

Deutsche Post DHL
Group

SUSTAINABLE FUELS FOR LOGISTICS

Status. Opportunities. Solutions.





AVAILABILITY
NON-DROP-IN BIO-LNG/CNG
PRODUCTION E-GASOLINE
SUSTAINABLE
GASOLINE PtL **PRODUCTION** E-FUELS
E-METHANOL KEROSENE ALTERNATIVE DROGGEN
E-KEROSENE
HYDROGEN LNG/CNG
E-LNG/E-CNG **FUELS**
BIODIESEL METHANOL
COST EFFECTIVENESS E-HYDROGEN

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Sustainable fuels for logistics

Over the next 10 to 20 years, sustainable fuels will play a critical role in efforts to reduce the impact of transport on the climate. This white paper offers an overview of the current discussion surrounding sustainable fuels and identifies the types of fuels and technologies that are needed for climate-neutral logistics.



***“There’s no getting
around the development
of sustainable fuels.”***

DR. FRANK APPEL
Chief Executive Officer
Deutsche Post DHL Group

Green Logistics **Requires Action**

Even in this digitally connected age, logistics still relies on a physical network to get transports from A to B. That network forms the backbone of global trade that drives prosperity around the world. As the leading company in our industry, we at Deutsche Post DHL Group are proud of the work we do to connect people in every part of the world and enable progress around the globe. Our industry must also assume a special responsibility for the future, not least because of the vital role that logistics plays in value creation and growth. The reason is clear: A sustainable economy is unthinkable without sustainable logistics.

Deutsche Post DHL Group sees itself as a climate-neutral logistics pioneer. Back in 2008, we became the first logistics provider to set measurable environmental and climate protection targets. This step inspired us to go one further and set out our Mission 2050: By then, we plan to reduce our carbon emissions to net zero. The first stage in this process is meeting our 2025 target to increase our carbon efficiency by 50% compared with 2007 levels. But to do so we will have to do more than simply deliver efficiency gains and modernize our fleets. We must also act as a driving force behind the transition from fossil fuels to clean alternative fuels.

Electricity is already a key resource in local and short-haul transport. In Germany, we are now using more than 10,000 StreetScooters – an electric vehicle we developed ourselves – to deliver and pick up parcels, and they will also soon become a more common sight on other European roads. In urban areas, we are using more and more cargo bikes and e-scooters to lower levels of local air pollution. Still, about 80% of our transports involve long-haul shipments using heavy-duty trucks. Future commercial use of electric drive systems for long-haul transports is unimaginable right now. The same applies for passenger transportation. If climate-neutral transport is our goal, there is simply no getting around the development of sustainable fuels.

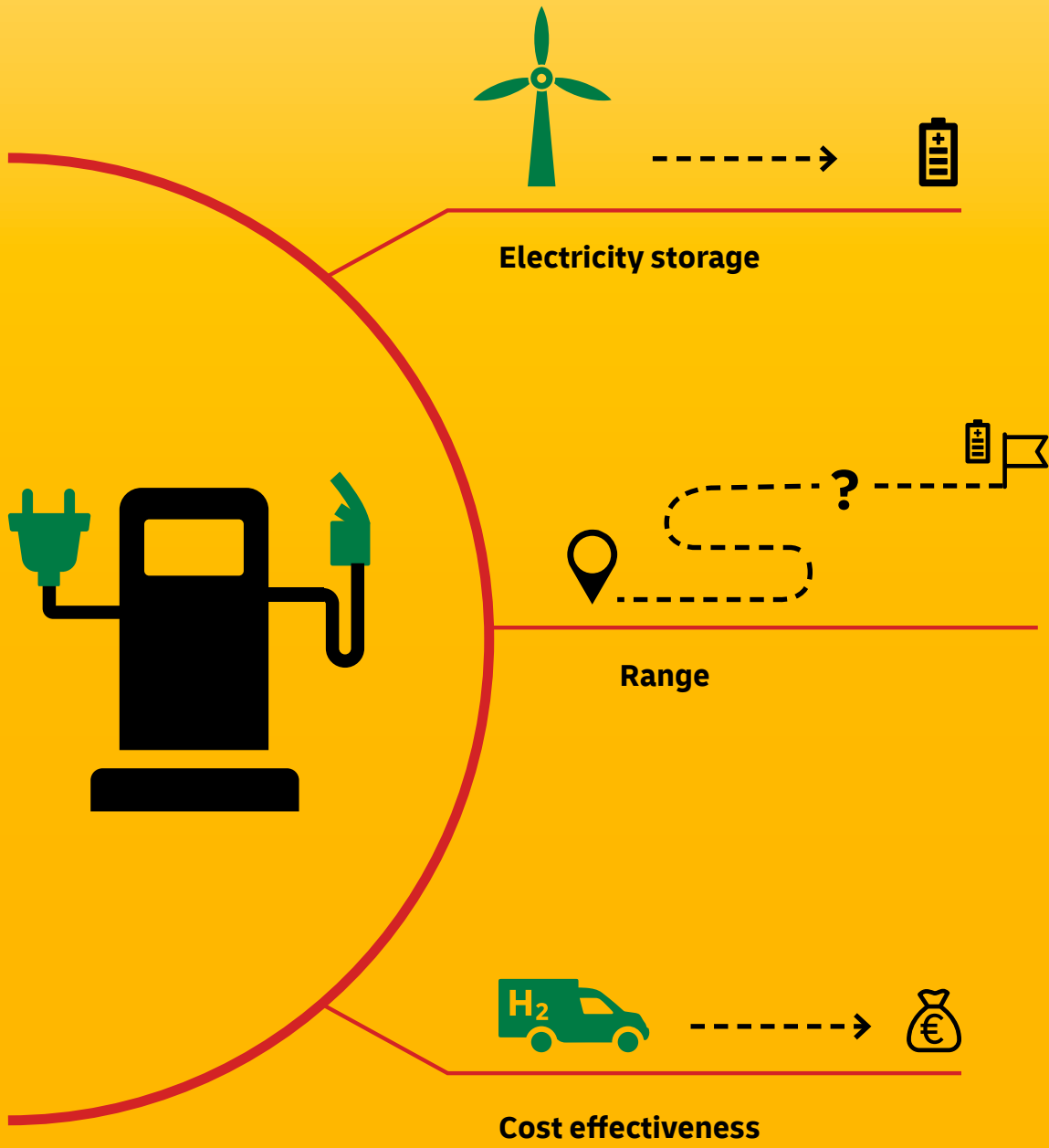
Fortunately, work on carbon-neutral fuels has accelerated in recent years and a wide array of potentially sustainable fuels now exists. We have a whole host of potentially sustainable fuels to choose from. These range from well-known alternatives like biofuels and hydrogen to lesser-known options like synthetic fuels. Each of these alternatives has strengths and weaknesses. Each brings its own set of challenges as well. Unfortunately, no single fuel or technology emerges as the obvious choice – the ideal alternative has yet to be found.

For companies, the ultimate goal is to find the sweet spot between environmental performance, commercial viability, and operational feasibility. The primary requirements are a continuous supply of fuel that is available at reasonable procurement costs, a smoothly functioning infrastructure and an extensive network of filling stations. We must also work in a far more coordinated way that extends across national boundaries and industry sectors. International compatibility is a critical success factor in a globalized world.

We have been promoting the development of alternative fuels for years. Deutsche Post DHL Group is one of the charter members of the initiative aireg e. V., an organization that promotes the use of renewable aviation fuels, and the fuel initiative Global Alliance Powerfuels. As an operator of large fleets of vehicles, we have also gained extensive experience with a wide range of fuels and technologies, both in tests and in live operations.

The following study discusses ways in which an intelligent strategy and bundling expertise can greatly increase the use of sustainable fuels in the coming years and explores the potential offered by the various fuels. It's also a platform on which to share the knowledge we have gained in diverse practical tests. The aim is to provide a vision for a climate-neutral future, highlight ways to get there – and generate momentum for continued development of sustainable fuels. In doing so, we hope to gain yet more supporters to help us drive green logistics. One thing is clear: Creating a more sustainable economy is only possible if we join forces and follow the right strategy, and logistics plays a critical role in this.

I hope you find the report an interesting, informative and enjoyable read.



Key Technology: E-mobility

Electromobility or direct electrification (referred to as “e-mobility” in this white paper) meets all of the criteria to become the ideal solution in decarbonizing transport.

Battery powered e-vehicles produce zero emissions and are quiet. They help improve air quality in urban areas and reduce noise disturbance for local residents. The relatively high purchase price of this form of transport is offset by low maintenance and operation costs due to its efficiency and robustness. In the logistics industry, however, battery-powered vehicles still lag behind vehicles powered by conventional internal combustion engines. Short ranges, long charging times, an inadequate national charging infrastructure and limited payloads are the main reasons why e-mobility is currently limited to short-haul shipments and deliveries in urban areas.

A large portion of greenhouse gas emissions is generated by heavy and long-haul transports. The major challenges in this area include developing higher performance batteries and expanding cross-border charging infrastructure.

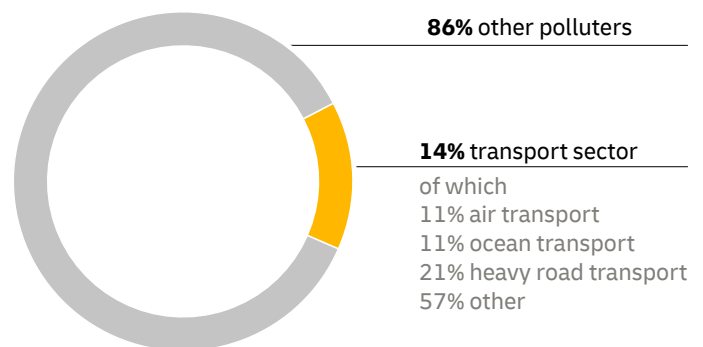
Sustainable e-mobility

E-mobility can only be described as environmentally sound and sustainable if conventional electricity is replaced by green electricity for battery drives. One of the major challenges posed by the transition to renewable energy is finding a needs-based way to store green electricity which relies on sun and wind. For this reason, it can be assumed that there will be no wide-scale power grids that can provide green electricity to e-vehicles between now and 2050.

Interim solution: Sustainable fuels for conventional internal combustion engines

Until the transport industry reaches the point where it can become fully electric, we will need other solutions to reduce greenhouse gas emissions. In air transports in particular, state-of-the-art, low-emission and fuel-efficient freight aircraft can make only a small contribution to lowering emissions. This is why we consider the development and improvement of sustainable fuels like biofuels – if sustainably produced – and e-fuels (electricity-based fuels or power fuels) to be essential.

Global greenhouse gas emissions



Source: SLoCaT, Transport and Climate Change Global Status Report 2018.

Strengths and weaknesses of e-mobility

+	The highest level of efficiency compared with other drive systems in which power is directly transmitted to the wheels of a vehicle
	Lower operating and maintenance costs
	Little wear and tear
	Zero emissions
	Low noise
-	Insufficient battery capacity for many uses
	High purchase price
	Limited ranges
	Inadequate network of charging stations
	Insufficient supply of green electricity
	Lack of cross-border and national distribution grids for green electricity supply; not cost-effective in rural areas
	Environmentally problematic battery production and disposal



William Todts

Executive Director, Transport & Environment

“We want to make sure that the full potential of batteries is exhausted before fuels are considered.”

Transport & Environment

Campaigning for cleaner transport in Europe, the NGO has contributed to a number of high-profile EU policy changes such as binding standards for more fuel efficient cars and vans.

Bold goals require bold action

How does Transport & Environment envision the way forward for green transport in Europe?

We’re certainly not advocating a cautious approach. Despite climate goals, global transport emissions are still rising today. So we need concrete action as well as targets. We want to see a deadline set for the end of the internal combustion engine in Europe and a coordinated, proactive push on the part of government, industry and consumers to get there. We believe a “Green New Deal” for transport to be the most effective way to not only combat climate change, but to make it an inclusive undertaking from which everyone benefits. This way, “zero emissions” becomes a rallying cry not just for urban elites, but for people in the suburbs, rural areas and peripheral regions of the European Union, too. Europe is in a position to become a powerhouse in electro mobility and create new, high quality jobs, in particular in the battery supply chain.

So electrification should be the main focus?

We want to make sure the full potential of batteries is exhausted before fuels are considered. Direct electrification is by far the most efficient way to decarbonize transport and this includes not only short-range transport. We also see some potential for battery electrification in short-sea shipping and long-haul trucking.

What about aviation and long-distance shipping?

Battery power is not yet an option here, but these are two important areas in terms of greenhouse gas emissions. Certainly sustainable fuels are a necessary part of the equation. Their deployment should be ramped up as soon as possible wherever electrification proves impossible. It’s the only way to reduce carbon emissions and air pollutants in all transport modes. But renewable fuels differ greatly in terms of their impact on the climate and environment.

What recommendations can you provide here?

The fuel landscape is complex, but we can help provide some clarity with our recommendation to exclude crop-based biofuels, which have proven very problematic in terms of sustainability. Instead, focus should be limited to next generation fuels: Advanced biofuels to some extent, but in particular synthetic e-fuels. This is why coordinated action – on the part of policy makers, NGOs, fuel producers, vehicle manufacturers and large fuel consumers such as Deutsche Post DHL Group – is so important.



Siegfried Knecht

Chairman of the Executive Board of aireg e. V.

“Effective climate protection will initially cost more.”

aireg e.V.

The German NGO promotes research into sustainable aviation fuels, their production and use. Deutsche Post DHL Group is a charter member and plays a role in a number of aireg projects.

Kerosene manufacturers and airlines must step up the pace

Climate protection has top priority. What options do you see for aviation between now and 2050?

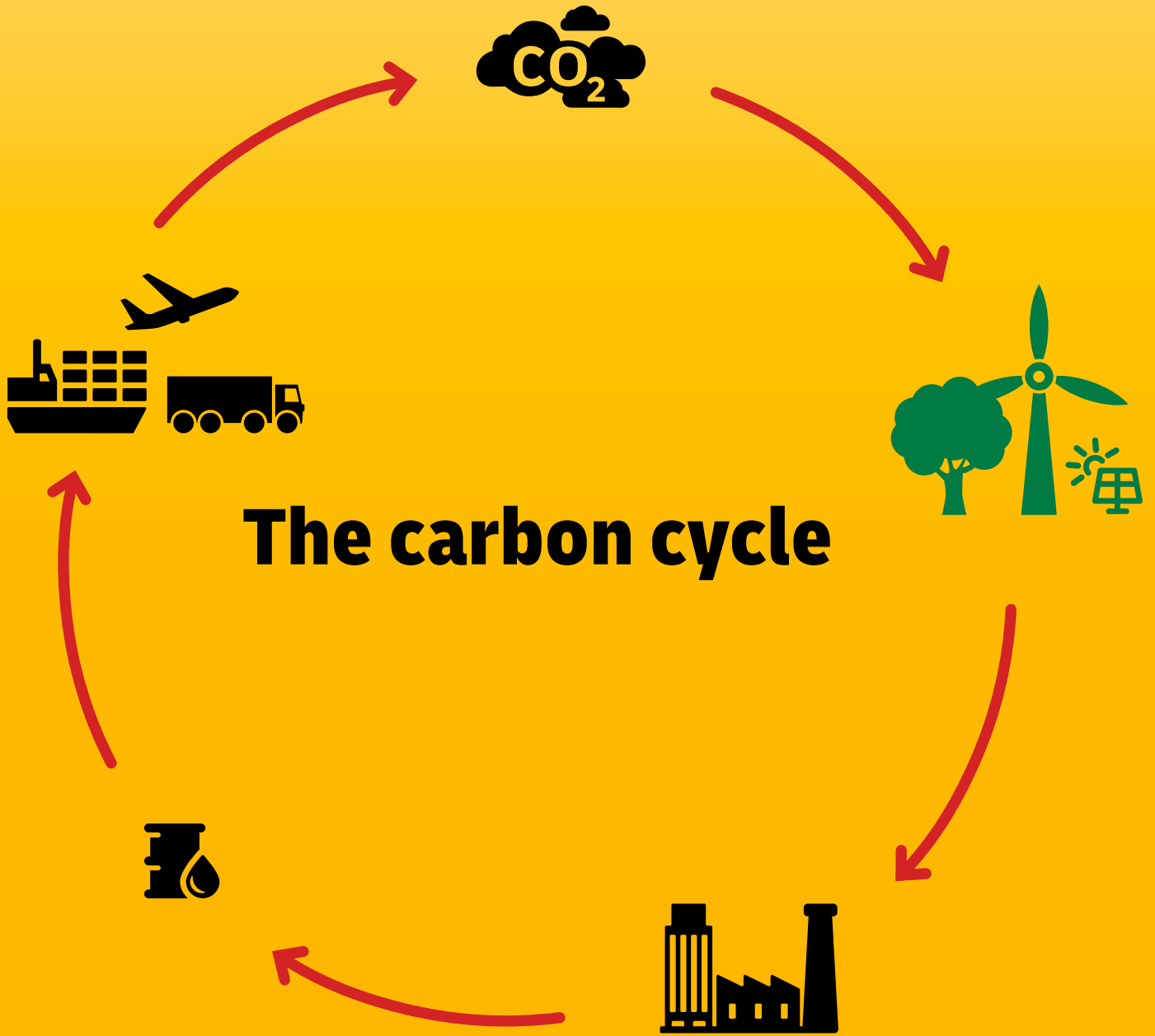
In terms of the future and carbon-neutral growth, aircraft manufacturers are already working to develop alternative engines and new types of airplane structures. But we will not be able to give up kerosene for quite some time, particularly when it comes to long-distance travel. It can only be supplied in sufficient quantities from conventional resources. This makes international collaboration in the development and market entry of sustainable, synthetic aviation fuel all the more important.

What are the biggest challenges in introducing sustainable fuels?

A number of approved processes have been developed to produce synthetic kerosene using biofuels – things like plant oils, waste oils and waste wood. Europe lacks a sufficient number of biorefineries that could meet the demand. And there's one other point to keep in mind: It still costs three to four times as much to produce sustainable kerosene as it does to make conventional aviation fuel. That difference is pretty significant when you consider that fuel makes up one-third of an airline's operating costs. Of course, passengers must also be prepared to pay a premium for climate protection. The approval process poses a challenge, too. As a rule, between 500 and 1,000 tonnes of fuel are needed to be able to assess the percentage of synthetic kerosene that can be added.

How is aireg e.V. tackling all of this?

By conducting pioneering scientific work and tirelessly working to bring decision-makers from the industrial, research and political communities together. So far, no one has succeeded in producing a sufficient amount of synthetic kerosene at marketable prices. And that's despite the fact that past projects have shown us that synthetic fuel has a higher energy density than fossil kerosene and there's no issue with using a 50% mixture with any type of aircraft commonly in service today. In 2016, we played a key role in forming a consortium of various industrial companies and the Hamburg University of Technology. The consortium plans to use the pre-engineering phase to explore how an industrial Power-to-Liquid (PtL) facility can be used to produce synthetic hydrocarbons in the most environmentally efficient way. This is to be followed by the construction of a larger-scale PtL plant in Germany to produce climate-neutral fuels that can be used in all transport modes – aviation, road freight and shipping.



Alternative or Sustainable

Today, the term “alternative” is used for all fuels that are not a part of the fossil fuel group – diesel, gasoline, heavy oil and kerosene. Liquefied natural gas (LNG) and compressed natural gas (CNG) are considered alternative fuels. However, they still originate from fossil sources, making them non-sustainable as a result. Truly sustainable fuels come from renewable sources, have no negative impact on the environment when they are burned and do not produce emissions of greenhouse gas.

Until it becomes possible to fully electrify the transport sector, we will need concrete interim solutions that can meet the requirements of the various transport modes. A number of initiatives have been launched to find alternatives to fossil fuels. As this work is still only in the developmental or trial phase, a universal solution has yet to emerge.




To date, there is neither a central coordinating body for research, development and testing of sustainable fuels, nor is there a common knowledge base. Both would be required to develop a binding standard. Economic considerations are usually at the forefront when it comes to investing in technology. The development of new technologies and modification of existing ones require far-sighted investments – investments whose long-term benefits are far from certain at times.

The range of sustainable fuels also adds to the complexity and complicates efforts for focused research work. Some fuels require new types of motors and drive systems. Others require no or only minor modifications to the technology or infrastructure concerned, such as replacing seals.

An alliance of international, cross-industry initiatives is urgently needed. This group could then devise a master plan that would combine a range of measures and investments in a purposeful way.

The world of sustainable fuels

The spectrum of sustainable fuels ranges from simple, conventional biofuel blends like E10 to revolutionary solar fuels that are produced exclusively from water, air and sunlight. The most promising sustainable fuels can be broken down into three categories.

	Biofuels
	E-fuels (electricity-based fuels or power fuels)
	Solar fuels

The greatest potential for real sustainability can be found in biofuels and e-fuels that can take the place of fossil fuels such as diesel, gasoline and kerosene. In the production of these fuels, CO₂ is absorbed from the air or other sustainable sources are used. This way, the emissions produced by combustion are offset, and the carbon cycle is closed.

Biofuels

Prerequisites for sustainability

Biofuels have many strengths – the main one being that they are readily available. They are produced from fast-growing energy crops such as corn and sugar beet. Agricultural and industrial waste can also be used as a basis for biofuels. Blending biofuels into conventional fuels limits production of local air pollutants, reduces CO₂ emissions and facilitates cleaner combustion. Both production and use of biofuels are also more environmentally friendly because the fuels are biodegradable and much less toxic than fossil fuels.

But there is a downside: Energy crops are not cultivated in line with common sustainable principles. For example, if rain forest areas are cleared to make way for palm oil plantations, greenhouse gases are released during deforestation and biodiversity is harmed. Monocultures also increase the risk of shortages in the supply of food and water. Incorrect irrigation practices or farming methods can affect agricultural yields and reduce soil fertility. Last but not least, harvesting and processing crops requires vast amounts of energy.



Deutsche Post DHL Group's Biofuel Policy

In 2010, the Group implemented a policy covering use of biofuels. Under this Group-wide policy, only sustainable biofuels that do not cause any change in land usage may be burned. National legal blending quotas are exempt from the policy.

Sustainable biofuels

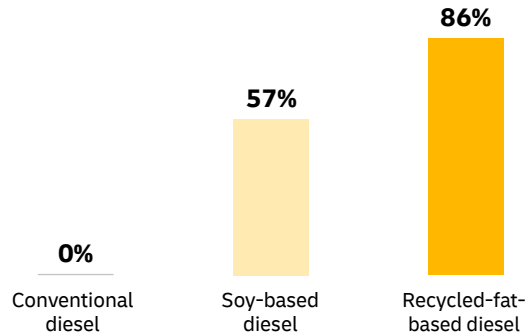
The three most common biofuels are biodiesel, bioethanol and biokerosene, whose specific characteristics are addressed below.

Biodiesel

This fuel is derived from vegetable or animal fats and alcohol. It is generally used as an additive to diesel fuels. The blend can range from 2% (B2) to 100% biodiesel (B100). It can possess very different characteristics depending on how it is produced:

- Hydrotreated vegetable oils (HVO) are often produced from waste feedstock and can be used as a pure fuel.
- Fatty acid methyl ester (FAME) is obtained from natural vegetable and animal fats in a process using methanol. It can only be blended into fossil fuels in low concentrations. A vehicle's engine and fuel system must be modified before higher concentrations can be used. Higher maintenance costs may be incurred as well.

GHG emission reduction potential



Source: EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis, 2010.

Bioethanol

Bioethanol is usually produced through the alcoholic fermentation of corn or grain, and is used as an additive to conventional gasoline. The most widely known version is E10, a blend of 10% ethanol and 90% gasoline. It can be used in passenger cars and in trucks weighing up to 7.5 tonnes without modifying the engine or the fuel system. Higher concentration blends like E85 (85% ethanol) and E100 (100% ethanol) call for minor modifications.

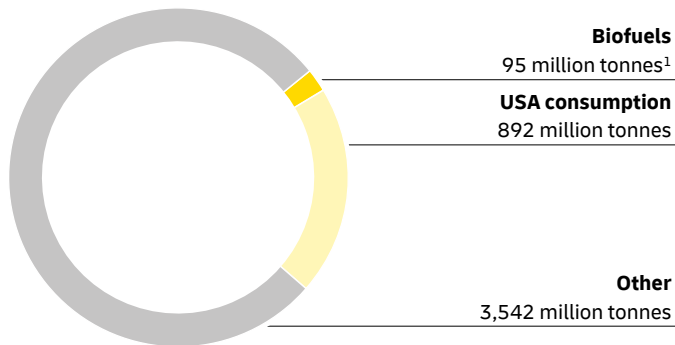
Biokerosene

This fuel is also known as biojet and is produced from vegetable and animal fats. In technical terms, it consists of hydroprocessed esters and fatty acids (HEFA). Biojet fuels can reduce greenhouse gas emissions in aviation by anywhere from 50% to 95% compared to fossil jet fuel, depending on the biofuel feedstock used (Source: International Renewable Energy Agency).

Commercial-scale production is technically feasible. However, usage has been limited so far, mainly due to high production costs. As a result, biojet is used only in isolated tests even though it is compatible with today's jet engines; a blend of up to 50% has already been approved with no modifications to technology or infrastructure required. Biojet production must be significantly stepped up if it is to play any great role in reducing emissions in aviation. There are currently no commercial incentives in place that could help biojet become a real, cost-competitive alternative to fossil fuels.

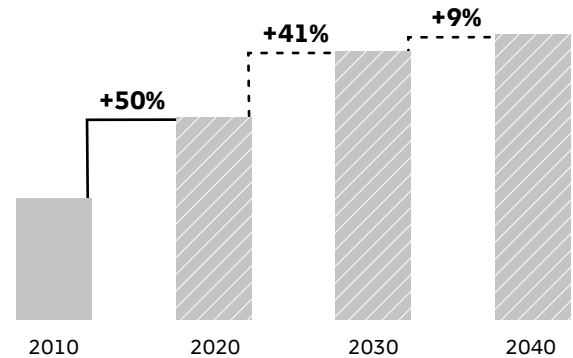
Global crude oil usage 2018

Total: 4,529 million tonnes



Source: BP Statistical Review of World Energy 2019. 1) Crude oil equivalents.

Projection of biofuel production



Source: BP Energy Outlook 2019.



Syncrude – crude oil from household garbage

A biofuel facility that will be able to create crude oil from household garbage is being built near Reno, Nevada in the US. Steady supplies of urban waste products perform better in terms of price and price stability and provide more supply certainty than other source products. Beginning in 2020, 33,000 tonnes of synthetic crude oil (syncrude) are expected to be produced annually from household trash. The raw material will then be processed further into biokerosene and biodiesel.

E-fuels – a fuel category with many benefits

E-fuels are synthetic fuels that can be produced from water and carbon dioxide (CO₂) using electricity. This process is known as power-to-fuel. The terms “power-to-gas” and “power-to-liquid” are used depending on whether the synthetic fuel is gaseous or liquid. E-fuels are sustainable if the power used comes solely from renewable sources and the CO₂ is either removed from the atmosphere or produced from biomass.

One of e-fuels’ strengths is that they can be seamlessly integrated into existing vehicles and infrastructure. However, these fuels are not yet commercially competitive. As with e-mobility, supply of green electricity is currently insufficient to enable e-fuels to be produced in a truly climate neutral manner.

Renewable electricity can be stored and transported as a liquid or gaseous fuel. One possible scenario sees renewable electricity being generated in a solar farm, converted into an e-fuel and transported to locations with high fuel needs. In this way, e-fuels could help solve one of the central challenges of the energy transition: The physical separation of production and use of green electricity to ensure continuous supply independent of sun or wind.



Production of e-fuels

In chemical terms, e-fuels have the same properties as liquid and gaseous fossil fuels. But they are produced synthetically through the use of electrolysis and other chemical reactions powered by renewable energy.

For synthetic (hydrocarbon) e-fuels, the carbon required for the process is separated from existing emission streams, such as a cement plant, or is filtered from ambient air via air-capture processes. The e-fuels produced are climate neutral because the carbon released by combustion is identical to the carbon that was bound to the fuel during production.

Potential e-fuel uses

Fuel	Potential use
E-diesel (liquid hydrocarbons)	Conventional internal combustion engine
E-methanol	Internal combustion engine, slightly modified
E-methane (gaseous hydrocarbons)	Gas engine
E-hydrogen	Fuel-cell vehicle

Prerequisites for sustainable e-fuels

- No direct or indirect use of fossil power in the production process
- Use of a sustainable CO₂ source
- Justification for fossil fuel power stations to be used as electricity suppliers or CO₂ source not permitted

E-hydrogen

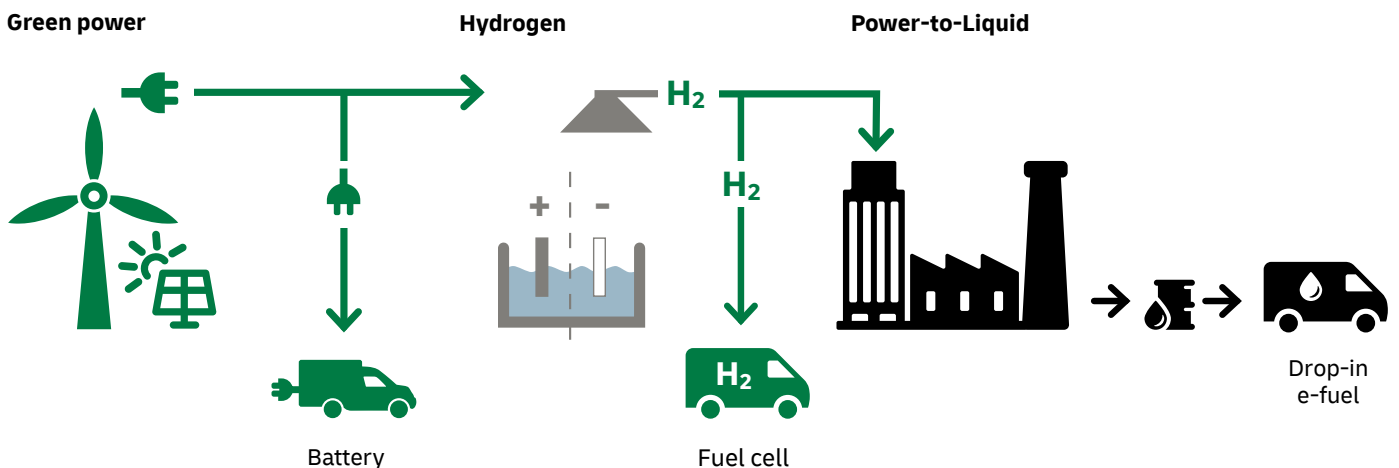
Availability of this most common e-fuel remains limited. The gas is used, among other things, to power vehicles equipped with fuel cells. These vehicles are not only quiet and emission free, but are also more efficient than conventional internal combustion engines. Storage of hydrogen in the vehicle poses

a challenge in terms of its wide-spread use in transport, as this requires either an insulated tank (liquid hydrogen) or a pressure tank (compressed hydrogen) that takes up more space than a tank used for conventional fuel.

E-methane

As a synthetic, sustainable substitute for natural gas, e-methane can either be used to operate natural gas vehicles or fed into the natural gas grid. It can be used in commercially available gas engines without modifications. But: Methane is a greenhouse gas that is about 25 times more harmful to the climate than CO₂. It has no impact on the climate during combustion, but leaks of methane can occur during transport, use in the vehicle or in case of damage to the tank. This would more or less negate any reduction in greenhouse gas achieved.

Production of power fuels (drop-in e-fuels)



Power-to-Liquid (PtL)

The various technical processes used in the production of liquid fuels are known as power-to-liquid (electrical energy to liquid). As a general rule, hydrocarbons are synthesized from hydrogen and CO₂ or carbon monoxide. Synthetic liquid hydrocarbons such as e-diesel, e-gasoline and e-kerosene imitate globally usable liquid fossil fuels. They have longer carbon chains than methane and require more CO₂ for synthesis as a result. This process drives up energy and production costs, and thus represents its biggest drawback. But these fuels have real strengths in terms of their practicality, transportability, storage and potential use. They would thus seem one of the most promising short- and medium-term transition solutions available until such time as the transport industry is fully electric. E-methanol is another form of liquid e-fuel that can be used in conventional engines and infrastructures with only minor modifications. Less CO₂ is required to produce it, and the synthesis is more efficient. Wide-scale use on roads could follow.

Innovative e-fuel projects in Germany

E-hydrogen: Hydrogen has been produced in a wind farm since 2011. This allows e-hydrogen to be stored without losses and is thus suitable for mass use. When needed, the fuel is converted into electricity or is provided as a gas for heating purposes, industrial processes or use by cars and buses.

E-methane: Since 2013, an automotive manufacturer has been operating an e-gas facility that produces methane for use in Germany's natural gas grid and in natural gas vehicles. About 1,000 tonnes of e-methane are produced there annually and about 2,800 tonnes of CO₂ are absorbed in the production process. Buyers of the brand's gas vehicles in Europe receive a free, three-year supply of "green" e-methane, and biomethane produced from waste.

PtL e-fuels: A producer of renewable technical gases and fuels operates a PtL facility that successfully converted green power, CO₂ and water into three tonnes of synthetic crude oil back in 2017. Larger demonstration facilities are currently being planned. Production is scheduled to be expanded at the beginning of the 2020s.

Solar fuels

Synthetic fuels can also be produced using solar-thermal, photoelectrochemical or photocatalytic processes. These are more efficient than other processes because they skip the step of converting solar energy into electricity. The photocatalytic process – artificial photosynthesis – imitates the food production system used by plants. Just as plants use CO₂, water and sunlight to produce "fuel" in the form of glucose, artificial photosynthesis converts CO₂, water and sunlight into such fuels as hydrogen, carbon monoxide, formic acids or even methanol. But this form of emission-free fuel production is only in its infancy. We do not, therefore, see it as a viable option in the drive to find a medium-range transition solution on the way to full electrification.

Key messages

- 1 Alternative fuels are sustainable only if they come from renewable sources and have no negative impact on the environment, climate or society when burned.
- 2 Sustainable biofuels are one way to gradually reduce the use of fossil fuels. They are readily available, biodegradable and less toxic than other fuels. One argument for e-fuels: Power from renewable energy can be stored and transported as a liquid or gaseous fuel.
- 3 Biofuels and e-fuels have the greatest potential to become a sustainable substitute for fossil fuels.
- 4 A range of alternatives is being developed right now or is already in use. But no comprehensive knowledge base or binding standards have been developed so far. Feasibility appears to be more a matter of commercial viability than one of technology.



Dr. Franziska Müller-Langer

Project Coordinator of DEMO-SPK Deutsches Biomasseforschungszentrum gemeinnützige GmbH

“Renewable kerosene can be used like fossil aviation fuel. But it is demonstrably more environmentally and climate friendly.”

DEMO-SPK

The research and demonstration project covering the use of renewable kerosene at Leipzig/Halle Airport (DEMO-SPK) with more than 20 international partners was initiated as a model project under the mobility and fuel strategy. It was funded by the German Ministry for Transport and Digital Infrastructure.

Unrestricted technical use is possible

What are the positive effects of renewable fuels in aviation?

The primary reason for using renewable kerosene is to reduce the greenhouse gas emissions associated with aviation, a step that makes an important contribution to climate protection. The emission of local air pollutants can also be cut significantly, as the DEMO-SPK project showed. To use renewable kerosene, compliance with sustainability criteria must be monitored along the entire supply chain. Renewable kerosene can thus, in some ways, have positive effects.

What role do renewable fuels play today?

Compared with electricity-based fuels (e-fuels or PtL), large amounts of biofuels are now commercially available: About 3.7 exajoules worldwide, or about 3% of transport's total energy needs. They are primarily used in road transport. The amount of proportionately blended biokerosene in aviation is minuscule by comparison. Use of renewable kerosene on a wider scale requires massive expansion in production capacities and infrastructure, for example to produce multiblend JET A-1 fuel.

What were the main findings of your project?

The primary goal was to examine and verify the behavior of blends of several renewable kerosenes with fossil JET A-1 under realistic conditions in the supply infrastructure of a major airport. Another aim was to successfully demonstrate the use of multiblend JET A-1 in the general fuel supply infrastructure, from procurement to plane fueling operations, on the international level for the first time. The results are promising. The project demonstrated that the supply chain for multiblend JET A-1 was technically feasible and that the fuel could be used without making any changes in normal operating procedures. The project also verified that the use of multiblend JET A-1 resulted in a 30% to 60% reduction in particulate emissions for ground operations and a reduction of about 35% in CO₂ equivalents compared with pure fossil JET A-1. A number of solutions and recommendations to facilitate practical use were developed as well.



Andreas Kuhlmann
Chief Executive of the German Energy Agency (dena) and spokesman for the Global Alliance Powerfuels

“The damage being caused by fossil fuels is not appropriately reflected in prices.”

Global Alliance Powerfuels

The cross-industry alliance of companies and trade associations is working to develop a global market for electricity-based energy sources and renewables-based raw materials. Deutsche Post DHL Group is a charter member of the Alliance.

Fair opportunities created by the polluter-pays principle

Powerfuels are the missing link in becoming climate-neutral. What do you mean by that?

Electricity-based, renewable energy sources and raw materials (powerfuels) can fill the gap by reducing greenhouse gas emissions if energy efficiency and green power do not suffice. Powerfuels are important for climate protection in five ways. First, they serve as a climate-neutral option in areas where we have no alternatives to fossil fuels. Second, they facilitate the global transport of and trade with wind and solar power. Third, they can be stored for long periods of time and flexibly used in existing energy infrastructures. Fourth, they can replace fossil energy sources in final consumption over the short term. In doing so, they would significantly accelerate the reduction of greenhouse gas emissions. And, fifth, they can be integrated into the widest range of national climate protection strategies.

What has to happen for powerfuels to become a viable alternative?

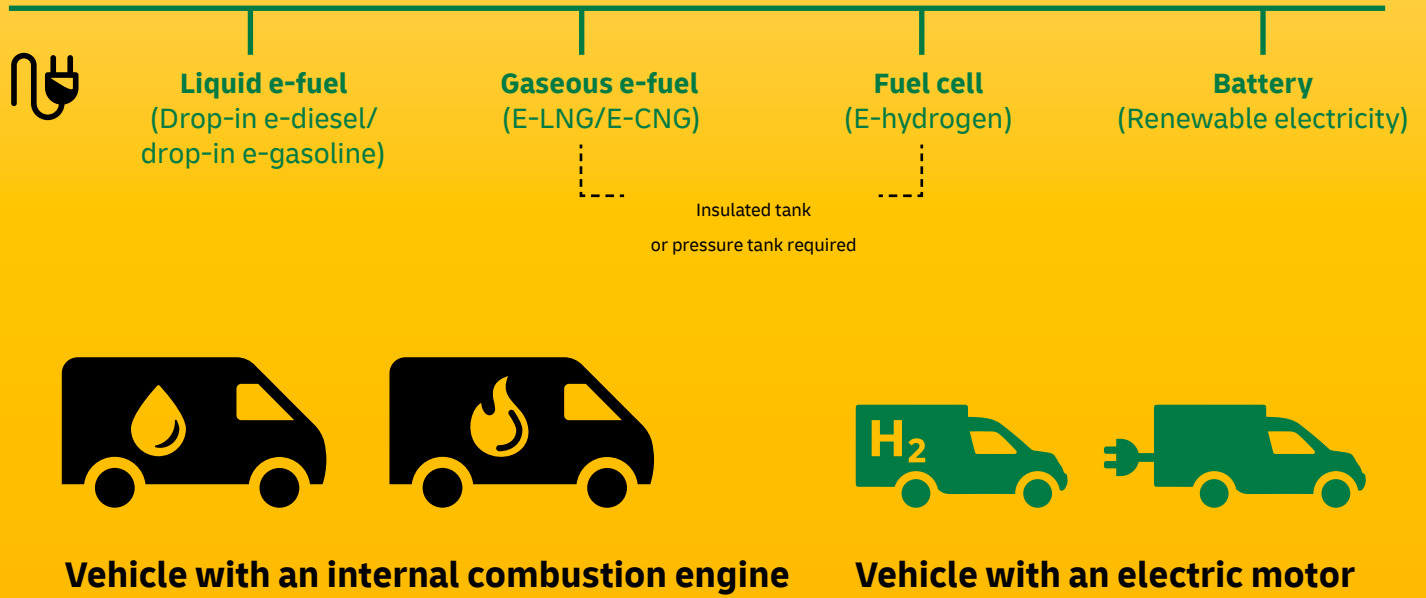
Powerfuels would have much better chances if the polluter-pays principle were strictly enforced. Reasonable approaches would include emission-trading systems, minimum prices and taxes as well as an end to subsidies for fossil fuels. One particular condition for creating a global powerfuel market is a stable demand that would provide players with a high degree of planning and investment certainty for powerfuel plants. This could be achieved by using admixture ratios in heavily regulated areas like air transport and ocean shipping. Such ratios have already been included in the EU Renewable Energy Directive and could be transposed into national law relatively quickly.

What can companies contribute as charter members of the Global Alliance Powerfuels?

By acting in networks like the Global Alliance Powerfuels, companies can jointly develop recommendations for setting up a global powerfuels market. They should also use their own networks to raise awareness among the political, business and scientific communities as well as the rest of society. They have the opportunity to act as innovative partners in pilot projects or to develop applications for their own use together with scientific organizations.

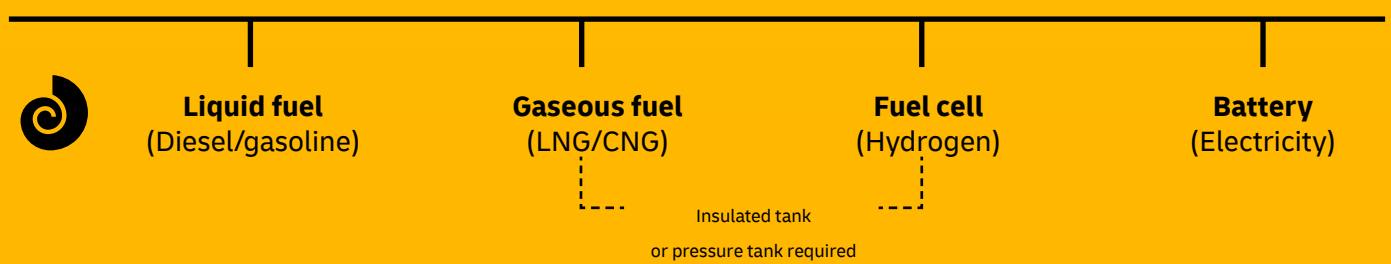
FUTURE

Conventional vehicles use sustainable fuels (e-fuels)



TODAY

Conventional vehicles use fossil – and alternative – fuels



Potential of Sustainable Fuels




The shift from conventional fuels to sustainable fuels is being slowed by the fact that the new fuels do not yet offer the same efficiency and practicality as fossil fuels yet. Not all sustainable fuels are marketable. Deciding whether a fuel is truly sustainable depends not only on environmental aspects, but also on criteria such as safety, cost effectiveness and functionality.

It is important to look not only at the materials used to produce the fuel, but also at the way in which it will be used. Fundamental differences exist between liquid and gaseous fuels, drop-in and non-drop-in fuels, as well as between biofuels and e-fuels.

Drop-in fuels are compatible with conventional drives and distribution systems. For this reason, they have greater potential than non-drop-in fuels that are not or only

partially suited to them. Gaseous fuels like hydrogen and methane are indeed easier to produce than liquid drop-in fuels. But they also have additional storage and transport requirements. Compared with biofuels, e-fuels primarily represent the most promising alternative for heavy shipments and long-haul transports. In particular, PtL fuels like e-gasoline, e-diesel and e-kerosene combine the practical strengths of liquid fossil fuels with the benefits of climate-neutral alternatives.

Sustainability of fuels

	Drop-in	Non-drop-in
	No modification needed	Modification to engine and infrastructure required
Sustainable fuels		
 Bio	<ul style="list-style-type: none"> ■ Biokerosene (HEFA) ■ Biodiesel 	<ul style="list-style-type: none"> ■ Hydrogen ■ Ethanol ■ Bio-LNG/Bio-CNG
 E-fuels	<ul style="list-style-type: none"> ■ E-gasoline ■ E-diesel ■ E-kerosene 	<ul style="list-style-type: none"> ■ Hydrogen ■ E-LNG/E-CNG ■ E-methanol ■ Direct power usage
 Fossil	Conventional fuels	Alternative fuels
	<ul style="list-style-type: none"> ■ Gasoline ■ Diesel ■ HFO ■ Kerosene 	<ul style="list-style-type: none"> ■ Hydrogen ■ LNG/CNG

Liquid or gaseous

Global mobility is based almost entirely on the use of fossil hydrocarbons because they are affordable and available in sufficient quantities. The job of replacing these fuels is complicated by the fact that they are so well-suited for use in the transport sector. Gasoline, kerosene and diesel – each a liquid fuel – have greater energy content per volume unit than gaseous fuels. Liquid fuels can be stored and transported in space-saving, conventional tanks. Gaseous fuels must be compressed under tremendous pressure or liquefied at extremely low temperatures in order to store comparable amounts of energy in comparable space.

Both processes require the use of additional energy. In addition, compressed gases can only be stored in elaborate pressure tanks and liquefied gases in insulated tanks. Even so, it takes less effort to produce gaseous fuels like hydrogen and methane than it does to make liquid fuels. They also have greater potential to reduce local air pollution.

Hydrogen and fuel cells

Hydrogen is considered to be the most promising solution for clean mobility because it can be produced in unlimited quantities from green power and is also emission-free. Hydrogen is available both as CH₂ (compressed at 350 bar or 700 bar) or as LH₂ (liquefied at -252°C).

Fuel-cell vehicles in which hydrogen is converted into electricity are considered to be particularly sustainable. The “emissions” produced in the process are so clean that one could drink them. But in technical and economic terms, fuel cells have not reached the maturity level of battery-powered e-vehicles (BEVs). Development of fuel-cell trucks is in its infancy. Wide-scale supply of hydrogen is also complicated by the special requirements for storage and transport of the gas. This challenge must be met and overcome.

Characteristics of hydrogen

Strengths

Efficient production of hydrogen from green power possible

Unlimited production possible

Clean fuel-cell vehicles

Weaknesses

Insulated or pressure tanks required

Higher costs and smaller load capacity

Fuel-cell technology not mature

Lack of a wide-scale filling station network

Supply is still cost and energy intensive



Drop-in or non-drop-in

In terms of range and overall performance, sustainable drop-in fuels are equal to conventional fuels and can be safely used as an additive. By contrast, non-drop-in fuels require either modifications to be made to the drive system, fueling or supply infrastructure of a conventional vehicle or new technical systems.

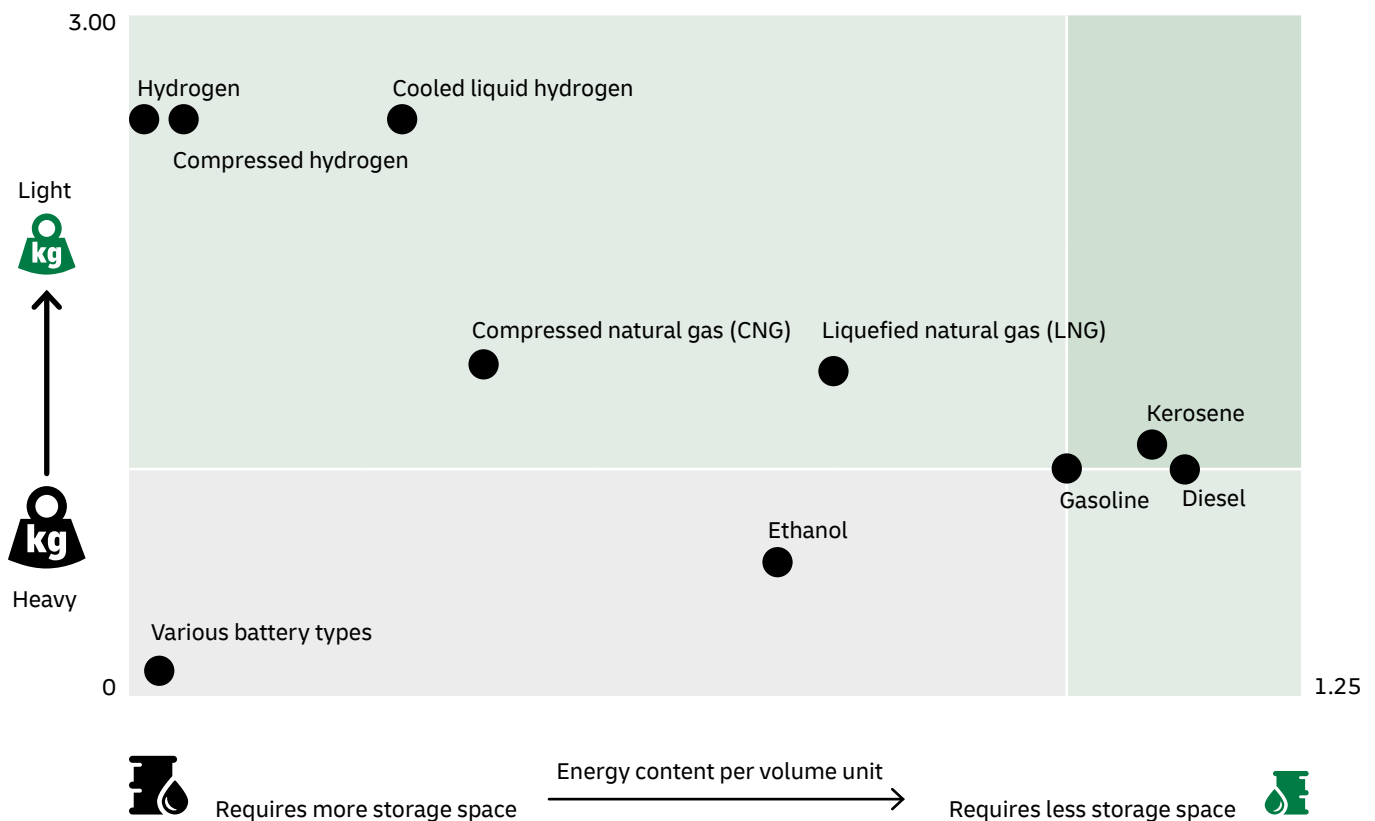
Gaseous fuels like LNG and CNG can already be used in slightly modified internal combustion engines, but they require a different fuel tank and a different fueling infrastructure. Hydrogen-powered fuel-cell vehicles and battery-powered e-vehicles also require a new fueling and supply infrastructure. Fuels such as E100 are called near-drop-in fuels because they only require slight modifications, such as new seals.

Biofuel or e-fuel

Biofuels and e-fuels could (potentially) be better than fossil fuels because they burn cleaner. This can increase engine efficiency and performance, reduce local emissions and extend an engine's service life. In addition, both biofuels and power fuels can be produced anywhere in the world, with some locations more suitable than others depending on the fuel.



There are, however, some important differences in terms of availability, price and sustainability. As mentioned previously in this white paper, biofuels are not always produced in a sustainable manner due to clearing of rain forests or use of improper farming methods. In addition, the low energy density of the raw materials is offset by high energy demand during their harvest and processing, resulting in relevant greenhouse gas emissions.

Energy density of the different fuel types is the key factor in storage¹



¹ Energy content per weight and volume unit. Scale indexed to gasoline.

Differences between biofuels and e-fuels

		Sustainability	Availability	Cost effectiveness
 Bio	+	<ul style="list-style-type: none"> If obtained from sustainable raw materials 	<ul style="list-style-type: none"> Already commercially available 	<ul style="list-style-type: none"> Price reductions possible through optimization of production processes and economies of scale Price of €1 per liter possible in the long term
	-	<ul style="list-style-type: none"> Questionable if obtained from certain raw materials 	<ul style="list-style-type: none"> Limited availability 	<ul style="list-style-type: none"> Price level still exceeds that of conventional fuels Price linked to the availability of raw materials
 E-fuels	+	<ul style="list-style-type: none"> Production possible on land not used for farming No competition between food and fuel production 	<ul style="list-style-type: none"> Production potential exceeds long-term demand 	<ul style="list-style-type: none"> Price projections for e-diesel and e-kerosene 2030: €1 to €2 per liter 2050: €0.50 per liter
	-	<ul style="list-style-type: none"> Documented proof required for electricity and carbon from renewable sources 	<ul style="list-style-type: none"> Not commercially available yet First demonstration facilities planned in 2022 First large facilities planned between 2025 and 2030 	<ul style="list-style-type: none"> No market price set to date

Key messages

- 1 We currently know of no fuel that can beat conventional gasoline, diesel or kerosene in terms of energy content, weight and handling. Liquid fuels are more practical than gaseous ones.
- 2 It is easier to switch to drop-in fuels than to non-drop-in fuels because conventional vehicles and systems do not have to be modified.
- 3 Until we reach the point where commercial vehicles weighing more than 7.5 tonnes as well as ships and airplanes can be electrified, we will need both sustainable biofuels and e-fuels, and these will be the driving force when it comes to achieving real progress in zero-emission logistics over the short and medium term.
- 4 E-fuels – both as liquid drop-in and as non-drop-in fuels – have the greatest long-term potential. They can be sustainably produced in sufficient quantities and be used, for example, as e-hydrogen in fuel-cell vehicles.



Robert Wagner, Ph.D.

Director of National Transportation Research Center
Oak Ridge National Laboratory

“The co-optimization of fuel and engine technologies has great potential to improve efficiency and reduce pollutant emissions.”

Co-Optima

The Co-Optimization of Fuels & Engines (Co-Optima) initiative of the US Department of Energy (DoE) aims to develop fuel and engine technologies in tandem in order to achieve environmental, economic and efficiency-related goals.

The combustion engine still has many miles to go

Can you briefly describe the tasks and goals of your initiative?

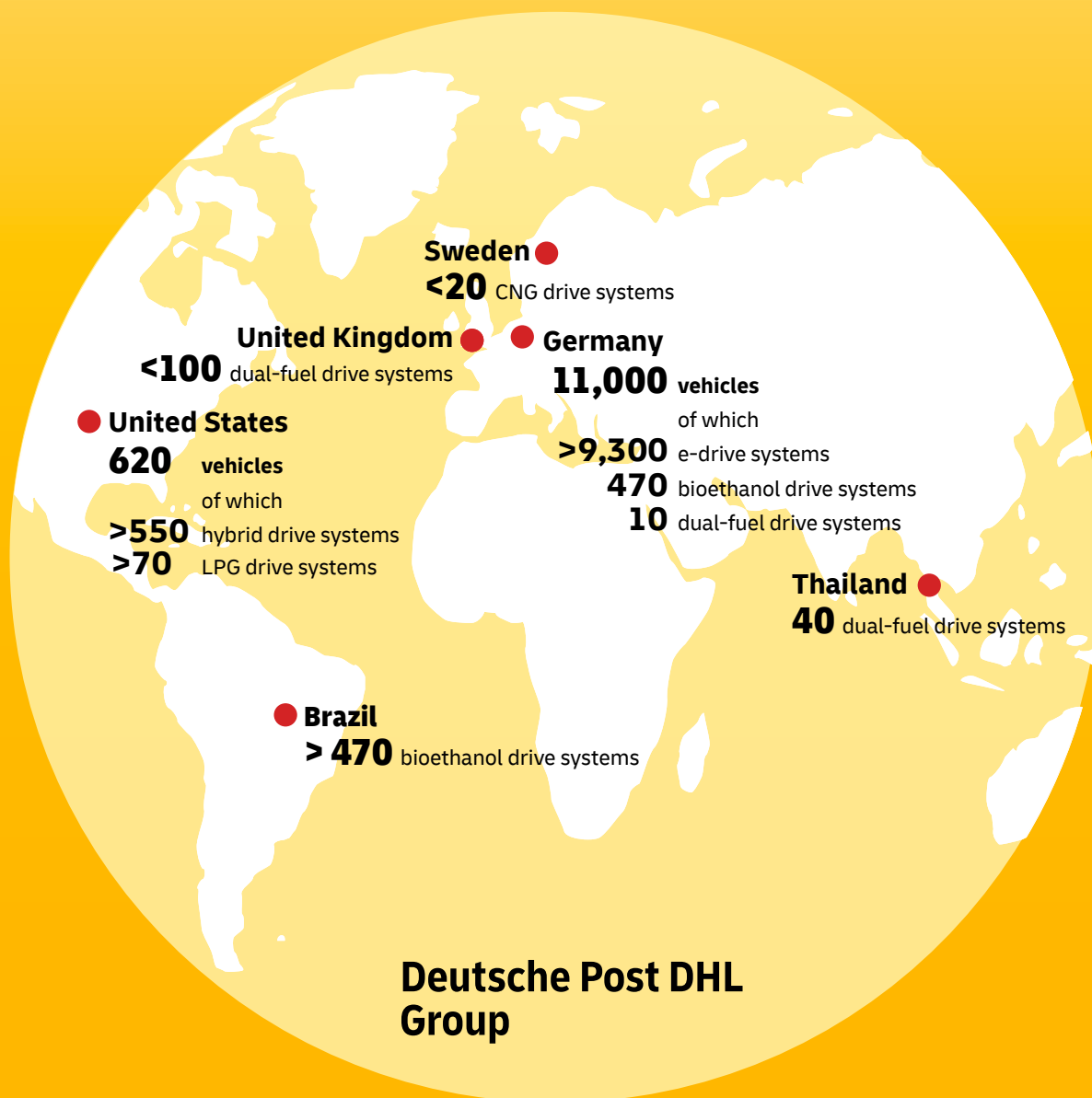
The co-optimization of fuel and engine technologies has great potential to improve efficiency and reduce pollutant emissions from internal combustion engines. This initiative brings together the know-how and resources of nine national laboratories, 20 universities and industry partners in a bid to explore how fuel and engines can work together to improve efficiency and performance while at the same time minimizing emissions. Our goal is to achieve broad application potential in road transport, from light passenger vehicles to heavy trucks.

Will internal combustion engines be banned from the road in the long term?

In the future, there will be a wide range of different technologies which will span pure electric and hybrid combustion-electric to combustion-driven drive systems. The decision to opt for a given technology requires like-for-like comparison of its social, economic and environmental impacts. Successful technologies need to be competitive, particularly in terms of cost, user requirements, life-cycle emissions and life-cycle efficiency; they must also ensure domestic security, while taking into account societal impacts associated with the manufacture and purchase or recycling of critical materials. In this regard, the internal combustion engine and its associated infrastructure have proven their worth. Innovative technological developments are improving the overall efficiency and emission signature of combustion-based technologies.

How do you envisage the vehicles and fuels required for GHG-neutral road transport?

That is the key question that the stakeholder industries are currently putting considerable time and investment into tackling. Fuels will be more diverse in the future. There is a clear trend towards renewable electricity and renewable liquid fuels. Synergistic with this is a need for energy-dense storage for improved utilization of renewable electricity through longer-term energy storage and/or the ability to ship large quantities of energy between regions. Liquid fuels are well suited for this dense energy storage. In addition, future greenhouse-gas-neutral solutions should leverage the infrastructure that already exists for electricity and liquid fuels. These infrastructures are for the most part already capable of handling net-zero or net-low carbon fuels.



Real-world Uses

Alternative fuels are already being used in many different ways in the business world, including at Deutsche Post DHL Group. We consider battery-powered e-vehicles like our StreetScooter to be the best way to improve air quality in cities in the short term and minimize our short-range carbon footprint. As we wait for direct electrification to become a commercially feasible option for trucks, we are testing alternative fuels such as LNG and CNG.

The StreetScooter, an e-vehicle we developed ourselves, is the flagship of our alternative road transport fleet. We now have 10,000 StreetScooters on the road in Germany as well as in other countries in Europe. In Asia, we are actively working to replace conventional motor scooters with e-scooters. In Europe, we are expanding the use of City Hub solutions in which vans are being replaced, among other things, by battery-supported cargo bikes.

StreetScooter: A success story

- 10,000 StreetScooters on the road
- Over 100 million kilometers driven
- Carbon savings of around 36,000 tonnes
- Large series production in Europe
- Sale to third parties and customers

Type	Load capacity	Range
Work	4.3 m ³	80 to 113 km
Work L	8 m ³	80 to 187 km
Work XL	20 m ³	up to 200 km



Testing the e-highway

Using pantograph-equipped overhead-line hybrid trucks, heavy transports for distances of more than 400 kilometers can be electrified while eliminating the known weaknesses of e-mobility caused by expensive, heavy batteries. The underlying technology is much more efficient than liquid or gaseous fuels and has the potential to dramatically reduce air pollutants. Compatible commercial vehicles can be equipped with battery, hydrogen or diesel hybrid drive systems.

The first e-highway was opened in Sweden in 2016. In May 2019, Germany began its first major, three-year trial on the A5 autobahn between the cities of Frankfurt and Darmstadt. Along that 5-kilometer stretch, specially equipped diesel-hybrid trucks can charge their batteries via overhead lines in both directions. Two other trials are planned for northern and southern Germany. We are convinced that this is an option worth pursuing. It could eventually play a key role for e-mobility.



Natural gas as a transition technology

Trucks equipped with LNG/CNG drive systems are one practical alternative to conventional diesel vehicles. Depending on availability, sustainable biomethane or e-methane could be used. In 2018, Deutsche Post DHL Group added four heavy duty vehicles with a total authorized weight of 40 tonnes and LNG drive systems to its fleet in Belgium. In March 2019, the first LNG heavy vehicle equipped with a megatrailer was deployed in Germany, something that had not been possible until then because of tank design. In Sweden, two heavy vehicles with bio-LNG are scheduled to augment the drop-in biodiesel fleet starting in 2020. The purchase of six more vehicles is planned through 2023 with the support of the Swedish government.

Hydrogen in heavy transports

Together with other logistics companies in Germany, Belgium and the Netherlands, we have joined the H2-Share project funded by the European Regional Development Fund. Starting in 2020, every company involved in the project will operate a 27-tonne, zero-emission hydrogen truck for a period of three months. Given the environmental benefits involved, we are supporting the effort to examine, develop and test this truck technology. We believe fuel-cell range extenders that can boost e-battery power are a more practicable use of hydrogen that could help extend ranges for BEV vans and e-trucks. In May 2019, we placed an order for 100 new hydrogen-powered StreetScooters with a gross vehicle weight of 4.25 tonnes, an additional fuel cell and a range of up to 500 kilometers. We are the first logistics provider to use a large number of electric vehicles with fuel cells for last-mile transports. Their purchase was made possible with financial support from Germany's Ministry of Transport and Digital Infrastructure (BMVI).

E-fuels nearing industrial production

As part of the GreenPower2Jet project, we are supporting the first large-scale production of PtL fuels in Germany. A consortium of companies and research institutes has plans to build a PtL plant near Hamburg. The plant would then deliver synthetic hydrocarbons to a refinery in Lingen for conversion into climate-neutral jet fuel. Byproducts from the process can then be used to produce green diesel for use in heavy-duty vehicles and ships. The project began as a proposal in the idea competition "Regulatory Sandboxes for the Energy Transition" launched by the German Ministry for Economic Affairs and Energy (BMWi). Even without funding from the ministry, the consortium remains confident that it can continue to push production of GreenPower2Jet.







Marijn Slabbekoorn

GoGreen Program Manager
Ground Operations Europe
DHL Express, Netherlands

“What we really need is a wider variety of actually available and suitable zero-emission vans, especially in the large commercial vehicle segment.”

DHL Express, Netherlands

As part of the Group-wide environmental protection program GoGreen, DHL Express in the Netherlands has initiated a range of projects to facilitate emission-free pick-ups and deliveries in our network in Europe.

Zero-emission logistics in Europe

What are your main focus areas?

Currently we're focused mainly on last mile solutions, which apply to a relevant share of our routes. More and more cities are banning diesel vehicles from their city centers, and we want to do our part in improving urban air quality. In several cities we've successfully tested our City Hub solution, which brings the shipments to a central location in the city where they're picked up by couriers and parcel delivery personnel. We're using more and more cargo bicycles and electric vans in densely populated urban areas to relieve traffic pressure.

What is needed for zero-emission logistics?

We are already using the StreetScooter on routes up to 200 kilometers. What we really need is a wider variety of actually available and suitable zero-emission vans, especially in the large commercial vehicle segment. There is still a large discrepancy between the clean solutions available on the market today and our targets for 2025. Public investment – both in e-vehicles and in the construction of charging stations – could help meet the challenges we face.

Where do you see opportunity for hydrogen technology?

We believe in the technology and see a lot of opportunity, especially for heavy duty and long range. That's why we're supporting the development of a hydrogen-powered truck to be used in a pilot in the Netherlands and Germany. Still, hydrogen-powered vehicles and the corresponding infrastructure are about five to ten years behind battery electric vehicles in terms of technology and infrastructure. I would have to travel ten kilometers to reach the closest hydrogen filling station. Creating the necessary infrastructure will require tremendous effort. But we're holding on to our vision of emission-free logistics in Europe nonetheless.



Maria Nilsson Öhman
Sustainability Manager, DHL Freight, Sweden

“The transition works if government officials, companies, subcontractors and customers pull together.”

DHL Freight, Sweden

In collaboration with its transport subcontractors, DHL Freight in Sweden is converting more and more of its fleet to sustainable fuels and alternative drive systems. And as it does, Global Forwarding, Freight plays an important role in achieving Deutsche Post DHL Group’s environmental targets.

Sweden – role model for Europe

What were the drivers behind the rapid increase in your biodiesel use?

It’s really a combination of government action and a commitment by DHL, its subcontractors and customers to greener freight. Government subsidies have made the price of biofuels competitive over the last few years. The government also requires fuel companies to blend roughly 26% biofuel in all diesel fuel. That percentage will increase gradually over time to help meet Sweden’s carbon reduction goal of 70% for the transport sector in 2030.

You mentioned the role of customers ...

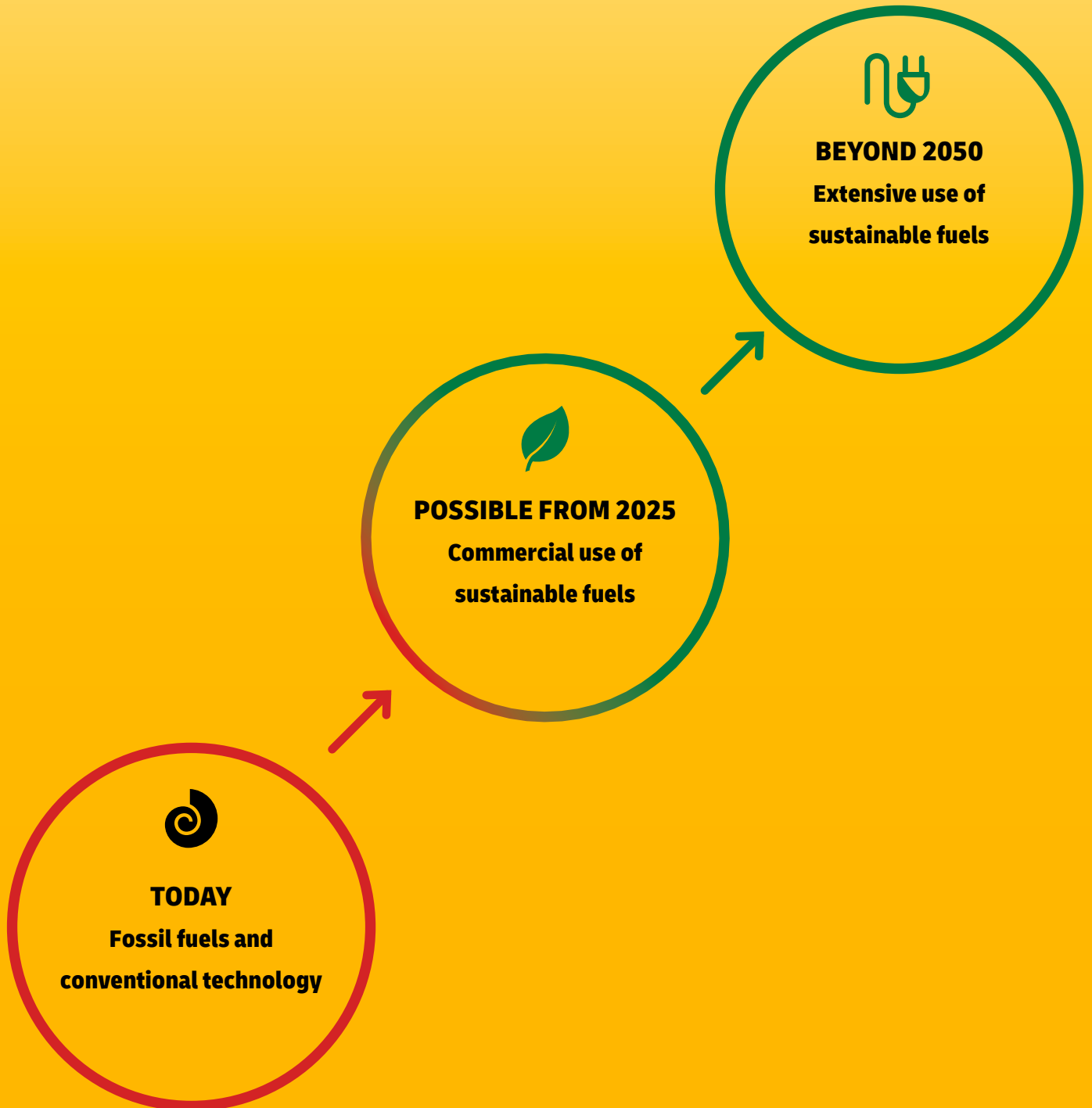
Despite government subsidies, biofuels often remain more expensive than regular diesel. Our approach here is to pay haulers more if they agree to use cleaner fuels or technologies. To cover this cost, we sell green “shares” to our customers; this revenue allows us to replace a fossil-fuel vehicle with one that runs on renewable fuels. For customers, it’s a way to reduce their carbon footprint and play an active role in making the freight industry greener. Customer demand plays an important role, too!

Why did you choose HVO as your biofuel?

HVO (hydrotreated vegetable oil) is used a lot in Sweden and has a proven track record for heavy vehicles such as buses, trucks and construction equipment. It’s made from 100% renewable raw materials, mostly from waste or residues, and can reduce carbon emissions by up to 90% compared to regular diesel. We like the fact that it’s mainly a waste feedstock and that it’s a drop-in, so perfectly compatible with existing diesel engines. As of Q1 2019, we had 677 heavy vehicles running on the 26% blend and an additional 171 trucks running on either 50% or 100% HVO.

Why are you investing in bio-LNG now?

Bio-LNG is actually cheaper than HVO and better in terms of carbon emissions over long distances, so there’s an economic and environmental win over the life cycle despite the investment required. The government has recognized these benefits and is subsidizing our investment in eight new LNG trucks. We also want to diversify our fuel stock because we expect a shortage of HVO when the rest of Europe goes for higher-blend biofuels in the future.



Conclusions

- 1 E-mobility is the technology of choice in the transport sector. But its use is currently restricted to short range transports only.
- 2 Drop-in fuels are compatible with current technology and can replace fossil fuels.
- 3 Non-drop-in fuels require modified engines or new technology.
- 4 Second-generation biofuels and e-fuels are beginning to gain a foothold.
- 5 Biofuels and power must come from renewable sources.
- 6 Production of plant-based biofuels should not lead to monocultures and destruction of crop land and rain forests.
- 7 Progress can only be accelerated through dialogue and coordinated action.
- 8 A global knowledge base is needed if we are to develop common standards.
- 9 Economic incentives could remove barriers for companies.

A Look at the Future

Is emission-free logistics possible?

Logistics involves road, air and ocean transports that currently still produce greenhouse gases. For this reason, we have to consider ways in which we can reduce this effect. Sustainability in everything we do lies at the core of our Group strategy and is integral to our processes and operations. Group policies take in environment and climate protection along with our social responsibility. In addition, we continuously invest in new technologies and test them under real business conditions. For example, we have been very successful with our StreetScooter, a vehicle that we have developed from the model project stage right through to being market leader in the electric delivery vehicle segment. As a large fleet operator, we bring our knowledge and experience to the public debate and play an active role in developing sustainable fuel initiatives to advance work on alternative drive options and fuels.

Which fuel offers the most potential?

There is no single sustainable fuel that can be used for all modes of transport and in all locations. One thing is certain: While we are primarily focusing on e-mobility for short distances, when it comes to long-haul shipments and heavy road transports, liquid fuels are set to remain the main fuel solution for some time to come. Until e-mobility has become mainstream for aviation and ocean transport, we view e-fuels from green electricity – in particular Power-to-Liquid (PtL) fuels – as a strong interim solution. Another interesting alternative, primarily when it comes to long-haul or extending the range possible over short distances, is fuel cells.

What are the next steps?

Deutsche Post DHL Group is involved in various initiatives aimed at developing sustainable fuels. In addition to this, we are already testing various alternatives such as biokerosene in our operations. But if an adequate range of new technologies such as synthetic fuels (PtL) were available, we might be a lot further forward in reducing greenhouse gas emissions. In order to make this new generation of fuels available on an industrial scale as quickly as possible, we need strong incentives to spur demand and production.

What makes e-fuels so interesting?

Even today, PtL fuels in particular can be used in conventional vehicles and aircraft, largely without any need for modifications. Better still, they are a solution to one of the biggest challenges facing Germany's energy transition. PtL involves capturing CO₂ from the air and serves as a carrier for energy from renewable sources – it can also be transported over long distances. Given these benefits, PtL fuels are set to become a key economic factor in the coming years.

One last question – what should happen next?

We won't make much progress with isolated solutions. To achieve lower-emission logistics in the near term and zero-emission logistics in the long term, we need to take a cross-sectoral, cross-border approach for e-mobility and synthetic fuels. I believe that other companies and interest groups will follow our example so that the markets for sustainable fuels and technologies will grow and become more robust. This will drive development and scalability – and increase competitiveness against traditional fossil fuels. We need global supply certainty and infrastructure so we can fuel and maintain our cross-border transport fleets. We could then secure our business model for the future and shape it in a way that promotes climate and environmental protection.



***“We need a common approach
and a global standard.”***

DR. THOMAS OGILVIE

Board Member Deutsche Post DHL Group
Human Resources, Labor Director, Corporate Incubations

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