International Energy Agency

The Global EV Outlook 2019 – life-cycle analysis

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ITF workshop “LCA of urban transport business models”, 1 October 2019, Paris

The Clean Energy Ministerial Electric Vehicles Initiative (EVI)

Electric Vehicles Initiative

Members (2018-19)

(Co-lead) (Co-lead)

Coordinator iea

Activities

Analytical publications

Commitments

- EV30@30
  EV3@30 Campaign (2017)
- Paris Declaration on Electro-Mobility and Climate Change (COP 21)
- Government Fleet Declaration (COP 22)

Collaborative projects

- Global EV Pilot City Programme
  EV Pilot City Programme
- € 4 million global electric mobility project for emerging economies (with UNEP and the GEF)
  UN environment gef iea

Global EV Outlook 2019 – Contents

Electric Vehicles Initiative

The 2019 edition includes:

- Updated EV market statistics (EV stock, sales EVSE)
- Overview of existing policies and targets
- Analysis of industry rollout plans (EV, EVSE, batteries)
- Role of EVs in low carbon scenarios (2030 timeframe and beyond)
- Implications on EVSE deployment, battery capacity and material demand)
- Electricity demand, oil displacement and WTW GHG emission mitigation
- Comparative life cycle GHG emissions assessment for different powertrains
- Battery technology and cost assessment
- Implications on the TCO of road vehicles
- EV battery materials and supply chain sustainability discussion
- Implications of electric mobility for the power system
- Impact of EVs uptake on government revenues from taxation

https://webstore.iea.org/global-ev-outlook-2019

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Electric vehicle life-cycle GHG emissions – methodology

Electric Vehicles Initiative

Vehicle emissions from materials (manufacturing, maintenance, disposal/recycling)

GREET LIFE-CYCLE MODEL

Tool: GREET 2
Developed by Argonne National Lab

Vehicle emissions from fuel use for motion

Mobility Model

Tool: Mobility Model and GFEI analysis
Developed by International Energy Agency

GLOBAL FUEL ECONOMY INITIATIVE FOR ZERO CARBON VEHICLES BY 2050

Life-cycle GHG emissions assessment of cars for GEVO 2019 (global perspective)

The life cycle assessment of cars' GHG emissions in the Global EV Outlook 2019 results from the combination of GREET 2 and the Mobility Model.

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Electric vehicle life-cycle GHG emissions – key parameters

Electric Vehicles Initiative

GREET 2

- Passenger cars, SUVs, Pick-up trucks
  - ↳ 3 sizes (based on GFEI)
- ICE, HEV (Ni-MH), BEV (Li-ion), PHEV (Li-ion), FCEV (Ni-MH)
- Battery size 11kWh (PHEV), 38kWh (BEV 200 km), 78 kWh (BEV 400 km)
- LMO, NMC 111, LFP, NMC 622, NMC 811, LMR-NMC, NCA
- Vehicle lifetime 15 000 km/year, 10 years
- Conventional materials, lightweight materials (GHG emissions intensity of materials and processes: US scope)

Mobility Model

- WLTP fuel economy by powertrain, by car size, based on GFEI
- BEV and PHEV fuel economy on electricity includes 5% charging losses
- E-driving rate of PHEVs: 60% electric
- Global average well-to-wheel GHG emissions of gasoline
- Global average and regional GHG emissions of electricity generation, transmission and distribution

The combination of both models allowed for the life-cycle comparison of GHG emissions for 5 powertrain types and 3 vehicle sizes, in conditions considered to be representative of the global average.

Red and Blue: inputs and assumptions used in Global EV Outlook 2019 analysis

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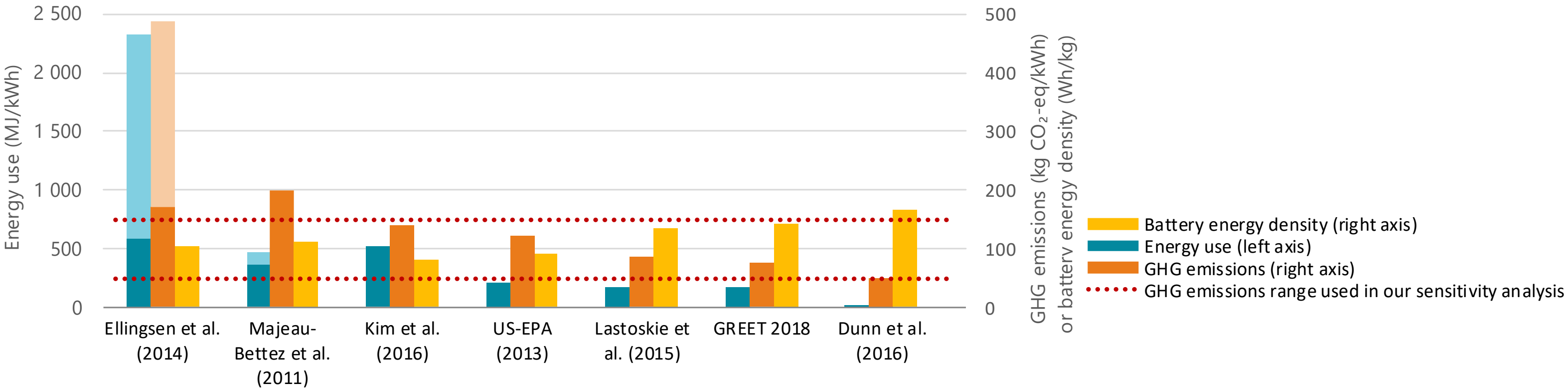
Electric vehicle life-cycle GHG emissions – batteries

Electric Vehicles Initiative

1. Literature review



2. Research on GREET approach: battery pack manufacturing 75 kg CO_2/kWh, NMC 111, plant size 2GWh and capacity factor 75% (representative of current commercial battery manufacturing)

3. Validation of GREET approach as satisfactory proxy for current commercial manufacturing globally, in this exercise. Possibility for regional refinement in future analysis.

> A rate of 75 kg CO_2-eq/kWh was considered representative of current commercial battery manufacturing. A 50-150 range was also taken into account in the analysis to encompass other possible cases.

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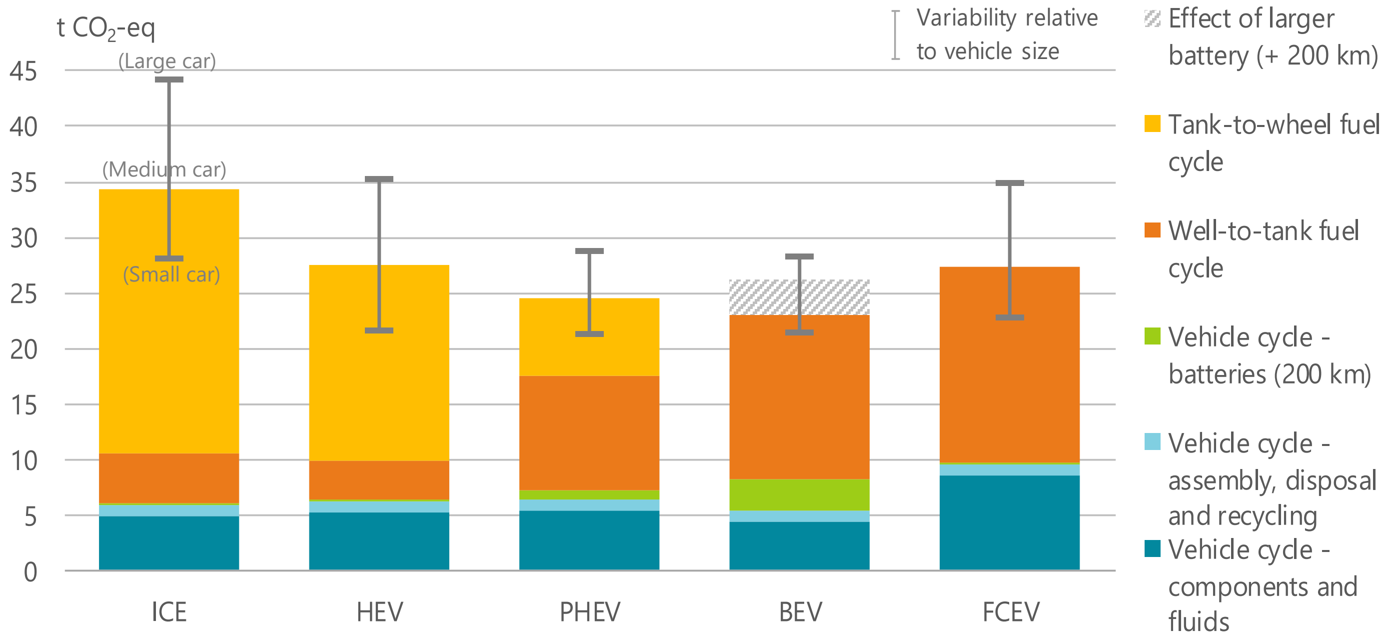
Electric vehicle life-cycle GHG emissions – results

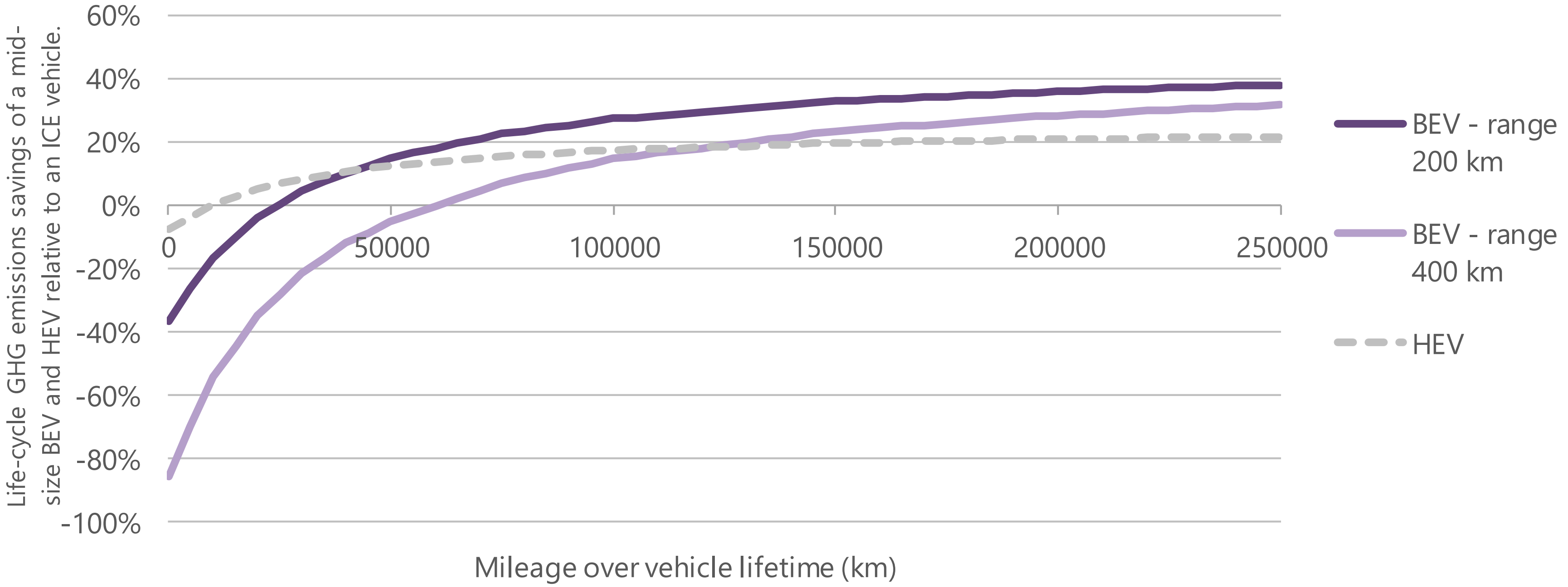
Life-cycle GHG emissions for passenger cars by powertrain, 2018



H_2 production pathway assumption: steam methane reforming from natural gas (representative of current production)

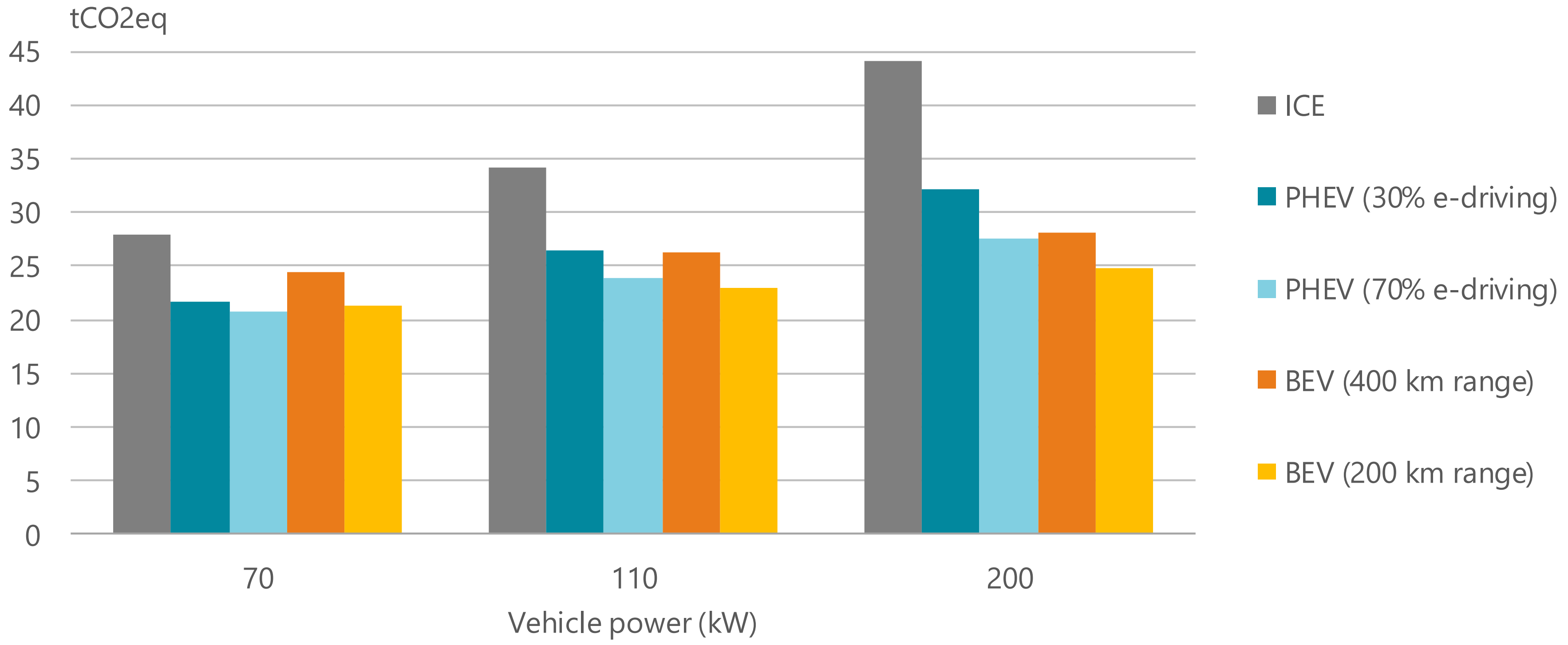
With the global average GHG intensity of electricity generation, EVs, FCEVs and HEVs have similar performance.
If electricity generation decarbonises, GHG emissions of BEVs and PHEVs can significantly decline.

Electric vehicle life-cycle GHG emissions – sensitivity to mileage



Life-cycle GHG emissions savings for BEVs kick-in from 25 000 – 60 000 km depending on driving range.

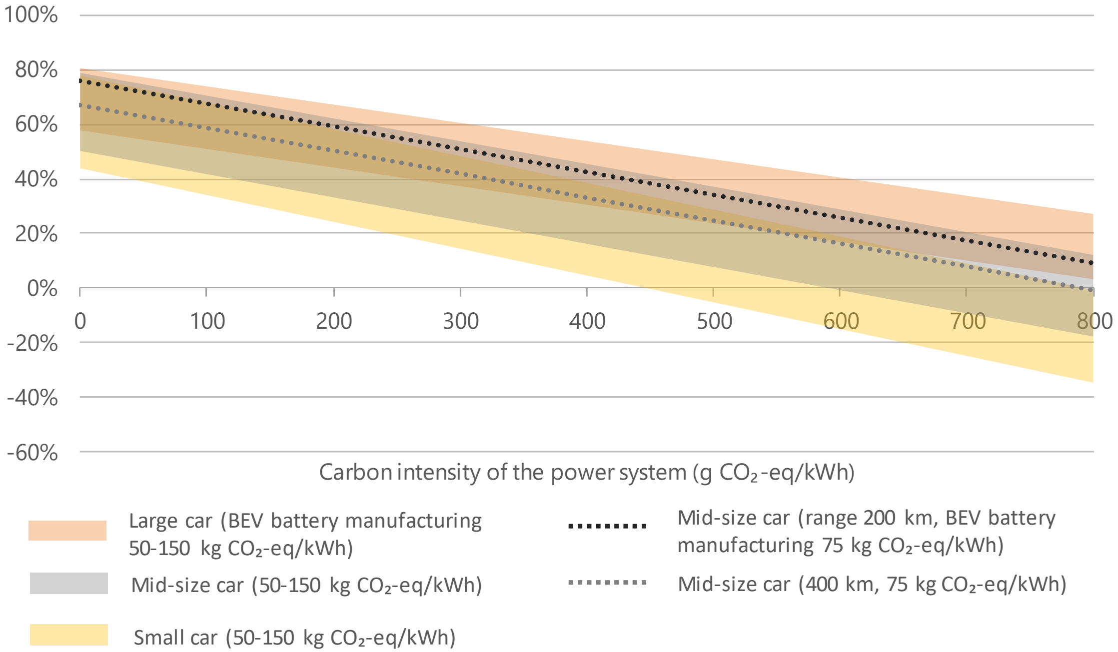
Electric vehicle life-cycle GHG emissions – sensitivity to size



GHG emissions savings from electric vehicles relative to equivalent ICE vehicles increase with size

Electric vehicle life-cycle GHG emissions – sensitivity to power mix

Life-cycle GHG emissions savings of a BEV relative to an ICE vehicle of the same size under various power system carbon intensities



Note: in this graph, only the GHG emissions from fuel use for motion vary according to the x axis

Over their life cycle, the extent of GHG emissions savings of BEVs relative to ICE vehicles depends on the carbon intensity of electricity generation for final use and the size of the car.

Possible future research areas

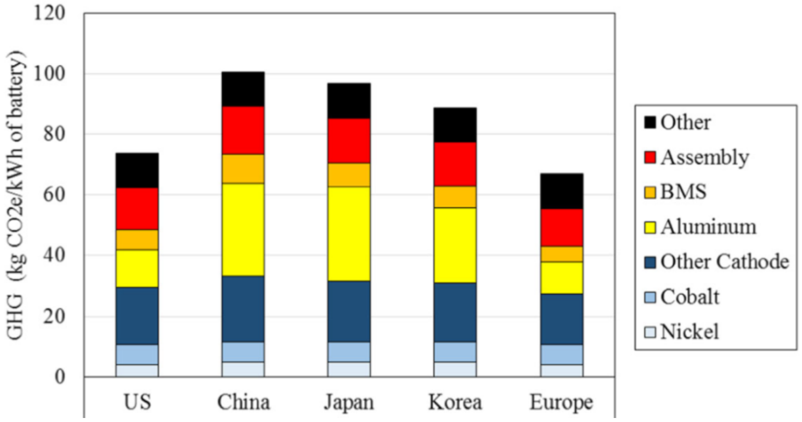
- Addition of significant materials recycling rates, in particular for batteries (potential tradeoff between raw materials production energy use and recycling energy use)

- Variation of materials/battery production for some materials (e.g. aluminum) based on e.g. plant scale, region
  - → Kelly, Dai and Wang, Aug. 2019 - ANL: regionalization of battery manufacturing process and material supply chains

- Evolution of emissions based on IEA scenarios for ICE improvement and power system decarbonisation potential

- Consideration of next generation battery technologies and chemistries

GHG emissions associated with NMC111 LIB production in five countries

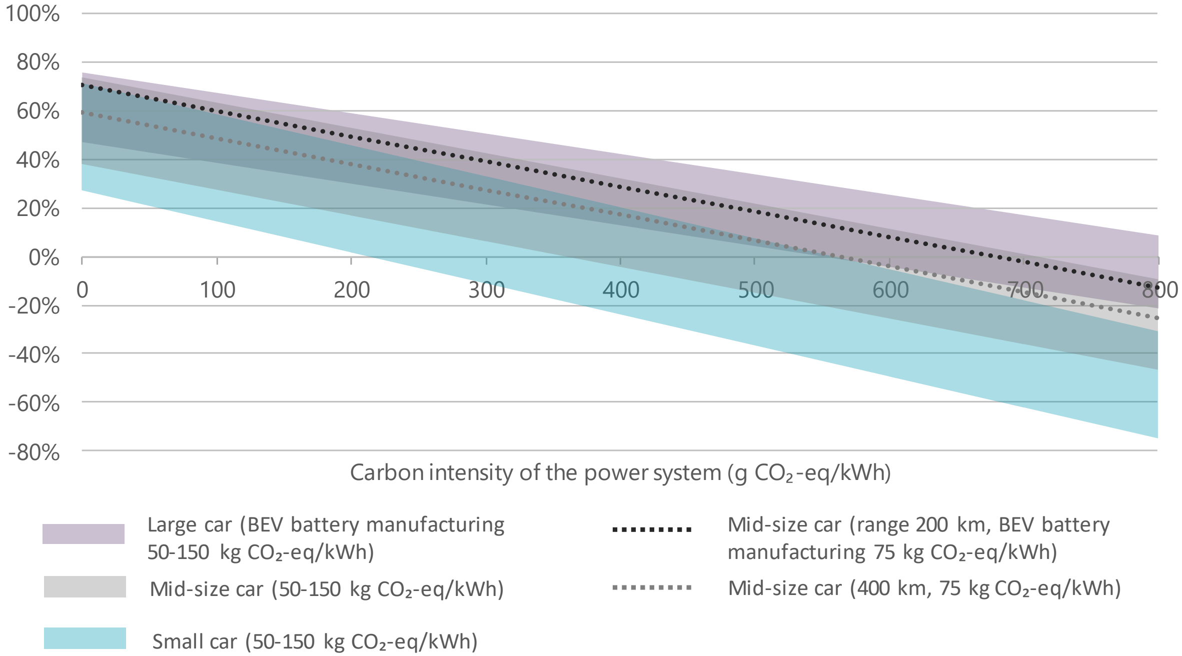


Source: Kelly, Dai & Wang, Argonne National Laboratory, 2019

There is scope for refining the analysis in particular with regards to regionalisation, bearing in mind the trade-off with increased complexity.

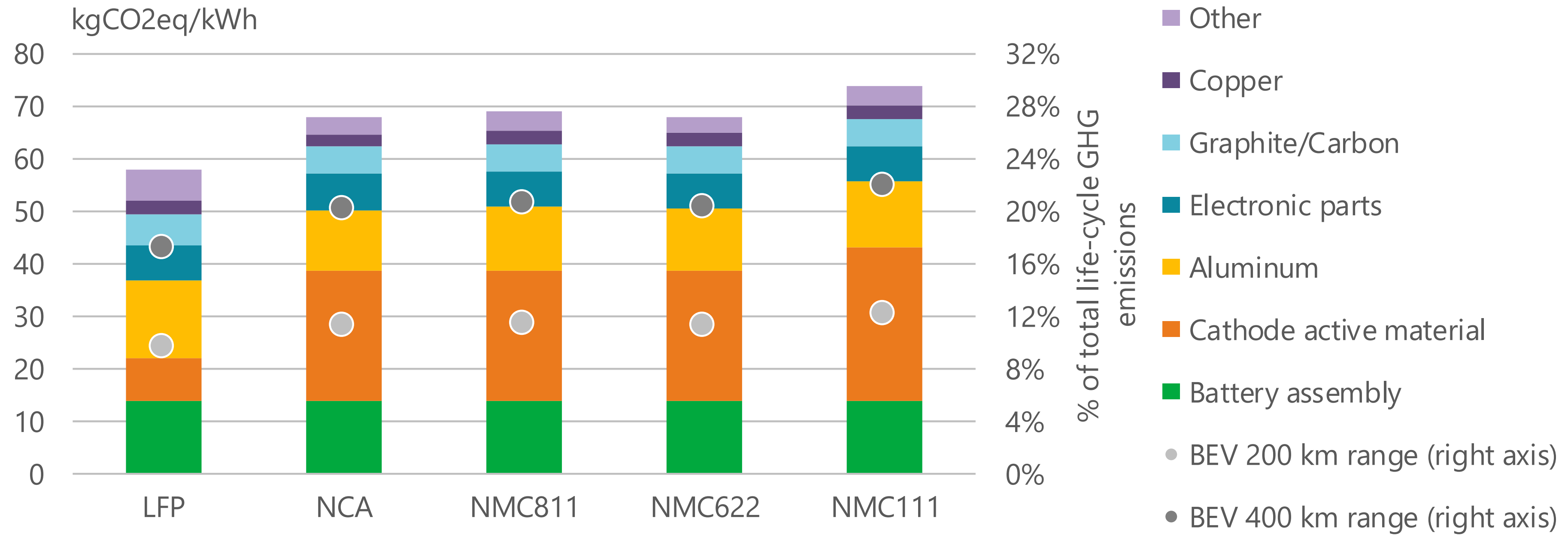
Assessing electric cars on a lifecycle basis

Life-cycle GHG emissions savings of a BEV relative to an HEV of the same size under various power system carbon intensities



In order for life-cycle GHG emissions of BEVs to break even with HEVs, the carbon intensity of the electricity consumed in the use phase must be lower than when comparing BEVs with ICE vehicles.

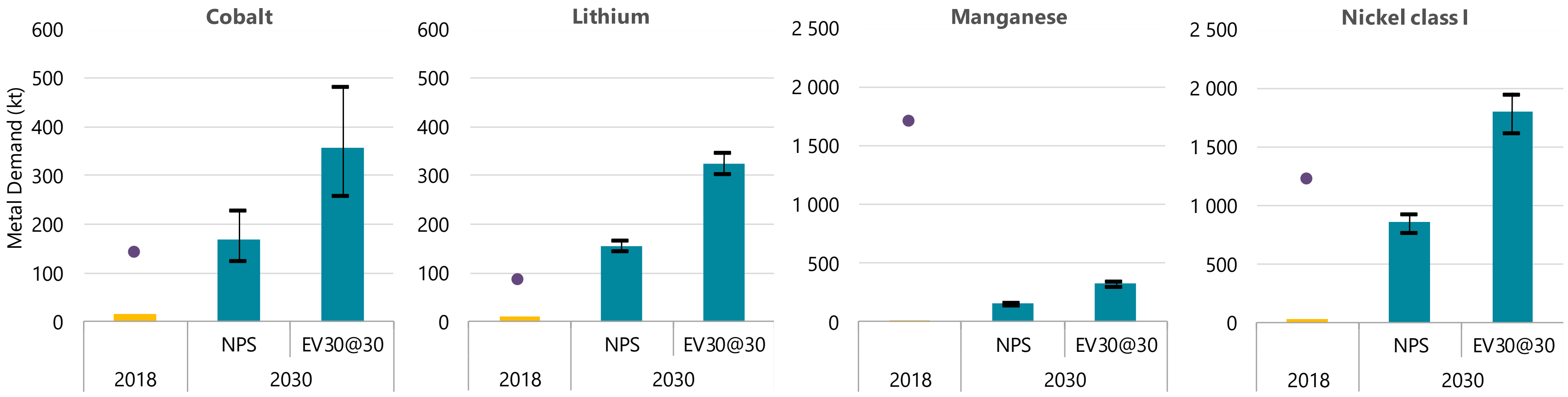
Battery chemistries affect EVs' life-cycle GHG emissions



The mix of active materials in the cathode is the main determinant of battery manufacturing emissions. The NMC 111 chemistry is the most GHG-intensive of the five chemistries shown and LFP is the lowest.

Electric mobility increases demand for new materials

Increased annual demand for materials for batteries from deployment of electric vehicles by scenario, 2018-30



Note: The battery chemistry mix considered for 2030 in this analysis is composed of 10% of NCA, 40% of NMC 622 and 50% of NMC 811

In both scenarios, demand for cobalt, lithium, manganese and nickel are expected to rise significantly by 2030. Scale-ups in supply are needed to enable the projected EV uptake.