Low carbon transportation

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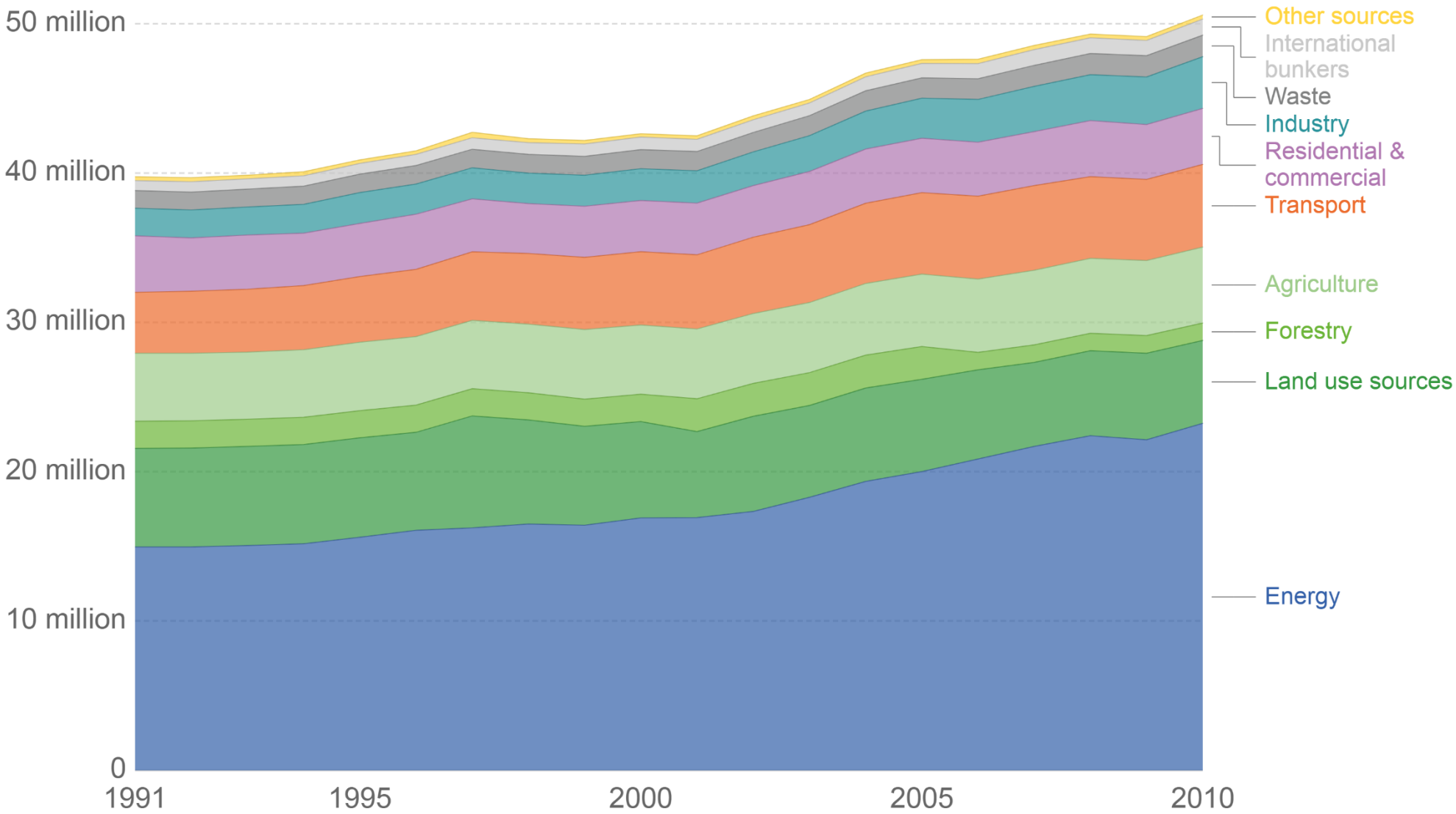
Transport and decarbonization

- Transport sector significant source of GHG emissions.
- Almost full dependency on oil products (but trains in Europe).
- Decarbonization difficult due to the technical barriers and cheap and supported supplies of oil.

Global greenhouse gas emissions (CO_2e) by sector

Breakdown of total global greenhouse gas emissions by sector, measured in gigagrams of carbon-dioxide equivalents (CO_2e). Carbon dioxide equivalents measures the total greenhouse gas potential of the full combination of gases, weighted by their relative warming impacts.

Our World in Data

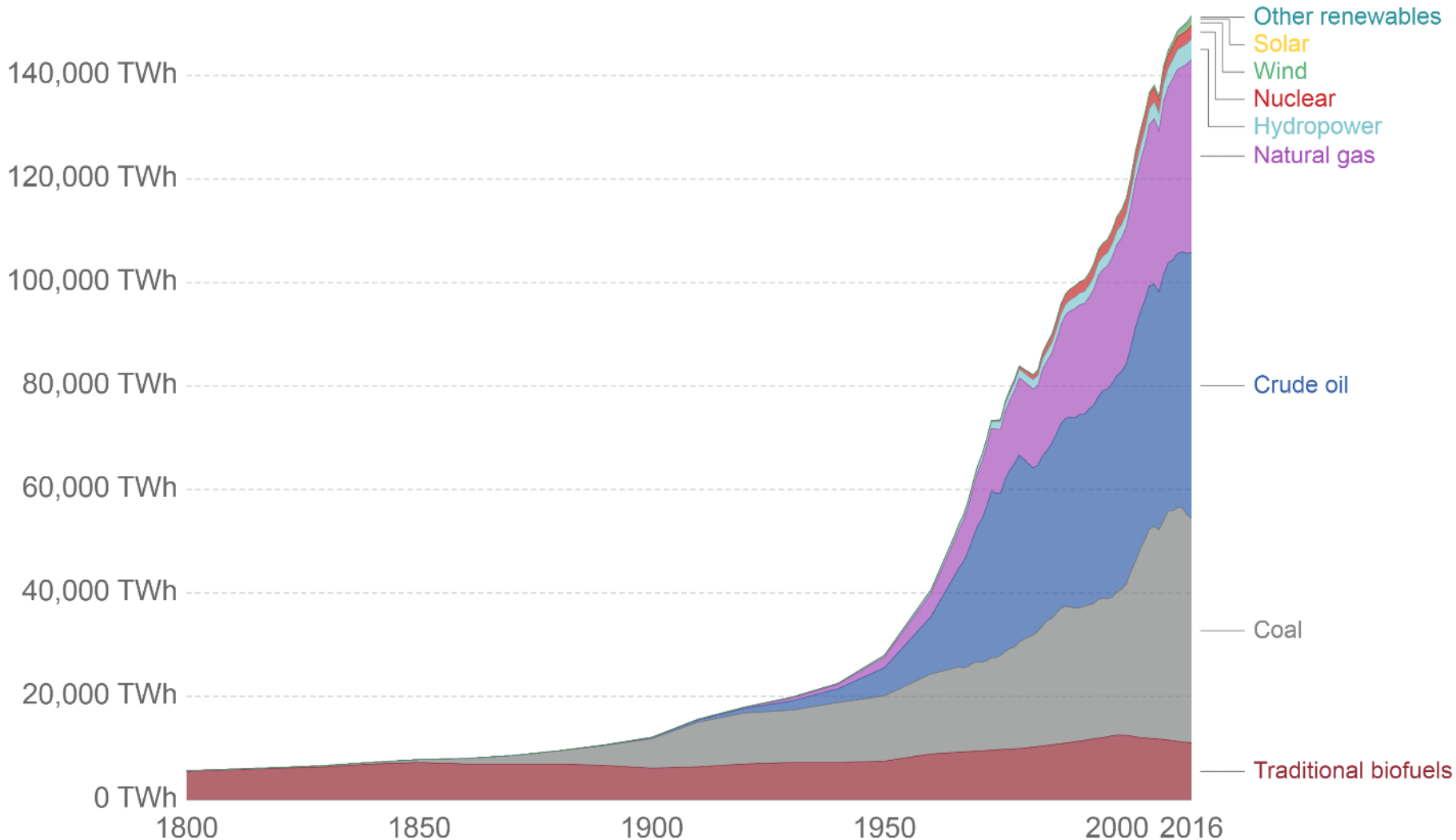


Source: UN Food and Agricultural Organization (FAO)

Global Primary Energy Consumption, World

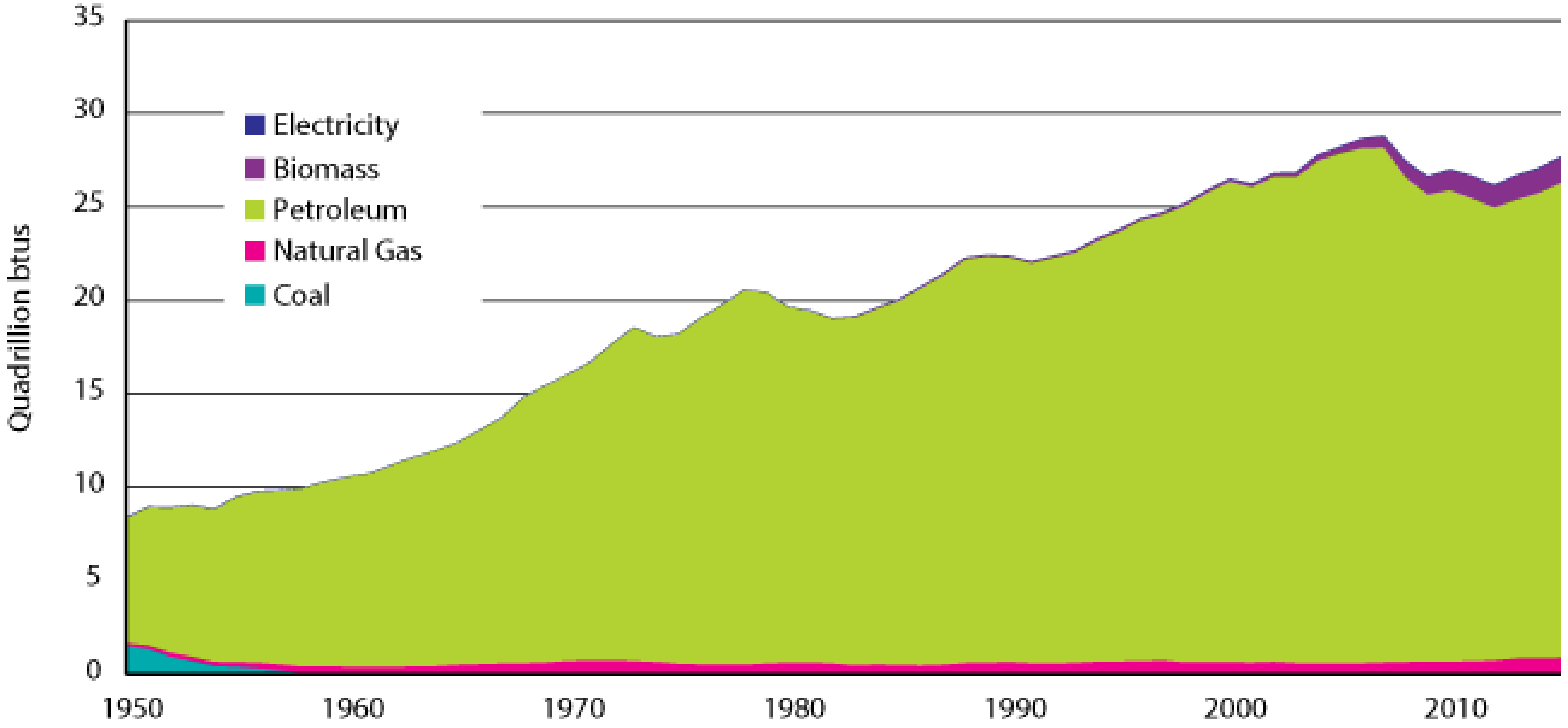
Global primary energy consumption, measured in terawatt-hours (TWh) per year. Here 'other renewables' are renewable technologies not including solar, wind, hydropower and traditional biofuels.

Our World in Data



Source: Vaclav Smil (2017) and BP Statistical Review of World Energy

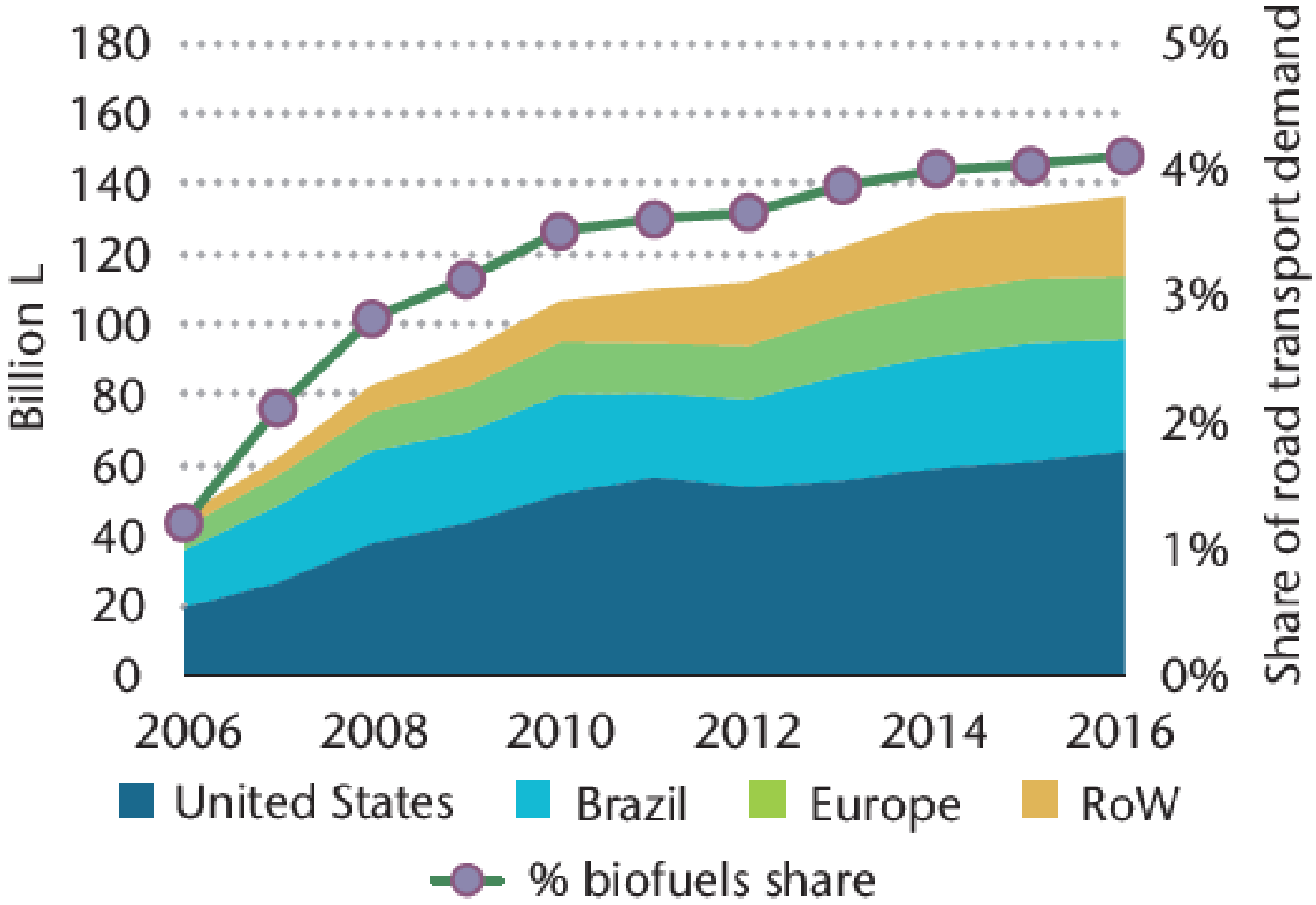
US transportation energy use by source



Available (climate related) 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.
- **Promoting the use of low-carbon fuels.**

Global biofuels production and share of world road transport fuel demand



Biofuels in transportation

Biodiesel

- Vegetable or animal fat-based oil, produced by transesterification. Used in diesel engines (also for heating).
- Rapeseeds, soybeam, palm oil, sunflower, peanut, hemp; waste vegetable oil; animal fats;

Bioethanol

- Ethanol produced by fermentation.
- Sugar and starch based feedstock (corn-maize, sugarcane).

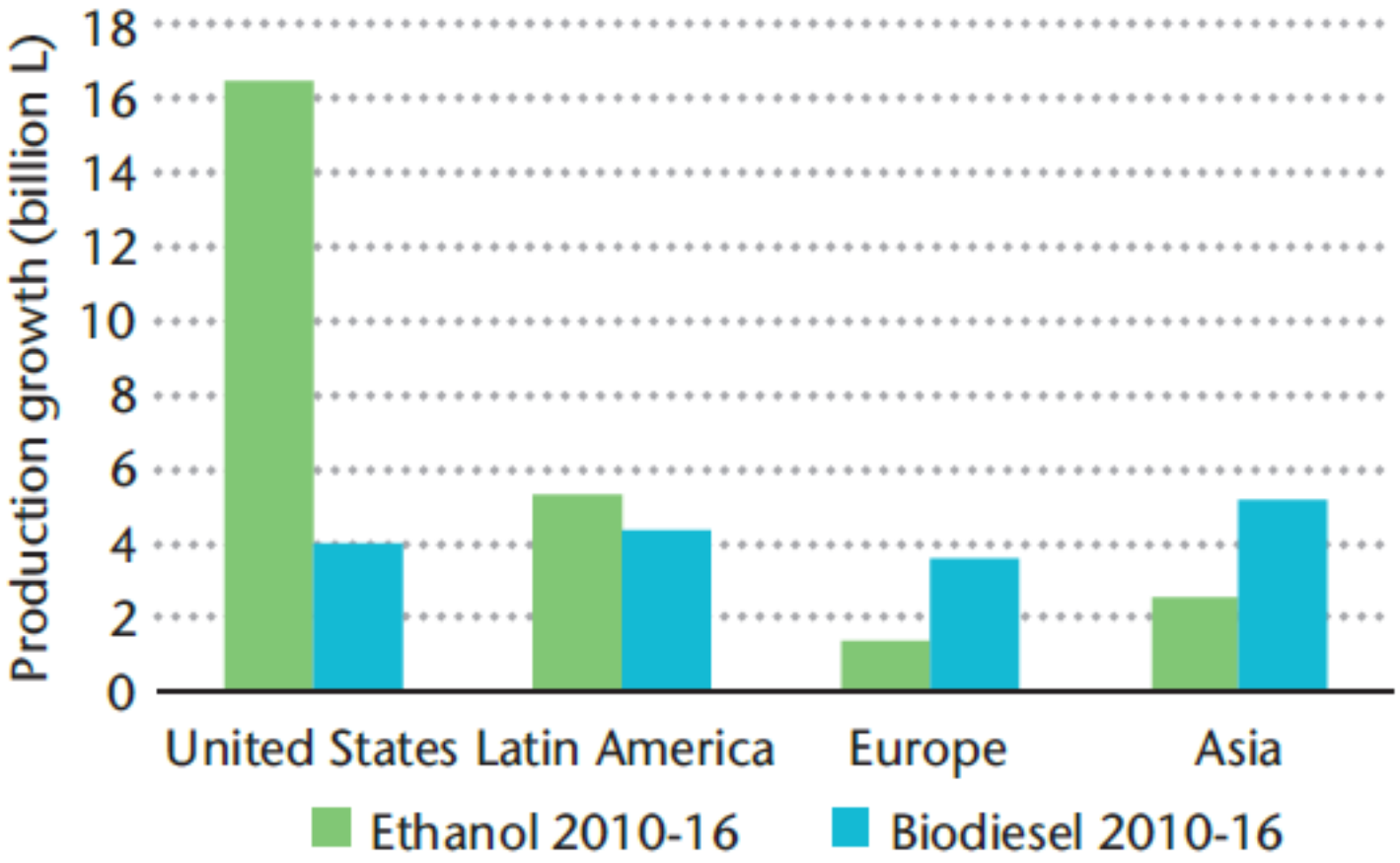
Biofuels in transportation

- 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.

Biofuels in transportation

- Global production of conventional biofuels at 136,5 bn. litres – around 4% of energy used in transportation.
- Double digit global output prior to 2010 slowed to about 4% y-o-y over 2010-2016 (economic and structural challenges, policy uncertainty in key markets). Growth of around 3% a year anticipated over the next five years.
- Ethanol production concentrated in a handful of countries (USA, Brazil, EU, China, Canada, Thailand, Argentina, India), biodiesel production more evenly distributed (US, Brazil, Germany, Argentina, Indonesia, France, Thailand, China, Canada…).
- Growth expected in China (10% blend goal), Latin America, Asia.

Ethanol and biodiesel production growth for key regions



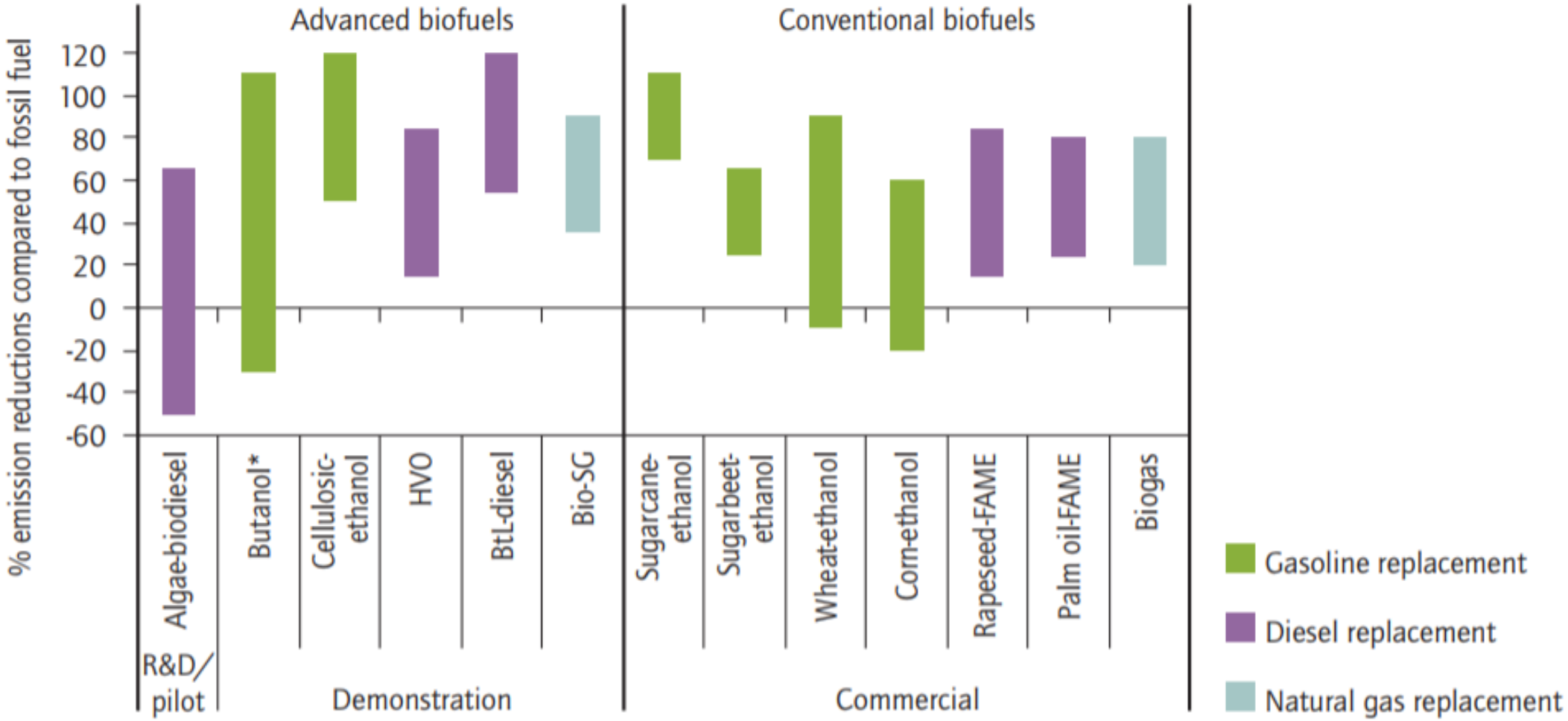
Biofuels in transportation - demand

- Demand driven primarily by mandates stipulating blending at low levels (Renewable Fuel Stadard in U.S., EU´s requirement for 10% of biofuels in transportation by 2020)
- Exemptions from, or reduced rates of, excise duty on fuel.
- Agricultural support.

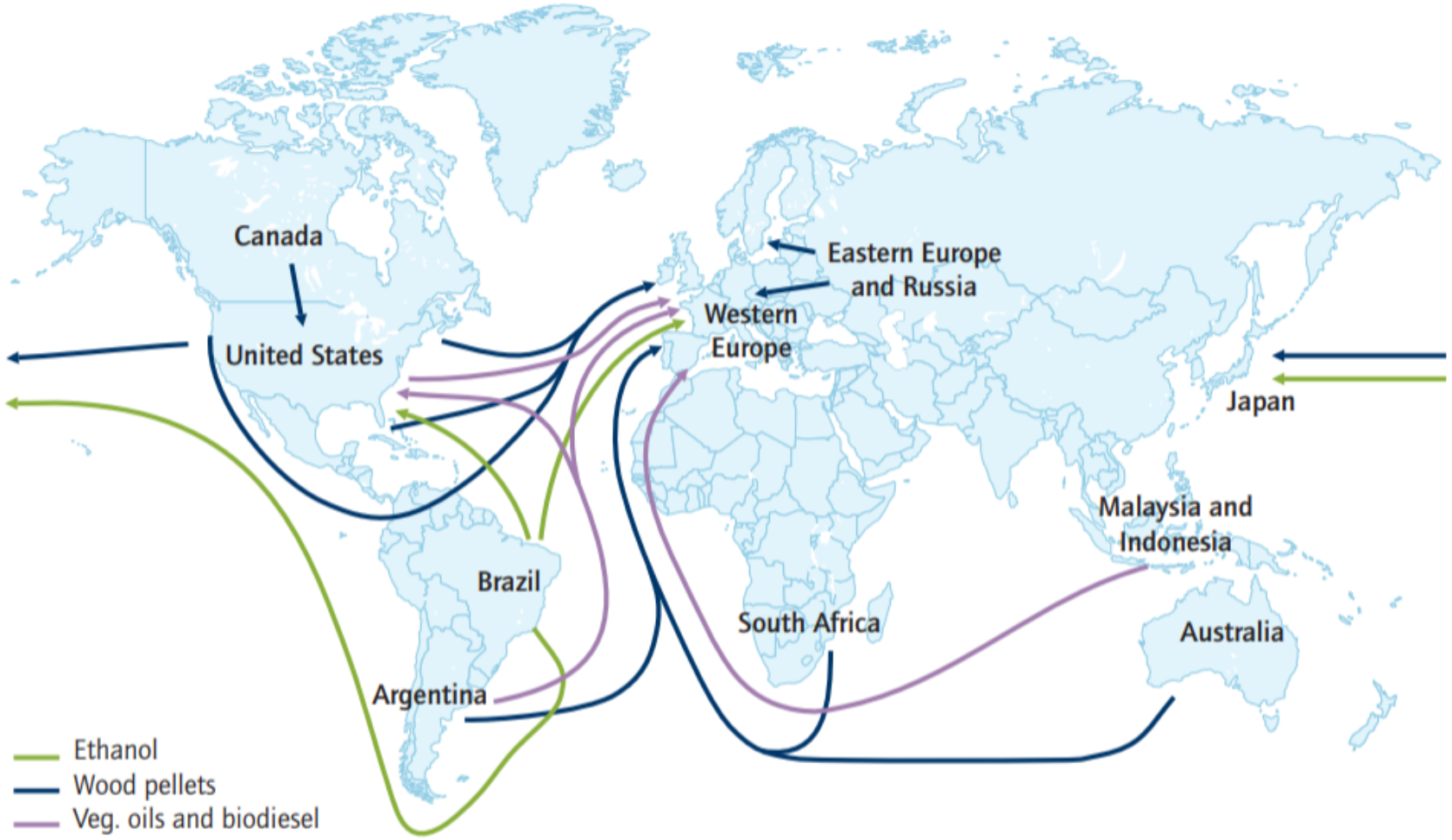
Controversy No. 1 – impact on the environment

- Contribute to global climate mitigation and cleaning up the atmosphere, but encourage monoculture of energy crops and reduction of biodiversity.
- Transport of biofuels 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 deliver savings under 40% compared to fossil fuel alternative (plus land use - soil acidification, fertilizer use, biodiversity loss, toxicity of agricultural pesticides).

Impact on environment



World biomass shipping today



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

Controversy No. 2 - Impact on food production

- Food price crisis in 2005-2008. Corn prices almost tripled, wheat increased by 130%, rice 170%. Traditional biofuels compete with food for the same arable land.
- Price impact 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 (later corrected for significantly smaller figures).
- Peak probably combination of high prices of oil, poor harvests, speculations and biofuels.

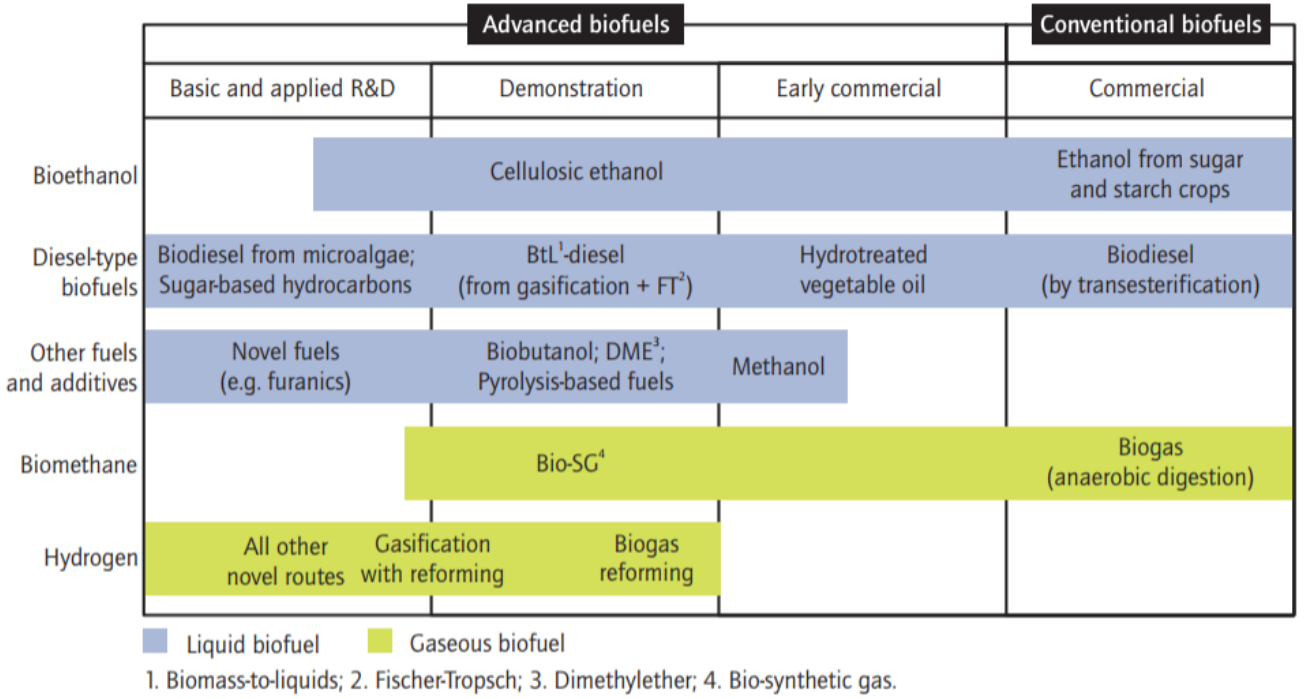
- (EU put a cap on food crop-based biofuels of 3.8% by 2030, overal 10% aim cancelled, overall support for the 1st generation decreasing).

Energy density of biofuels

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

Future of biofuels

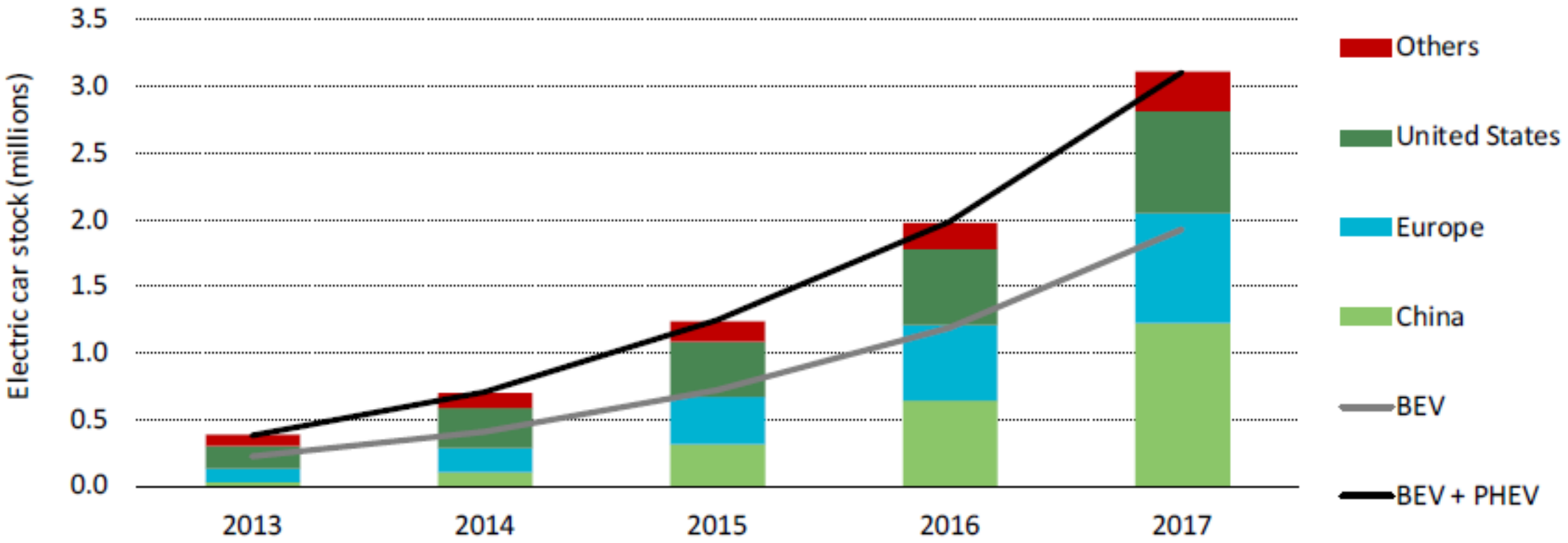
- Dependent of successful development of advanced biofuels - fuels produced from non-food crop feedstocks, with significant life-cycle GHG emissions savings compared with fossil fuel alternatives, and which do not directly compete with food and feed crops for agricultural land or cause adverse sustainability impacts.



EV deployment in 2017

- More than 1 million EV cars sold – growth of 54% compared with 2016.
- More than half of the sales in China (market share of 2.2% in 2017) – twice as much as in the United States. In Iceland and Sweden, 11.7% and 6.3% of electric car sales share, respectively.
- 100 000 electric buses and about 30 million of two-wheelers, most in China.

Evolution of the global electric car stock



Notes: The electric car stock shown is primarily estimated on the basis of cumulative sales since 2005. Where available, stock numbers from official national statistics have been used (provided that the data can be shown to be consistent with sales evolutions).

EV deployment

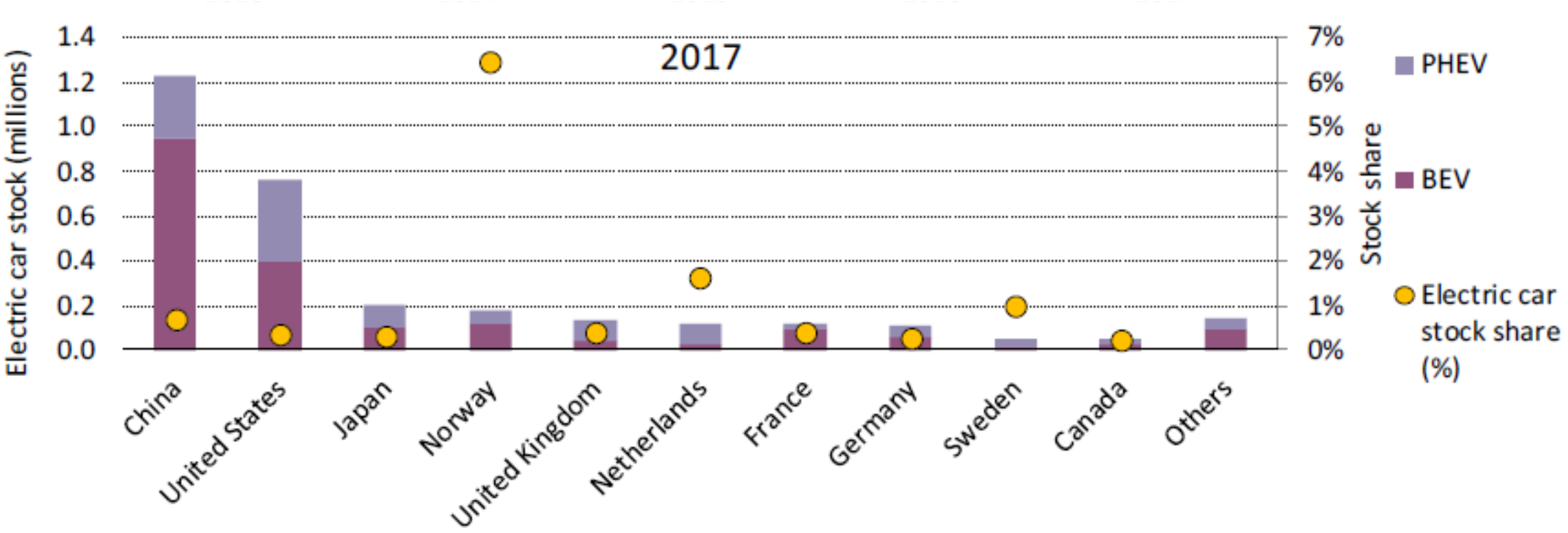
Vehicle stock

- 3 million in 2017 (40% in China).
- 370 000 of electric buses and 250 million of two-wheelers (99% in China, increase in India and Europe-buses).
- Highest market share in Norway (6.4%), considerable share also in Netherlands (1.6%) and Sweden (1.0%).

Chargers

- About 3 million worldwide, mostly owned by households and fleets.
- About 320 000 slow charging publicly available outlets, 110 000 fast charging ones.

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



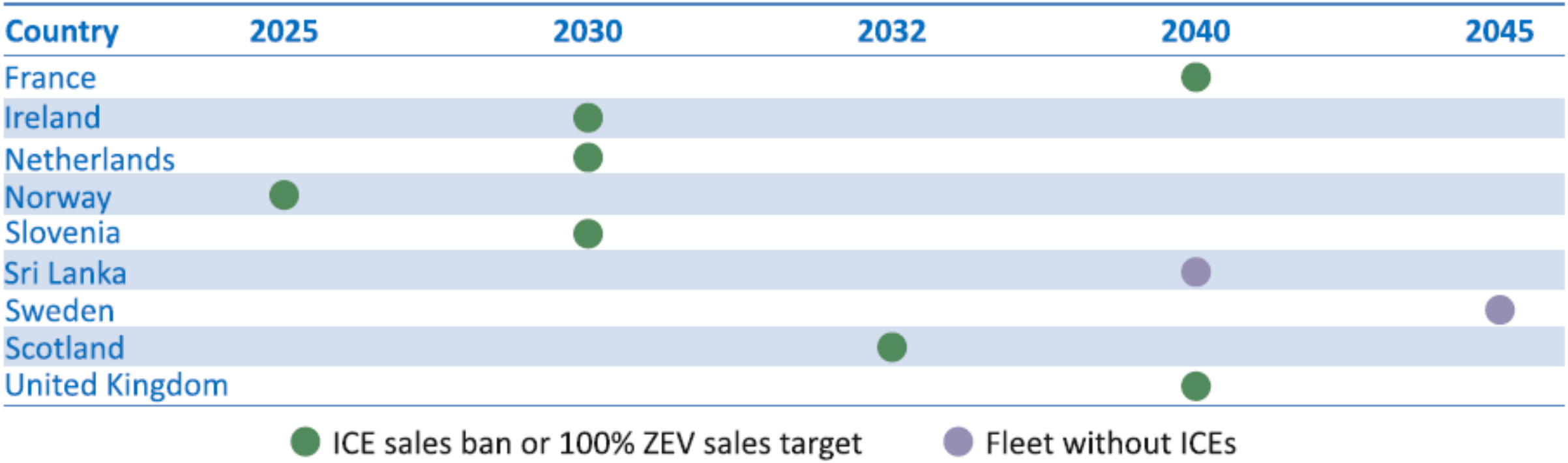
Battery-electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)

Support mechanisms for EV deployment

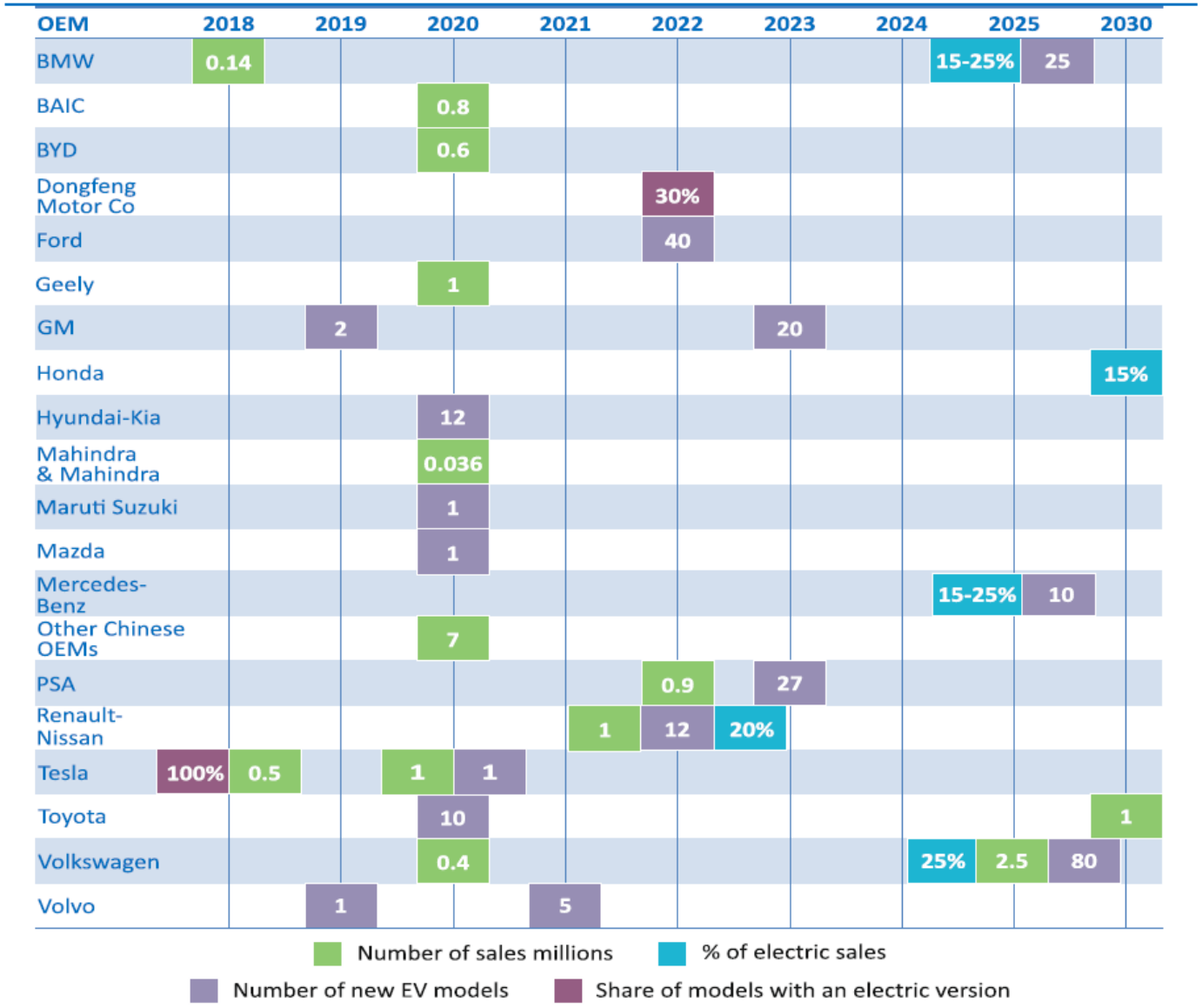
- The uptake of EV driven primarily by the policy environment. Policy measures makes EV more appealing for customers, while reducing the risk for investors and manufacturers.

- Public procurement programmes.
- Financial incentives (esp. upfront costs deliver best results) to facilitate the acquisition of EVs (Norway´s VAT reduction and vehicle registration tax exemptions…).
- Cutting their usage costs (free parking…).
- Regulatory measures at different administrative levels (fuel economy standards …).
- ICE vehicle bans.

Announced sales bans for ICE vehicles



Car makers announcements related to electric cars



Support mechanisms for EV deployment

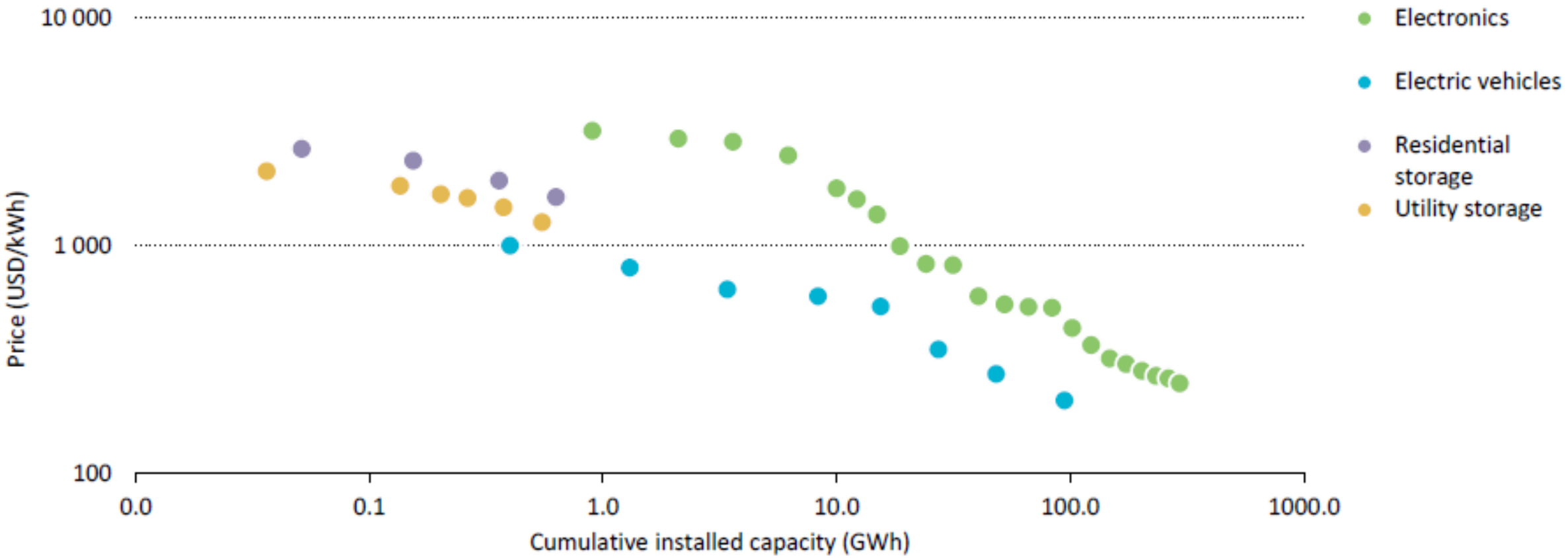
China

- Minimum requirements for the car industry regarding the production of new electricity vehicles (credits).
- Credit target is 10% of the passenger car market in 2019, 12% in 2020. (not the same as actual sales, since EV cars are getting more than 1kredit/1car).
- National Electric Vehicle Subsidy Program
- Consideration of the ban on the production and sales of ICE cars (not progressed)

EU

- In 2017 update of the CO2 emissions standards.
- Multiple measurements on the national level.

Lithium-ion storage technology price developments



EV emissions

- Long tailpipe emissions (the whole lifecycle – 270 000km for all of them)
  - Tesla Model S P100D saloon – 226g/CO2/km (US midwest)
  - 7-series BMW 750i xDrive – 385g/CO2/km
  - Mitsubishi Mirage – 192g/CO2/km
- Controversy about proper measurement – MIT and FT

- Source of electricity?
- Source of aluminium? Cobalt? Lithium?
- Local pollution vs GHGs?
- Export article (China)

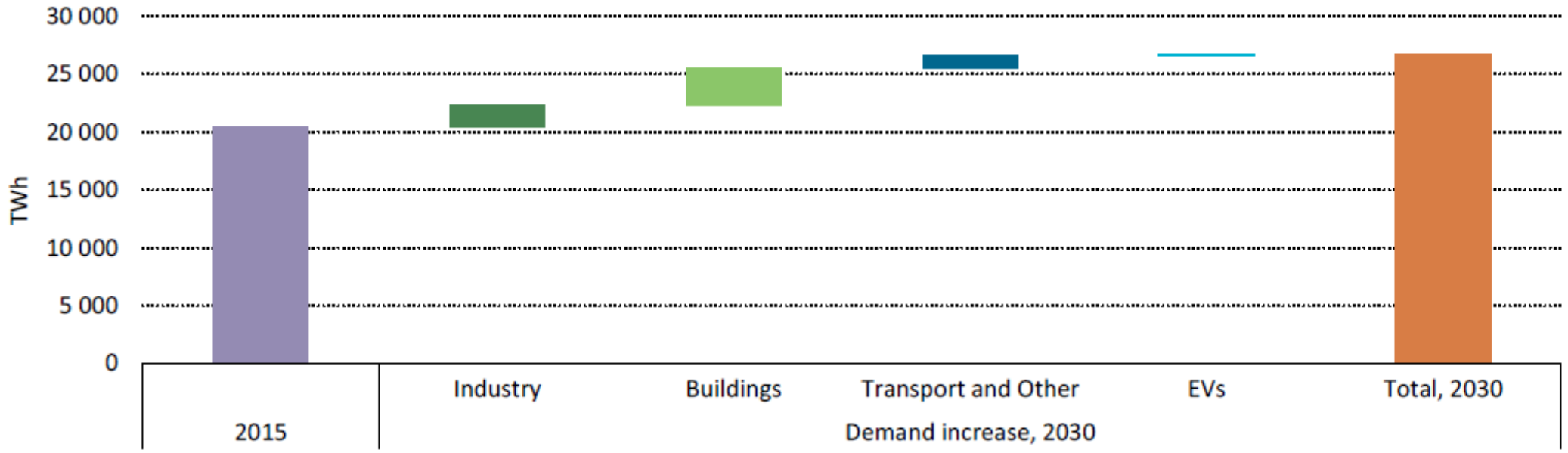
EV future

- Will there be a tipping point for EV? When?
  - Price of technology (primarily of batteries)
  - Development of charging infrastructure
- Development driven by both global and local pollution.
- Interlinked with the development of the electricity sector as a whole.
- What would be the impact on ICE-related industries?

Sources

- IEA (2018): Global EV Outlook 2018
- IEA (2017): Global EV Outlook 2017
- OECD/IEA (2017): Technology Roadmap: Biofuels for Transport
- Stakhovsky (2017): The Hidden Cost of Electric Cars
- McGee, P.(2017): Electric cars´ green image blackens beneath the bonnet.
- Miotti, M.(2016): Personal Vehicles Evaluated against Climate Change Mitigation Targets

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.