

# Towards a climate-neutral building stock – GHG emissions of Austrian buildings

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In order to achieve climate-neutrality around mid of the century, EU member countries need to develop strategies for each economic sector. While the European Commission (2019, p.9f.) urged that building-related emissions need to decrease substantially, we argue that yet there is no consistent system boundary of the latter that comprises the whole *area of action buildings*. In many European countries, a tradition of building-related greenhouse gas emission reporting evolved which primarily focuses on direct operational emissions of residential and commercial buildings. This however omits indirect emissions (e.g. generated by the use of electricity and district heat) and emissions embodied in deployed building materials by allocating them to the distinct sectors electricity and industry respectively. Thereby it does not capture life-cycle effects and cross-sectoral implications that are highly relevant for developing a comprehensive Paris-compatible buildings strategy. Therefore, we propose a system boundary including all building types (residential, commercial and industrial) located in a country as well as their direct and indirect operational and embodied GHG emissions. According to this definition, we estimate building-related GHG emissions for Austria in 2014 as one exemplary EU country, strongly involved in European and international trade. Building on the approach of Muñoz and Steininger (2010) and Steininger et al. (2018), we conduct an environmentally extended multi-regional input-output analysis based on the GTAP database V10 (Aguiar et al. 2019) in order to estimate embodied GHG emissions. Additionally, more detailed information regarding industrial process emissions (UNFCCC 2020) is processed and incorporated in the estimation of embodied emissions. For estimating operational emissions, National Useful Energy Analysis data (Statistik Austria 2018) and emission factors including direct emissions (from fuel combustion) and indirect emissions (arising in the fuels' supply chains), taken from Environment Agency Austria (2016, 2020 and 2021), are used. We find that the Austrian *area of action buildings* is responsible for 30.3 Mio t of CO<sub>2</sub>e in 2014. Therein, embodied emissions account for 43% confirming their ever-increasing importance with higher energy efficiency of the building stock. Moreover, our estimates reveal the distribution of building-related emissions across building type, region, emission source and economic entity that ultimately demands construction/renovation activities and uses the building. Our results also illustrate the potential impact of cross-sectoral carbon reduction on building-related emissions. Finally, our estimates can serve as a reasonable basis for designing strategies to achieve a climate-neutral building stock until mid of the century. At the same time, they give an indication of challenges arising on the way towards climate neutrality that need to be addressed by policymakers.

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