EBA European Biogas Association

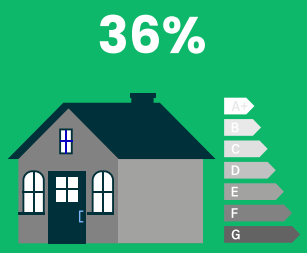
Liquid Gas Europe

The Strategic Role of

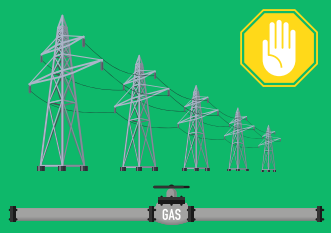
Off-Grid Renewable Gases

Challenges of Off-Grid Decarbonisation

There are **49.2 million rural households in the EU**[1] and most of them are **not connected to a gas grid.** These buildings primarily use fossil fuels for heating, these are generally higher carbon fossil fuels.[2]

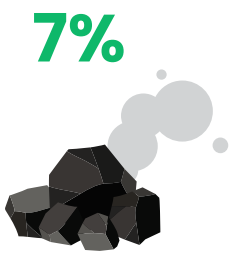


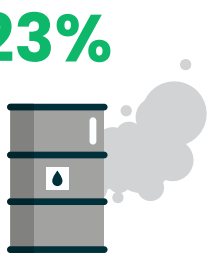
Rural building stock is often old, 36% of building stock in the EU was built **before the first thermal regulations in 1970s.**[3]



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

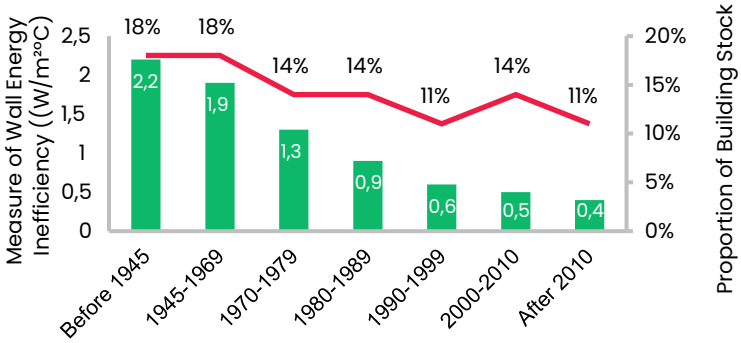
Heat demand varies significantly more than renewable electricity generation throughout the year. Electrification requires constant balancing of supply and demand which will be challenging to meet with intermittent renewable energy.



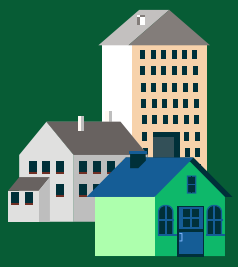


7% of off grid homes **heat with coal**[3] and a further 23% **with fuel oil**[3]. These fuels have high air pollution and greenhouse gas emissions.

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 above[5], 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 grid[3]. These fuels have high carbon and air pollution emissions.

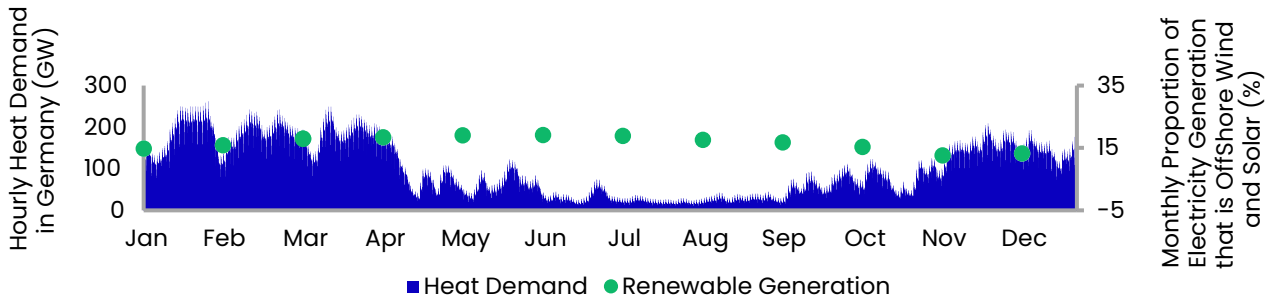
Different buildings and consumers require different energy solutions suited to their needs and circumstances, as there is no 'one size fits all' solution. Consumers should be provided with a choice to ensure rapid decarbonisation and a just energy transition.

[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

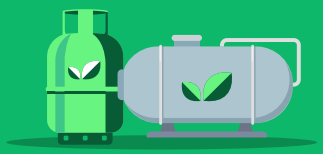
Energy Security and Flexibility

Heating demand varies significantly throughout the year with much higher winter consumption than in summer, as shown on the graph for Germany below[6]. 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 reliability[7]. 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

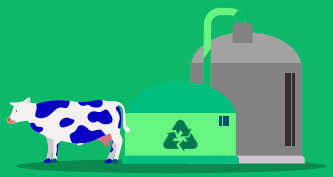


What Are Off-Grid Renewable Gases?



BioLPG

Chemically identical to conventional LPG, bioLPG is a drop-in solution which can be produced from **sustainable feedstocks** such as plant and animal waste materials, vegetable oils, and biogas, and can be used in existing LPG infrastructure and appliances.



Biogas

Biogas is produced through the **decomposition of organic matter** (such as agricultural wastes, manure and sewage sludge) and can be used as a fuel in vehicles and in typical gas appliances to provide heat and power.

BioLNG

Is produced by **separating methane and other critical components from biogas** to bring it to a methane content **similar to that of natural gas**, and subsequently liquefied.

rDME

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 liquefied 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

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Key Benefits of Off-Grid Renewable Gases

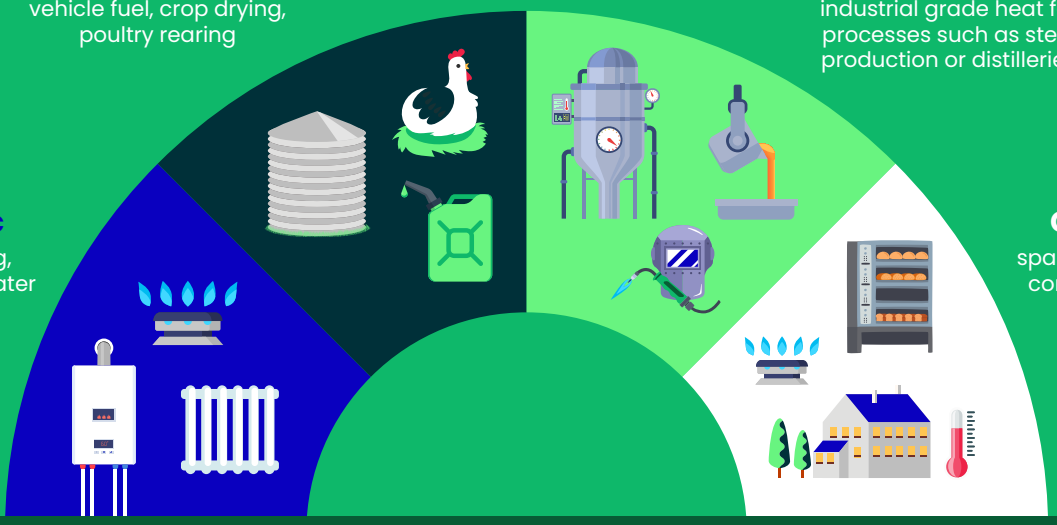
Applications of Renewable Off-Grid gases

Agriculture
vehicle fuel, crop drying, poultry rearing

Industry
industrial grade heat for processes such as steel production or distilleries

Domestic
space heating, domestic hot water and cooking

Commercial
space and hot water for commercial buildings e.g. rural hotels



Consumer Acceptability

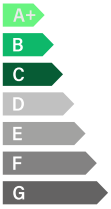
A study by Eurogas suggests that initial renovation work and high upfront expense are the factors that have the highest influence on consumers that will make them unlikely to upgrade their heating system[10]. **Renewable gases such as bioLPG, rDME and biogas can provide an easy decarbonisation solution 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. Biogas, bioLPG and rDME are also a good fit for combined heat and power technologies (CHP) and biomethane can be used directly in existing gas boilers. 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)

38%

of consumers would be unlikely to upgrade their heating system if **they have to undertake initial renovation work**

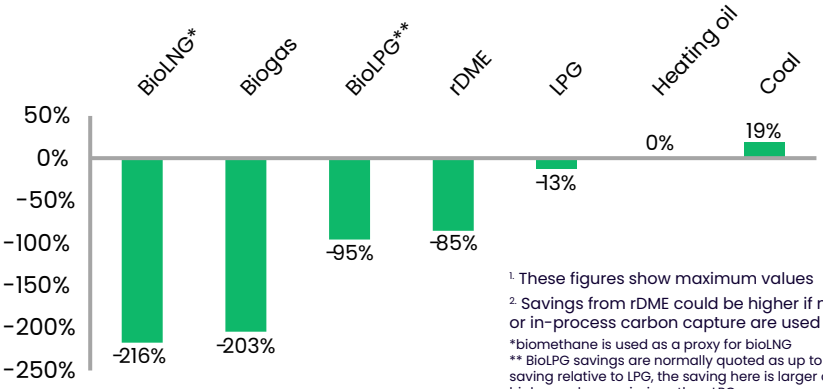


36%

of consumers would be unlikely to upgrade their heating systems if **they have to pay an upfront expense.**

[10] Eurogas (2019) Energy Survey 2019

Greenhouse Gas Emission Saving Relative to Oil[11,12]



1. These figures show maximum values
2. Savings from rDME could be higher if manure or in-process carbon capture are used

*biomethane is used as a proxy for bioLNG
** BioLPG savings are normally quoted as up to 80% saving relative to LPG, the saving here is larger as oil has higher carbon emissions than LPG.

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.

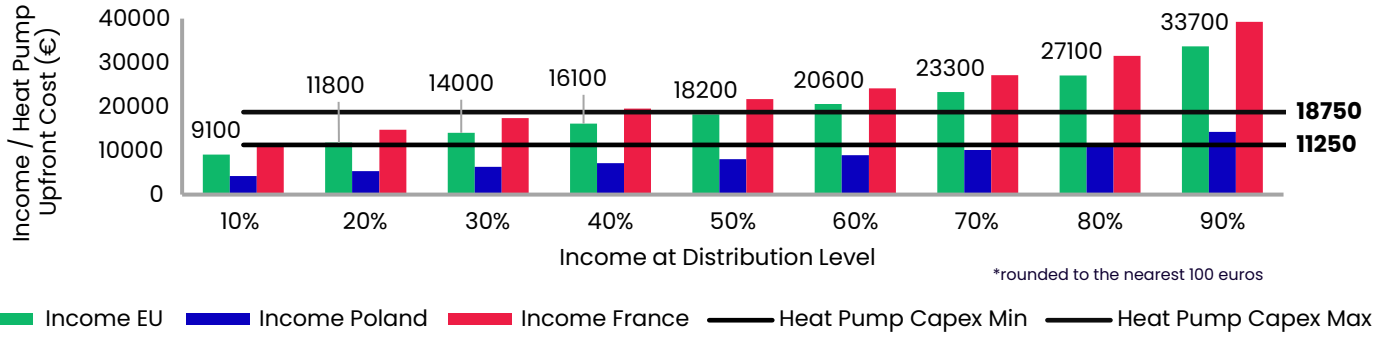
In 2019, 307,000 premature EU deaths were attributed to fine particulate matter ($PM_{2.5}$)[17]. The $PM_{2.5}$ emissions of renewable gases per unit of energy are around 37% less than oil and 99% less than coal.[18]

Affordability

Gas boilers which can run on renewable liquid gases are roughly **a quarter of the investment cost of heat pumps and even cheaper compared to biomass boilers**, making them more affordable for households and business with low levels of disposable income[19].

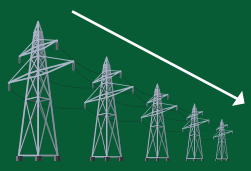
While heat pumps are an efficient technology, for many the higher costs are prohibitive. The chart below illustrates this by comparing annual income deciles[20] with heat pump capital costs, for example 50% of people in the EU earn less than €18200. This means that for 50% of the EU, annual incomes could be lower than the upfront cost of a large heat pump. The installation of a heat pump would require years of saving for even high-income households to be affordable without a subsidy or loan. Heat pumps are assumed to have a thermal capacity between 15kWth and 25kWth.

Significant Proportion of Households Cannot Afford Heat Pumps*



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. Eurostat (2022) Income Distribution by Quantiles
[21] Imperial College London (2020) The flexibility of gas: what is it worth?
[22] Entsog & Entsoe (2020) Scenario Results
[23] Energy (2016) Electricity, gas, heat integration via residential hybrid heating technologies

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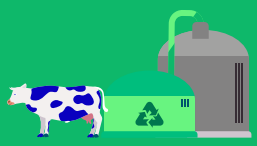
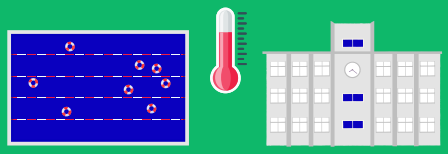
Biogas Supporting Sustainable Dairy Farming and Green Community Building



A 499 kWe AD plant in western France **combines the effluents from 12 farms** located less than 8 km away to produce energy for the local area.

The biogas produced by the AD facility is **used as fuel for hay and cereal drying as well as cogenerator fuel** which provides electricity and heat.



The 1,500 MWh/year of heat generated feeds into a community heating network, providing **heat for the local swimming pool, secondary school and communal buildings**[24]. Image copyright Déméter Energies.

BioLPG For Hard-to-Treat Rural Homes

26%

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:

90%

annual CO_2 savings of 63%, rising to **90% when using bioLPG.**

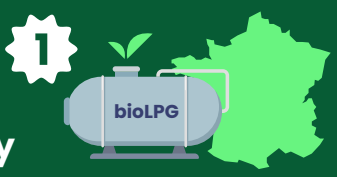
68% **66%**

68% NOx savings and 66% PM emissions savings.

€933

€933 annual energy bill savings and a capital cost back period of 8.4 years.[25]

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 192tCO_2 per year, which fell to zero in 2019 – with bioLPG being the last step towards carbon neutrality on the industrial site.[26]

[24,26] EBA (2020) Biogas Success Stories 2020
[25] 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

83%

Rural areas **represent 83% of EU territory**, and include 25% of all households in the EU which equates to 49.2 million households these are often not connected to the grid.[27]

25%

of EU households are **located in rural areas.**

33% in towns & suburbs.

42% in cities.[28]

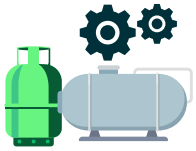
GDP

GDP per head in rural regions is lower than urban regions at 75% and 125% of the EU average respectively.[29]

22.4% AT RISK

The percentage of population **at risk of poverty or social exclusion is higher in rural areas** (22.4%), compared to cities (21.3%) and towns and suburbs (19.2%).[30]

Policy Recommendations



Recognise all Renewable Gas Production Pathways

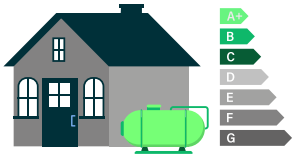
All renewable gas production pathways and related technologies should be recognized in policy frameworks to support their development and uptake. This will help to diversify supply, ensure supply security and maximise production. Renewable gases can be produced through a host of technologies such as 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

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