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The effect of digitalization in the energy consumption of passenger transport: An analysis of future scenarios for Europe

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ABSTRACT

Digital technologies have the potential to make the transport system more connected, intelligent, efficient, reliable and sustainable. That is, digital technologies could fundamentally transform how people and goods are moved, with significant impacts on transport demand and on the related energy consumption and environmental impacts. This article proposes a scenario analysis for the future of European passenger transport, by evaluating the potential effects of digitalization on mobility demand, energy consumption and CO_2 emissions under different assumptions. The analysis illustrates that the penetration of digital technologies can lead to opposite effects with regard to both energy consumption and emissions. Two opposite scenarios are compared, to evaluate the effects of a "responsible" digitalization, in the direction of a sustainable mobility, against a "selfish" digitalization, where the final users maximize their utility. The likelihood of these two possible pathways is related to multiple drivers, including users' behavior, economic conditions and transport and environmental policies. Results show the variability range of the potential effects on energy consumption and CO_2 emissions in Europe by 2030 and 2050, by considering digitalization trends including Mobility as a Service, Shared Mobility and Autonomous Vehicles. The variability of key parameters is evaluated in a dedicated sensitivity analysis, where the effects of electric vehicles, electricity generation mixes and vehicles' efficiency improvements are assessed. The article concludes that in order to fully exploit the advantages of digitalization, proper policies are needed to support an efficient and effective deployment of available technologies through an optimized and shared use of alternative transport options.

1. Introduction

Fossil fuels consumption is the first cause of climate change. Among different sectors, transport is currently the most reliant on fossil fuels, and specifically on oil (IEA, 2019). Transport thus represents a key bottleneck in the transition towards a low-carbon economy. And decarbonizing transport is challenging, due to the issues related to guarantee the high energy density allowed by fossil fuels by using alternative energy sources.

There is a growing interest in analyzing the potential scenarios of transport decarbonization in different countries, including China (Pan et al., 2018; Wang et al., 2017), Europe (Siskos et al., 2018; Xylia and Silveira, 2017), United States (Zhang et al., 2016) and South America (Espinosa Valderrama et al., 2019; Rehermann and Pablo-Romero, 2018). Different technologies are considered in the literature for the transition towards a low-carbon future in the transport sector, including electrification (Bellocchi et al., 2019; Crozier et al., 2018), biofuels (Hunsberger et al., 2017) and hydrogen (Ajanovic and Haas, 2018). Multiple factors will have a role in the success of each solution, starting from the costs of the vehicles and the required infrastructure (van der Zwaan et al., 2013), as well as the quality of the service (Mugion et al., 2018). Due to the strengths and weaknesses of each pathway, an optimum scenario may include a combination of technologies to be used in specific applications (Dalla Chiara and Pellicelli, 2016). Financial incentives may be required to reach the best technology mix for the decarbonization of transport (Haasz et al., 2018).

In this process of decarbonization, digital technologies may represent a game-changer, fostering the deployment of innovative mobility solutions and technologies. Mobility as a Service (MaaS)

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