

Transport And Energy

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An increase in world population, together with growing urbanization and mobility led to a substantial increase in energy demand in the transportation sector, accounting for approximately 25% of world energy use (Rodrigue, 2020). Within industry, road transport is the largest contributor, followed by air, maritime and rail transport (Ribeiro et al., 2012). While in other sectors the energy use is decreasing and/or gets more efficient, in transport, which primarily relies on fossil fuels, the progress is both - much slower and strongly related to other issues such as spatial opportunities, personal and cultural values, or technological development.

Alternative power sources to alleviate transport related GHG emissions

Currently, transport contributes up to 30% of climate-relevant green house emissions in Austria. Hence, the electrification of personal and commercial vehicles is seen an important step forward to alleviate this issue. Importantly, the market for electric vehicles (EV) grows exponentially where global sales of EVs in 2020 increased by 39% compared to the previous year (Singal, 2021). Although, the largest growth is observed among personal transport modes (PLDV) and private charging point, increasingly more vehicles in the commercial and public transport sectors are being electrically powered. In many cities across Europe such as Cologne, Berlin, Krakow or Gothenburg electric buses are already part of regular service (automotive world.com, 2020; Kurzempa, 2018). The wider use provides environmental benefits (e.g. reduction of traffic noise and CO₂ emissions) but also exhibits the potential to shift the energy demand from fossil fuels to renewable energy sources (SolarPower Europe, 2019).

From monocentric to polycentric, mixed, dense, diverse urban structure

Transport related energy consumption has a strong correlation with build environment. On one hand, growing urbanization gives individuals an comparative advantage providing access to resources, services and facilities. At the same time, extensive spatial systems require more energy dedicated to transport to support it. In fact, energy use related to transportation and build environment can be split into two categories, namely, the *infrastructure* where the energy use is linked to transport efficiency, capacity and level of service provided, and *spatial structure* where the energy consumption depends on the distribution of activities that directly translate into average distance travelled (Rodrigue, 2020). For this reason, the idea of traditional monocentric cities is frequently being replaced by multi-modal model. There is evidence from more than two decades of research, showing that polycentric, mixed, dense, and diverse urban structures can act as a stimulus for a shift from private-car oriented to public-transport oriented cities. Figure 1 shows how different urban structures stimulate different mode share, and subsequently CO₂ emission and energy use in selected Nordic cities. Figure 2 illustrates the decrease of energy use, based on the estimation generated from 187 travel surveys in 108 Chinese cities in 2010.

Multimodal automation for increased efficiency

An increasing automation of different transport modes allows significant efficiency gains in terms of energy consumption. For example, rail telematics introduces the automation in rail operation for both, passenger and freight services. Constant interface between the train and the infrastructure allows for real-time monitoring, improvement in incident management and encourages intermodal operation which all contribute to energy savings (EIM, 2019). Further, due to their built-in algorithms automated vehicles (AVs) are expected to deliver significant advantages regarding their energy requirements. On one hand, by smoothing and optimizing driving behaviour to minimize fuel consumption and reduce braking-acceleration phases (Barth & Boriboonsomsin, 2009). But also, by adopting to a large extent hybrid or electric solutions. In fact, eco-driving is already one of the key focuses of AV development (Noussan & Tagliapietra, 2020).

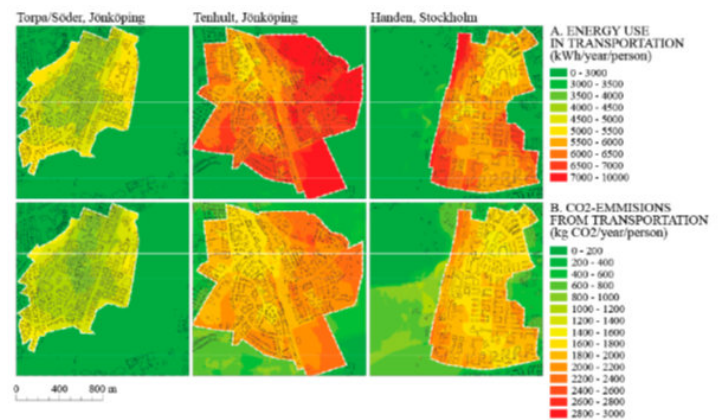


Figure 1: Energy use and CO₂ emissions based on estimated mobility choice (Stojanovski, 2019)

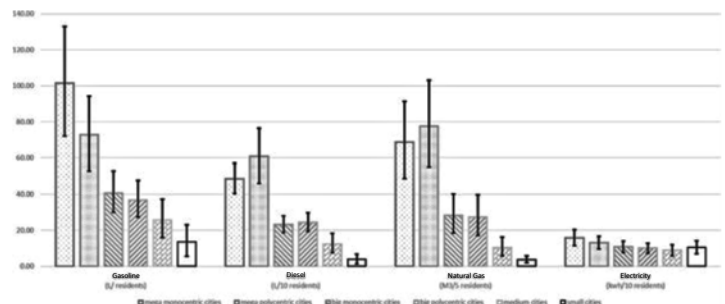


Figure 2: Per capita annual energy consumption of urban passenger transport by energy types, city scale, and urban form (Li et al., 2018)



Figure 3: Scania automated full-sized bus which is expected to be deployed in public roads (Susilo)

Transport digitalisation shapes current energy demand

Digitalisation of transport potentially improves connectedness, efficiency and sustainability by changing how people and goods travel. This, in turn, yields considerable consequences for energy demand and environmental impact. On the one hand the advantages stemming from transport digitalization can be direct, where the Cooperative Intelligent Transport Systems (C-ITS) allow gains in energy efficiency of the connected and highly digitalized vehicles through optimised driving (such as platooning) and predictive maintenance. On the other hand, the indirect effects are based on the improvement of current services and/or development of new approaches. Examples of such new approaches include Digital Journey Planners (Jakob et al., 2014), contactless travel cards, micro-mobility fleets or concept of MaaS (Rastenyte, 2020), which increase the share of journeys done with public transport or vehicle sharing (Noussan & Tagliapietra, 2020). May (2020) quantified the tank to wheel (TTW) greenhouse gas (GHG) emissions of a CMaaS (Corporate Mobility as a Service) and found that, on average, the trip of CMaaS users generated half of energy use and emissions than regular workers.

Importance of understanding people and promoting behavioral change

Finally, when considering an impact of the transport sector on energy use it is important to consider individual-specific characteristics, people's preferences, behaviour and attitudes (Muro-Rodríguez et al., 2017). The behavioural aspect of transportation enables planners to provide tailored solutions that better address people's needs (Burian et al., 2018). Therefore, nowadays an understanding of human elements within the transportation system plays a significant role in turning it more efficient and environmentally sustainable. Using longitudinal datasets from the United Kingdom and the Netherlands, Stead and Susilo (2009) demonstrate that a very small fraction of society is responsible for the majority amount of transport related energy consumption and also emissions, explaining why a targeted approach is needed. For example, the exploration of population travel patterns contributed to the emergence of first-last-mile-solutions, park and ride stations (P+R) or mobility hubs to support synergies between human travel behaviour and technological developments of transport systems.

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Figure 4: Linking of services through digital journey planner (Austriatech.at, 2019)

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