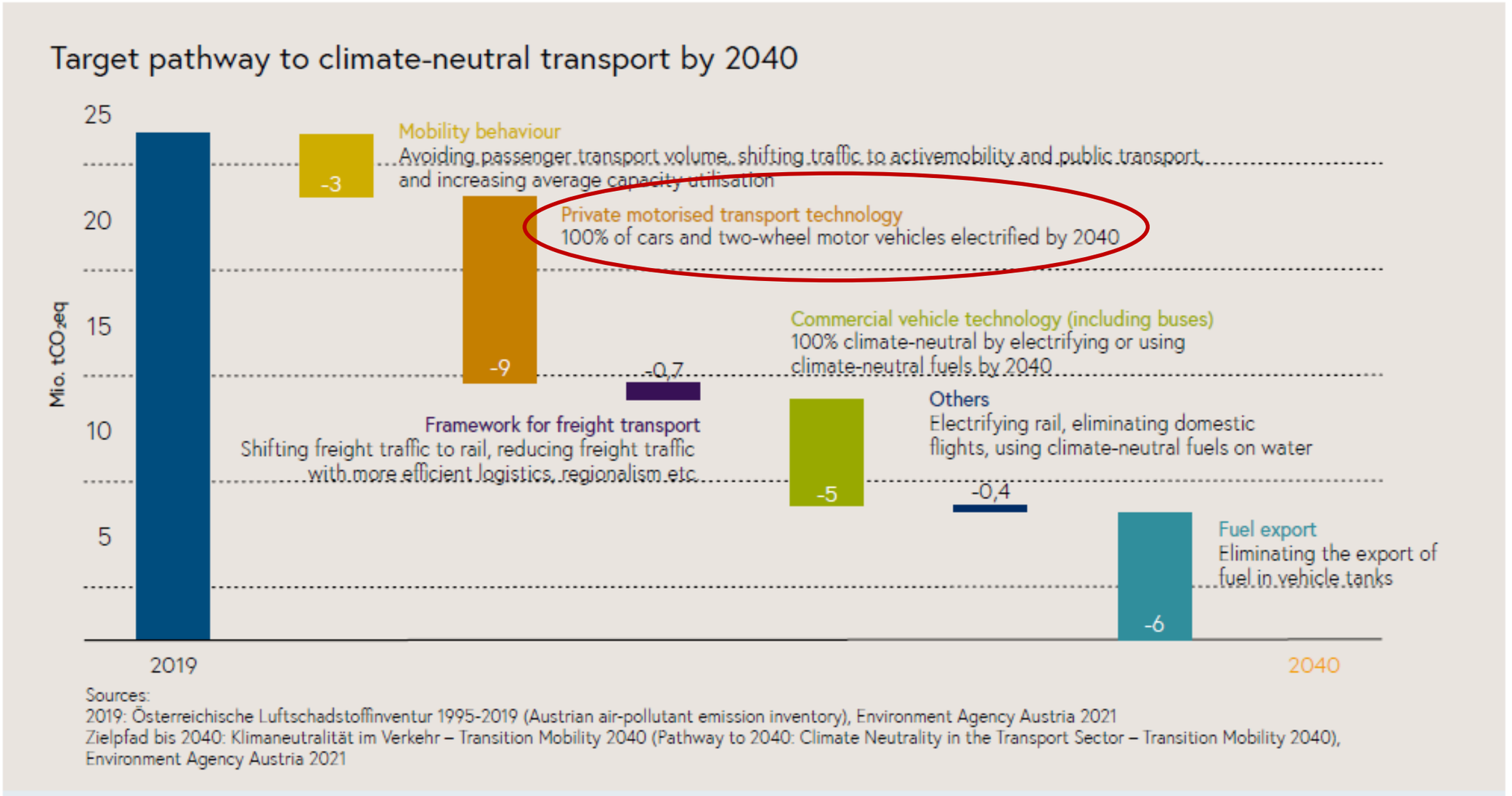
Critical raw material demand on the path to a climate neutral vehicle fleet

Martin Beermann

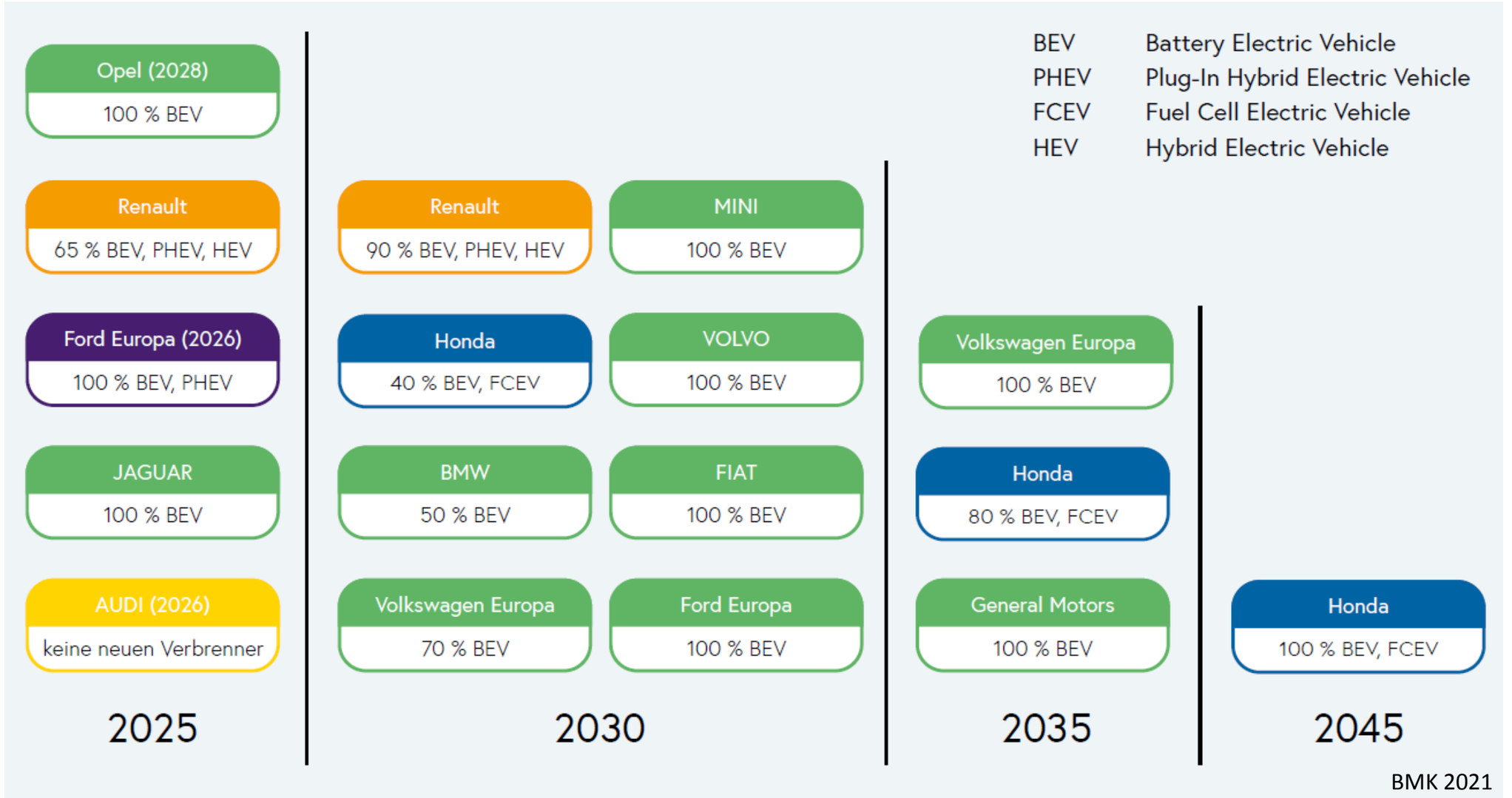
A3PS conference
„Paths to climate-neutral mobility“?
19.11.2021, online

JOANNEUM RESEARCH LIFE

Austria's 2030 Mobility Master Plan
(BMK, 2021)



OEM targets



BMK 2021

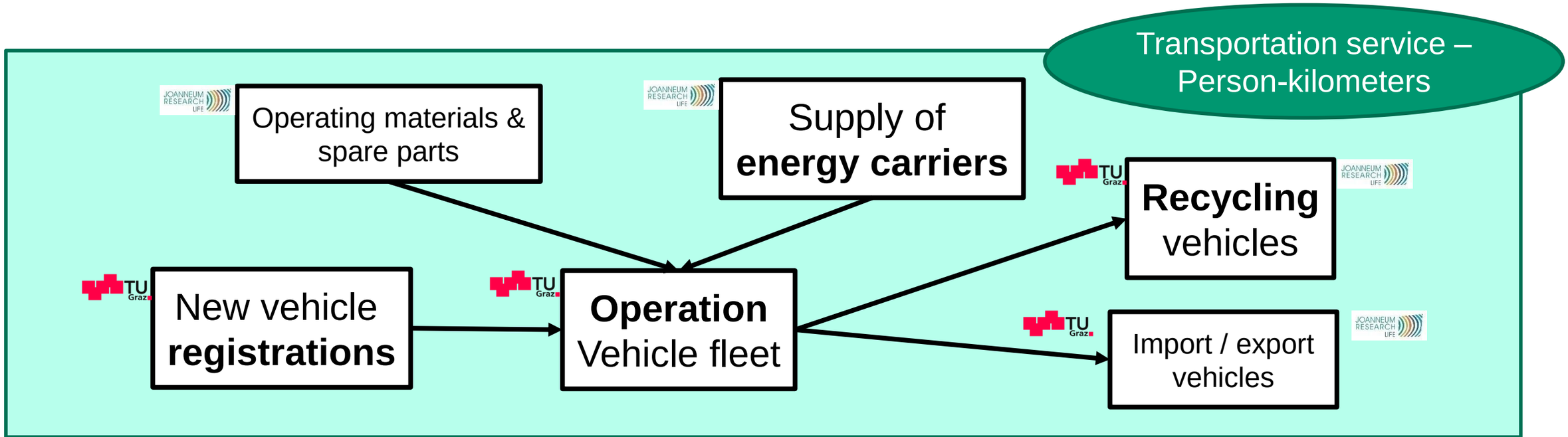
Passenger vehicle fleet in Austria: 2 scenarios towards climate neutrality in 2040/2050: „BEV“ (and „e-Fuel“)

See poster in exhibition area by G. Jungmeier

- **GHG reduction goals**
  - 2030: Austria about 55% reduction (based on 1990)
  - 2040: Austria „climate neutral“ transportation sector
  - 2050: EU and USA climate neutral
  - 2060: Rest of the world climate neutral
- **Fleet modelling** with NEMO (Network Emission Model) used for OLI (Österreichische Luftschadstoff-Inventur)
  - **Different shares of new registrations** from 2021: BEV and ICE/PHEV
  - Only **domestic passenger vehicles** (without „tank tourism“)
  - **Vehicle fleet:** constant from 2025
  - **Total annual kilometres:** constant from 2020
- **Renewable electricity** for BEV generated in new power plants in Austria/abroad integrated in existing renewable electricity mix
- **Amount of biofuels** for passenger vehicles remain constant from 2020 (about 250 kt)
- **Cooperation**
  - JOANNEUM RESEARCH (LCA & modelling)
  - Graz University of Technology (vehicle fleet)
  - IEA HEV Task 30 and Task 40 (methodology)

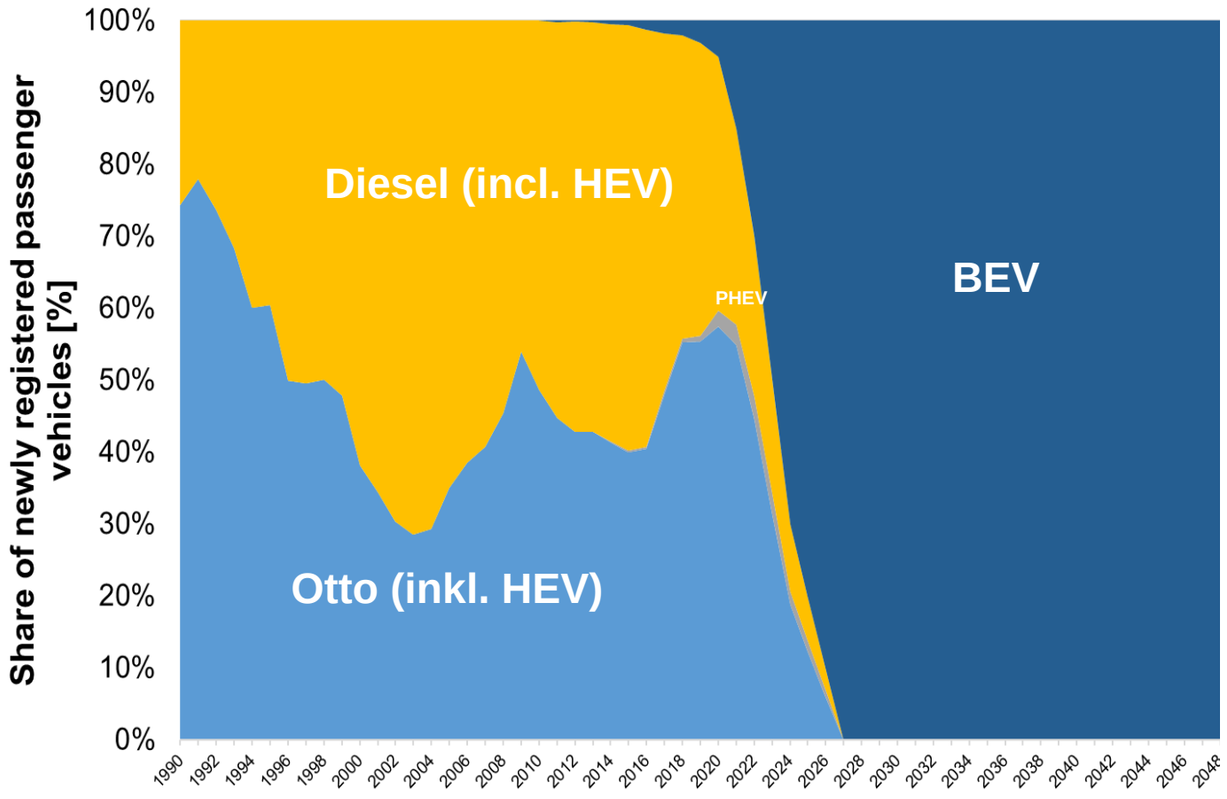
Yearly GHG-emissions of passenger vehicle fleet in Austria from 1990 to 2050, based on LCA

- Vehicle **production** of new registrered passenger cars
- Imported **second use vehicles**
- **Operation of vehicle fleet**
  - Supply of energy carriers
  - Operating materials and spare parts
  - Direct vehicle emissions
- Vehicle **end-of-life**
  - Recycling
  - Export of used vehicles (second life)



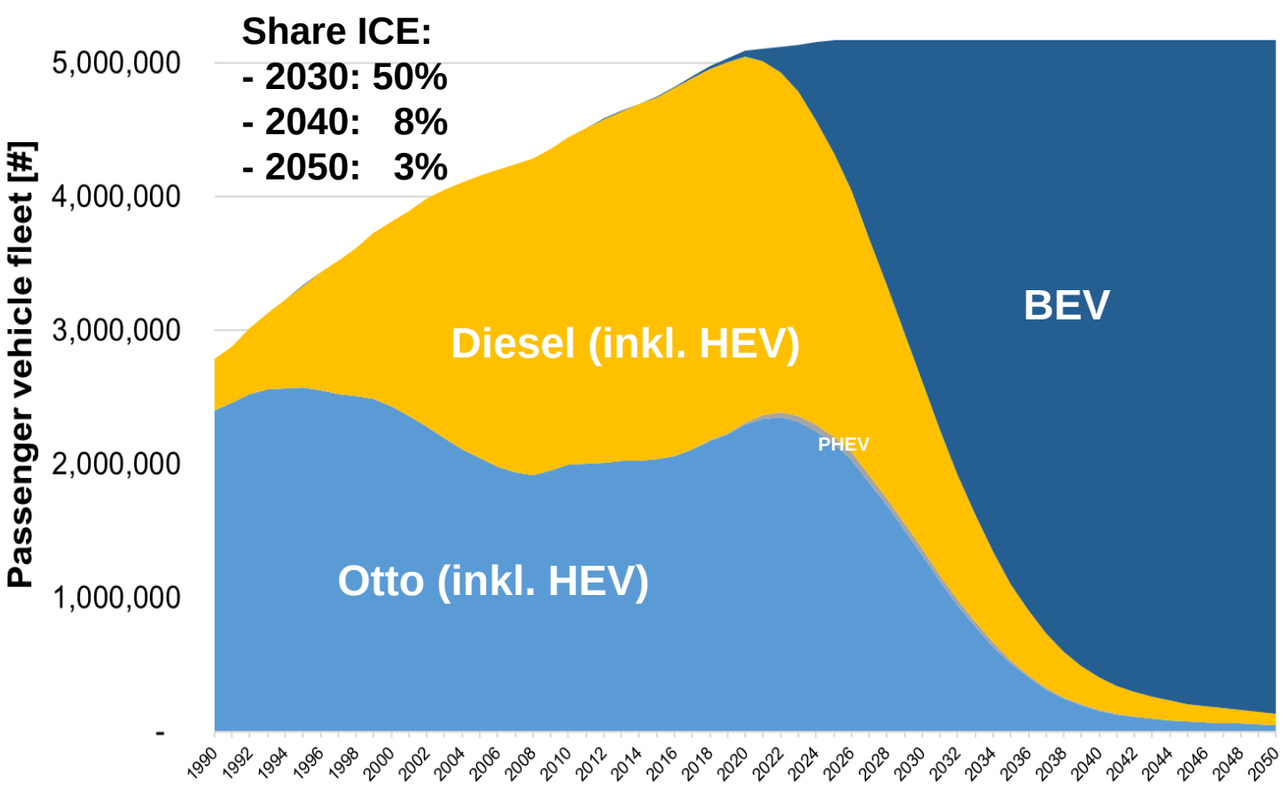
Development of passenger vehicle fleet in Austria

New vehicle registrations



2028+: new registered vehicles: 100% BEV

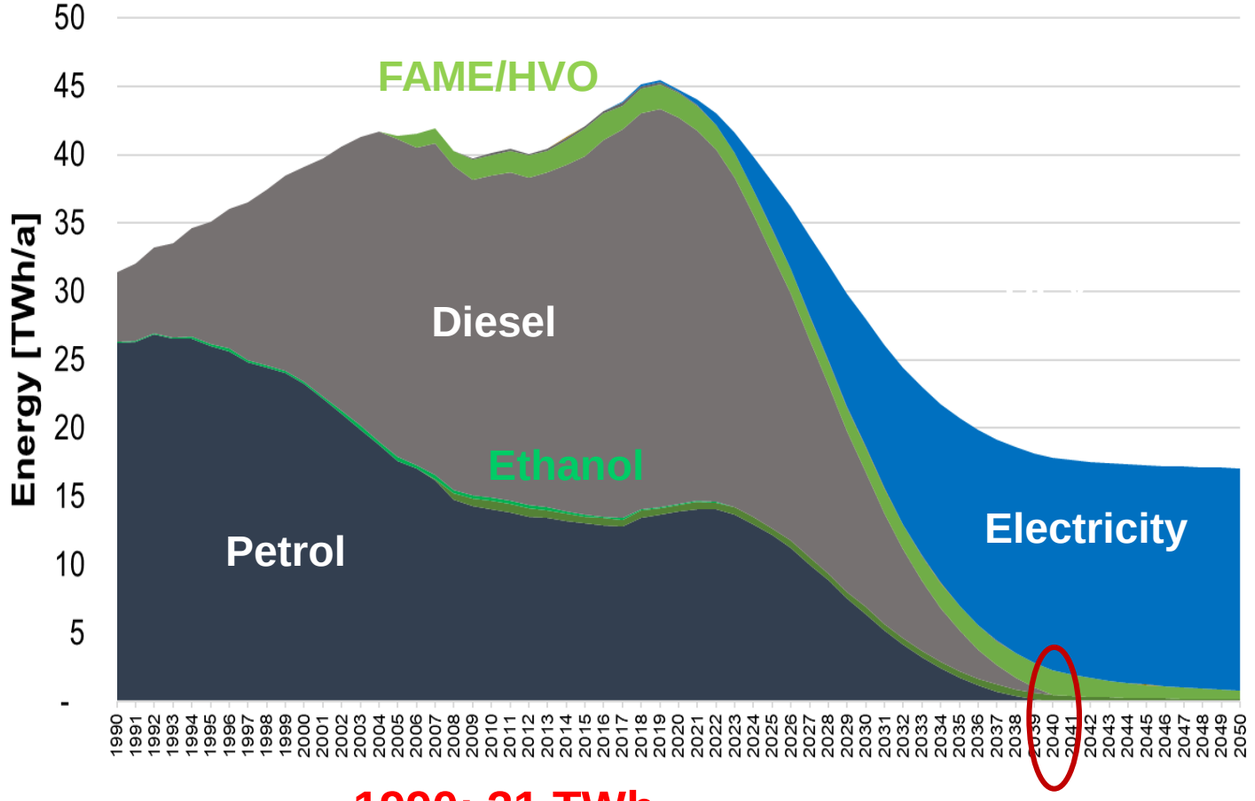
Vehicle fleet



2025+: constant vehicle fleet

Passenger vehicle energy consumption

Energy consumption vehicle fleet

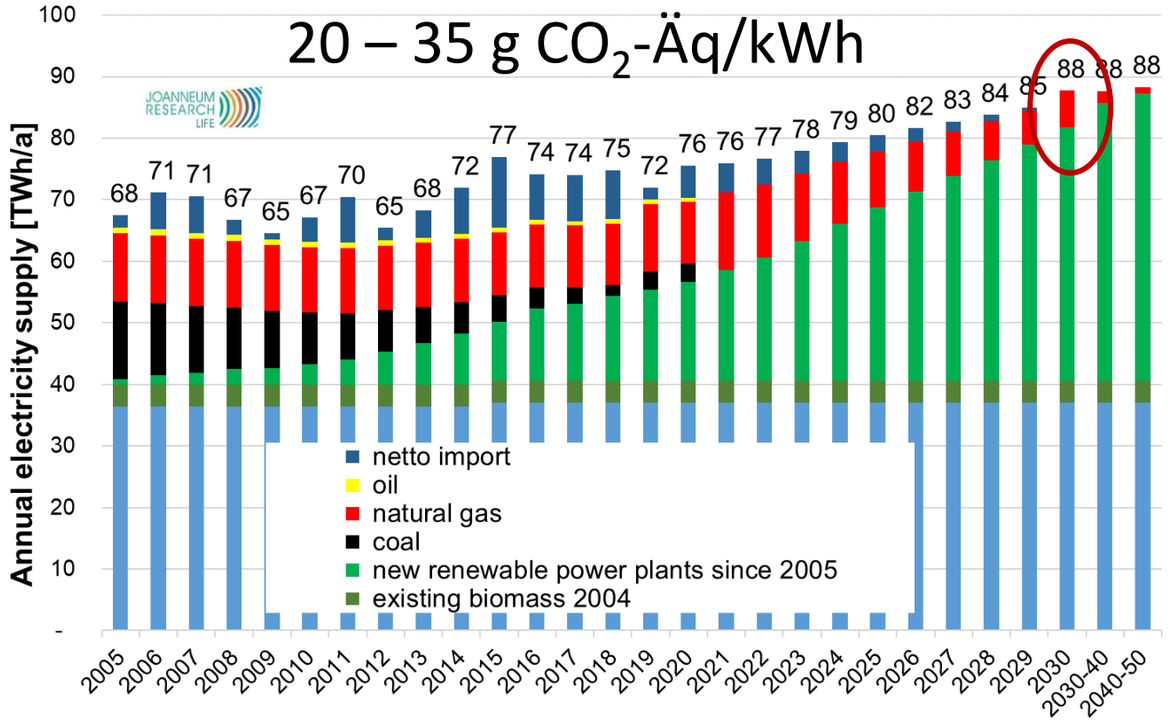


1990: 31 TWh
2020: 45 TWh
2030: 27 TWh

2040: 17 TWh

100% Renewable electricity in Austria 2030

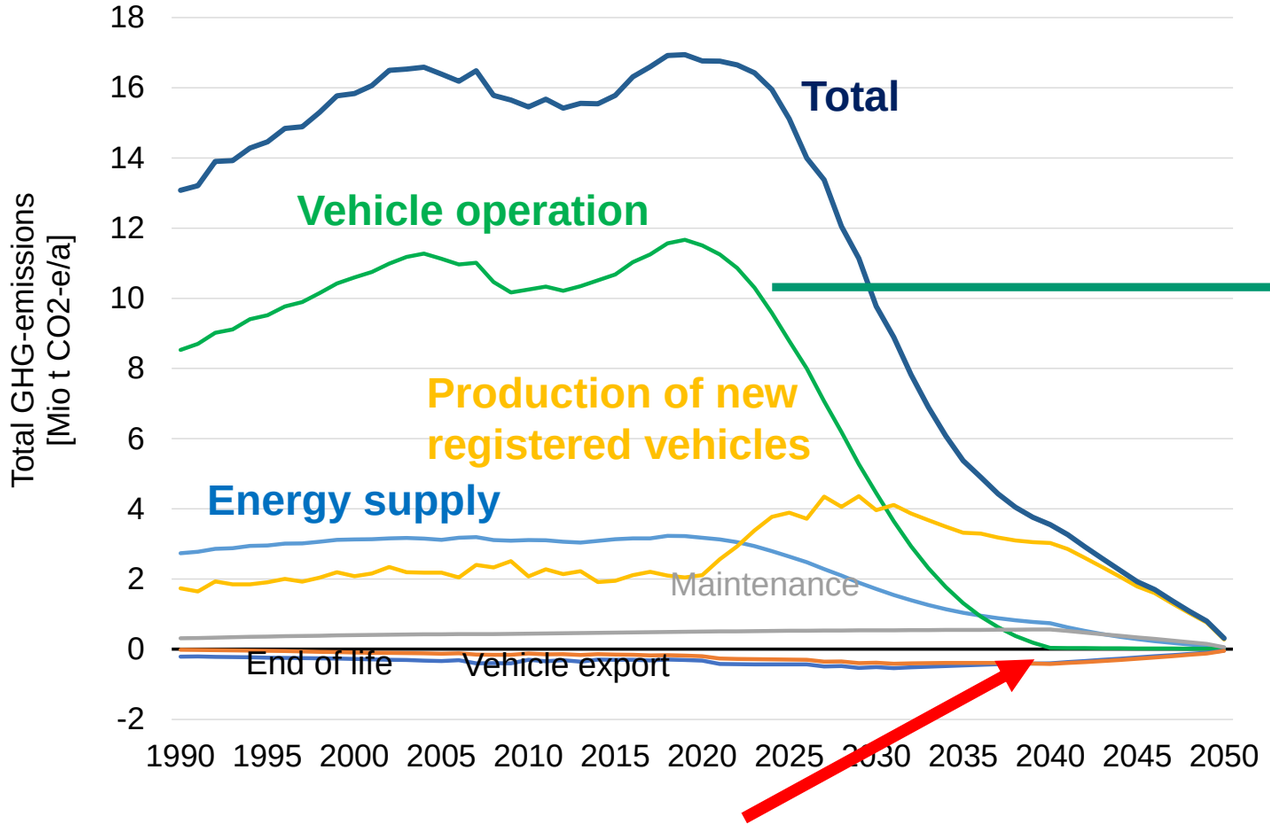
(based on EE-Ausbaugesetz 2021)



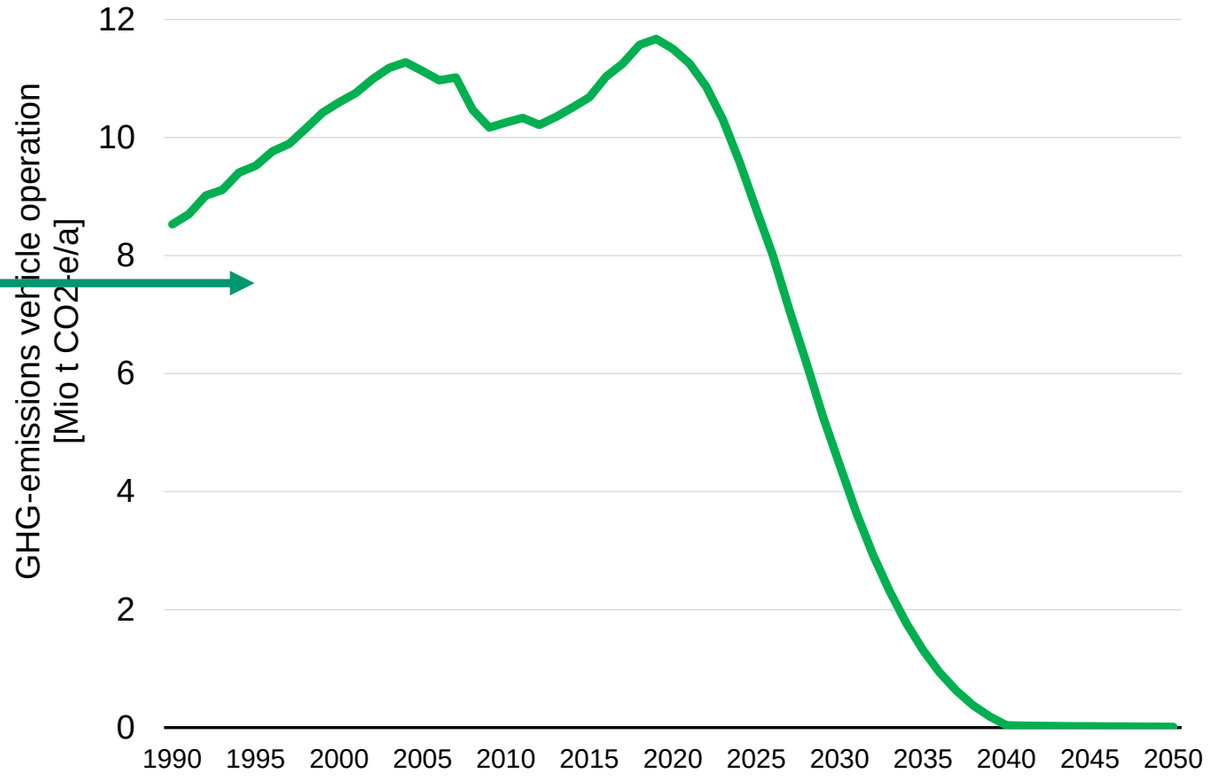
Source: Electricity supply 1.0, JOANNEUM RESEARCH

GHG-emissions of passenger vehicle fleet

Total GHG emissions of the fleet



GHG emissions from fleet operation

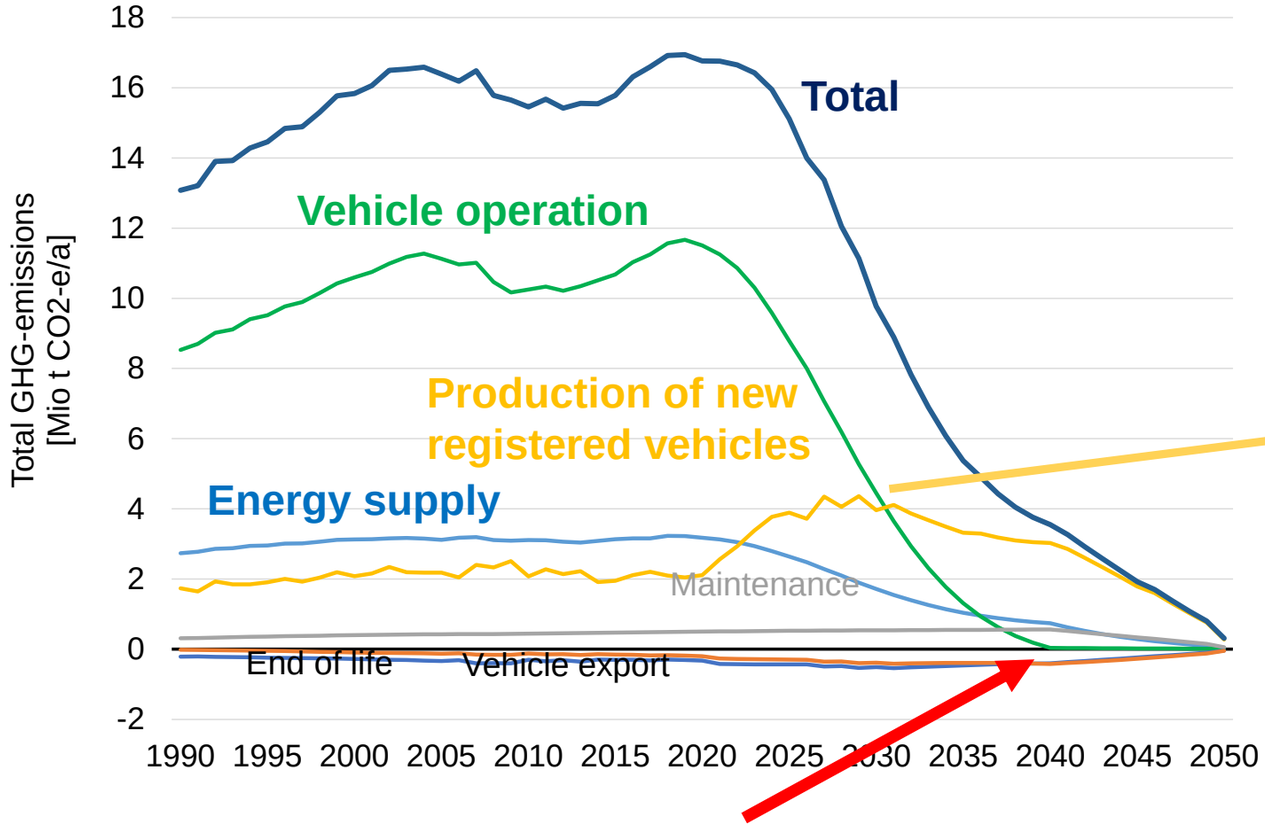


2040: climate neutrality in Austria
(except 40 – 55 kt CO_2-eq from N_2O and CH_4)

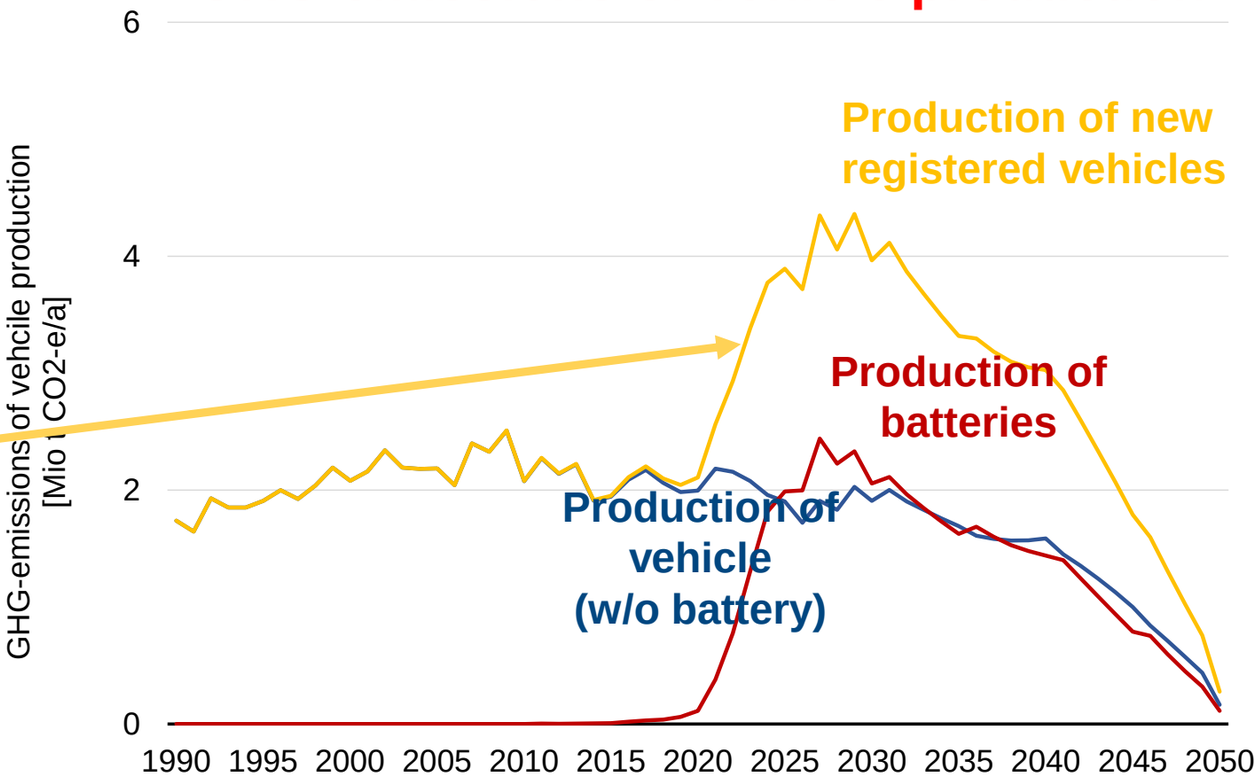
1990: 8.5 Mio t CO_2-eq
2020: 11.5 Mio t CO_2-eq
2030: 4.5 Mio t CO_2-eq
2040: 0 Mio t CO_2-eq

GHG-emissions of passenger vehicle fleet

Total GHG emissions of the fleet



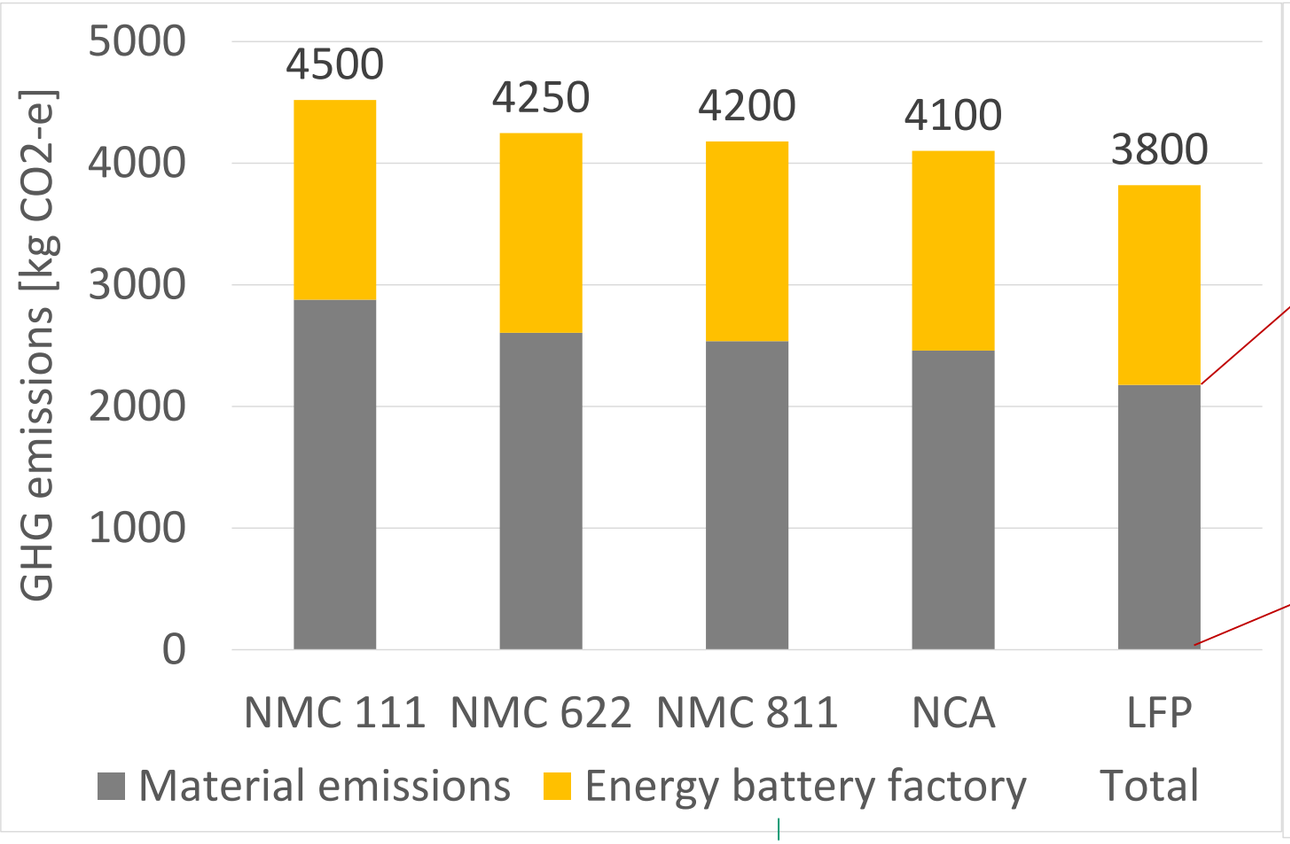
GHG emissions of vehicle production



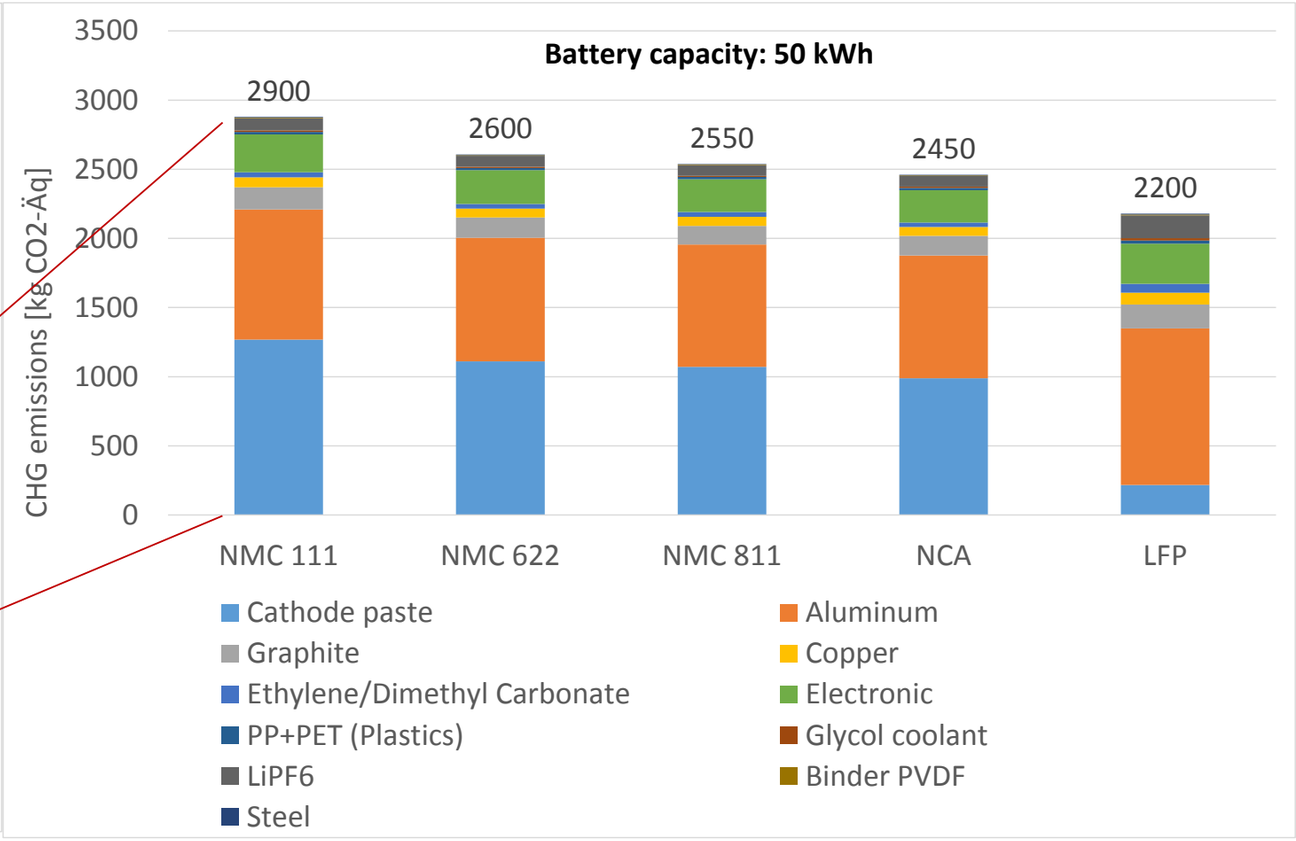
2040: climate neutrality in Austria
(except 40 – 55 kt CO_2-eq from N_2O and CH_4)

GHG emissions of battery pack production (example 50 kWh, China, 2020)

GHG emissions of battery production



GHG emissions of material production

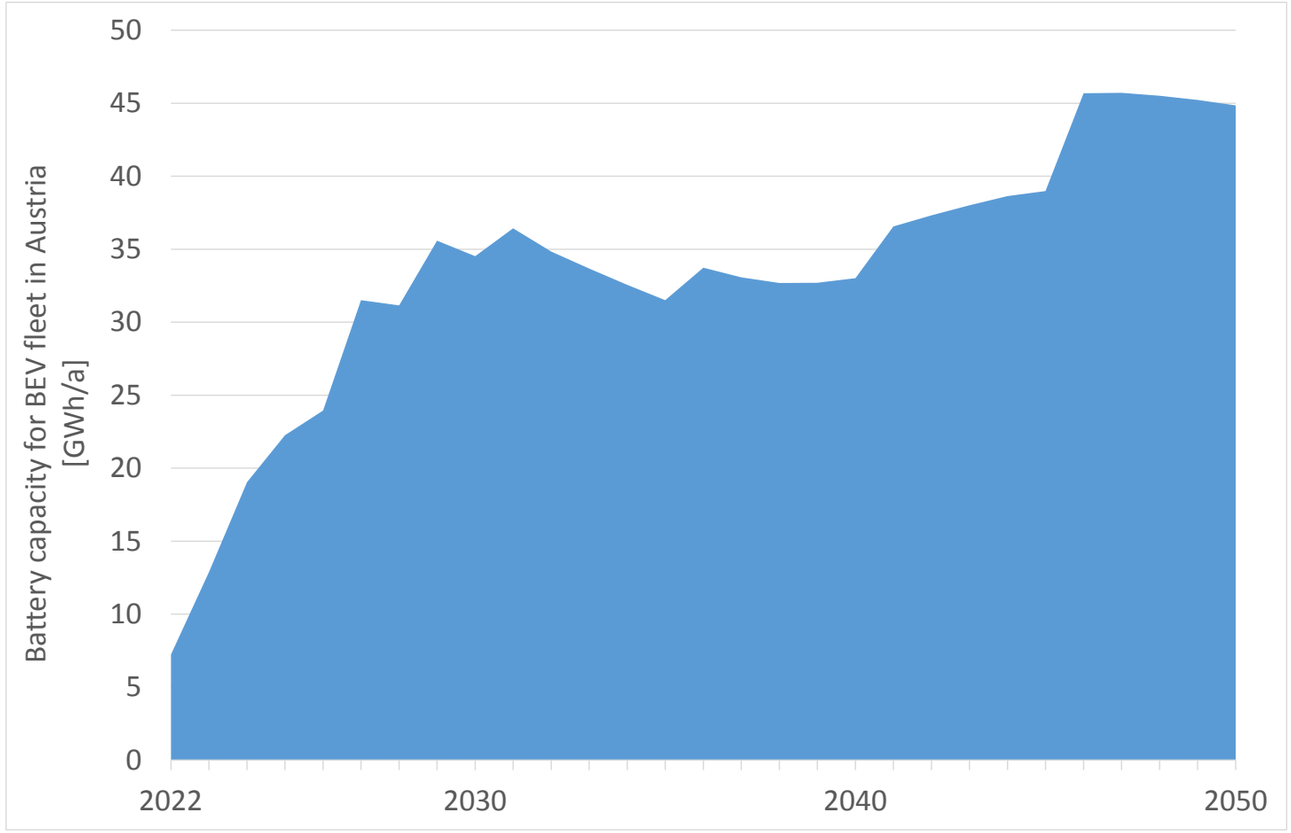


Energy demand battery factory: 55-65 kWh / kWh battery capacity

Source: Battery Lifecycle model, Joanneum Research

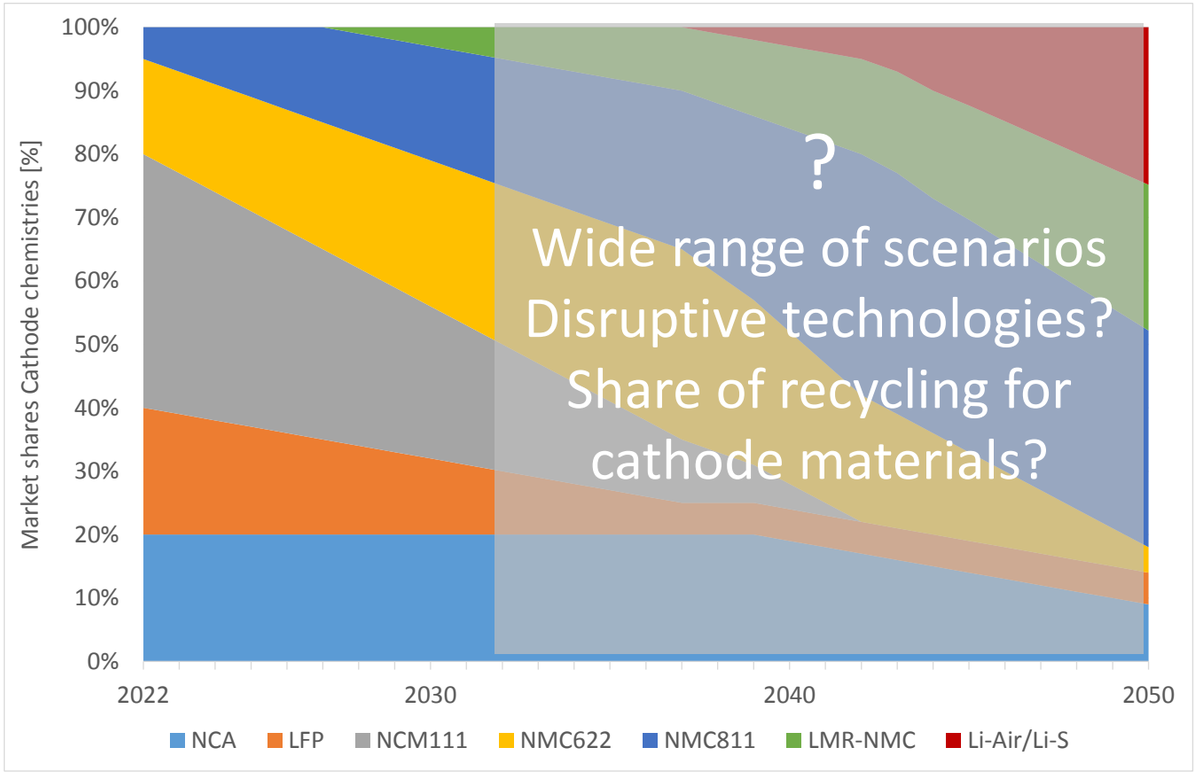
Batteries for BEV fleet

GWh battery capacity for the BEV fleet in Austria



2020: 75 kWh/battery
2030: 100 kWh/battery
2040: 110 kWh/battery
2050: 140 kWh/battery

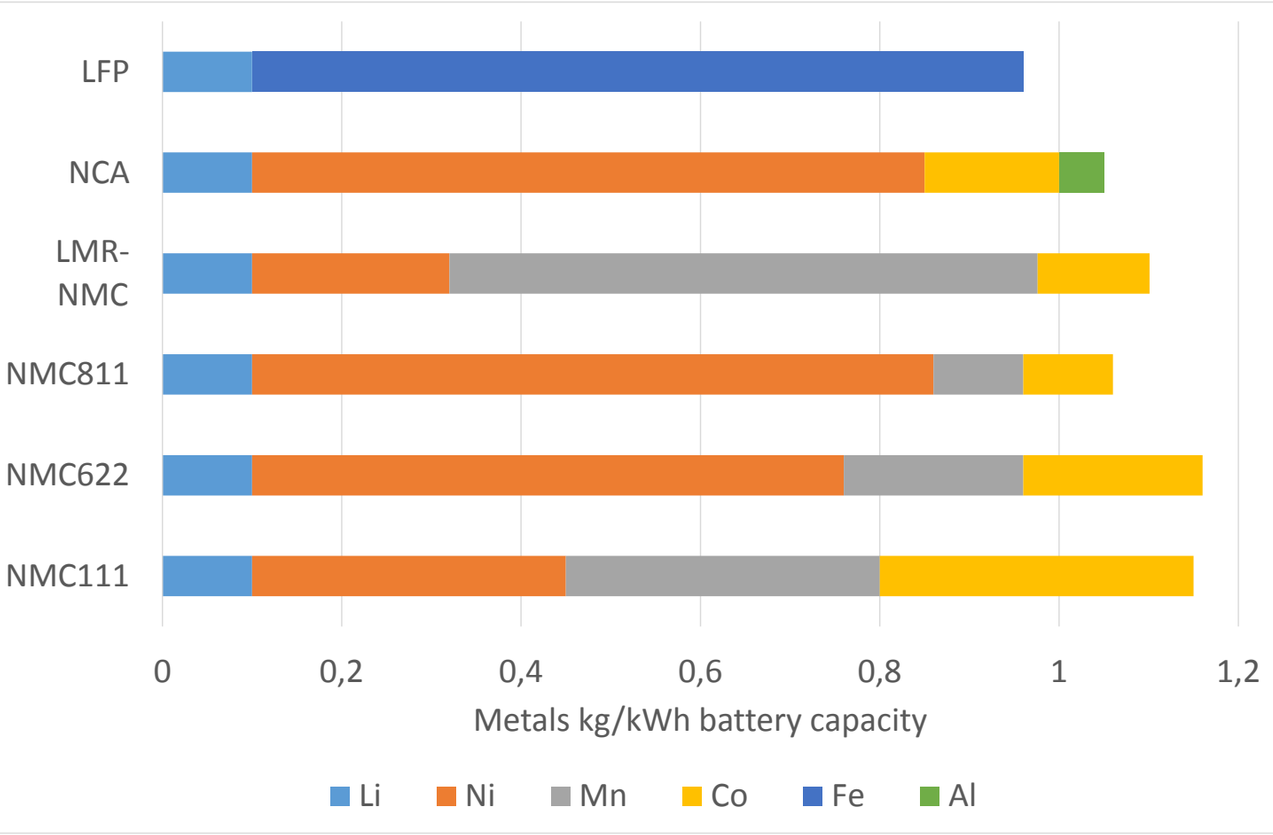
Market shares of cathode chemistries



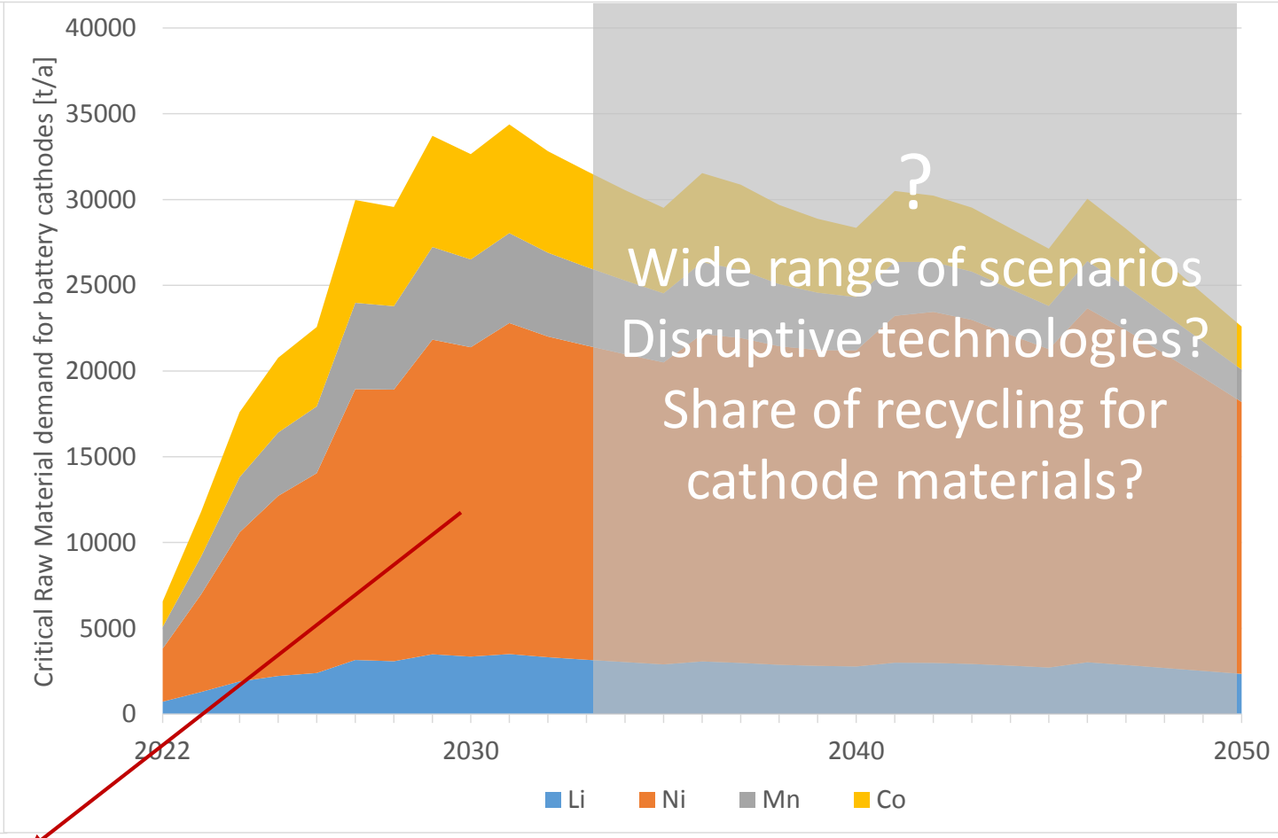
NMC-scenario with 60-70% NMC batteries

Critical raw material demand for BEV fleet

Metal demand for cathode chemistries



NMC-scenario with 60-70% NMC batteries

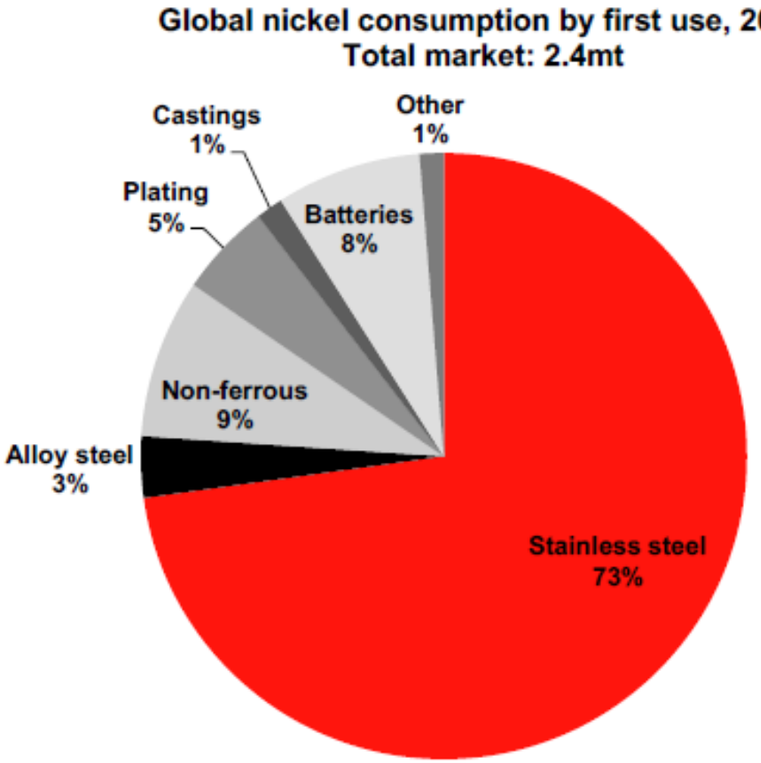


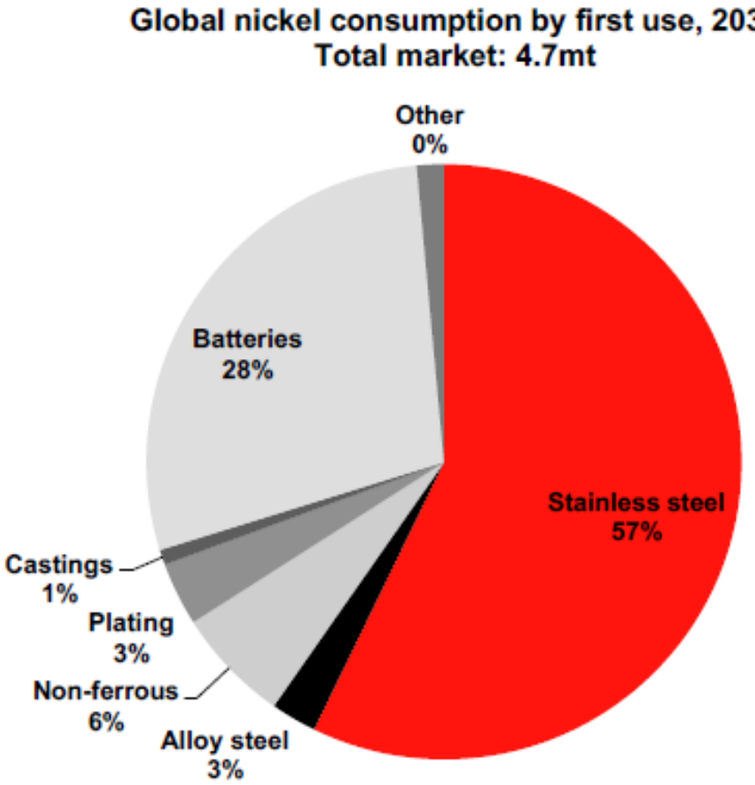
Ni-demand BEV fleet in Austria 18-19kt/a ⟷ Ni-demand Industry in Austria ~ 24 kt/a

(Source: Country factsheet Ni-Institute)

Future Nickel supply for batteries

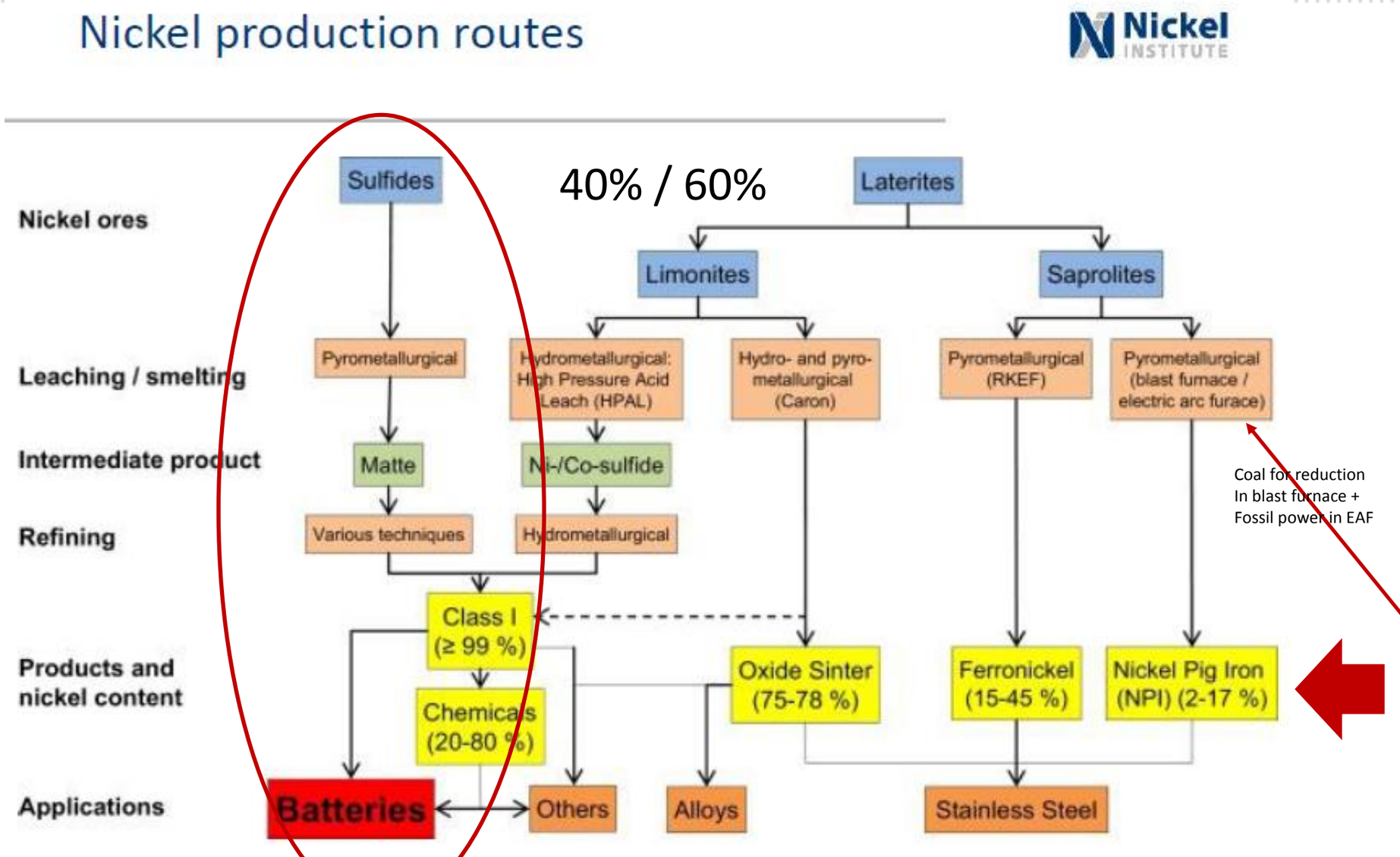
Batteries to become almost 30% of nickel market by 2030





Source: INSG, Macquarie Commodities Strategy, October 2021

How to cover the additional Nickel demand for batteries? Nickel is complicated…



Significant growth in NPI production (SE-Asia) due to stainless steel production in China

BUT

CO2-emissions per ton Ni via NPI 3-10 times higher (40-80 t CO2-e/t Ni) than via sulfidic Ni (8-12 t CO2-e/t Ni)

Findings

- **Climate Neutrality 2040** in Austria passenger vehicle fleet is possible with BEV
- **Main challenges** are
  - rapid renewal of fleet with high share of BEV registration
  - Renewable power supply covering the demands of all sectors (mobility, industry, buildings)
- Main **influences to reach climate goals** in passenger vehicle fleet are:
  - Increasing high number of newly registered BEV
  - Development of vehicle stock
  - Development of annual driven mileage of vehicle fleet
  - Generation of additional renewable electricity for BEV
  - Climate neutral raw material processing in the main resource countries remains big challenge
- **Next:** discussion and scenarios for climate neutral mobility in Austria for persons & goods using all transportation modes

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