can always be met.

Heat Demand Variation Will be Challenging to Meet with Renewable Electricity Alone



What Are Off-Grid Renewable Gases?



BiOLPG

Chemical feedstocks are converted to useful products and sold for a wide range of applications. Produced from 40% of the feedstocks, it is a clean and green waste material, which is biodegradable, and it is used as a clean energy source for industrial and residential applications.



Biogas

Biogas is produced through the decomposition of organic matter such as agricultural waste, manure, and other organic matter. It is used as a fuel for power generation and as a feedstock for other applications.



BioLNG

It is produced by separating methane and other critical components from biogas to create a methane content similar to that of natural gas and is subsequently liquefied.



rDME

It has similar properties to LPG and can be produced from a wide range of renewable feedstocks, including municipal waste and biogas. It can be used as a pure renewable fuel or blended with conventional LPG.

How are Renewable Gases Produced?

Bio-Refining

Bio-Refining can be used to **convert biomass into a number of useful products** such as food, chemicals and renewable gases.

This is achieved through a number of different technologies including microbial fermentation, biocatalysis and thermochemical processes, to produce renewable gases such as bioLPG and rDME. Renewable gases such as rDME and bioLPG can also be used as hydrogen carriers due to the lower cost of transporting and storing these gases.

Power to Gas (P2G)

Power to gas involves using **electrolysis to convert electricity to hydrogen**.

This can then be combined with carbon to produce synthetic hydrocarbons with very low emissions if renewable electricity is used. These renewable fuels are much cheaper and easier to store than pure hydrogen due to their greater volumetric energy density.

Anaerobic Digestion (AD)

Anaerobic digestion is the **breakdown of organic matter using micro-organisms** in the absence of oxygen. This produces **biogas** which can be **upgraded to biomethane**. Biomethane can then be compressed into bioLNG which can be stored in tanks and used in off-grid applications.

Gasification and Pyrolysis

Gasification and pyrolysis use **heat, pressure and steam to convert biomass into renewable gases**.

Gasification is a thermochemical process where materials decompose in an environment with less oxygen than is required for combustion. Pyrolysis is a similar process, performed at higher temperatures, but in the absence of oxygen.

⁶ Stratego (2018) Creating Hourly Profiles to Model both Demand and Supply

⁷ ECOFYS (2018) Rural energy in Europe

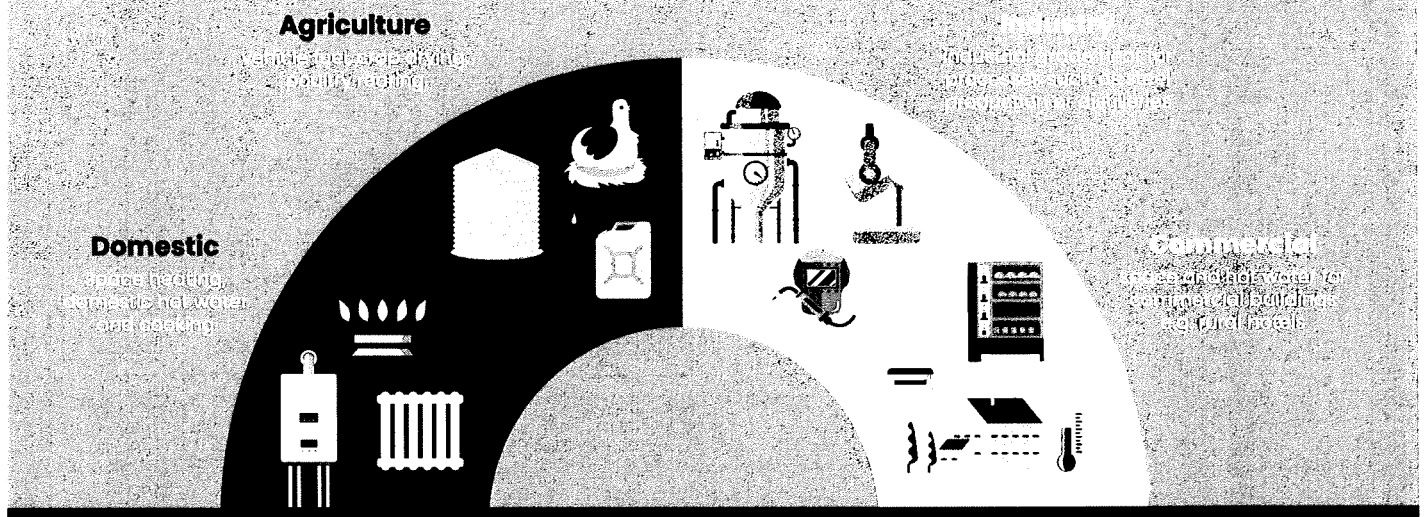
⁸ IEA (2020) Monthly generation of solar PV in Germany

⁹ IEA (2020) Monthly generation of offshore wind in Germany

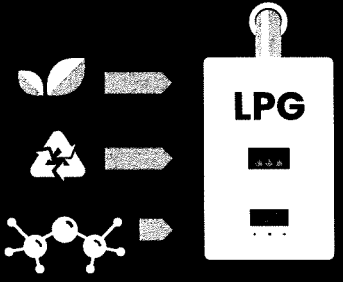


Key Benefits of Off-Grid Renewable Gases

Applications of Renewable Off-Grid Gases

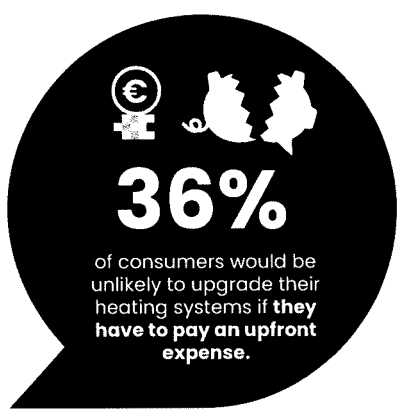
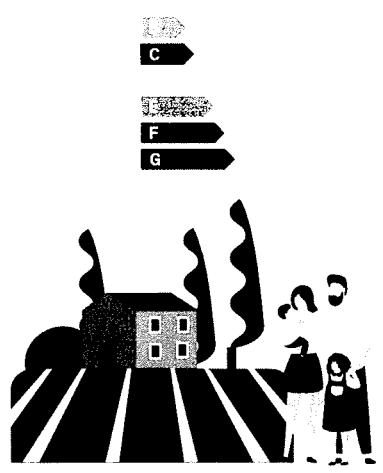
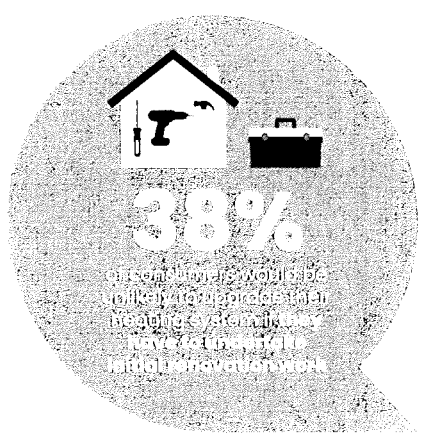


Consumer Acceptability



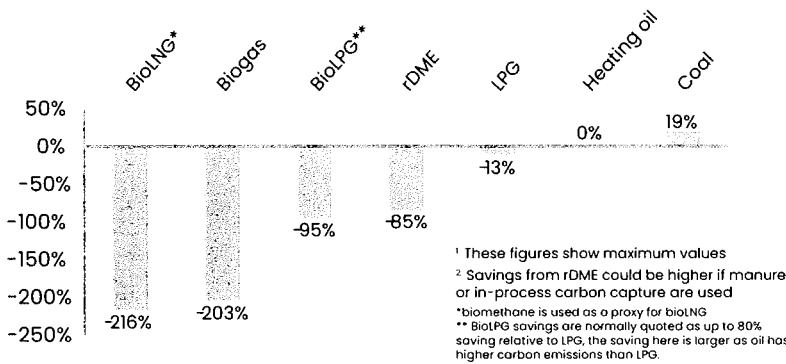
A study by Eurogas suggests that initial renovation work and high upfront expense are the factors that have the highest influence on consumers that will make them unlikely to upgrade their heating system¹⁰. **Renewable gases such as bioLPG, rDME and biogas can provide an easy decarbonisation solution for consumers.** BioLPG is a drop in fuel for current LPG boilers, while rDME can be used up to a certain percentage blend without any changes to LPG boilers, and with small modifications 100% rDME can be used. Keeping existing heating systems makes it convenient for consumers to opt for solutions that are increasingly renewable and lower carbon.

Factors That Make Consumers Unlikely To Upgrade Their Heating System (Average % of Countries Surveyed)



¹⁰ Eurogas (2019) Energy Survey 2019

Greenhouse Gas Emission Saving Relative to Oil^{11,12}



Emissions



BioLPG, rDME, biomethane and biogas all have greenhouse gas emissions that are **significantly lower than fossil fuels** at a reduction of up to 95%¹³, 85%¹⁴, 216%¹⁵ and 203%¹⁶ respectively depending on the feedstock used.

PM_{2.5}



In 2019, 307,000 premature EU deaths were attributed to fine particulate matter (PM_{2.5})¹⁷. The PM_{2.5} emissions of renewable gases per unit of energy are around 37% less than oil and 99% less than coal.¹⁸

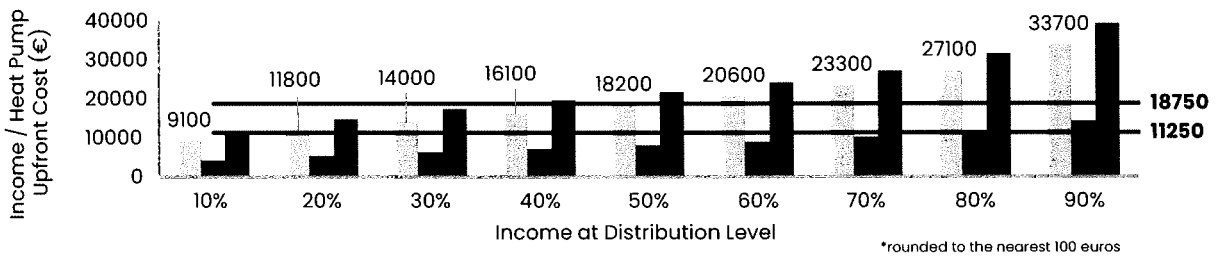
Affordability



Costs of renewable gases are generally lower than fossil fuels, but the high variability of the price of natural gas and the high price of electricity in some regions may impact the affordability of renewable gases. However, the price of natural gas is expected to decrease in the long term, and the price of electricity is expected to increase.

While natural gas prices are expected to decrease, electricity prices are expected to increase. This may impact the affordability of renewable gases, as electricity is used in the production of renewable gases. However, the price of natural gas is expected to decrease in the long term, and the price of electricity is expected to increase.

Significant Proportion of Households Cannot Afford Heat Pumps*

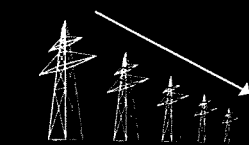


Income EU Income Poland Income France Heat Pump Capex Min Heat Pump Capex Max

System Benefits



Flexibility of renewable gases is much easier to manage than renewable electricity due to cheaper storage and more consistent generation.²¹



The use of renewable gases results in **reduced peak electricity demand**²², this significantly reduces power grid reinforcement and dispatchable power costs.



Hybrid systems help balance peak demand on the electricity grid. They can be installed with less requirement for electricity grid or radiator upgrades and the low carbon heating system can be installed before insulation upgrades.²³



Off-grid renewable gases can be **produced locally** reducing energy distribution requirements.

^{11,17} European Environment Agency (2021) Air Quality in Europe 2021

^{12,18} NAEI (2020) Emission factors detailed by fuel and source

¹³ Cedelft (2021) Emissions of (bio)LPG and other energy carriers in domestic heating, BBQs and forklift trucks

¹⁴ SHV Energy (2022) Renewable DME

¹⁵ JRC (2017) Solid and gaseous bioenergy pathways: input values and GHG emissions

¹⁶ Bilans Ges (2022) Direct Emissions and Upstream Fuels

¹⁹ European Commission (2018) Decentralised heat pumps: system benefits under different technical configurations

²⁰ Income deciles are 9 income figures that divide the population into 10 equal sized groups, the first decile represents the poorest 10% of the population.

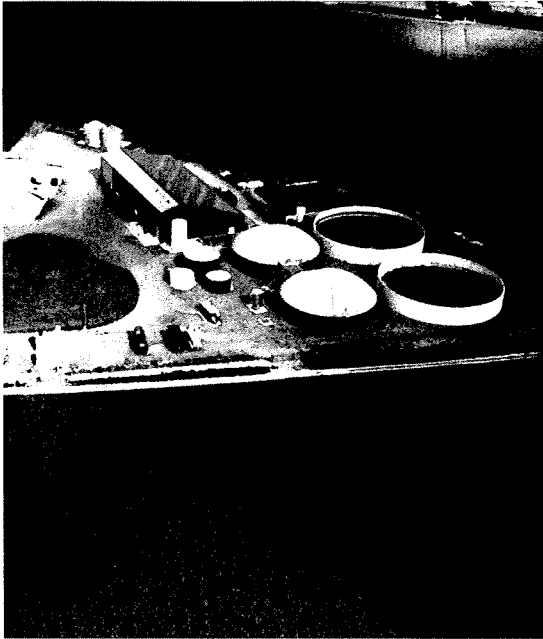
²¹ Eurostat (2022) Income Distribution by Quantiles

²² Imperial College London (2020) The flexibility of gas: what is it worth?

²³ Entso-g & Entso-e (2020) Scenario Results

²⁴ Energy (2016) Electricity, gas, heat integration via residential hybrid heating technologies





Biogas Supporting Sustainable Energy Production and Smart Community Building

Biogas production from agricultural waste and manure provides a sustainable energy source. A biogas plant in the Netherlands produces 100,000 m³ of biogas per year, which is used for energy production.

The biogas plant also produces digestate, a nutrient-rich fertilizer that is used on local farms. This creates a circular economy where waste is turned into energy and fertilizer, supporting local agriculture and energy production.

The biogas plant also produces electricity, which is used to power the local community. This helps to reduce the carbon footprint of the community and supports sustainable energy production.

The biogas plant also produces heat, which is used to warm the local community. This helps to reduce the carbon footprint of the community and supports sustainable energy production.

BioLPG For Hard-to-Treat Rural Homes



Over a quarter (26%) of Germany's population live in rural areas; of these homes, 25% use heating oil.

Installing a bioLPG ready boiler, alongside thermal insulation would result in:



BioLPG Supporting Net Zero Targets of a Cosmetic Industry



La Roche-Posay, offering innovative skincare solutions for fragile skin, became the first industrial site in France to use bioLPG in 2018.

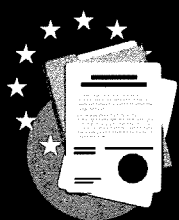
This was a simple transition, as the product has no impact on the performance of their manufacturing activity and is easily incorporated into the distribution network of Primagaz France.

In 2005, the La-Roche-Posay site was producing 192tCO₂ per year, which fell to zero in 2019 – with bioLPG being the last step towards carbon neutrality on the industrial site.²⁶

^{24, 25} EBA (2020) Biogas Success Stories 2020

²⁶ Liquid Gas Europe (2019) Beyond the Gas Grid: Residential and Industrial Case Studies

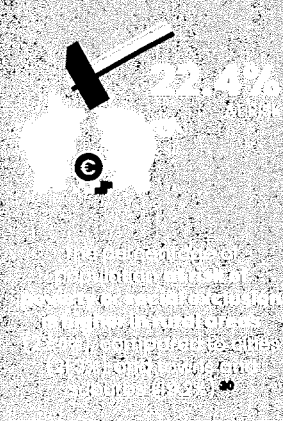
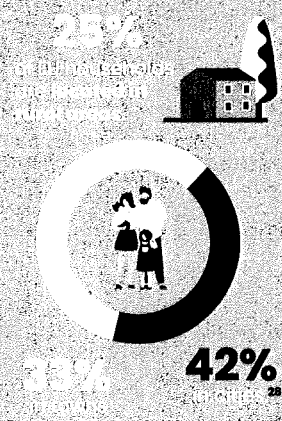




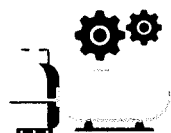
Policy Landscape

The EU has a target of a **55% reduction in greenhouse gas emissions by 2030** and a net zero ambition by 2050. It is critical that the legislative frameworks and associated policies enable a Just Energy Transition where no one is left behind. Solutions that are available, easily deployable, cost effective and socially acceptable will be needed to achieve ambitious climate targets, and in view of rising energy security concerns it is equally important to consider solutions that ensure supply security and energy system resilience. **The role of off-grid renewable gases is critical in this respect as they can facilitate the sustainability journey of communities in rural areas** that often do not have the luxury to choose from many sustainable alternatives that are cost effective as well as lower carbon.

Rural Areas Require Attention

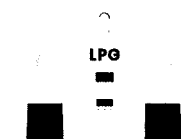


Policy Recommendations



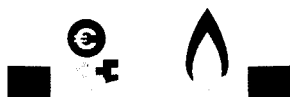
Recognise all Renewable Gas Production Pathways

All renewable gas production pathways and related technologies should be recognized in policy frameworks to support their development and uptake. This will help to diversify supply, ensure supply security and maximise production. Renewable gases can be produced through a host of technologies such as hydro-treatment of vegetable oils, fermentation, gasification, pyrolysis, anaerobic digestion, etc.



Support Renewable Ready Gas Boilers

Policies should support the use of gas boilers that can operate on renewable gases. Hybrid solutions must also be considered where gas boilers are combined with heat pumps or solar thermal units and can offer flexibility and resilience to the energy system on top of GHG emission reduction benefits. It is important that efficient renewable ready gas boilers are recognized as an energy efficiency measure in building regulations and energy performance certificates.



Develop Markets for Renewable Gases

Financial incentives in the form of tax rebates, capital grants and fuel subsidies should be deployed to encourage switching to all renewable technologies including renewable gases. Renewable gases that are produced off-site must be allowed to contribute to zero-emission buildings. Renewable gases use the existing infrastructure in achieving decarbonisation objectives and therefore can make the energy transition cost-efficient and affordable for end consumers. Intelligent policy design is needed to make sure that incentives for renewable liquid and gaseous fuels in one sector do not artificially raise their price in other sectors.



Facilitate Consumer Choice

There is no 'one size fits all' solution, certainly not for heat decarbonisation. Consumers should be made aware of possible options for decarbonising heat, including the benefits of using renewable gases in their current heating system. Policies should not pick favourites but instead should help guide consumer choices and help them decide what fits their needs while remaining aligned with our collective climate goals.

²⁷ Eurostat (2022) Number of households by degree of urbanisation
^{28, 29, 30} EU Commission (2021) A long-term vision for the EU's rural areas

