

Low carbon transportation

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Transport and decarbonization

- Transport sector accounts for 23% of global energy-related GHG emissions (2017) – dependency on crude oil.

Available improvements:

- Reduction of travel distances (urban planning).
- Increase of share of public transportation.
- Shift of road freight activity to rail and shipping.
- Development of energy efficiency of vehicles.
- Increase the share of zero-emission vehicles.
- Promoting the use of low-carbon fuels.

Biofuels

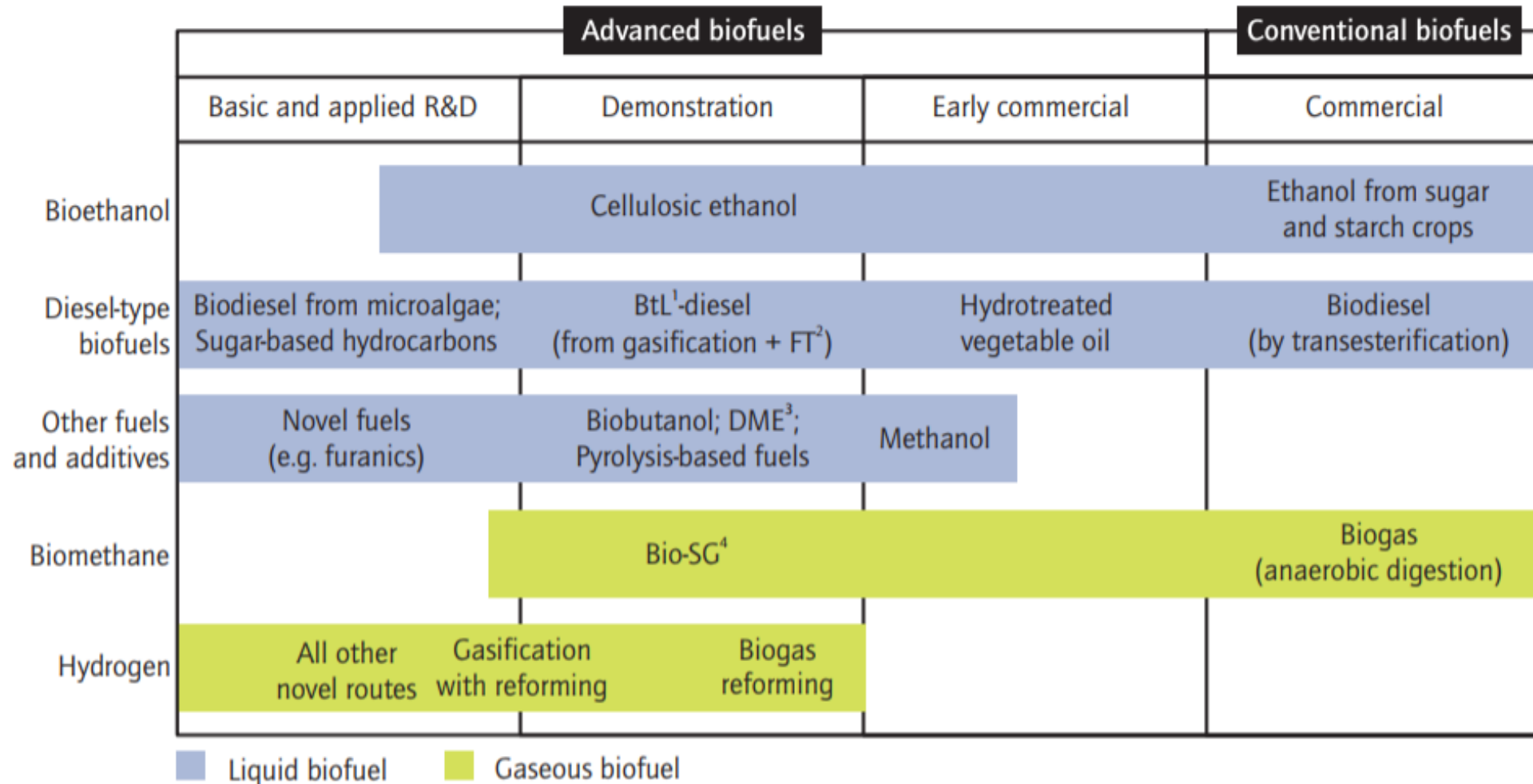
- Replacement of imported oil with domestic biofuels – benefits in energy security and balance of payment.
- Carbon neutral.
- Support of domestic agriculture, revitalization of rural economy.

- Supported in multiple countries (in the EU the aim of 10% of RES in transportation by 2020, preference given to second and third generation).
- Specific aims, since crops, wood and waste is better to be used in electricity or heat production.

Biofuels

- In 2016 accounted for around 4% of world road transport fuel (4,9% in the EU, 81% out of it being biodiesel). Double digit global production growth before 2010 slowed to 2% year-on-year.
- In U.S., ethanol output plateauing due to lower investments in new capacity and reaching the corn ethanol limit of Renewable Fuel Standards.
- Brazil approaching its 2030 18% share of biofuels in its energy mix.
- EU put a cap on food crop-based biofuels of 3.8% by 2030, overall 10% aim cancelled.
- Boosting Asia markets for ethanol (e.g. India, Thailand) and biodiesel (e.g. Indonesia, Malaysia). Projects in China...
- International aviation to achieve 'carbon –neutral growth' by 2020.

Commercialisation status of main biofuel technologies

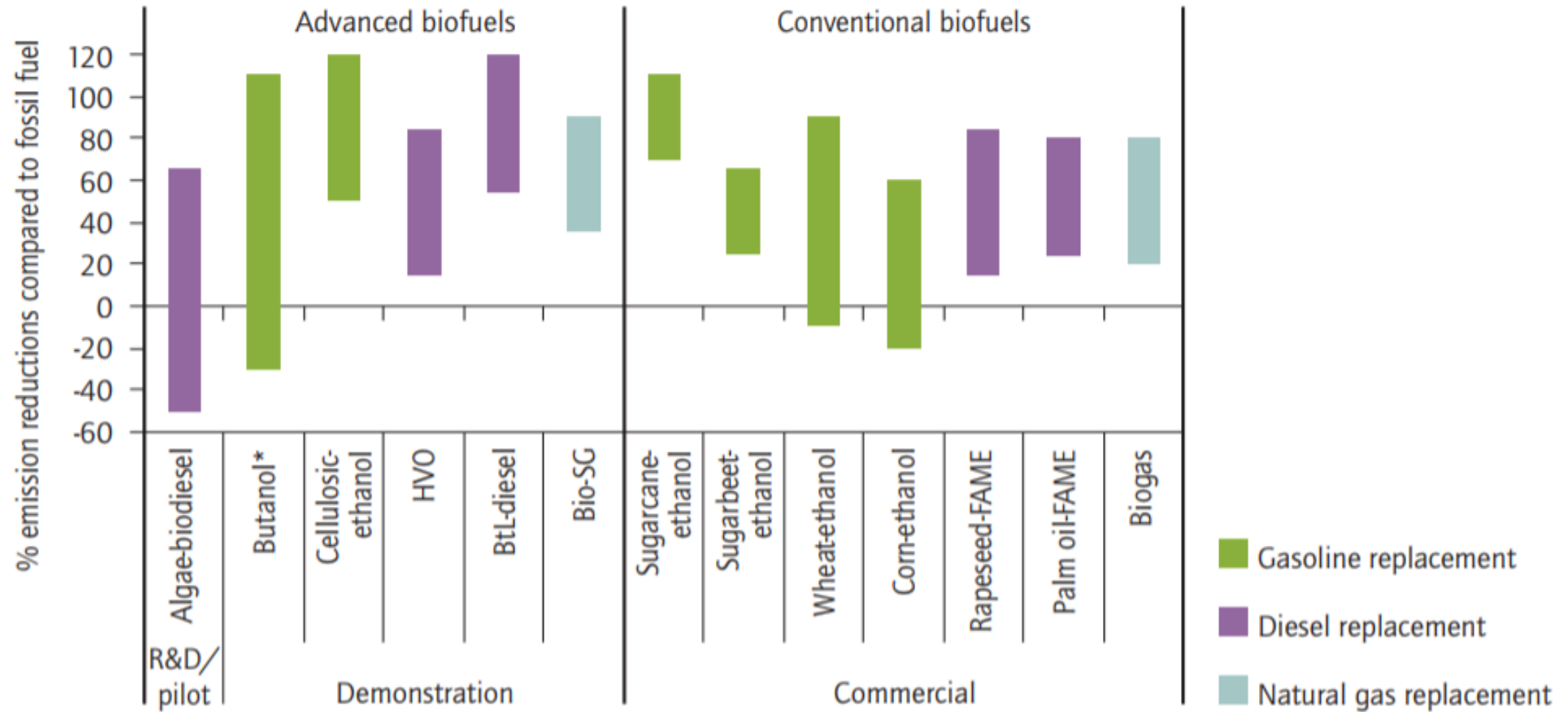


1. Biomass-to-liquids; 2. Fischer-Tropsch; 3. Dimethylether; 4. Bio-synthetic gas.

Impact on environment

- Contribute to global climate mitigation and cleaning up the atmosphere, but encourage monoculture of energy crops and reduction of biodiversity.
- Transport of biofuels from around the world (supported by subsidies).
- So far only Brazil's and Thailand's sugarcane-to-ethanol; ethanol as a by-product of cellulose output in Sweden or Switzerland, and manufacture of biodiesel from animal fats and used cooking oil are delivering significant climate benefits.
- The other conventional biofuels delivers savings unders 40% compared to fossil fuel alternative (plus land use - soil acidification, fertilizer use, biodiversity loss, toxicity of agricultural pesticides).

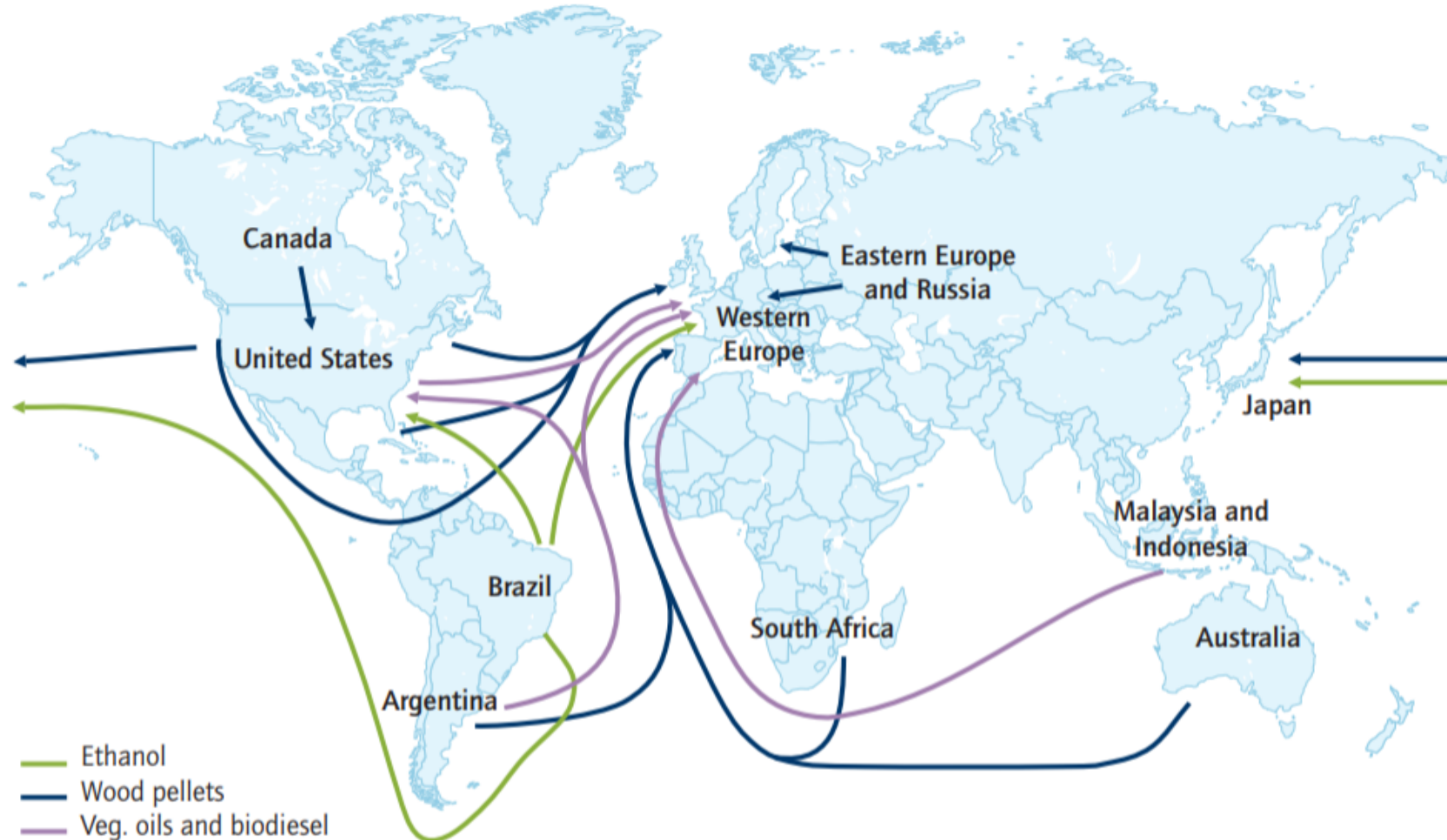
Impact on environment



Impact on food production

- Calculated by the U.S. administration as low as 3% but by World Bank as high as 75-140% rise of a basket of food commodities in the period of 2002-2008.
- Peak in agricultural commodity prices in 2007-2008 – supposedly combination of high prices of oil, poor harvests, speculations and biofuels.

World biomass shipping today



Source: Based on Bradley *et al.*, 2009.

Economics of biofuels

- Exemptions from, or reduced rates of, excise duty on fuel.
- Regulation on blending them to fuels.
- (Some) link to the price of oil.
- Problem with transportation.
- Competition with other industries – woody material (construction, packaging), agriculture products (chemistry).

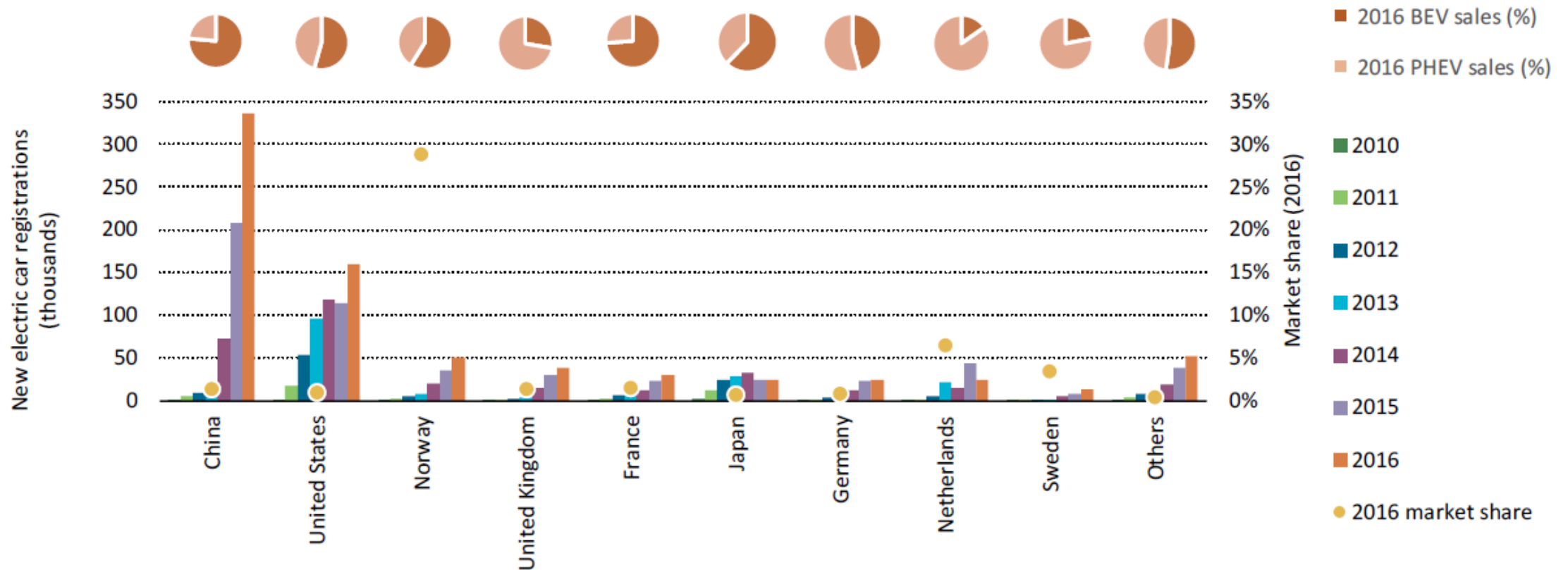
Limited potential

- Brazil's sugarcane (energy density $0,45\text{W}/\text{m}^2$) = 600 million ha to replace existing consumption of oil in transport. Equivalent of 40% of all agricultural land worldwide or of all tropical areas combined.
- In U.S., all corn ($0,35\text{W}/\text{m}^2$) production (280 million tons) processed to ethanol ($0,4\text{l}/\text{kg}$) provides for 13% of fuel consumption in transportation. 120% of all arable land needed to cover the whole transport demand for fuels.

EV deployment

- Reduced fuel combustion, limited noise → in 2015, nearly a 1/3 of EVs sold in 14 cities.
- 95% of the EVs stock in Canada, China, France, Germany, Japan, the Netherlands, Norway, Sweden, UK and U.S.
- In 2016 over 750 000 sales worldwide.
- China the biggest market by far (336 000), followed by U.S. (160 000) and the EU (215 000). Also Norway, UK, France, Germany, the Netherlands, Sweden.
- In Norway, EVs have 29% market share. 6.4% in the Netherlands and 3.4% in Sweden.

EV sales, market share, BEV and PHEV sales shares in selected countries



Battery-electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)

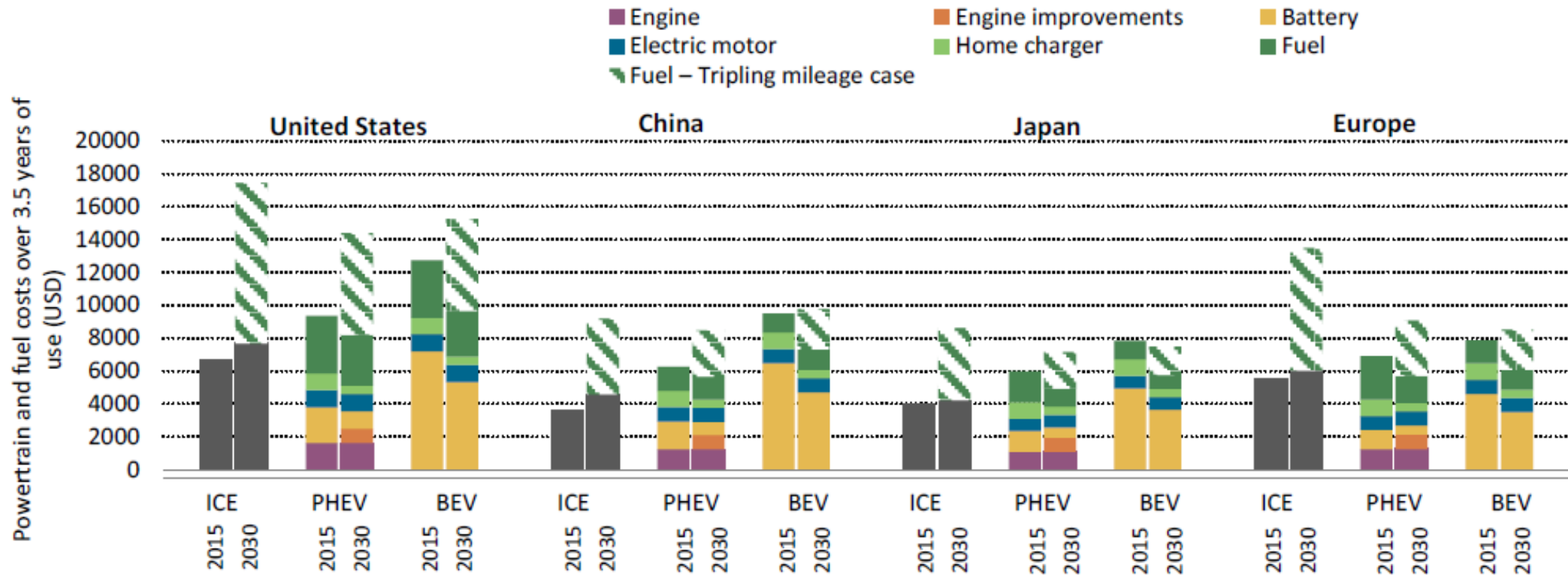
Support mechanisms for EV deployment

- Research support (supports and supported by mass production).
- Targets and regulations.
- Financial incentives (direct rebates, tax breaks and exemptions...).
- Policies for increasing the value of EV (exemption from limits of licence plates for ICE vehicles, exemptions from access restriction to urban areas, exemptions from usage fees for specific parts of the road network – parking, road tolls, dedicated parking, access to public charging infrastructure, access to bus lanes and high-occupancy vehicle lanes).
- Fleet procurement (both private and of public authorities).

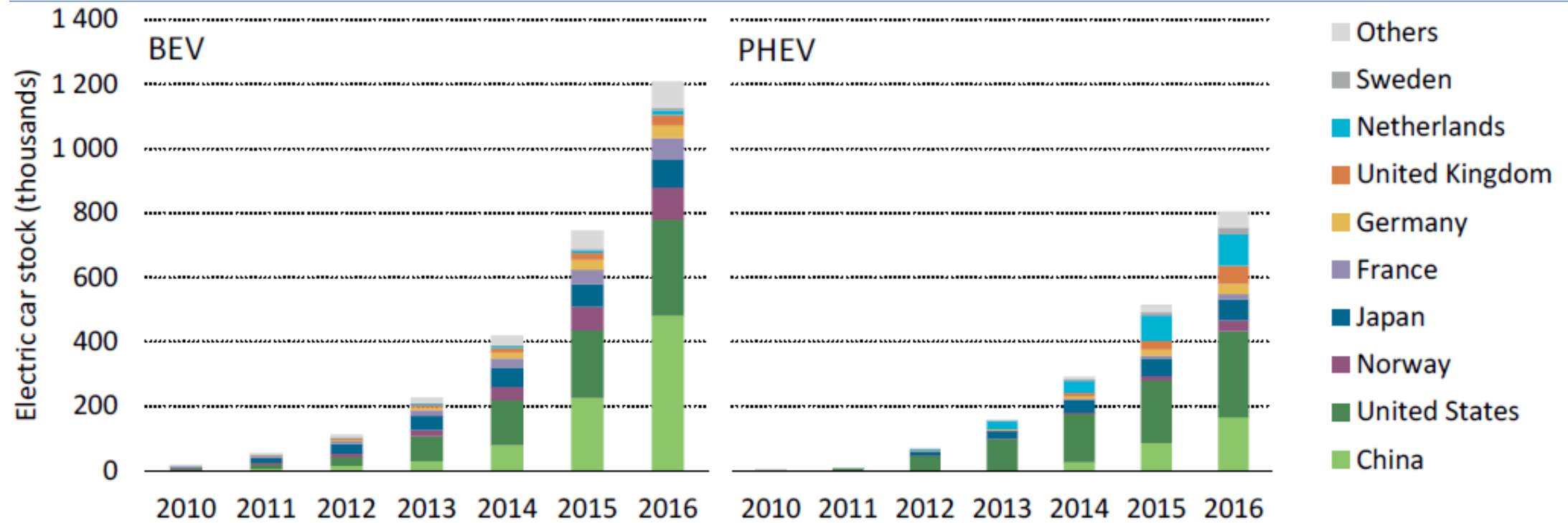
EV incentives development in selected countries, 2016

Country	2015 vs. 2016 policy developments		2015 vs. 2016 sales growth		2016 sales	
	BEV	PHEV	BEV	PHEV	BEV	PHEV
China		~	75%	30%	257 000	79 000
United States		~	22%	70%	86 731	72 885
Norway	~	↗	6%	164%	29 520	20 660
United Kingdom		~	4%	42%	10 509	27 403
France		~	26%	36%	21 758	7 749
Japan		~	48%	-34%	15 461	9 390
Germany		~	-6%	20%	11 322	13 290
Netherlands	~	↘	47%	-50%	3 737	20 740
Sweden	~	↘	0%	86%	2 951	10 464
Canada		~	19%	147%	5 220	6 360
Denmark		↘	-71%	-49%	1 218	182
Korea		~	75%	-40%	5 099	164

Costs of PLDV technologies by country/region in the 2DS



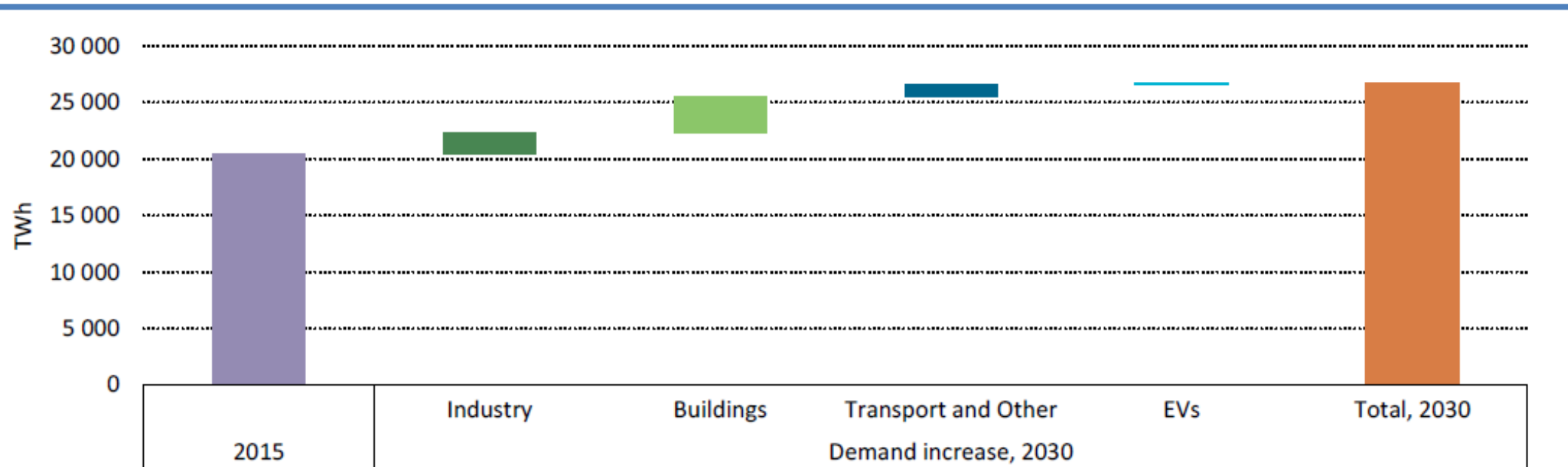
Global electricity car stock



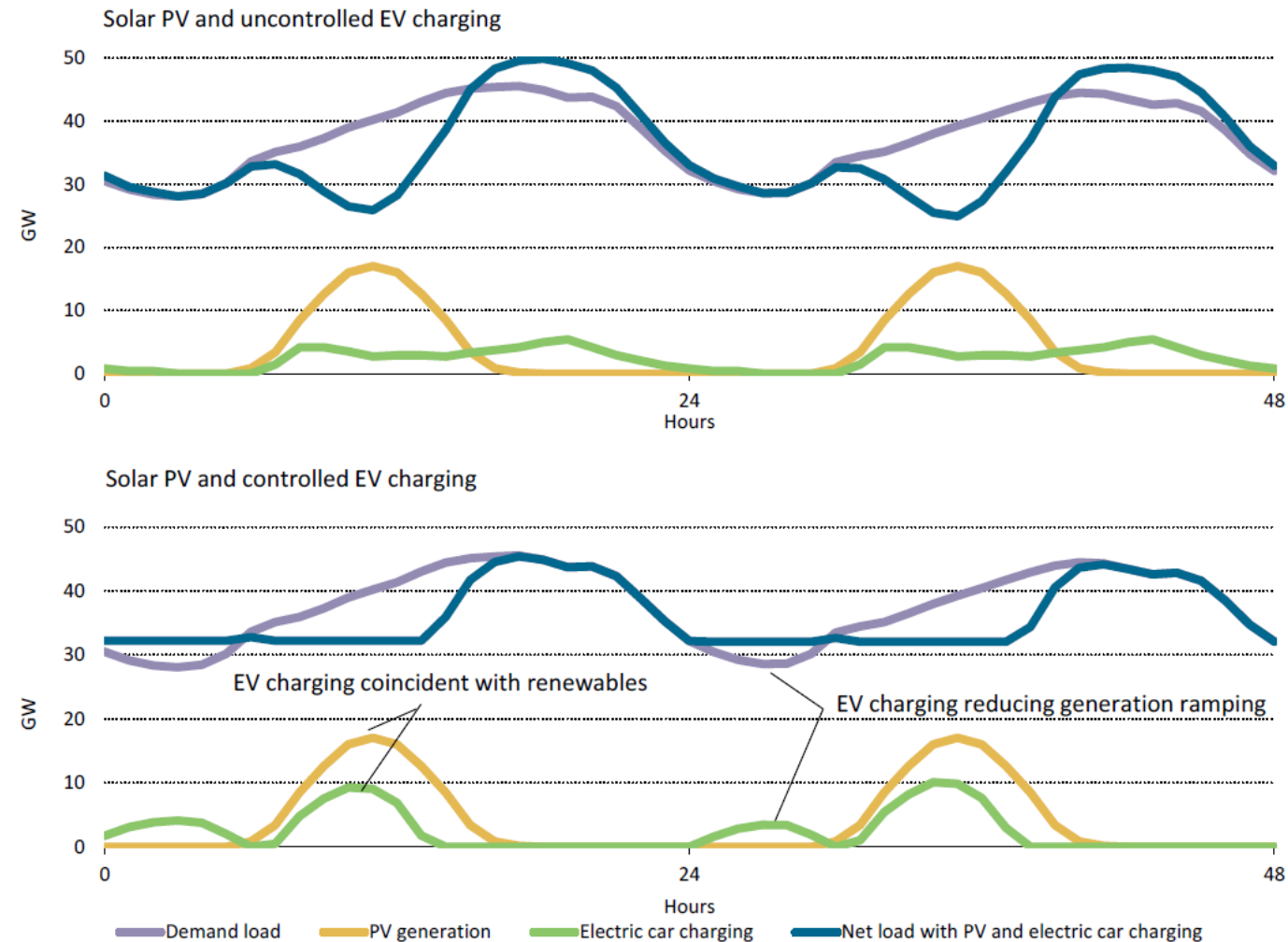
Global electricity car stock

OEM	Announcement	Source
BMW	0.1 million electric car sales in 2017 and 15-25% of the BMW group's sales by 2025	Lambert (2017b)
Chevrolet (GM)	30 thousand annual electric car sales by 2017	Loveday (2016)
Chinese OEMs	4.52 million annual electric car sales by 2020	CNEV(2017)
Daimler	0.1 million annual electric car sales by 2020	Daimler (2016a)
Ford	13 new EV models by 2020	Ford (2017)
Honda	Two-thirds of the 2030 sales to be electrified vehicles (including hybrids, PHEVs, BEVs and FCEVs)	Honda (2016)
Renault-Nissan	1.5 million cumulative sales of electric cars by 2020	Cobb (2015b)
Tesla	0.5 million annual electric car sales by 2018 1 million annual electric car sales by 2020	Goliya and Sage (2016), Tesla (2017a)
Volkswagen	2-3 million annual electric car sales by 2025	Volkswagen (2016)
Volvo	1 million cumulative electric car sales by 2025	Volvo (2016)

Impact of EV deployment on global electricity demand, 2DS



Local demand profile and electric car charging in the EU on a typical day, B3DS, 2030.



Sources

- IEA (2017): Global EV Outlook 2017
- OECD/IEA (2017): Technology Roadmap: Biofuels for Transport