

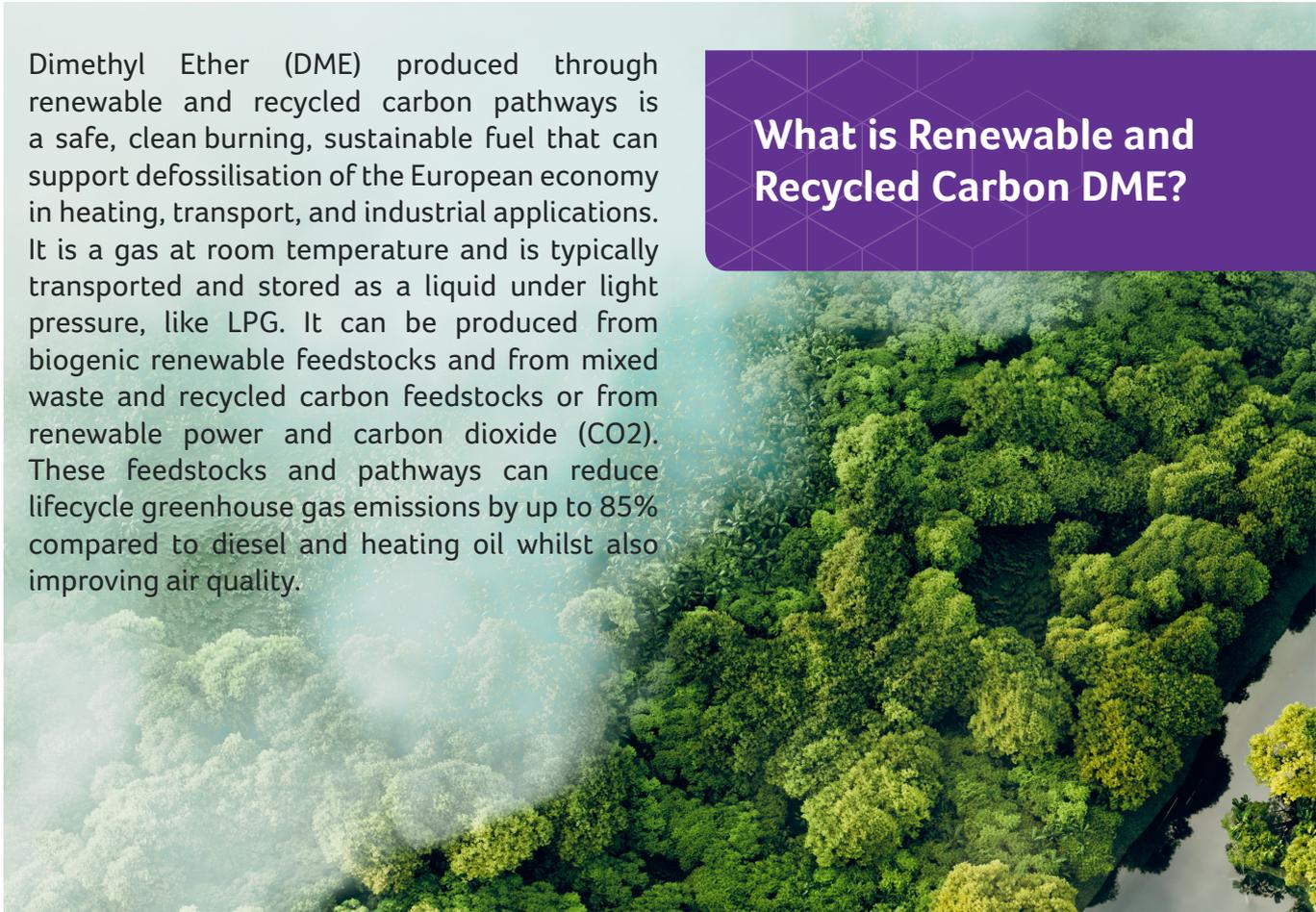


## Meeting Europe's decarbonisation challenge with **Renewable and Recycled Carbon DME**

To reach the 2030 EU climate and energy targets, and achieve climate neutrality by 2050, European citizens urgently need available, clean, and affordable solutions.

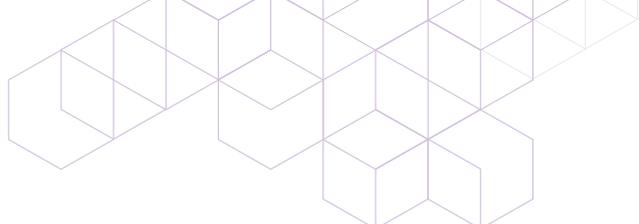
The EU has a responsibility to include all citizens as part of the energy transition and prevent leaving behind vulnerable communities, especially in rural areas, home to more than 130 million Europeans.

Renewable and Recycled Carbon DME offers a viable solution as it can directly contribute to the defossilisation of parts of the transport, residential and industrial sectors. DME can be added to the existing liquid gas supply chain, or used as a stand-alone fuel, making it a versatile and readily available solution to build a greener future for all.



Dimethyl Ether (DME) produced through renewable and recycled carbon pathways is a safe, clean burning, sustainable fuel that can support defossilisation of the European economy in heating, transport, and industrial applications. It is a gas at room temperature and is typically transported and stored as a liquid under light pressure, like LPG. It can be produced from biogenic renewable feedstocks and from mixed waste and recycled carbon feedstocks or from renewable power and carbon dioxide (CO<sub>2</sub>). These feedstocks and pathways can reduce lifecycle greenhouse gas emissions by up to 85% compared to diesel and heating oil whilst also improving air quality.

## What is Renewable and Recycled Carbon DME?



# Use of Renewable and Recycled Carbon DME

Renewable and Recycled Carbon DME can be used directly in boilers, burners or engines, or blended with other liquid gases such as LPG up to 20% mass, with out any changes needed to existing appliances.

## Multiple applications for Renewable and Recycled Carbon DME (blended or 100%)



Renewable and Recycled Carbon DME is a versatile liquid gas that is easy to transport, store and use in many different applications across multiple sectors

### Industry



High-temperature heating used by the industry can be hard to electrify. Renewable and Recycled Carbon DME is an alternative method of defossilising industrial applications. Coal or oil-fired boilers can be replaced with boilers that can use DME or DME blended with LPG.

### Transport



Blended with LPG (up to 20%), DME can also be used to progressively defossilise existing LPG vehicles.

### Domestic and non-domestic heating and cooking

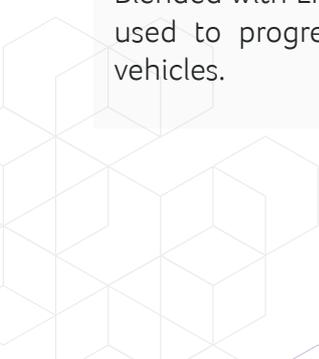


Domestic and non-domestic heating and cooking can be fuelled with a blend of up to 20% Renewable and Recycled Carbon DME with LPG or renewable LPG (rLPG) without needing new stoves or heaters. This “drop-in” blend uses existing infrastructure and appliances, saving cost and making it easy for citizens to adapt.

### Hydrogen carrier



Renewable and Recycled Carbon DME can be transported inexpensively. Because it contains a significant proportion of hydrogen, it can act as an ideal hydrogen carrier. Once transported to its destination it is a relatively simple process to separate this hydrogen and make it available as a fuel.



# Production of Renewable and Recycled Carbon DME

Renewable and Recycled Carbon DME can be produced from a wide range of sustainable feedstocks and technology pathways

## Fuel type

## Pathway



Advanced Biofuel

Renewable Methanol



Catalysis

→ DME



Advanced Biofuel

Agriculture & Forest Residues, Energy Crops, Sewage Sludge & Biogenic Waste



Gasification & catalysis

→ DME



Recycled Carbon Fuel (RCF)

Non-Biogenic Waste



Gasification & catalysis

→ DME



Renewable Fuel of Non Biological Origin (RFNBO)

CO<sub>2</sub> + renewable hydrogen



Catalysis

→ DME

## Sustainable credentials of Renewable and Recycled Carbon DME

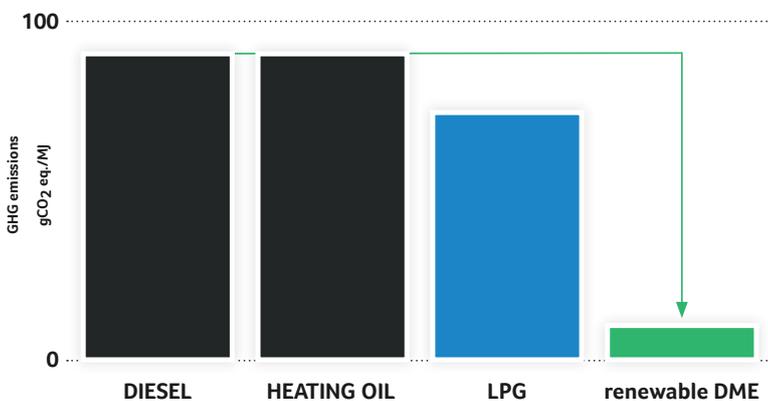
Up to 85% GHG emission reduction compared to diesel and heating oil can be produced from multiple renewable feedstocks including waste streams and residues, with a low GHG footprint



UP TO **85%**

GHG reduction

saving could be higher if manure or in-process carbon capture is used



## Air Quality





## Policy recommendation

Achieving the EU target of a 55% reduction in GHG emissions by 2030 and net zero by 2050 will require deployment of every available form of low or zero carbon energy available. Zero and low carbon gases have an important part to play in decarbonising industrial boilers, building heat, cooking, off-grid power, and heavy-duty transport. These sectors have limited options and the use of Renewable and Recycled Carbon DME will not only reduce greenhouse gas emissions but can leverage the existing fossil gas infrastructure and workforce to reduce the transition costs. To stimulate investments and development of future projects in renewable liquid fuels and Renewable and Recycled Carbon DME the European policy framework should:

### **Support and stimulate all renewable and recycled production pathways which lead to the development of DME**

Depending on the pathway used to produce it, Renewable and Recycled Carbon DME can be classified as an Advanced Biofuel, a Renewable Fuel of Non-Biological Origin (RFNBO) or a Recycled Carbon Fuel (RCF). As new pathways are developed it should be possible for them to be recognised in the relevant regulation, so that they can contribute to decarbonisation efforts, at the earliest opportunity.

### **Support renewable liquid gas ready boilers**

Modern, highly efficient condensing boilers operating on fossil liquid gases today can seamlessly transition to renewable liquid gases. These boilers can use blends of Renewable and Recycled Carbon DME, which can lead to up to an 85% reduction in GHG emissions. Additional blending with renewable LPG can further reduce GHG emissions. Due to the similarity between DME, rLPG and LPG fuels, a drop-in blend means no changes need to be made to a boiler currently operating on LPG. These innovative solutions can greatly benefit European citizens, particularly the 40 million rural households in the EU, of which many are not connected to the natural gas grid.

### **Incentivise production of Renewable and Recycled Carbon DME**

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 liquid gases, like Renewable and Recycled Carbon DME. Renewable liquid gases that are produced off-site must be allowed to contribute to zero-emission buildings. Importantly renewable liquid gases, like Renewable and Recycled Carbon DME, use existing infrastructure to achieve decarbonisation objectives hence they can make the energy transition more cost-efficient and affordable for end consumers.

### **A clear and stable policy environment for RCFs is essential to support project development**

While RCFs are not made from 'renewable' feedstocks, they have many environmental benefits. Turning waste into fuel is a more efficient use of this resource than burning or landfilling and can prevent the local pollution sometimes associated with landfills. RCFs can save significant greenhouse gas emissions compared to fossil fuels, and when combined with Carbon Capture Usage & Storage (CCUS), the emissions can be slashed even further. All fuel sectors have an enormous task ahead to displace fossil fuels with sustainable ones and biomass feedstocks are not endless – it is for this reason we need to maximise fuels from non-biogenic and waste sources. The EU can support RCFs by recognizing the role for them beyond the transport market, and into the heating sector, as well as supporting RCF projects that can benefit the hardest-to-decarbonise in Europe.

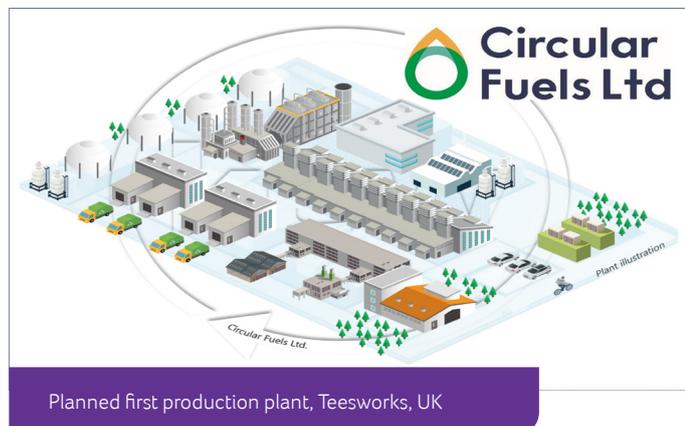


# Production of Renewable and Recycled Carbon DME is being scaled up in Europe and globally

Dimeta was established in early 2022 by two of the world's largest distributors of off-grid energy, SHV Energy & UGI International, to advance the production and use of Renewable and Recycled Carbon DME.

Dimeta is targeting the development of up to 6 production plants within the next 5 years, with a total production capacity of 300,000 tonnes of Renewable and Recycled Carbon DME per year by 2027. The aggregate investment is estimated to be up to \$1 billion.

Dimeta has recently announced Teesworks in the UK as the intended location of its first commercial production plant, which will be operational from late 2025. Circa 200kt of mixed waste will be converted into 50,000 tonnes of Renewable and Recycled Carbon DME – the equivalent of over 25% of the UK's LPG domestic heating market and a huge step on the UK's sustainability journey.



The announcement of the plant in the UK saw support from political stakeholders, including the Secretary of State for Business, Energy & Industrial Strategy at UK Government and the Tees Valley Mayor, on the basis of the Net Zero transition, but also the creation of 250 jobs during construction and 50 jobs during operation – a welcome boost to the local economy.



In parallel to the developments in the UK, subsequent plants are under development in Europe and the United States. Dimeta have also recently partnered with Enerkem, a leading waste gasification company, to explore the opportunity for the development of Renewable and Recycled Carbon DME plants in Europe and the United States, at a larger scale and with a strong focus on maximising CO2 recycling.

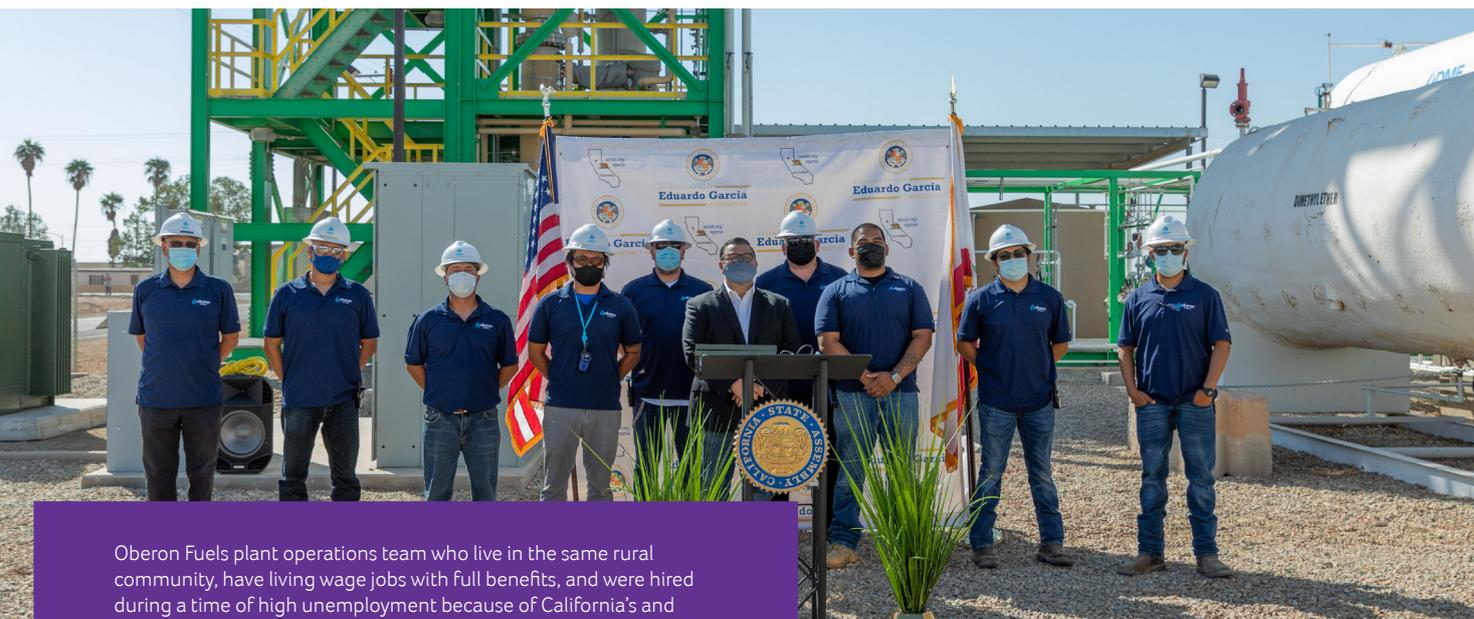


**Oberon Fuels is the first company in the world to commercialize renewable DME as a straightforward way to both slash the CO2 emissions of the huge LPG industry, and transport renewable hydrogen more efficiently and cost effectively.**

In May 2021, Oberon's 'Maverick' plant started making renewable DME and has a capacity of 1.5 million gallons per year. This plant was brought to life with the generous support of the State of California, and created full-time local jobs in this rural community.

Oberon is finalizing planning for its second and third production plants, each with multiple times the capacity of its first plant, with startup planned for early 2025. With over 30 projects under

production plant in California is producing renewable DME made from naturally occurring, waste methanol from Kraft pulp mills. Oberon's rDME™ fuel is presently being blended with LPG by Suburban Propane and used in on-road vehicles and forklifts in California today.



Oberon Fuels plant operations team who live in the same rural community, have living wage jobs with full benefits, and were hired during a time of high unemployment because of California's and Oberon's investments in this project.

development in the US and around the world, Oberon currently estimates over 200 million gallons per year by 2027.

Oberon is also currently working with Lipigas, the largest LPG/propane distributor in South America to test Oberon's renewable DME in a variety of equipment for a variety of uses, including home heating and cooking, industrial equipment, and transportation. Oberon's rDME™





Celebration of California legislation passed in 2020 (AB 2663) equalizing tax treatment of DME. Dr. Rebecca Boudreaux with Assembly Member Eduardo Garcia, who authored the legislation and sits on the board of the California Air Resources Board (CARB).

## View from an end-user equipment manufacturer

**Rinnai is a heating technology manufacturer and is recognised as a key player and supplier of continuous flow gas fired water heaters for commercial usage as well as innovative multipoint water heaters for domestic and light commercial applications.**

More recently Rinnai UK has expanded its product portfolio to include market leading heat pumps and electrical water heaters.

Rinnai's products are both Hydrogen and BioLPG ready and Rinnai UK is actively involved in the development of technical standards governing the use of Renewable and Recycled Carbon DME. The future of heating is a combination of electrons and molecules: electrification and gaseous solutions. For instance for dairy farming, liquid gaseous fuels is the affordable solution for producing the large amount of hot water needed for milk production.

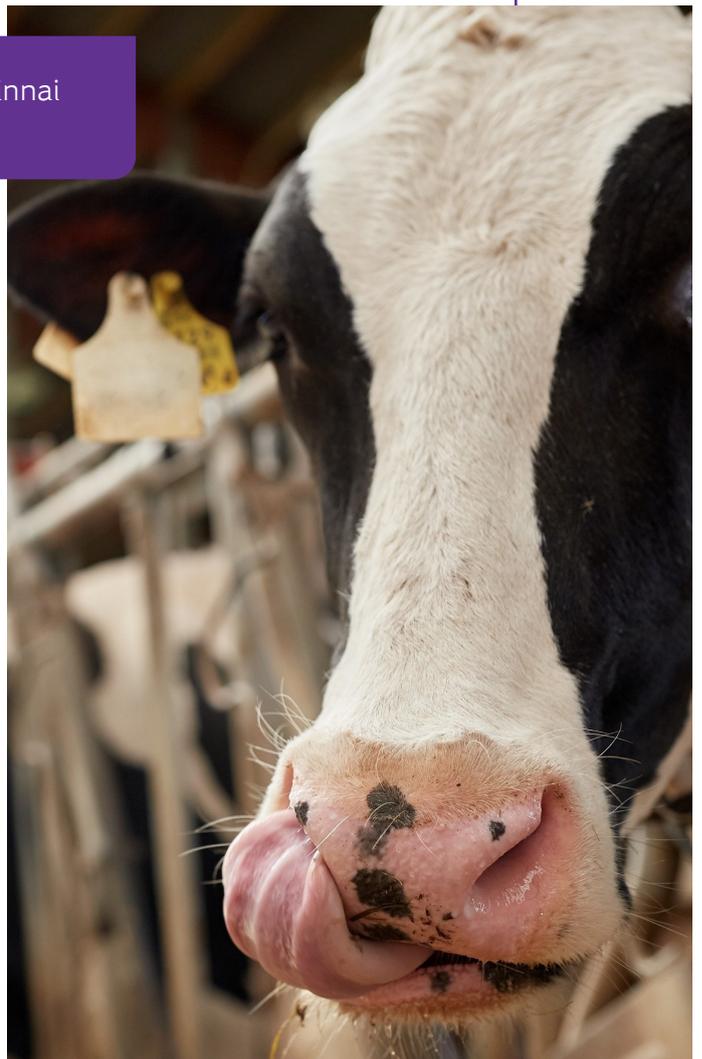


Liquid Gas System for a Modern Dairy Farm Author: Rinnai UK Application Department

The schematic above is of a hot water system, used by a modern dairy, fuelled by liquid gas. This solution can benefit from a drop-in combination of LPG and a renewable liquid fuel, to ensure system continuity and performance, whilst minimising disruption.

If we assume a Renewable and Recycled Carbon DME from Municipal Solid Waste (MSW) blended with LPG, in an 80% (LPG) to 20% (Renewable and Recycled Carbon DME) ratio, then we can expect a CO<sub>2</sub>e emission reduction (from LPG) of approx. 14.5%.

There are many applications that require a reliable supply of liquid gas for which Renewable and Recycled Carbon DME is an appropriate solution. Source: Rinnai\*



\*The Rinnai corporation's mission is to create a "healthier way of living" the group's Path to Becoming Carbon-Neutral focuses on key technologies including low carbon gases, heat pumps and hybrids heating and hot water systems. We are pursuing a long-term business strategy by developing systems that combine hydrogen and R&RCDME combustion equipment to support the multiple decarbonisation pathways that exist today and will emerge in the future.