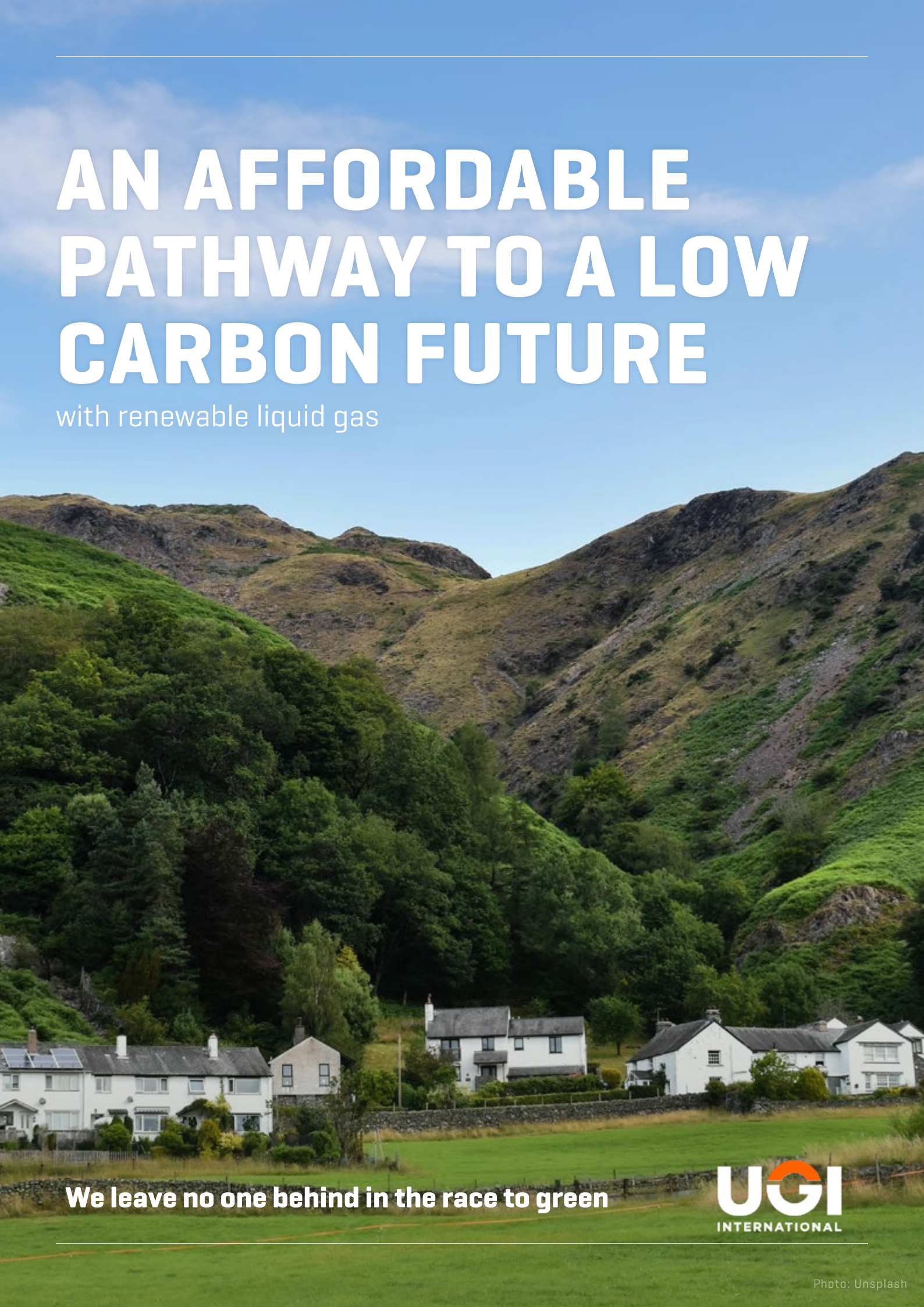
AN AFFORDABLE PATHWAY TO A LOW CARBON FUTURE

with renewable liquid gas



We leave no one behind in the race to green

UGI INTERNATIONAL

Photo: Unsplash



UGI Roadmap 2030

We have the ambition to reduce the carbon footprint of our energy products by 50 per cent from our current (2020) levels of emmissions. This is to be done by 2030. At the same time, we are setting the foundation for a 100 per cent carbon-neutral future by 2050 at the latest.

Photo: Unsplash

UGI ROADMAP 2030

Multiple pathways to a more climate friendly heating future

Buildings produce about 25 per cent of the European Union's (EU) total greenhouse gas (GHG) emissions. Therefore, it is natural to look at reducing CO2 emissions from the energy we use to heat our homes, schools, companies, hospitals, and other buildings.

Today, LPG (Liquefied Petroleum Gas) covers the heating needs of more than 20 million[1] EU citizens. Many of these people are in rural parts of Europe. If we are to reach the goal of the green transition, we must leave no one behind.

We take great pride in the fact that our customers rely deeply on our ability to provide a renewable and affordable anternative to LPG. Therefore we focus on heating and the conditions where renewable liquid gas is a more affordable and climate-friendly alternative to other low carbon solutions.

We recognise that a low carbon heating future relies predominantly on the principle of electrification.
However, electrification is not a cost-effective solution in all cases. This fact is particularly apparent for homes and businesses off the gas grid for example for properties built in the first half of the 20th century or before. Therefore, we must move forward in the green transition with a technology-neutral approach allowing the best alternative to fossil fuels to be implemented. There are cases where renewable liquid gas is the most economically viable and climate-friendly solution.

A sustainable future with renewable liquid gas

The current climate crisis calls for renewable solutions. That is why we focus our investment efforts on replacing our fossil fuel products with renewable liquid gases such as BioLPG and rDME.

Already today, LPG offers a lower carbon alternative to oil and natural gas because our conventional LPG emits 35 per cent less CO2 than coal and 12 per cent less CO2 than oil.
Today LPG covers the heating needs of more than 20 million EU citizens. Many of these people are in rural parts of Europe, without access to a power or gas grid. The production of renewable liquid gas is expected to increase rapidly in the coming years. When we look at the use of renewable liquid gas in heating the conclusion is clear: renewable liquid gas is an affordable pathway to decarbonise the heating of homes and businesses across Europe.

What is renewable liquid gas?

Renewable liquid gas is a liquid fuel which resembles the same chemical and energy content as LPG and can be used as a drop in fuel. It is, however, produced through technology pathways that utilise renewable feedstocks, thus meaning it has a low carbon content when compared to conventional LPG.
UGI International has prioritised three technology pathways, as follows:

Renewable Dimethyl Ether (rDME): Renewable Dimethyl Ether (rDME) produced from organic matter is a sustainable renewable liquid gas with up to 85 per cent lower greenhouse gas emissions than fossil alternatives. rDME can be produced from sustainable feedstocks such as waste and residues, using gasification and catalytic synthesis.

Alcohol to Hydrocarbon: Renewable liquid gas from advanced bioethanol (Gen 2) derived from waste and residues.

Power to X: Power to X-technology combines captured CO2 and renewable hydrogen (made by electrolysis of water using excess renewable power) and converts to methanol or an intermediate molecule, this in turn can be made into renewable liquid gas or eFuel.

[1] www.liquidgaseurope.eu/publications/biolpg-2050-pathway-report

With our Roadmap 2030, we will be able to serve our customers with a renewable alternative to conventional LPG

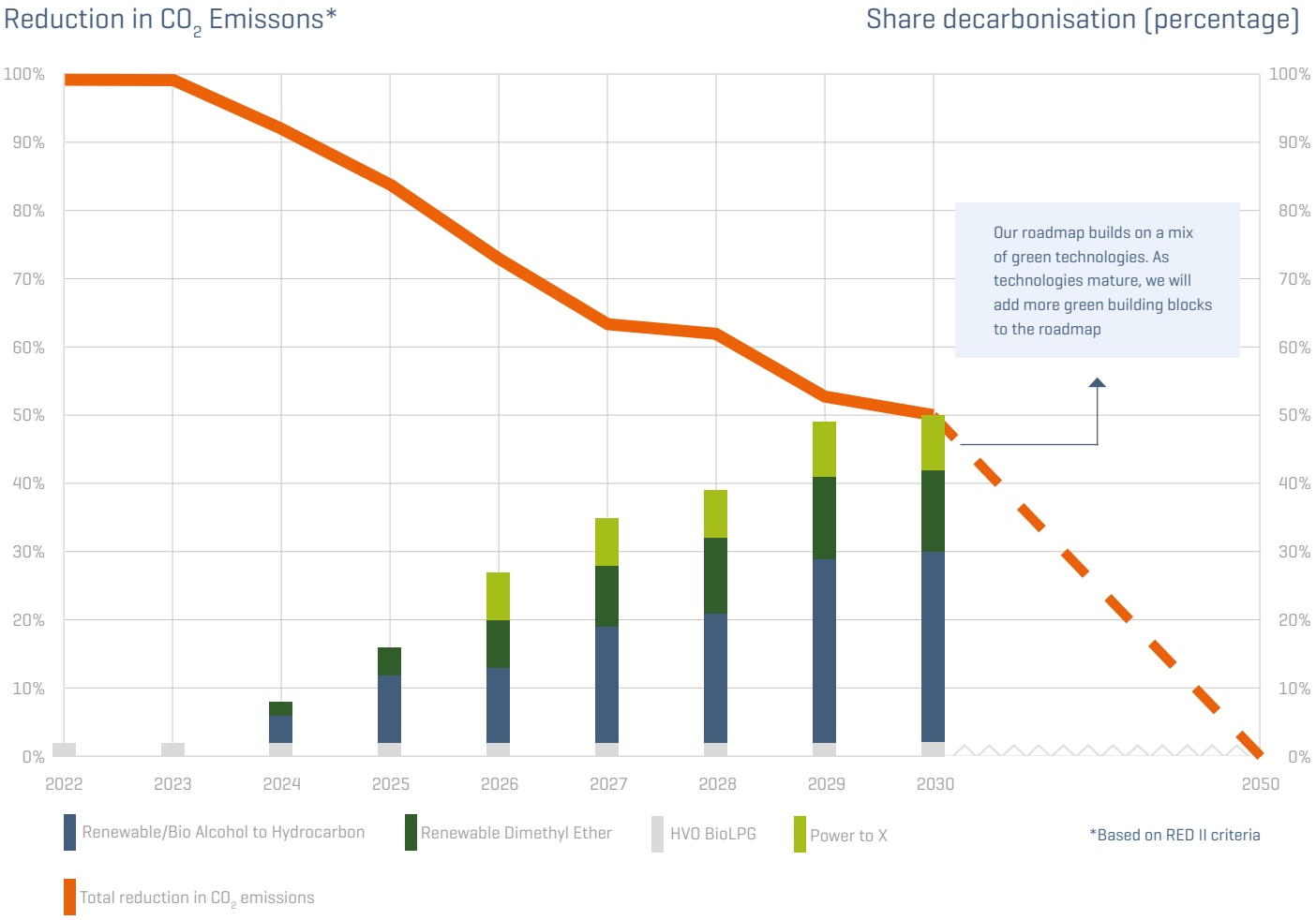




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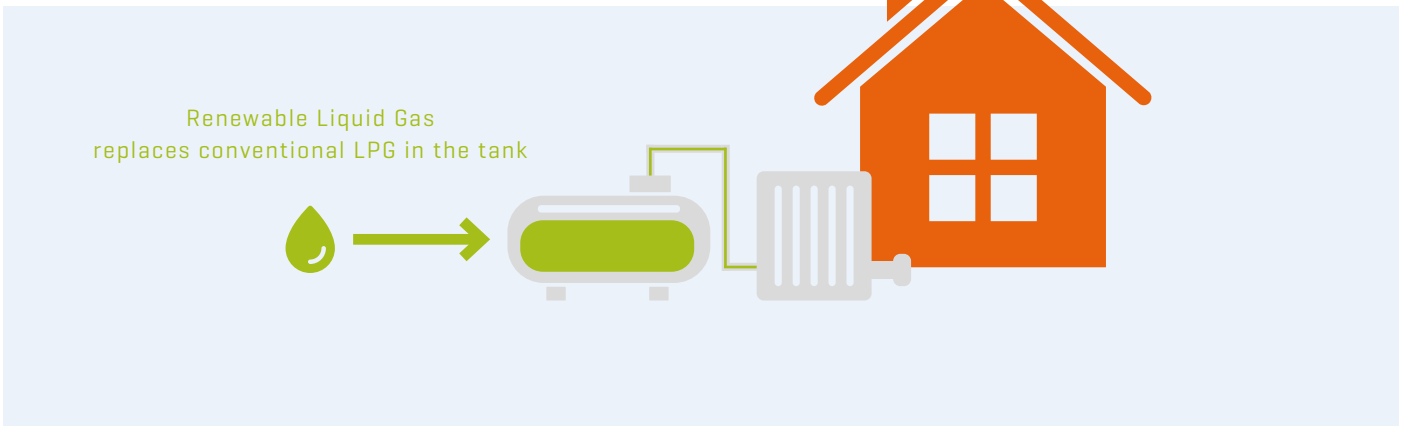
Renewable liquid gas is a drop-in solution, which means that existing boilers and heating equipment can be re-used, thus avoiding extensive new investments.

The use of renewable liquid gas in heating

LPG is used in industrial processes and for heating households and business buildings that are not connected to the gas grid. Normally, LPG is used in a 'wet' heating system. LPG is used to heat water boilers, providing central heating through radiators and hot water. It can also be used in direct air heaters and other methods of heating, particularly in industrial applications. Renewable liquid gas is a drop-in solution, which means existing boilers and heating equipment can be re-used, thus, avoiding new investments and potential installation disruptions. Furthermore, it is possible to mix renewable liquid gas with conventional LPG, allowing a smooth transition towards decarbonising heating homes across Europe.

CO2-reductions from the shift from oil to LPG and renewable liquid gas.





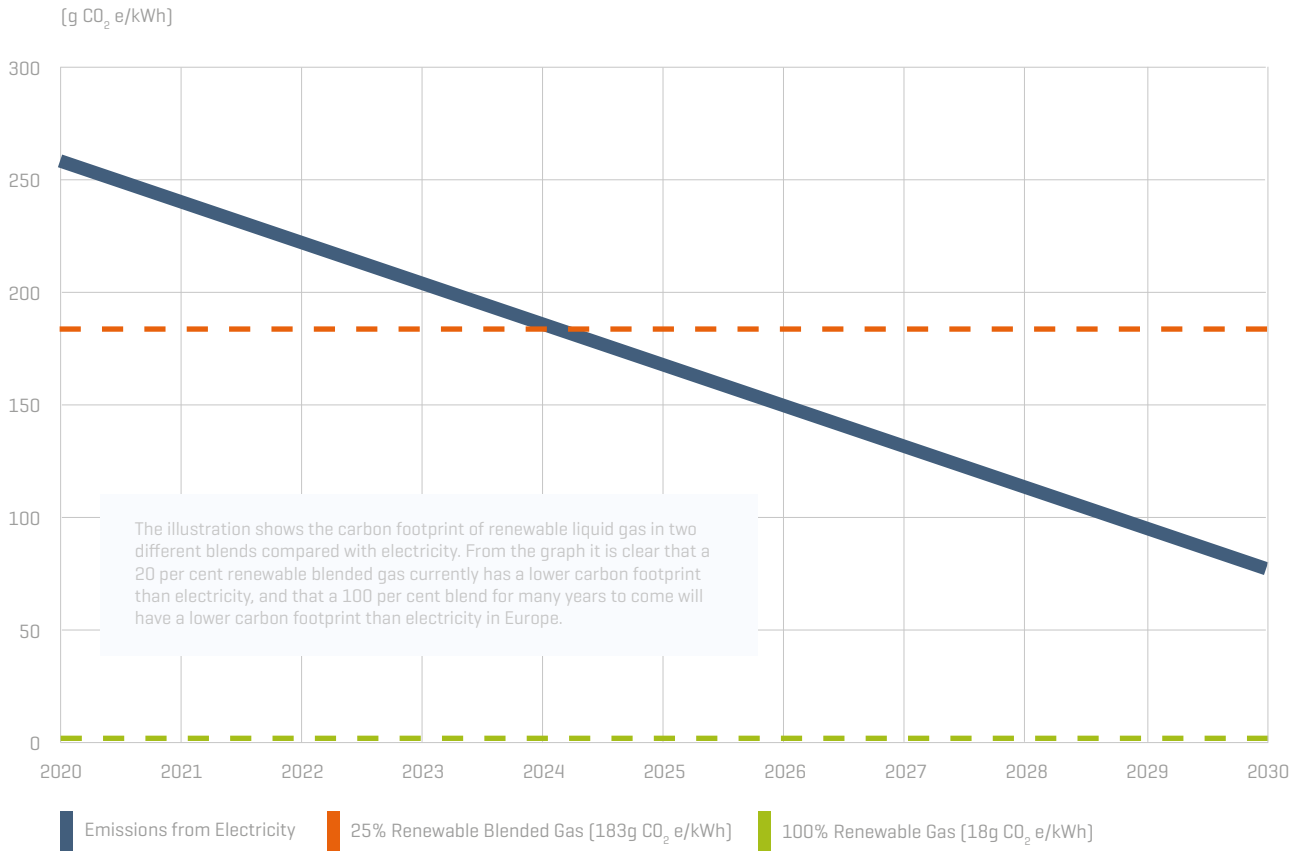
Decarbonisation of heating in Europe

Our ambition is that in 2030, 25 per cent of the energy content of the total product delivered to our customers across Europe will be from renewable liquid gases leading to a 50 per cent emission reduction. This goal, in turn, will lead to a lower carbon intensity of the liquid gas being used across Europe.

When comparing the decarbonisation progress we will deliver by converting to renewable liquid gas, it is necessary to compare with the level of decarbonisation across Europe. These levels vary considerably. Poland, for instance, depends on coal for around 70 per cent of its energy needs, and in France, 70 per cent of the electricity derives from nuclear energy. Therefore, when you compare between countries, the near-term impact differs due to the varying carbon intensity of the different energy systems. Because of these differences, the affordability and the level of decarbonisation vary among heating alternatives reliant on electricity.

In the next decade, renewable electricity will play an increasingly more significant role in the energy supply across Europe. The CO2 emissions will decrease with the electricity being produced at wind farms and solar panels. Nevertheless, there will still be variations across Europe and a part of the energy supply will be based on fossil energy.

Carbon footprint of electricity and renewable liquid gas in Europe 2020 - 2030[2]



To calculate the bioLPG factor 48 g/kWh, it is assumed that 25% comes from HVO production and gives 18 g/kWh (data from LiquidGas UK), 25% comes from rDME production with 32 g/kWh, and that 50% is mixed with a product of 69g/kWh, that specifically fulfills criteria of sustainability.

[2] https://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production-3/assessment-1

FOUR CASE STUDIES

To demonstrate the affordability of renewable liquid gas versus other pathways to a low carbon future, we have analysed the relative life cycle costs between renewable liquid gas and four other technologies and in four different target European markets: France, Italy, Poland and United Kingdom.

In order to make a fair comparison between renewable liquid gas and the other technologies we have included a full view of costs including; the capital for the equipment, the installation and rennovation costs and the fuel costs - all of which vary depending upon which low carbon heating system you select. The calculations for the study were made over April to June 2021

Technologies included in the analysis are:

- **Boiler consuming renewable liquid gas**
- **Air source heat pumps**
- **Ground source heat pumps**
- **High-temperature heat pumps**
- **Wood pellet boiler**

The case studies show that renewable liquid gas is a more affordable pathway when compared to these other low carbon heating solutions, underlining that a technology-neutral approach to decarbonisation in heating is the recommended way forward.

When we exclude boiler replacement and subsidies, our analysis shows that the abatement cost – the cost of reducing greenhouse gas emissions – on average, is ten times lower than the alternatives analysed. In Poland, the abatement cost with renewable liquid gas is more than 37 times lower than the alternative.

Replacing conventional LPG with renewable liquid gas does not require new installations or modifications to the storage, distribution, and combustion technology.

In comparison, heat pump technology is a technology that requires investments and a significant cost of installation and renovation.

“Case studies show that renewable liquid gas, when compared to these other low carbon heating solutions, is a more affordable pathway, underlining that a technology neutral approach to decarbonisation in heating is the recommended way forward.



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Air Source Heat Pumps

All heat pumps use electrical energy to drive their operations and rely upon a strong and reliable electricity network. Air Source Heat Pumps (ASHP) use heat exchange processes with the outside air to create the temperature difference. But this kind of heat pump cannot always guarantee the heat requirements, especially in some cold areas. They also have a low energy efficiency index. The abatement cost of an ASHP is directly dependent on the source of electricity generation. For instance, in Italy, where over 60 per cent of the electricity produced still comes from natural gas, the use of ASHP has a high cost of CO_2 reduction.

High-Temperature Heat Pumps

High-temperature heat pumps (HTHP) use water as a thermal carrier and achieve higher efficiency indexes than ASHP and adequate thermal performance at low temperatures. However, the systems become more complex, and the capex increases because of the required installation and renovation costs.

Ground Sourced Heat Pumps

This complexity is also the case with ground sourced heat pumps (GSHP). GSHP rely on the fact that the earth (beneath the surface) remains at a relatively constant temperature throughout the year. The heat pump transfers heat stored in the earth or ground-water into a building during the winter and transfers it out of the building and back into the ground during the summer using buried pipes.

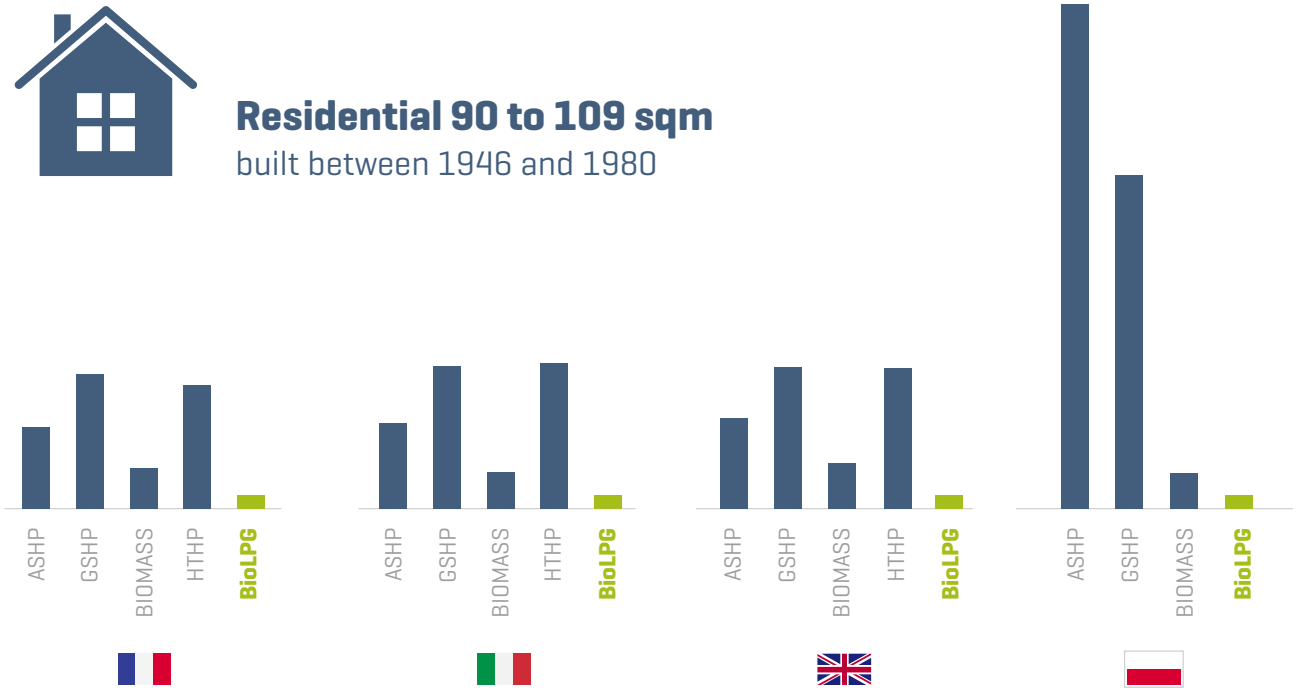
Biomass Pellets

Though the abatement cost of biomass (pellets) is relatively low compared to heat pumps, the abatement cost is still more than two times higher than renewable liquid gas. Furthermore, the combustion of any biomass, even certified, is imperfect combustion that generates particulate matter, benzo-a-pyrene and NOx, all substances highly harmful to human health. Therefore, it helps minimise air pollution.



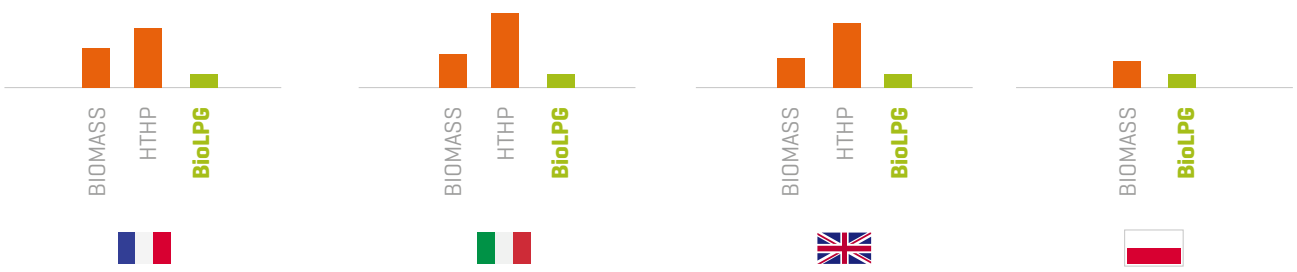
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Residential 90 to 109 sqm
built between 1946 and 1980



Abatement cost comparison on the residential segment, for a 90 to 109 sqm house, built between 1946 and 1980. CO2 abatement cost (EUR/t; TCO) 10 years; without boiler replacement and subsidies.

Industrial (6-40T per year)
built between 1946 and 1980



Abatement cost comparison on the industrial segment, for a 6-40T production per year, built between 1946 and 1980. CO2 abatement cost (EUR/t; TCO) 10 years; without boiler replacement and subsidies.

CASE STUDY: ITALY



Italy has one of the largest natural gas networks in Europe, and around 80 per cent of the Italian households and businesses are connected to the natural gas networks. Therefore, a majority of Italian households and business are heated with natural gas.

However, the natural gas network has reached its saturation in the coverage rate of civil and industrial customers as Italy has a geography with many mountainous and rural areas. In these areas, the methane networks do not have further expansion facilities because of population density and orographic reasons.

Except for Sardinia, most off-grid households and small industries are located in the Alps or the mountain areas of the Apennines. Off-grid users have an energy requirement in these mountainous areas that cannot be satisfied solely with electrification, even if supported by solar panels and storage systems.

Today, about seven million Italian households and businesses are heated by LPG. Our analysis shows that the costs of reducing greenhouse gas emissions with the use of renewable liquid gas (without the distortion of state incentives and without the costs of replacing the boiler) are by far the lowest, compared to both the costs of heat pumps and the costs of biomass.

Infographic: CO2 abatement cost [EUR/ t; TCO 10 y; without boiler replacement and subsidies]



CASE STUDY: UNITED KINGDOM



In the United Kingdom, around 4 million homes are not connected to the gas grid, and roughly 1.5 million of these use oil for heating: an energy source that produces high levels of greenhouse gas emissions and significantly worsens air quality.

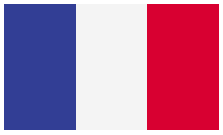
As lower carbon alternatives to heating oil, electrification and heat pumps have been preferred for off-grid homes and businesses. For properties or applications not suitable for heat pumps, solid biomass (i.e. pellets) has been the preferred alternative.

As LPG is increasingly being replaced with renewable liquid gases such as BioLPG and rDME, it is more relevant than ever to analyse the competitiveness of renewable liquid gases for those buildings and other hard-to-treat applications.

Our analysis shows that the abatement cost of renewable liquid gas is by far the lowest among the five alternatives analysed, almost 30 per cent of biomass on average and much below heat pump solutions.



CASE STUDY: FRANCE



In France, approximately one third of the homes are heated with heating equipment supplied with electricity. Another third of the homes are heated with natural gas. And the last third of the homes in France are heated with other energies such as biomass, Fuel Oil and LPG. The use of LPG in heating in France is limited to around 2 per cent of the homes.

With the recent French law on climate (Loi climat et Resilience), France has set an objective to reach 40 per cent of renewable energy in the energy mix by 2030. Today, public incentives give strong advantages to heat pumps, solar installations, and biomass.

As LPG increasingly will be replaced with renewable liquid gases, we have analysed the competitiveness of renewable liquid gases in France. When we compare the abatement cost of different renewable alternatives without subsidies and replacement of boilers, renewable liquid gas is by far the cheapest way to reduce emissions from heating in France.

The reason for this is primarily the fact that renewable liquid gas requires no investments. The boiler does not need to be replaced when switching to renewable liquid gas. Furthermore, upgrading the electrical grid and integrating new centralised electrical production sources to supply basic consumers will necessarily lead to an increase in the cost of electricity, making decarbonised alternatives (such as liquid biogas) competitive.



CASE STUDY: POLAND

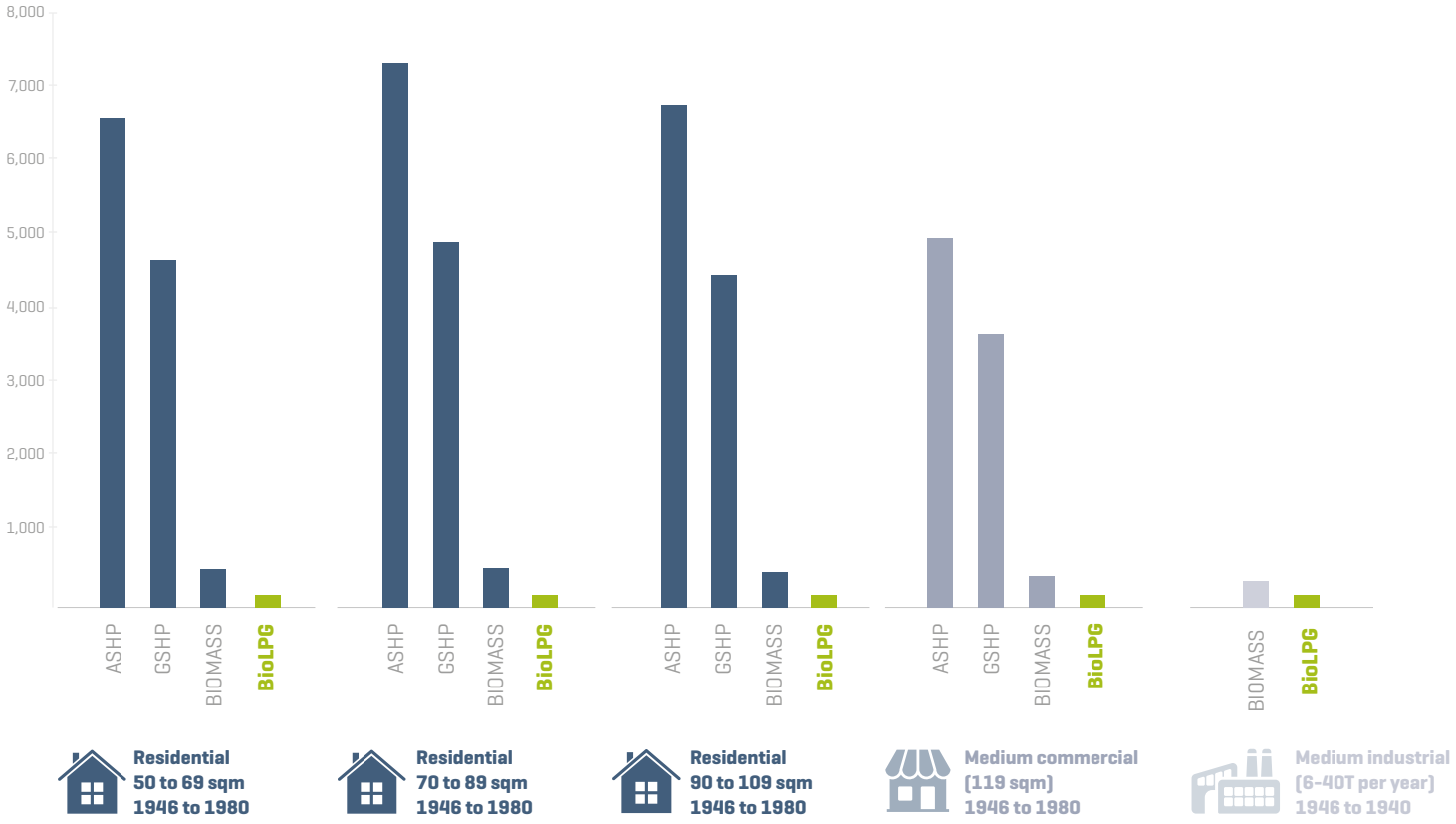


Around 70 per cent of single-family homes in Poland are heated with coal. This amount equates to around 3.5 million coal-fired boilers. Most of these homes (about 3 million) are heated by manually fed coal boilers that are technologically outdated, inefficient, and responsible for high carbon emissions and air pollution[3].

The energy policy in Poland is undergoing a shift from solid fossil fuels to more climate-friendly solutions. Thus, a program with mandatory switching out from off-class fossil heating systems (coal) has been put in place. The goal of the program is to make climate-friendly solutions affordable to end-users by state support. Currently, most climate-friendly solutions are recognised as more expensive in comparison to more traditional solutions.

When looking at the alternatives in our analysis, the CO2 abatement cost of renewable liquid gas is by far the lowest, almost 30 per cent of biomass on average, and much below heat pump solutions.

[3] https://www.liquidgaseurope.eu/images/what-is-lpg/Poland.pdf



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- An affordable pathway to a low carbon future with renewable liquid gas

February 2022

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