



Technology pathways and policies for electric mobility in Europe and Asia

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Electric car take-off started slowly ...

- end of 2014: 665,000 passenger EV worldwide
- 0.08% of all passenger cars globally

... but is likely to accelerate quickly:

- Growth of sales very fast
- Large offer of technologically mature EV
- Technological progress reg. batteries cost and density
- Stricter regulations



Why? Enormous **uncertainty** stemming from

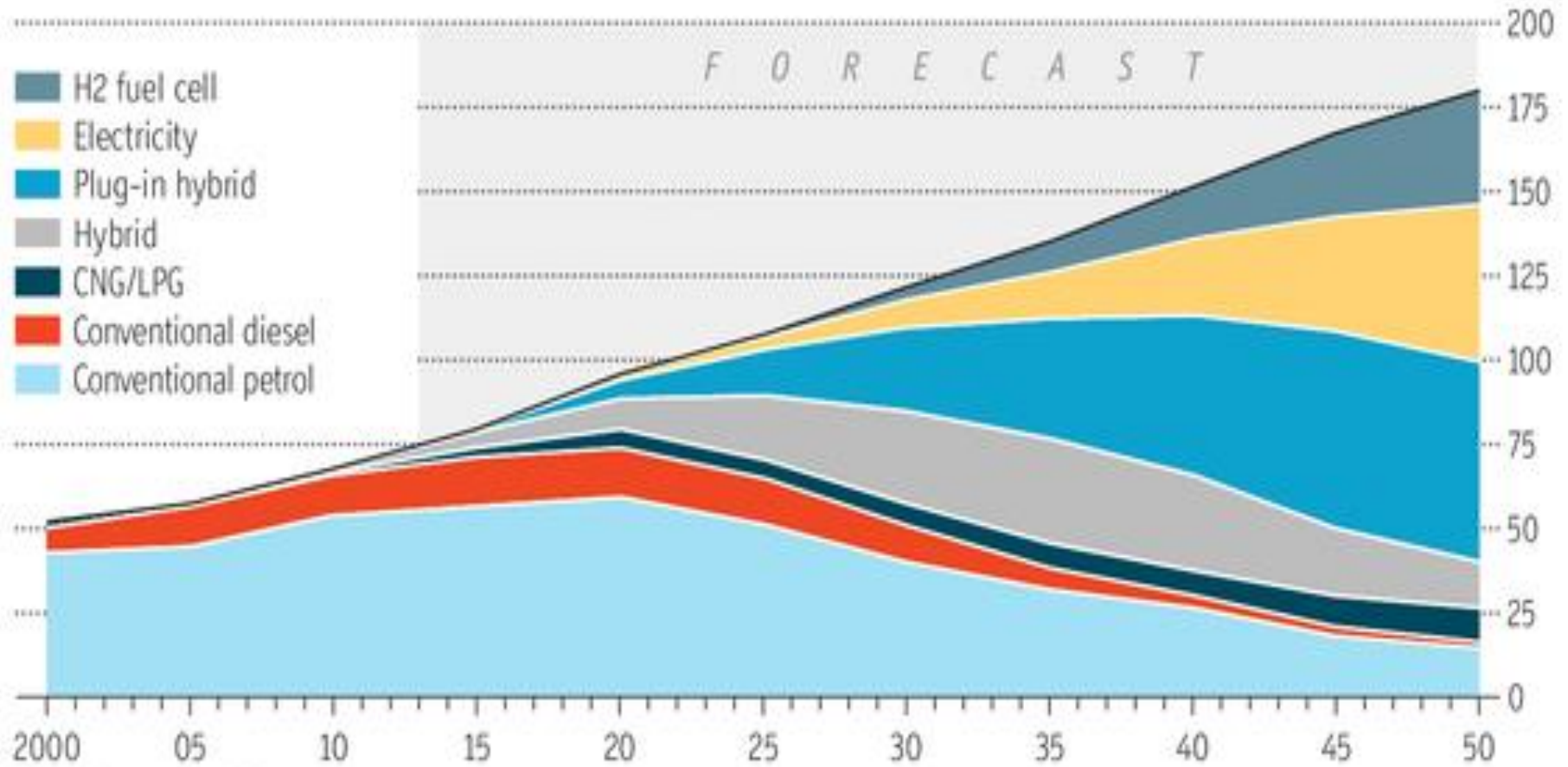
- **technology** risks: Time to solve battery problems (low energy density, high cost ..)? How fast will competing technologies (fuel-cells, methane) develop? in comparison with battery-electric vehicles? And to what extent do carmakers succeed in improving the efficiency of ICE
- **market** risks: How fast will battery prices go down, how will oil prices develop ..
- **policy** risks: How strictly will governments regulate, will there be a carbon price, will fossil energy be taxed, will there be incentives for EV purchase ...



Carmakers pursue diversified strategies

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Light-vehicle sales by technology type, units m



Source: International Energy Agency

Source: Economist



Key questions

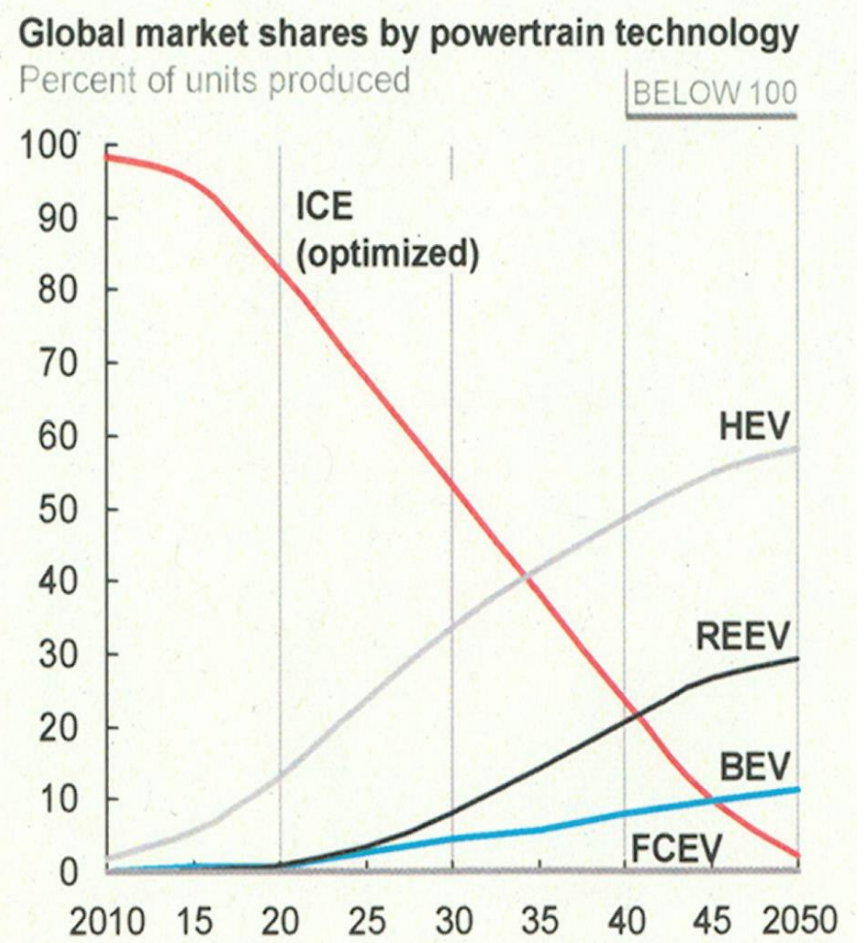
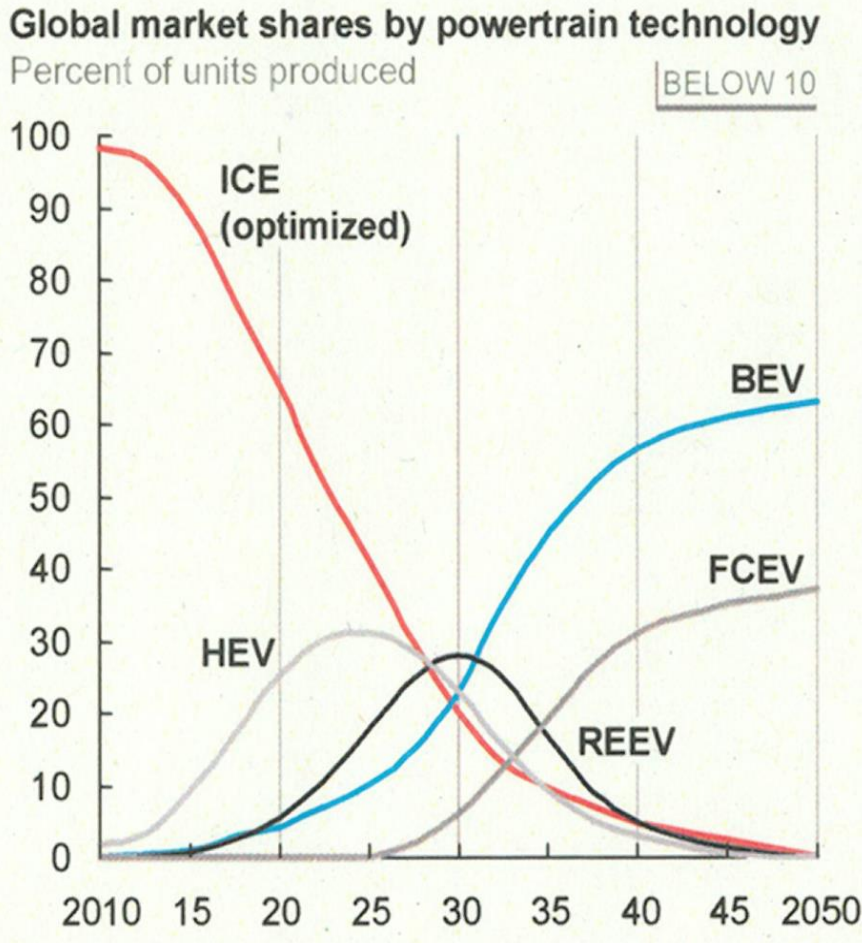
- **What are the right policies?**
- **How are technologies developing (differently) across the globe?**



What can policymakers do?

- **Concerted action** to overcome coordination failure
- **R&D** to accelerate technology development
- Encourage city and fleet **trials**
- Subsidies (e.g. EV purchase)
- Public procurement
- **Predictable policy roadmaps related to emission standards**, fuel taxes, subsidies
- Esp. regulatory standards drive technology choice.
Example: Admissible fleet emissions in the EU

Policies



McKinsey 2011: Boost. Transforming the powertrain. p. 7



Sequencing:

- Decarbonise electricity generation first
 - Electrify end-uses (cars) later when energy mix is „clean“
- If not, total emissions (well-to-wheel) may actually **increase!**



“Well-to-wheel” CO₂ emissions (g/km) of ICE and electric vehicles assuming different energy mixes

	Total well-to-wheel
Conventional ICE car	145-215
EV EU-27 mix 2010 (27% nuclear, 20% renewable, 53% fossil)	85-105
EV French mix (75% nuclear, 20% renewable, 5% fossil)	20-25
EV 100% renewable (50% photovoltaic, 50% wind)	8

Source: ERTRAC (2010).



Technologies tend to evolve gradually along certain pathways that reflect specific country conditions / policies

... especially when markets are not yet mature and deployment depends on (national) politics and incentives

We compared France and Germany, China and India.



Different initial conditions:

- Expanding home markets in China and India, contraction in Europe
- Sophisticated consumers mainly in Europe, emerging consuming middle classes in China India, demand simpler goods but economies of scale
- More established innovation systems & more related variety in Europe
- Strategies for technology adoption differ. In emerging Asia huge role for FDI, M&A, return migration, tapping into OECD-IS
- Financial power in China > India, and Germany > France
- Concepts of Industrial and Innovation Policy more state-led in China and France than Germany and India ...
- Lower labour costs in Asia
- Energy security valued higher in Asia than carbon emissions ...



Electric mobility France

Specific conditions relevant to EV technology development

- French carmakers with competitive edge in *small functional* cars
- Dependence on Southern European market => crisis
- Cheap nuclear energy makes pure BEV attractive
- Innovation leader in certain diesel technologies
- Long tradition of (military-led) battery technology
- Tradition of state-led industrial policy favours strong incentives for electric mobility: purchase subsidy, public procurement, charging infrastructure



Electric mobility France

Emerging technological specialisation

- Early mover in BEV
- Focus on small, affordable cars
- diesel hybrid technology as an area of specialisation
- Specific national battery technology developments



Electric mobility Germany

Specific conditions relevant to EV technology development

- Strong car industry specialised in luxury cars. High emissions, lobbying against EU regulations. Germans pay twice as much for new cars as French
- Strong export orientation
- Customers value hi-tech
- New generation open to new mobility concepts
- Strong automotive innovation system
- Energiewende: Electric mobility clearly linked to renewables
- Battery research abandoned in the 1970s
- Industrial policy focused on R&D, innovation clusters, city trials



Electric mobility Germany

Emerging technological specialisation

- hi-tech / high cost solutions, friction-free combination of electric + combustion engine, break energy recuperation, high demands on power electronics.
- Battery Management Systems a brand-differentiating factor => no battery swapping
- Fancy e-cars for high-end techno-friendly consumers. First hybrids Porsche Panamera, Mercedes S class ...
- Late market entry, but via modular production concepts rapid catching up => economies of scale with many drive technologies
- Smart grid solutions to cope with renewables ??
- Young urban consumers => new mobility concepts ??



Electric mobility China

Specific conditions relevant to EV technology development

- Huge market growth with first-time consumers in low-end market
- Own innovation capabilities still incipient
- Massive subsidies for new drive technologies
- Main reasons: leapfrogging und urban pollution control: EV “allowed” to drive on fossil fuel energy mix
- Segmented market: SOE, Chinese private, Joint Ventures
- Massive pressure on international investors to share technologies
- Regulation discouraging “frugal” innovations



Electric mobility China

Emerging technological specialisation

- Huge market for two- & three-wheelers with lead acid batteries
- Regional development of low speed, low-voltage, low-range vehicles
- range-extended EV with simple additional motorbike engine
- Strong in public fleets, buses
- battery-swapping tested
- Remote battery monitoring systems to substitute for absence of integrated BMS
- EV built on ICE-car platforms
- Strong market position in battery cell manufacturing ... leading to wider competitive edge in batteries?



In sum:

- Lot of variation in policy and technology development

Why is this important?

- More experimentation
- More adaptation to local requirements
- More country ownership if there is national technology development and new competitive advantages



Thank you for your attention !