

# Insights into economics of future vehicles

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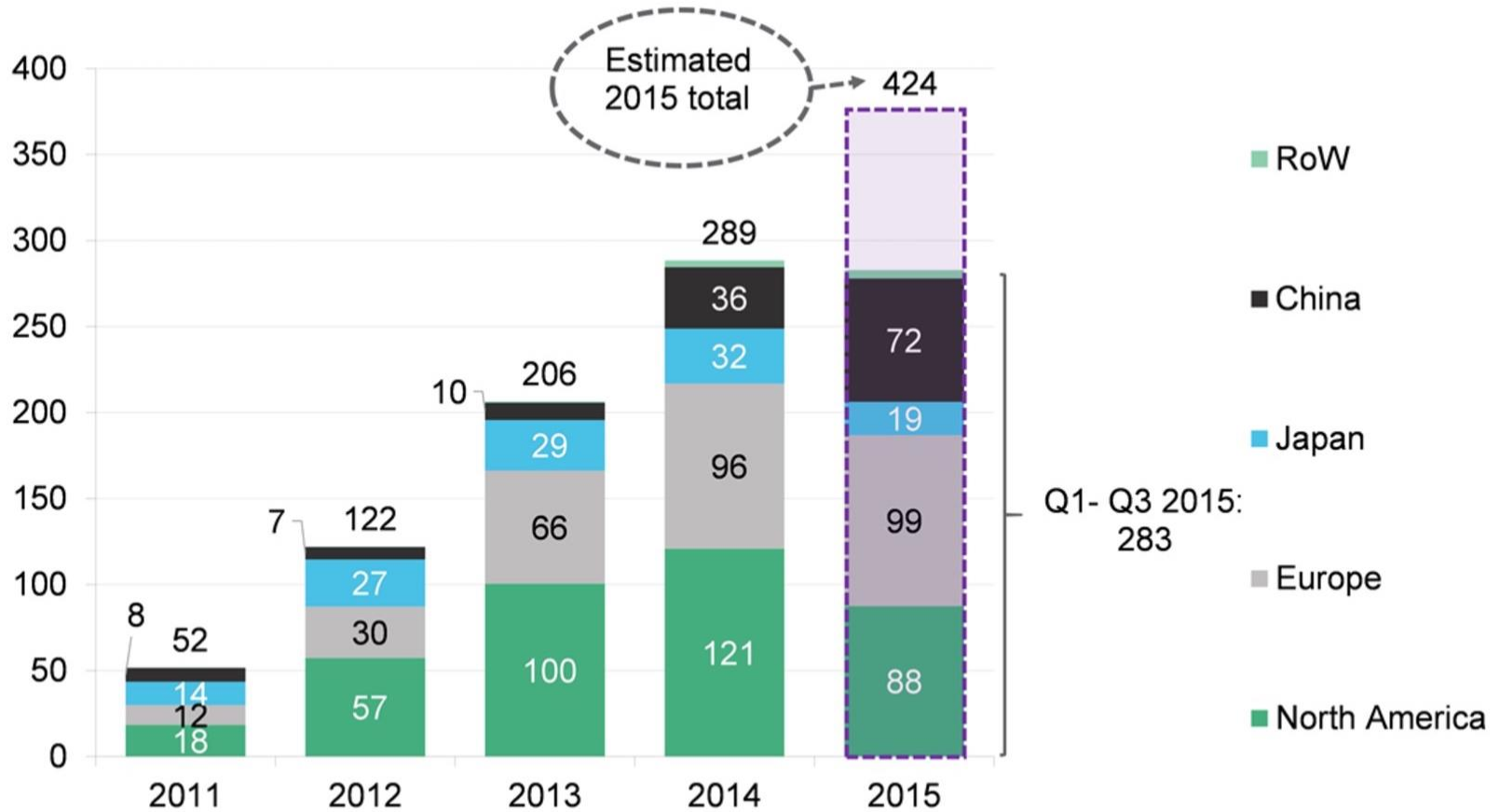
Director Development  
Energy Center EPFL



Global Issues – 15 March 2016

# Global EV sales

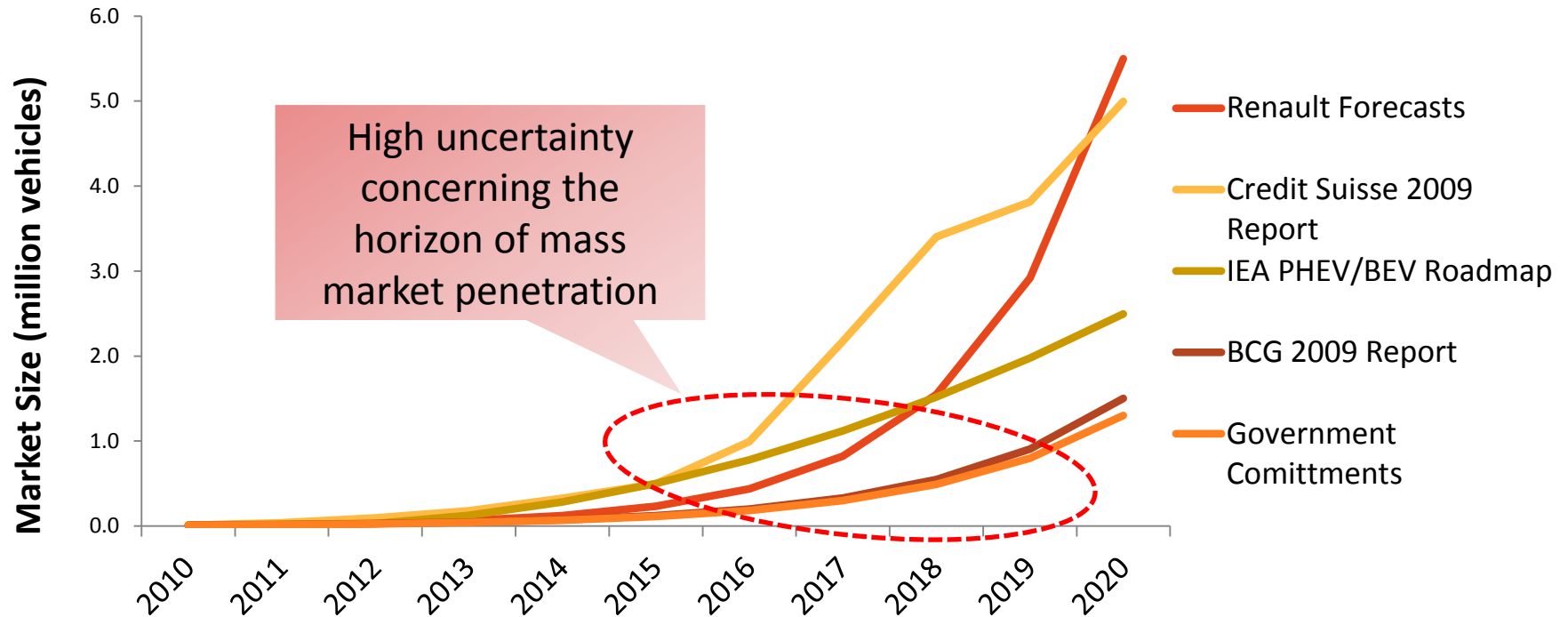
Thousand vehicle sales



The EV penetration rate of total new car sales in Q1-Q3 2015 was 0.63% - up from 0.49% at the end of 2014

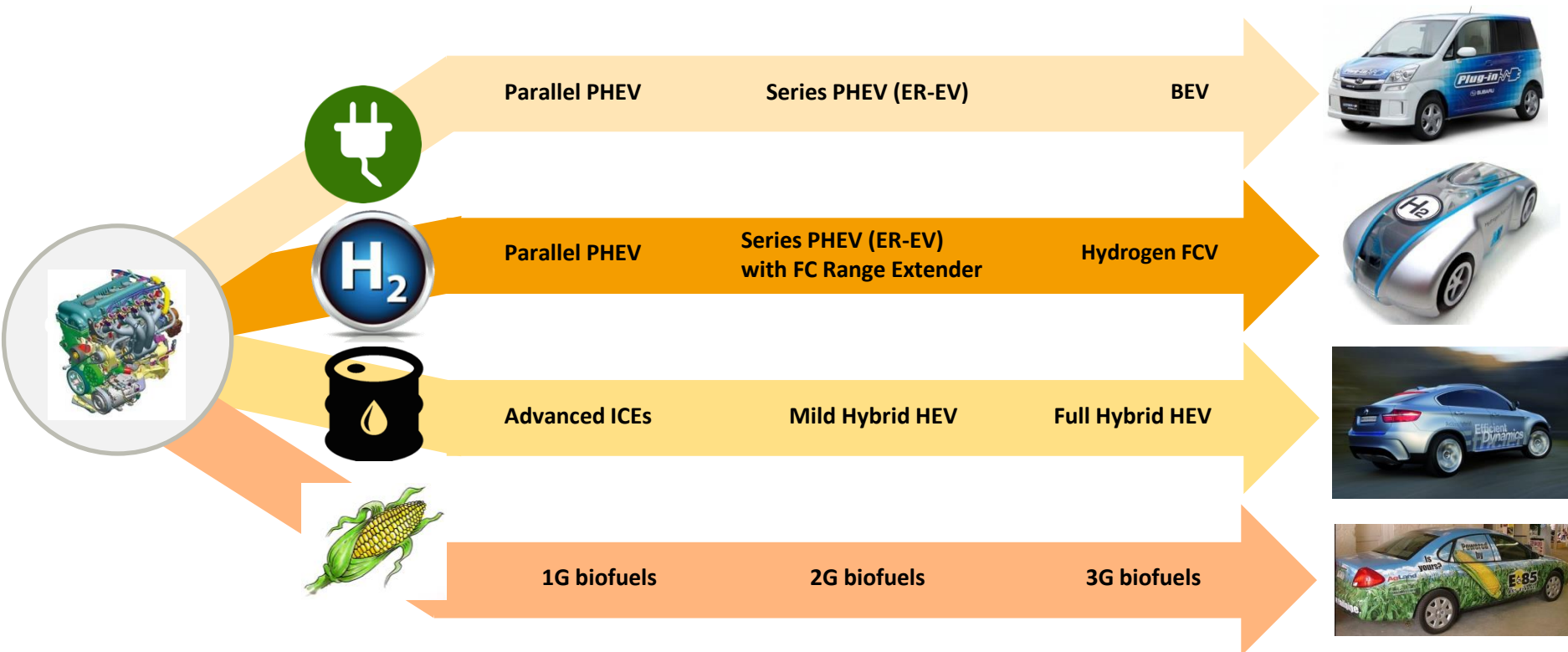
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# Large spectrum of sell projection for a market volume close to \$50 billions in 2020

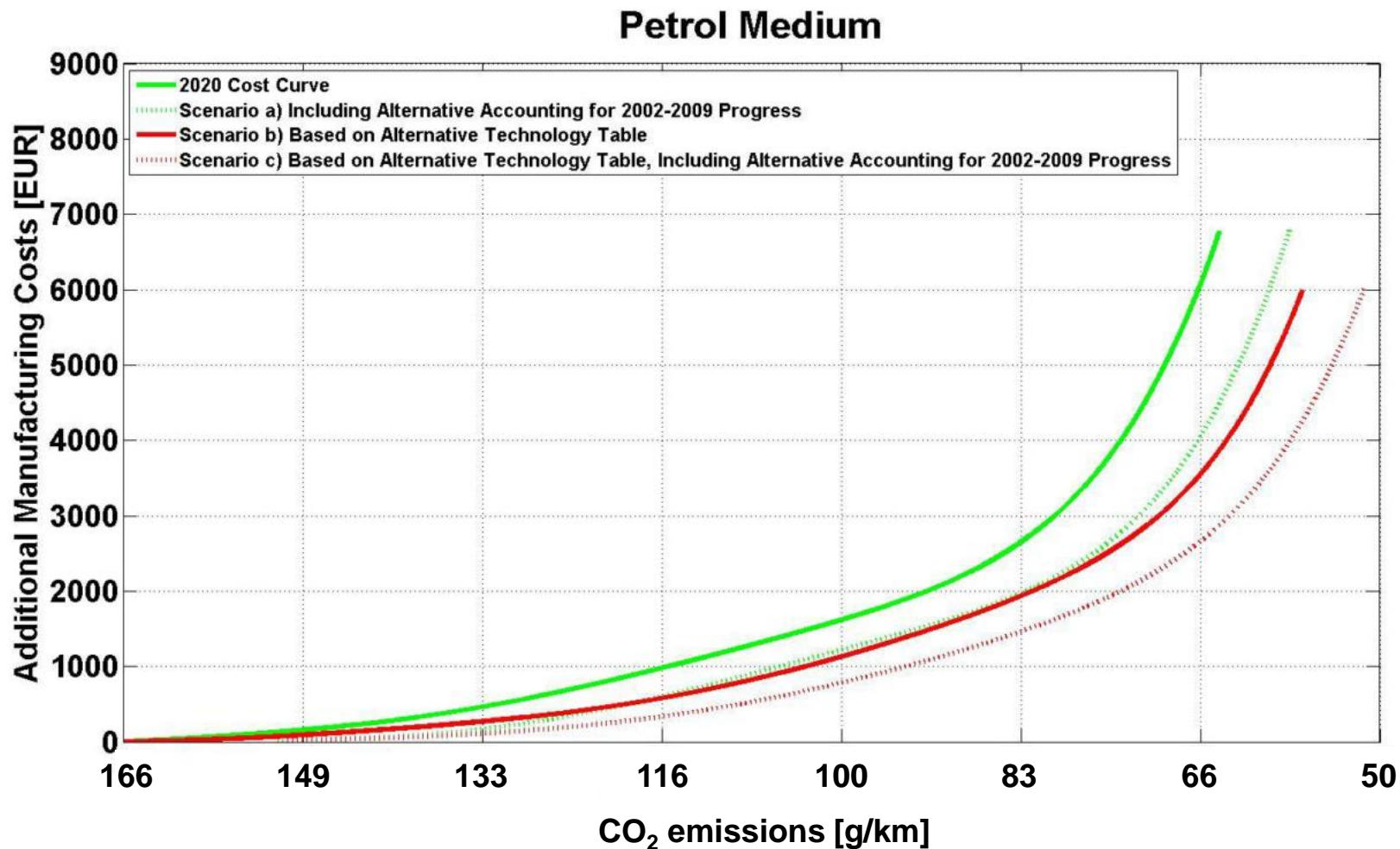


Source: E4tech Analysis of listed reports

# The electrification of the vehicles is one possible option for a low carbon transport



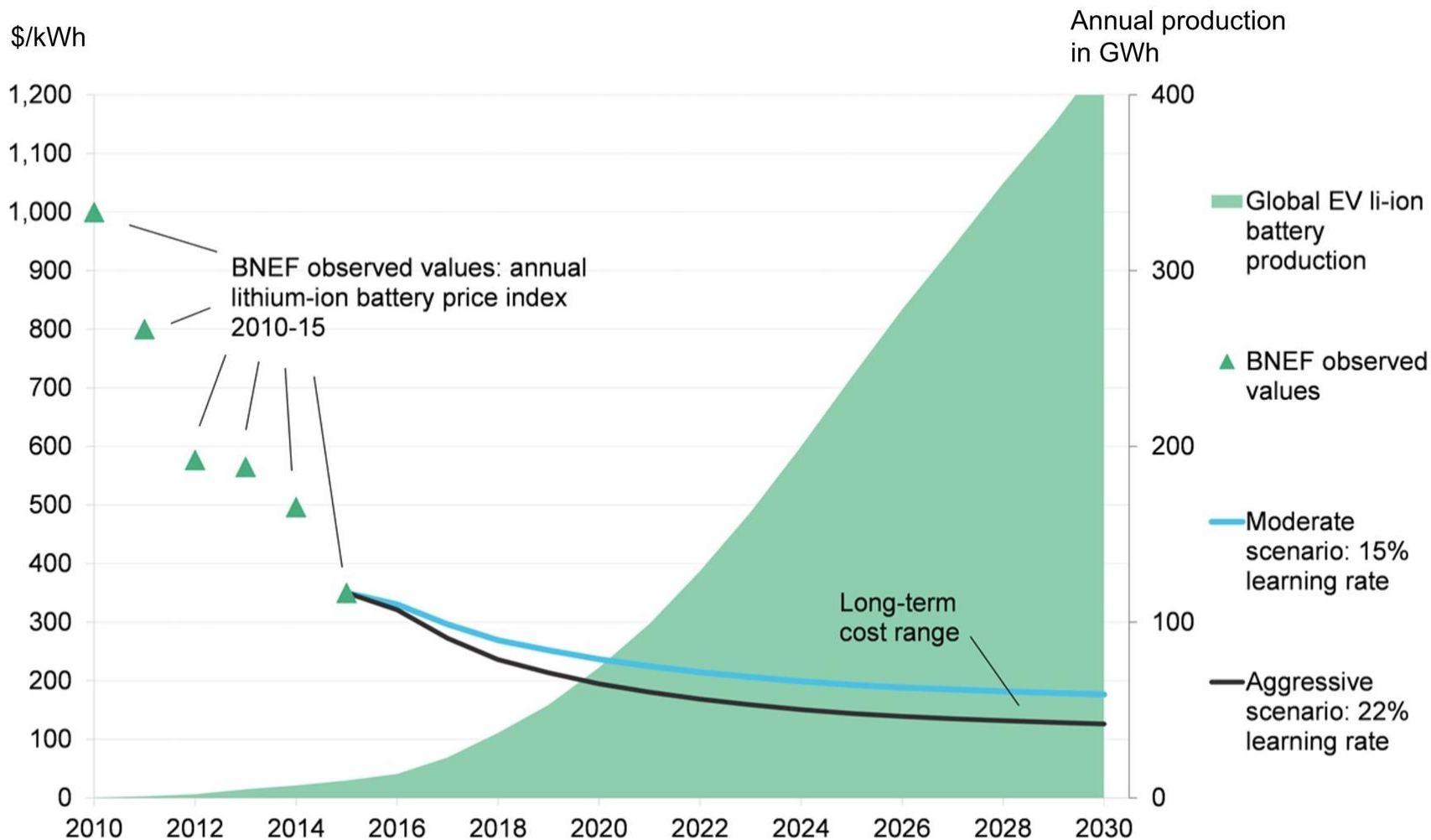
# Marginal cost of CO<sub>2</sub> emission reduction



ce: TNO

Cost curves for CO<sub>2</sub> emission abatement in medium size gasoline vehicles in 2020, relative to 2002 baseline vehicles (166g CO<sub>2</sub>/km)

# Battery price – past and future

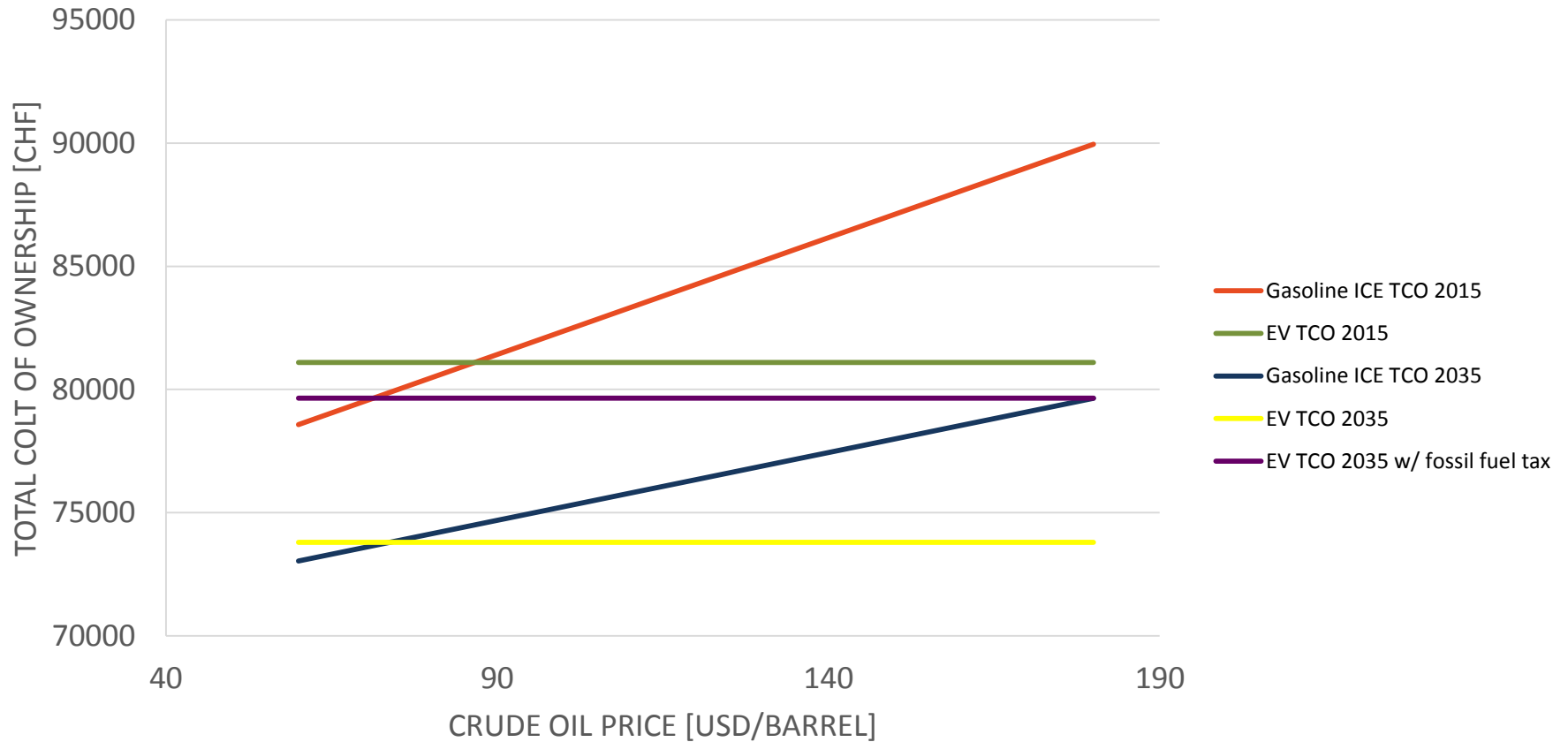


Note: Values from 2010-2015 are based on BNEF's annual battery price outlook. For more see here: <https://www.bnef.com/Insight/10299>. Cumulative production is based on total EVs sold and their respective battery pack size.

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# TCO scenarios

## TOTAL COST OF OWNERSHIP - 2035 95 gCO<sub>2</sub>/km












Source: EPFL Energy Center 2015

# Does electromobility make sense overall ?





# Existing policy instruments across selected countries

Incentives		France	California	Denmark	Germany	Sweden	Norway	Japan	China	Switzerland
										
Quotas	ZEV quota									
Monetary incentives	Purchase subsidy									
Fiscal incentives on CAPEX	VAT purchase tax									
	Registration tax									
Fiscal incentives on OPEX	Annual tax									
	CO <sub>2</sub> -based vehicle tax									
Non fiscal incentives	Free parking									
	Free toll road									
	Access to bus lanes									
	High occup. vehicle lanes									
	Low emission zone									

# Same energy, different power!



Consequence of  
the load shifting?



- **Number:** 176 million light vehicles in USA
- **Power:** Average Shaft power: 110 kW
- **Total power:** Capacity: 19,500 GW
- **In use:** 4% of time

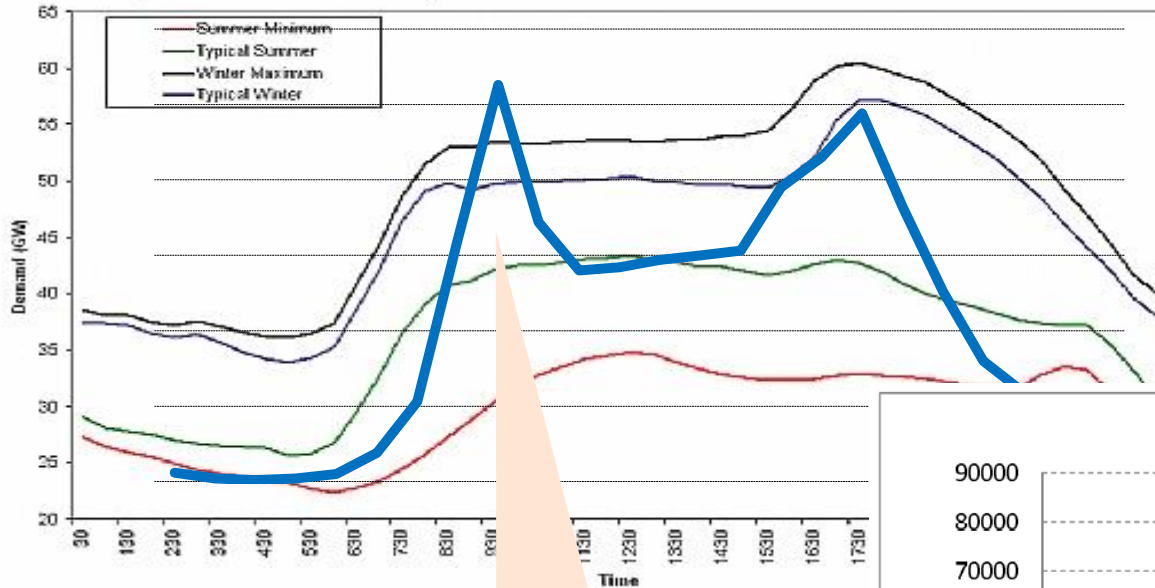
- **Number:** 9351 electric utility generators in USA
- **Power:** Average Unit Power: 64 MW
- **Total power:** 602 GW
- **In use:** Capacity factor : 57%

**Energy ratio: ~ 2:1**

**Power ratio: ~ 32:1**

# Intelligence of charging infrastructure is paramount

Figure 2.2 - GB Summer and Winter Daily Demand Profiles in 2007/08

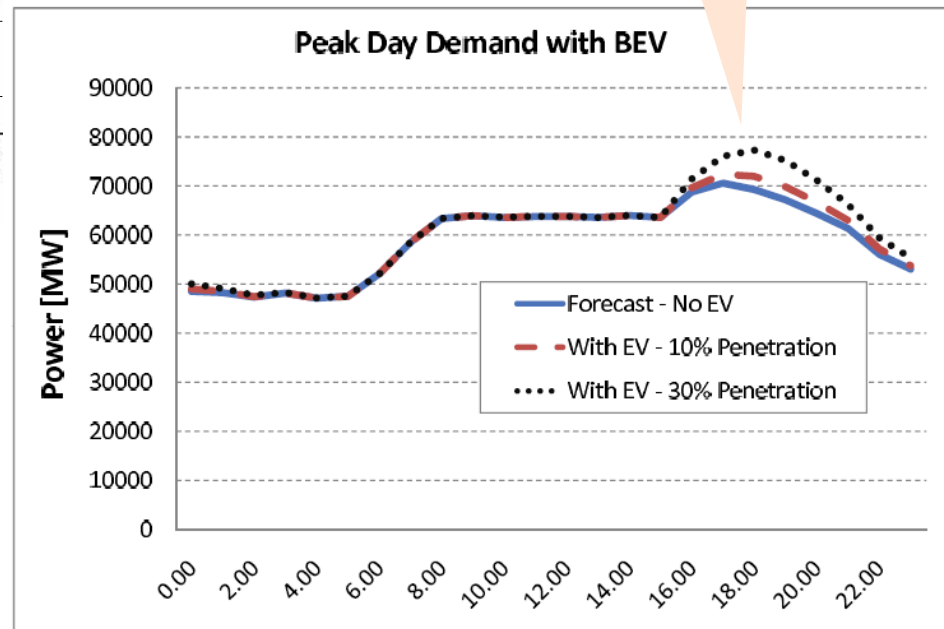


High increase of load peak (>10GW)

Time horizon: 1 day

High correlation between charging profile and load profile

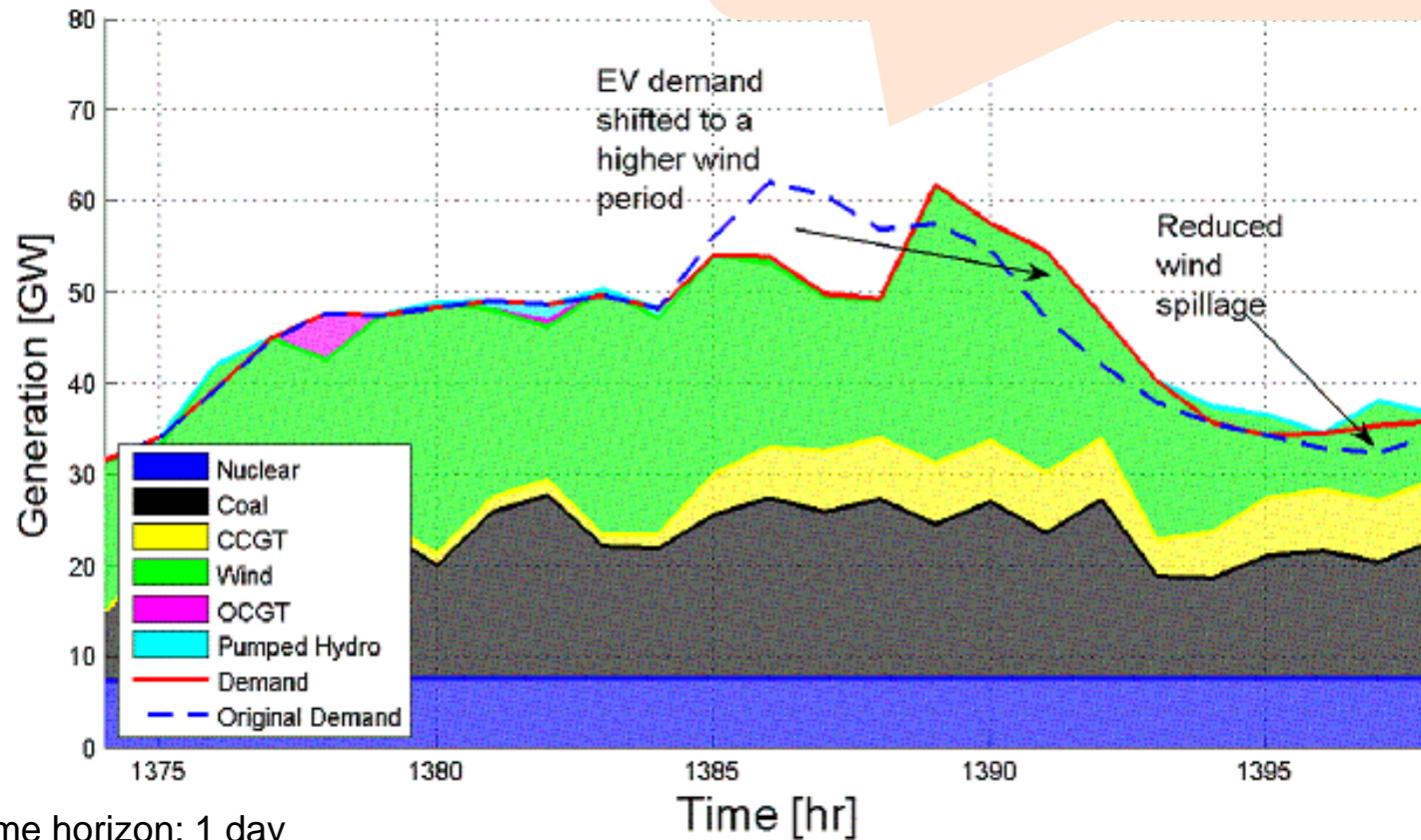
Peak Day Demand with BEV



# Demand Side Management opportunity, but issues of cost and payback remain

Case study Great Britain:

- Reduction of thermal peaks (> 10GW)
- Reduction of wind curtailment
- Reduction of pumped-storage

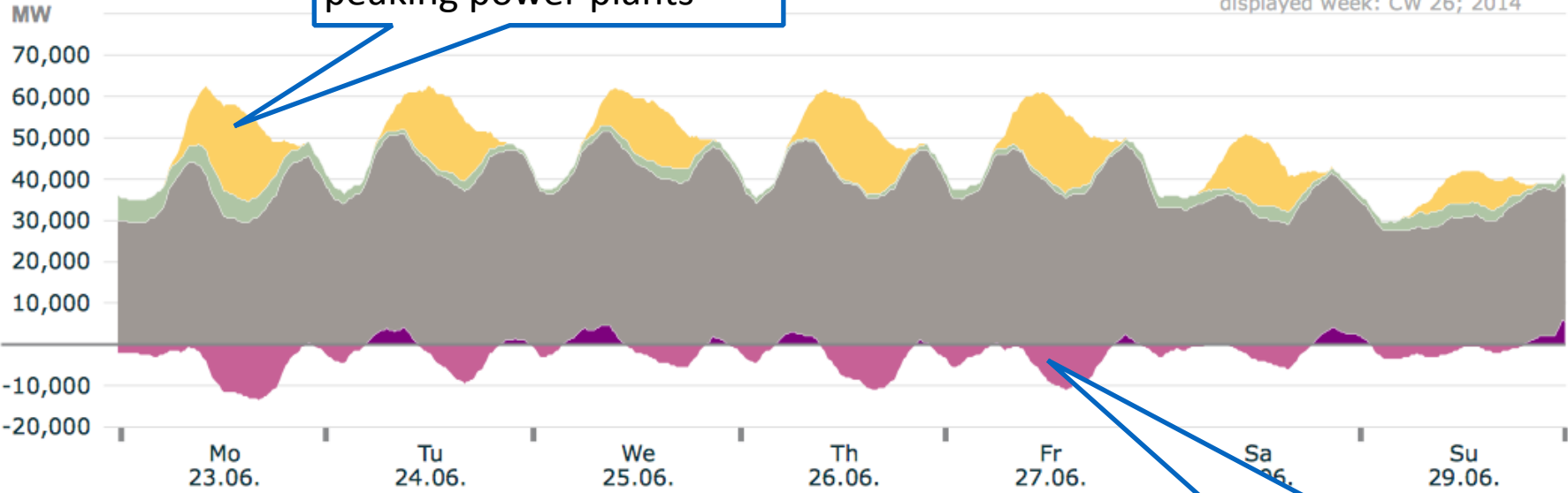


# We currently lack solutions for absorbing excess power

## Actual production

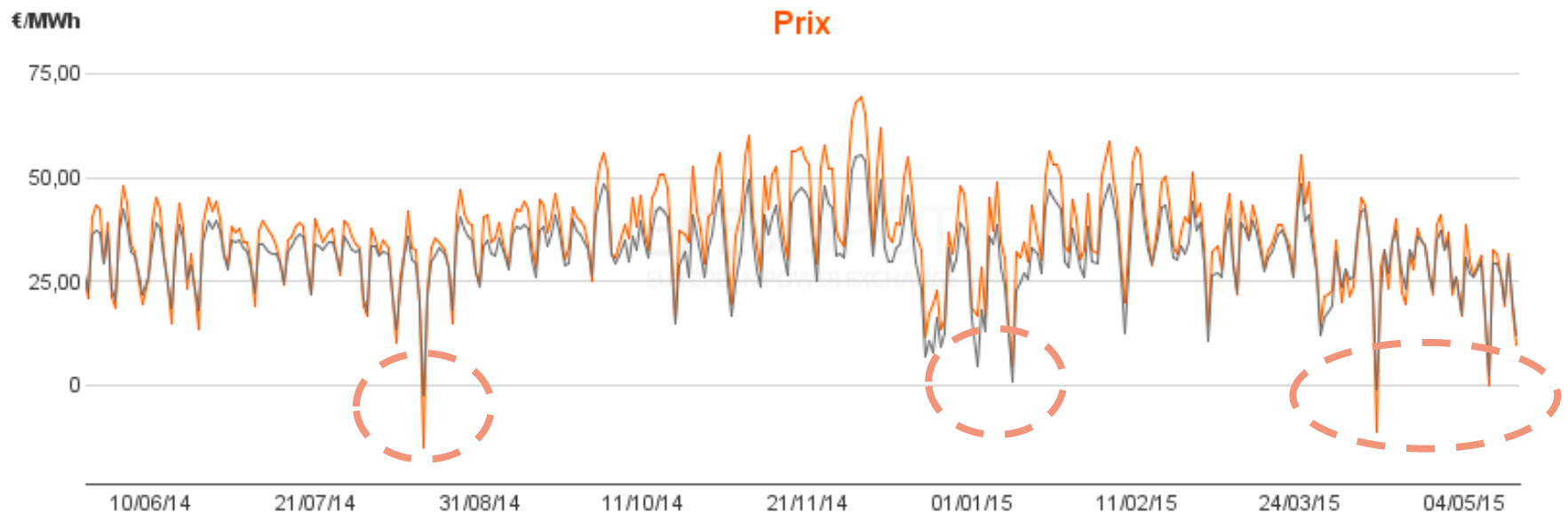
PV displaces traditional peaking power plants

Fraunhofer Institute  
displayed week: CW 26; 2014



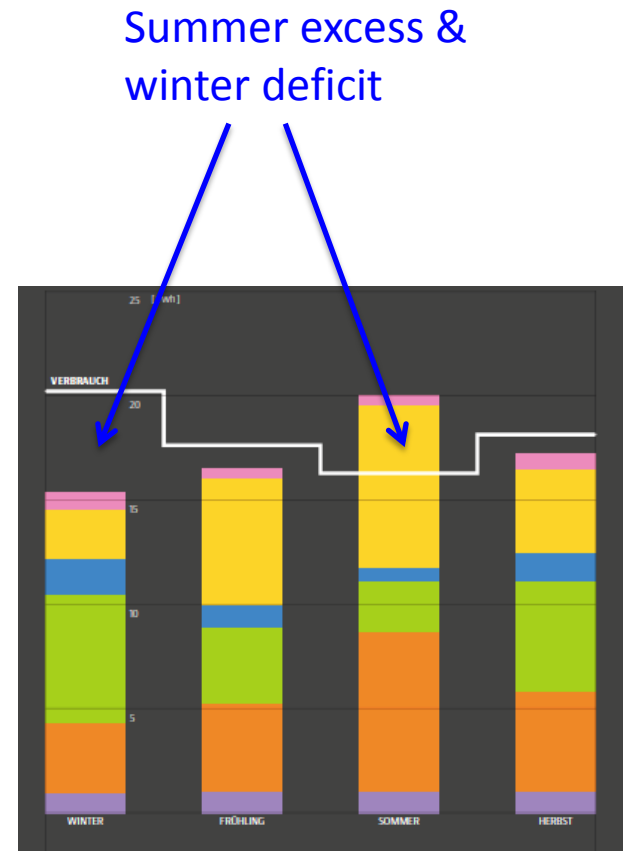
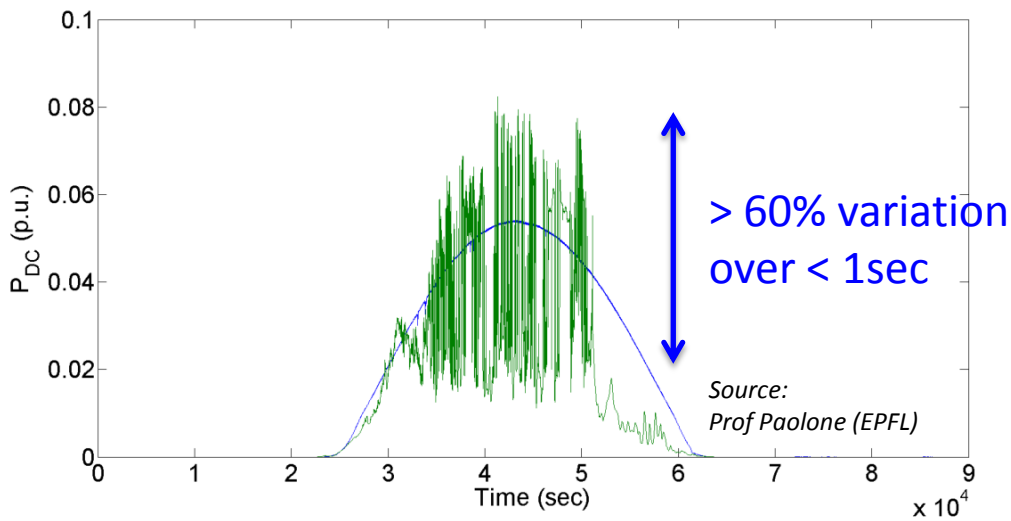
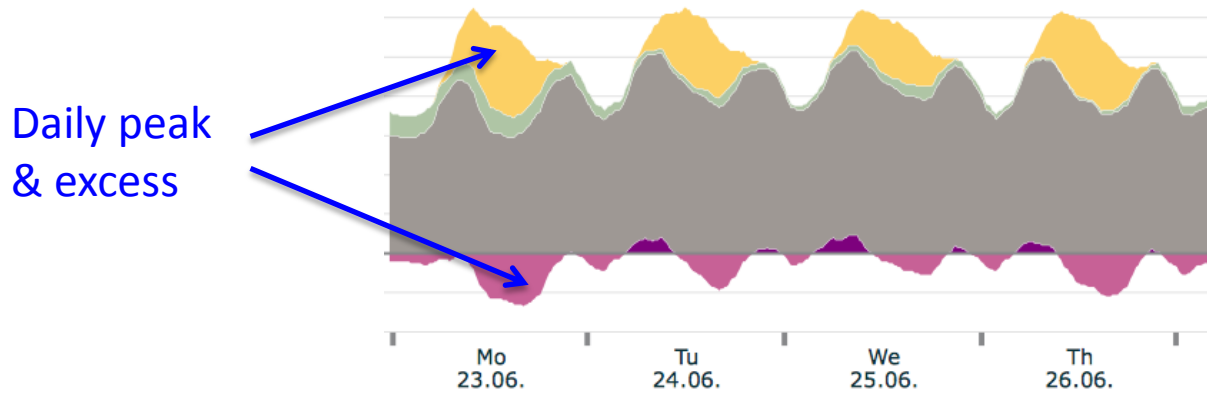
Excess power must be exported or curtailed.

## Events with negative electricity price are more and more frequent



An increasing number of event with negative electricity prices are being recorded on the EU spot markets, in line with the increasing share of intermittent renewables.

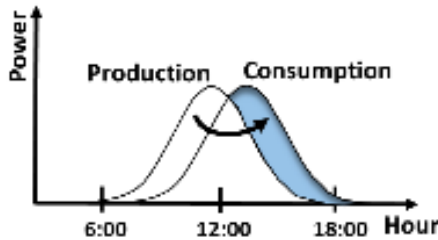
# A supply/demand mismatch on all timescales



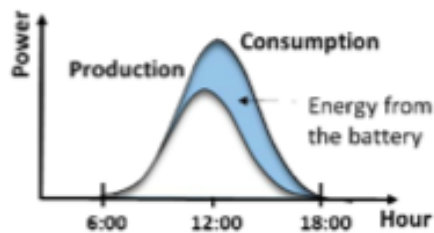
Source: Vuille et al. Book 2015

# This new paradigm generates vast opportunities for storage applications

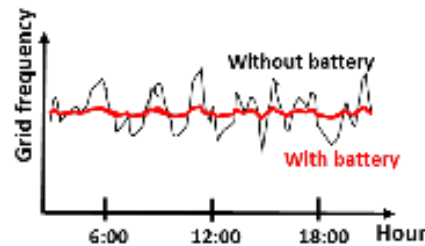
**Load leveling**



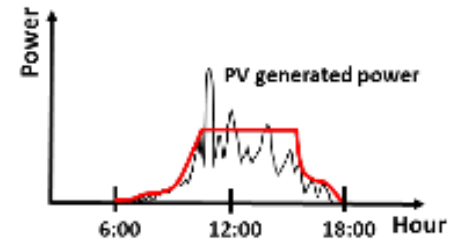
**Peak shaving**



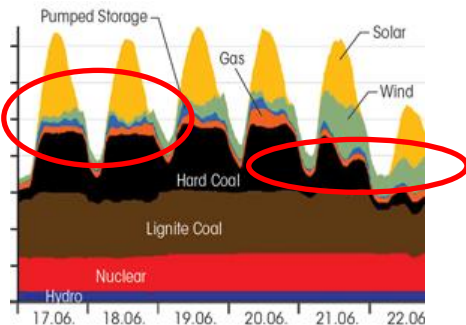
**Frequency control**



**Renewable smoothing**



**Part-load avoidance**



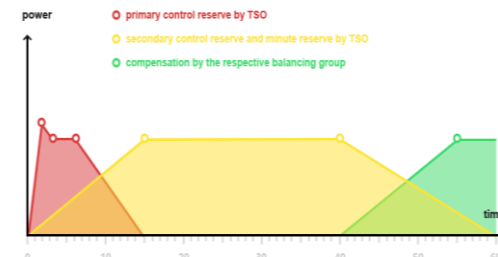
**Reduces need for Standing reserves**



**Backup power & black start**



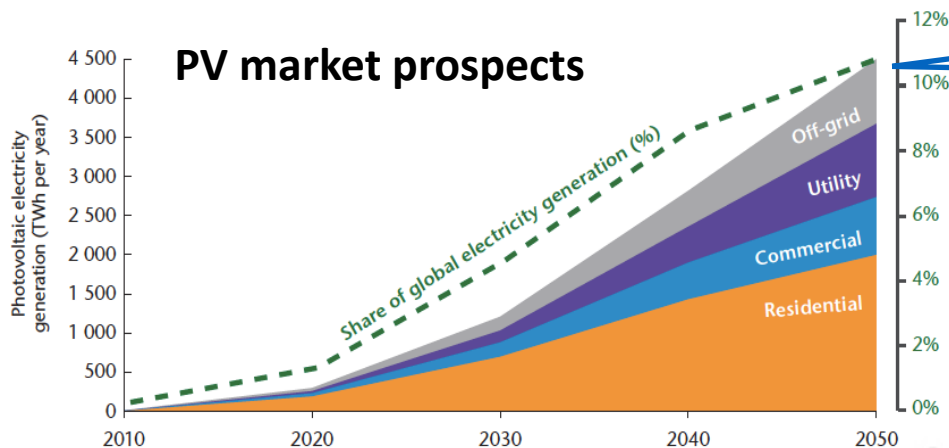
**Power control & capacity markets**





# This new paradigm generates vast opportunities for storage applications

**PV market prospects**



Source: IEA 2013

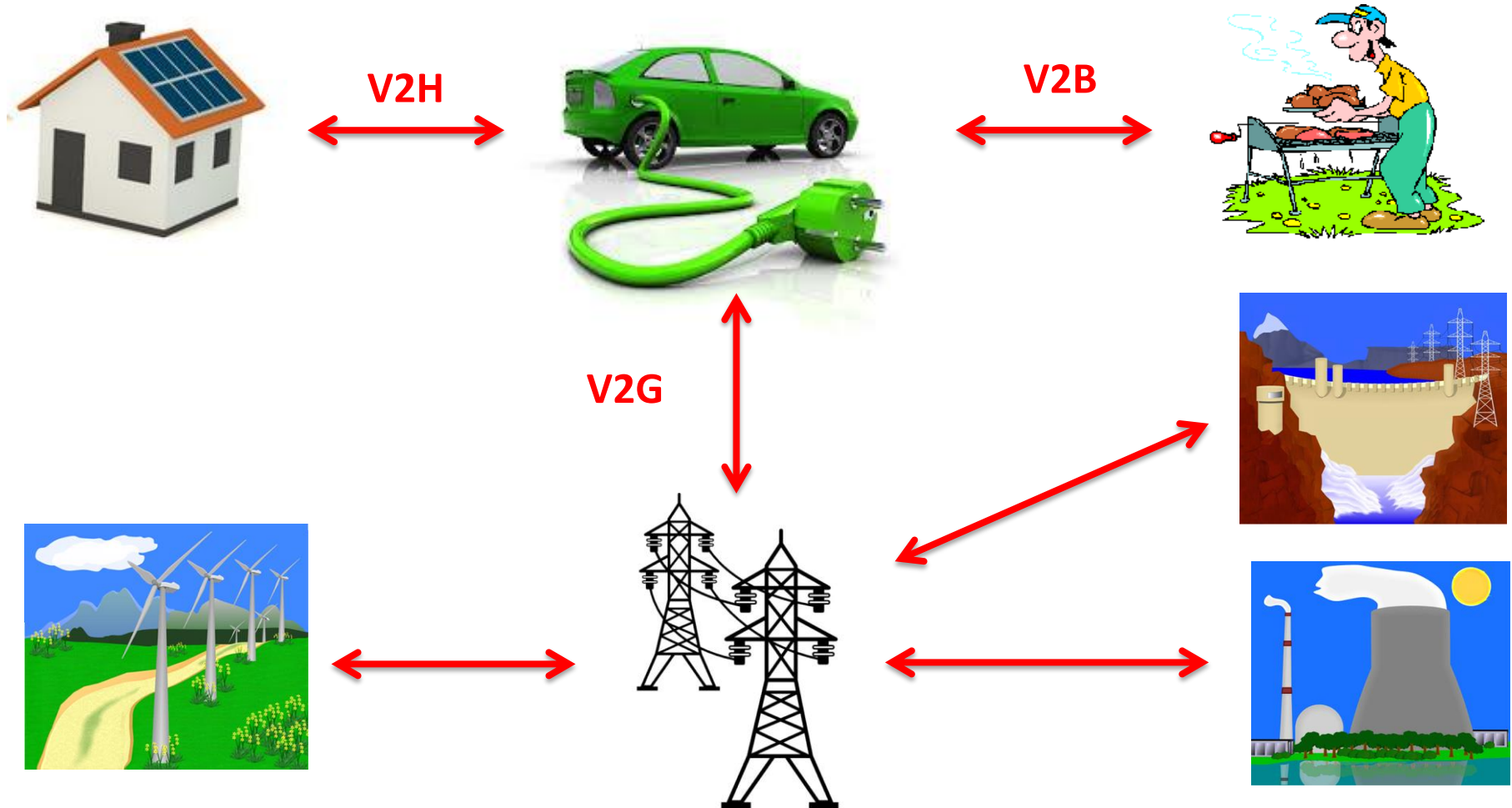
20% of installed PV generation supplied by storage = 800 TWh

**Stationary battery market value**



Source: Yole 2014

# V2X – Diversifying the role of mobile power



# Synergy with the integration of renewables: V2G?

## Benefits

- Grid management and regulation:
  - Peak load levelling
  - Reduced Spinning reserves
  - Renewable integration
  - Protection during power outage
- Opportunities for new business models!

## Challenges

- Battery life
- Guaranteed parked ratio
- Transaction and aggregation cost
- Regulation limiting market access
- No viable business model yet





# Thank you for your attention

A high-angle, wide shot of a massive traffic jam on a multi-lane road. The road is completely filled with vehicles, including cars, buses, and motorcycles, stretching far into the distance. The scene is brightly lit, suggesting a sunny day. The vehicles are packed closely together, and the overall impression is one of a significant traffic bottleneck.

Je suis content  
de contribuer à  
sauver le monde !!