STRATEGY FOR SUSTAINABLE AND SMART MOBILITY:

Putting European transport on the right green path for the future

Insights from scenarios, options and challenges, in line with the 2030 and 2050 ambitions of the European Green Deal

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Energy scenarios

Scenario selection between 2017 and mid-2019, 26 publications on energy scenarios, stemming mainly from governmental organizations or the private sector (Figure 1 (left)), present 67 scenarios for the EU energy system (Figure 1 (right), Figure 2). About two-thirds of these scenarios follow deep decarbonisation trajectories (i.e. reducing emissions by more than 80% by 2050) (2). One-third (20 scenarios) meet the ambition of the "European Green Deal" to reduce emissions by at least 50% by 2030 [7], and another third (16 scenarios) with the strategic vision for the EU to become a climate neutral economy by 2050 (3) [8] (Figure 1 (right)).

Figure 1 Overview of energy scenario studies that include the EU28, between 2017 and June 2019

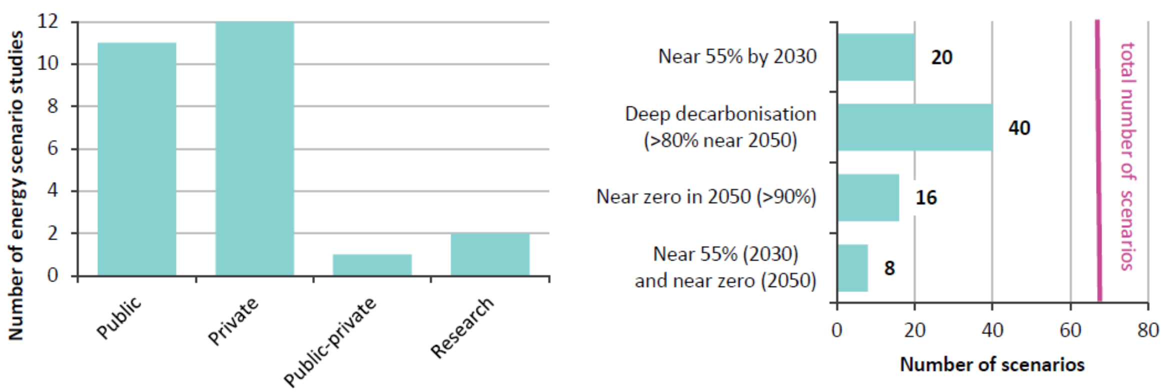
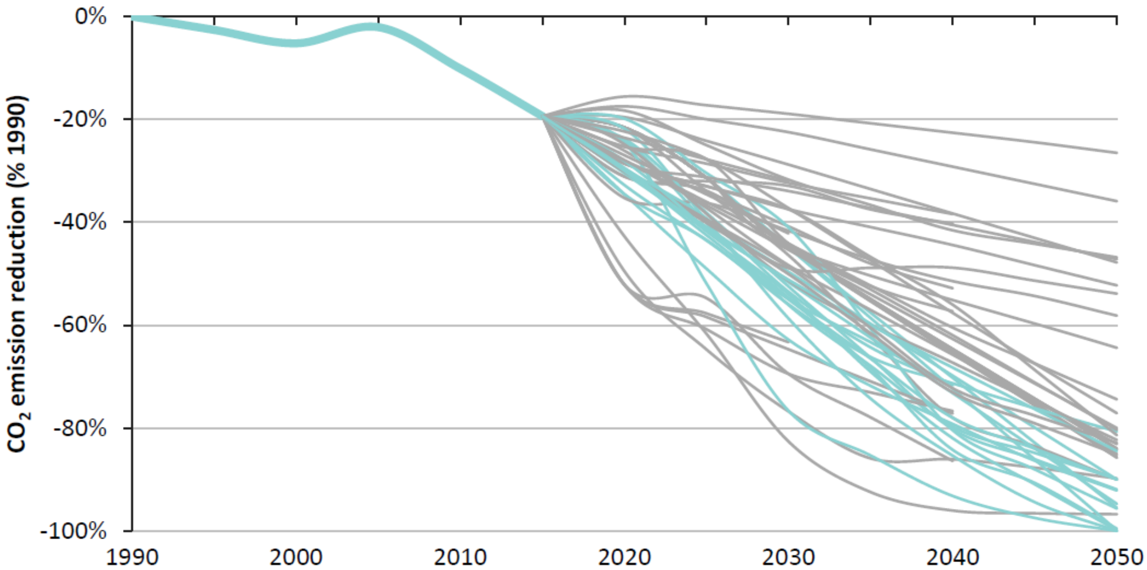


Figure 2 *CO_2 emission trajectories in energy scenarios for the EU28 to 2050, published between 2017 and June 2019*



Note: The scenarios reviewed in this report are highlighted in blue. *Source*: JRC.

This report analyses two subsets of scenarios (Table 1), more specifically (4):

• Those that meet the mid-term ambition (i.e. emission reduction of at least 50% by 2030 compared to 1990, excluding those that exceed a 56% reduction). This group includes 8 scenarios from 7 different publications and 6 different stakeholders. Notably the EC Long Term Strategy (LTS) scenarios are not part of this selection as they do not meet the criterion;

• Those that meet the long-term vision (i.e. near-zero emissions or emission reduction of at least 90% by 2050 compared to 1990). This group includes 16 scenarios from 10 different publications and 9 different stakeholders, including two scenarios from the EC LTS.

The Intergovernmental Panel on Climate Change confirms the need for urgent action to reduce greenhouse gas emissions to meet the agreement to limit global warming to less than 2 ° C. These goals and commitments are in the spotlight of experts from all over the academic world to review the options available for reducing CO2 emissions from the transport sector.

The use of motorized transport is a key feature of daily life but the use of fossil fuels in it is the cause of the emission of a quarter of all "greenhouse gases" (GHG) in the EU.

Decarbonization of transport is a challenge; but also an opportunity for industries and businesses.

This article summarizes the analysis, conclusions and advice received from the experience of these works to serve the policy makers of our Albania and Kosovo to be coherent with the path of development to the EU.

GHG reductions

- To meet medium and long-term climate targets requires robust **"decarbonisation"** of the transport system. The overarching long-term EU target for the transport sector is set out in the "**2011 Transport White Paper**" (EC, 2011b). It was set at 60% carbon dioxide (CO2) emissions reduction in 2050 compared to 1990 levels.
- This target has its origin in the long-term worldwide goal to limit global warming in this century to no more than 2°C above pre-industrial levels. Recently, a more ambitious target was adopted through the Paris Agreement in response to the latest report of the "**Intergovernmental Panel on Climate Change**" (**IPCC**). The Paris Agreement aims to strengthen the global response to climate change by "***holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change***". Clearly, a 1.5°C target is substantially more ambitious than a 2°C target, which will have implications for all sectors, including transport.
- Considering the existing medium and long-term "**GHG"** reduction targets and the recently stepped up ambition, the question arises how these targets are to be met and what implications they have for EU transport policies. This paper describes the effectiveness of current and future climate policies for transport and discusses the policy action needed at EU level for meeting the commitments made in Paris.

EU's GHG emissions

- While the EU's GHG emissions have been declining since 1990, GHG emissions from transport have increased. GHG emissions from international shipping increased even more between 1990 and 2014, while those from international aviation nearly doubled over the same period.
- This increase occurred despite EU policy efforts to limit transport GHG emission. The EU policies that had the largest impact on decarbonisation were CO_2 standards for passenger cars and policies aimed at increasing the share of renewable energy sources in transport. However, in both cases, real-world emission reductions have been far smaller than the intended reduction. The growing discrepancy between real-world CO_2 emissions and those

measured in the 'New European Driving Cycle' (NEDC) test cycle has had an important impact on the effectiveness of CO_2 standards for cars and vans. The use of biofuels might even have led to a net increase in CO_2 emissions if indirect emissions are taken into account.

- The effectiveness of EU modal shift policies has not been properly assessed to date, but may very well have been limited. The policy impact on GHG emissions from aviation and maritime shipping has so far been limited.
- Very significant GHG reductions are still necessary in the transport sector to meet the longer term climate agreements. The urgency of swift policy action has increased with the Paris Agreement.
- Although the GHG reduction target for 2020 of 20% compared to 1990 levels looks likely to be met, further policy action is needed to meet the proposed 2030 target of 40% compared to 1990 levels. Limiting warming to the proposed 1.5°C requires net zero emissions globally at some point between 2040 and 2060.
- A step change in GHG emissions reductions will be needed to meet the 60% GHG reduction target for transport in 2050. This becomes especially clear when it is realized that without further policy action, transport GHG emissions are expected to be 15% above 1990 levels by 2050. Moreover, the 2050 target is based on a maximum temperature increase of 2°C, not 1.5°C. In 2014 transport GHG emissions were 20.1% above 1990 levels, implying they will need to fall by 67 % by 2050 in order to meet the Transport White Paper target (EEA, 2016d) and even significantly more to meet the commitments made in the Paris Agreement.
- A wide range of measures are available to reduce the future CO_2 emissions of the transport sector. The largest potential comes from technological options to improve the energy efficiency of vehicles, ships and planes.
- The second largest potential comes from renewable fuels and energy carriers for the different transport modes.
- A more limited impact may be expected from measures that improve the efficiency of the transport system itself (i.e. measures that impact on transport demand).

Options and challenges

Current technologies are either insufficient or need further development to meet the future GHG reduction targets. Of particular importance are:

- Cost reductions for battery electric vehicles and fuel-cell vehicles.
- Realization of charging and/or fuelling infrastructure for electric and fuel-cell vehicles.
- Technologies for the production of large-scale, affordable, low-carbon and renewable fuels from biomass, wind and solar power, in particular for transport modes or applications for which electrification is unlikely to be a viable option (e.g. aviation, shipping and possibly heavy-duty vehicles). In particular, the development of power to-gas and power-to-liquid should be developed.
- To decarbonise the transport sector further, it is recommended to continue and strengthen the existing range of polices, targeting the efficiency of vehicles, the decarbonisation of fuels and the efficiency of the transport system as a whole.
- In designing a strategy and policies for the decarbonisation of transport, it is important not to focus solely on the 2050 emission target, but also on the cumulative GHG emissions over time.
- Since the costs for companies and citizens are likely to increase, it is important to adequately communicate the reasoning behind the policies and have a transparent decision process in place in order to ensure broad support for the actions taken throughout the EU.
- It is recommended to continue and strengthen vehicle CO_2 regulations over time, to introduce regulations for heavy-duty vehicles (HDVs), and to ensure that the effectiveness of the regulations is improved by reducing the gap between real-world and test-cycle emissions.
- Swift policy action on vehicle regulations is recommended, since new legislation takes time to adopt and applies only to new vehicles, which means it takes roughly ten to fifteen years (depending on vehicle lifetime) for the full effects to kick in.
- In the long-term, climate targets can only be met if light-duty vehicles become nearly zero emission. A mandate for ultra-low or zero-emission vehicles has the potential to ensure a sufficiently fast uptake of electric and fuel-cell vehicles.

- Efficiency policies will induce rebound effects: they will result in lower costs per kilometer in both passenger and freight transport, which will induce additional travel demand and result in additional GHG emissions. Moreover, climate policies will result in reduced demand for fossil fuels, which will in turn decrease oil prices. To meet long-term targets, climate policies should give due consideration to these rebound effects

- To speed up the use of renewable energy sources in transport, implementing stable and effective sustainability criteria for the period after 2020 is key, combined with equally stable targets thereafter, such as blending obligations, CO_2 targets. To set these targets at an optimum level, a longer-term outlook is needed on the future transport energy mix with which the climate targets can be met.

- Policies and strategies for RES-T should not be assessed and developed in isolation, but be considered together with the other sectors working on decarbonisation of their energy supply, notably the power sector, industry and the built environment.

- To meet their decarbonisation targets and challenges, these sectors will also have a growing need for sustainable biomass as a renewable energy source (and chemical feedstock), for renewable electricity output and for renewable fuels from solar or wind power. Since the availability of sustainable biomass feed stocks is limited, competition for these feed stocks and other sources of renewable energy is likely to increase costs. At the same time, though, this might also create opportunities for cooperation and synergies, in bio-refinery processes, for example, resulting in output of multiple biomass products making fully use of the available biomass.

- Power-to-gas and power-to-liquid should be developed in order to ensure the transport sector can also benefit from the full potential of decarbonisation from renewable fuels produced from wind and solar power.

- Climate policies for transport need to anticipate the possibility that vehicle efficiency measures in tandem with sustainable fuels may be insufficient to meet long-term climate targets. Currently, cost-effective measures to improve the efficiency of the transport system are largely overlooked in EU policy. Measures such as improving logistics efficiency through Cooperative Information Technology Systems (C-ITS), congestion charges and optimizing spatial planning and infrastructure planning might be more cost-effective than certain vehicle-efficiency and low-carbon fuel measures.

- There is a wide variety of tools that can potentially achieve this, including speed limits, environmental zones, energy taxation based on CO_2 emissions, road charging and spatial planning policy. Each of these can contribute to meeting long-term climate goals.
- Urbanization is an ongoing process in many Member States and will lead to further pressure on air quality, noise, safety and general live ability, in addition to the increasingly stringent climate goals which will alter (urban) transport (e.g. car and ride-sharing and a resurgence of cycling and walking). As a result, cities will play an important role in the transition towards sustainable transport. Considering that decisions on infrastructure and spatial (urban) planning will have an impact for many decades, the EU could promote these being tied more closely to GHG emission policy. Sustainable Urban Mobility Plans (SUMPs) can function as an important tool in this respect.
- Aviation and maritime transport are preferably regulated at a global level in ICAO and IMO, respectively, as these are global sectors. Still, in the case of aviation, the EU policy framework needs to recognize the weaknesses of both the current global market-based measures for aviation and the CO2 standards for aircraft. It is recommended to ensure that aviation makes a fair and appropriate contribution to long-term GHG reduction efforts. Keeping a share of aviation emissions in the EU ETS in the short-term could be considered.
- To meet medium and long-term climate targets requires robust decarburization of the transport system. The overarching long-term EU target for the transport sector is set out in the 2011 Transport White Paper (EC, 2011b). This took as its starting point the need to reduce carbon dioxide (CO2) emissions from transport by 60% in 2050 compared to 1990 levels.

- This target has its origin in the long-term worldwide goal to limit global warming in this century to no more than 2°C above pre-industrial levels. To achieve this goal, the Intergovernmental Panel on Climate Change (IPCC) has stated that GHG emissions reductions of between 80% and 95% are needed by 2050 compared to 1990 levels in developed countries.

Transport in 2020

Increasing the use of motorized transport is a key feature of daily life that is evidenced by the summary of the following figures in the years 2020

- The EU passenger car fleet grew by 5.7% over the last five years; the number of vehicles on the road went from 243 to 257 million.
- 31.5 million vans are in circulation throughout the European Union. Counting more than 6 million vehicles, France has the largest van fleet, followed by Spain, the UK and Italy.
- There are 6.3 million trucks on the EU's roads. With more than 1 million trucks, Poland has the largest truck fleet in the EU, followed closely by Germany and Italy.
- 745,000 buses are in operation throughout the European Union.
- Cars are on average 10.5 years old in the EU. Lithuania and Romania have the oldest fleets, with vehicles older than 16 years, while the youngest cars can be found in Luxembourg (6.3 years) and the UK (7.8 years).
- The average age of vans in the EU is 10.5 years. Among the EU's five big automobile markets, Spain has the oldest light commercial vehicle fleet, followed closely by Italy.
- Trucks are on average 11.7 years old in the European Union. Greek trucks are the oldest ones, with an average age of almost 21 years.
- Despite an increase in registrations in recent years, alternatively-powered passenger cars make up only 3.4% of the total EU car fleet.
- Diesel-powered light commercial vehicles are dominant in all EU countries except for Greece: almost 90% of the EU van fleet runs on diesel.
- Nearly all trucks in the European Union run on diesel (96.1%), petrol fuels only 1% .
- The EU counts 511 cars per 1,000 inhabitants. The highest number of cars per inhabitant can be found in Luxembourg, while Romania has the lowest car density in the EU There are 77 commercial vehicles per 1,000 inhabitants in the EU, Portugal has the highest number per inhabitant: 119 .
- In Hungary nearly half of all households (48.3%) do not have a car and in Denmark almost 40%.
- By contrast, more than 30% of French families have two cars.

Source :ACEA – Vehicles In Use In Europe 2020

Transport in 2030

The emissions from the transport sector (including bunker fuels) increased by 28% in 2017 relative to 1990, contributing significantly to the EU28 GHG emissions (27% in 2017) [16]. Road transport accounts for about three-quarters of the sector's energy use and GHG emissions (including international bunker fuels) [11], [16]. International aviation and maritime transport consume slightly more than one-fifth of the total fuel used for transport in the EU28; in the absence of existing technological alternatives at a large scale, their emissions are hard to abate. The EU28 may need to transform radically the sector in order to reverse these trends and reach its 2030 (and 2050) goals on emission reduction. The energy scenarios indicate the following main options:

• Battery electric vehicles, plug-in hybrids and/or fuel cell vehicles are technological solutions that can reduce the environmental burden of road transport. Conventional and advanced biofuels are also examined as technologically feasible options, although there are uncertainties regarding their environmental impact, especially due to indirect land-use change effects [17], [18];

• Airplanes and ships require energy-dense fuels to cover long distances. Technological options available for road transport are less suitable for these modes (e.g. electrification of airplanes may be suitable only for short intra-EU distances, small weight and taxi mode). Therefore, advanced biofuels and synthetic fuels from hydrogen (e-fuels) or syngas (synfuels) are the most promising in view of deployment. These solutions may also find use in road transport, for example in heavy duty vehicles;

• Other scenarios explore social innovation as means to alleviate the demand for transport (e.g. modal shift, teleconferencing, car-pooling). Coupled with technological innovation, they may significantly reduce the impact of transport on the energy system and the environment.

The scenarios consistently project similar developments for transportation in 2030 in terms of final energy demand, reduction of fossil fuels and penetration shares of new technologies. They achieve the ambition of at least 50% emission reduction by 2030 by (Figure 23):

• Lower final energy consumption in transport by around 20% to 45% in 5 scenarios and about 5% to 10% in 2 scenarios, compared with today (21);

• Reduction in energy demand, primarily achieved by switching from oil (28% to 55% reduction compared to 2017) to electricity and biofuels. While mitigation efforts are required in all transport sectors, the oil reduction for cars may be larger. As a result, also the equivalent CO2 emission reduction for cars may be larger than 28% to 55%;

• Scenarios agree on electric vehicles' penetration (22):

  o total electricity consumption in transport increases by a factor of 3 to 7 compared to today;

  o this growth is mainly attributed to road transport as energy scenarios see 7 to 90 million battery electric vehicles on EU roads by 2030;

Transport in 2050

The decarbonisation efforts for the transport sector strengthen from 2030 towards 2050:

•Most scenarios expect transport to consume around one-third of the energy it consumes today (40% to 80% reduction in most scenarios between 2017 and 2050), while the demand for mobility varies depending on the scenario:

- by 2050, passenger road transport activity increases by about 20% in EC LTS and LCEO Zero Carbon, decreases by20% in ECF, whilst in IEAETP B2DS is more than halved compared to 2015;

however, final energy consumption in transport does not necessarily follow similar trends, a sit is also affected by other underlying assumptions (e.g. on utilisation and occupancy of vehicles) and the car fleet composition;

• In most scenarios, electricity consumption increases approximately by a factor 10 and together with biofuels they cover about60%of the sector's energy demand (i.e. excluding international aviation and maritime bunker fuels); the range, however, is rather wide across all scenarios assessed, from 40% to almost 90%;

•The electric vehicle fleet reaches 100 to 220 million battery electric vehicles in most scenarios. The ECF scenarios project as little as 5 to 10 million passenger battery electric vehicles, owing to the irradically different assumptions on utilization and occupancy of different modes of transport (in ECF the total passenger car fleet is between10 to 35million vehicles);

•Hydrogen and e-fuels are fully deployed and become key element sin decarbonizing transport; they supply from 15% to 50% of the sector's energy needs;

•Oil is still used in transport in most scenarios (2 to 50 M toe, 1% to 16% of today's consumption; only 6 out of 17 scenarios phase out oil completely);

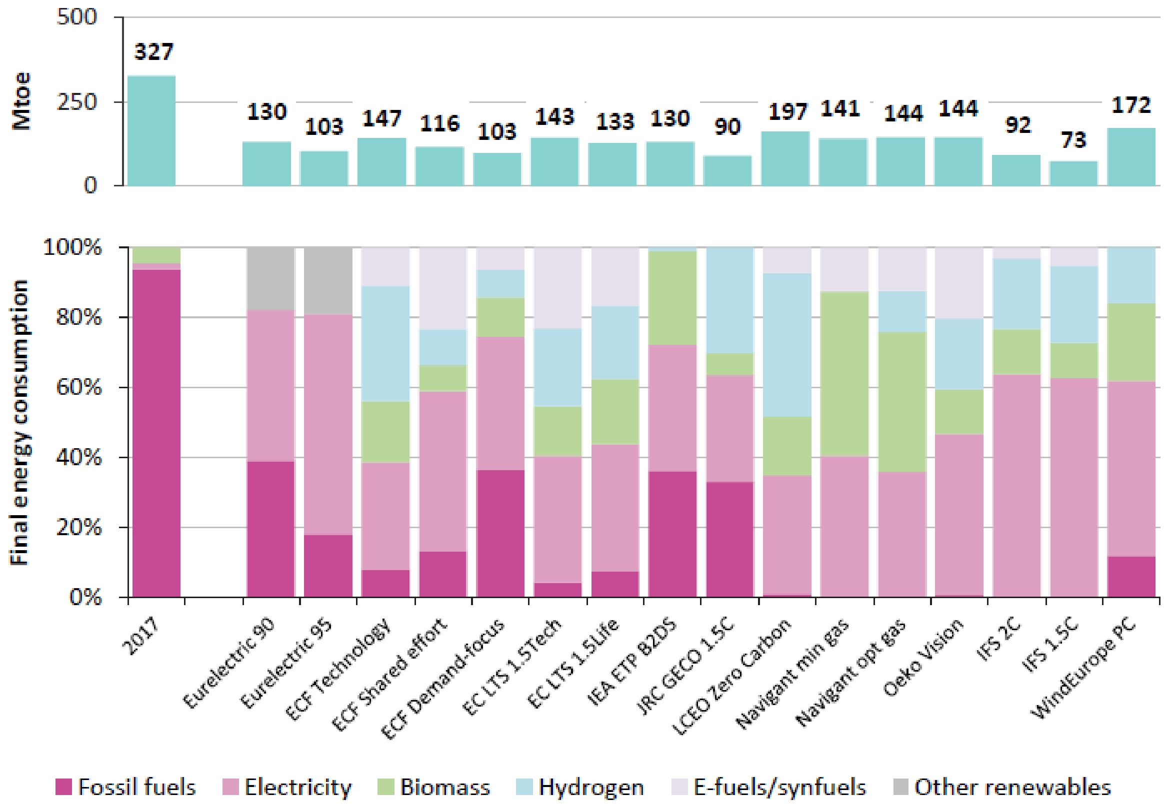
•The 10 scenarios that achieve net-zero emissions in the EU by 2050, all seem to follow a different route in decarbonizing transport. The three ECF scenarios still use fossil fuels but have significant reduction in the car fleet. The two ECLTS scenarios still use oil and increase passenger road transport activity compared to 2050. The remaining five scenarios completely phase out oil .

The share of decarbonised energy consumed in transport in 2050 (29) is around 60% in 2 scenarios (ECF Demand-focus, IEA ETP B2DS), 75% and84% in Wind Europe PC and ECF Shared effort respectively, and above 90% in all other scenarios. Own interpretation of scenario results and their implication on the passenger vehicle fleet in 2050 is described in Box4.

Vehicle fleet composition in 2050

The share of electricity (battery electric vehicles) and hydrogen use (fuel cell vehicles) in road transport ranges from 32% to 69% in 2050. Assuming that all electric vehicles in 2050 are zero-emission vehicles (i.e. and not plug-in hybrids) and by applying the same approach as in Box3, then the share of zero-emission vehicles can be estimated. Based on own interpretation of scenario results, it is concluded that the total vehicle stock will be comprised of between 65% and 90% zero-emission vehicles, which are either battery electric or based on fuel cells. The remaining vehicles use mainly bio fuels or e-fuels.

Figure 3. Final energy consumption in the EU28 transport sector in scenarios that reach at least 90% emission reduction in 2050



Note: "Other renewables" includes non-emitting secondary fuels such as bio methane, biodiesel, bioethanol, hydrogen and others in Eurelectric. *Source:* JRC.

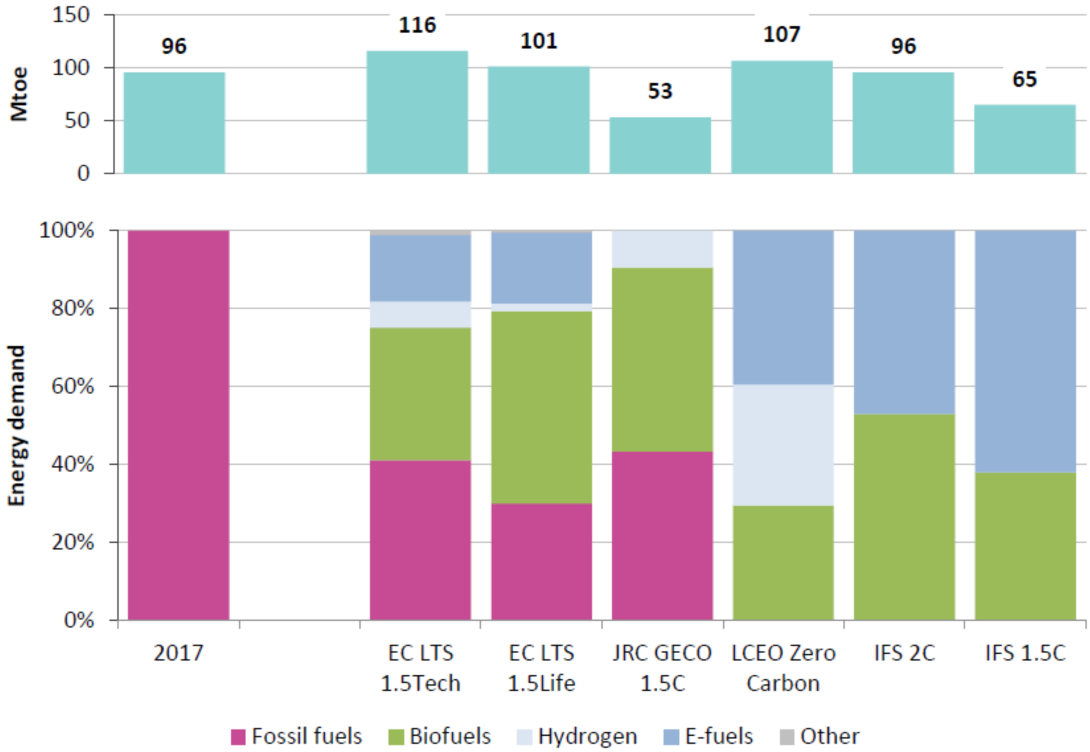
International aviation and maritime bunker fuels are not part of the above analysis, as according to the new definition of Eurostat, they are reported separately from final energy consumption in transport. Due to the limited insights into the assumptions for transport but also due to the inconsistent reporting of international bunker fuels across the reviewed energy scenarios, a more detailed comparative assessment for aviation and maritime separately is not possible. Based on the available data presented in Figure 31, it is seen that:

• Final demand for international bunker fuels in energy scenarios varies by a factor 2; it can be as low as 50 Mtoe (JRC GECO 1.5C) to as high as 115 Mtoe (EC LTS 1.5C);

• Out of 6 scenarios, 3 show full decarbonisation of international aviation and maritime fuels, whilst the remaining 3 show oil consumption up to 40% of the sector's demand;

• In 5 out of 6 scenarios, biofuels are mostly consumed as international bunker fuels (60% to 80% of total biofuel consumption from Figure 3 and Figure 4). Only JRC GECO 1.5C shows that biofuel consumption is higher in road transport.

Figure 4 International bunker fuels in scenarios that reach at least 90% emission reduction in 2050



Note: For the EC LTS scenarios, the maritime bunker fuels of 1.5LIFEMar scenario is added with the international aviation fuels of 1.5Tech and 1.5Life. "Other" includes mainly electricity and small fraction from other liquids in EC LTS. *Source:* JRC.

Conclusion

- Over the past ten years numerous reports have focused on the policy actions that are needed to meet the transport climate targets (PBL, 2009); (AEA, CE Delft, TNO, 2010); (EC, 2011c); (EEA, 2016d); (ITF, 2017).

- A constant in the conclusions of these reports is that there is no 'silver bullet' that tackles all problems simultaneously.

- Each and every transport mode will have to make a substantial contribution to CO2 reductions.

- Moreover, a combination of measures aimed at :
  (1) Vehicle efficiency,
  (2) Decarbonisation of transport fuels and
  (3) Efficiency of the transport system (aimed at controlling modal split, promoting efficient vehicle use and curbing transport demand) is needed for each of the various modes.

- The European Commission revises the **CO_2** emission standards for cars and vans by June 2021. But go further and propose a European "**ban on the sale**" of cars and vans powered by diesel, petrol and gas with Internal Combustion Engine (**IC**E) - including **hybrids** - as soon as possible and by 2028 at the latest, moving all remaining sales to new electric vehicles with light batteries.

- National governments should also stop selling all new vehicles powered by fossil fuels with ICE - including hybrids - by 2028 at the latest, in order that after 2050 there will be no cars and vans with MDB and Hybrids in circulation worldwide.

References

[1] Greenpeace Italia "UNA ROADMAP PER DECARBONIZZARE IL SETTORE DEI TRASPORTI IN EUROPA ENTRO IL 2040" Settembre 2020.

[2] CE "Strategia per una mobilità sostenibile e intelligente: Mettere i trasporti europei sulla buona strada per il futuro" .

[3] Applied Energy Journal "Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070", Homepage: www.elsevier.com/locate/apenergy.

[4] ACEA Report "Vehicles in use Europe 2018"

[5] I.Tsiropoulos, 2020 W.Nijs, D.Tarvydas, P.Ruiz, "Towards net-zero emissions in the EU energy system by 2050 Insights from scenarios in line with the 2030 and 2050 ambitions of the European Green Deal "

[6] Research for TRAN Committee - Decarbonisation of EU transport - ISBN 978-92-846-1277-2 doi:10.2861/840058 QA-04-17-668-EN-N

[7] A position paper prepared by MoZEES and CenSES "Decarbonization of transport". ISBN 978-82-93198-25-3