On the future of passenger mobility and its GHG-emissions in Vienna: Scenarios for different types of policies

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Motivation and main question

Due to the steady population growth in urban areas, it is important to offer enough energy and mobility. Currently, around 1.9 million people are living in Vienna. According to population forecasts, between 2.1 million and 2.2 million people could be living in Vienna by 2050 [1, 2]. Because of the increasing energy demand, more and more CO_2 emissions are emitted. The transport sector is with 43% the biggest causer next to energy generation (20%) and buildings (17%) for these emissions [3].

The study's core objective is to analyse scenarios up to 2030 for the future development of energy use and resulting CO_2 emissions in the transport sector in Vienna. The focus of the scenarios is on business as usual (BAU), the promotion of public transport and the promotion of battery electric vehicles.

First and foremost, strict policy measures must be set to reduce emissions in cities even more. Moreover, it is important to avoid travel activity (km driven per passenger). There is a need to expand public transport further and exclude conventional cars from road traffic to reduce CO2 emissions sustainably.

Methods of approach

The vehicle stock (VST_{j_t}) in the scenarios is modelled as:

$$VST_{j_t} = VST_{j_{t-1}} \cdot f_{g_{j_t}} \tag{1}$$

VST_{j_t}….. Stock by vehicle type *j* in year *t*; $f_{g_{j_t}}$ ……. Growth factor by vehicle type *j* in year *t;*

The total flow energy demand (E_t) in the scenarios is calculated as:

$$E_t = \sum E_{ijt} = VST_{ijt} * FI_{ijt} * skm_{jt} \tag{2}$$

E_{ijt} ………. Energy consumption by fuel type *i*, vehicle type *j* and in year *t* (MWh); VST_{ijt} …... Stock by fuel type *i* and vehicle type *j* in year *t*; FI_{ijt} …….. Fuel intensity by fuel type *i* and vehicle type *j* in year *t* (MWh); skm_{jt} …... Service kilometre by fuel type *i* and vehicle type *j* (km); i ∈{petrol, diesel, LPG, electricity, CNG, biogenic fuels, hydrogen}; j ∈{cars petrol, cars diesel, cars LPG, cars electricity, cars CNG, cars hybrid (petrol-electric, diesel-electric), cars hydrogen};

The total CO_2 emissions (CO_{2Tot}) are calculated as:

$$CO_{2Tot_t} = CO_{2Flow_t} + CO_{2Emb_t} \tag{3}$$

CO_{2Tot_t} ….. Total CO_2 emissions in year *t* (Mill tons CO_2); CO_{2Flow_t}…. Total CO_2 emissions of flow energy in year *t* (Mill tons CO_2); CO_{2Emb_t}….. Total CO_2 emissions of embedded energy in year *t* (Mill tons CO_2);

The CO_2 emissions of flow energy (CO_{2Flow_t}) are calculated as:

$$CO_{2Flow_t} = \sum_{j=1}^{n} f_{CO_{2i_t}} * E_{i_t} \tag{4}$$

$f_{CO_{2j_t}}$ …….. Overall CO_2 emission factor by fuel type *i* in year *t* (kg CO_2/kWh)

The embedded CO_2-Emissions (CO_{2Emb_t}) for passenger cars are calculated as:

$$CO_{2Emb_t} = \sum CO_{2_{embsp_{jt}}} * V_{new_{it}} \tag{5}$$

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Results and conclusions

Figure 1 shows the development of the passenger car stock in Vienna up to 2030 in the Public Transport Scenario. The growth of public transport is accelerated from an average growth rate of 2.6% in recent years to 4% in the following years up to 2030. Private motorised transport with non-conventional vehicles grows by 3% per year in the public transport scenario. Note that private diesel use is reduced by about 4% in the scenario following the trend of the last years. In the public transport scenario, the stock of public transport vehicles increased sharply from 2,570 in 2019 to 3,670 in 2030. The scenario shows that the market share from public transport rises sharply. Fossil-fueled vehicles decreased from 691,000 in 2019 to 358,000 in 2030.

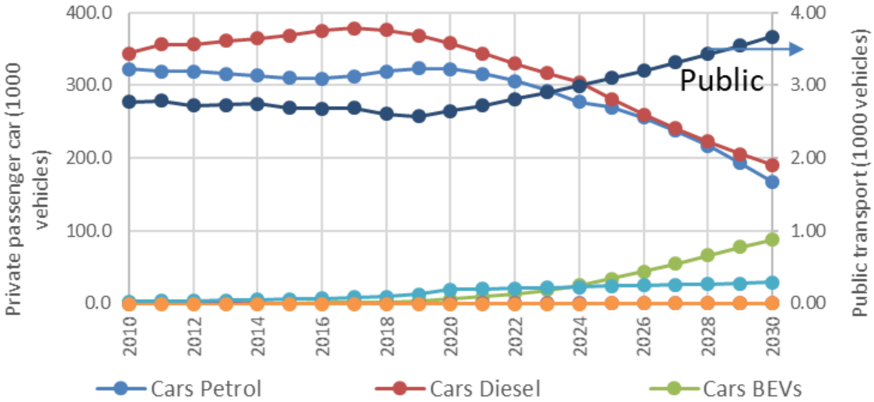

Figure 1 – Development of passenger car stock of conventional and electric cars in the Public Transport Scenario in Vienna up to 2030

Figure 2 shows the development of total CO_2 emissions in passenger car transport and public transport in the different scenarios, with a conventional electricity mix and electricity from RES. We have considered six possible paths. It can be noticed that the electricity mix used in the BEV scenario has a considerable impact on total emissions, as well as the use of electricity from RES in the BEV scenario can significantly reduce emissions from passenger transport.

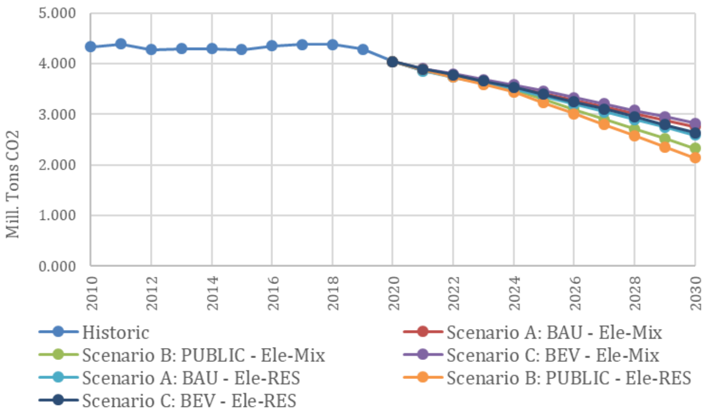

Figure 2 - Development of the total CO2 emissions in the different scenarios

The results demonstrate that only minor reductions in energy demand can be achieved with a more ambitious focus on alternative drives. It needs a strong mix of policies that also focus on public transport and non-motorised individual transport.

References

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