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THE IMPACT OF URBAN TRAFFIC PLANNING AND THUS IMPLIED MODAL CHOICE AND MOTORIZATION RATE ON FUTURE RESOURCE CONSUMPTION AND CONSTRUCTION AND DEMOLITION WASTE GENERATION

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ABSTRACT: The transport sector plays a decisive role in climate change mitigation, especially in cities, as it significantly contributes to global resource and energy consumption. Hence, traffic planning in cities must be adapted accordingly. In the social and political discourse, a shift in transport mode choice versus technological development often represent counterpoles. The impact of these various pathways on the long-term resource demand and waste generation has not yet sufficiently investigated on an overall city perspective. In this study, we investigate the effects of the transformation of an urban transport system on future material stock and material flows using the city of Vienna as a case study. For this purpose, a material flow analysis for the infrastructure and vehicles required until 2050 has been conducted taking different scenarios into consideration, which are mainly characterized by different modal splits and related motorization rates. The results show that different paths of development among the various transport modes significantly affect the overall material stocks and flows. If the modal split remains constant, the road-infrastructure has to be further expended to provide the transport service needed due to the expected increase in population in Vienna. Based on the results, it can be concluded that the transformation of an urban transport system towards lower greenhouse gas emissions also has the potential to reduce future material demand and waste generation. However, this requires a change in the modal split, whereas solely moving to a fossil-free vehicle fleet has the contrary effect.

Keywords: modal split, built environment, urban passenger transport, Smart city initiatives

1. INTRODUCTION

Humankind has been experiencing a shift from a purely rural to a predominately urban living society

and this trend seems to continue in the future (Grimm et al., 2008). Additionally, the material demand and waste generation have been constantly growing over the last century (Krausmann, Lauk, Haas, & Wiedenhofer, 2018) whereat cities are the main drivers of this development (Kennedy, Cuddihy, & Engel-Yan, 2007). The transport sector contributes significantly to global resource and energy consumption (Sims et al., 2014), hence, the sector accounts for a significant share of the overall $CO_{2\text{-eq}}$ emissions. Furthermore, due to the significance of the transport infrastructure with respect to the built-in of recycled construction materials mainly in road construction (Hiete, Stengel, Ludwig, & Schultmann, 2011), the construction activities related to transport infrastructure play a major role regarding construction and demolition waste (CDW) management as well as for the implementation of closed material cycles of construction materials. Thus, the objective of decarbonizing the transport sector and closed construction material cycles can be found in strategic papers at all levels of decision-making. On city level, transport policy has always been an important issue, with a particular focus on traffic management. In recent years, however, issues concerning decarbonization and a shift towards sustainable transportation have gained in importance. For this reason, targets in this regard are addressed in smart city initiatives (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014). One advocate of such a scheme, which also includes within in its smart city initiative a transformation of the transport system, is the city of Vienna in Austria. In its Smart City Wien Framework Strategy (SCWFS), different targets for urban and social development have been defined. Among them is the target to reduce Vienna's per capita $CO_{2\text{-eq}}$ emissions in the transport sector by 50% by 2030 and by 100% by 2050. This is to be achieved by converting the vehicle fleet to low-emission propulsion technologies (e.g. battery electric vehicles) and/or a shift towards more environmentally friendly transport modes (e.g. walking, public transport) (City of Vienna, 2019). To which extend the various measures are implemented in the upcoming years, is part of the city's current and future traffic and urban planning policy actions. In particular, decisions regarding the investments in transport infrastructure and the strategic strengthening of specific transport modes can potentially influence the resource demand and waste generation for decades to come. Hence, an assessment of the expected impacts on resource demand and waste generation are very important.

2. METHODOLOGY

In the study presented, we have examined different possible measures to decarbonize the urban transport system regarding their impact on future resource consumption and waste generation. Therefore, we investigated the effects of transforming urban transport systems on future material stock and annual material turnover (material demand/waste generation) using the city of Vienna as a case study. For this purpose, a material flow analysis for the infrastructure and vehicles required until 2050 has been conducted taking different scenarios into consideration, which are mainly characterized by different modal splits and morization rates.

3. RESULTS

The results show that different paths of development among the various transport modes significantly affect the overall material stocks and flows. If the modal split and morization rate remains constant, the road-infrastructure has to be further expended to provide the transport service needed due to the expected increase in population in Vienna. The material stock per capita for the transport system remains constant at around 54 t/capita for this scenario. If the motorized individual transport can be reduced to a share of less than 10% of all trips (today's share amounts to 25%), the material stock per capita decreases to around 47 t/capita in 2050. As this case allows for infrastructure (e.g. parking infrastructure, road lanes) to be dismantled, the annual material demand for maintenance efforts is also reduced by a fifth (to 460 kg/cap/yr). Despite the reduction in material stocks and flows achievable by changing the current modal split, a significant change in the waste composition in terms of the end-of-life vehicles generated is to be

expected in the coming decades. Annual quantities of old batteries, for instance, might rise from today's 1.5 kg/capita up to 70 kg/capita. These changes will challenge the waste management sector, but also represent an opportunity for the recovery of valuable resources.

4. CONCLUSION

Based on the results, it can be concluded that the transformation of an urban transport system towards lower greenhouse gas emissions also has the potential to reduce future material demand and waste generation. However, this requires a change in the modal split, whereas solely moving to a fossil-free vehicle fleet has the contrary effect. The choice of transport modes and thus the development of the motorization rate will play an important role in terms of the development of the material stock and annual resource consumption. The greatest savings potential results from a reduction in the private vehicle fleet and road infrastructure as well as from the associated decline in maintenance efforts. To foster the transformation of the transport system towards less carbon and resource intensity and to avoid negative feedback loops, obsolete (road) infrastructure should be dismantled and converted for other purposes. What's more, the resource aspect should be considered in any extension and rehabilitation project connected with road infrastructure. Hence, each project should be evaluated for its impact on the targets set in the Smart City Wien Framework Strategy in order to reduce greenhouse gas emissions and resource consumption.

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