Pathways towards a European Low Emission Society
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EUCALC

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Avoid, shift, improve

Decarbonisation pathways for the transport sector in Europe

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Headlines

- Current trends in the transport sector are very unlikely to bring us to significant reductions of greenhouse gas (GHG) emissions by 2050, missing by far the ambition required to meet the Paris Agreement.
- The transport sector has the potential to do much more than what is pushed with current policies. This can be verified by running the EUCalc model with its user interface – the Transition Pathways Explorer - and setting its levers: alternatives to travel are being explored (the Avoid levers), a lot of social innovation is taking place around mobility with many new cleaner and softer alternatives appearing in city centers (the SHIFT levers), new technologies are being developed on the drive trains with electric mobility slowly becoming a credible option, particularly when Total Cost of Ownership (TCO) is taken into account (the IMPROVE levers).
- The deployment of innovative low-carbon technologies (such as hydrogen-fueled cars, catenary highways for trucks and synthetic fuels for the aviation and shipping sectors) will still be required to stay aligned with the EU 2050 carbon mitigation commitments.
- Exploiting the full potential of decarbonisation options may lead to transport reaching zero greenhouse gas emissions, given that the electricity sector itself will be decarbonized. The willingness for citizens to adopt new ways of interacting with various transport options, along with their willingness to invest in better and more expensive cars which are cleaner and consume much less over their lifetime are some of the key factors essential for decarbonising the sector.

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The EUCalc model and the Transition Pathways Explorer

The EUCalc model user interface - the Transition Pathways Explorer - is a tool that allows users to build a pathway to a net-zero carbon future at European and Member State level. Its scientific mission is to provide a sophisticated, yet accessible, model to fill the gap between integrated climate-energy-economy models and the practical needs of decision-makers. The model relates emission reduction with human lifestyles, the exploitation and/or conservation of natural resources, job creation, energy production, agriculture, costs, etc. in one highly integrative approach and tool which enables decision-makers to get real-time policy support underpinned by comprehensive trade-off analyses.

Politicians, innovators and investors can use the EUCalc Transition Pathways Explorer to create their own pathways to a low-carbon future online, in real-time and together. This tool can help policy makers in the EU28 + Switzerland explore the routes they can take to delivering climate protection, whilst securing energy and other important policy priorities.

Background

Current trends

The transport sector is a growing climate issue for the EU. Apart from the years between 2008 and 2012, where the shrinking European economy led to a reduced transport demand, the emissions from the sector have been steadily increasing from 1990. In fact, transport is the only sector in which GHG emissions have grown since 1990 (Figure 1). In 2016, it was responsible for 24.3% of domestic GHG emissions in Europe, second only to energy industries (mainly electricity production) (EEA, 2018). This is due to a steadily increasing demand for freight and passenger transport.

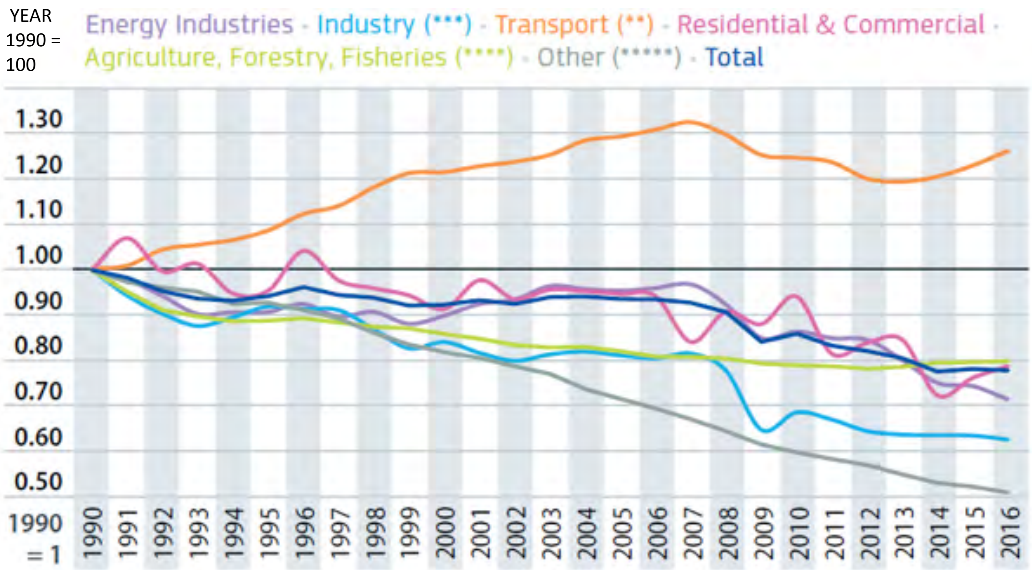

Figure 1: Growth of GHG emissions in Europe by sector, relative to 1990 (EEA, 2018).

Challenges in decarbonizing transport in Europe

The ever-increasing passenger and goods transport demand is still mainly powered by fossil fuels. The demands for passenger and goods transport both increased by around 27% between 1995 and 2016 (Figure 2). Furthermore, they still heavily rely on fossil fuels that amounted to more than 95% of the sector energy consumption in 2015 (JRC, 2017).

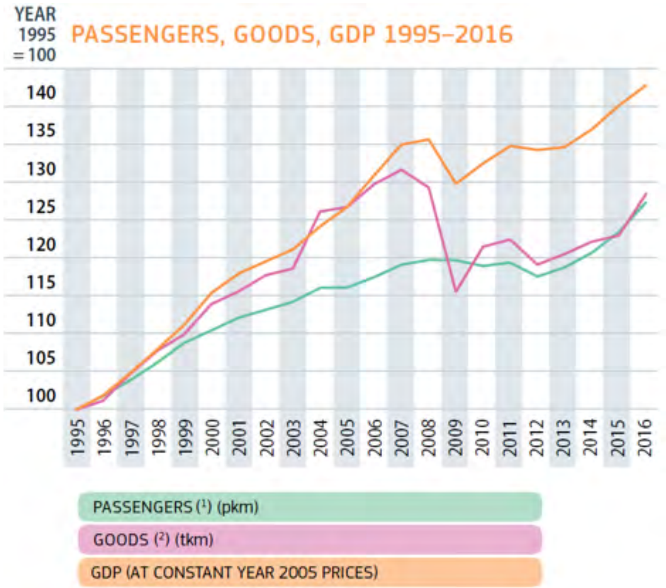

Figure 2: Evolution of the demand for freight and passenger transport (EEA, 2018).

A quick and massive scale-up of zero-emission vehicles needs to happen. It is widely acknowledged that Europe needs to set ambitious GHG reduction targets for 2030 in order to reach net-zero emissions by 2050. While the European Commission officially announces a 55% reduction target economy-wide compared to 1990 levels, other organizations call for a more ambitious 65% reduction target . Given the typical 10-15 years lifetime of a car, there needs to be a massive increase in the uptake of zero-emission vehicles (e.g. battery electric vehicles) in the coming years in order to reach the aforementioned levels of decarbonization in the transport sector by 2030.

Aviation and shipping may be hard to decarbonise. While a variety of options already exists for decarbonizing road and rail transport, aviation and shipping still face significant challenges in reducing their emissions, as shown in the High-Level Panel of the European Decarbonisation Pathways Initiative (EC, 2018). In the EUCalc model, the potential penetration of zero-emission technologies such as battery electric vehicles (BEV) or fuel cell electric vehicles (FCEV) in these modes is considered as limited. Hence, alternative fuels such as biofuels (e.g. bioethanol, biodiesel, biokerosene) or synthetic hydrocarbons (e.g. Fischer-Tropsch fuels) have to be considered in different transport modes, among other options, in order to fully decarbonize these sectors. Commercial aviation, for example, has been heavily dependent on the use of liquid fuels for their jet engines and, therefore, technologies such as biojet fuel are an important alternative. This raises other concerns related to the sustainability of bioenergy supplies or the economic and technical potential of synthetic hydrocarbons.

Decarbonisation pathways in European transport sector

This section shows a brief description of some group of actions used in the EUCalc model for reducing GHG emissions in the transport sector as well as some important insights provided by this model. It is worth noting that these simulations were prepared using a preliminary version of EUCalc available in 2019 and, therefore, future updated version may affect the results here shown. The results are illustrative simulations and not forecasts. For running simulations in the Transition Pathways Explorer – the user interface of the EUCalc model - the transport sector comprises the following levers (each of them with four levels of growing ambition to reduce GHG emissions by 2050): passenger efficiency, passenger technology, freight efficiency, freight technology, freight mode, freight utilization rate, and fuel mix. Reducing emissions in the transport sector is challenging, according to the European Green Deal (EC, 2019, p.10) “to achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050. Road, rail, aviation, and waterborne transport will all have to contribute to the reduction.”

[1] *http://www.caneurope.org/publications/press-releases/1733-meps-call-for-stepping-up-eu-climate-action*

The Avoid-Shift-Improve approach

This approach (GIZ, 2015) illustrates the main factors of influence to reduce transport energy demand and GHG emissions. It can be summarized as follows (EUCalc, 2019):

- **Avoid** vehicle activity and further reduce the number of vehicles needed by:
    - reducing transport demand;
    - increasing vehicle occupancy/load factor;
    - increasing the utilization rate of vehicles;
    - increasing the mileage lifetime of vehicles.
- **Shift** to more efficient/environmentally friendly modes (e.g. active modes or public transport)
- **Improve** efficiency of transport by:
    - making more efficient new vehicles;
    - shifting to more efficient fuels and technologies.

It is important to consider this list of levers as an ordered sequence of action in order to avoid unfeasible decarbonization pathways. For example, if a massive electrification of the European car fleet is considered without a reduction of the passenger transport demand or an ambitious modal shift, the resulting additional electricity demand might be too large for the European electricity production system to cope with, not to mention the ability of the car industry to produce such an amount of new electric vehicles.

AVOID: behavioural and territory planning changes

The first levers for reducing the energy consumption and related GHG emissions consist in decreasing both the passenger and freight demand.

For the passenger transport, this can be achieved through a series of individual behaviour changes such as car sharing, homeworking or territory planning in order to decrease commuting distances to workplace. **For the freight transport**, this requires a re-localisation of industry and food production. The implementation of circular economy measures can also help in shortening the supply chain and the freight distance, by integrating material and energy flows and reducing wastes across the production change of industrial and food products.

Figure 3 illustrates how passenger transport GHG emissions can be reduced through these measures. The graph on the left illustrates the situation in the 2016 Reference Scenario from the European Commission (EC, 2016). On the right hand side graph, the passenger transport demand and the vehicle occupancy are set to the most ambitious level (all things being equal), i.e. a slight decrease (-7%) in the demand between 2015 and 2050 and a 70% increase in car occupancy. This causes GHG emissions to decrease by around 46% compared to the 2016 EU Reference Scenario.

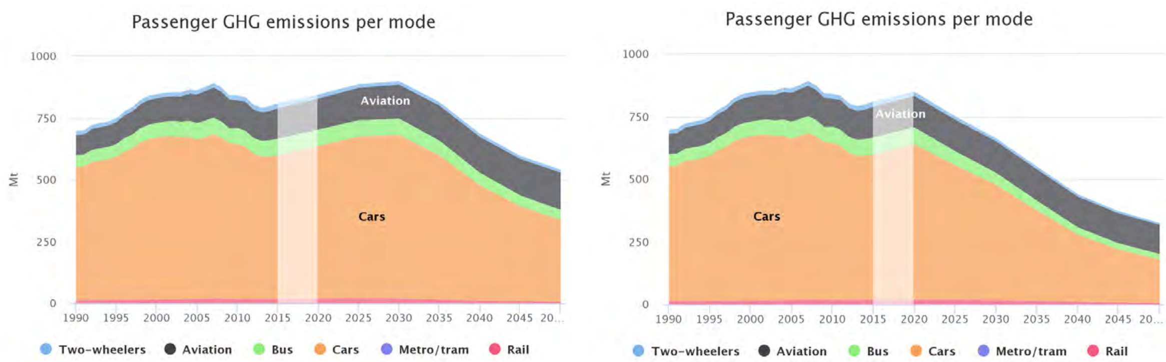

Figure 3: Example of GHG reductions in passenger transport in the European Union, using 'Avoid' measures in the EUCalc model.

SHIFT: modal shift to soft modes

A modal shift from cars to public transportations or active modes allows to further reduce the GHG emissions by making use of these less energy-intensive modes to address a given transport demand. This requires suitable public policies and investments in public transportation infrastructures. This also requires a behavioural change from users, which can be triggered by a high-level of service (spatial extent, timeliness, comfort).

Figure 4 compares the emissions from passenger transport in the 2016 EU Reference Scenario (left) and in an alternative scenario modelling the highest ambition in modal shift, all things being equal (i.e. the other levers' levels in the EUCalc model remaining the same in both scenarios). In this situation, cars and two-wheelers only represent 46% of inland passenger transport in 2050 (vs 78% in the 2016 EU Reference Scenario). This represents a 20% reduction of inland GHG emissions by 2050 compared to the 2016 EU Reference Scenario. This represents a 24% reduction of inland GHG emissions by 2050 compared to the 2016 EU Reference Scenario.

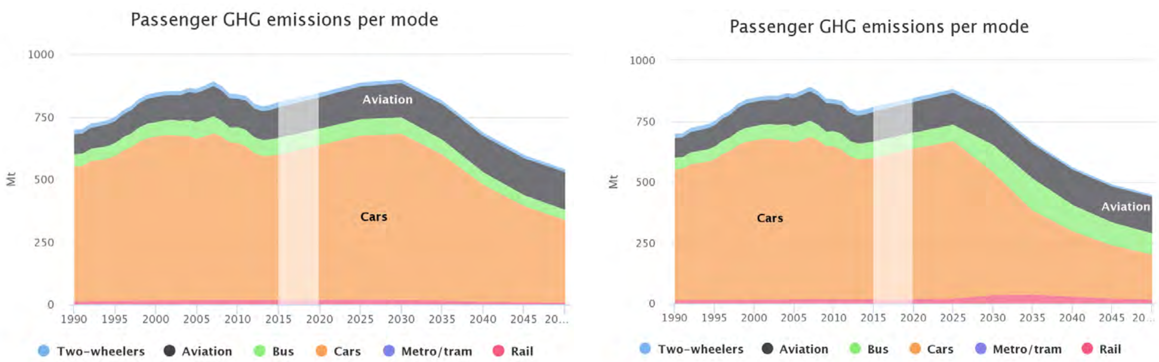

Figure 4: Example of GHG reductions in passenger transport in the European Union, using 'Shift' measures in the EUCalc model.

IMPROVE: technology shift, efficiency improvements and fuel switch

The last group of actions to decarbonize requires technical improvements (increased vehicle efficiency) and technological shifts (low- or zero-emission vehicles, alternative fuels). Figure 5 compares again the passenger emissions in the 2016 EU Reference Scenario against the emissions in a scenario with the most ambitious technological shift and efficiency settings, all things being equal in the EUCalc model. In this ambitious scenario for tech changes and energy efficiency, 100% of new car sales by 2050 are BEV or FCEV and the cars specific energy consumption is decreased by 50%. This allows to reduce inland GHG emissions by 67%. However, such a scenario is only mentioned for illustrative purpose. Indeed, such a technological change without transport demand reduction or modal shift can have other unwanted consequences such as a massive increase in power demand.

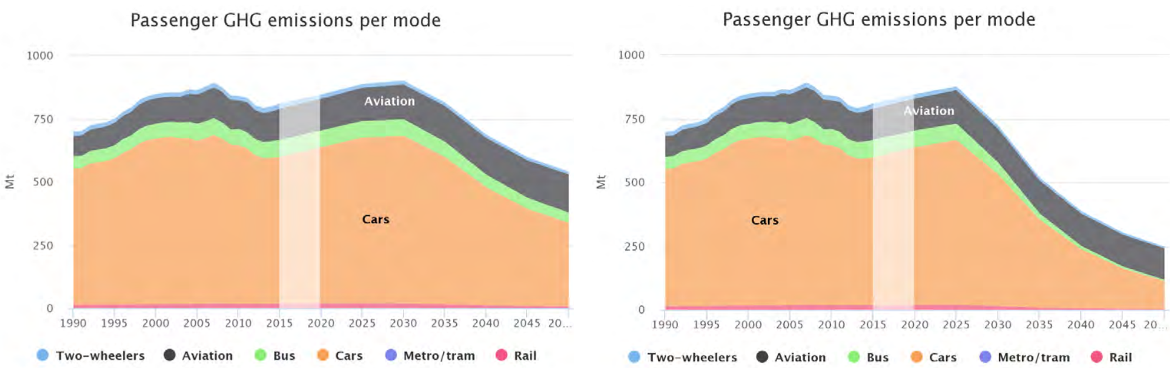

Figure 5: Example of GHG reductions in passenger transport in the European Union, using 'Improve' measures in the EUCalc model.

Balanced pathways to decarbonize EU transport

The last group of actions to decarbonize requires technical improvements (increased vehicle efficiency) and technological shifts As illustrated in the above sections, no single group of actions is able to fully decarbonize the transport sector alone in the European Union by 2050. For achieving near net-zero emissions in the transport sector, a balanced combination of all these actions should be urgently addressed. Figure 6 shows the impact of a balanced approach with all levers being activated at an ambitious level (level 3) but not the most ambitious (level 4, transformational change) on emissions for the passenger transport sector. As shown in Figure 6, this brings emissions close to zero emissions, but the aviation sector continues emitting significantly. Alternatives should be explored with the EUCalc Transition Pathways Explorer to increase the ambition on levers such as synthetic fuels for this sector as well. Therefore, the EUCalc model is able to provide several example pathways for the transport sector, which could help inform policy makers, business leaders and NGOs working on carbon mitigation in the European Union.

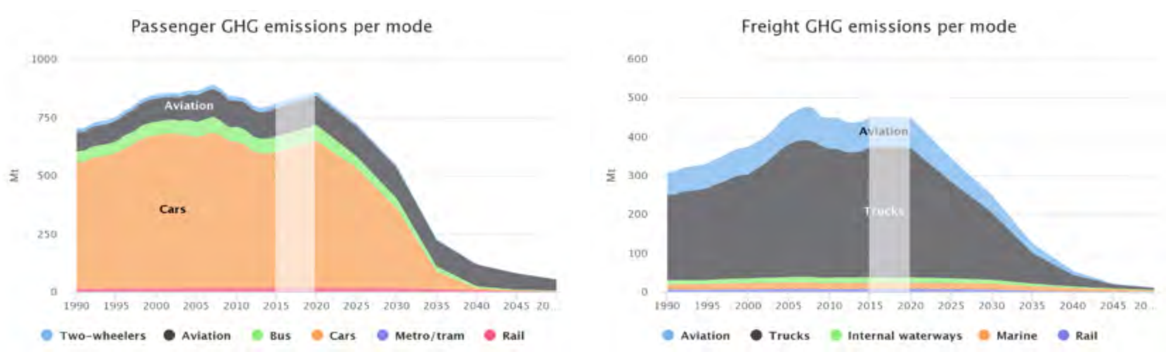

Figure 6: Possible balanced pathways with all transport related levers set at high ambition (level 3) in the EUCalc model.

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Further information on the EUCalc project:

The EUCalc project aims at providing a highly accessible, user-friendly, dynamic modelling solution to quantify the sectoral energy demand, greenhouse gas (GHG) trajectories and social implications of lifestyle and energy technology choices in Europe.

The novel and pragmatic modelling approach is rooted between pure complex society-energy systems and integrated impact assessment tools. The EUCalc model with its user interface - the Transition Pathways Explorer - has been designed to be both accurate but also accessible to decision-makers and practitioners. It covers all sectors and can be used by one or many people. The model is also open source so that experts can refine the model itself. The tool will have an e-learning version, the "My Europe 2050" tool as well as a Massive open online course (MOOC). See more on the EUCalc project, its scientific reports and all other outputs and access the Transition Pathways Explorer at:

www.european-calculator.eu

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Policy Briefs - Pathways towards a European Low Emission Society

The Policy Briefs on Pathways towards a European Low Emission Society, summarises key finding of the EUCalc project with a clear policy orientation, which provides practical climate change mitigation insights to both EU and individual Member States decision-makers. These policy briefs cover the following topics:

No. 1	The role of lifestyles changes in EU climate mitigation - Insights from the European Calculator
No. 2	Innovation and technology development - Decarbonisation pathways for manufacturing & production sector
No. 3	Long-Term Renovation Strategies: How the building sector can contribute to climate neutrality in the EU
No. 4	Avoid, shift, improve - Decarbonisation pathways for the transport sector in Europe
No. 5	Mitigating GHG Emissions through Agriculture and Sustainable Land Use - An Overview on the EUCalc Food & Land Module
No. 6	Decarbonizing the EU electricity sector - From ageing powerplants to renewable energy futures
No. 7	Implications of decarbonizing the EU economy on trade flows and carbon leakages - Insights from the European Calculator
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No. 9	Pathways towards a fair and just net-zero emissions Europe by 2050

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