Climate Neutrality of Growing Electric Vehicles Fleets (2010 - 2050) in a Dynamic LCA Considering Additional Renewable Electricity: Example Austria

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Goal

The environmental effect of electric vehicles can only be assessed based on life cycle assessment (LCA) covering production, operation and end of life. Since 2011 in the Technical Collaboration Program (TCP) on "Hybrid & Electric Vehicles" (HEV) of the International Energy Agency (IEA) with 20 participating countries an expert group develops and applies LCA methodology to estimate the environmental effects of the increasing electric vehicle (EV) fleet globally.

An approach of dynamic LCA was develop and exemplarily applied to Austria by taking the time depending effects of the BEV fleet introduction and the parallel increasing supply of renewable electricity into consideration aiming for a climate neutral vehicle fleet 2050

Results

The annual GHG emissions of installing new renewable electricity generation plants in Austria were 100 - 800 kt CO_2-eq. Dynamic LCA approach shows GHG emissions of renewable electricity generation in Austria in existing and newly installed power plants of 8 - 33 g CO_2-eq/kWh, whereas the GHG emissions of the additionally installed renewable electricity generation is 31 - 250 CO_2-eq/kWh. The Austrian BEV fleet is 50,000 BEVs and consumes 140 GWh electricity, which is about 1% of the additional renewable electricity generated since 2010. Assuming each BEV substitutes for an ICE the BEV fleet emitted 170 kt CO_2-eq and avoided 190 kt CO_2-eq in 2020 in dynamic LCA. (Figure 1)

Based on fleet development scenarios are developed to reach climate neutrality in 2050 using dynamic LCA. Figure 2 shows the development of the Austrian passenger vehicle fleet with a strong increasing of newly registered BEV with a limitation of the total number of passenger vehicles and the final energy demand with a strong increase in electricity.

Figure 3 shows the GHG emissions and primary energy demand of the Austrian Passenger Vehicle Fleet based on dynamic LCA. The GHG emissions of fleet operation in 2030 is 55% less than in 1990 and nearly zero in 2040. The remaining GHG emissions e.g. electricity supply, in the dynamic LCA are reduced until 2050 by global decarbonisation. The GHG emissions decrease significantly after 2025 due to the strong increasing amount of BEV. The cumulated primary energy demand significantly decreases due to the higher energy efficiency of BEV.

Timing of environmental effects in dynamic LCA of EVs covering production, operation and end-of-life becomes relevant in the transition time of BEV introduction in combination with an increase of additional renewable electricity generation.

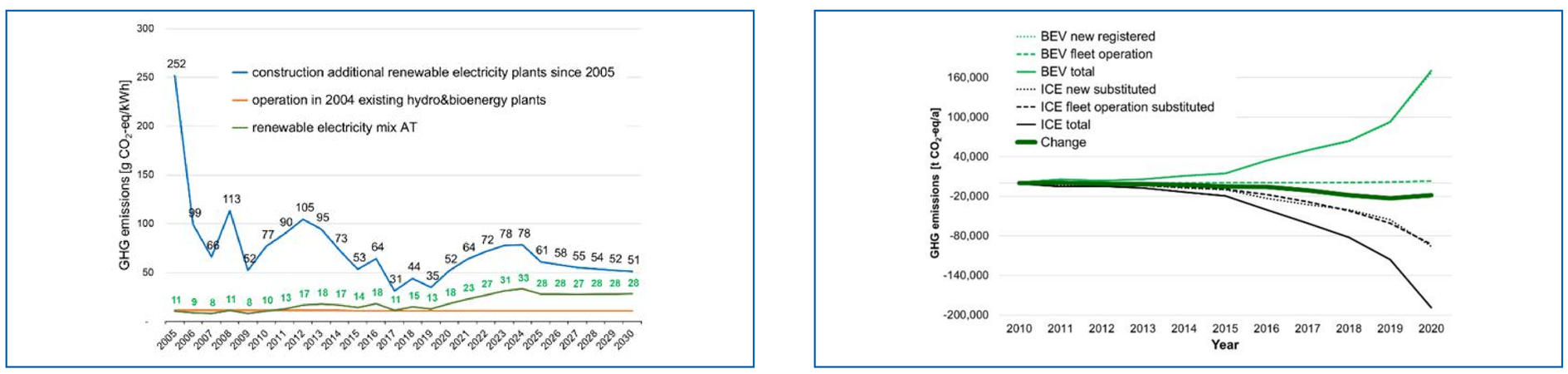

Figure 1: *GHG emissions in dynamic LCA of renewable electricity generation in Austria and of BEV substituting ICE fleet*

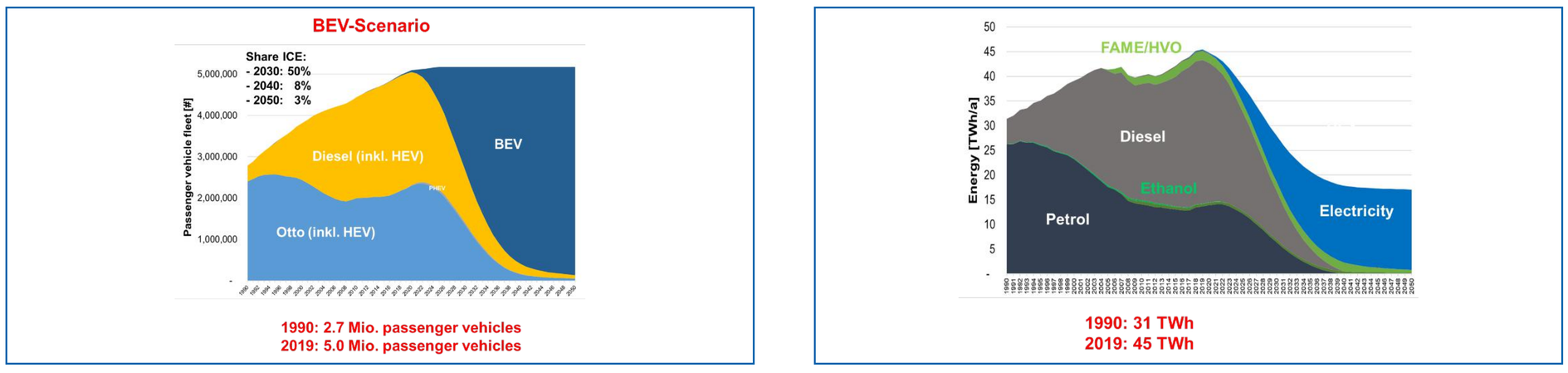

Figure 2: *Characteristics and final energy demand of climate neutral passenger vehicle fleet 2050*

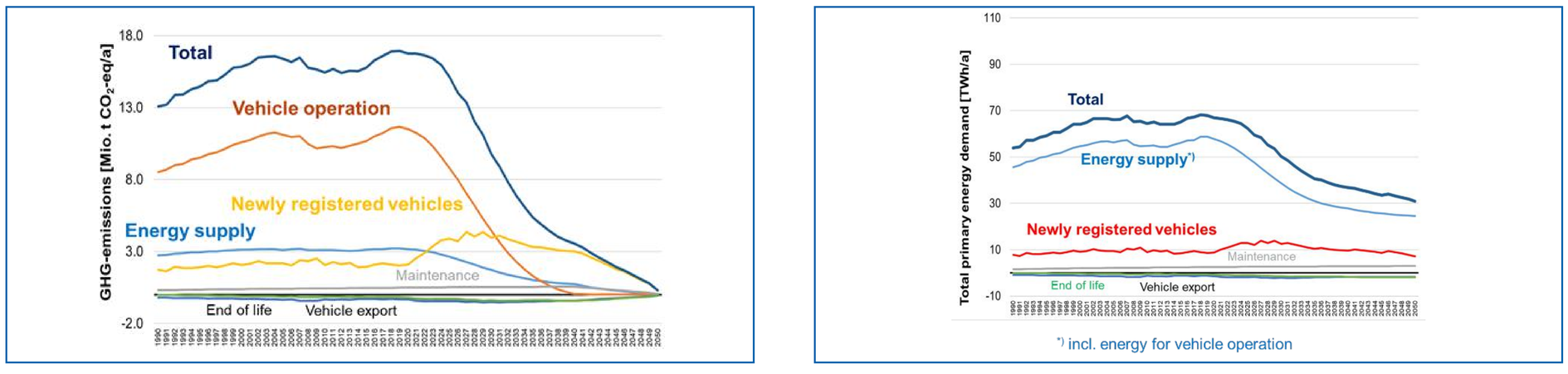

Figure 3: *GHG emissions and primary energy demand of passenger vehicle fleet in dynamic LCA*

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JOANNEUM RESEARCH (LCA & modelling)

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