Electric Vehicles and the Energy Transition

Fuel Choices and Smart Mobility Summit 2017

Albert Cheung

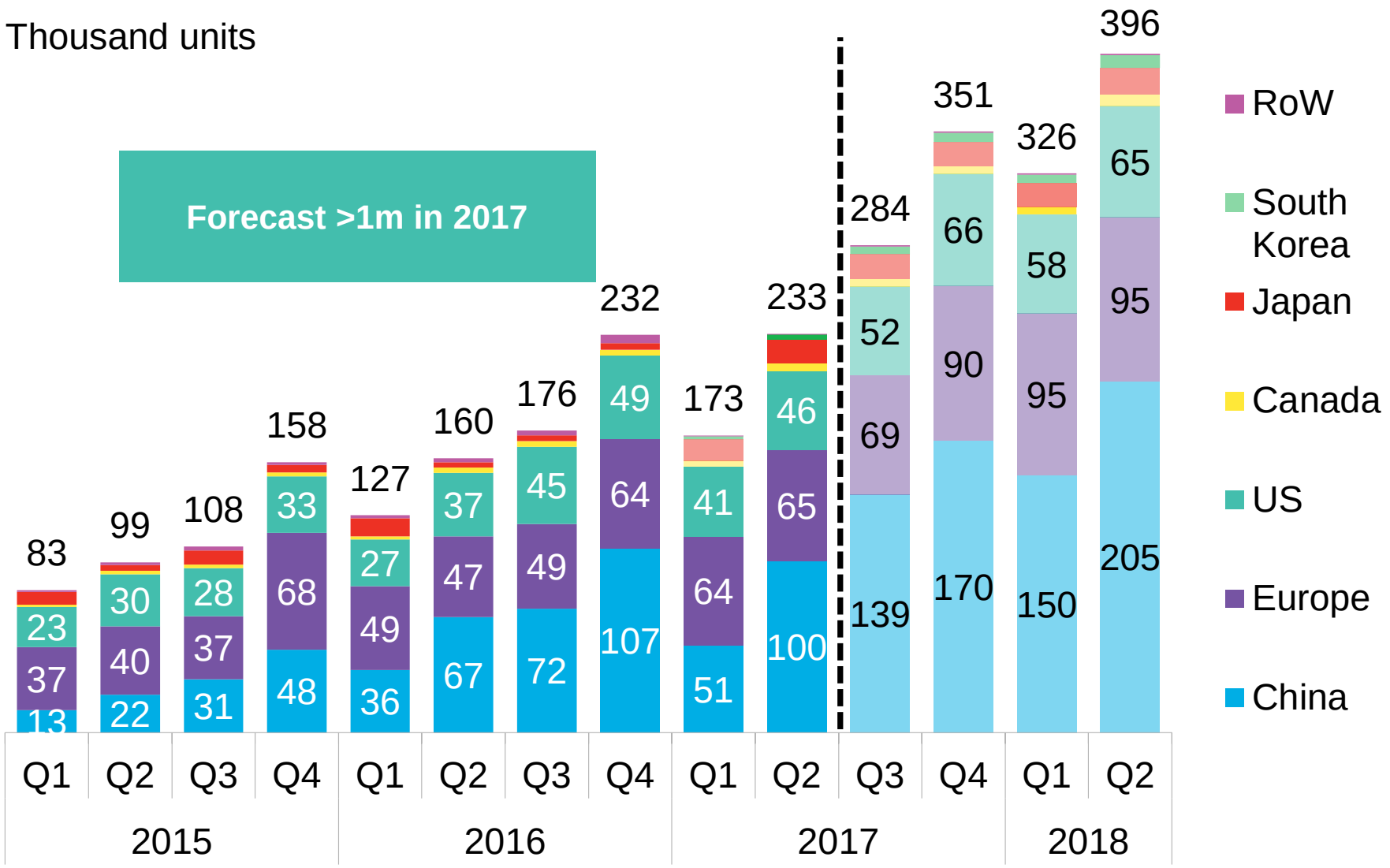
Head of Analysis, BNEF
acheung89@bloomberg.net
@albertwycheung

November 1, 2017

Bloomberg New Energy Finance

Copyright and disclaimer

Global EV sales by region



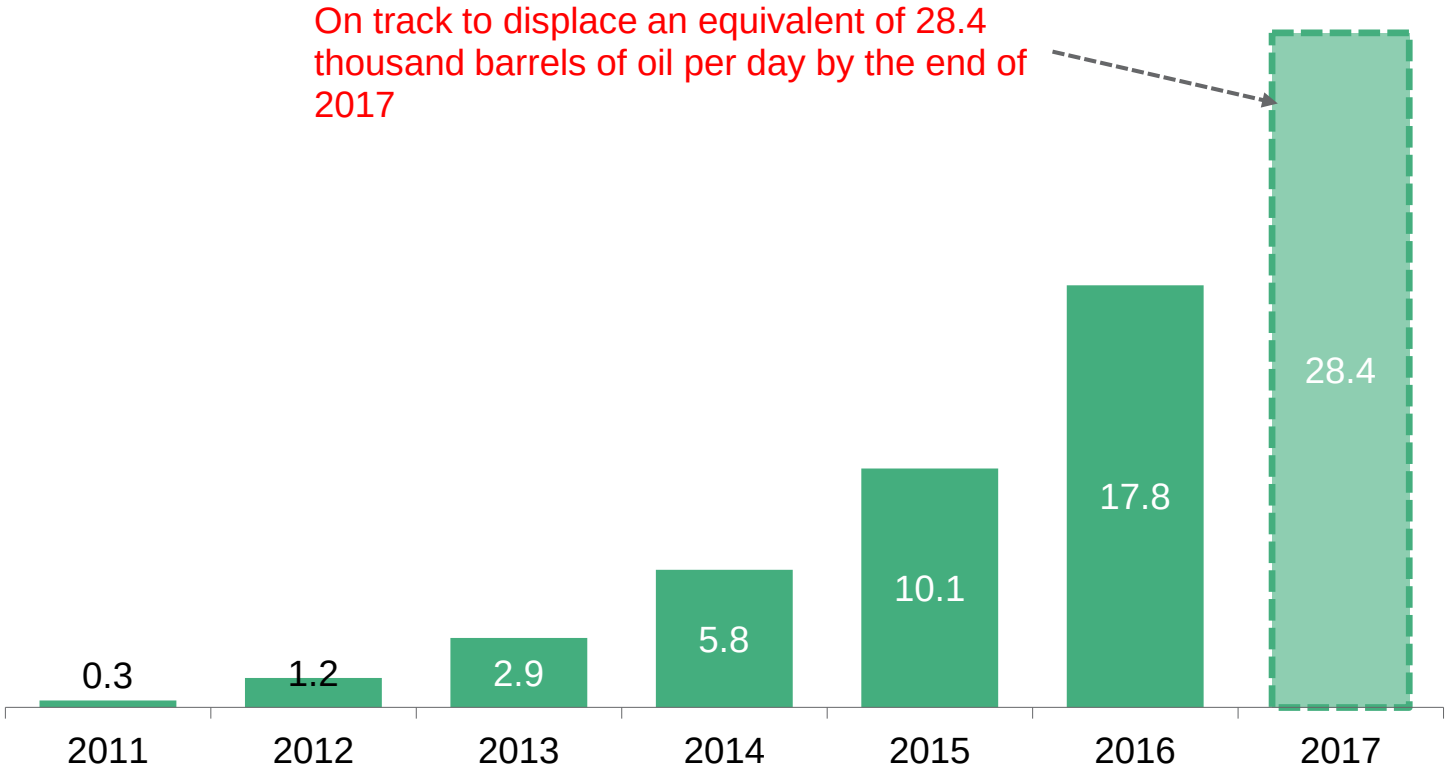
Source: Bloomberg New Energy Finance Note: includes highway-capable passenger vehicles only. Excludes low speed EVs, buses or other commercial vehicles.

Bloomberg New Energy Finance

Transport fuel displaced by EVs on the road today

If all BEVs and PHEVs currently on the road were bought instead of an average gasoline or diesel car ….

Thousand barrels per day



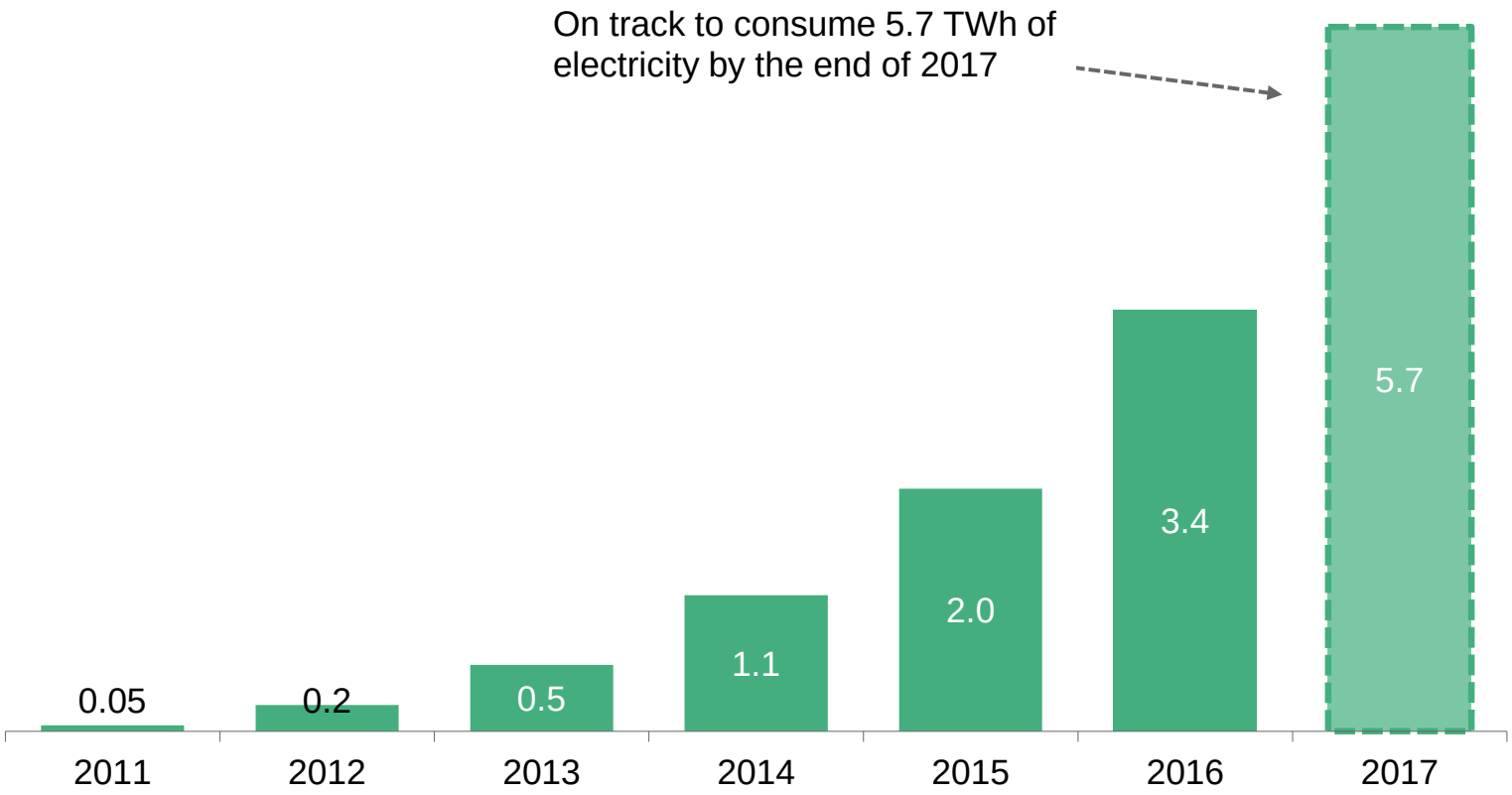
….then EVs on the road today, are displacing an equivalent of 28 thousand barrels of oil per day

= ~0.03% of oil production

Note: Average ICE miles travelled per quarter: 2,722, BEV – 2,177, PHEV – 1,361. We have updated the average fuel economy value in this report and therefore our fuel displacement values are slightly lower than previously. Our 2016 "forecasted" value has also changed as a result, from 18.2 thousand barrels of oil per day to 17.6 thousand barrels of oil displaced per day.

Electricity consumed by EVs on the road today

TWh



Based on EV models' fuel consumption values, BNEF estimates that EVs on the road in 2017 will use 5.7TWh of electricity.

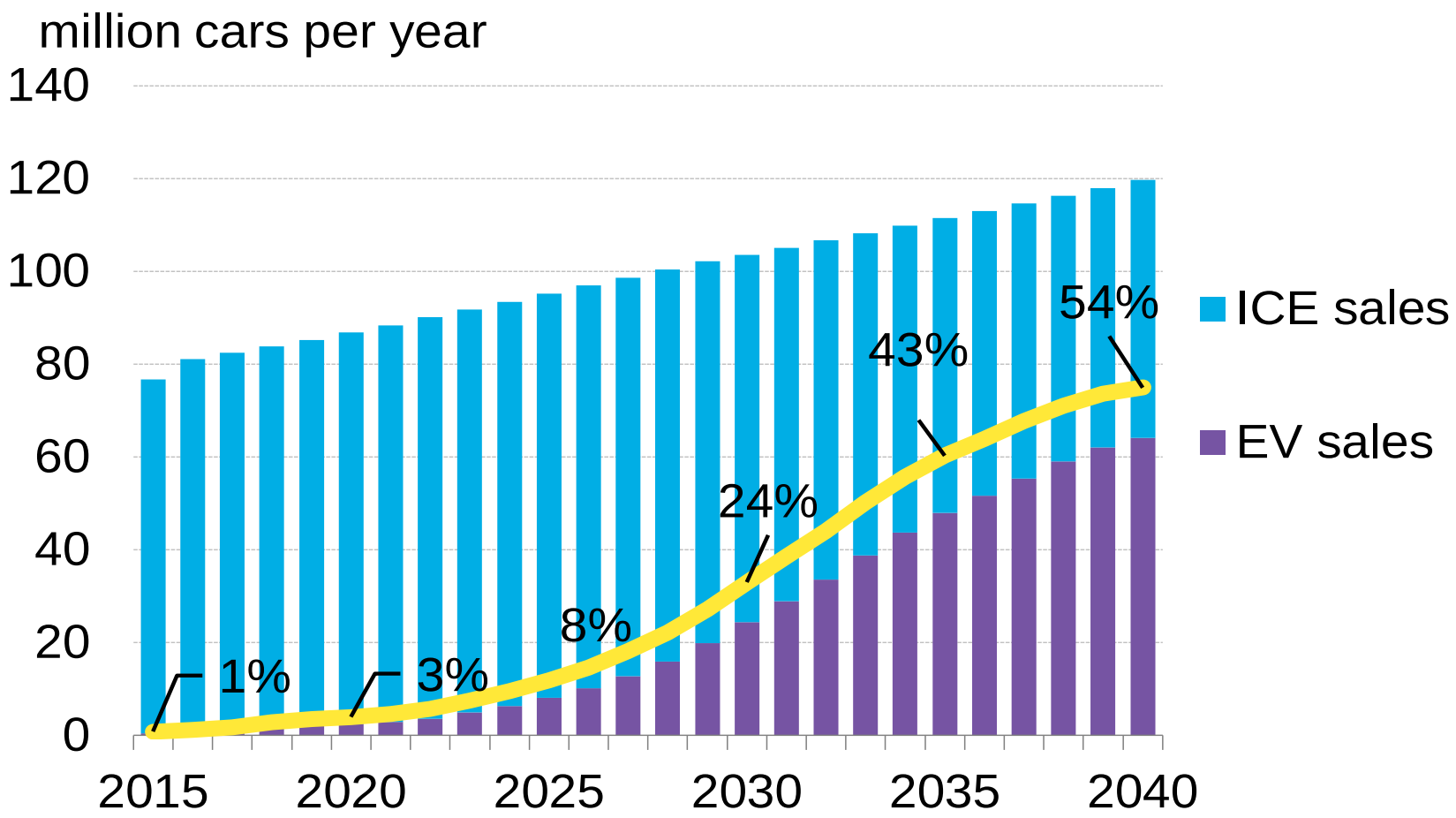
= ~0.14% of U.S. power generation in 2016

E-miles travelled per quarter: BEV – 2,177, PHEV – 1,361

Bloomberg New Energy Finance

2040 Electric Vehicles Outlook

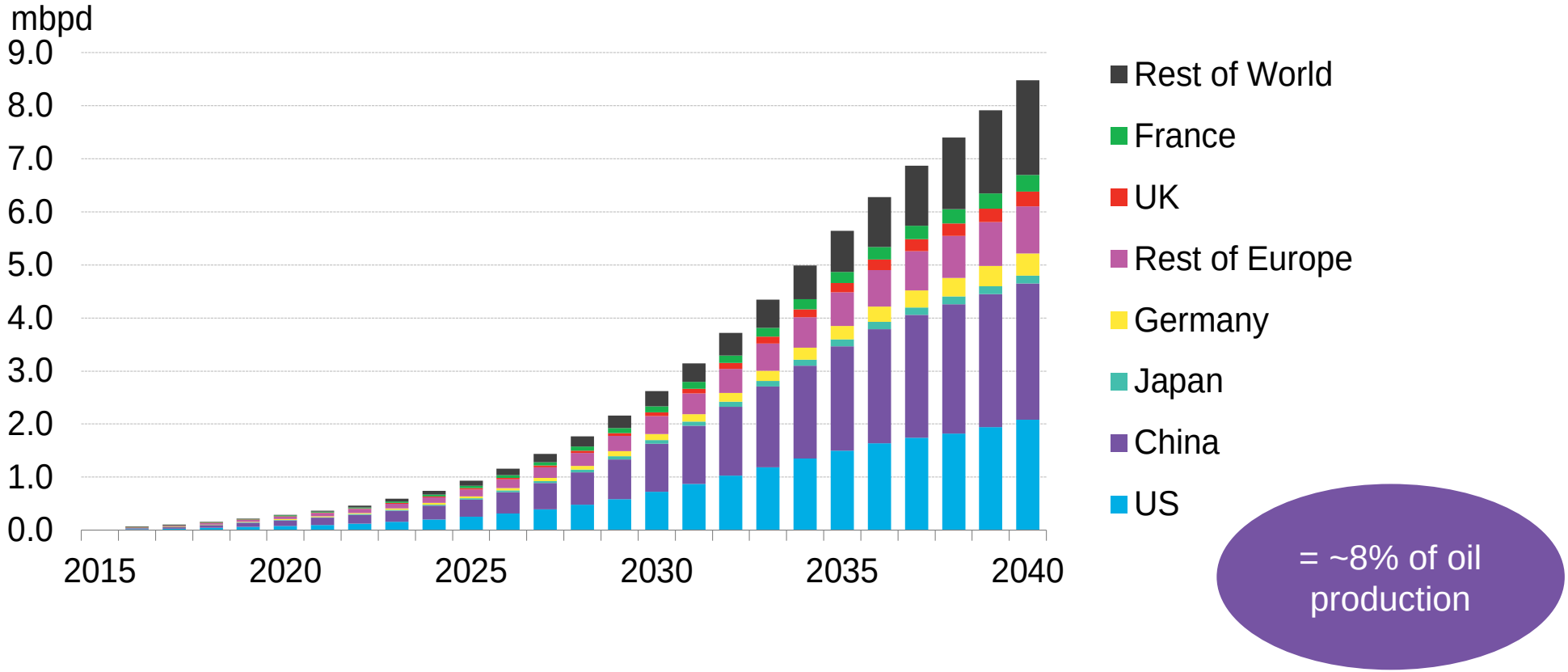
Annual global light duty vehicle sales



Bloomberg New Energy Finance

Bloomberg New Energy Finance

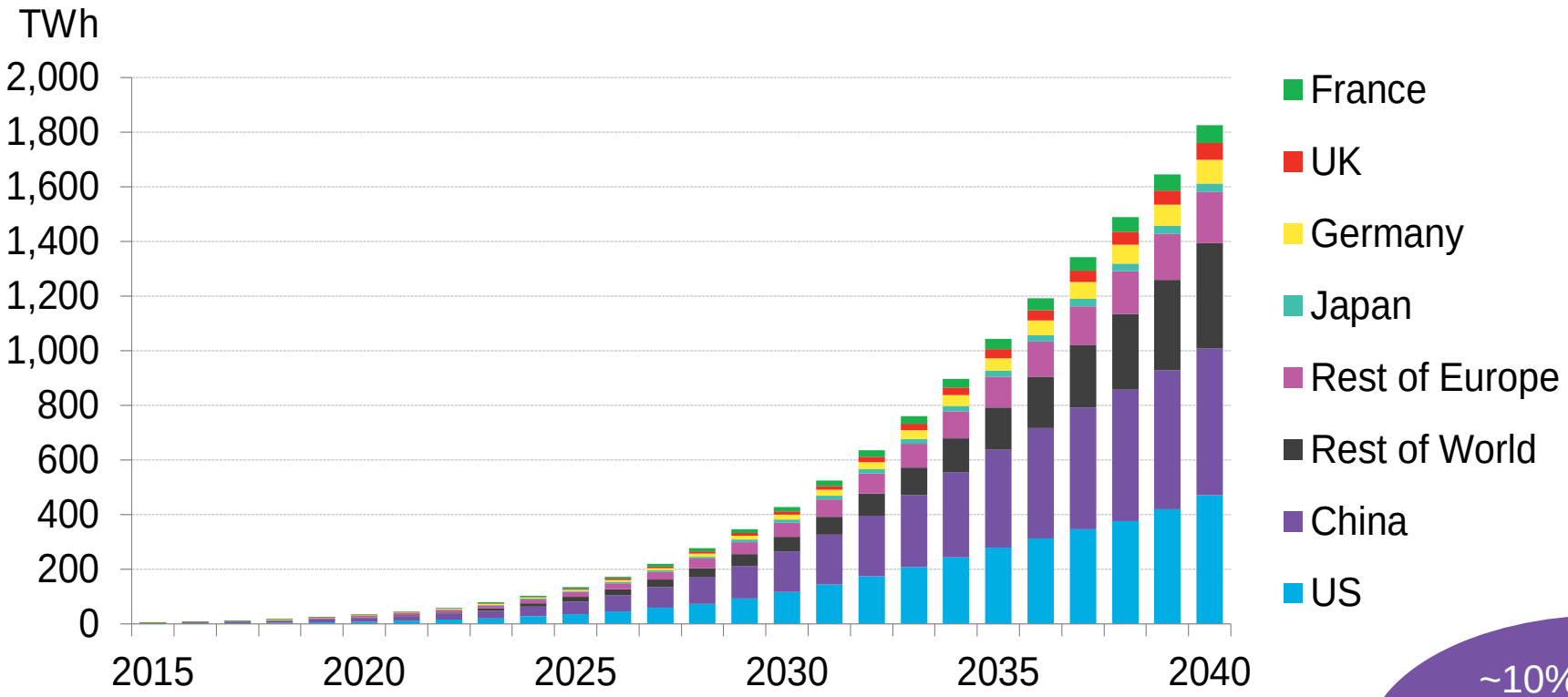
Global fuel demand displacement from EV sales



Bloomberg New Energy Finance Note: we calculate the number of barrels displaced by multiplying the cumulative number of EVs on the road in a given year by the average vehicle miles travelled by the EV, divided by the average miles per gallon of an internal combustion engine vehicle on the road. This is then divided by 365 days/year, and divided again by 42, which is the number of gallons in one barrel. Our figures likely understate actual crude oil displacement given that one barrel of crude oil produces around 19.5 gallons of gasoline and 12 gallons of diesel. Our calculation treats a barrel displaced as entirely made of finished transportation fuel.

Bloomberg New Energy Finance

Yearly electricity consumption from EVs

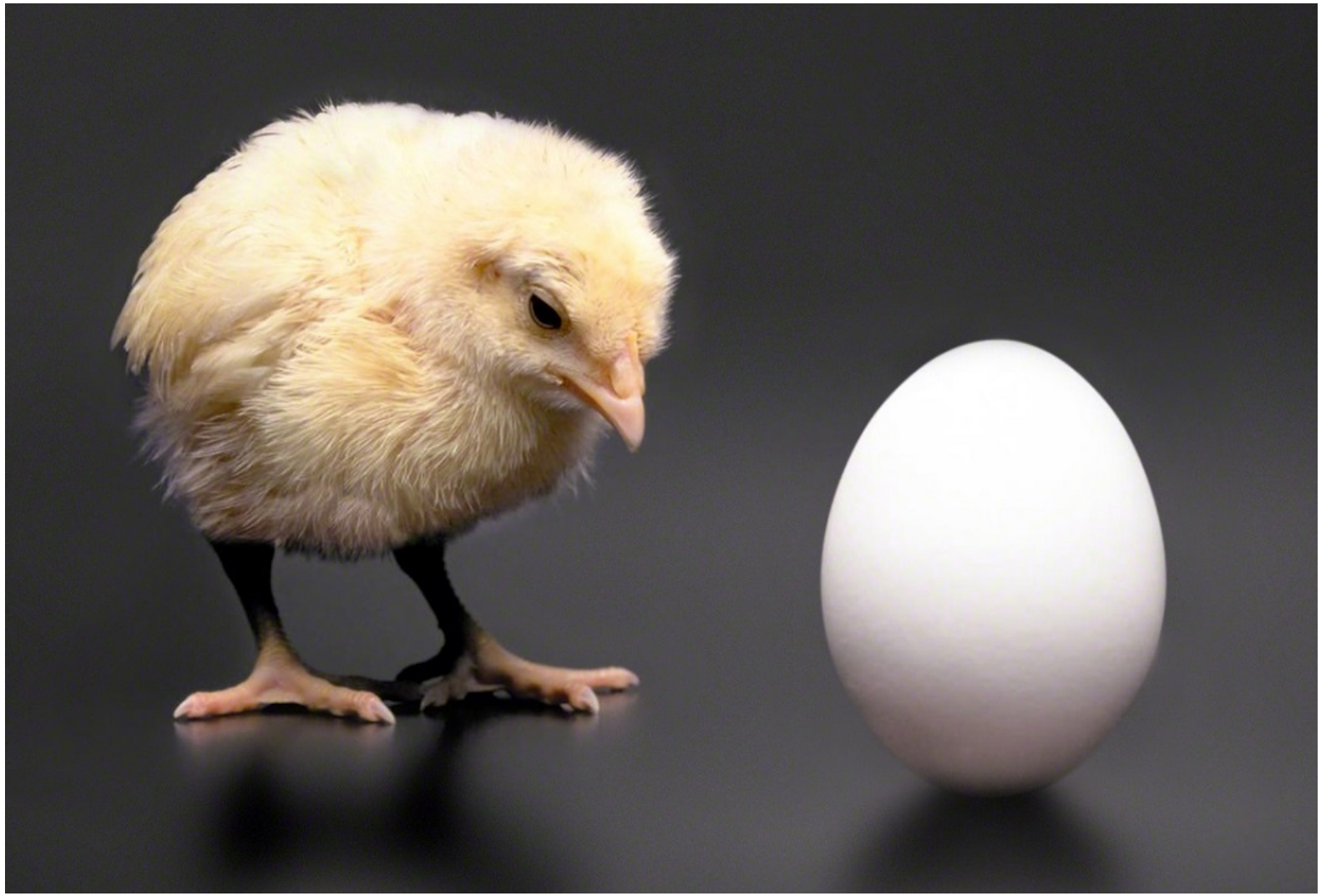


~10% of power generation in 2040 in high-adoption markets

Bloomberg New Energy Finance

Bloomberg New Energy Finance

Remember this?



How people used to think about charging infrastructure

theguardian — Electric cars: it's a chicken and egg issue

gtm: A Wood Mackenzie Business — DC Fast Charging: A Chicken-and-Egg Problem

the energycollective — The world's best thinkers on energy & climate — Electric Vehicles and their Infrastructure: The Chicken/Egg Dilemma

National Science Foundation — WHERE DISCOVERIES BEGIN — Improving electric vehicle sales may require solving unique chicken and egg problem

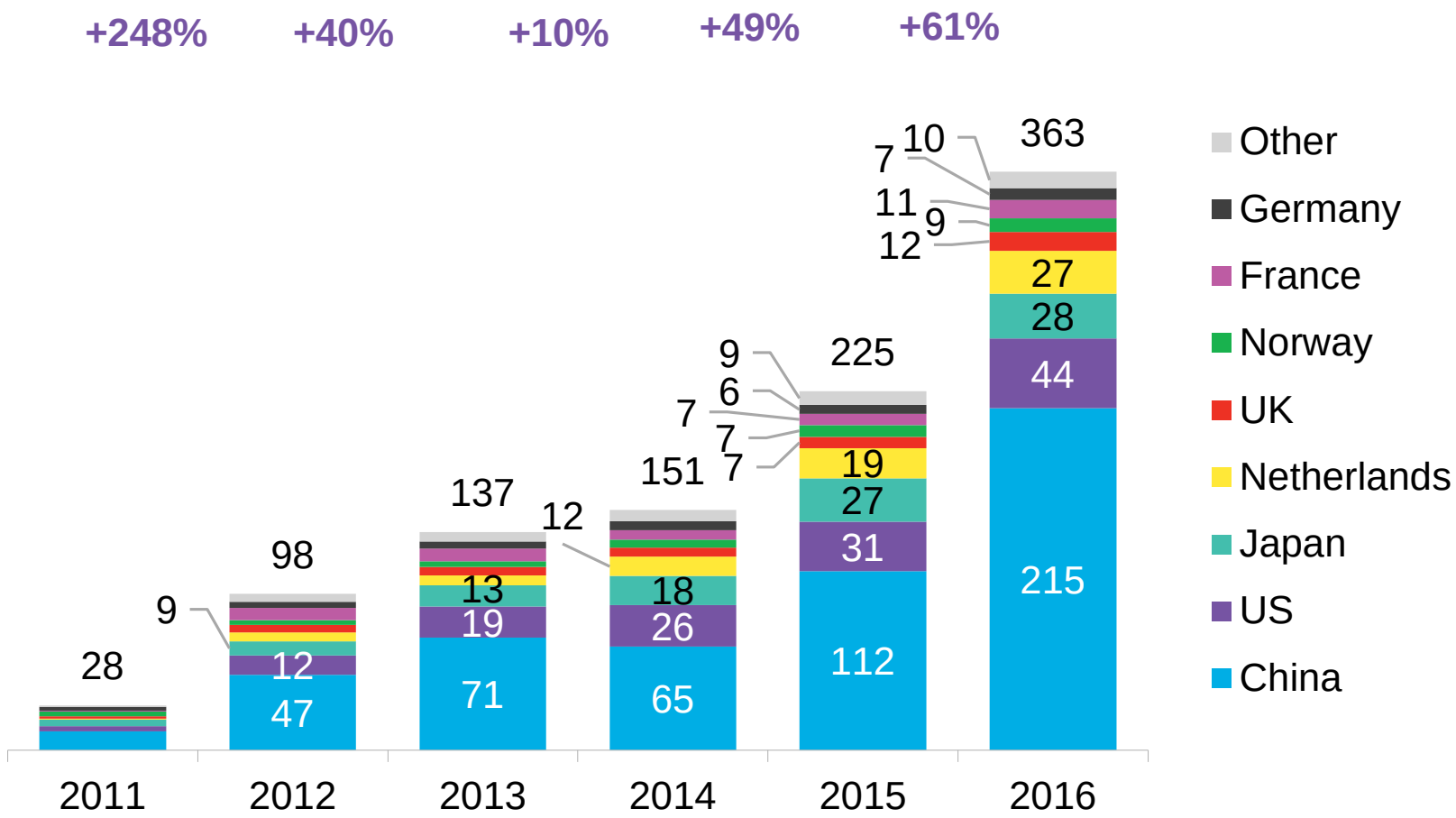
Bloomberg NEW ENERGY FINANCE — **2012**

"The installation of public EV charging infrastructure is often described as a classic chicken and egg problem. Which will come first – a significant penetration of EVs, or a widely deployed charging network?"

Public EV charging infrastructure

Cumulative installations in selected countries

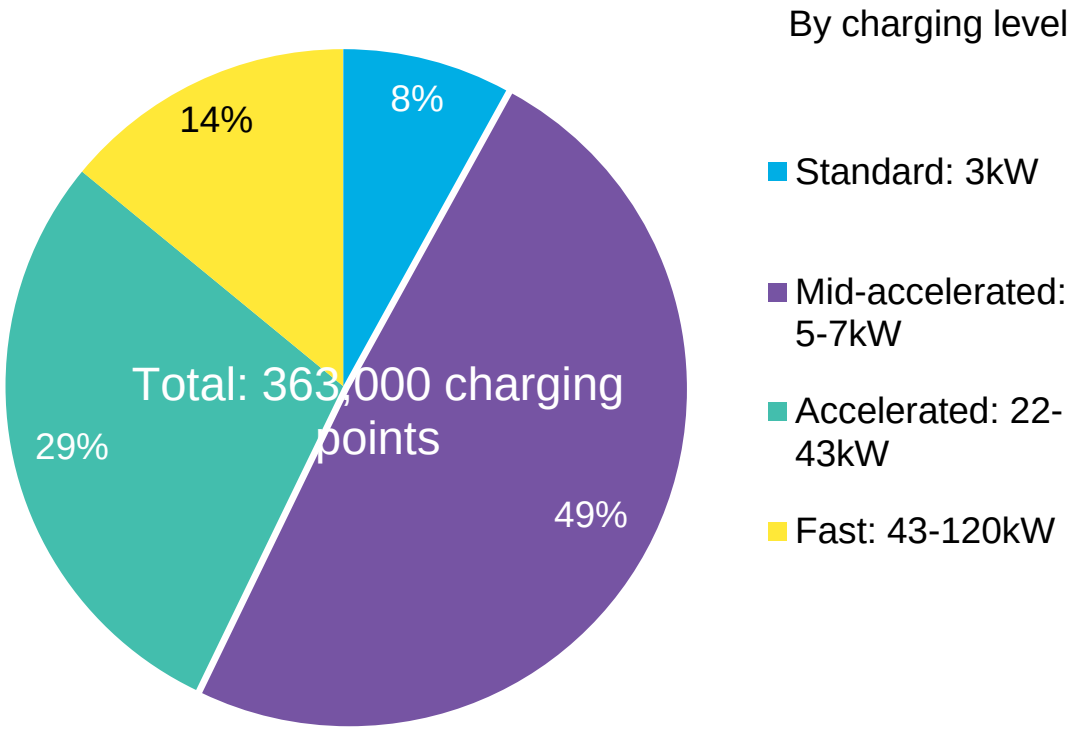
Thousand units installed



Note: Other includes: Belgium, Denmark, Italy, and Sweden. Public and semi-public chargers only. China values assume 2 outlets for every 1 charging pole reported by the China National Energy Administration. China 2015 number is an estimate as the official numbers have not yet been reported.

Source: Bloomberg New Energy Finance, China National Energy Administration, Danish EV Alliance, data.gouv.fr, BDEW, NOBIL, National Charge Point Registry, AFDC

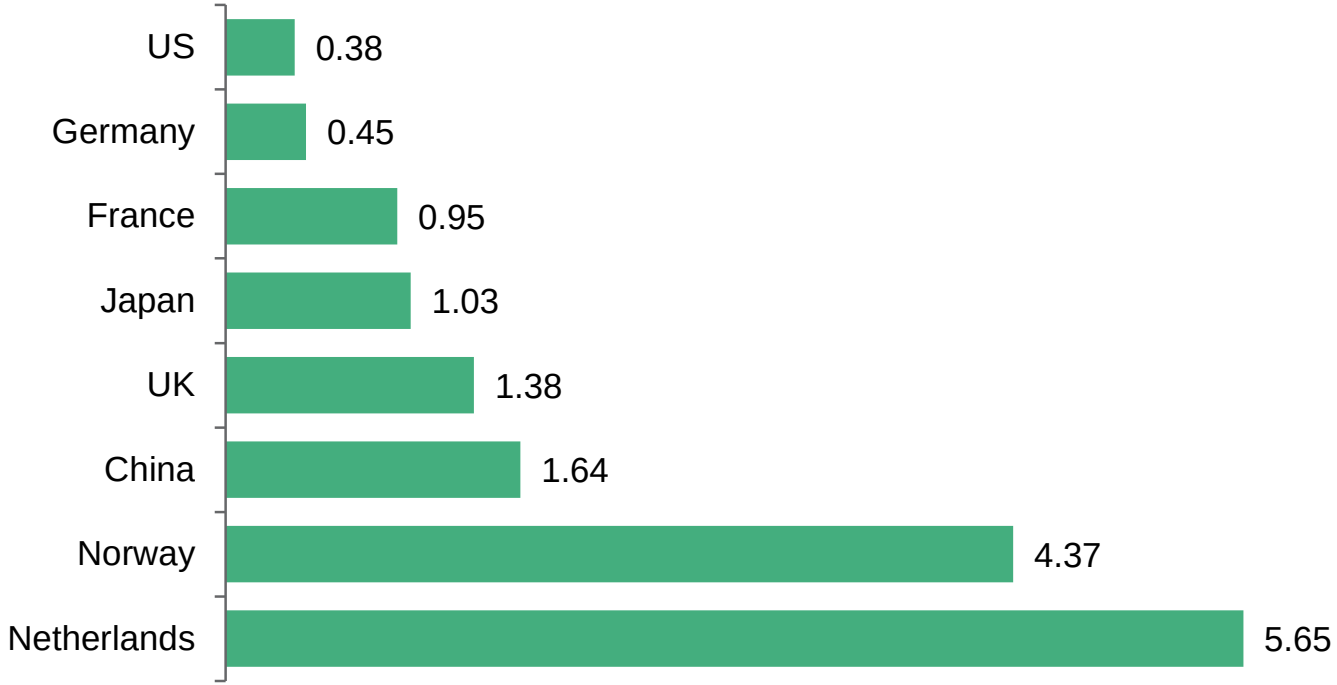
Charging speeds of public EV charging infrastructure globally, 2016



Bloomberg New Energy Finance, ChargeMap, Avere, National charge Point Registry, MIIT, BDEW, Nobil, Alternative Fuels Data Centre

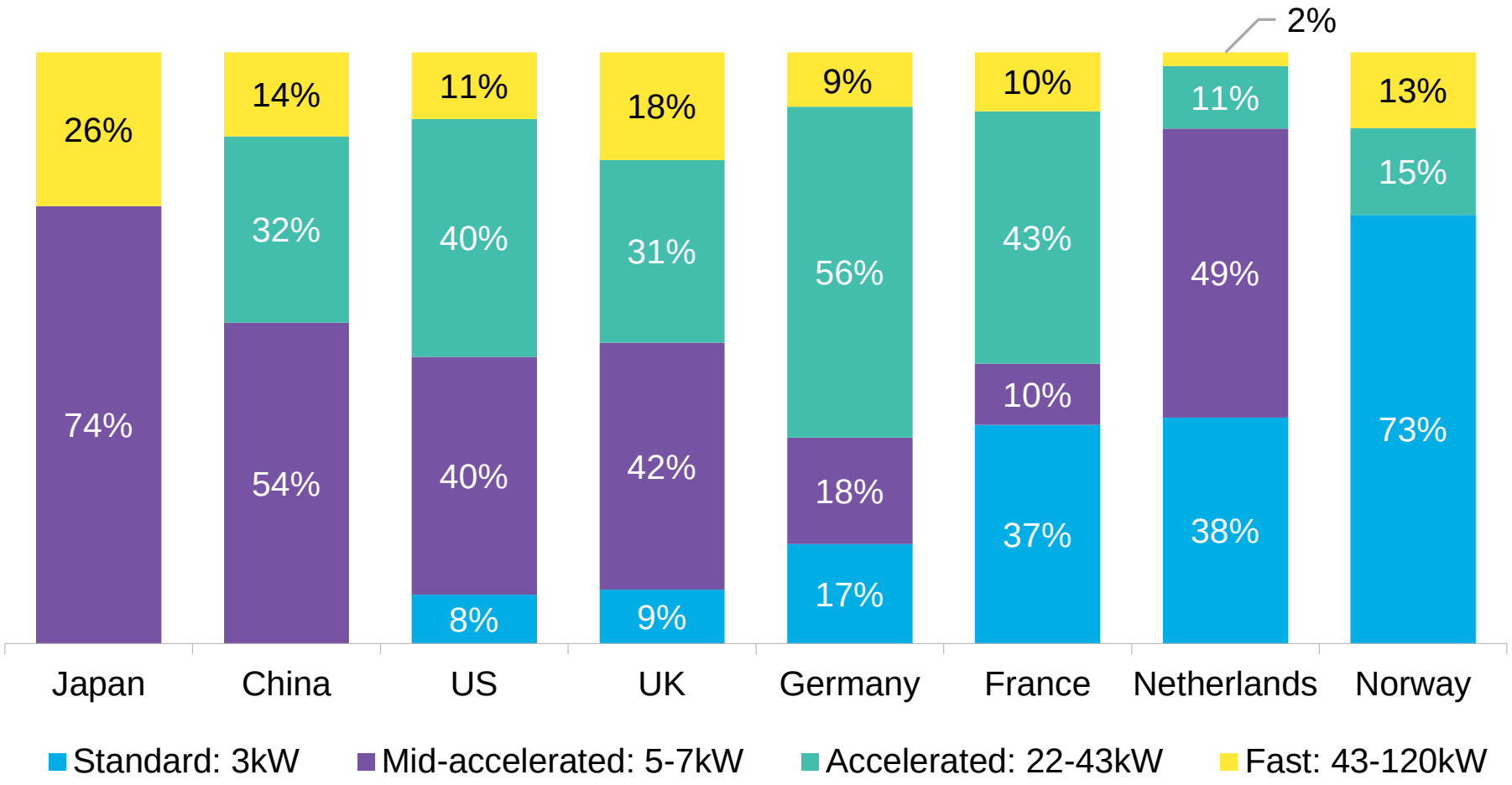
Bloomberg New Energy Finance

Ratio of publicly available EVSE to the number of petrol filling stations, 2016



Source: Bloomberg New Energy Finance

Charging speeds of public EV charging infrastructure globally, 2016



Bloomberg New Energy Finance, ChargeMap, Avere, National charge Point Registry, MIIT, BDEW, Nobil, Alternative Fuels Data Centre

Bloomberg New Energy Finance

Who will own the infrastructure – and the customer relationship?

‘Big oil’

Shell acquired (Oct 2017) newmotion charge smart

- 30,000 charge points
- 100,000 members
- NL, UK, DE, FR

Auto

Ford, DAIMLER, BMW, Volkswagen

- Alliance of 4 automakers
- 400 rapid chargers planned across Europe
- 350kW rapid charge

Power

enel ENERNOC acquired (Oct 2017) eMotorWerks

- Residential and commercial charge points
- EV charging-based demand response

Regulated utilities

SDGE, PG&E, Southern California Edison An EDISON INTERNATIONAL® Company

- California: public utility-led roll-outs with regulated returns
- Public, commercial and residential charge points

Independent

chargepoint, CLEVER – driving electric made easy, POLAR The EV charging network, FASTNED

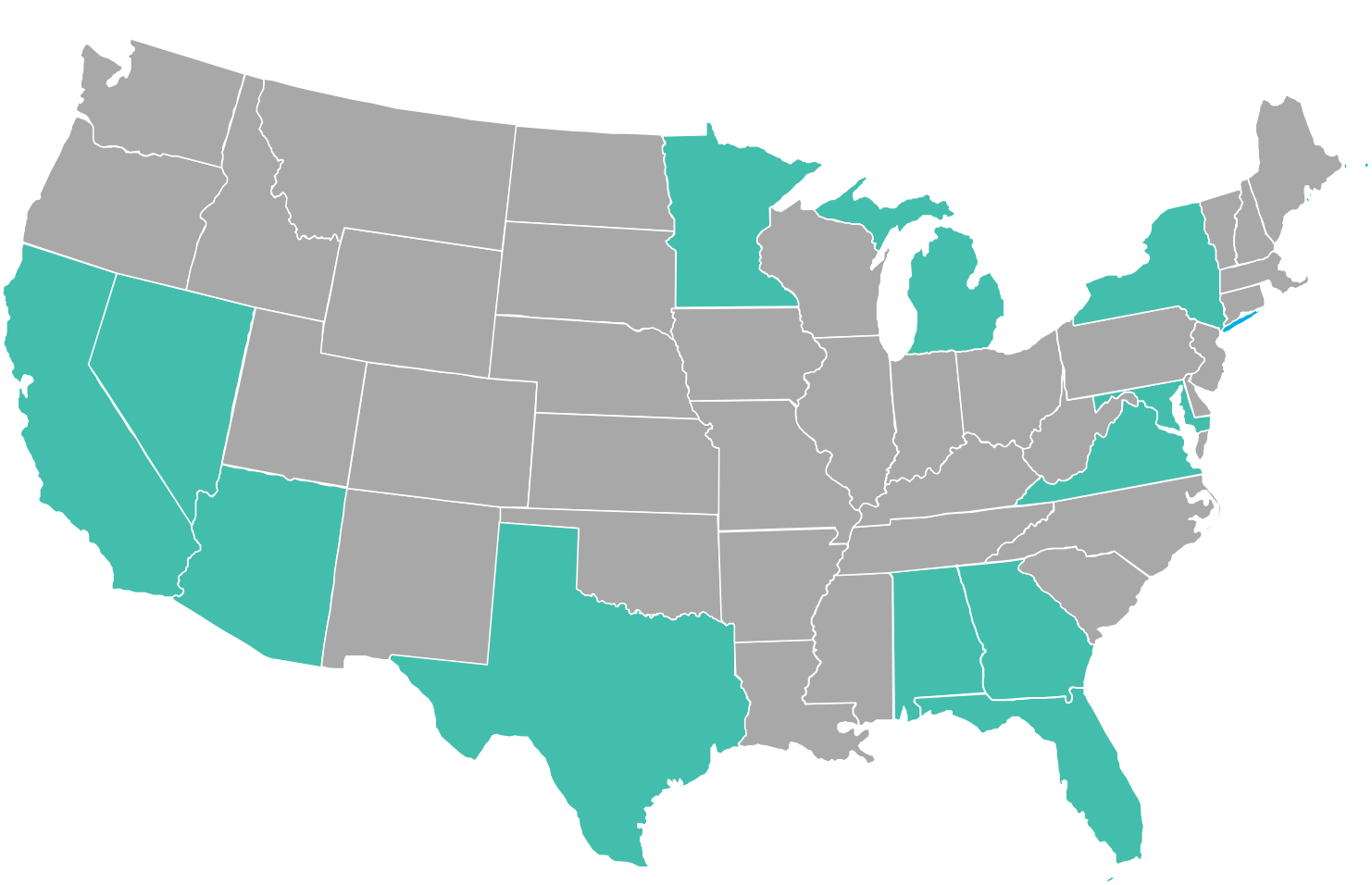
- Various independent players

EV-specific home charging tariffs in Europe

Country	Utilities involved	Notes
	OVO Energy	• Flat rate of £83 per month • Access to UK Polar Network (50,000 EV chargepoints)
	Good Energy	• 15% per kWh cost reduction on variable EV tariff
	Ecotricity	• £40 a year discount for EV owners.
	Endesa	• 1,200 kWh of free electricity per year between 1:00am and 7:00am. • Free installation of a home charging point • Access to a public charging network that will be built in 2018.
	EDP	• 10% discount per kWh during night time charging. • All electricity is sourced from renewables. • The first 500 customers who sign up and have an EV from one of EDPs partner brands* get the first 15,000km of electricity for free, which is applied as a 40 euro per month bill reduction over 10 months.

**EDP partner brands include: BMW, Mercedes, Audi, Mitsubishi, Nissan, Peugeot, Renault, Smart, Toyota, VW and Volvo*

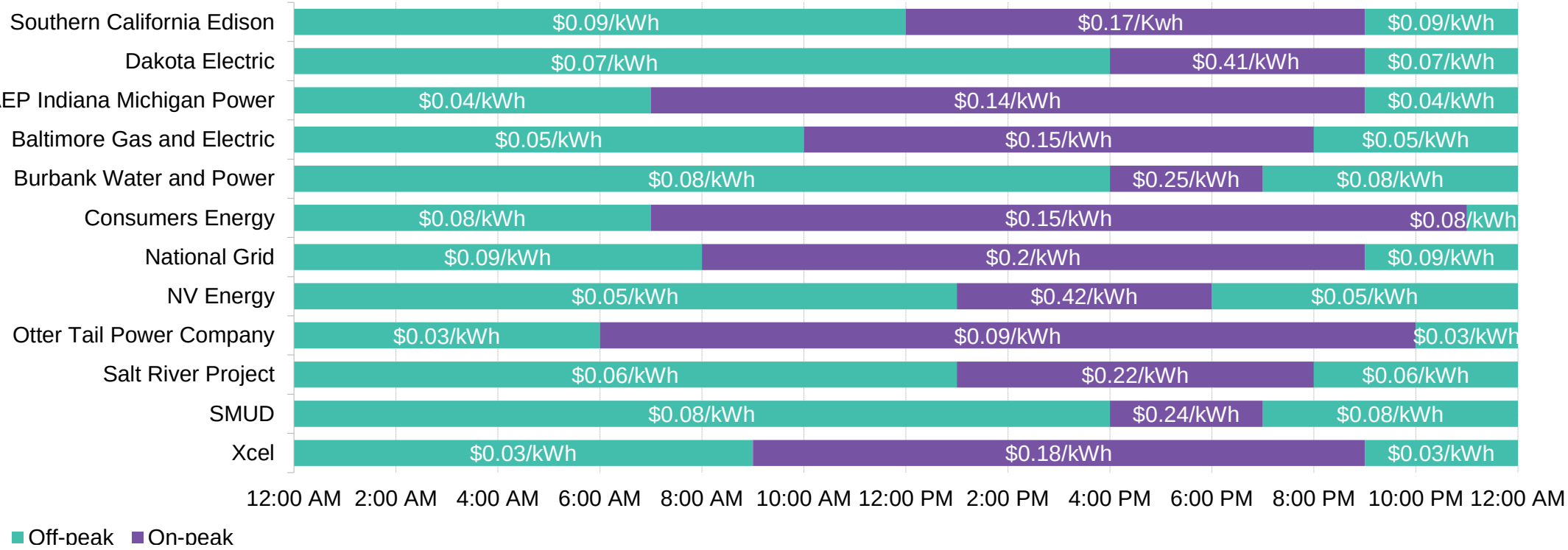
U.S. states with utilities that offer EV-specific Time of Use rates



Data current as of September 1, 2017. Utilities in Hawaii and Alaska also have EV-specific TOU trial rates but are not shown. See Appendix for full list.

Selected EV-specific utility TOU charging rates in the U.S.

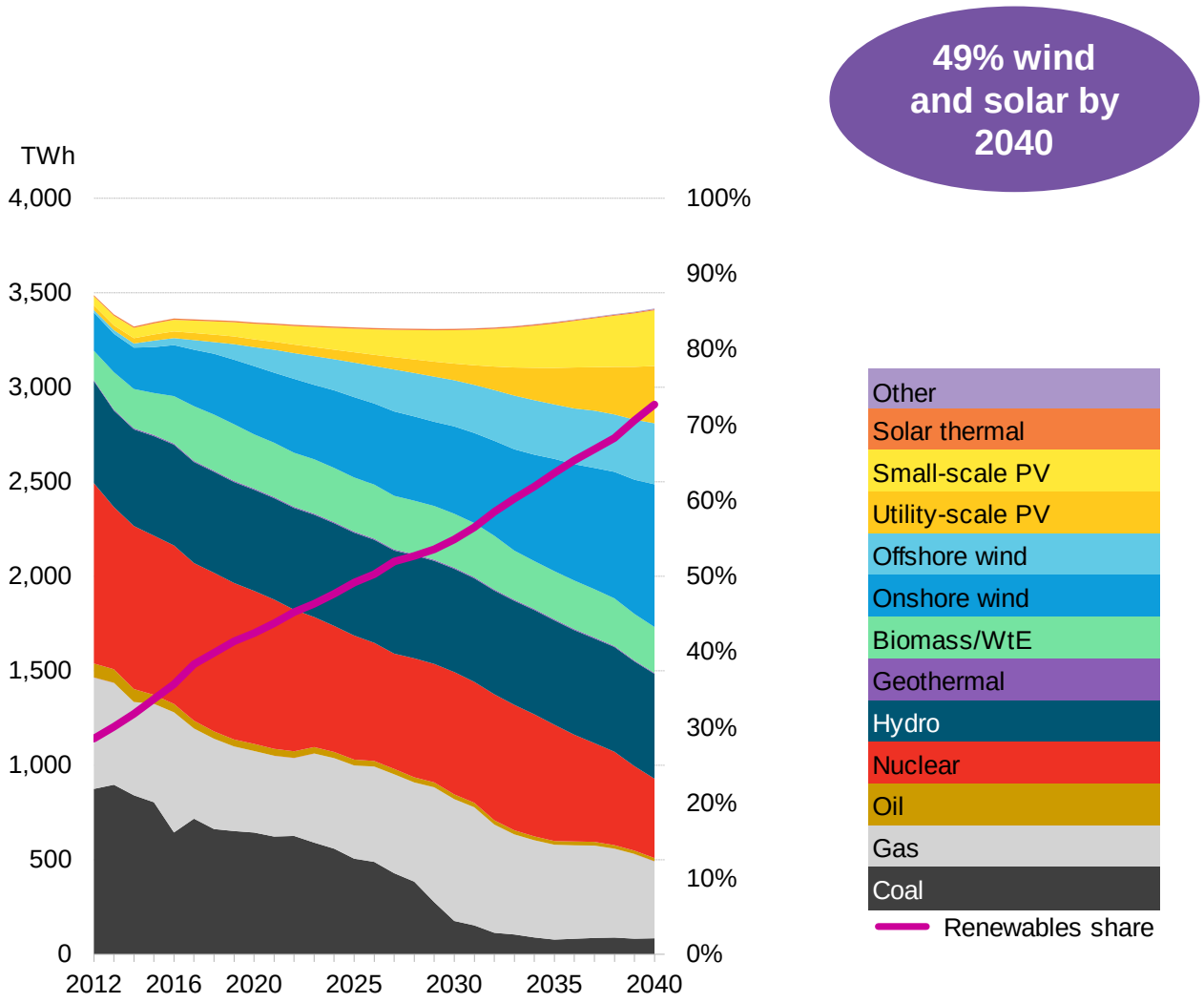
U.S. utility EV charging tariff hours and rates ($/kWh)



Source: Bloomberg New Energy Finance, rate filings and webpages of respective companies. Note: Data shown is for summer peak. Some rates include a monthly fee which is not included here. See subsequent slide for further notes.

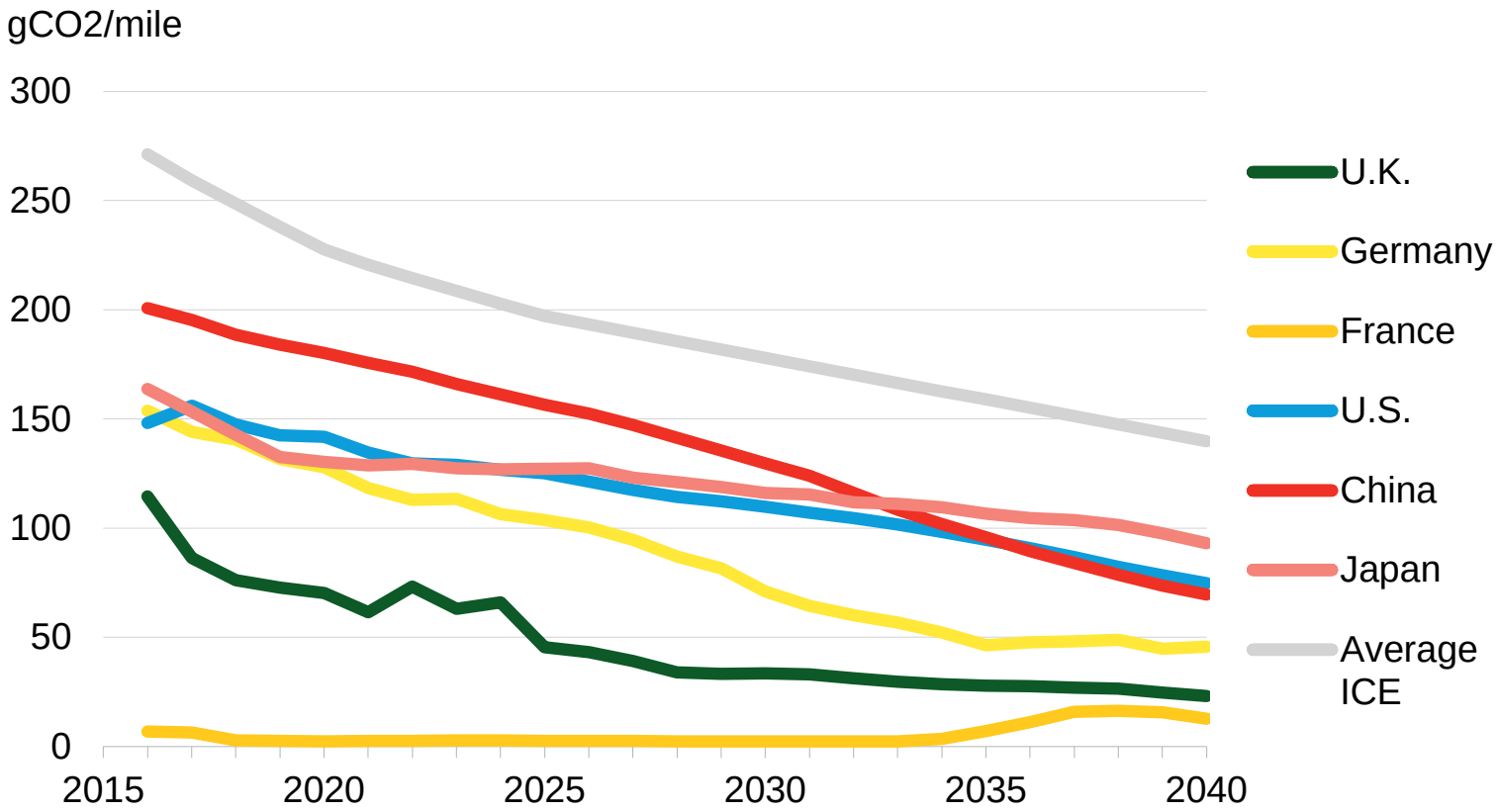
Bloomberg New Energy Finance

Europe power generation forecast (BNEF NEO 2017)



Bloomberg New Energy Finance

Forecast grid-related emissions from the operation of battery electric vehicles

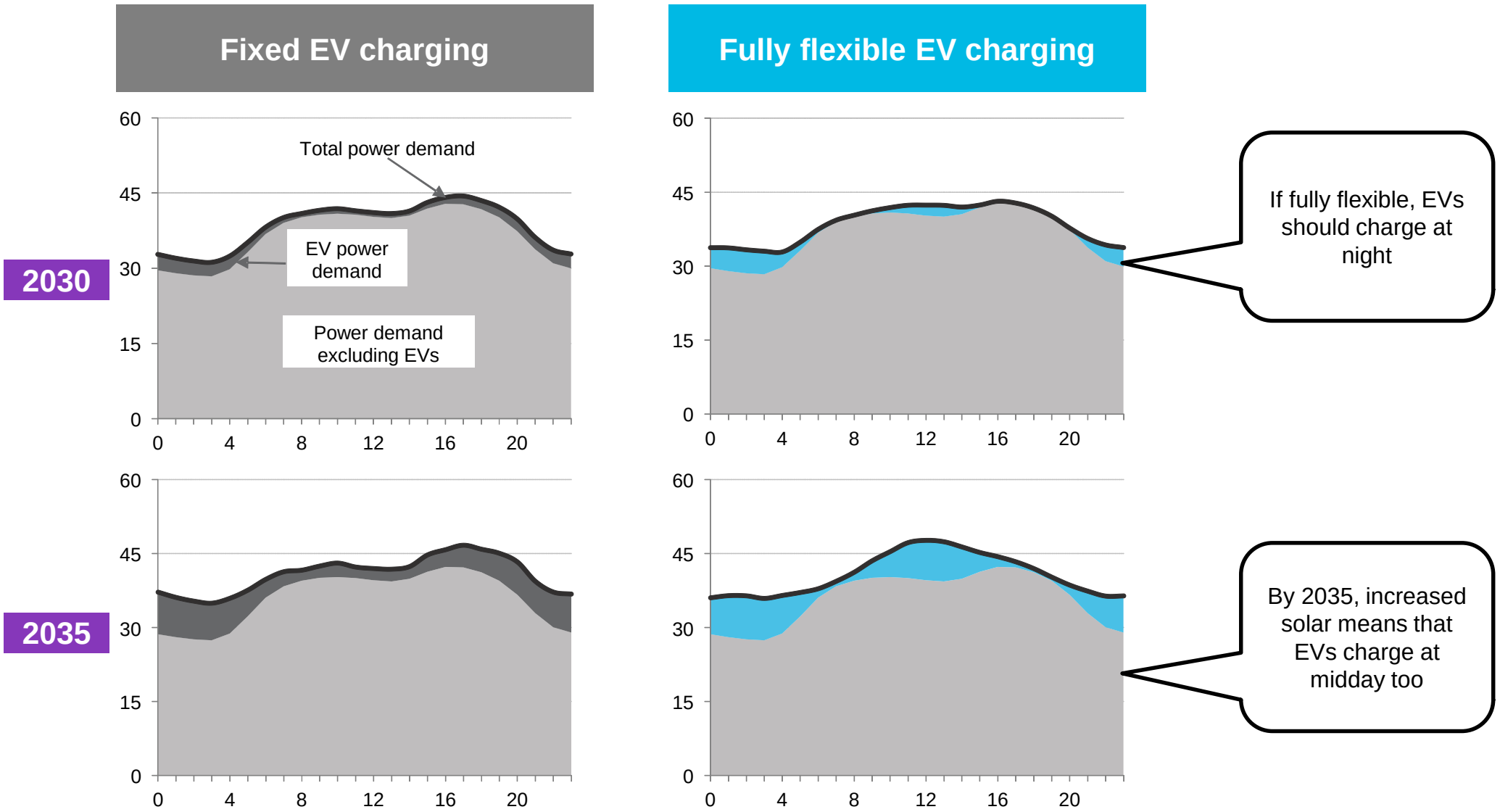


Growing renewables will make EVs cleaner and cleaner to 2040

Source: Bloomberg New Energy Finance, New Energy Outlook 2017. Note: The average ICE CO2 emissions are sales weighted across all six countries

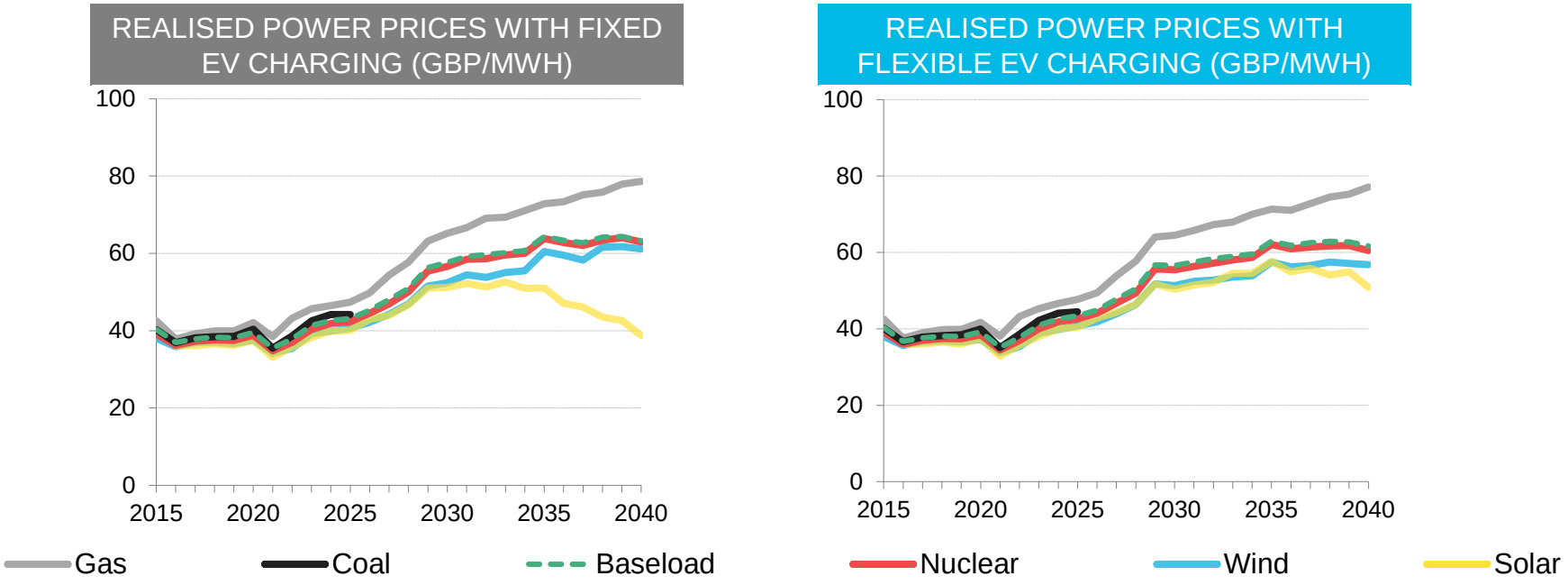
Bloomberg New Energy Finance

Future EV charging patterns (UK)



Bloomberg New Energy Finance

Realized power prices with different charging patterns (UK)



In 2040 it will make most sense to charge in the daytime (due to solar):

- Charging costs are **10% lower compared** to fixed night-time charging
- Daytime charging leads to a **42% improvement in solar realized prices**

EVs can be a flexible load that supports renewable energy economics

Source: Bloomberg New Energy Finance Note: Realised power prices are calculated as energy revenues divided by generation. They do not measure profitability.

Bloomberg New Energy Finance

Bloomberg New Energy Finance is a research firm that helps energy professionals generate opportunities. With a team of experts spread across six continents, BNEF provides independent analysis and insight, enabling decision-makers to navigate change in an evolving energy economy.

BNEF research and analysis is accessible via web and mobile platforms, as well as on the Bloomberg Terminal.

Coverage.

Renewable Energy
Power & Utilities
Gas
Carbon Markets & Climate Negotiations
Energy Smart Technologies
Storage
Electric Vehicles
Mobility and Autonomous Driving
Frontier Power
Emerging Technologies

sales.bnef@bloomberg.net
about.bnef.com
@BloombergNEF

Thank you!

Albert Cheung

Head of Analysis, BNEF
acheung89@bloomberg.net
@albertwycheung

Bloomberg New Energy Finance