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# EV penetration and 'peak' ICE: creative destruction

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# Introduction

- ICE “lock-in” has lasted 100 years
- All EV forecasts point to deep penetration and ”peak” ICE
- What drives and could slow or shape EV penetration?
- What are the implications and opportunities of EV penetration?
- What policies are required to make the transition a success?

# Messages

1. Public policy, improved economics, greater range, excess electricity capacity and smart charging all support deep EV penetration
2. Alternative mobility options, congestion, supply chain stresses, consumer preferences, regulatory/fiscal policy can all slow and shape penetration
3. Implications of penetration are exciting opportunities, but as disruptive for transport as renewables were for electricity
4. Policy measures critical for efficient EV ‘take off’ and smooth transition

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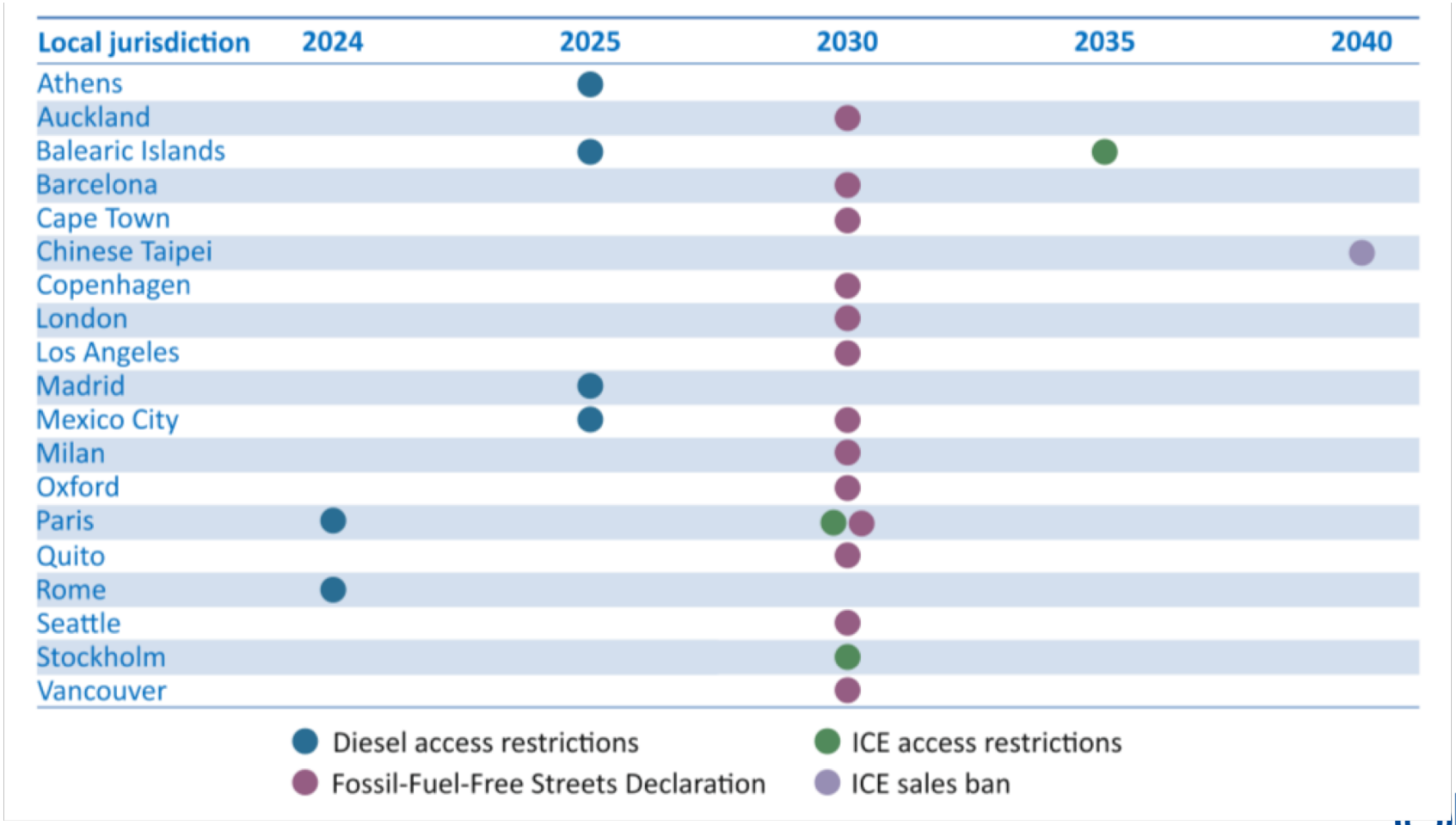
# What are the positive drivers?

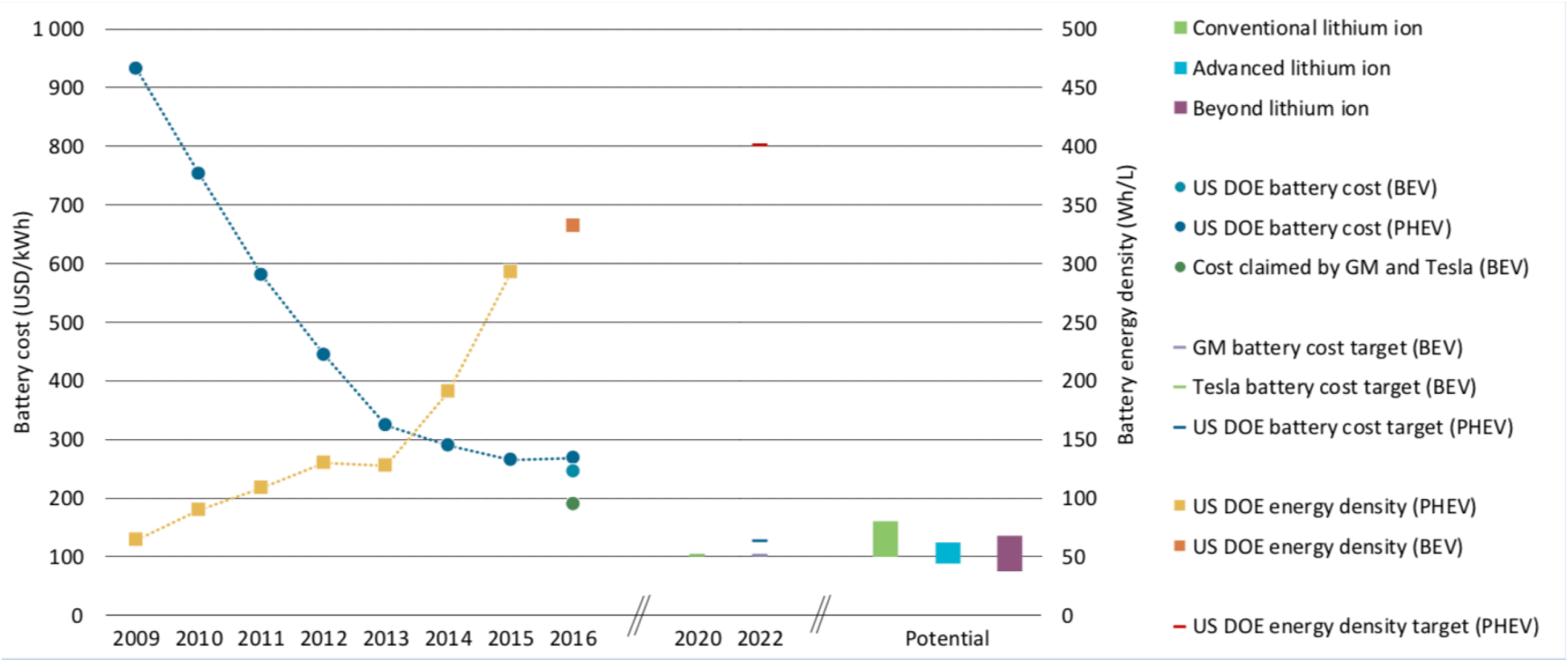
- Strong olicy support
  - Climate change concerns lead to policy promotion of EVs
  - Local pollution leads to restrictions on ICE access to cities
  - Industrial policy support (e.g. China) reflects economic benefits
- Improving EV economics and technology trends
  - EV economics increasingly attractive, especially for fleets due to falling battery cost, increased range of EVs, growing charging network
  - OEM commitment to curbing or halting production of diesel ICE and to increased EV deployment and number of models
- Electricity network and smart charging support for EVs
  - Growing investment in charging network (private and public)
  - Investment in electricity network manageable, with smart charging
  - EVs strengthen electricity network's ability to absorb renewables

# Announced ICE urban access restrictions




Source: IEA Global EV Outlook 2018

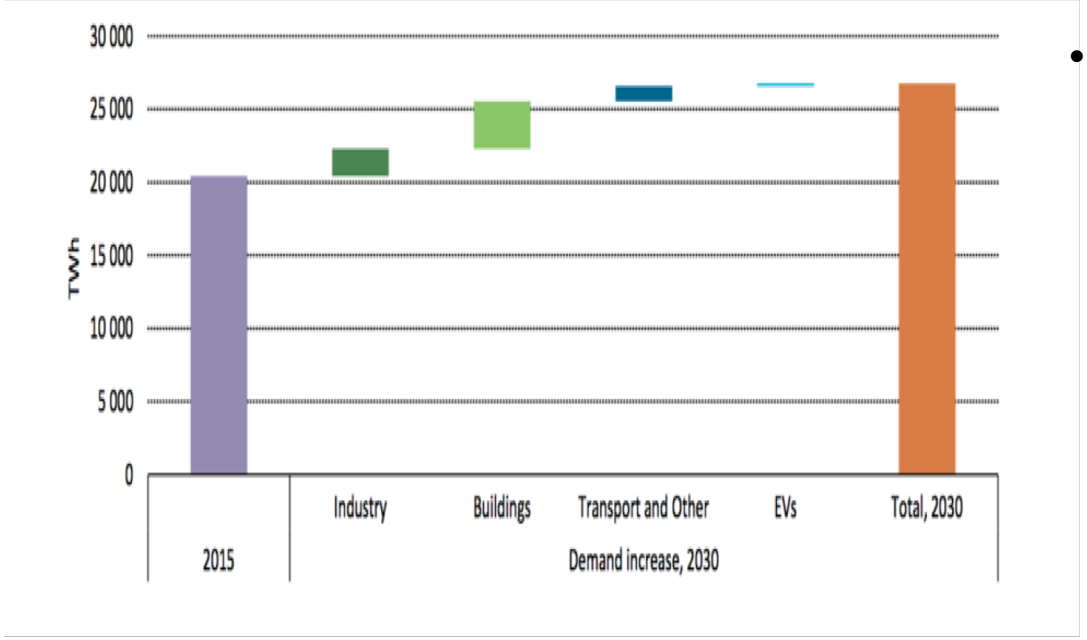
# Falling EV Battery Cost and Increased Density




Source: IEA Global EV Outlook 2017

# Investment in electricity infrastructure should be manageable with smart charging

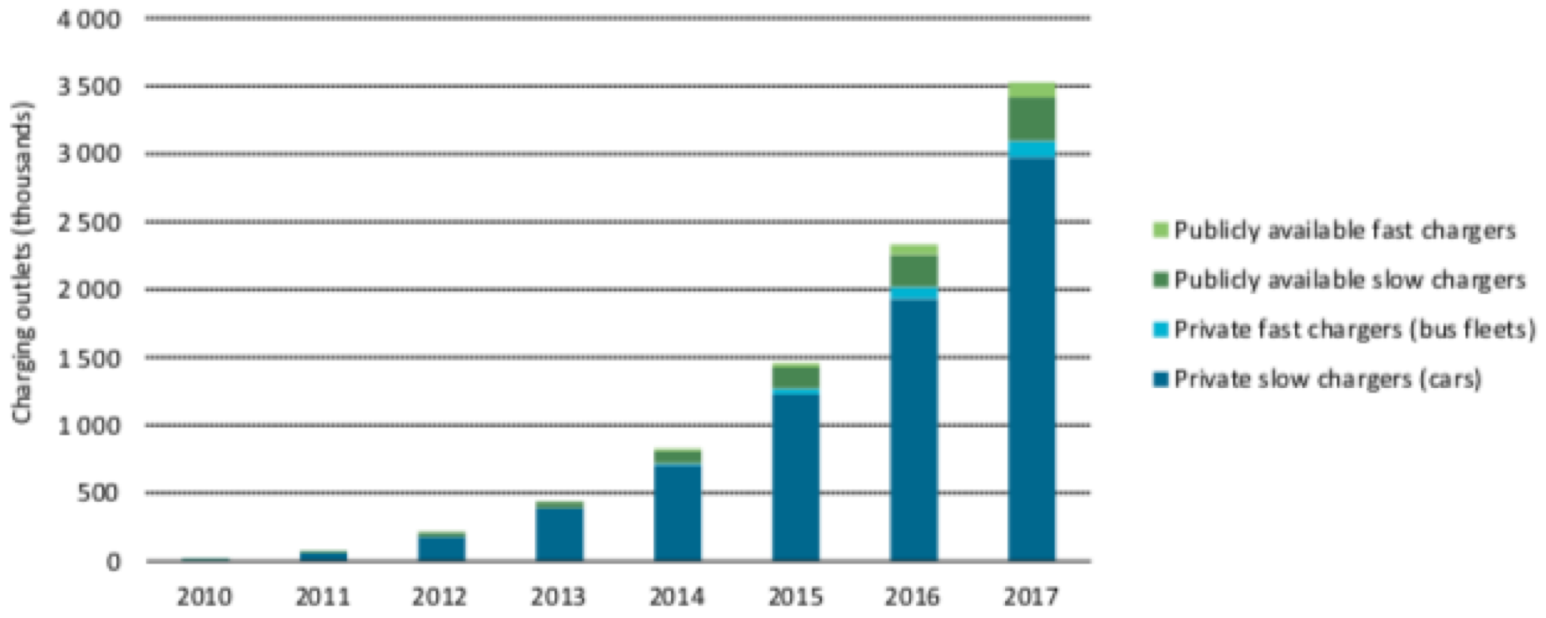
**2030 global electricity demand, IEA 2DS**




- IEA 2D scenario additional generation required to meet EV demand amounts to 1.5 percent of total electricity demand in 2030, which is only 6 percent of the expected increase in demand due to new loads from electrification in the industrial, residential and commercial sectors.

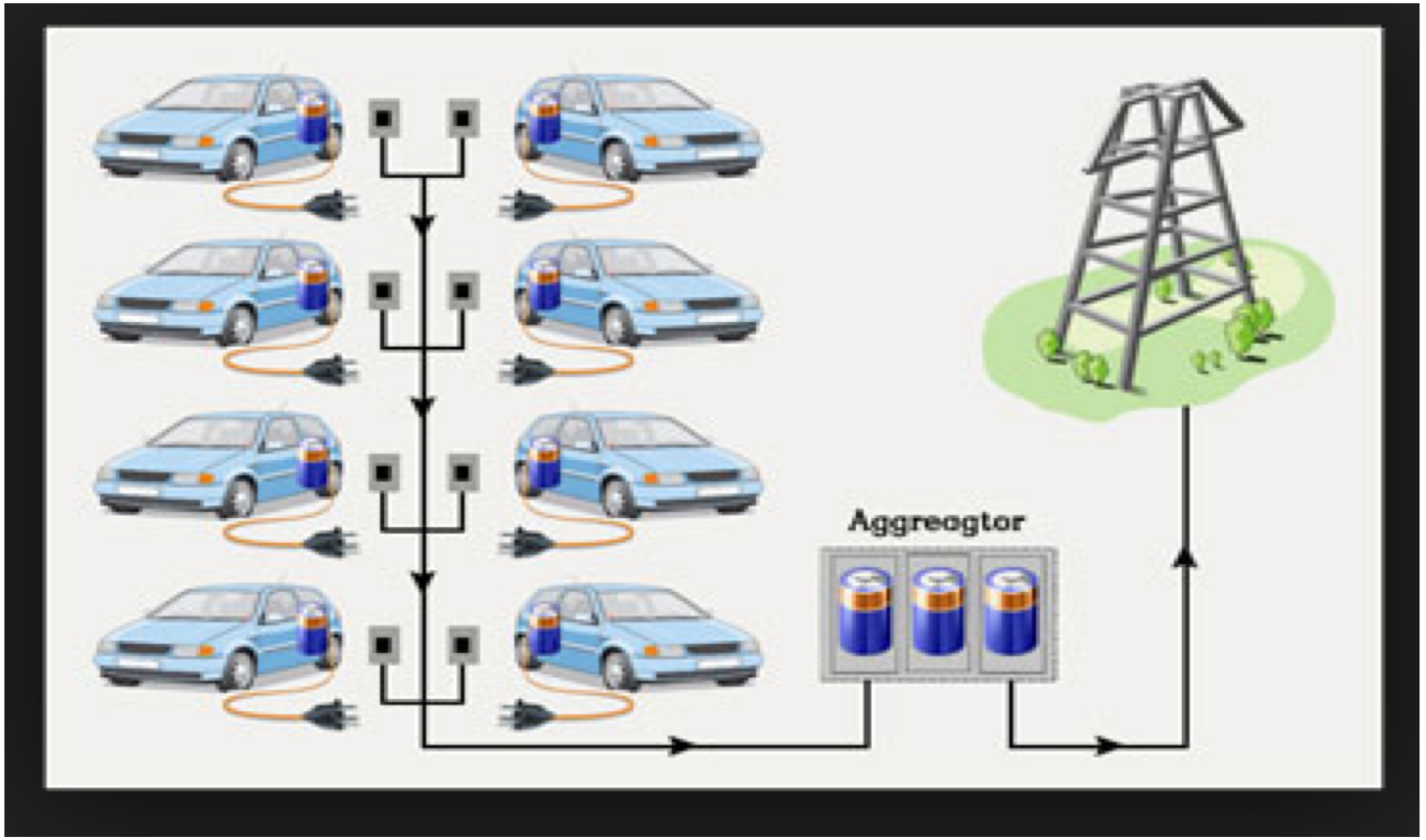
Source: IEA EV Outlook 2017

# Global EV charging outlets, 2010-2017




Source: IEA Global EV Outlook 2018

# EVs can improve efficiency and stability of decarbonised electricity sector

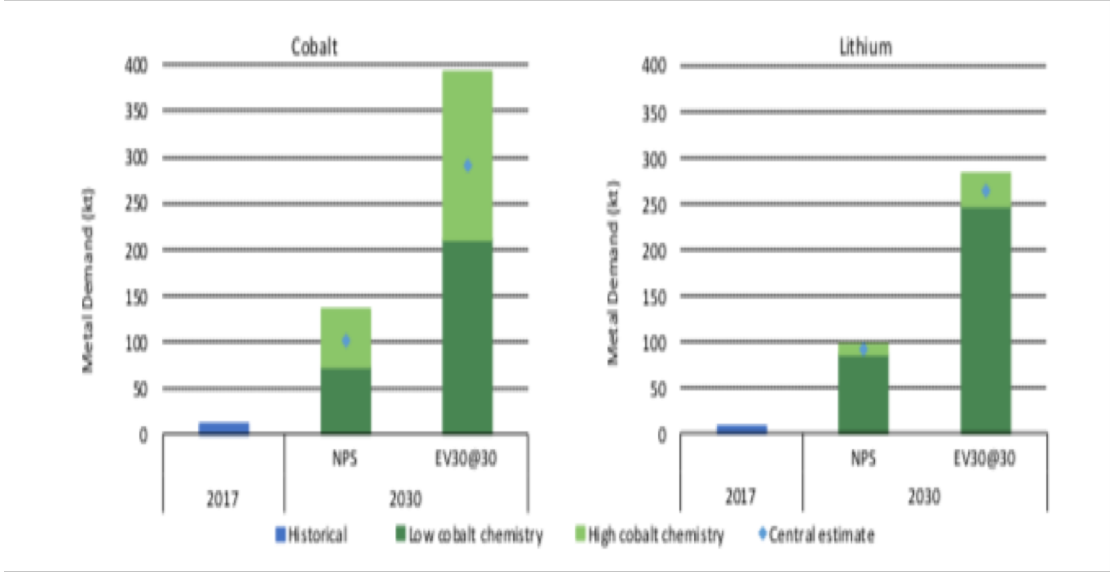



https://www.google.com/search?q=Vehicle+to+grid+contribution+to+electricity+system&client=safari&rls=en&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiE1Nqhg53eAhWSDuwKHcAQCgIQ_AUIDigB&biw=1908&bih=1220#imgrc=xArT2AfiwLbRhM:

# What factors limit/shape EV penetration?

- Good (improve social welfare)
  - Policies to deal with congestion (all vehicles)
  - Alternative vehicle technologies (competition)
  - Alternative modes of transport and urban planning
  - Social behaviour – preference for sharing, walking, cycling
  - Concern over affected parties (equality, employment)
- Not good (do not improve social welfare)
  - Supply chain problems
  - Charging infrastructure barriers
  - Electricity network and generation barriers

# Supply chain pressures
# Cobalt and lithium demand, 2017 + 2030




Source: IEA Global EV Prospects 2018

- Commercial incentives are strong to relieve these supply chain pressures
- However, battery costs will limit early and rapid EV penetration before mid 2020's.

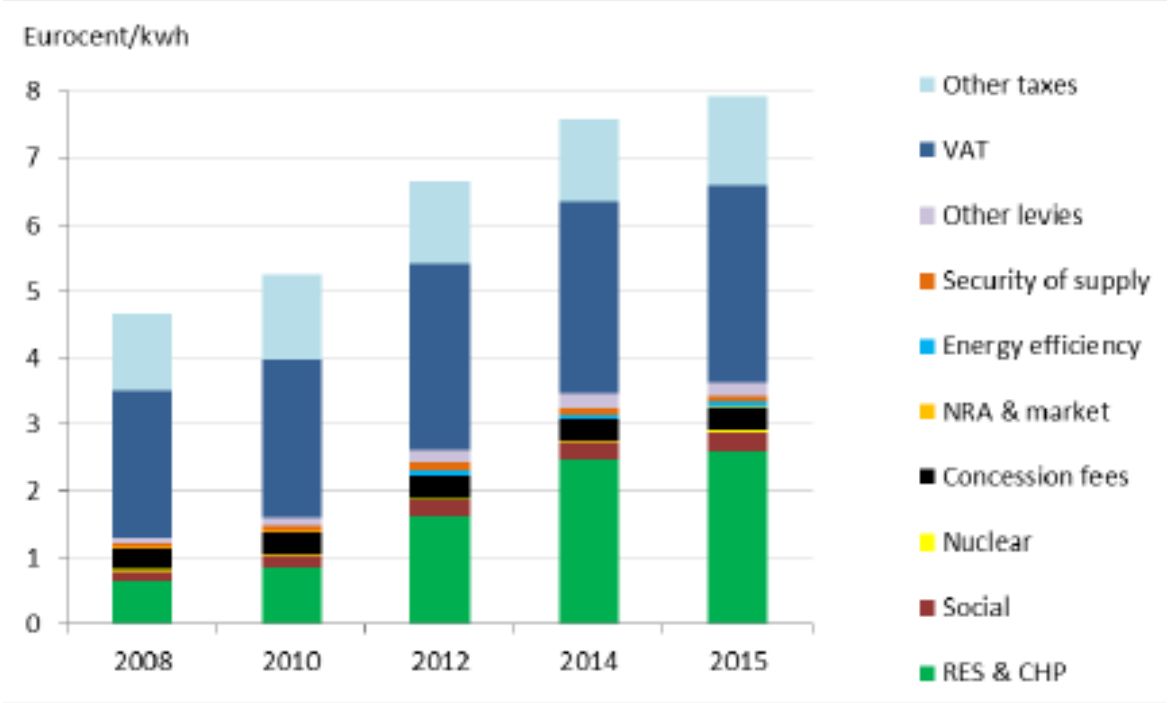
# Charging infrastructure barriers

- Inadequate charging infrastructure caused by various problems
  - Chicken/egg problem delays building charging networks
  - Restrictions on private investment in infrastructure
  - Uncertain policy to remunerate electricity distribution services required to support EV charging
  - Planning difficulties and lack of coordination between charging companies and distribution companies
  - Limited charging infrastructure favours PHEVs and reduce potential for emission reduction compared to penetration of BEVs
- Investment requirements could be significant in some regions
  - Some banks estimate major investment requirements (over $2 trillion) in charging infrastructure for full global EV adoption

# Electricity barriers to EV deployment

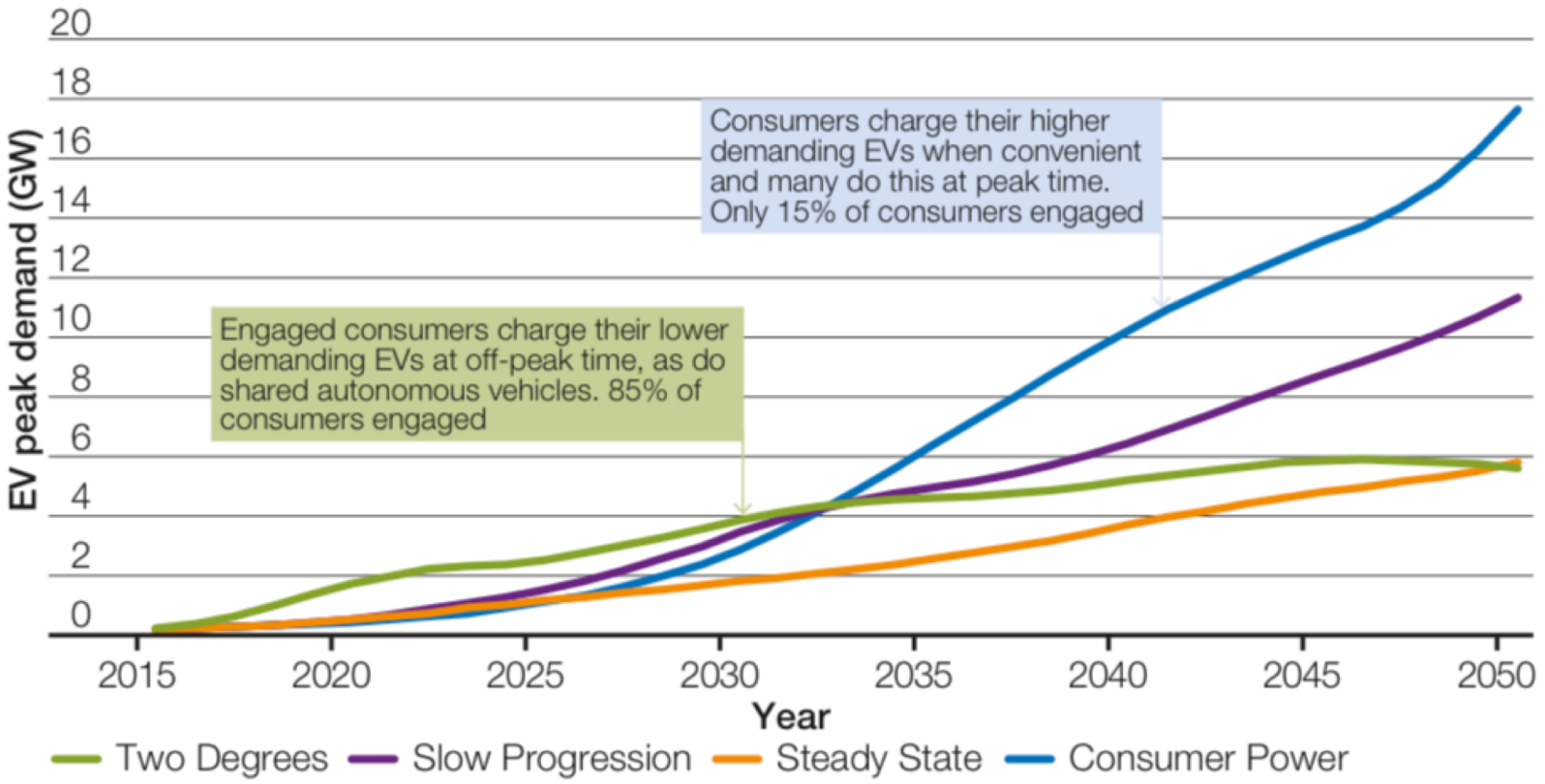
- Fiscal policy trends (as in EU) can make EVs uncompetitive with ICEs
- Badly designed (volumetric) tariffs can encourage consumers to fill up PHEVs with gasoline, undermining environmental benefit of EVs
- EV benefits are greater where electricity is not decarbonised
- One bank estimates almost $3 trillion of investment in grid capex for full adoption of EVs.
- The economics of EVs are less attractive where electricity markets do not enable EV owners (through aggregation) to sell battery storage services
- Key challenge is to encourage smart charging

# Fiscal policy trend in EU 2008-2015
# Rising taxes & levies on electricity prices for households




*Source*: Energy prices and costs in Europe {COM(2016) 769 final}

# UK Incremental Peak Electricity Demand for EVs Scenarios 2015-2050
# Smart charging (off-peak) limits investment




Source: National Grid

# Deep EV penetration very likely

- EV penetration will increase rapidly, but ICE vehicles will dominate until the key barriers are overcome: battery cost and infrastructure (electricity and charging)
- Once these barriers are overcome, expect deep penetration to replace ICE as dominant technology because the key actors favour it or are now planning for it:
  - Governments for environmental and other policy reasons
  - Electricity sector because it benefits in various ways
  - New entrants (EVs, sharing services, aggregators)
  - Consumers will get a superior vehicle and price will be acceptable
  - Even incumbent transport & energy companies preparing
- This deep EV penetration is expected after 2030 and will require continued policy support at least until then

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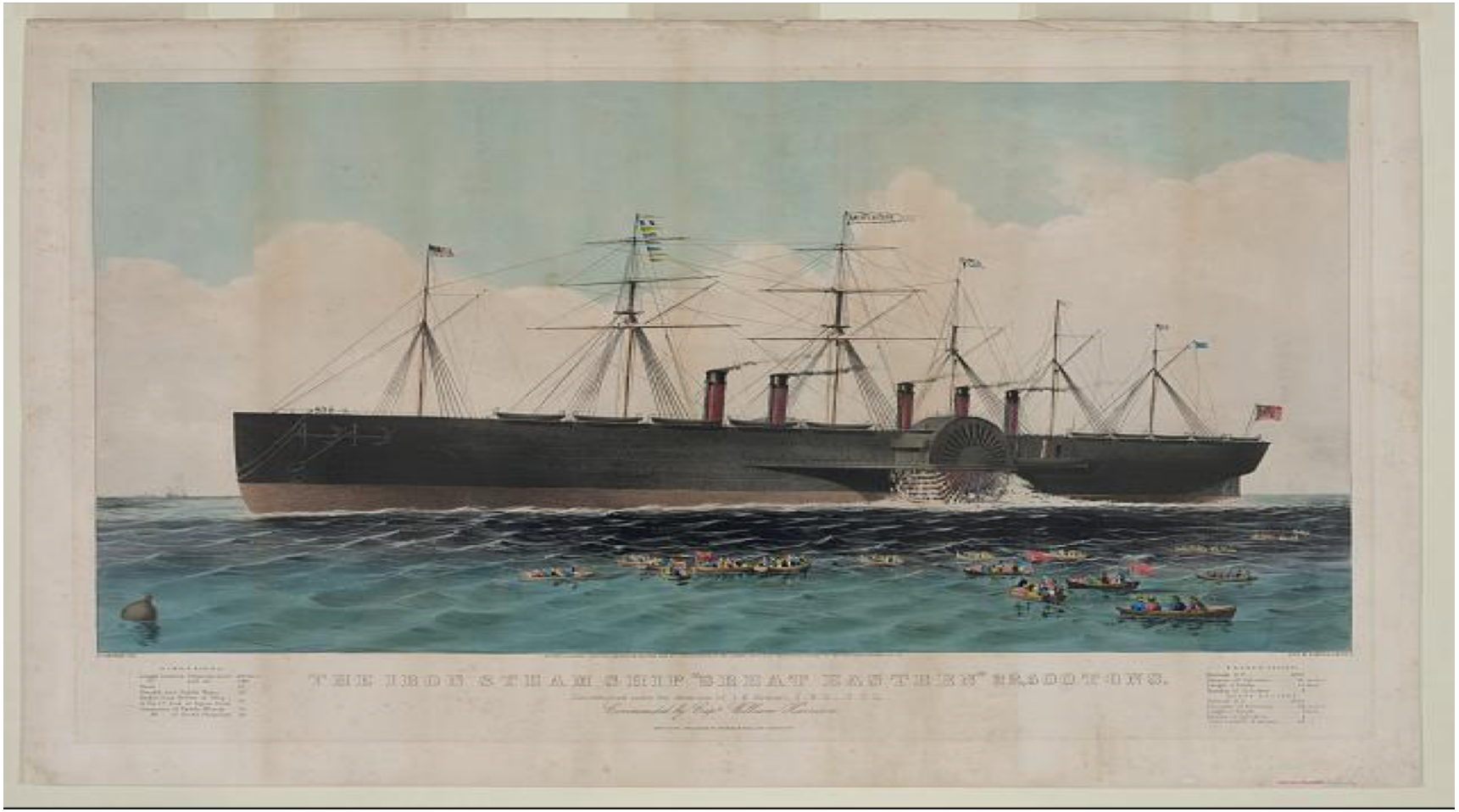
# Disruptive implications

- Power sector
  - EV penetration means expansion of power sector and supports deep RE penetration
  - Reinforces vertical disintegration, with specialised focus on distribution networks and collaboration with connected customer with distributed energy resources
- Oil
  - Reduced oil demand; much greater impact if heavy transport decarbonised
  - Opportunities from EV penetration for expanded forecourt services and building on retail brand reputation with customers
- Transport
  - As disruptive for transport sector as renewables are for electricity
  - New OEM entrants and competitive pressure (e.g. China, Tesla, Dyson)
  - New cost structure: lower manufacturing and maintenance cost
  - Potential for stranded assets affected corporate valuation
  - Labour market: pressure to reduce employment at OEMs (see GM announcement)
  - New business models: sharing, autonomous vehicles
  - New corporate structures focused on connected customers

# Sail to steam - why the hybrid period may be short



Source: Currier & Ives : a catalogue raisonné / compiled by Gale Research, Library of Congress, LC-DIG-pga-00795. URL: http://www.loc.gov/pictures/item/2002699730/

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# Policy

- Charging infrastructure
  - Encourage private investment with clear signals about policy goals
  - Public support for ‘missing’ charging infrastructure
  - BEV focus offers greater guarantee of environmental benefits
- Electricity
  - Align fiscal policy with decarbonisation of transport (in EU, reduce public policy levies now in electricity tariffs)
  - Tariff reform to encourage ‘smart charging’ (variable charge to recover only variable costs, with dynamic prices reflecting real time cost) will reduce required electricity generation and grid investments
  - Market design to facilitate sale of battery services to electricity system
- Policies to promote competition (dealerships, technology neutrality)
- Transition arrangements to smooth political economy frictions

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# Conclusion

- EV deep penetration very likely post 2030, although volume of vehicles limited by alternative sustainable mobility options
- EV deep penetration very disruptive, especially for transport sector; potentially as great as RE for electricity sector
- Important new opportunities and risks in electricity, transport and oil
- Policies still needed to address key barriers, especially electricity and charging infrastructure costs, and to smooth transition frictions
- Key to remember that technological change has unexpected consequences and that the transition can be much faster than anticipated
- So, important to drive the change.

Thank you

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