ECFD
European Confederation of Fuel Distributors

ECFD information

10 facts about e-fuels:
The essential contribution of synthetic fuels for a successful energy transition

Our policy proposals to accelerate the scale-up of e-fuels:

1. EU CO_2 emission standards regulation for cars and trucks: Recognition of renewable fuels as an option to achieve the CO_2 reduction targets via a fuel crediting system for new vehicles.

2. Renewable Energy Directive: Ambitious sub-target for e-fuels and thus minimum quantity quota for the entire transport sector.

3. Renewable Energy Directive: Application-optimised design of the electric power procurement and sustainability criteria for power-to-X-products like hydrogen and e-fuels.

4. EU Emissions Trading Scheme: Application of a zero-emission factor for CO2-neutral fuels such es e-fuel in the event of an extension of the ETS to the transport and heating sectors.

5. EU Energy Efficiency Directive Buildings: Rejection of the legal basis for a national ban on heating systems from 2027 onwards, as CO_2-neutral fuels can be used in these as a compliance option for achieving renewable energy targets.

6. EU Energy Tax Directive: Minimum tax rate as in the current proposal should be welcomed as it provides the basis for a low tax level for e-fuels.

Johannes Heinritzi
President

Matthias Plötzke
Secretary General ECFD

Dear Ladies and Gentlemen,

Last year, the European Commission presented numerous regulatory proposals, among others in the framework of the “Fit for 55” package, all of which have the common goal of implementing the climate protection goals of the EU’s “Green Deal”. In essence, it is about the climate-neutral conversion of energy-intensive sectors such as energy, transport and heat and the expansion of renewable energies in all forms, such as green power, hydrogen and liquid energy sources. The regulatory proposals provide for a broad portfolio of technology-based, market-based and regulatory measures.

The fact is that without CO_2-neutral fuels the climate targets will not be achieved. It is therefore imperative to use all potentials. This includes the use of sustainable conventional and advanced biofuels. It is also urgently necessary to start the rapid market ramp-up of renewable fuels of non-biological origin (RFNBO). These synthetic liquid fuels, also called e-fuels, can be used as fuels in the transport and heating sectors.

E-fuels are made from hydrogen and CO_2 by using electricity from renewable sources, thus a sustainable liquid energy carrier that can make an enormous contribution to the EU’s climate protection goals. E-fuels can be used in the existing 1.3 billion motor vehicles worldwide as well as in new vehicles with internal combustion engines coming onto the market in the future. Cars, trucks, aircraft, ships or even heating devices do not need to be technically adapted for this purpose.

E-fuels are a so-called no-regret measure and a global solution to the global challenge of defossilising the transport and heating sectors. They make it possible to import renewable energies from sun- and wind-rich areas in liquid form and make them usable worldwide.

In this brochure we present facts about e-fuels, such as production process, costs, possible applications and contribution to climate protection. This brochure is a compilation of a series of single e-fuels information editions we wish to make available to you.

As the European Confederation of Fuel Distributors, we are committed to the regulatory and political recognition of e-fuels in Europe and would like to win your support.

We wish you informative insights and will be happy to answer any questions you may have.

Johannes Heinritzi
President

Matthias Plötzke
Secretary General

Content

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E-fuels – CO_2-neutral synthetic fuels

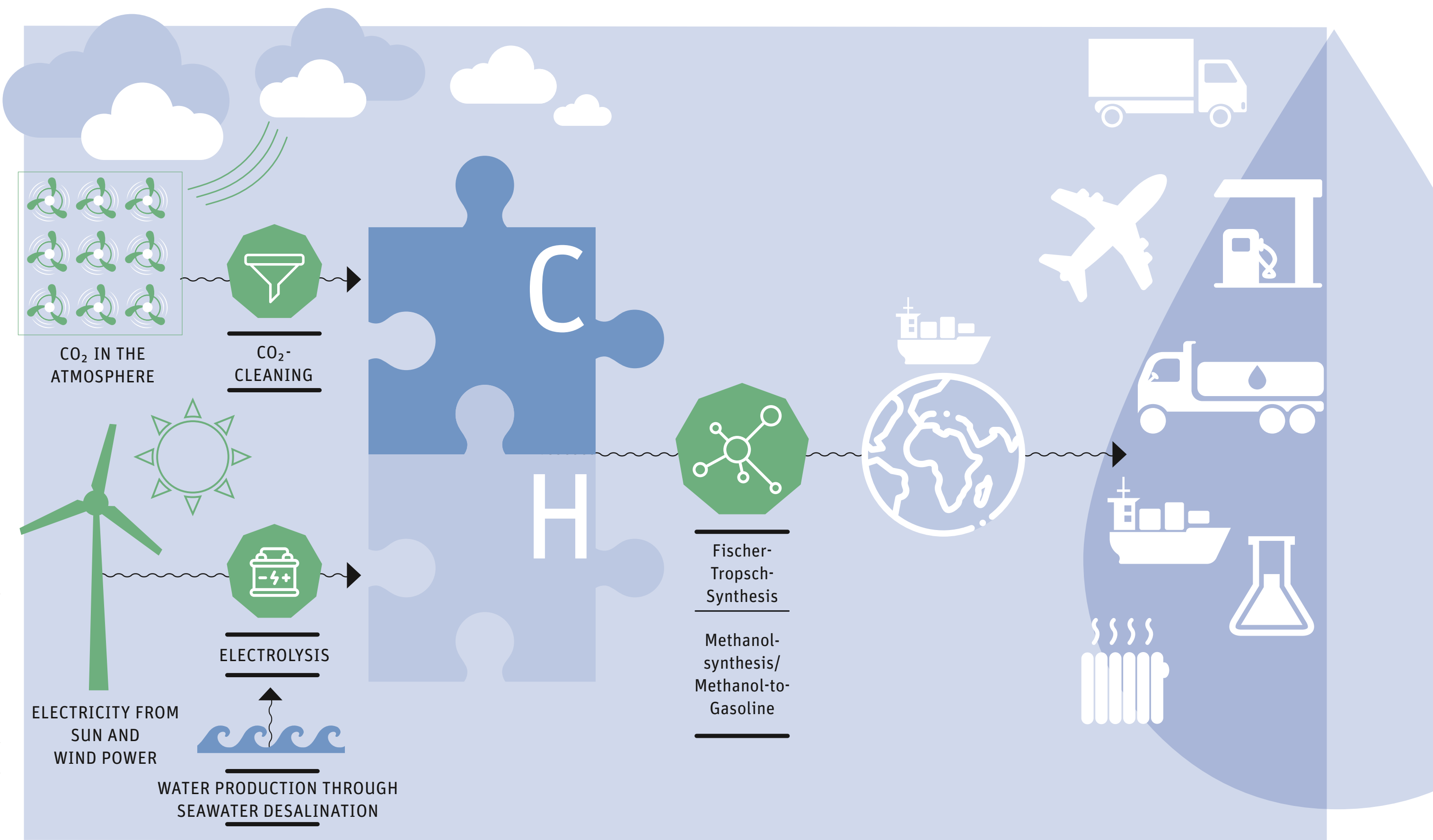
A successful energy transition can only succeed with e-fuels:
For large segments of the passenger car and commercial vehicle fleets, the goals of the energy transition – security of supply, sustainability, and affordability – can be achieved most efficiently with e-fuels.
Furthermore, no sensible technological alternative to CO_2-neutral synthetic fuels is in sight for aviation, shipping, and heavy-duty transport.

What are e-fuels? Liquid, storable, renewable electricity!

E-fuels are CO_2-neutral liquid fuels produced from renewable energy sources. All it takes is electricity from the sun and wind, water and carbon dioxide (e.g. from the air). E-fuels can thus make a significant contribution to the achievement of climate protection targets in the transport and building sector. E-fuels have decisive advantages: they have high energy density and are easy to store. This enables low-cost renewable energies from sun- and wind-rich areas to be harnessed worldwide.

How are e-fuels manufactured? Exclusively renewable!

E-fuels have been extensively researched, and scientific expertise is available for a market ramp-up. Power-to-liquid (PtL) pathways, which generate electricity-based liquid fuels using renewable electricity, are the basis for producing e-fuels. First, hydrogen is produced from desalinated seawater via electrolysis using renewably generated electricity, which is then synthesized with carbon dioxide using the Fischer-Tropsch process, or methanol synthesis, developed in Germany as early as 1925 to produce a greenhouse-gas-neutral liquid fuel. This can then be used as an additive in gasoline, diesel or heating oil, or as a pure CO_2-neutral fuel and combustible that can replace all of today's conventional liquid energy sources.



What are the arguments pro e-fuels? CO_2-neutral, affordable, usable everywhere!

E-fuels are environment- and climate-friendly.

- E-fuels can be imported from sun- and wind-rich areas of the world. In Germany, no additional expansion of wind power and solar plants is needed just to make use of e-fuels. This will increase acceptance of the energy transition.
- E-fuels are CO_2-neutral. They do not produce any additional greenhouse gases.
- E-fuels can be easily stored. The general problem of the energy transition, namely being unable to continuously feed renewable energy to the grid and have it permanently available, can thereby be elegantly solved.
- The combustion of e-fuels produces less nitrogen oxides and particulate matter than conventional fuels.
- E-fuels do not have battery electric mobility's disposal and recycling problem.

E-fuels are swiftly useable and versatile.

- E-fuels can be used with conventional combustion engines and fuel-efficient condensing boilers. They can thus be used in roughly 58 million vehicles as well as for efficient heating in millions of private households in Germany.
- The established flexible distribution logistics network enables e-fuels to reach the market and consumers quickly.
- E-fuels can be easily blended with conventional liquid fuels (from 1 to 100%).
- E-fuels are universally suitable for all modes of transport – passenger cars, trucks, aircraft, ships. Furthermore, they can be used as a crude oil substitute in the chemical industry.
- In aviation and shipping, in construction, agriculture and forestry, and in large segments of heavy-duty transportation, there is no viable technical alternative for the use of e-fuels.

E-fuels are user-friendly and convenient to deploy.

- Thanks to e-fuels, there is no longer any need for expensive technology changes in transportation and residential heating. For consumers, this means no conversion costs, no reorientation to new technologies, and hence the familiar, relaxed use of a safe energy source. This encourages acceptance.
- E-fuels can be distributed throughout Germany and are therefore readily available to consumers.
- E-fuels bring together all the advantages of liquid energy sources in transportation: a short refuelling process and high energy density, allowing vehicles to travel a long distance.
- E-fuels can be produced for around €1 per litre in the medium term, as studies by renowned research institutes have shown. This will keep fuels and combustibles affordable for consumers.

E-fuels strengthen international energy cooperation and secure Germany as a business location.

- Germany cannot satisfy its energy needs from CO_2-neutral energy sources alone and is therefore compulsorily dependent on imports of renewable energy. With e-fuels, this is both economically and technologically possible.
- E-fuels can be used throughout the world. This means developing countries can also establish CO_2-neutral energy solutions. As a result, international energy cooperation is promoted at the same time.
- Germany's world-leading expertise in engine manufacturing, including the mid-sized supplier industry, will be retained; hundreds of thousands of jobs will be safeguarded.
- German engineers are leading the world in the development of power-to-X technology, which can be used to produce e-fuels. This will strengthen the German export economy and create more than 470,000 additional jobs.

When will e-fuels be available? If the policy framework is right, then from tomorrow!

- Universities, research institutions and the industry are working intensively on CO_2-neutral fuels and have already successfully produced small quantities of e-fuels. Extensive field tests confirm their market readiness.
- At the moment, e-fuels are still being produced in small pilot plants, but the first large-scale industrial plants are expected in the mid-term.
- By 2050, complete supply of the fuels and heating market is possible.

What we request from the policymakers: Technology-neutral legal regulations that also take e-fuels into account!

- Openness to technology instead of calls for bans on internal combustion engines and oil-fired heating systems.
- Establishment of a minimum e-fuels quota of 10% by 2030 in the European Renewable Energies Directive.
- Eligibility of e-fuels for the EU-CO_2 fleet targets for new passenger cars/light commercial vehicles and trucks/heavy commercial vehicles and enforcement of a holistic view of the CO_2 balance of synthetic fuels (well-to-wheel).
- Support for e-fuel market launch by converting the energy tax to tax the fossil fuel portion of transportation and exempting it from SESTA taxation.
- Inclusion of synthetic and paraffinic fuels (EN 15940 standard) in the 10th BImSchV (Bundes-Immissionsschutzgesetzes, or Federal Emissions Abatement Act) so that e-fuels can be sold as pure fuels.
- Establishment of an import strategy for power-to-X products such as e-fuels from global low-cost locations based on energy partnerships.
- Incentive regulation via toll regulation and vehicle tax.

Video: *E-fuels - the solution for tomorrow's CO_2-neutral transport*

Video: *E-fuels – climate-friendly alternatives for the heating market*

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Energy efficiency comparison of passenger cars with synthetic fuels and battery electric propulsion

I. The overall technical efficiency of passenger car powertrains is crucial – not the efficiency of the engine alone!

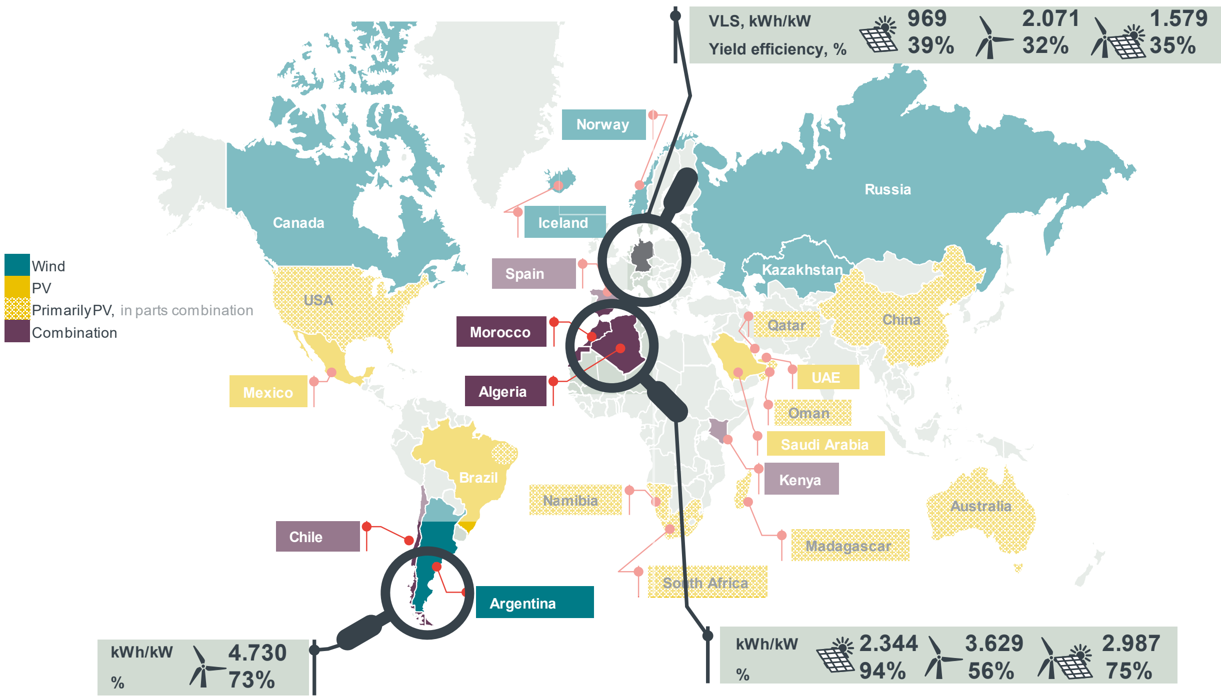
High full-load hours in electricity generation lead to high RE yield efficiencies which play a central role in overall efficiency analyses.

- Overall technical efficiency is defined as the ratio between the benefit achieved at the passenger car and the available solar and wind energy (RE), taking into account key influencing variables:
  - Use on the passenger car: driving operation, interior air conditioning, media applications.
  - Available RE: internationally accessible solar and wind power potential.
  - Influencing variables: energy conversion, charging, electricity storage losses, energy transport, etc.
- The overall technical efficiency is considered for
  - an internal combustion engine passenger car (ICEV) and renewable electricity-based synthetic fuel (PtL) and
  - a battery electric vehicles (BEV) running on RES-E.

II. Decisive in RES-E generation: The global yield efficiency! Full-load hours are what count!

- Yield efficiency makes global locations with significantly varying solar and wind energy supplies comparable across achievable full-load hours.
- Examples:
  - Yield efficiency in Germany: **PV = 39 percent, Wind = 32 percent.**
  - Yield Efficiency in NA/MAR: **PV = 94 percent, Wind = 56 percent.**

At non-European RE sites, several times the amount of renewable electricity can be "harvested" with the same PV or wind power plant compared to Germany.

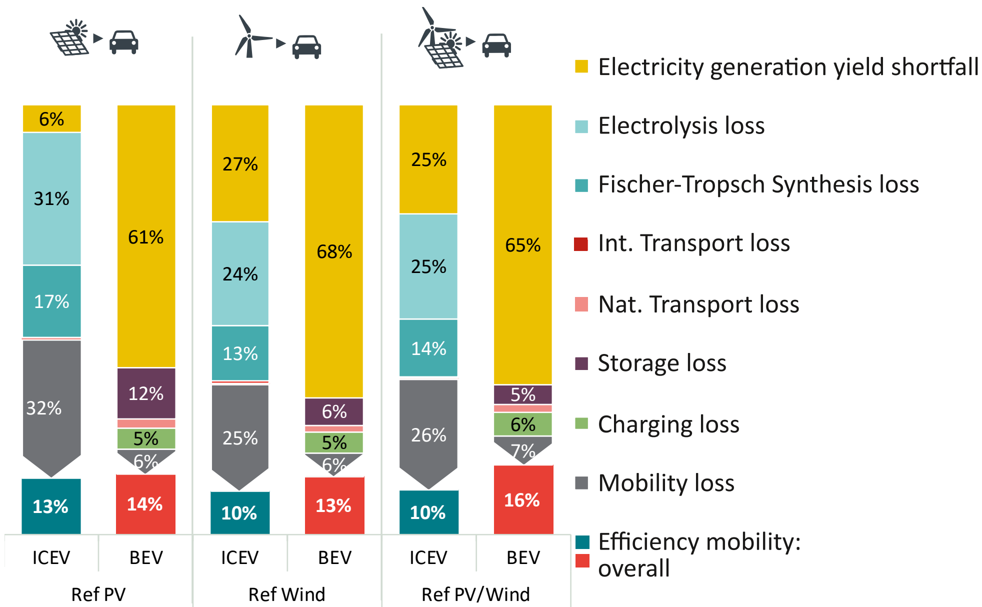


Source: RE potential at the country level: Frontier Economics (2018); VLS: D - PV/Wind/Mix: Calculated by Frontier based on the BMWi (2020) time series on the development of renewable energy in Germany; Calculated based on the actual yield efficiency of the technologies; Wind: onshore share 90% and offshore share 10%, Mix: 50:50 ratio between wind and PV. North Africa/Morocco-PV/wind/mix: Frontier Economics calculated on the basis of Agora and Frontier Economics (2018) and expert interviews. Argentina/Patagonia-Wind: Frontier Economics calculated on the basis of EVwind (2020) - Wind energy in Argentina: YPF wind farm

III. Overall efficiency: passenger cars with e-fuels are on par with battery passenger cars!

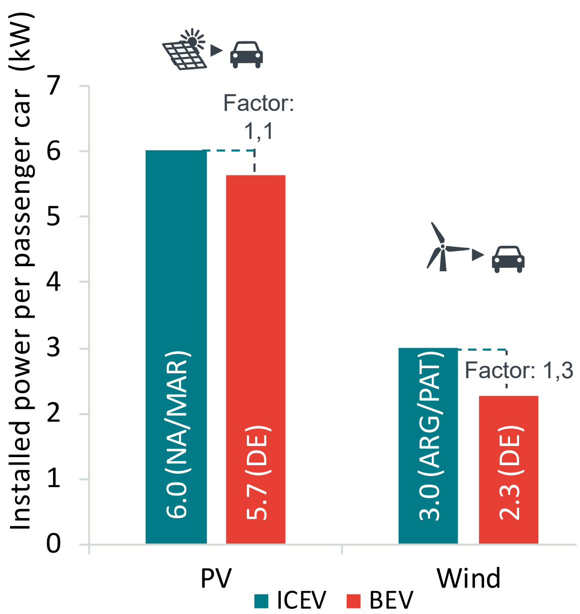
- Consideration of RE yield efficiency and other influencing parameters leads to an overall technical efficiency of
  - for PtL-ICEVs, amounts to **approx. 10 to 13%** (PtL production: international locations)
- for BEVs amounts to **approx. 13 to 16%** (RE electricity generation: domestic or local to passenger car operation).

Source: Frontier Economics
Note: **Ref PV** – BEV: PV generation in DE (969 VLS/ 39% yield efficiency), Grid/transport losses: 5%, Charging losses: 20%, Storage losses (seasonal): 15%, BEV efficiency: 71%; ICEV: PV generation in North Africa/ Morocco (2344 VLS/ 94% yield efficiency), Electrolysis (Ee) efficiency (NT): 67%, Fischer-Tropsch Ee.: 73%, Transport losses (int.): < 1%, Transport losses. (nat.): 1%, Efficiency ICEV: 29%.
Ref Wind – BEV: Wind power plants in Germany (2071 VLS/ 32% yield efficiency), Grid/transport losses: 5%, Charging losses: 20%, Storage loss (seasonal): 10%, BEV efficiency: 71%; ICEV: Wind generation Argentina/ Patagonia (4730 VLS/ 73% yield efficiency), Electrolysis (Ee) efficiency: 67%, Fischer-Tropsch Ee.: 73%, Transport losses (int.): < 1%, Transport losses. (nat.): 1%, Efficiency ICEV: 29%.
Ref PV/Wind – BEV: PV and wind power plants for electricity generation in Germany, each 50%. (1,579 VLS/ 35% yield efficiency), Grid/transport losses: 5%, Charging losses: 20%, Storage losses (seasonal): 5%, BEV efficiency: 71%; ICEV: PV and wind power plants in North Africa/Morocco, 50% each. (2,987 VLS/ 75% yield efficiency), Electrolysis (Ee) efficiency (NT): 67%, Fischer-Tropsch Ee.: 73%, Transport losses (int.): < 1%, Transport losses. (nat.): 1%, Efficiency ICEV: 29%.



Efficiency differences between BEVs and ICEVs powered by PtL melt away when considered as a whole.

IV. E-fuels do not require more installed PV or wind plants. Only better international locations.



Result:

- BEV use in Germany would require an installed PV power of **5.7 kW** or wind power of **2.3 kW** in Germany.
- An installed PV capacity of **6.0 kW** in NA/Morocco or a wind capacity of **3.0 kW** in Argentina is required to use a PtL-ICEV in Germany.

(Based on an average passenger car mileage of 13,975 km according to KBA 2020).

Overall efficiency analysis does not provide any justification for favouring a single technology.

Important conclusions:

- A political pre-selection of drive technologies in the passenger car sector based on conventional efficiency considerations is misleading, as this view ignores key influencing parameters.
- Holistic efficiency analysis takes into account all the key stages of the value chain and its influencing parameters. This provides an appropriate basis for evaluating the efficiency of technologies.
- A purely national approach is not suitable for the energy transition. Importing renewable energies in the form of e-fuels is imperative for achieving our ambitious climate targets.


frontier
economics

Translation from German original

THE CONCEPT OF EFFICIENCY IN THE GERMAN CLIMATE POLICY DEBATE ON ROAD TRANSPORT

A comprehensive approach to assessing the efficiency of technologies
(translation from the German original version)

November 2020

The study is available at
www.fuel-distributors.eu/news-and-publications

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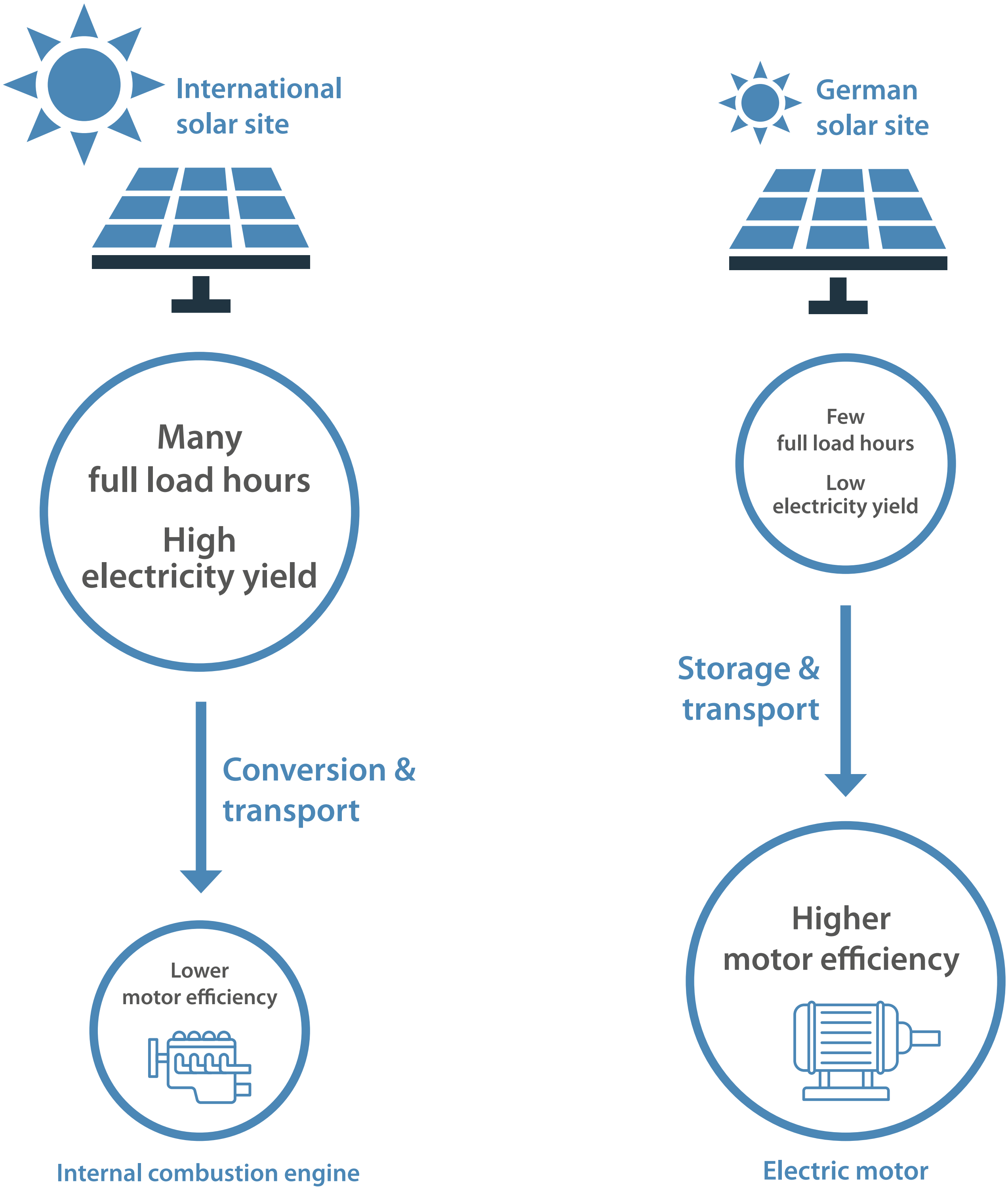
Overview: efficiency comparison ICEV vs. BEV

Overall efficiency is crucial

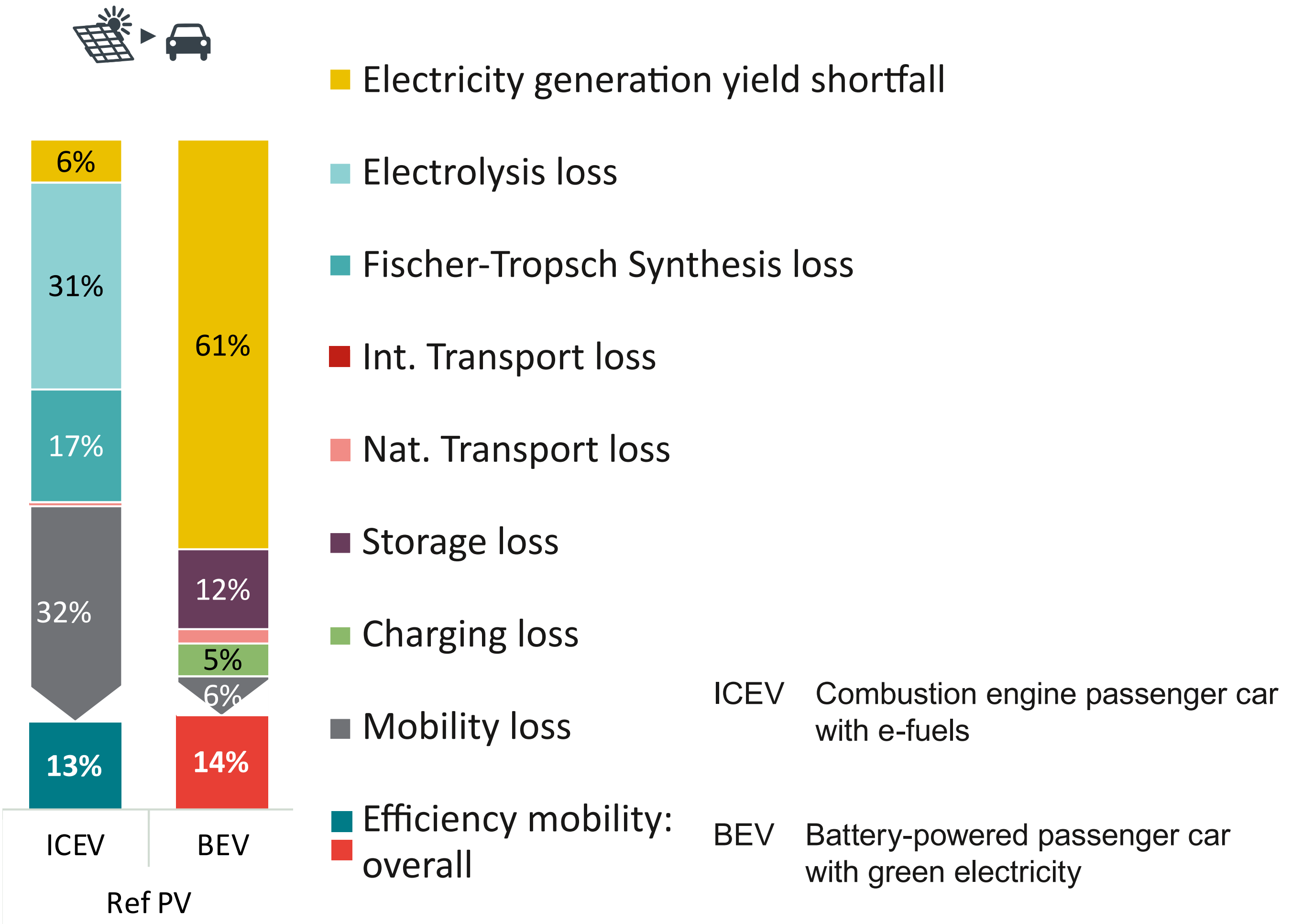


Overall efficiency Combustion engine with e-fuels

13%

Overall E-motor efficiency with charging current

14%



Source: Frontier Economics
Note: **Ref PV** – BEV: PV generation in DE (969 VLS/ 39% yield efficiency), Grid/transport losses: 5%, Charging losses: 20%, Storage losses (seasonal): 15%, BEV efficiency: 71%; ICEV: PV generation in North Africa/Morocco (2344 VLS/ 94% yield efficiency), Electrolysis (Ee) efficiency (NT): 67%, Fischer-Tropsch Ee.: 73%, Transport losses (int.): < 1%, Transport losses. (nat.): 1%, Efficiency ICEV: 29%.

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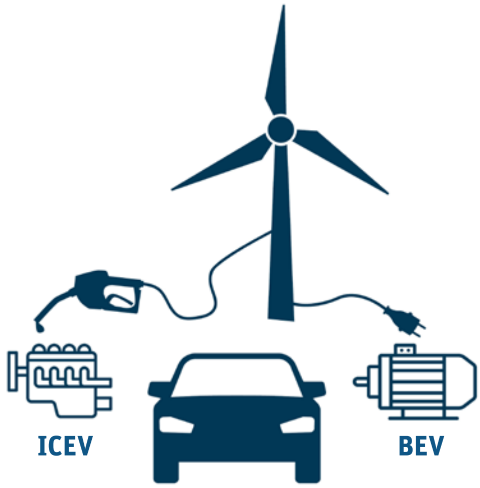
How many wind turbines does it take to drive a car in a CO_2-neutral way?

How many wind turbines or photovoltaic systems are required to cover the average annual mileage of a mid-sized passenger car (about 14,000 km) with direct electricity or with e-fuels?



Answer:

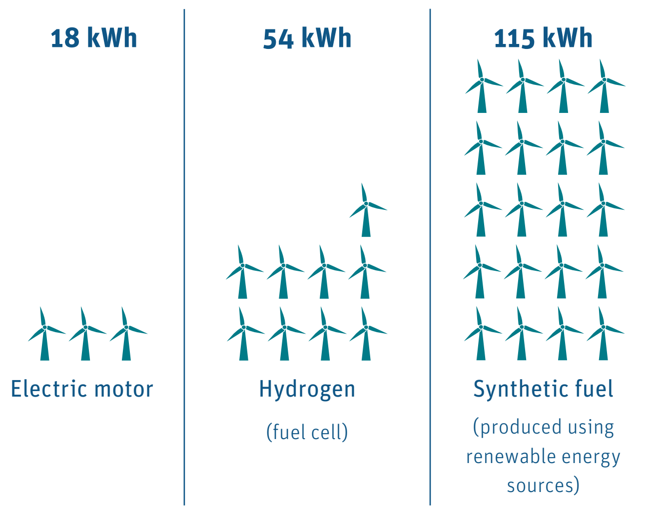
It takes almost the same generation capability/number of wind and photovoltaic (PV) plants to power a battery electric vehicle (BEV) as it would take to power an internal combustion engine vehicle (ICEV) driven by e-fuels. **This is because the location where energy is generated for the drive is what matters!** For technical reasons, the charging current for a BEV must be generated in Germany, whilst the green electricity for the production of e-fuels can be generated internationally, at particularly favourable wind- and sun-rich locations.

An erroneous basic assumption leads to wrong results and conclusions

It is frequently suggested on the basis of graphs that significantly more wind turbines would have to be constructed in Germany to generate the green electricity needed for synthetic fuel production than for the charging current of battery electric cars. **This depiction is based on the erroneous basic assumption that the electricity required for the synthesis of e-fuels is generated in Germany.**

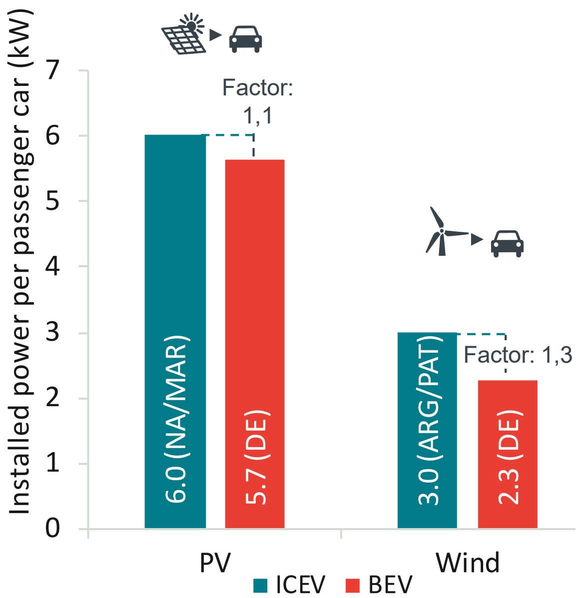
Electricity for e-fuels will be generated at international sites. This is because producing e-fuels only makes sense **technically and economically in regions with high solar and wind availability.** Potential locations are characterised by **higher full-load hour figures** – for example, in North Africa, the Middle East, Patagonia, or Australia.

Incorrect basic assumption of the German Federal Ministry of the Environment: that all renewable energy plants are located in Germany



Source: BMU: "How environmentally friendly are electric cars?" (01/2021), Icons: Porcupen – stock.adobe.com, Graphic: UNITI e. V.

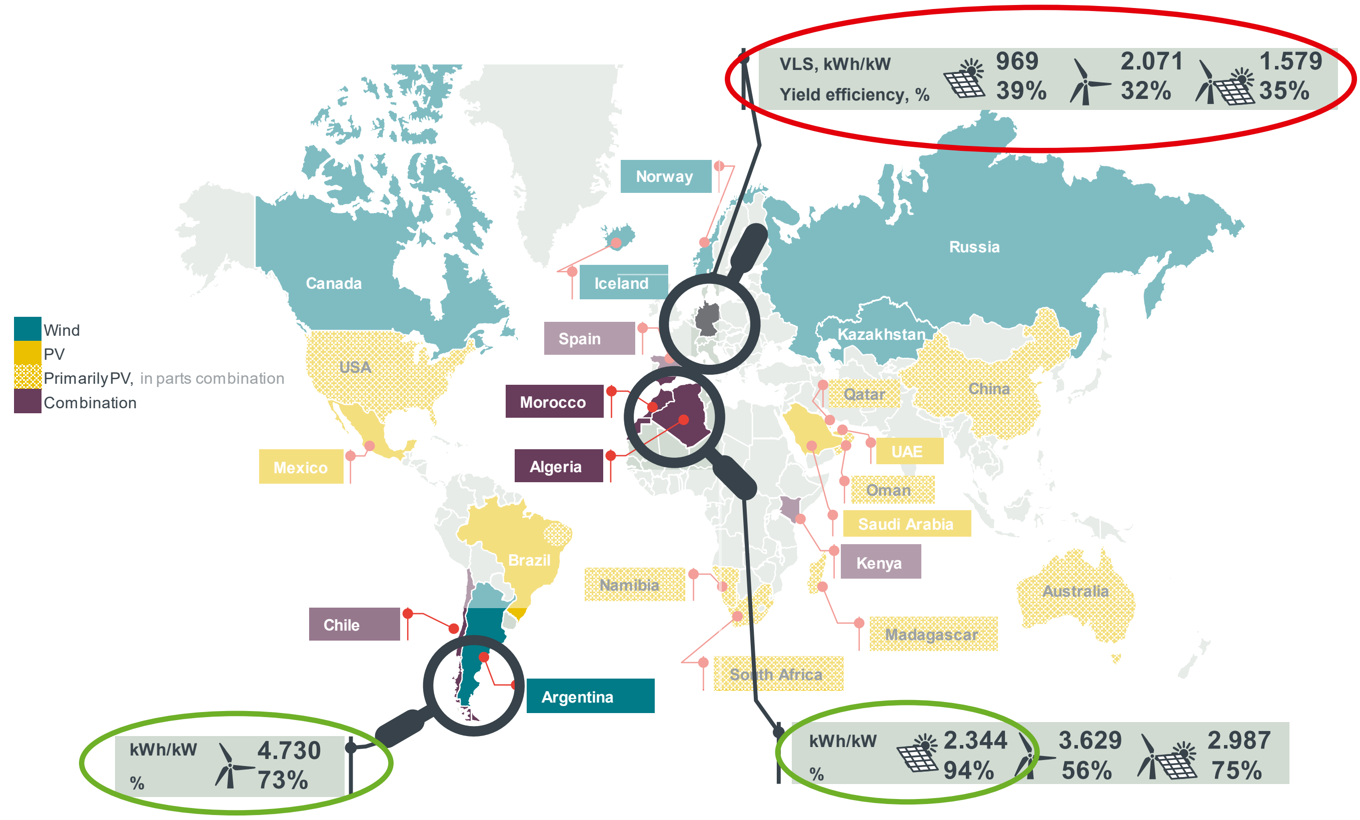
Correct basic assumption:
RE plants are located at appropriate national and international sites.



NA/MAR = North Africa/Morocco; ARG/PAT = Argentina/Patagonia; DE = Germany
Source: Frontier Economics

The number of full load hours is what counts!

With the same PV or wind power plant as used in Germany, a multiplied amount of renewable electricity can be generated from international locations. **In comparison, plants located in Germany are limited in their potential** – for example, a wind turbine used in Germany (onshore) achieves a maximum of 2,500 full load hours (VLS); on average, a wind turbine in Germany will only run for 1,500 VLS. A wind turbine installed in Patagonia can reach up to 5,200 VLS. Germany has 969 VLS available for **photovoltaic yields** and Morocco has 2,344 VLS.



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Electricity generation costs in Germany are too high

Lower electricity yields in Germany also result in **electricity generation costs** (excluding taxes, in euro cents) for wind electricity in Germany that range from 4 to 13.79 cents/kWh *. By contrast, a kilowatt-hour of onshore electricity in Morocco can be produced for between 2.5 and 4.5 cents** and a kilowatt-hour of PV electricity in Saudi Arabia for 1 cent***. Lower power generation costs, use as energy storage, and balancing of volatile RE power generation (particularly seasonal storage) make synthetic fuels a key building block for the energy transition in transportation. This is especially true since Germany will have to import about 50 percent of its future green power demand anyway.

* Fraunhofer 2018 – LCOE (Levelised Cost of Electricity) Renewable Energies
** Agora Energy Transition 2017 – Future Cost of Onshore Wind
*** Photovoltaic project "Al Shuaiba PV IP"

Conclusion: taking into account overall efficiency, corresponding potential RE locations and other factors, the alleged efficiency advantages of driving BEVs instead of ICEVs powered by e-fuels disappear.

Furthermore, there is only very limited land available for complete green power generation in Germany. Any comparisons involving production of synthetic fuels in Germany are simply misleading, because such production is not envisaged in Germany, partly for reasons of efficiency and economy. If e-fuels are produced in regions of the world with higher full-load hours, then no more wind turbines or PV plants are needed for this than for electromobility charging power!

ECFD demands:

Political pre-selection of propulsion technologies in the passenger car sector, based on abridged and thus misleading comparative analyses, hinders achievement of the CO_2-neutral transport target. The conventional efficiency analysis does not achieve its goal as this view ignores key influencing parameters.
The holistic efficiency analysis, on the other hand, accounts for all relevant stages in the value chain and influencing parameters - first and foremost, the selection of appropriate locations for RE plants. Only this provides an appropriate basis for assessing the efficiency of technologies.
A purely national approach is not helpful to the energy transition. Importing renewable energies in the form of e-fuels is absolutely essential for achieving our ambitious climate targets.

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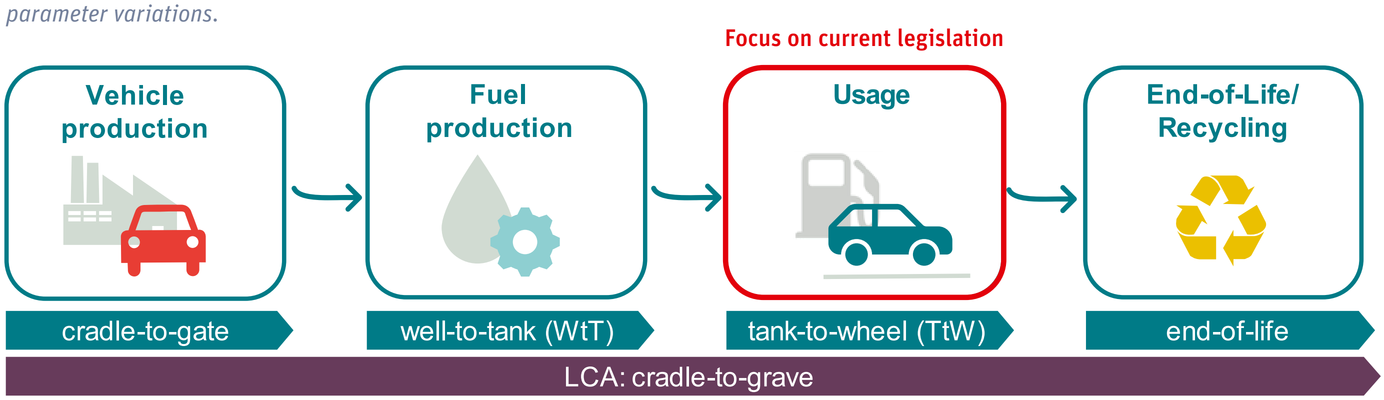
CO_2 emissions in the passenger cars and light commercial vehicles segment

Methodology of the study:

To determine the **total balance of CO_2 emissions** in the present studies for **battery electric vehicles (BEV)** and **internal combustion engine vehicles (ICEV)**, the **LCA approach** (Life Cycle Assessment) is used. The associated LCA calculation tool allows **variations of significantly influential parameters on the CO_2 overall balance**, such as vehicle segment, battery capacity, utilisation period, electricity generation[1)] and fuel mix (including prospective e-fuels admixtures[2)]), as well as country of manufacture and operating country.

Four key findings from the LCA analyses

For a comprehensive overview, it is recommended that one view the study itself or use the underlying calculation tool for one's own parameter variations.



LCA provides information about the real CO_2 balances and only then enables reliable system comparisons.

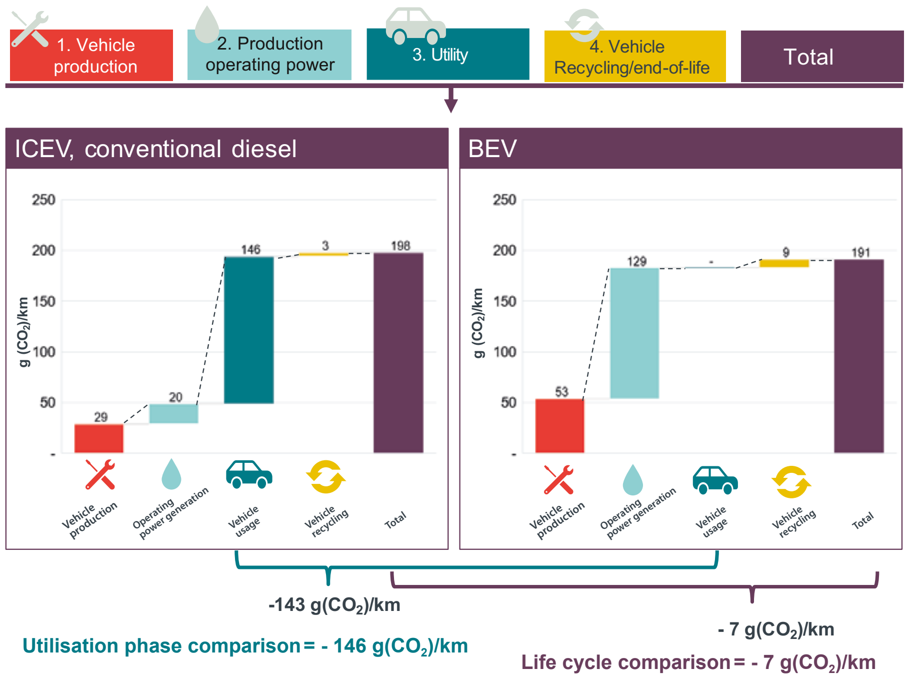
Finding 1

"Tank-to-Wheel": This accounting system is in widespread use in currently applicable legal regulations. However, it does not represent the real CO_2 emissions balance. A system comparison of drive technologies on this basis is misleading.

"LCA Approach": This system approach accounts for CO_2 emissions over the entire life cycle of the drive technology and thus represents real CO_2 emissions. The LCA approach is not taken into account in current legal regulations although it would be justified.

Finding 2

- CO_2 emissions vary in the individual life cycle phases: for BEVs, primarily in production and propulsion energy; for ICEVs in the utilisation phase.
- The accumulated CO_2 emissions over the overall life cycle for BEVs and ICEVs are relatively close to each other (example picture mid-size passenger vehicle within a standard set of practical parameters[3)]).
- A system comparison restricted to vehicle use would lead to inaccurate conclusions.

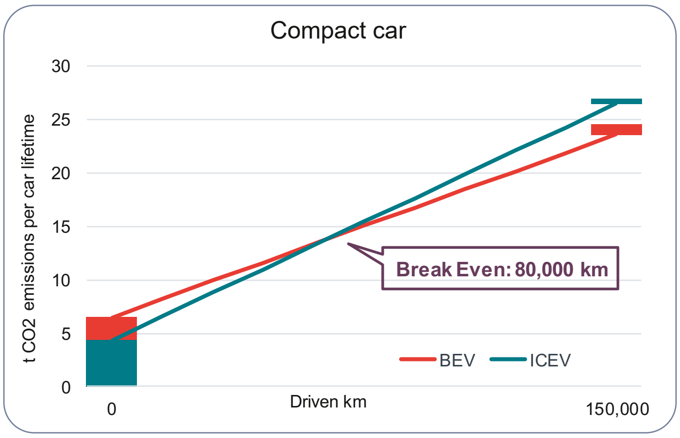


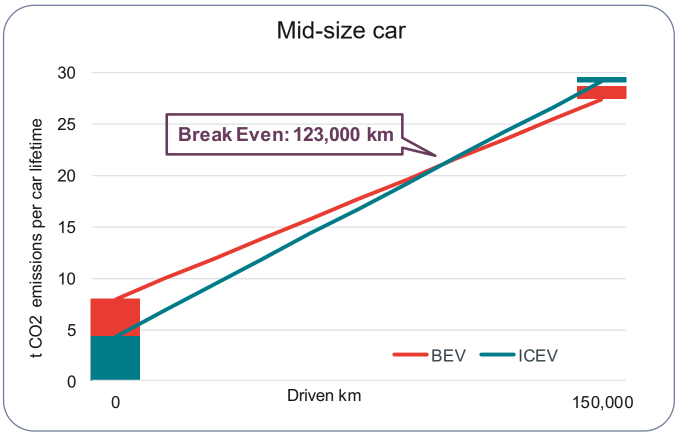
1) Developments in the electricity mix according to the World Energy Outlook 2018 (WEO) of the International Energy Agency (IEA) and "Long-term Scenarios for the Transformation of the Energy System in Germany" (on behalf of BMWi)

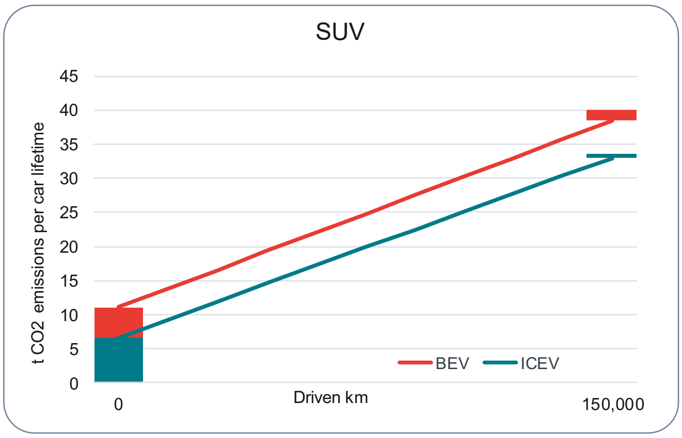
2) Possible market ramp-up of e-fuels with adequate political framework conditions ("Status and prospects of liquid energy sources in the energy transition", Prognos et al., 2018)

Finding 3

- Which technology is more beneficial over the complete life cycle with regard to their CO_2 emissions depends on several parameters. For the selected parameter set[3], for example, the compact car requires a mileage of 80,000 km before the BEV becomes advantageous over the ICEV (graphic: break even point).
- The tendency applies generally: the higher the demand for drive power, the more advantageous ICEV technology becomes (ICEVs quickly gain the advantage in terms of overall CO_2 balance at higher power levels).

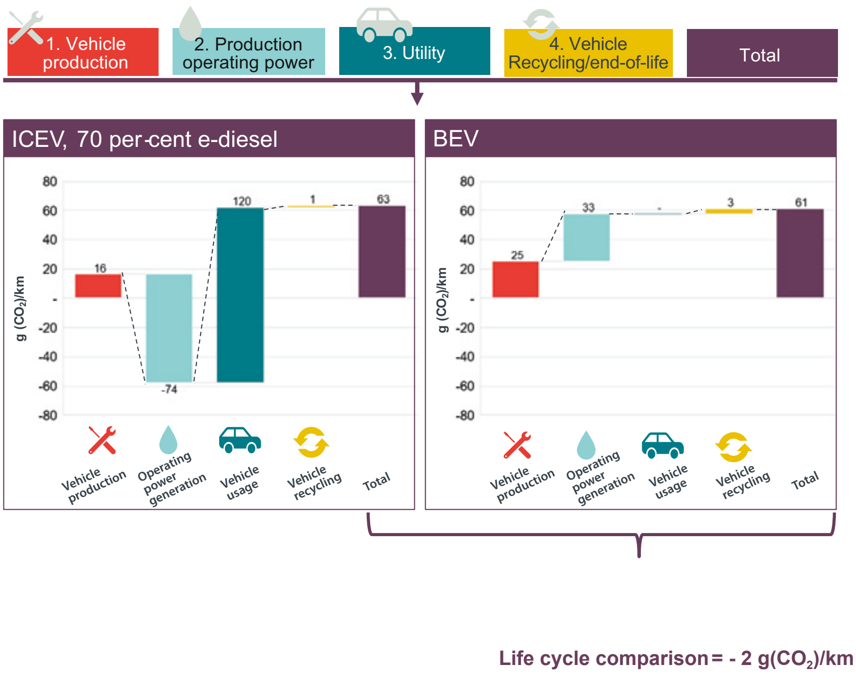






Finding 4

- With prospective increases in the RES-E proportion [1] globally, in Europe and nationally, the overall CO_2 balance improves.
- This applies for both BEVs and ICEVs, in this case with increasing shares of synthetic e-fuels.



- In the mid-size car segment, the total CO_2 emissions for BEVs and ICEVs with an assumed utilisation phase from 2040 through 2050 are at similar levels (parameter set[4]).
- From 2050, all the drive technologies under consideration could become nearly climate-neutral.

Conclusions ⇨

[3] Parameter set: Purchase year: 2020, Service life: 10 years, Annual capacity: 15,000 km, Fuel: Diesel, Operating country: Germany (Reference scenario), Manufacturing country (battery): EU (Reference scenario), Development of electricity mix: Dynamic

[4] Parameter set: Purchase year: 2040, Service life: 10 years, Annual capacity: 15,000 km, Fuel: Diesel with 70 per cent e-diesel admixture, Operating country: Germany (Reference scenario), Manufacturing country (battery): EU (Reference scenario), Development of electricity mix: Dynamic

Important conclusions:

- Technologies must be assessed holistically with regard to their real CO_2 emissions using the LCA approach.
- These days, in practical scenarios, BEV and ICEV perspectively are at relatively similar levels in terms of their total CO_2 balances.
- In further designing climate policy strategies and regulations, all target-oriented technologies in the individual mobility field must be taken into account.
- Synthetic e-fuels must be recognised as an essential measure to achieve the climate goals, i.a. in the European regulations setting emission performance standards for cars, vans and heavy-duty vehicles.


frontier
economics

THE OVERALL CO2 IMPACT FOR DRIVE TECHNOLOGIES IN INDIVIDUAL TRANSPORT TODAY AND IN THE FUTURE

LIFE CYCLE ANALYSES AS THE BASIS FOR TARGETED CLIMATE POLICY AND REGULATION

November 2019

The study is available at **www.fuel-distributors.eu/news-and-publications**

European Confederation of Fuel Distributors

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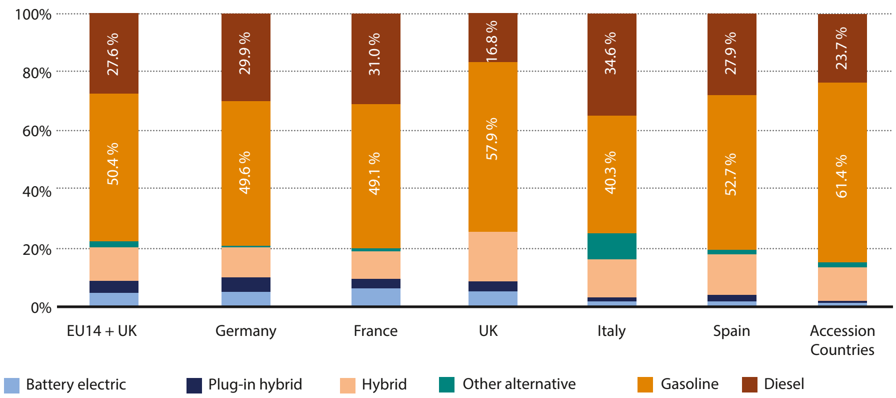
Synthetic Fuels: Economic growth, value-added and employment potential for Europe

Synthetic fuels with great potential for climate protection and value creation

- Manufactured from green electricity, synthetic fuels (so-called e-fuels) can make a **significant contribution to** reducing greenhouse gas **emissions**, worldwide, especially in the transportation and heating markets.
- Produced from hydrogen and CO_2 via renewable electricity, these **liquid energy carriers can be used in combustion engines in a CO_2-neutral manner.** This process is called power-to-liquid (PtL).
- CO_2-neutral liquid fuels offer **great leverage for improving the CO_2 balance**, as they can be used in the existing vehicle fleet.
- In the 27 EU Member States, there are currently around **249 million passenger cars**, of which only around 0.5 percent are powered purely by battery electric vehicles (BEVs). 99.5 percent, by contrast, have an internal combustion engine.
- Even just a **five-percent admixture of CO_2-neutral** fuels would be roughly equivalent, in terms of climate balance, to an entire new passenger car registration year consisting only of battery-electric vehicles powered exclusively by renewably generated electricity, via the effective leverage of the passenger car population in Germany.

Market shares for various drive concepts in new vehicle registrations in the first three quarters of 2020



Source: ACEA, 2020. IW Cologne 2021 calculations, Graphic: UNITI e. V.

The goal of **complete CO_2-neutral** can therefore only be achieved with the inclusion of **greater quantities of synthetic fuels.**

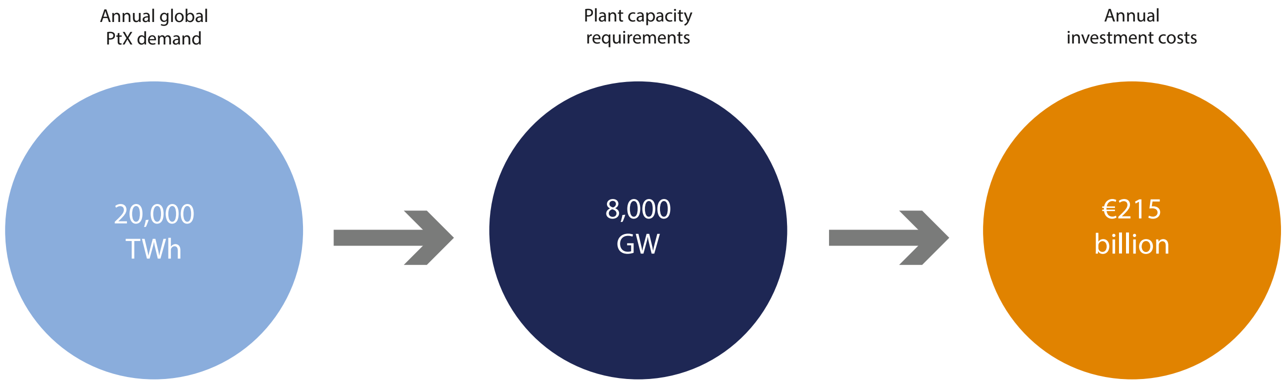
The production of synthetic fuels will require **extensive investment in facilities** for the generation of renewable electricity and its conversion into liquid energy resources (PtL). These facilities **are largely developed** and manufactured in Germany and Europe.

Institute of German Business names PtX value-creation potentials

The PtX [1]market in 2050 will equate to half of today's crude oil market.

The following values are achievable on this basis:

Calculations based on global energy demand forecasts (OECD/IEA).



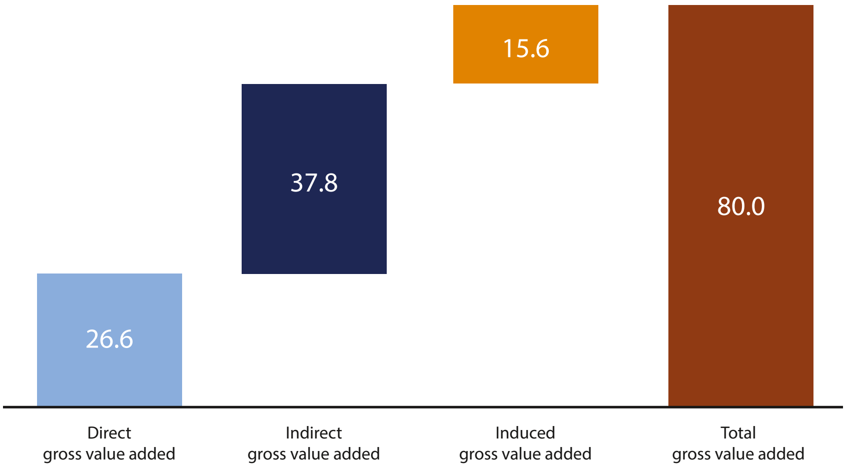
Source: Bothe et. al. (2018), Graphic: UNITI e. V.

[1]PtX includes liquid (PtL), but also gaseous synthetic energy resources PtH2, PtG).

Positive effects on value added and employment in the EU

- **Economic effects from increased demand** for PtX equipment can be estimated from present-day upstream inputs (suppliers, transportation, manufacturing).
- **An annual investment demand of €215 billion** could generate significant direct, indirect and induced increases in value added.
- Around **80 billion euro annually in additional gross value added** in the EU would result from the export of machinery and equipment for PtX production.

Value-added effects of investment goods production in billions of euro (PtX world market reference scenario)



Source: Eurostat (2020), OECD (2020), UN (2020) OECD (2018); own calculations, Graphic: UNITI e. V.

The EU will have the opportunity to position itself as a leading supplier of sustainable PtX technologies. However, although the global market for electrolysers to produce hydrogen has already doubled over the last 20 years, most of the growth to date has taken place outside of the Europe region. For that to change, relevant investments need to be made as soon as possible!

1.2 million new jobs created through PtX in Europe!

In addition to value creation, exports of PtX equipment would provide a **considerable employment effect.** 350,000 new jobs would be created directly. A further **600,000 employees** would be added to create the intermediate inputs and their supplier networks. Another 250,000 or so additional workers would be expected as a result of the overall effect, including the employment effects triggered by additional consumer demand. **A total of 1.2 million new jobs would be created through manufacturing and exporting machinery and equipment in Europe.**

Value-added and employment effects outside the EU - e-fuels make outstanding global RE potentials viable

- **Favourable production potentials for PtX production** exist in view of the ready availability of wind, solar and land at locations outside Europe, for example in North Africa and the Middle East, or in Australia and Patagonia. **More than 346,000 highly productive jobs** can already be created at PtX production sites which serve only one fiftieth of worldwide PtX demand potential! This opens up **new future opportunities** for these regions.
- The **economic reinforcement of electricity generation from renewable energies** in potential PtX-producing countries could also provide important impetus for developing **resource-efficient and CO_2-neutral energy supply systems** in those countries.

Appropriate framework conditions are required for the ramp-up of PtX:

- The **promotion** of European and non-European **Energy projects** in the form of energy partnerships to build a hydrogen-based energy economy.
- Further development of the national and **European hydrogen strategy** with regards to the **import of PtX energy carriers**.
- The **credibility of CO_2-neutral fuels** in the EU's CO_2 fleet limits.
- The innovative **redesign of energy taxation** in the transportation sector, e.g., with consideration of a CO_2 price component.
- A **technology- and application-open design** for the European **Renewable Energies Directive**.
- The **recognition of liquid** and gaseous **PtX energy sources** as renewable energy in the heating and building sector.

The study is available at
www.fuel-distributors.eu/news-and-publications

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E-fuels for aviation only – does it technically and economically make sense?

How can aviation become CO_2-neutral in the future?

There is no alternative to CO_2-neutral, synthetic liquid fuels (e-fuels) in aviation for non-fossil, CO_2-neutral mobility, because electrification is technically and economically impossible.
Therefore, politicians of all parties are in favour of the use of e-fuels in aviation.
However, both technical and economic arguments stand against producing and using synthetic fuels exclusively for aviation.

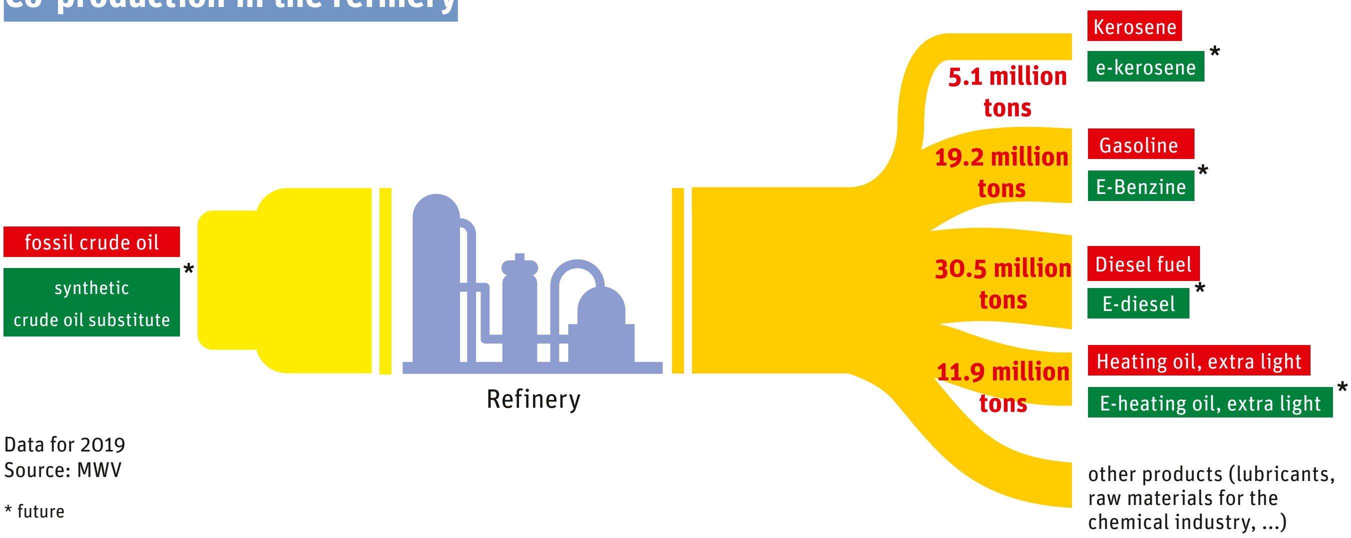
Technical reasons: Fuels are co-products

- Fuels are produced in what is known as co-production, i.e. their production inevitably gives rise to various fuels and other products in refineries, primarily diesel and gasoline along with kerosene. This is true whether fossil crude oil (crude) is used as the basis or synthetic crude oil substitute (e-crude).
- The ratio of kerosene to co-products obtained when fossil crude oil is processed in a refinery amounts to between 5 and 10 percent in Germany at present. When e-crudes are processed, the share of e-kerosene in the mix of synthetic co-products can be boosted – by exactly how many percentage points depends on further processing steps selected for Fischer-Tropsch products. In the case of completely new plants built specifically for the production of e-kerosene, it may be feasible to considerably increase the e-kerosene yield.
  The required technology is highly complex and very expensive, and corresponding plants are not yet under construction. In any case, e-kerosene will always be only one amongst many – also synthetic – end products resulting from refinery processing.

Economic considerations: All co-products must be marketable

- The high level of competition in international air traffic ensures that airlines are greatly sensitive to kerosene prices. Since kerosene is not taxed for international air traffic, rising kerosene prices raise costs for companies very sharply in percentage terms. Airlines would shift refuelling to lower-priced regions.
- There is a stable market with global demand for fossil fuels. As for synthetic fuels, on the other hand, the still comparatively higher costs of plants for synthesising e-crudes mean they are more expensive for airlines and would therefore be de facto unmarketable in unregulated competition.
- Manufacturing e-kerosene as cost-effectively as possible will only be achievable if the entire range of co-products obtained in the refinery process can be sold on the market. This requires suitable regulatory framework conditions.
- In road transport, on the other hand – unlike in aviation – there is a high willingness to pay. This component would also be covered by a compulsory e-fuel blending quotas for all transport, which would ensure a suitably high and sufficiently stable demand for synthetic fuels. This would encourage investment in plants for the industrial production of synthetic crude oil substitutes; the result would be falling production prices for e-kerosene, amongst other things.

Co-production in the refinery



Data for 2019
Source: MWV

* future

E-kerosene, e-diesel as well as e-gasoline are interconnected co-products

- In 2019, refineries in Germany produced around 5.1 million metric tons of kerosene. This was sufficient to cover around half of domestic sales. Moreover, 30.5 million metric tons of diesel fuel and 19.2 million metric tons of gasoline were produced as part of this co-production. This fully meets the annual demand in Germany for gasoline and around four-fifths of the demand for diesel fuel.
- In the case of production using Fischer-Tropsch processes, the amount of e-kerosene required for the German market, e-diesel and e-gasoline would be produced in volumes sufficient to also make road traffic in Germany CO_2-neutral as part of the co-production process.

→ The technologically unavoidable effect of producing e-kerosene alone creates an opportunity to include Germany's fleet of around 58 million vehicles (passenger cars, trucks, buses, construction machinery, agricultural vehicles, etc.)[1], over 99% of which are powered by internal combustion engines, in reaching our ambitious climate targets.

→ However, a suitable regulatory framework must be established to facilitate the scaling up of e-fuels as transportation fuels on land, water, and in the air.

→ E-kerosene and e-diesel, as well as e-gasoline, are interconnected co-products – both technically, in their production, and economically, in their marketing.

→ If we want e-fuels in aviation, we must also allow e-fuels in road transportation.

→ Non-recognition of e-fuels in road transportation makes e-fuels in aviation more difficult!

→ CO_2-neutral aviation is thus being blocked.

[1] Source: KBA, portfolio as of 01.01.2021

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Why electromobility divides Europe

E-mobility splits Europe!

There are around 249 million passenger cars across the 27 EU member states, of which only around 0.5 per cent are battery electric vehicles (BEV). 99.5 per cent, on the other hand, have a combustion engine. BEV can be found almost exclusively in the economically strong states in Northern and Central Europe, where they make up more than 0.5 per cent of passenger vehicles. It is not just that there are virtually no battery electric vehicles in Southern and Eastern Europe, there is also an almost complete lack of charging infrastructure. Around 70 per cent of public charging stations can be found in the Netherlands, France and Germany, but these three countries only account for approximately 23 per cent of EU territory.
The divide between the regions in terms of e-mobility is only set to get bigger as many people in the often economically weaker countries in Southern and Eastern Europe question whether they can afford an electric car or whether a comprehensive network of public charging stations can be built.

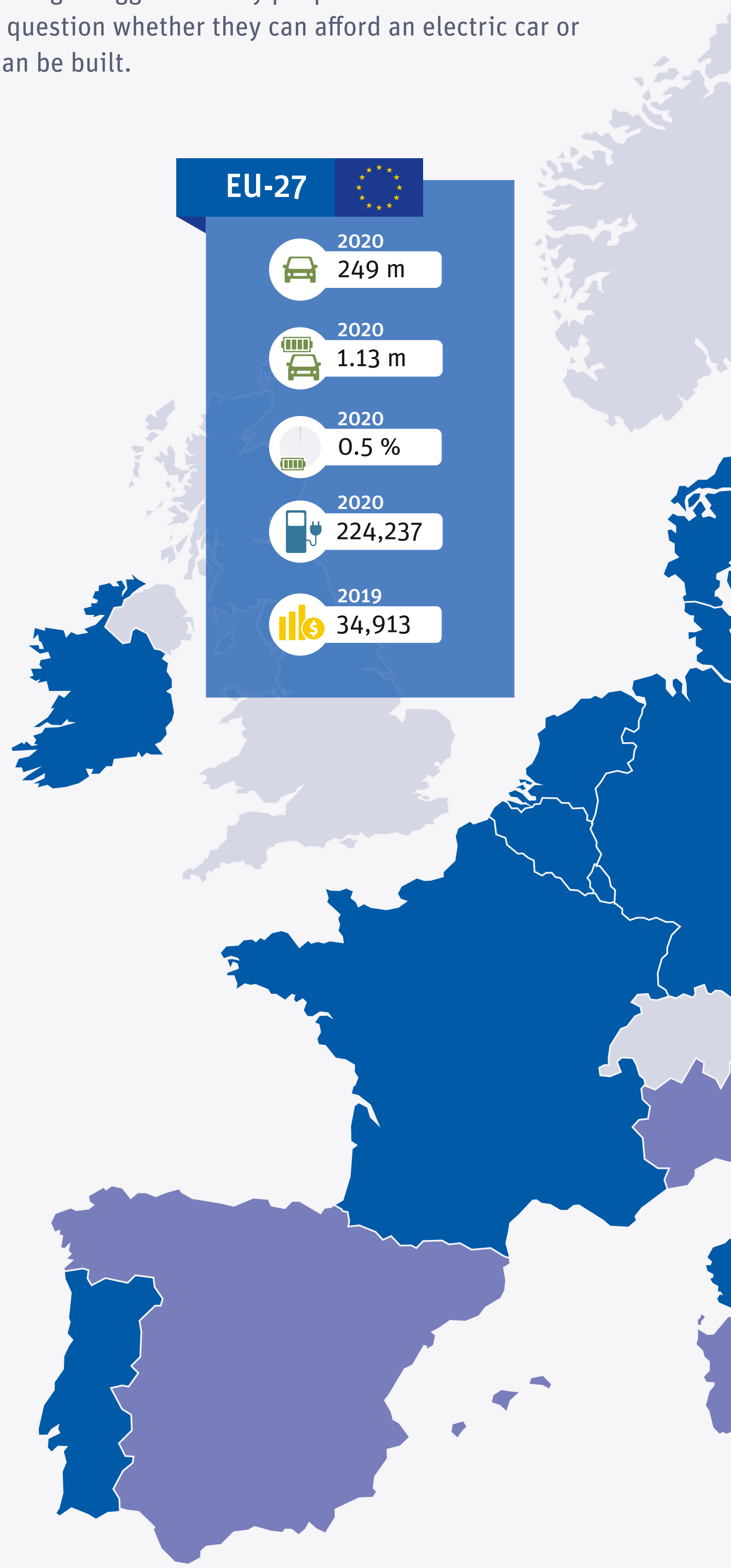
Share of BEV above EU average

	2020	2020	2020	2019
Netherlands	173 thou.	2.0 %	66,665	50,744
France	277 thou.	0.9 %	45,751	41,158
Germany	308 thou.	0.6 %	44,669	44,885
Belgium	34 thou.	0.6 %	8,482	44,914
Denmark	31 thou.	1.1 %	3,254	59,808
Ireland	11 thou.	0.5 %	1,082	79,904
Luxembourg	4 thou.	0.9 %	1,063	109,910
Malta	2 thou.	0.6 %	101	32,933
Austria	42 thou.	0.8 %	8,232	48,591
Portugal	37 thou.	0.7 %	2,470	22,690
Sweden	58 thou.	1.1 %	10,412	55,650

70 % (Netherlands, France, Germany – public charging stations)

EU-27

2020	249 m
2020	1.13 m
2020	0.5 %
2020	224,237
2019	34,913

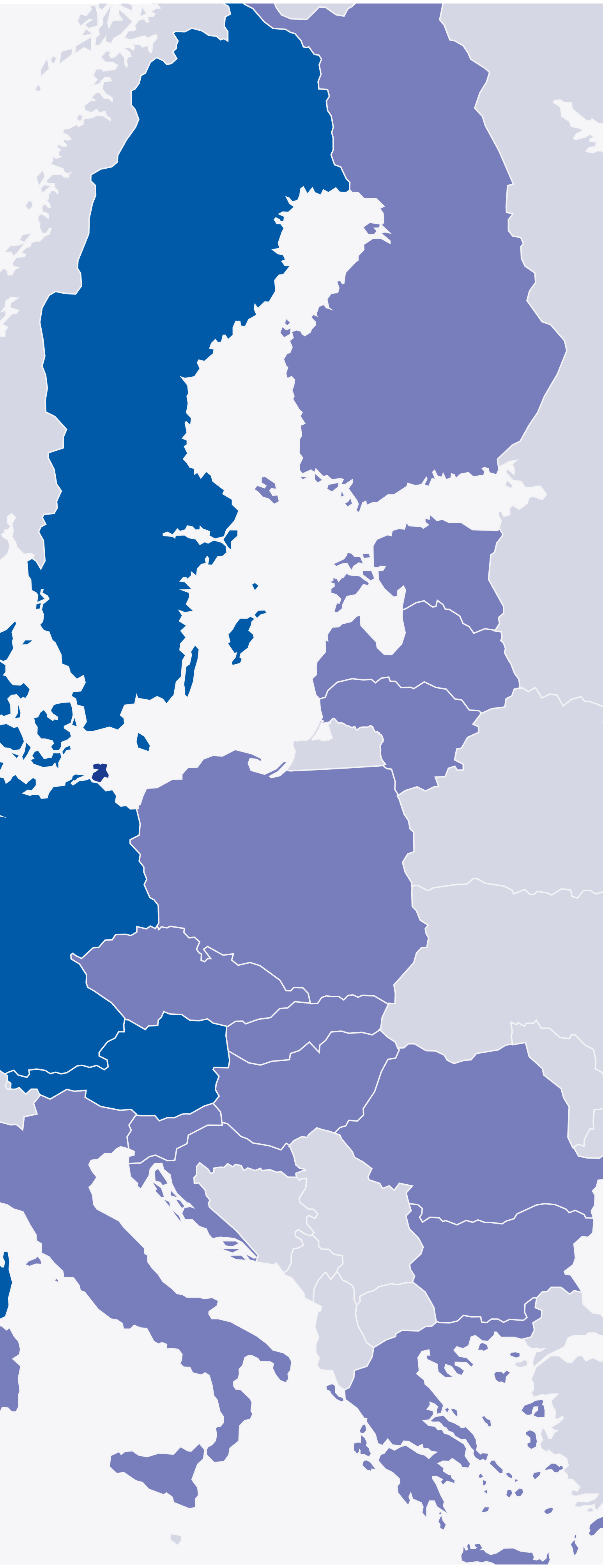


statista

Sources: EAFO, World Bank, Statista Country Outlook

Number of passenger cars | Number of battery electric vehicles (BEV) | Share of battery electric vehicles (BEV) | Public charging stations* | GDP/capita in USD

* Normal (<= 22 kW) and rapid charging stations (> 22 kW)



Share of BEV below EU average

Country	Number of BEV (2020)	Share of BEV (2020)	Public charging stations (2020)	GDP/capita in USD (2019)
Bulgaria	1 thou.	0.1 %	195	8,992
Estonia	2 thou.	0.2 %	424	22,268
Finland	10 thou.	0.3 %	3,728	47,356
Greece	1 thou.	0.0 %	334	20,178
Italy	55 thou.	0.1 %	13,381	32,745
Croatia	1 thou.	0.1 %	670	14,158
Latvia	1 thou.	0.1 %	314	16,915
Lithuania	2 thou.	0.2 %	179	18,632
Poland	7 thou.	0.0 %	1,691	15,254
Romania	6 thou.	0.1 %	502	11,883
Slovakia	2 thou.	0.1 %	924	18,608
Slovenia	4 thou.	0.3 %	747	24,910
Spain	45 thou.	0.2 %	8,173	29,303
Czech Republic	7 thou.	0.1 %	1,200	21,597
Hungary	6 thou.	0.2 %	1,295	16,113
Cyprus	0.3 thou.	0.1 %	70	20,282

- The proportion of purely battery electric vehicles (BEVs) in the fleet is higher than 0.5 percent in just 11 of 27 EU Member States. Only wealthy countries such as the Netherlands, Sweden and Denmark manage to break through the one-percent barrier.
- Particularly in economically weaker countries in Southern and Eastern Europe, the share of BEVs tends toward zero. This includes populous countries such as Spain, Italy and Poland.
- It is questionable whether low-income populations in low GDP/capita countries in Southern and Eastern Europe can afford the expensive switch to e-cars.
- The charging infrastructure required for e-mobility is only found in a few wealthy countries in the European Union in sufficient quantity and density to supply even the existing BEV fleet. For example, around 70 percent of publicly accessible charging stations within the EU can be found in the Netherlands, France, and Germany.
- In large countries in southern and eastern Europe in particular, there is virtually no charging infrastructure. Building a network of publicly accessible charging stations would cost many billions of euro and overburden these countries economically.

E-fuels as the solution to prevent the division of Europe:

- With CO_2-neutral e-fuels, the nearly 248 million passenger cars with internal combustion engines in the entire European Union could be powered in a CO_2-neutral manner without technical adjustments or conversions.
- Discussions at the EU level about possible blanket “combustion engine bans” are not helpful, because it is not the combustion engine that determines whether a vehicle is CO_2-neutral or not, but the fuel used. With e-fuels, all internal combustion engines could be operated with CO_2-neutrality
- With e-fuels, drivers in economically weaker EU states would also retain the option of affordable individual automobility whilst making indispensable contributions to climate protection. At the same time, the countries’ public budgets would be unburdened because the construction of expensive charging infrastructure for e-mobility would thus be unnecessary.

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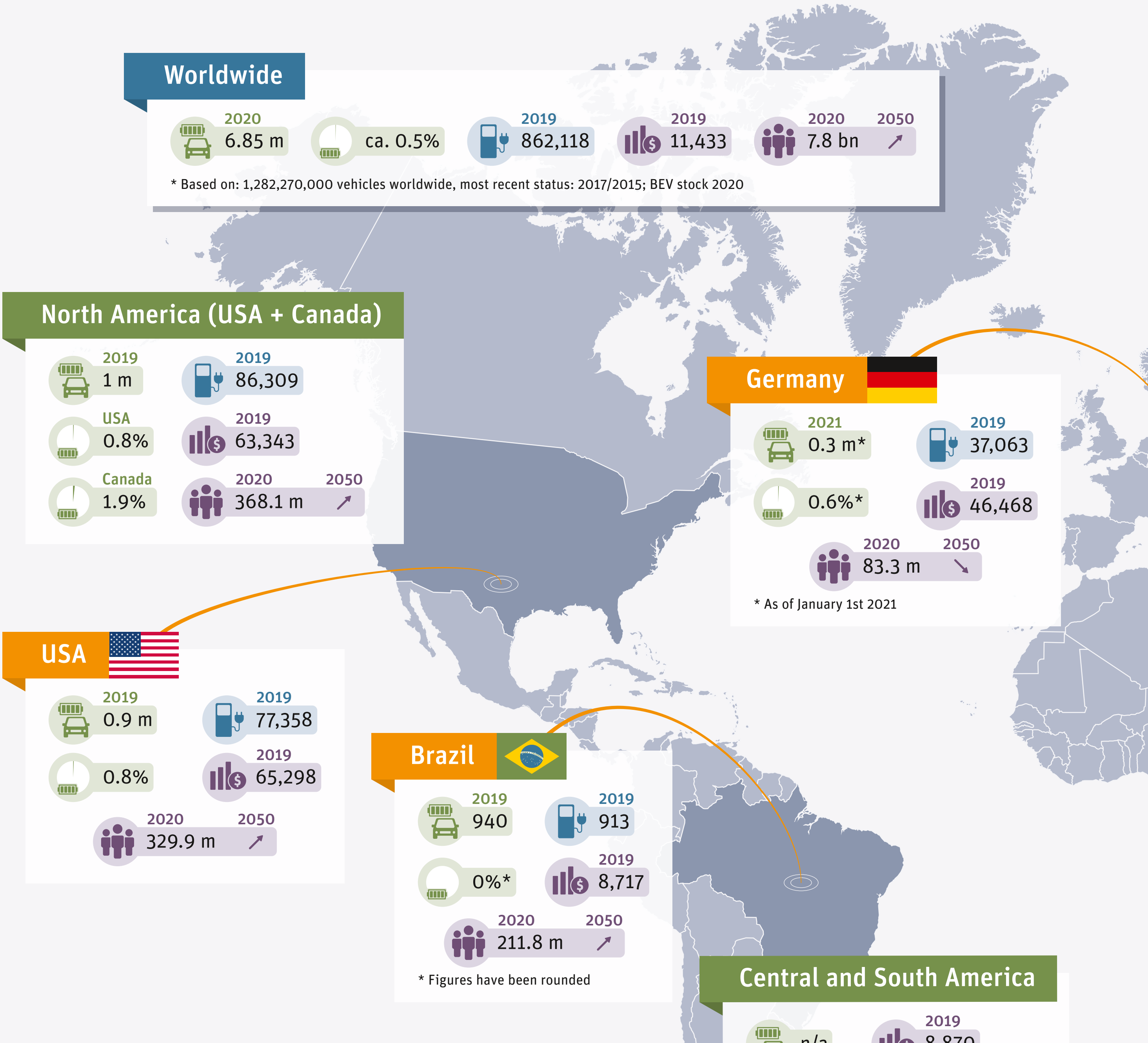
Why only e-fuels make global road transportation CO_2-neutral

E-mobility around the world

E-mobility not yet global player

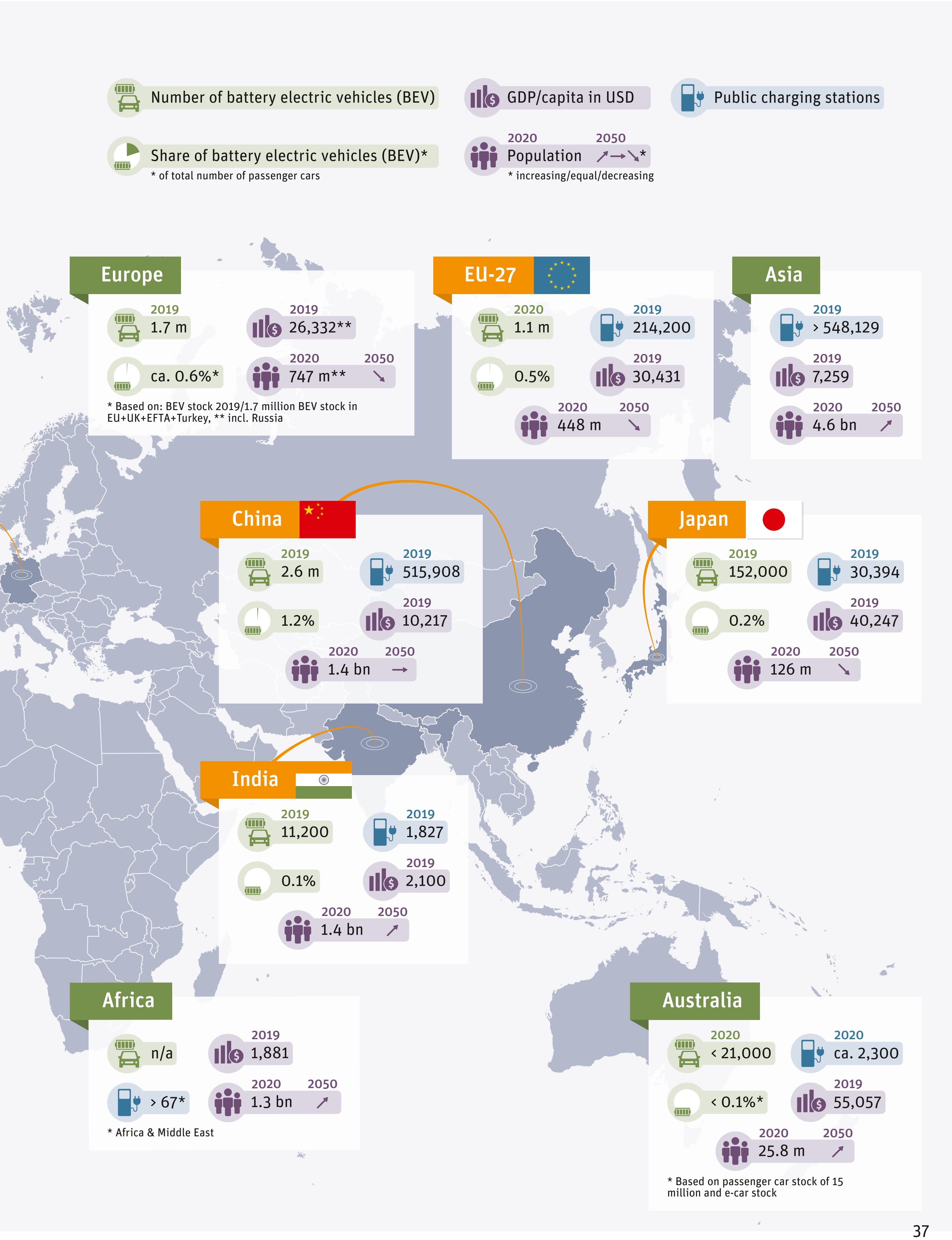
Just 0.5 per cent of vehicles worldwide are battery electric vehicles (BEV), while 99.5 per cent have a combustion engine. Even in economically developed countries e-mobility is lacking in importance. The share of battery electric vehicles is 0.5 per cent in the EU, 0.8 per cent in the USA and 1.2 per cent in China. 90 per cent of electric cars are sold in these three markets. In many developing yet densely populated regions such as South America, Africa and large parts of Asia, e-mobility plays no role at all.



statista

Research and calculations: Statista and UNITI

Sources: ACEA, Australian Bureau of Statistics, Bisresearch, Deutsche Stiftung Weltbevölkerung, European Alternative Fuels Observatory, Eurostat, IEA, KBA, Ministry of Transport of China, MLIT (Japan), OICA, PRB, Statistic Times, TheDriven, The Electric Vehicle Council, The International Council of Clean Transportation, US Department of Transportation, World Bank


Number of battery electric vehicles (BEV)
GDP/capita in USD
Public charging stations
Share of battery electric vehicles (BEV)*
* of total number of passenger cars
2020 2050
Population ↗→↘*
* increasing/equal/decreasing
Europe
2019 1.7 m
2019 26,332**
ca. 0.6%*
2020 747 m** 2050 ↘
* Based on: BEV stock 2019/1.7 million BEV stock in EU+UK+EFTA+Turkey, ** incl. Russia
EU-27
2020 1.1 m
2019 214,200
0.5%
2019 30,431
2020 448 m 2050 ↘
Asia
2019 > 548,129
2019 7,259
2020 4.6 bn 2050 ↗
China
2019 2.6 m
2019 515,908
1.2%
2019 10,217
2020 1.4 bn 2050 →
Japan
2019 152,000
2019 30,394
0.2%
2019 40,247
2020 126 m 2050 ↘
India
2019 11,200
2019 1,827
0.1%
2019 2,100
2020 1.4 bn 2050 ↗
Africa
n/a
2019 1,881
> 67*
2020 1.3 bn 2050 ↗
* Africa & Middle East
Australia
2020 < 21,000
2020 ca. 2,300
< 0.1%*
2019 55,057
2020 25.8 m 2050 ↗
* Based on passenger car stock of 15 million and e-car stock

Reducing CO_2 emissions from road transport requiressolutions that will work anywhere in the world

- Electromobility continues to appear in vehicle inventories only in parts of North America and Europe as well as in a few countries in Asia. And even there, the proportion of BEVs is often only in the per thousand range.
- In many developing, densely populated parts of the world, such as South America, Africa and vast parts of Asia, e-mobility so far plays no role at all. The lack of even the rudiments of a charging infrastructure and green charging power precludes this from changing in the foreseeable future.
- Liquid fuels, on the other hand, are already available today in all regions of the world at low cost and can be used in a consumer-friendly manner.

  → In light of this, the main focus should therefore be on rapidly making internal combustion engines CO_2-neutral.

  → Climate change is a global challenge that requires a global solution that works everywhere in the world. E-fuels offer just that. They make it possible to power the approximately 1.3 billion motor vehicles in all areas of the world in a CO_2-neutral manner. Only in this way can all countries and regions really be included in the efforts to save CO_2 emissions.

  → The German government should take a more technology-open approach to the decarbonisation of road transportation than it has in the past and view the achievement of climate targets as a global challenge that can only be successfully mastered with a globally effective solution. Germany should advocate for a rapid market ramp-up of e-fuels at national, European and international levels.

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Is there a one-size-fits-all solution for carbon-neutral transport?

E-fuels can be used in all existing fleets of combustion-powered transport and special-purpose vehicles, as well as in new vehicles. No technical adaptation is required to do this. The necessary infrastructure is already in place.

So e-fuels really are a one-size-fits-all solution!

Fuel sources

Means of transport and special-purpose vehicles	E-fuels can be used		Battery ele… can be
	Existing	For new vehicles	Existing
Scooters and motorcycles	✓	✓	✗
Cars	✓	✓	✗
Public transport buses	✓	✓	✗
Coaches	✓	✓	✗
Delivery vehicles (up to 7.5 t)	✓	✓	✗
Trucks (up to 40 t)	✓	✓	✗
Construction machinery	✓	✓	✗
Agricultural and forestry machinery	✓	✓	✗
Emergency and rescue vehicles	✓	✓	✗
Waste disposal and street cleaning vehicles	✓	✓	✗
Military vehicles	✓	✓	✗
Helicopters	✓	✓	✗
Commercial and cargo aircraft	✓	✓	✗
Cargo and container ships	✓	✓	✗
Cruise ships and ferries	✓	✓	✗

* and technica… economically…

Public infrastructure

ctric power used* — For new vehicles	Refuelling infrastructure widespread and adequately available 🇩🇪	🇪🇺	🌐	Charging infrastructure widespread and adequately available 🇩🇪	🇪🇺	🌐
✓	✓	✓	✓	○	○	○
✓	✓	✓	✓	○	○	✗
✓	✓	✓	✓	✗ **	✗ **	✗
✗	✓	✓	✓	✗	✗	✗
✓	✓	✓	✓	○	○	✗
○	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗
✗	✓	✓	✓	✗	✗	✗

✓ yes

✗ no

○ partly

lly or
y viable

** Possible to charge at depots

The goal: Carbon-neutral mobility in transport

Going forward, hundreds of millions of vehicles will continue to be powered by internal combustion engines (currently 1.3 billion worldwide). Whether it is farmers, the emergency services, the construction industry, the military, haulage firms or utility companies – they all need access to fast, easily available energy to power their vehicles. E-fuels meet their needs with a one-size-fits-all solution.

Energy density is the key

The list of means of transport and special-purpose vehicles illustrates their variety and different areas of application. High energy density is particularly important when a large volume of energy is needed for movement and transportation, such as by plane or truck. Energy density is the amount of energy stored per unit mass (watt-hours per kilogram). Due to their chemical properties, the energy density of diesel and petrol is much higher than a comparable lithium-ion battery. Conversely, this means that a large-volume, heavy battery would have to be installed to provide the same amount of energy in a battery electric vehicle, whereas a comparatively small tank with a low weight when full would be sufficient for a vehicle powered by liquid fuel.

Maintain investment, conserve resources.

The majority of today's public transport and special-purpose vehicles are still powered by internal combustion engines. Battery-electric drives still play a minor role, if any. And most newly registered vehicles still have internal combustion engines. These could use existing refuelling infrastructures to fill up with carbon-neutral e-fuels. Keeping existing fleets running on e-fuels in a carbon-neutral manner not only helps to protect the climate, but also contributes to conserving resources. Otherwise, it is technically or economically viable to electrify only a few types of vehicles (motorcycles, passenger cars, public transport, light trucks), meaning that the necessary charging infrastructure is generally patchy and inadequate, at both EU and global level.

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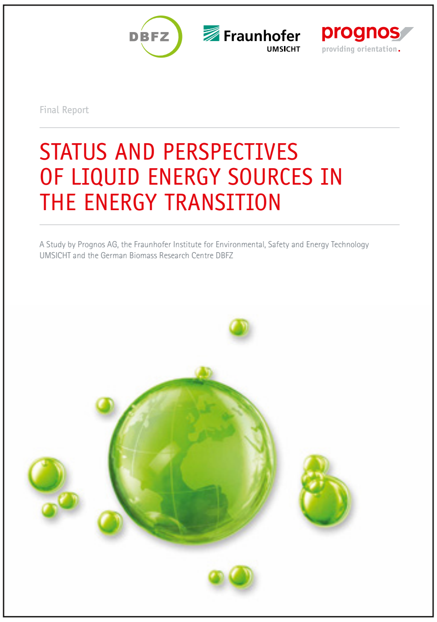

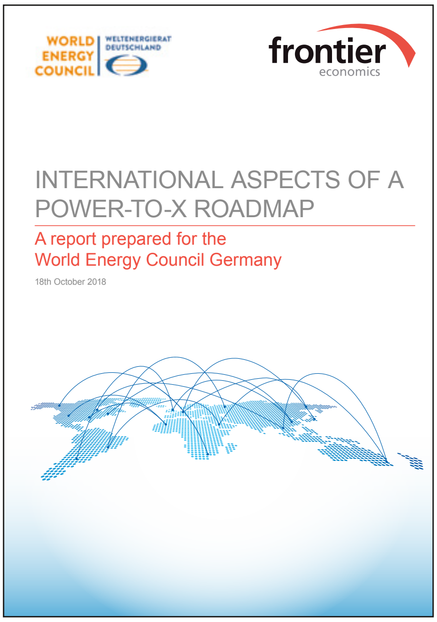

The European Confederation of Fuel Distributors

ECFD is the voice of of more than 10,000 distributors of liquid fuels in the EU member states, bringing their competence to the EU level. With an average share of 60 % of filling stations being family-owned members operate mainly independently from major energy companies. ECFD members maintain and secure a reliable supply of conventional fuels, biofuels, LPG and CNG to customers across Europe. In addition, ECFD is actively engaged in the low-carbon energy transition via renewable fuel for the mobility and heating sector. Our members supply sustainable conventional and advanced biofuels and are committed to the rapid market take-off of synthetic powerbased fuels in order to achieve the European climate protectiontargets. Our members own convenience retail outlets and motorway service areas and provide a range of high qualityproducts and services to European consumers. They also manage and supply fuels used in non-road areas like agricultural machinery, shipping and public sector works.

Modern heating and mobility with liquid fuels provides millions of European households with:

- Improved air quality, thanks to cleaner fuels with reduced sulphur content
- Higher energy savings, thanks to well-proven and mature technology
- Affordable solutions for vulnerable consumers, thanks to the low cost of upgrading to more energy efficient heating systems and alternative clean mobility solutions.

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