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**EU ENERGY AND PROPULSION TRANSITIONS IN THE MOBILITY  
SECTOR OF GERMANY – A REALIZABLE STRATEGY OR EVEN  
RATHER IDEOLOGICAL ASTRAY?**

*Ralph Pütz<sup>1\*</sup>*

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RESEARCH ARTICLE

**ABSTRACT:** The EU policy – with the intended exclusion of combustion engines and consequently the dictate to electric mobility in the on-road and off-road sectors on the one hand, and on the other hand with the exclusive focus of the Euro legal limit stages solely on driving operation (tank-to-wheel, TtW) while neglecting the influences of all relevant processes of vehicle production (cradle-to-gate, CtG), energy supply (well-to-tank, WtT) and recycling/disposal (end-of-life, EoL) – leads to a misleading distortion of the ecological facts while at the same time ignoring the constraints of a free market economy. The necessity of a “propulsion transition” is questionable, and the feasibility of an “energy transition” with an exclusive focus on German domestic renewable energies and thus energy autarky seems to be underestimated by far. With comprehensive “system thinking” (vehicle load and range, charging times and charging spaces, energy generation, distribution and refuelling infrastructure as well as required power grids) the intended energy transition for Germany is more than questionable.

**KEY WORDS:** *EU energy transition, EU propulsion transition, New Green Deal, holistic ecological balancing, technology-neutrality*

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*1 Prof. Dr. Ralph Pütz, Faculty of Mechanical Engineering, Landshut University UAS,  
[ralph.puetz@haw-landshut.de](mailto:ralph.puetz@haw-landshut.de),  <https://orcid.org/0009-0000-5312-8778> (\*Corresponding author)*

## **EU TRANZICIJE ENERGIJE I POGONA U SEKTORU MOBILNOSTI NEMAČKE – OSTVARIVA STRATEGIJA ILI ČAK IDEOLOŠKA ZABLUDA?**

**REZIME:** Politika EU – sa nameravanim isključivanjem motora sa unutrašnjim sagorevanjem i posledično diktatom električne mobilnosti u drumskom i terenskom sektoru s jedne strane, a s druge strane, sa isključivim fokusom evropskih zakonskih ograničenja isključivo na vožnju („od rezervoara do točka“), dok zanemaruje uticaje svih relevantnih procesa proizvodnje vozila („od klevke do kapije“), snabdevanja energijom („od izvora do rezervoara“) i reciklaže/odlaganja („kraj životnog veka“) – dovodi do pogrešnog iskrivljavanja ekoloških činjenica, a istovremeno ignoriše ograničenja slobodne tržišne ekonomije. Neophodnost za „pogonsku tranziciju“ je upitna, a izvodljivost „energetske tranzicije“ sa isključivim fokusom na nemačke domaće obnovljive izvore energije i samim tim energetske autarkiju, čini se da je daleko potcenjena. Sa sveobuhvatnim „sistemskim razmišljanjem“ (opterećenje i domet vozila, vremena punjenja i prostori za punjenje, infrastruktura za proizvodnju, distribuciju i punjenje energije, kao i potrebne elektroenergetske mreže), planirana energetska tranzicija za Nemačku je više nego upitna.

**KLJUČNE REČI:** *Energetska tranzicija EU, pogonska tranzicija EU, Novi zeleni plan, holističko ekološko uravnoteženje, tehnološka neutralnost*

# EU ENERGY AND PROPULSION TRANSITIONS IN THE MOBILITY SECTOR OF GERMANY – A REALIZABLE STRATEGY OR EVEN RATHER IDEOLOGICAL ASTRAY?

Ralph Pütz

## INTRODUCTION: POLITICAL REQUIREMENTS IN THE EU WITH THE FOCUS ON THE TRANSPORT SECTOR ESP. COMMERCIAL VEHICLES

The political and social goal is to limit global warming to 1.5°C. On 14 July 2021, the European Union (EU) adopted the "European Green Deal" to reduce global emissions (greenhouse gas emissions, GHG) in the EU by 55% by 2030 compared to 1990 and to then no longer cause any net emissions of greenhouse gases or CO<sub>2</sub> equivalents by 2050 [1]. As early as 2045, no more greenhouse gas emissions may be emitted in Germany. Every sector in the EU - thus also the transport sector - must achieve these ambitious goals, for which EU policy provides coupled political measures as so-called "transitions", which, in addition to the necessary "energy transition" to the exclusive use of renewable energies, also consider a "mobility transition" (traffic avoidance, shift of individual transport to public transport) and a "propulsion transition" (accelerated use of electromobility) to be necessary. However, it is questionable whether the absolutely indispensable energy transition in connection with an intended energy self-sufficiency with domestic energy can be realised at all - especially in Germany. In addition, the sense of a "propulsion transition" with the exclusion of locally highly clean combustion engines while using regenerative primary energies must be questioned in a holistic balance. So in the recent European elections, for example, the European People's Party (EPP/EVP) propagated the withdrawal of the decided exclusion of combustion engines as an election promise.

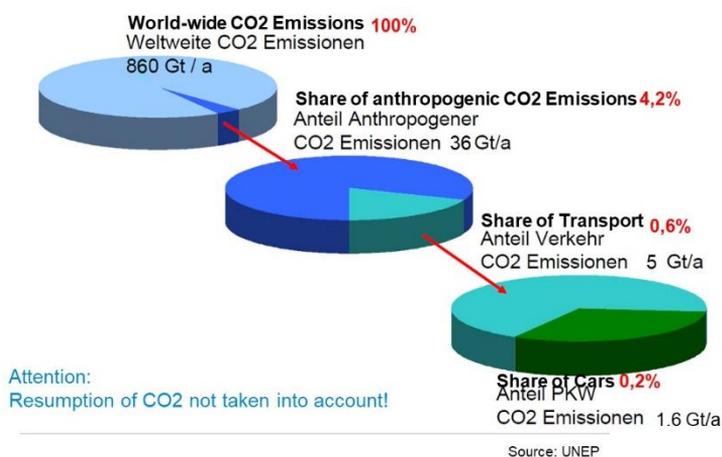


Figure 1 World-wide annual CO<sub>2</sub> emissions 2020 – overall and anthropogenic share

Currently, global emissions from all transport modes (including ships and aircraft) in the EU account for around 25% of EU anthropogenic greenhouse gas emissions, of which road transport is responsible for four-fifths (20%) overall, which, however, corresponds to just under 2.4% of global anthropogenic CO<sub>2</sub> emissions (road transport: 1.9%). The commercial vehicle sector (trucks including coaches and buses) emits 6% of CO<sub>2</sub> anthropogenic

emissions in the EU, which is only a neglecting 0.4% of global anthropogenic CO<sub>2</sub> emissions. Taking into account that world-wide anthropogenic CO<sub>2</sub> emissions only amount to 4,2% of the overall world-wide CO<sub>2</sub> emissions (see Fig. 1), the EU road transport emissions amount to only 0,08% (sic!) of the overall world-wide CO<sub>2</sub> emissions. If every CO<sub>2</sub> molecule regardless of its origin – anthropogenic or natural – has the same influence, this should be classified accordingly and be a reason to consider. On the other hand, the reports of the International Panel on Climate Change (IPCC) leave no doubt about the urgent need to drastically reduce greenhouse gas emissions [2]. However, in order to achieve the required climate neutrality in the EU by 2050, enormous demands will be placed on the transport sector without, in all likelihood, having a measurable effect on climate change. In the fight against climate change, therefore, the EU's actual, limited "leverage arm" must be taken into account in its actions. The EU in total is responsible for about 9.5% of anthropogenic global CO<sub>2</sub> emissions (or 0,4% (sic!) of the overall world-wide CO<sub>2</sub> emissions), see Fig. 2. The largest CO<sub>2</sub> emitter within the EU, Germany, is responsible for a total anthropogenic global contribution of 1.85% (0,078% of the overall world-wide CO<sub>2</sub> emissions), followed by Italy with 0.93%. Against this background, the EU's pioneering role in combating climate change alone seems futile if the four main emitters - China, the USA, India and Russia, which together account for around 55.7% of anthropogenic CO<sub>2</sub> emissions - do not live up to their responsibility.

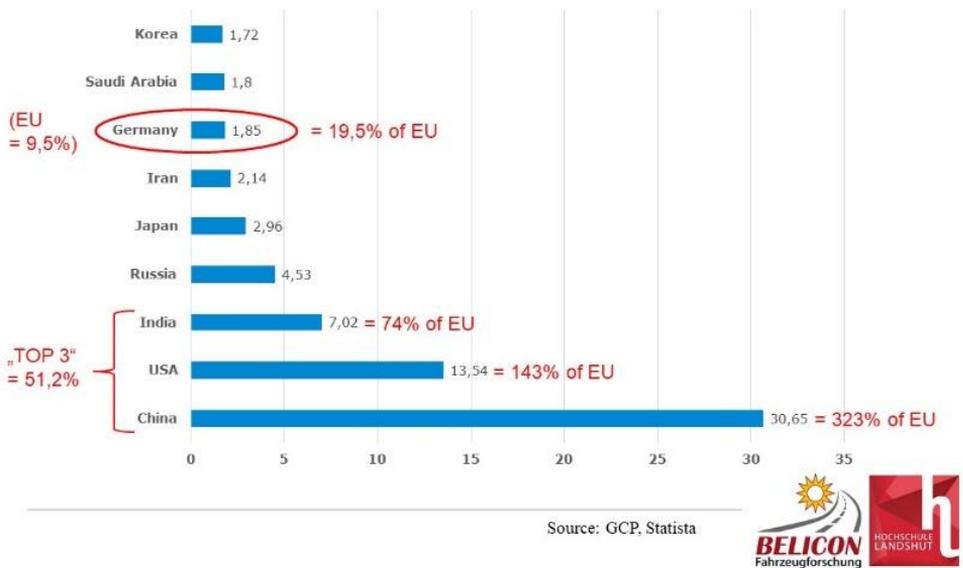


Figure 2 World's largest anthropogenic CO<sub>2</sub> emitters (share in %) and limited lever of EU measures

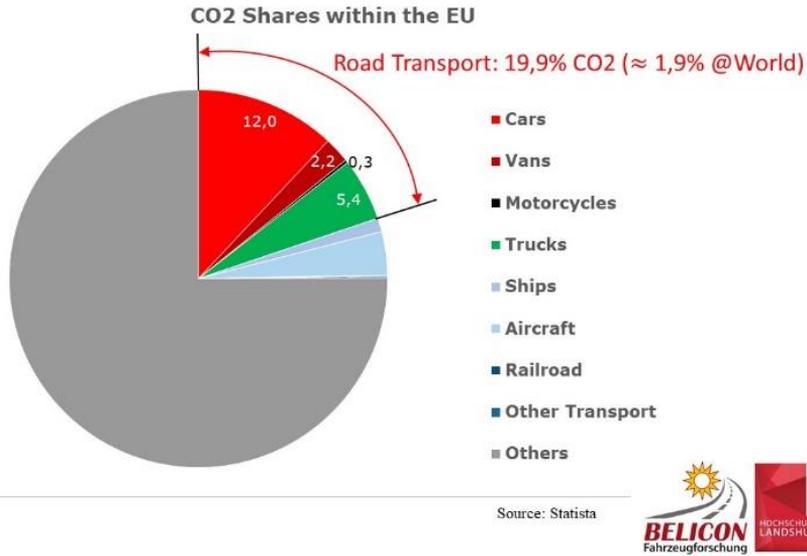


Figure 3 Contribution of the EU Transport Sector to EU global anthropogenic emissions in 2022

In the public transport (PT) bus sector, the so-called "EU Clean Vehicles Directive" (implemented in Germany since 2.8.2021) has prescribed fixed quotas for the procurement of new public buses with "clean" and "emission-free" drives, see Fig. 4 [3]. The EU policy focus in this directive only on local tailpipe emissions inadmissibly completely ignores the provision of raw materials and energies for vehicle production including drive systems (cradle-to-gate, CtG), the generation and distribution of energy in the fuel supply chain (well-to-tank, WtT), and subsequent recycling and disposal (end-of-life, EoL), but all these subsystems are highly relevant for a robust holistic ecological (and economic) balance.

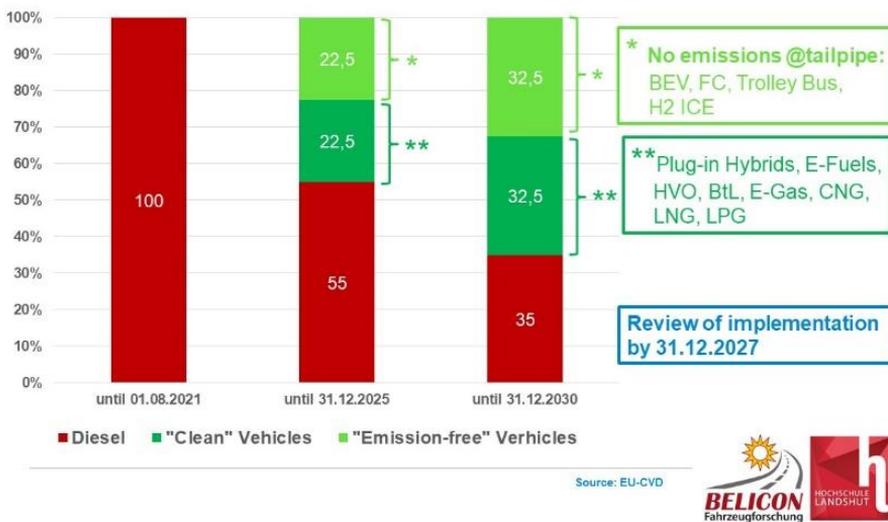


Figure 4 EU „Clean Vehicles Directive“: Fixed quotas for procurement of new PT buses

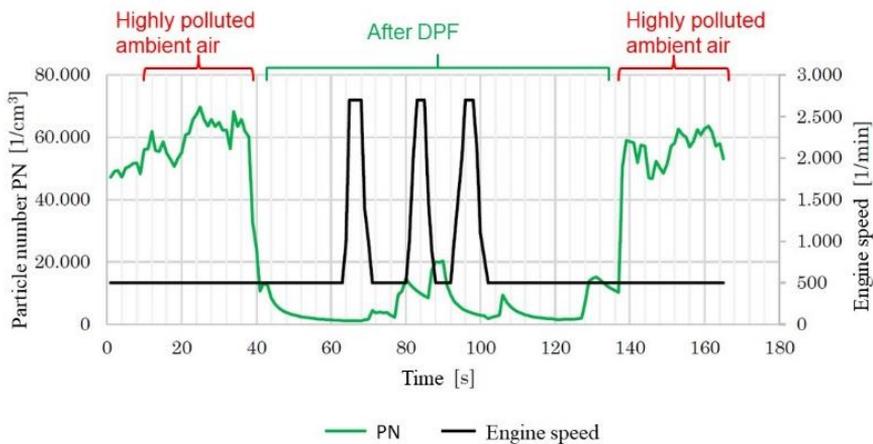
While the targeted elimination of pollutants such as particles (particulate mass PM and particle numbers PN) and nitrogen oxides (NO, NO<sub>2</sub>) from the tailpipe makes perfect sense,

the elimination of CO<sub>2</sub> from the tailpipe is completely irrelevant, as GHG emissions have a "global" effect and it is irrelevant whether the emissions of CO<sub>2</sub> occur in the upstream chain (WtT), in driving cycles (TtW), in vehicle production (CtG) or recycling/disposal (EoL).

## 1 ANALYSIS OF FIELDS OF ACTION FOR LOCAL EMISSIONS

As far as particle emissions during driving are concerned, Fig. 5 shows for a Euro VI PT diesel bus with DPF that the intake air (in this case polluted ambient air) contains significantly more particles than the exhaust gas - which hence represents a partial air cleaning that is not possible with the electromobility options (battery BEV or fuel cell FC drives).

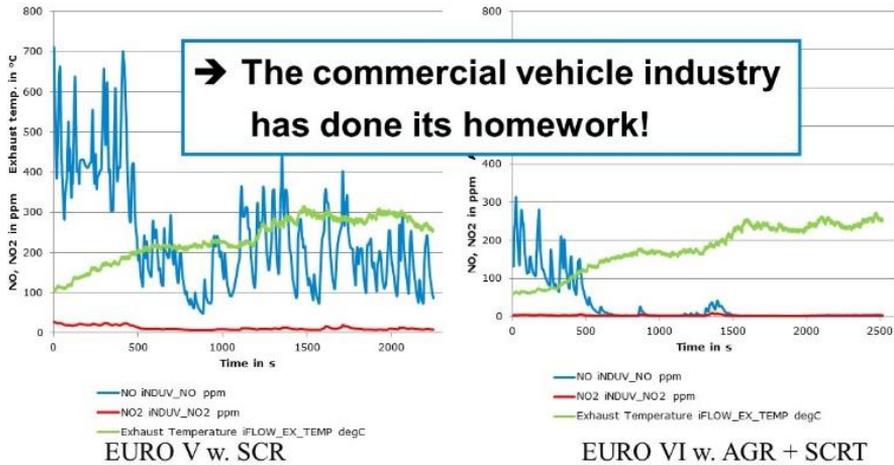
Fig. 6 shows the NO<sub>x</sub> emissions measured during the real operation of articulated buses in urban traffic with typical SORT 2 pattern ("stop-and-go operation") for a route with demanding topography. The emission behaviour of a Euro V articulated bus is shown on the left and that of a Euro VI articulated bus on the right. In the case of the Euro VI articulated bus, nitrogen oxide emissions are almost at ambient air level after only 10 minutes due to the effective SCR exhaust gas aftertreatment. Incidentally, the same also applies to diesel engines of Non-Road Mobile Machinery (NRMM) stages 4f and 5 in tractors in heavy agricultural use.



Source: Löw, J.; Pütz, R.

*Figure 5 Particle emissions @tailpipe of a Euro VI bus with DPF: cleaning the ambient air*

In view of the near-zero emission level of internal combustion engines already achieved today, it is doubtful whether the Euro VII (or 7 in cars) limit values envisaged after 2025 can be proven in practice to improve air quality at all.



Source: BELICON/Pütz

Figure 6 Comparison of nitrogen oxide emissions @tailpipe of Euro V and Euro VI articulated buses (SORT 2, demanding topography)

## 2 ANALYSIS OF THE FIELDS OF ACTION FOR GLOBAL EMISSIONS, ENERGY CONSUMPTION AND RANGE

Today, there is an undisputed need for action in the forced use of renewable energy sources, not only to significantly reduce globally effective emissions, but also to conserve fossil resources. In order to analyse the energy demand for the German „energy transition“ in the transport sector, a commercial vehicle-specific scenario is examined below, in which initially only the energy demand for handling the heavy-duty trucks’s toll kilometres on German motorways with currently 359 motorway filling stations is considered. 500,000 domestic trucks and 360,000 foreign trucks, each with an average mileage of 93,000 km/year, travel a total of 41.6 billion toll kilometres on German motorways with an average energy consumption of 30 l Diesel fuel/100 km (2.97 kWh/km). This corresponds to a total of 12.49 billion litres of Diesel fuel per year for the completion of toll kilometres. It was assumed that, due to the company filling stations available at the haulage companies depots, only about half of the fuel (52%) is filled up at the motorway filling stations. The following promising drive/energy system options for heavy-duty trucks were to be investigated:

- •EURO-VI-Diesel with E-Fuel (Power-to-Liquids; PtL),
- •EURO-VI-CNG with E-Gas (Power-to-Gases; PtG),
- •Fuel Cell (FC or BZ) with „green“ compressed gaseous hydrogen (CG H<sub>2</sub>) from wind power,
- •Battery electric vehicle (BEV) with wind power.

In each case, a range of 1,500 km with one tank filling/ charging process was assumed, as this represents a minimum requirement from the operator's point of view. A lower range with more frequent refuelling/charging processes would theoretically be possible, but from the operator's point of view it appears to be an unrelated restriction. The "In-motion charger" truck option (trolley truck with overhead catenary or induction rails and small batteries on board) is not considered here due to the lower operational flexibility and probably greatly reduced interoperability in international freight transport. In public transport, however, it could be sensibly implemented as a trolley hybrid bus due to the fixed bus lines [6].

While the lower energy consumption in driving mode (TtW) speaks in favour of the use of BEV and FC trucks, the BEV option is already ruled out de facto when the required volumetric and gravimetric tank capacity is taken into account, as there are significant losses in payload and load volume, see Fig. 7. The influence on the load density  $\rho_{N,g}$  in  $t/m^3$  and the payload factors  $GN'$  in  $t/m$  and  $GN''$  in  $t/m^2$  are shown in Fig. 8. It can be seen that to cope with the load that can be transported in diesel vehicles with E-fuel, BEV trucks would require an additional vehicle demand of 17.2%, with an equivalent increase in energy demand and also in driver cost, the latter which account for about 35% of km costs in long-distance transport (50% in short-distance transport). When considering energy consumption and load planning factors at the same time, only the two options "EURO VI diesel + E-fuel" and "FC + CG H2" appear to be target-oriented for heavy-duty long-haul trucks.

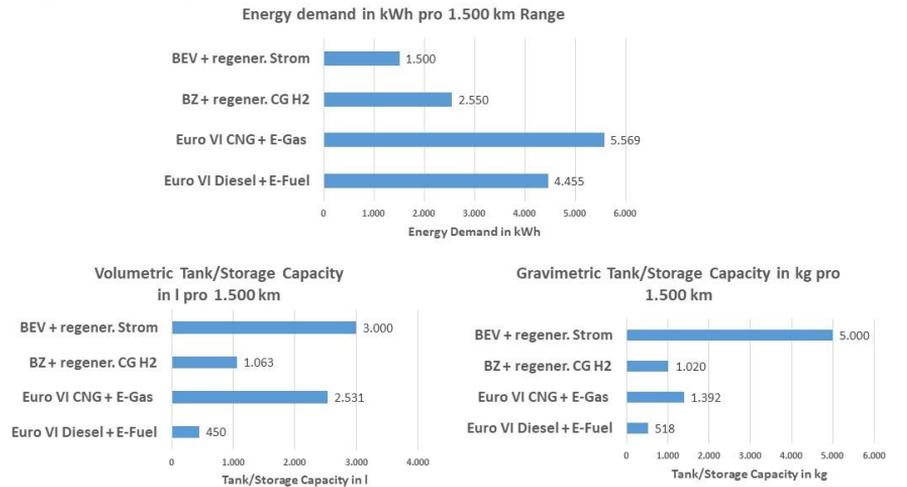
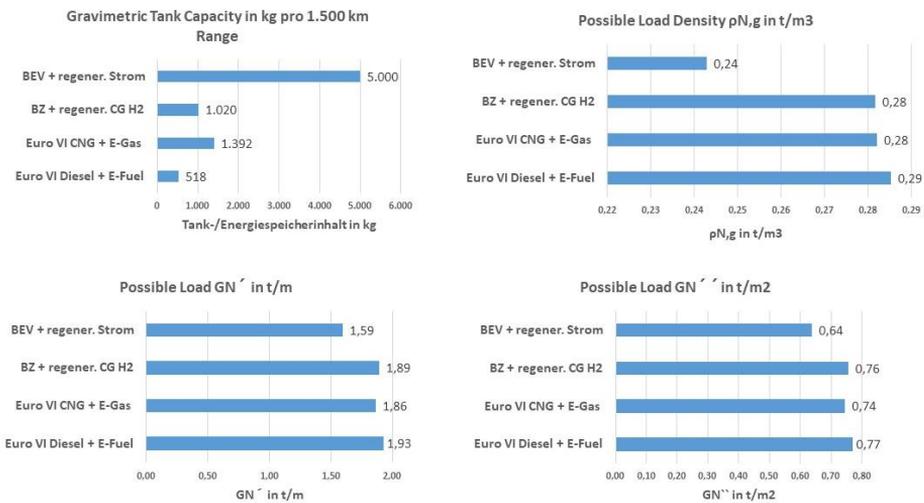


Figure 7 Energy requirements and tank contents for usual truck ranges of 1,500 km



BZ = FC

Figure 8 Impact of gravimetric energy content on truck payload

The refuelling times for the investigated options are shown in Fig. 9 for a refuelling or driving distance of 1,500 km on the one hand and on the other hand for the daily refuelling processes at a motorway filling station with around 50 truck refuellings per day. A fast

charge with 250 kW was assumed on average for the BEV option because the power dissipation in the form of process heat with 500 kW or even MW charging is excessive! While the daily net refuelling times of all trucks at an average motorway filling station can easily be completed in 24 hours for the target options "EURO VI diesel + E-fuel" and "FC + CG H2", BEV trucks would require more than two weeks (17.3 days) - 48 times as long as the "EURO VI diesel + E-fuel" option - considering the additional vehicles mentioned, which would only ensure truck operation with an equivalent, hardly feasible increase in space at filling stations.

Due to the politically intended energy self-sufficiency with domestic renewable energy from preferably wind power and photovoltaics, the feasibility of this toll transport scenario within the "energy transition" in the transport sector was analysed on the basis of "10 GWh wind power plants" (also referred to as "Growian" = Große Windkraftanlage; large wind power plant) with an average yield of 10 GWh/a in Germany. To cover the energy demand for the trucks toll kilometres on German motorways, 2,023 of the "10 GWh wind turbines" would be required for the BEV truck option, see Fig. 10. For this purpose, the average number of full-load hours (VLS) of wind power of 1,500 VLS/a in Germany was taken into account. For the operation of the BEV truck option, however, the long-haul transport companies would have to accept highly significant, non-practical restrictions in the up to now flexible operation. For the practical option "FC + CG H2", however, 4,543 of the "10-GWh wind turbines" would be required in Germany, and for the likewise practical option "EURO-VI Diesel + E-fuel" even 9,202 of "10-GWh wind turbines" in Germany, which would make a regular production of E-fuels in Germany absurd. However, if the required volumes of E-fuels were produced in Patagonia, for example, with an average of 5,200 VLS/a, only 2,654 "10-GWh wind turbines" would be needed at typical German wind speeds. On the other hand, it must be taken into account that the wind turbines in sparsely populated Patagonia could well be larger and, due to significantly higher wind speeds, even significantly fewer than the number of wind turbines required for BEV trucks in Germany would be needed - because the kinetic energy flux density is proportional to the third power of the wind speed ( $v^3$ ) [7]. Consequently, a wind speed of just 1.5 times higher than in Germany increases the extractable wind power by almost 3.4 times, which means that comparatively 781 Growians (about 40 per cent of the number of wind turbines needed for BEV trucks) would only be required for E-fuel production in Patagonia. Comparably favourable conditions would also result from the use of photovoltaics for E-fuel production in North Africa. However, despite the highest energy efficiency in driving operation, the BEV truck option for the truck toll kilometre scenario would mean that statistically an average of 5.6 "Growian" wind turbines would be required per motorway filling station in Germany, and even 12.7 for the "FC + CG H2" option. The preconditions for this would be either on-site energy production at the filling stations (if sufficient wind power is available on site) or a sufficient electricity distribution network, which, however, could only be established in the long term.

In order to classify the above-mentioned regenerative energy demand for covering only the trucks toll kilometres, the previous and projected further development of wind energy development in Germany must be considered. Under the conservative assumption that the progression of the previous development of renewable energy expansion is continued, the scenario shown in Fig. 11 results. It was assumed that the energy yield from wind turbines (on- and off-shore wind energy) doubles from 2020 to 2030. It can be seen that with this development, already today's net electricity consumption (488 TWh in 2020 and 484 TWh in 2022) can only be covered by renewable energies in 2035 and consequently there is until then still no capacity available to provide the energy demand for E-mobility – not even only for trucks toll kilometers!

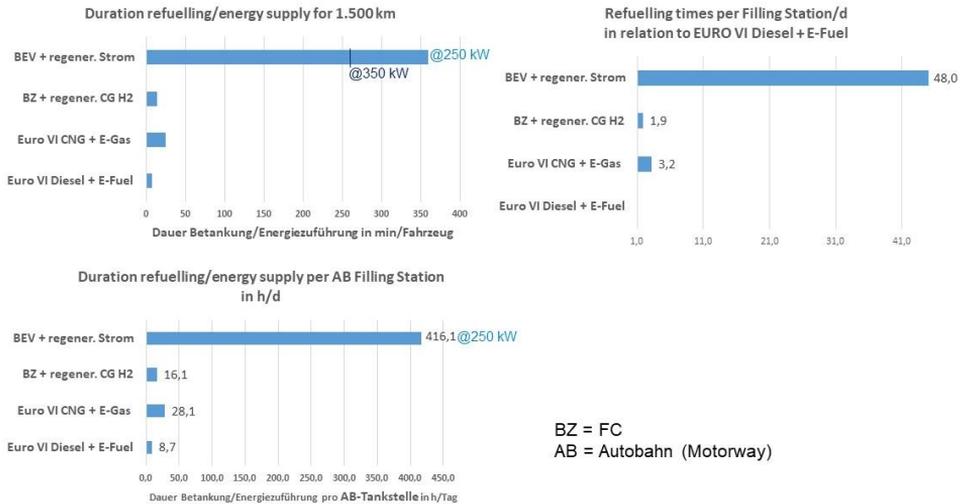


Figure 9 Comparison of heavy-duty trucks refuelling times

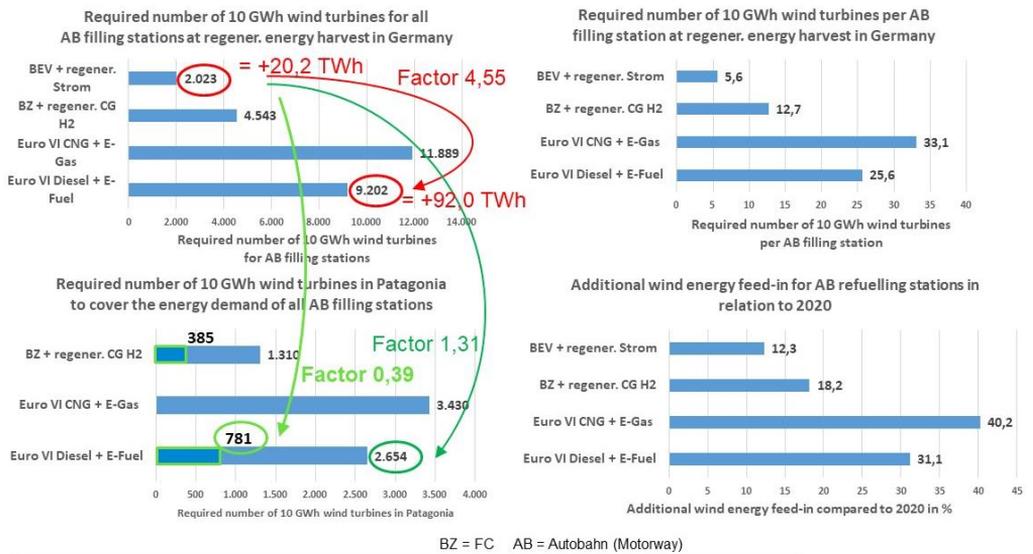


Figure 10 Required additional number of „10 GWh wind turbines“ in Germany for the coverage of the trucks toll kilometres @motorway filling stations

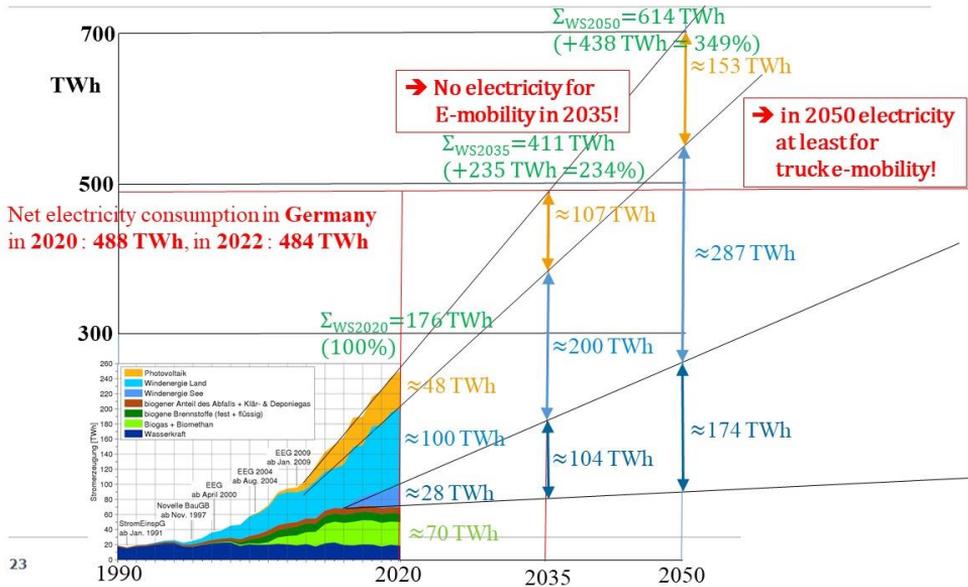


Figure 11 Development of renewable energies in Germany (conventional scenario)

Within the foreseeable future an insufficiently developed electricity distribution network and assuming that renewable energy would be sufficiently available on site, the BEV truck option would require an average area of 2.2 ha per motorway filling station, and even 5.1 ha for the "FC + CG H2" option, the latter which is significantly more practicable from an operational point of view. The total additional land requirement of 809 ha for the „BEV with German wind power“ option and 1,817 ha for the "FC + CG H2" option would be euphemistic and completely insignificant for Germany (see Fig. 12). Compared to "BEV with German wind power", the option "EURO VI Diesel + E-fuel" would only require a slightly larger area of 1,062 ha in Patagonia if E-fuel is generated in Patagonia, and even significantly less if higher wind speeds are taken into account – e.g. only 312 ha at 1.5 times the wind speed. The advantage of the latter option would also be the unchanged use of the existing infrastructure for energy distribution and refuelling in Germany and Europe, while the planned expansion of the German electricity grid according to the German Grid Development Plan for Electricity and the required construction of fast charging stations for trucks involve high, presumably by far underestimated cost dimensions.

As a further scenario for analysing the energy demand for the „energy transition“ in the transport sector, a passenger car-specific scenario was examined, in which only the energy demand for handling the entire domestic passenger car traffic with 45.8 million vehicles (31 million petrol and 14.8 million diesel passenger cars) at 14,460 filling stations throughout Germany was considered. It was assumed that 90% of the driving of domestic cars takes place in Germany. An average vehicle of the lower middle class from the German passenger car fleet was chosen as the average value. Furthermore, a range of 700 km was assumed, which is common for passenger cars today.

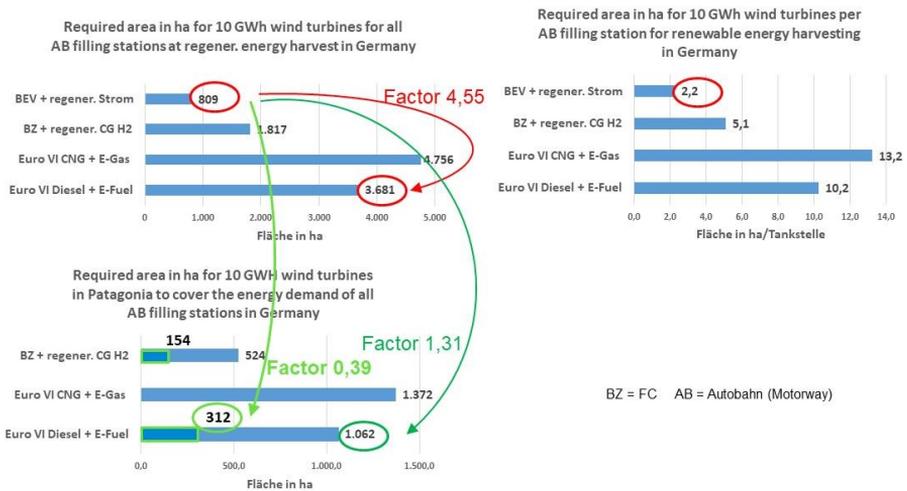


Figure 12 Required areas for "10 GWh wind Turbines" in Germany for heavy-duty trucks on German motorways

For the refuelling times for one „tank filling“, a fast charge with 50 kW and with 250 kW was alternatively investigated for the BEV car option. While the net "refuelling time" of a BEV car at 250 kW charging power takes only a little more than half an hour (34 min), taking into account the charging losses, the usual charging with 50 kW today would require almost three hours (168 min). Not only the latter would lead to an almost unrealisable increase in filling station space with today's battery technology, which is obviously also an underestimated item. To cover the required energy demand with domestic wind energy, 21,707 "10 GWh wind turbines" would be needed for the "BEV car" option, and 48,972 for the "FC car + CG H2" option. The required areas for wind turbines in Germany would - purely superficially considered - not be a problem either for the "BEV car" option with 12,161 football pitches or 0.2% of the grassland in Germany or for the "FC car + CG H2" option with 27,436 football pitches, if a sufficiently stable electricity distribution grid were available. The equivalent production of E-fuels for the internal combustion engine option would require only an area of 8,205 football pitches in Patagonia, due to the significantly higher wind full load hours (VLS) and assuming a 1.5-fold average wind speed compared to Germany. This would mean only 0.005% of the area of Patagonia. It follows that the conventional scenario shown in Fig. 11 for the further development of domestic renewable energy production in Germany is far from sufficient for the "BEV passenger car" and "FC passenger car + CG H2" options; instead, a forced scenario would be required as shown in Fig. 13. It further follows that for the exclusive regenerative energy supply of domestic cars, until the year 2050 around six "10 GWh wind turbines" for the "BEV cars" option and as many as ten of these wind turbines for the "FC cars + CG H2" option would have to be newly erected in Germany at every working day - with immediate effect! Considering the previously analysed trucks toll kilometres scenario with renewable energy, for which 52% of the energy consumption of heavy-duty trucks on German motorways was assumed, and additionally the energy supplied at the companies' depot filling stations, the number of "10 GWh wind turbines" to be erected per working day for the "BEV" option increases to at least seven and for the "FC + CG H2" option to at least eleven of these wind turbines! However, this still does not take into account the high number of trucks under 7.5 t including the van class as well as the substitution of today's still fossil net electricity generation and as well as the additional electrical energy with the intended German

exclusion of oil and gas heating systems etc., which would still highly significantly increase the requirements for the daily erection of "10 GWh wind turbines". In this respect, the emphatically positive statements on BEVs in some recent studies and discussion papers are definitely to be questioned, although these are often used by politicians, while other recent studies and open letters to the responsible EU representatives, signed by hundreds of scientists, are apparently completely ignored by politicians.

Since the generation and consumption of renewable energies do indeed not correlate in a resilient manner, energy storage systems are also indispensable, because energy management ("smart grids"; bidirectional charging) alone will hardly be effective without dispensing with unacceptable interventions such as limited electricity allocations.

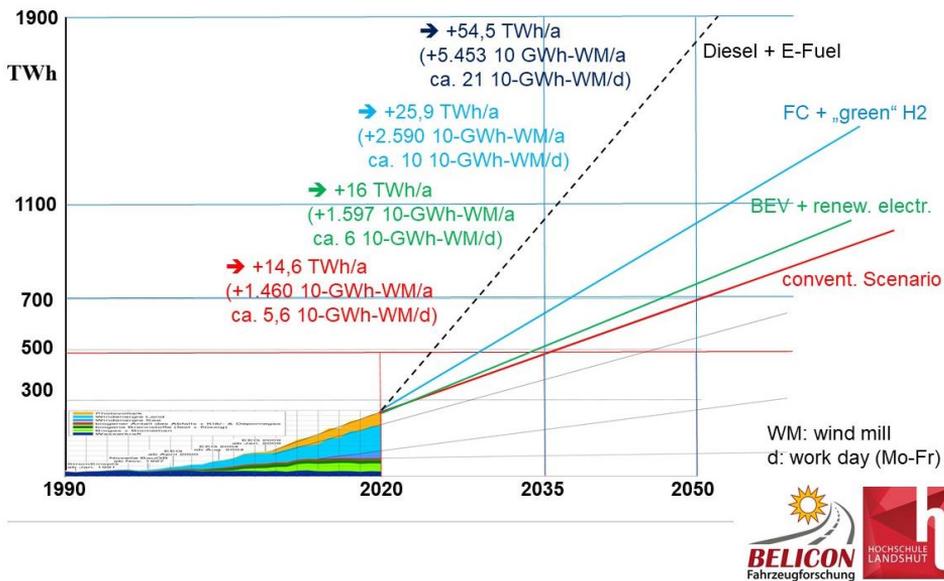


Figure 13 Required availability of renewable energy in Germany only for sustainable car mobility in 2050

### 3 ANALYSIS OF THE OVERALL ECOLOGICAL PROFILES OF DIFFERENT PROPULSION/FUEL OPTIONS AND CONCLUSION

For a comprehensive ecological and economic evaluation of vehicle fleets of different propulsion systems and fuel types, all stations of the life cycle of transport systems must be included in a comprehensive analysis, as mentioned at the beginning, since the isolated consideration of only the actual driving operation (TtW) can lead to completely wrong conclusions [8]. The following analysis is carried out using the example of a PT bus fleet.

The overall ecological assessment for the time horizon "today" (year 2020) shows that for comprehensive sustainability, the modern Euro VI Diesel bus fleet is already today sufficiently positioned with even fossil Diesel fuel, and with the German electricity mix, little to no improvements are achieved through the procurement of alternative electric drive options (BEV and FC), although according to the EU Clean Vehicles Directive, all electric vehicles - regardless of the electricity mix - are mistakenly declared as "emission-free". Even in the long term, there would therefore be de facto no ecological need to dispense with internal combustion engine technology, especially as further ecological potential can be

tapped with E-fuels. Depending on the scenario, the World Energy Council (WEC) assesses the demand for PtX in 2050 to be between 10,000 TWh (low demand) and 41,000 TWh (high demand), according to which even the aforementioned high demand could be covered by the potentially available global generation volumes [9]. However, the calculation with the average German power plant mix, as optimistically also applied here, is an „ecological whitewash“, because the fluctuating residual load must be predominantly covered by controllable power plants. In concrete terms, this means that when the demand for charging electricity increases, the ecologically worst electricity mix is used. This significantly worsens the eco-balance of electromobility. With E-fuels, Re-Fuels (as HVO100) and E-gas, the same GHG emission level is already achievable today in combination with EURO VI engines as with the alternative drive variants of the electromobility spectrum with exclusively renewable energies.

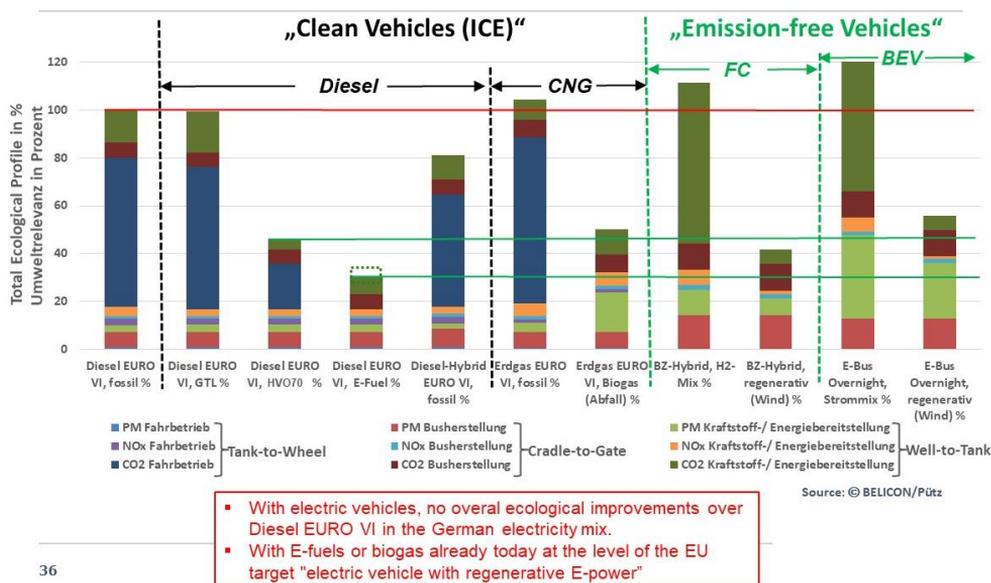


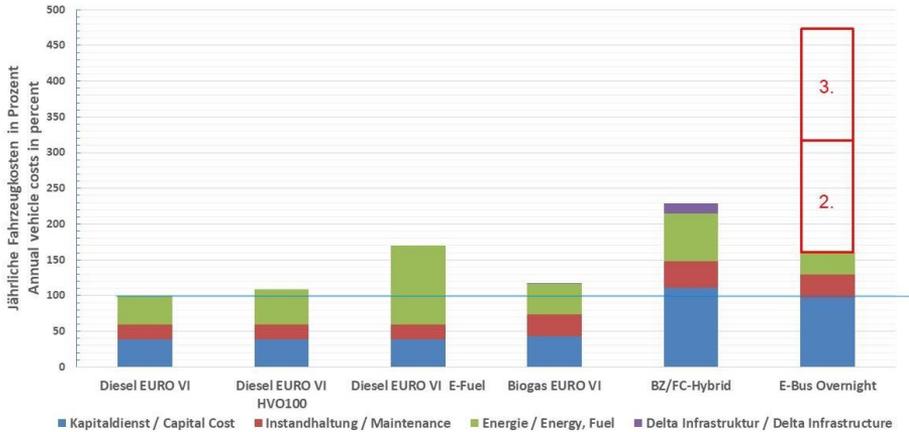
Figure 14 System-related overall environmental profile of a real PT bus fleet for the time horizon „today“

The implications of the range problem of BEV vehicles have already been discussed before in section 3 in the scenarios for heavy-duty trucks and passenger cars. For PT buses, this problem is less significant due to fixed routes. Nevertheless, it must be taken into account that the range of BEV buses drops significantly, especially at low temperatures, as the heating energy must be covered from the limited energy supply of the battery. Considering the additionally limited passenger capacity due to the mass of the required battery capacity, it can even be assumed in the best case that one Diesel bus must be replaced by at least by two battery buses in winter, which worsens the environmental balance of the BEV buses accordingly, see Fig. 15. The equivalent additional demand for drivers must also be taken into account. An operational evaluation is shown in Fig. 16.

By the way: The demand for fossil energy in Europe before the start of the Corona pandemic was around 17,100 TWh. In order to be able to replace this demand with renewable energies, more than 2.9 million (sic!) new wind turbines would have to be installed in Europe in addition to the 82,000 already existing. The calculation would be similar for photovoltaics: The current photovoltaic area of just under 2,100 km<sup>2</sup> would have to be increased to around 230,000 km<sup>2</sup> by a factor of 110 (11,000%! ). The decision-makers

in the EU should be well aware of these dimensions - which border on utopia - bearing also in mind the requirements of a completely new electricity grid design.

The well-intentioned climate protection goals of the EU may be honourable, but the quasi-dictated paths seem politically naive and possibly economically disastrous - if key industries are sacrificed and ultimately the rest of the world is not willing to follow the European lead.



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Source: © BELICON/Pütz



Figure 15 System-related overall Total Cost of Ownership (TCO) of a real PT bis fleet for the time horizon „today“

	Gravimetric Tank Capacity	Volumetric Tank Capacity	Payload Density	Refuelling Time	Operational Flexibility	Infrastructure Availability	Infrastructure Flexibility
EURO-VI-Diesel + E- or Re-Fuels	++	++	++	++	++	++	++
EURO-VI-CNG + E-Gas	+	+	+	++	++	+	+
FC + CG H2	+	+	+	++	++	-	+
BEV	--	--	--	--	-	--	+

Figure 16 Evaluation of perational requirements for selected propulsion options with regenerative energy

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