The Global EV Outlook 2018

Focus on batteries and battery charging

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IEA

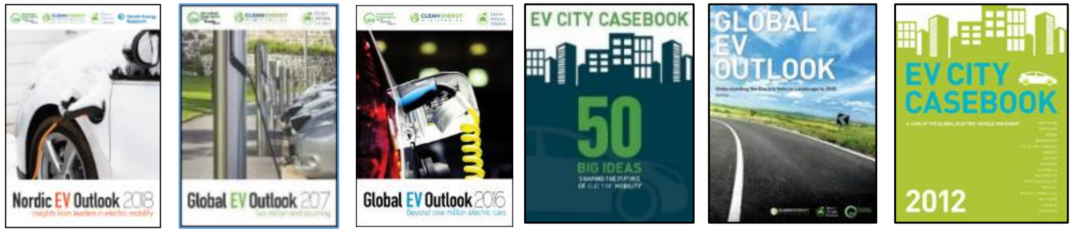
Electric Vehicles Initiative (EVI)

Multi-government policy forum dedicated to conducting collaborative activities that support the design and implementation of domestic electric vehicle (EV) deployment policies and programs

In 2010, EVI was one of several initiatives launched under the CEM

Currently co-chaired by Canada and China, and coordinated by the IEA

Released several analytical publications, demonstrating leadership to strengthen the understanding of the opportunities offered by electric mobility to meet multiple policy goals



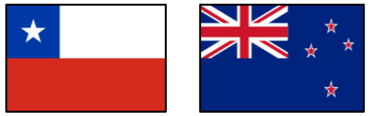
Instrumental to mobilize action and commitments (Paris Declaration on Electro-Mobility and Climate Change at COP21, Government Fleet Declaration at COP22)

Launched the EV30@30 Campaign in June 2017, updated in September 2018

Launched the **Pilot City Programme** in May 2018

Also working with the **Global Environment Facility** on the preparation of a project for the support of EV policy-making in developing regions

Members



in 2018

EV30@30 Campaign

Designed to accelerate the global deployment of electric vehicles

Sets a collective aspirational goal to reach <u>30% sales share for EVs by 2030</u>

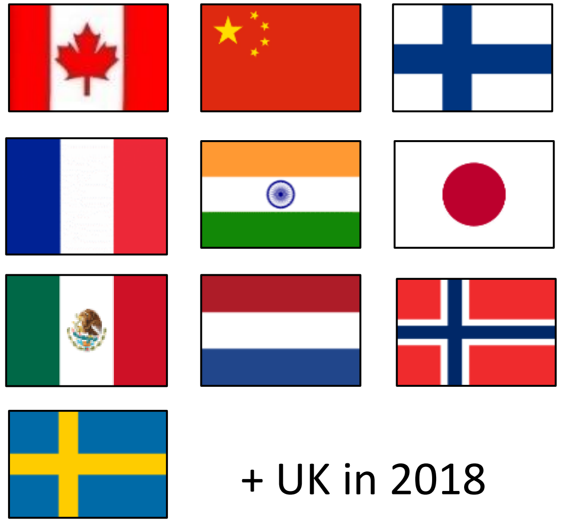
Launched at the 8th CEM meeting, in Beijing, by Minister Wan Gang

Enlarged participation announced at the UK ZEV Summit in September 2018

Implementing actions include:

- Supporting the deployment of chargers and tracking its progress,
- Galvanising public and private sector commitments for electric vehicle (EV) uptake in company and supplier fleets
- Scaling up policy research and information exchanges
- Supporting governments for policy and technical assistance through training
- Establishing the Global EV Pilot City Programme, aiming to achieve 100 EV-Friendly Cities over five years. The PCP counts over 30 cities by September 2018.

Members



+ UK in 2018

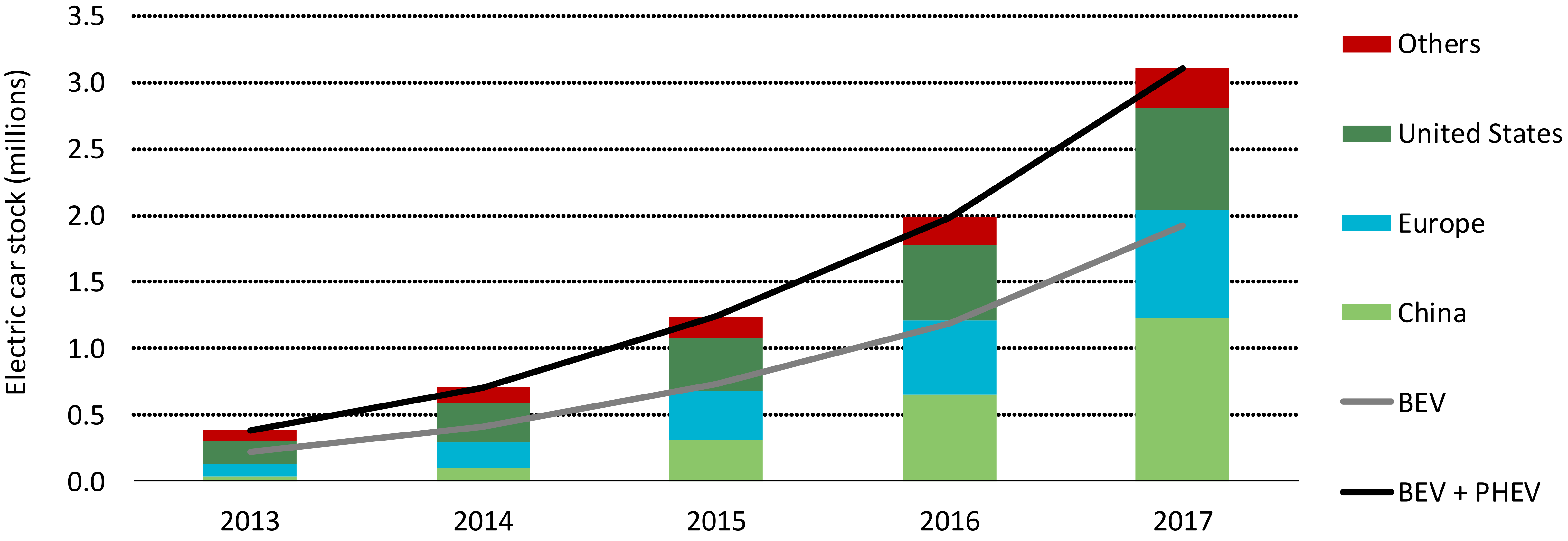
Supported by several partners, including the private sector since 2018

C40 CITIES · GFEI · NRDC · Partnership on Sustainable Low Carbon Transport · M2020 · UN environment · UN-HABITAT · ZEV ALLIANCE

Global EV Outlook 2018

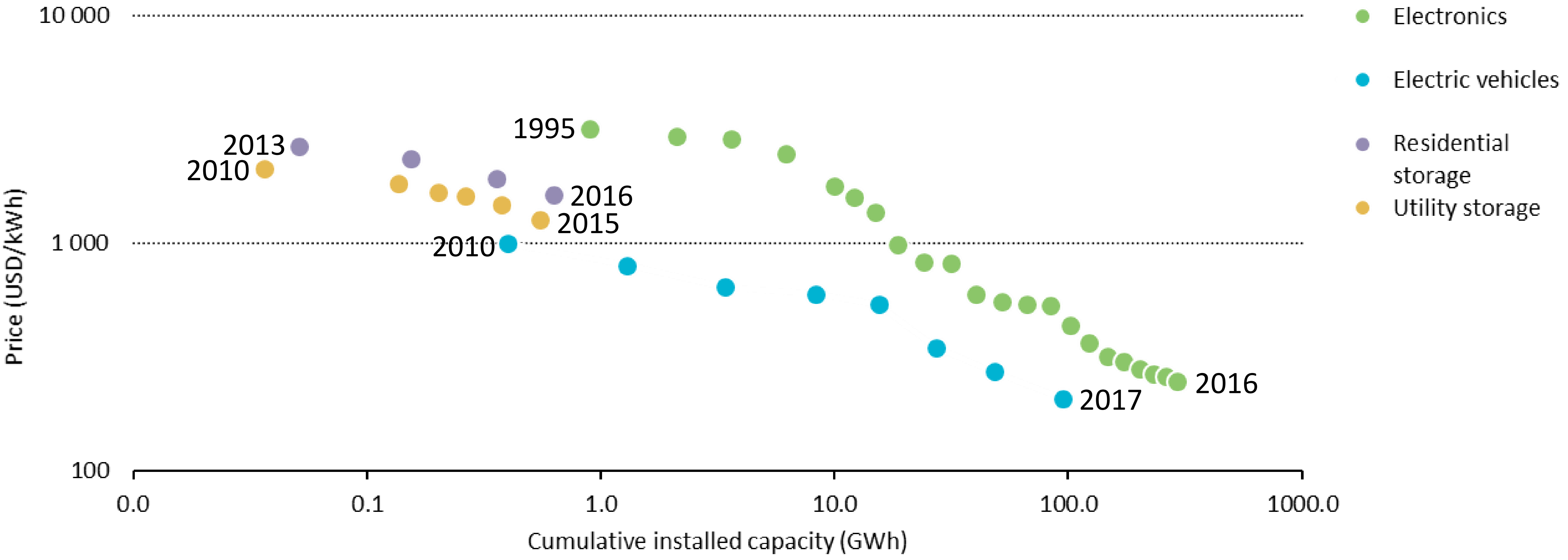
- EVI flagship report by the IEA
- 2018 edition includes
  - Data reporting (EV stock, sales, EVSE, battery costs)
  - Overview of existing policies
  - Battery technology and cost assessment
  - Implications on the TCO of road vehicles
  - Role of EVs in low carbon scenarios (2030 timeframe)
  - Electricity demand, oil displacement and GHG emission mitigation
  - Material demand
  - Policy recommendations
- 2018 edition also paired with the Nordic EV Outlook 2018
  - Focus on one of the most dynamic global regions for EV uptake
  - Opportunity to learn on policy efficacy and consumer behaviour

The number of electric cars on the road continues to grow



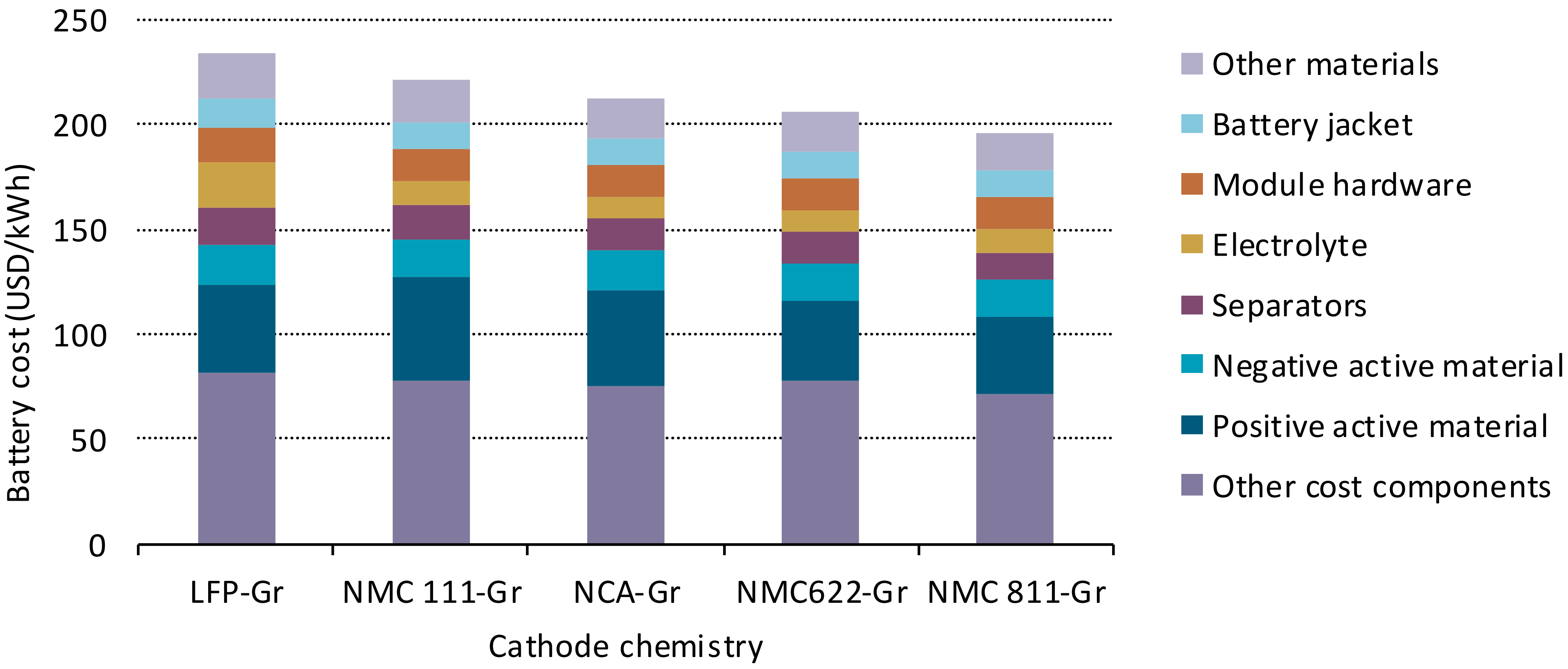
The electric car stock exceeded 3 million in 2017
However, electric cars still only represent 0.3% of the global car fleet

The role of consumer electronics for Li-ion battery improvements



Consumer electronics led to cost declines (through technology progress and scale) for Li-ion in the past
This benefited both EV packs, now set to deliver the next scale up, and stationary storage

Li-ion improvements: battery chemistry



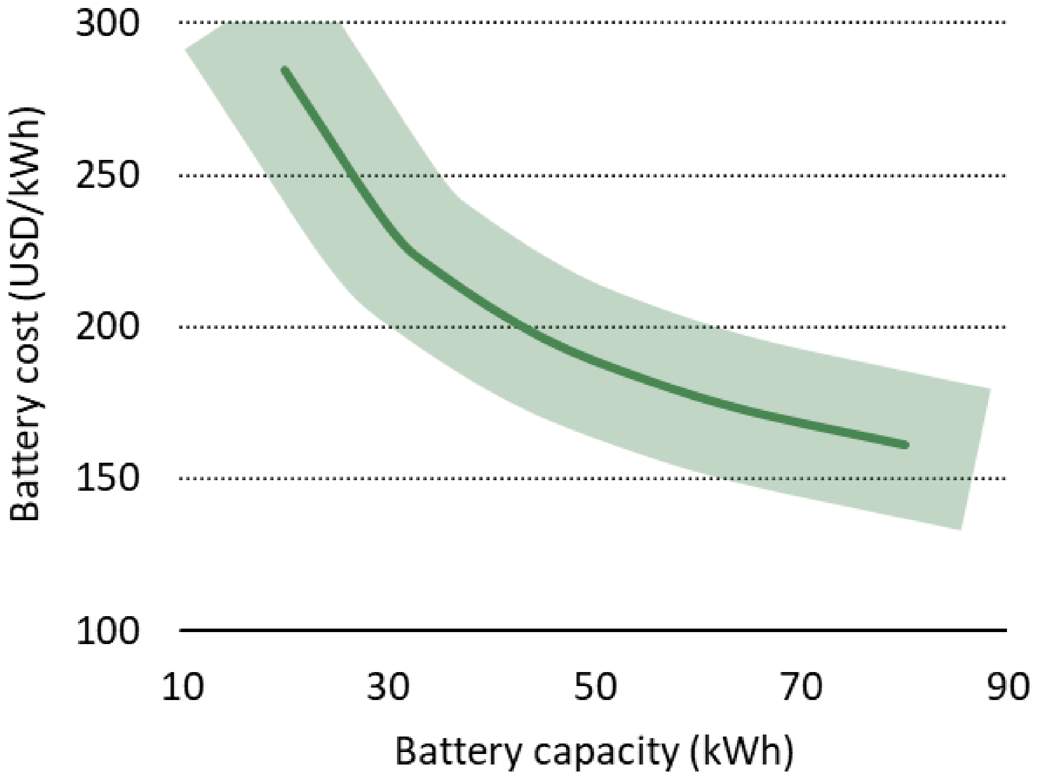
Battery chemistries influence costs per kWh through changes in energy density and materials
Reducing the content of cobalt in battery chemistries also results in lower unit costs, all else being equal

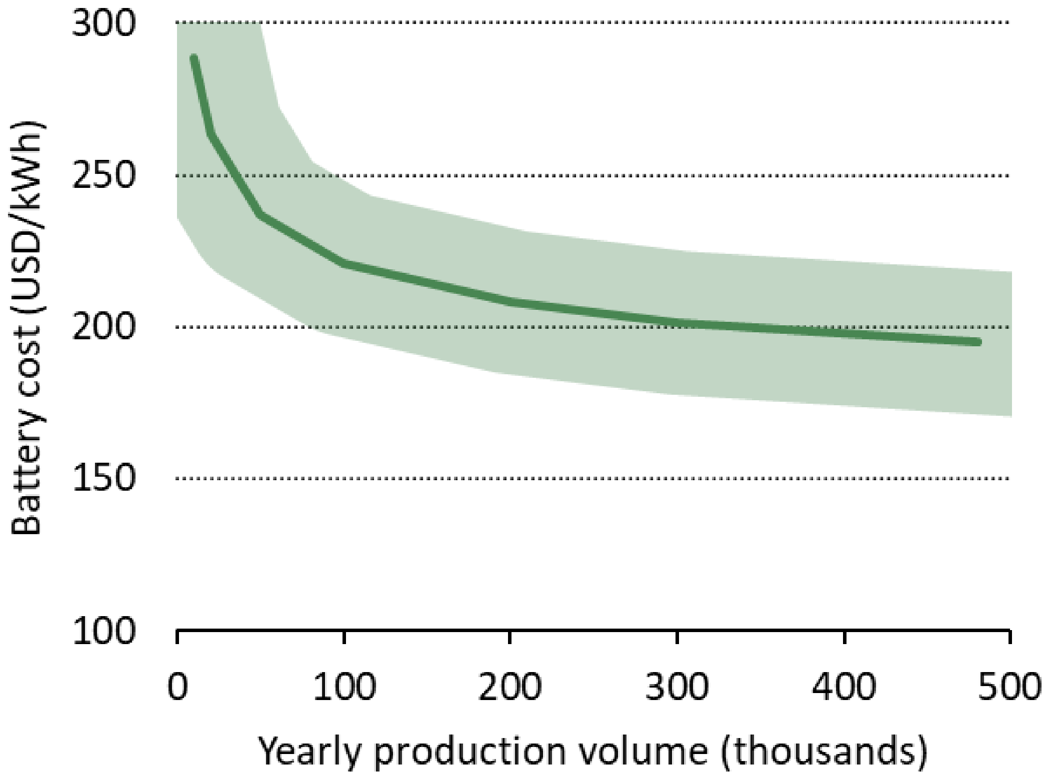
Industry is mobilizing investment in large scale manufacturing

Country	Manufacturer	Production capacity (GWh/year)	Year of commissioning	Source
		Operational		
China	BYD	8	2016	TL Ogan (2016)
US	LG Chem	2.6	2013	BNEF (2018)
Japan	Panasonic	3.5	2017	BNEF (2018)
China	CATL	7	2016	BNEF (2018)
		Announced		
Germany	TerraE	34	2028	TerraE (2017)
US	Tesla	35	2018	Tesla (2018b)
India	Reliance	25	2022	Factor Daily (2017)
China	CATL	24	2020	Reuters (2017f)
Sweden	Northvolt	32	2023	Northvolt (2017)
Hungary	SK innovation	7.5	2020	SK innovation (2018)

Current battery factory capacity ranges between 0.5-8 GWh/year
Much larger plants (7.5-35 GWh/year), aiming to reap economies of scale benefits, already announced

Li-ion improvements: effects of size & production volumes on costs

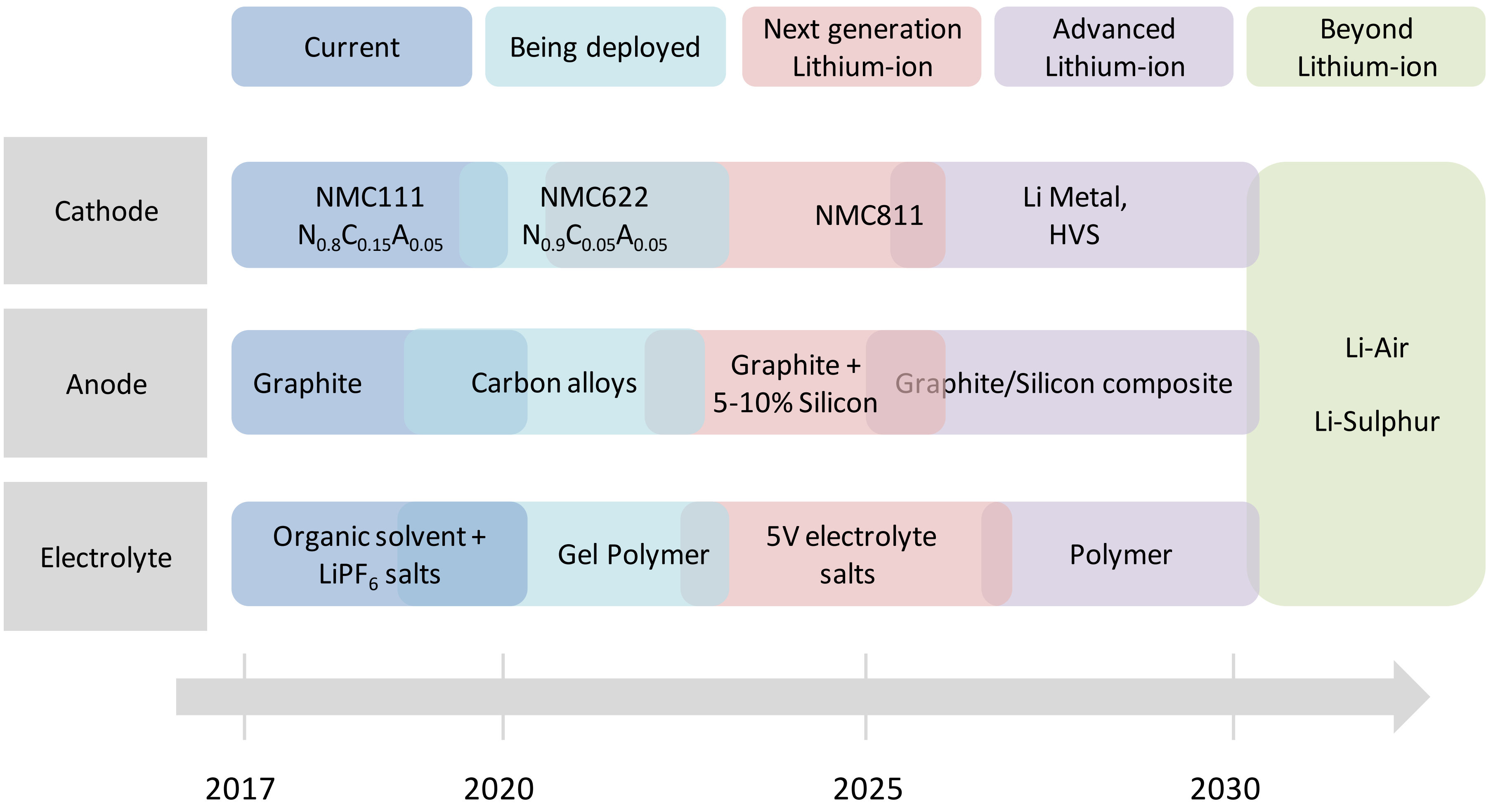




Note: graphics developed for BEV batteries for cars

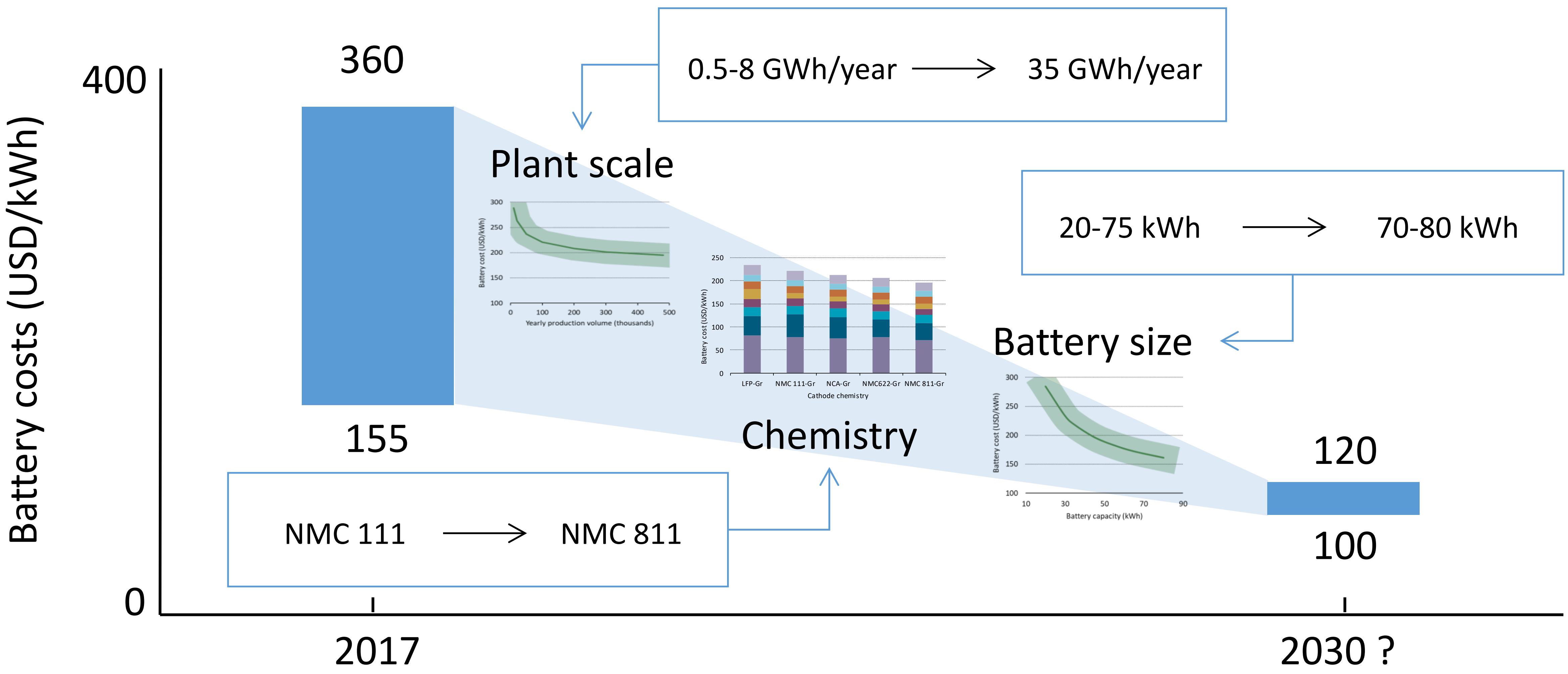
Battery size and manufacturing capacities have sizable impacts on the cost of batteries per kWh
Over time, both these factors will help delivering significant cost reductions

Li-ion expected as the technology of choice for the next decade



Li-ion will continue to improve, thanks to several enhancements possible in battery performance
Other technology options will be ready after 2025, and scaled up in the following years

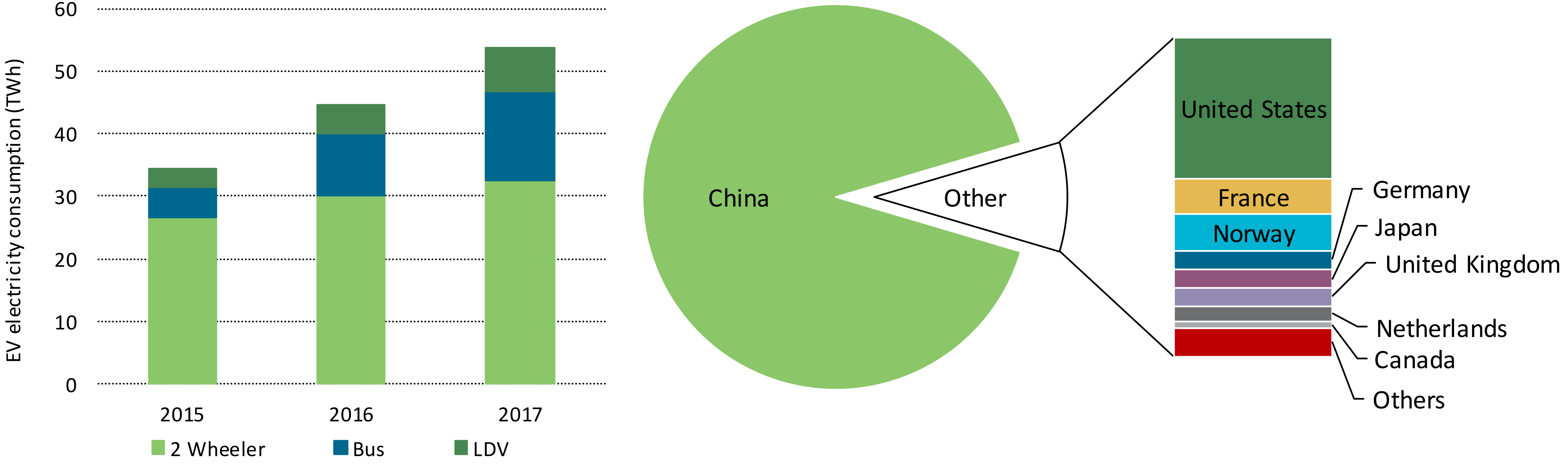
Lithium-ion batteries: further cost reductions at reach…



The combined effect of manufacturing scale up, improved chemistry and increased battery size explain how battery cost can decline significantly in the next 10 to 15 years

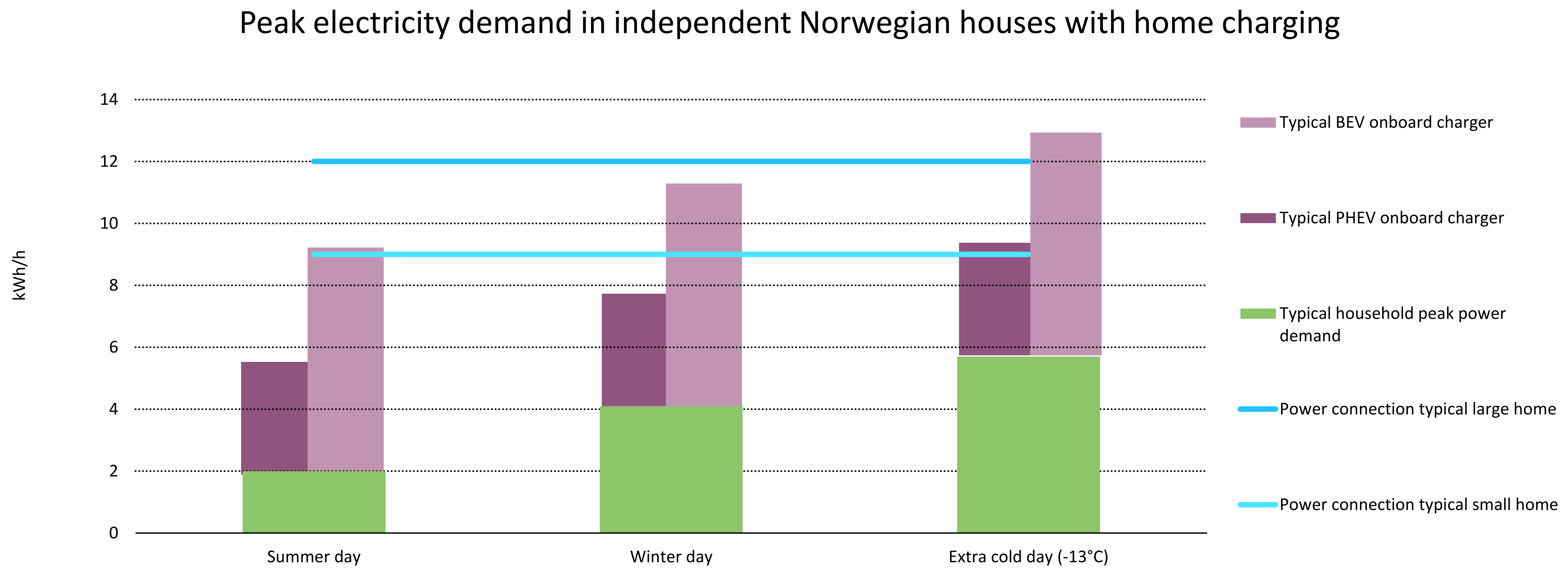
EVs lead to higher electricity demand…

Electricity demand due to EVs: 54 TWh (more than the electricity demand of Greece)



Around 91% of the power for electric vehicles in 2017 was consumed in China
The share of electricity demand from EVs was 0.8% in China and 0.5% in Norway

Are electric cars impacting the power grid?



Home chargers can add significant loads to the household power demand. Unless properly managed (e.g. delayed charging), electricity demand due to electric car charging could exceed the maximum power in the distribution grid.

Ensuring that EVs are effectively integrated in the electricity grid

- Power generation: variable renewable capacity additions are breaking records
- Local power distribution: need to minimize the risk of local grid disruptions and the need for costly grid upgrades

→ Flexible charging is key

- To accommodate efficiently variable renewable generation (e.g. daytime workplace charging when PV generates most)
- To release pressure on the grid at high power demand peak hours
- To avoid grid disruptions locally, provide frequency and load balancing services

→ How?

- Default vehicle software allowing flexibility
- Time-of-use pricing
- Smart-meters
- Regulatory environment favourable to aggregators
- Who pays for local grid upgrades? Utility? EV owner x? All EV owners? Everyone?

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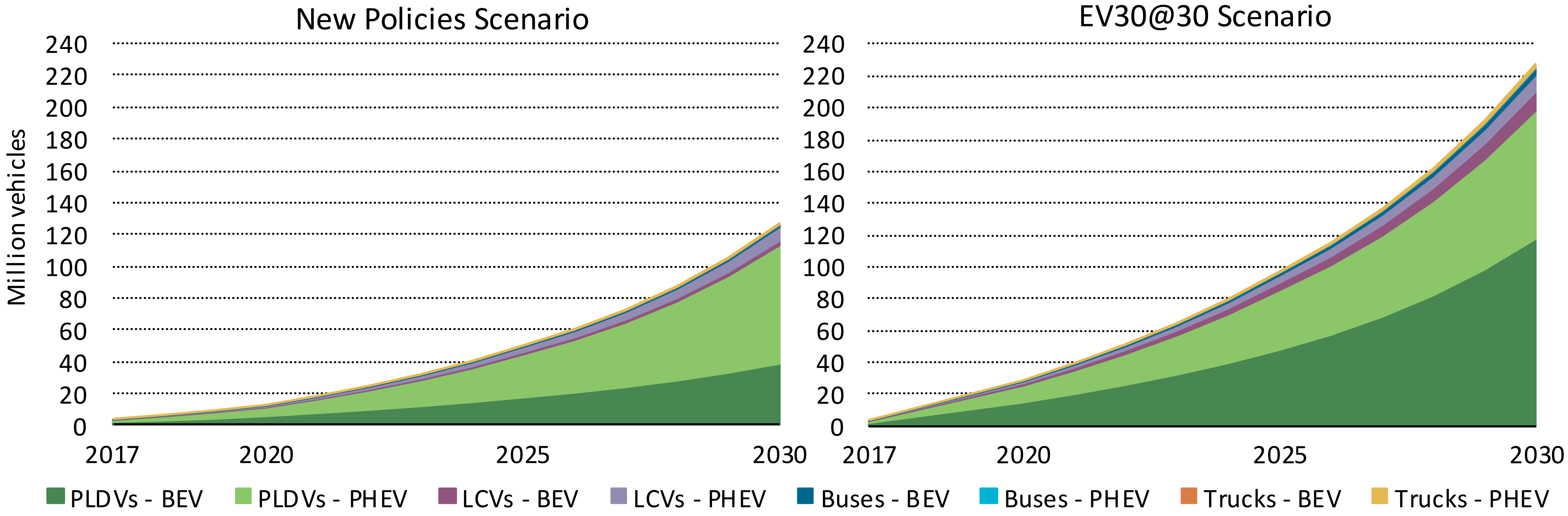
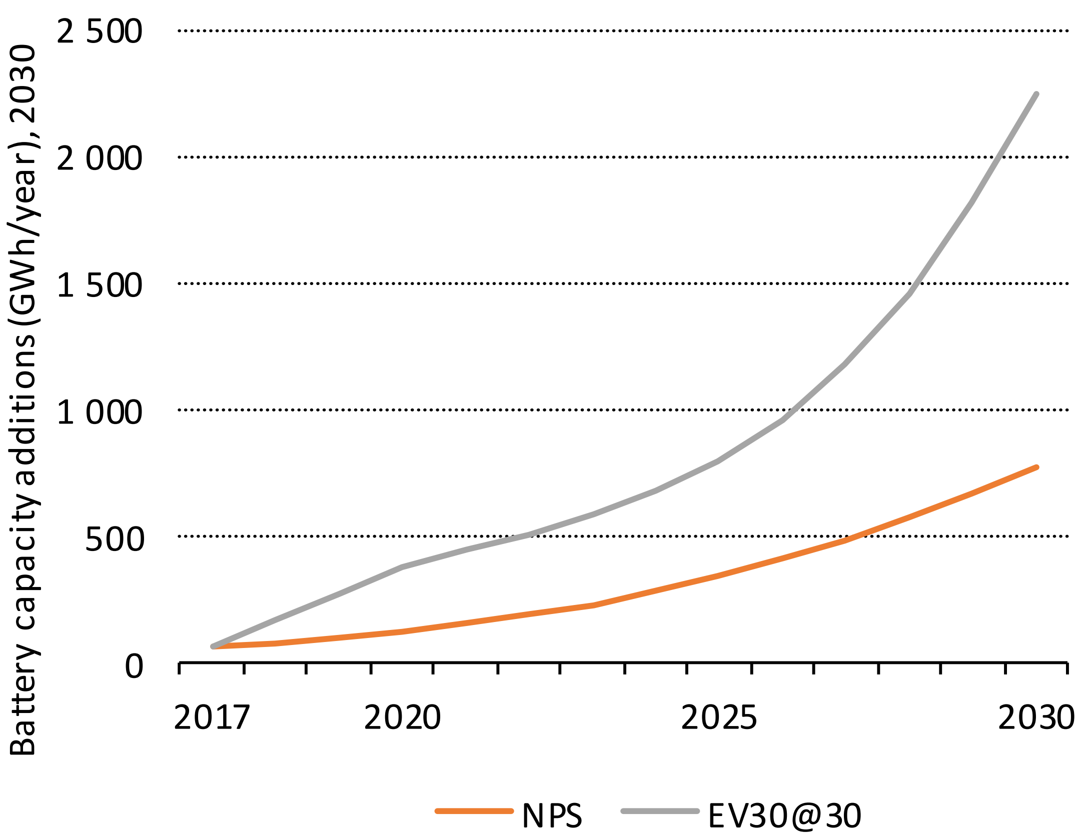
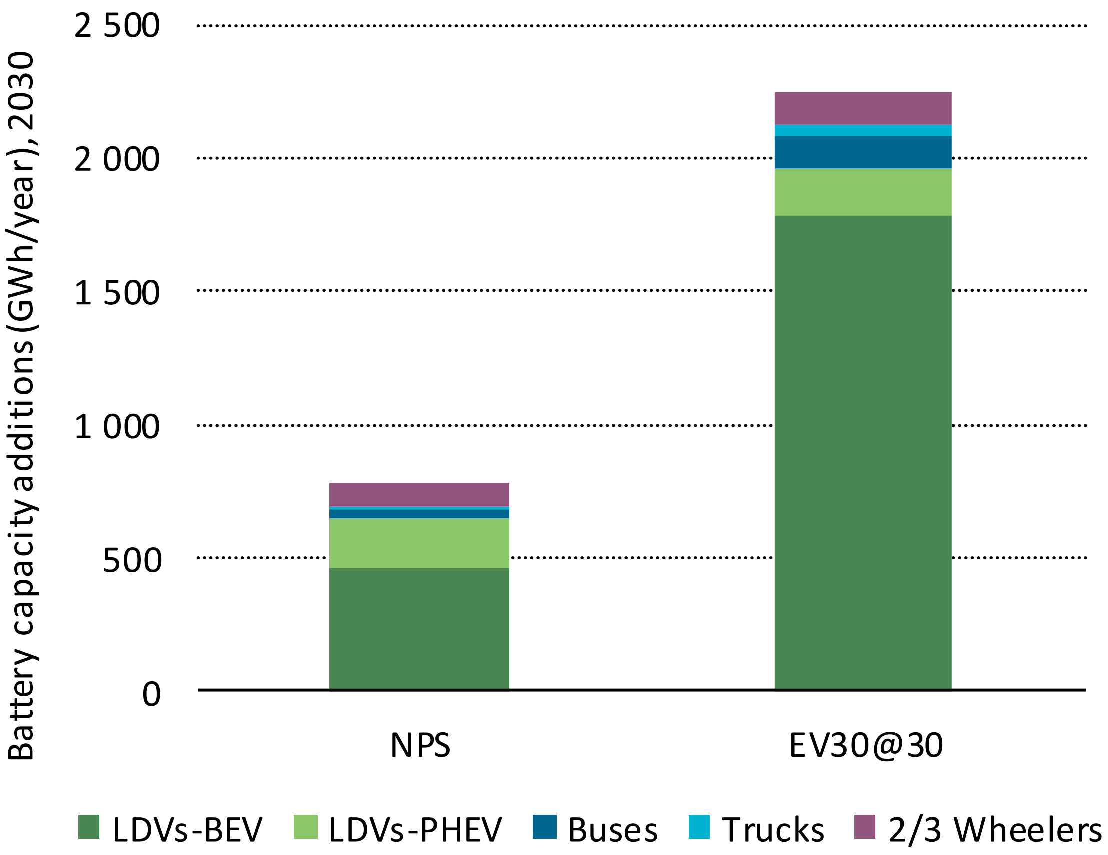
Global EV deployment under the NPS and the EV30@30 scenario



The EV30@30 Scenario sees almost 230 million EVs (excluding two- and three-wheelers), mostly LDVs, on the road by 2030. This is about 100 million more than in the New Policies Scenario

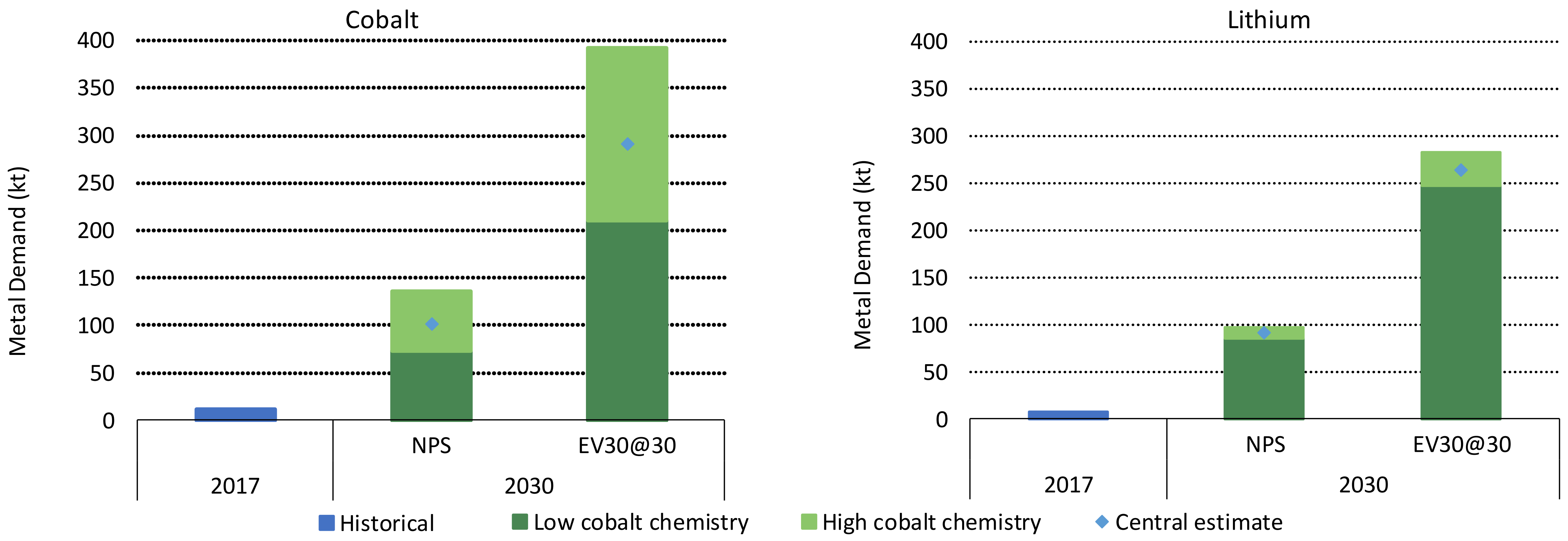
Battery capacity





Demand for battery capacity for electric vehicles, primarily PLDVs, is projected to increase to 0.78 TWh per year in the New Policies Scenario and 2.2 TWh per year in the EV30@30 Scenario and to 2030

Material demand



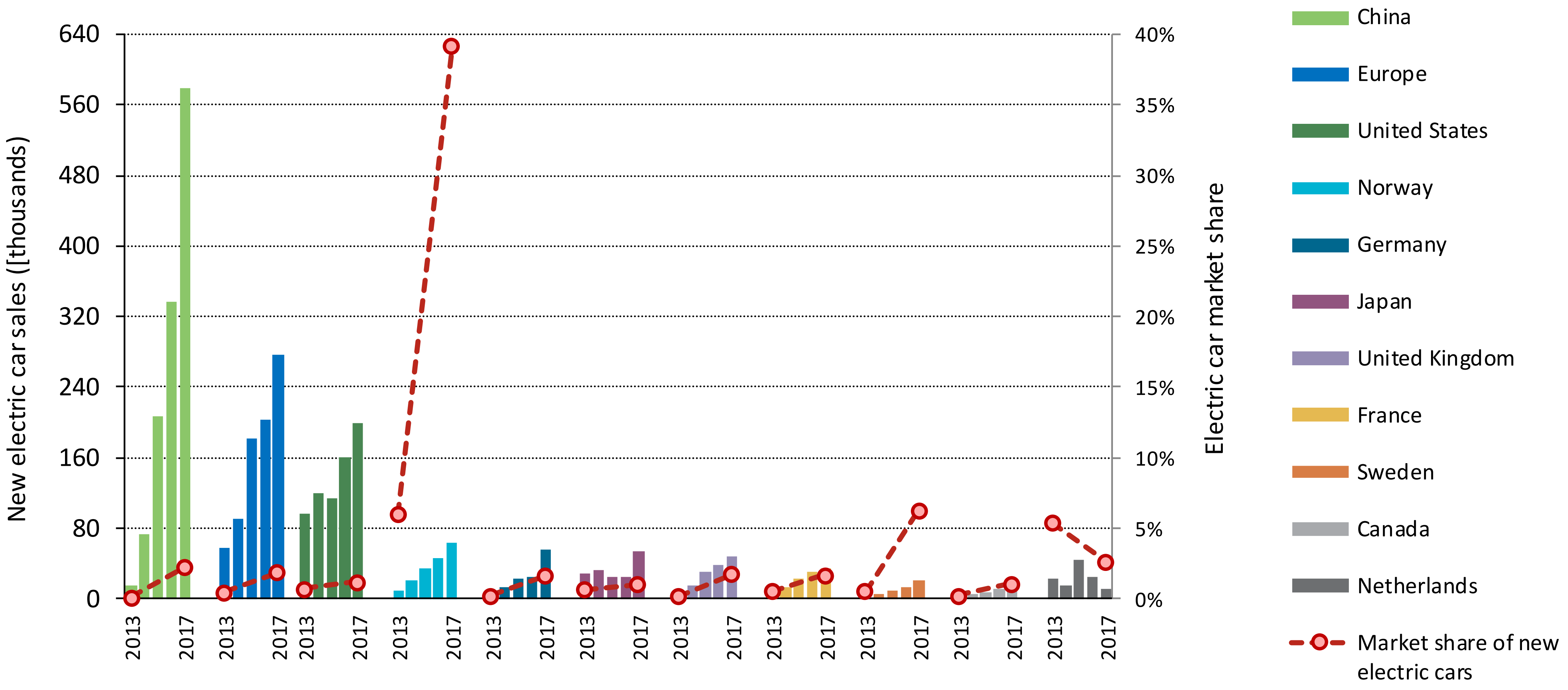
Lithium and cobalt demand from electro mobility in 2030 will be much higher than current demand
Developments in battery chemistry can greatly affect future demand

Managing changes in material demand from EV batteries

- Challenges (material procurement):
  - Fluctuating prices, stockpiling
  - Uncertainty for EV developments and battery technologies
  - Concentrated extraction (DRC for cobalt)
- Solutions:
  - Long-term contracts
  - Need clarity and certainty over future market → key area with national/local governments influence (ZEV mandates, targets, bans)

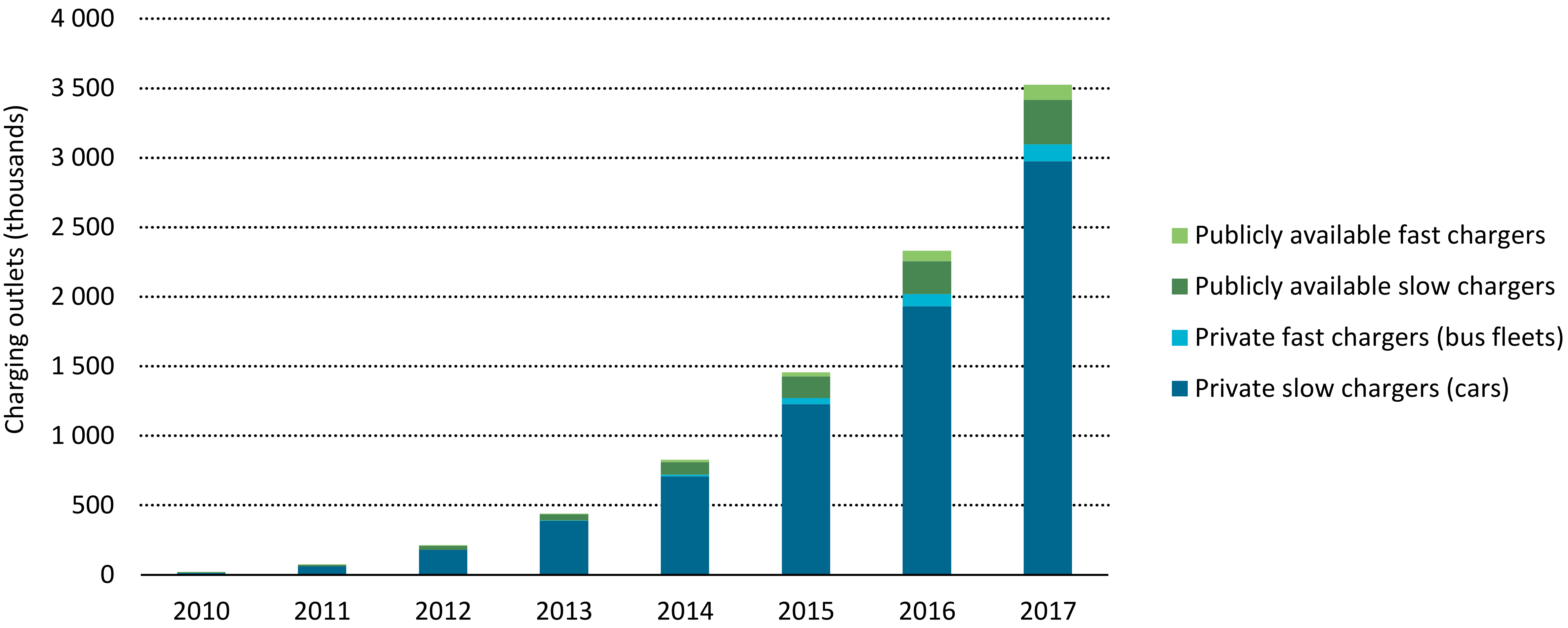
- Challenges (social and environmental sustainability):
  - Environmental impact of mining
  - Black market/child labour
  - Extremely untransparent supply chains
- Solutions:
  - Multi-stakeholder actions and signals (governments, civil society, NGOs, industry)
  - Sustainability standards to be developed, labelling

Electric car sales are on the rise in all major car markets



China is the largest electric car market globally, followed by Europe and the US
Norway is the global leader in terms of market share, with 40% in 2017

Charger deployment accompanies EV uptake



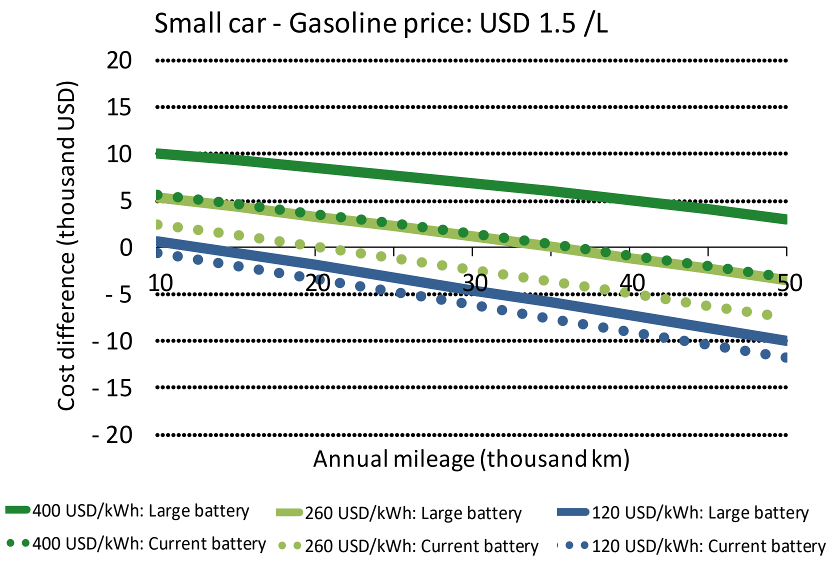
EV owners charge mostly at home or at work: private chargers far exceed publicly accessible ones
Publicly accessible chargers important to ensure EV market expansion, fast chargers essential for buses

…but they enable reductions in oil use, GHG & pollutant emissions

- EVs consume (in final energy terms) half to one third of the energy used by ICE powertrains
  - This is due both to the higher efficiency of the powertrain and the EVs' ability to regenerate kinetic energy when braking
- EVs displaced 0.4 mb/d of diesel and gasoline demand in 2017
  - The majority of the displacement is attributed to two- and three-wheelers (73%), the rest to buses (15%) and LDVs (12%)
- EVs also allowed to reduce global well-to-wheel CO_2 emission savings of 29.4 Mt CO_2 in 2017, and abated pollutant emission savings in high exposure areas (urban environments), thanks to zero tailpipe emissions

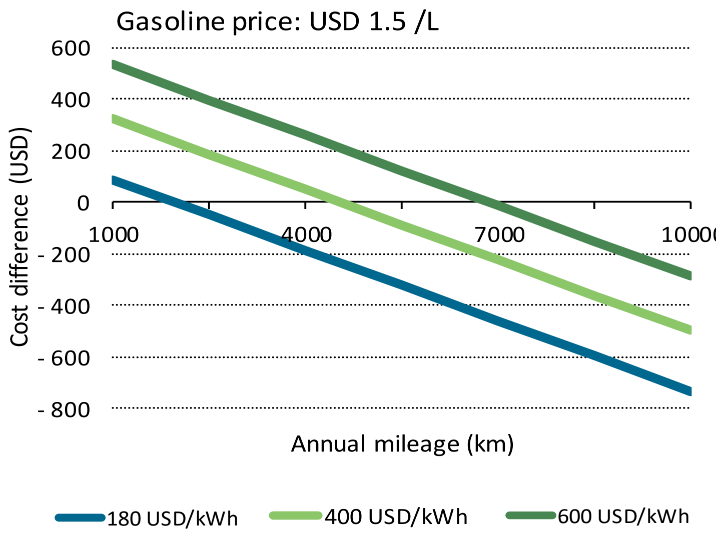
Implications for the cost competitiveness of EVs

LDVs - BEV



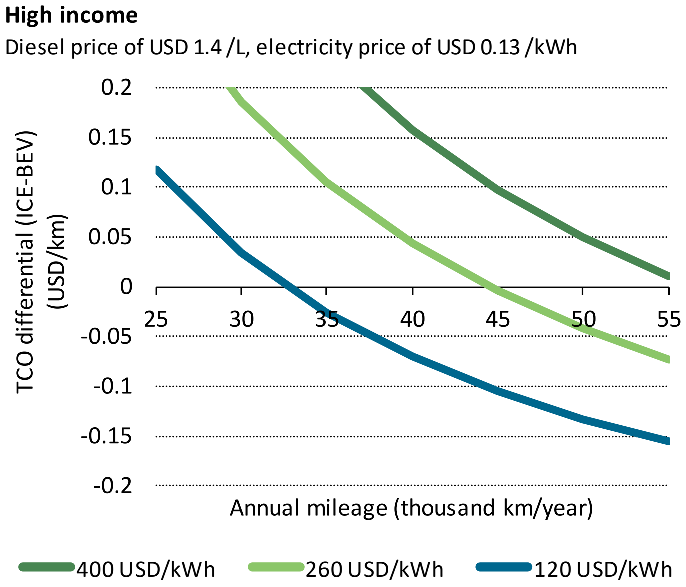
BEVs are most competitive in markets with **high fuel taxes** and at **high mileage** At a USD 120/kWh battery price and with EU gasoline prices, BEV are competitive even at low mileage

2-wheelers



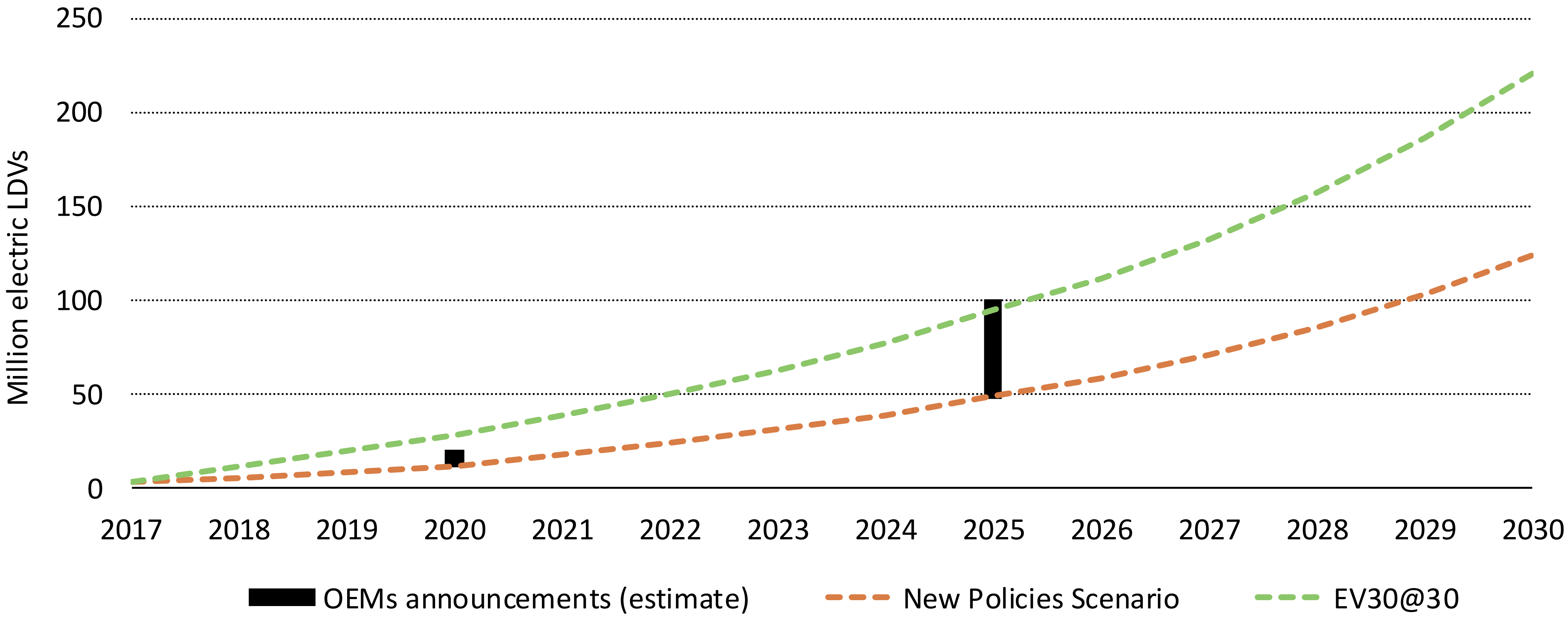
The economic case for electric two-wheelers is strong: in countries with **high fuel taxes** electric two-wheelers **are already cost competitive** with gasoline models

Buses



Electric buses travelling 40 000-50 000 km/year are cost competitive in regions with **high diesel taxation** regimes if battery prices are below USD 260/kWh

Benchmarking scenario results against OEM targets for PLDVs



Estimates based on manufacturers' projections suggest an uptake of electric LDVs ranging in-between the New Policies and the EV30@30 scenarios by 2025

EV uptake is still largely driven by the policy environment

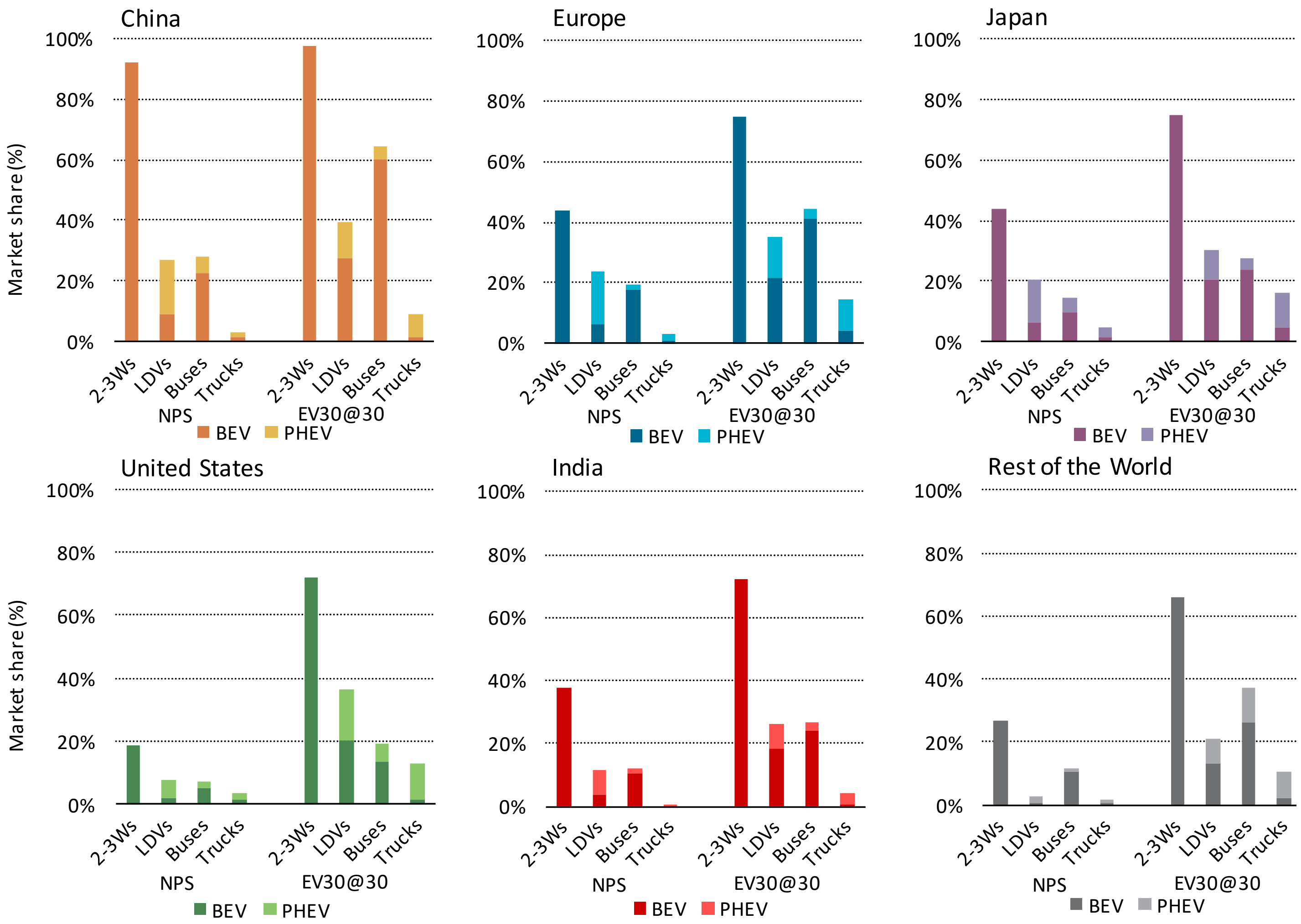
- All 10 leading countries in electric vehicle adoption have a range of policies in place to promote the uptake of electric cars

- Policies have been instrumental to make electric vehicles more appealing to customers, reduce risks for investors and encourage manufacturers to scale up production

- Key instruments deployed by local and national governments for supporting EV deployment:
  - public procurement
  - financial incentives facilitating the acquisition of EVs and reducing their usage cost (e.g. by offering free parking)
  - financial incentives and direct investment for the deployment of chargers
  - regulatory instruments, such as fuel economy standards and restrictions on the circulation of vehicles based on their tailpipe emissions performance

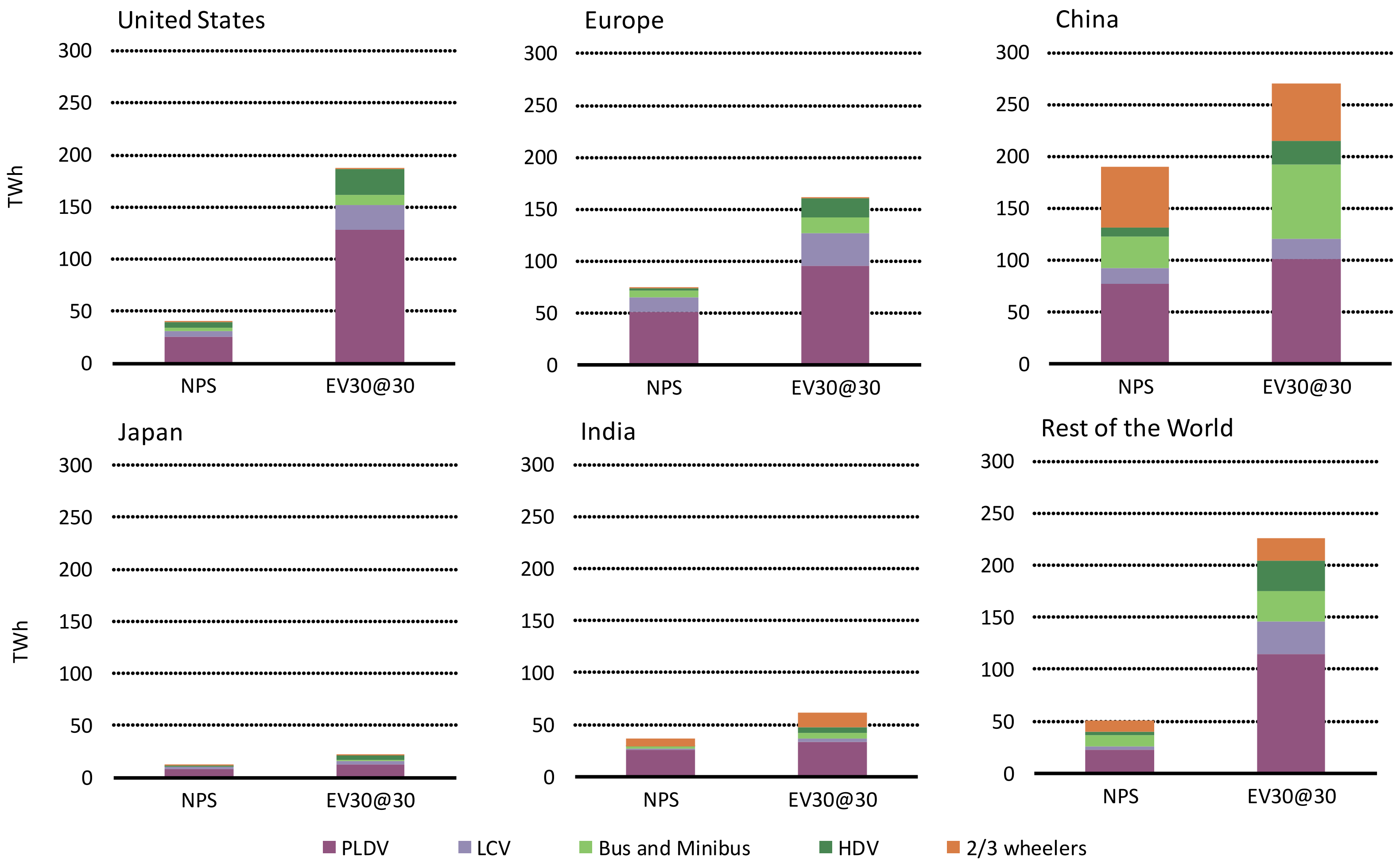
Regional insights on the GEVO 2018 scenarios

EV market share by mode in a selection of regions, NPS and EV30@30 scenario, 2030



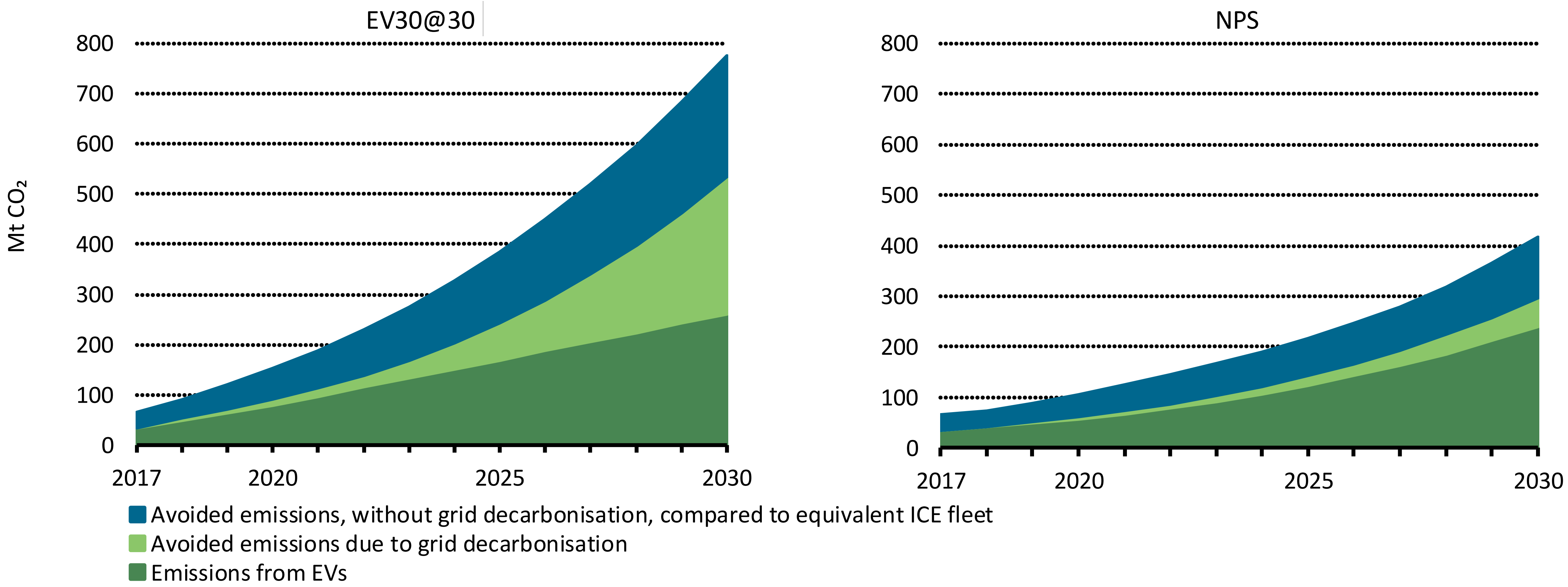
China and Europe are the global regions with the fastest development of EVs in both scenarios and in virtually all modes

Power demand projections



Two-wheeler and bus electricity demand make China the highest consumer of electricity for EVs in both scenarios. In the EV30@30 Scenario, electricity demand for EVs is more geographically widespread

GHG emissions



In 2030, CO_2 emissions associated with the use of EVs are lower than those of equivalent ICE vehicles at a global scale, even if electricity generation does not decarbonise from current levels

Managing the battery end-of-life treatment

- Rules over legal responsibility for battery end-of-life (1st/2nd/3rd life)
  - Risk of disengagement and no battery management chains / recycling
  - Risk of landfilling in-country or abroad (consumer electronics battery problem)
- Certifications and traceability schemes along the lifecycle of batteries (material extraction, assembly, use, 2nd/3rd life, recycling/disposal)
- Encourage manufacturing design enabling recycling processes that allow the recovery of high-value materials minimizing costs and energy use
  - Regulatory framework mandating that batteries are suitable for physical separation?
  - Need for multi-stakeholder coordination to understand scope for feasibility without hindering technological advances in battery chemistries/manufacturing

Policies favouring the transition to electric mobility

Carbon pricing of fuels

Public procurement

Bridging the price gap

Fuel economy standards

Local access regulations

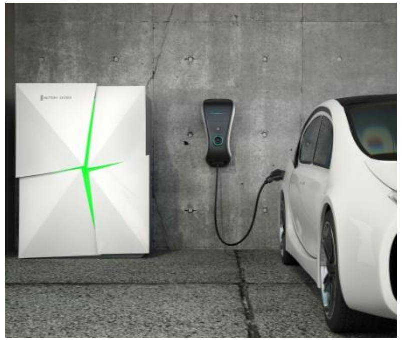
Road pricing

Private & public EVSE rollout

Demand-driven & business-driven EVSE

Successful grid integration

Material demand management



Second life, end-of-life and recycling

Stimulating the adoption of electric vehicles

- **Carbon pricing on transport fuels**
- **Targets to phase in zero emission vehicles**
- **Public procurement** programmes for zero-emission vehicles, providing a pivotal stimulus to market creation and expansion
- **Bridging the price gap** (adjusting to the EV uptake)
  - Differentiated taxes on vehicle purchase, best if based on environmental performances (bonus/malus, feebates)
  - Circulation advantages (free or discounted parking, free charging and access to priority traffic lanes and reduced charges on the use of transport infrastructure)
- **Fuel economy standards**
- **Zero emission incentives** (more flexible to technology development) **or mandates** (higher certitude)
- **Local initiatives to regulate access**

Focus on fuel economy standards and ZEV incentives/mandates

- Fuel-economy and tailpipe CO_2 emissions standards have demonstrated their efficacy to lead to improved ICE vehicle efficiency
- Standards must be sufficiently stringent to secure timely investment and help ramp-up production and supporting infrastructure
- Once legislated standards shall not be compromised by changes
- Standards can be coupled with differentiated purchase taxes
- Standards can also be coupled with ZEV incentives (more room for flexibility to manage technology uncertainties) or mandates (higher certitude on volumes)
- Life cycle approach desirable, but there is a risk of overlaps with other regulatory frameworks (such as those regulating emissions for the fuel supply chain) and implementation challenges
- Need to ensure that power generation and other fuels will also decarbonize (need for complementary measures in the power and fuel production sectors)