E-Mobility and its future effect on demand and flexibility

Chances and challenges 2035 from a transmission system operator's perspective

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Dr. Roland Bauer, Dr. Georgios Papaafthymiou

elia grid international

Agenda

1. Introduction
    1. Key Questions
    2. Forecast methodologies
    3. Some thoughts on EVs relevance for the energy system in Germany
2. Developments in other countries
    1. Status-quo and targets of EV uptake
    2. Status-quo and targets of charging infrastructure
    3. Conclusion

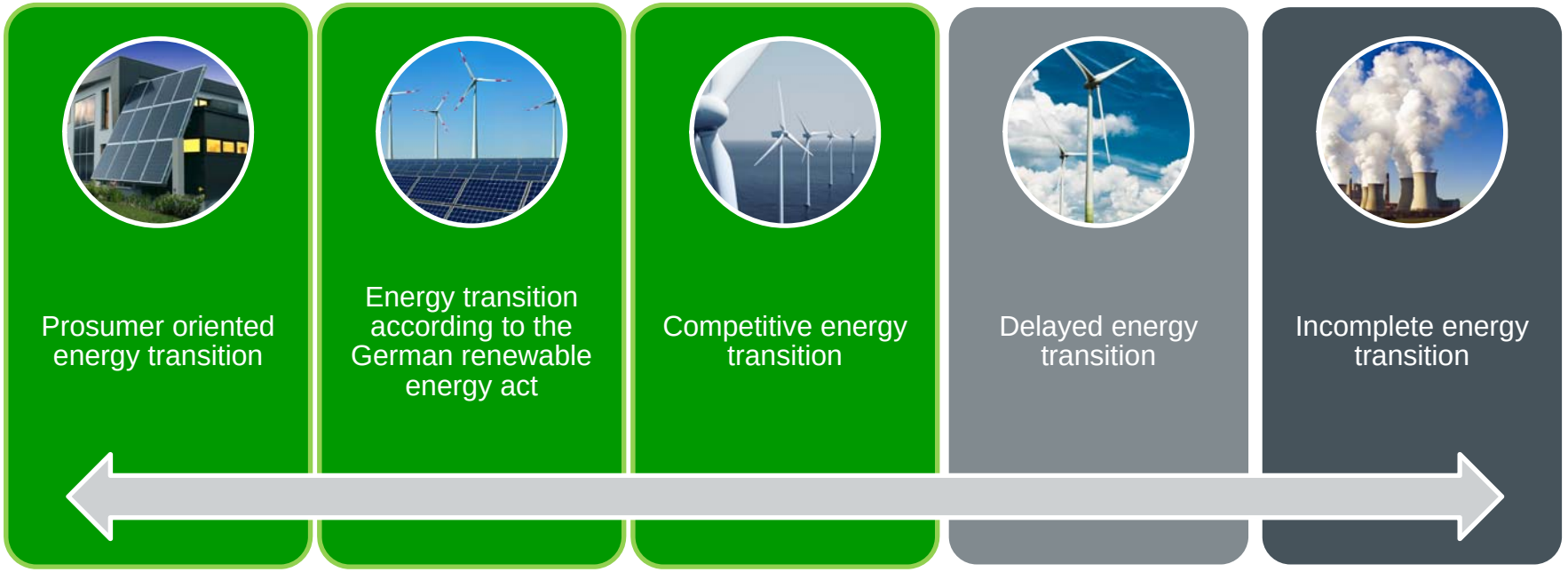
Objectives: give a view on effects due to the surge of EVs from a TSO perspective and widen the focus to different countries

- **Will the energy system and its** current **infrastructure** in Germany **limit** a large scale roll-out of **e-mobility?**
- Can we identify necessary **technological requirements** resulting from a large scale EV roll-out?
- Do we see **opportunities for e-mobility to contribute to cost-efficiency** of the future energy system? Other business models?

The energy development paths form a wide spectrum …

- Looking at the future as a part of 50Hertz Energiewende Outlook 2035, five energy transition scenarios were developed, all of which are realistic.

Policy objectives are achieved through… **Policy objectives are not achieved due to…**



… a strong buildup of PV systems.

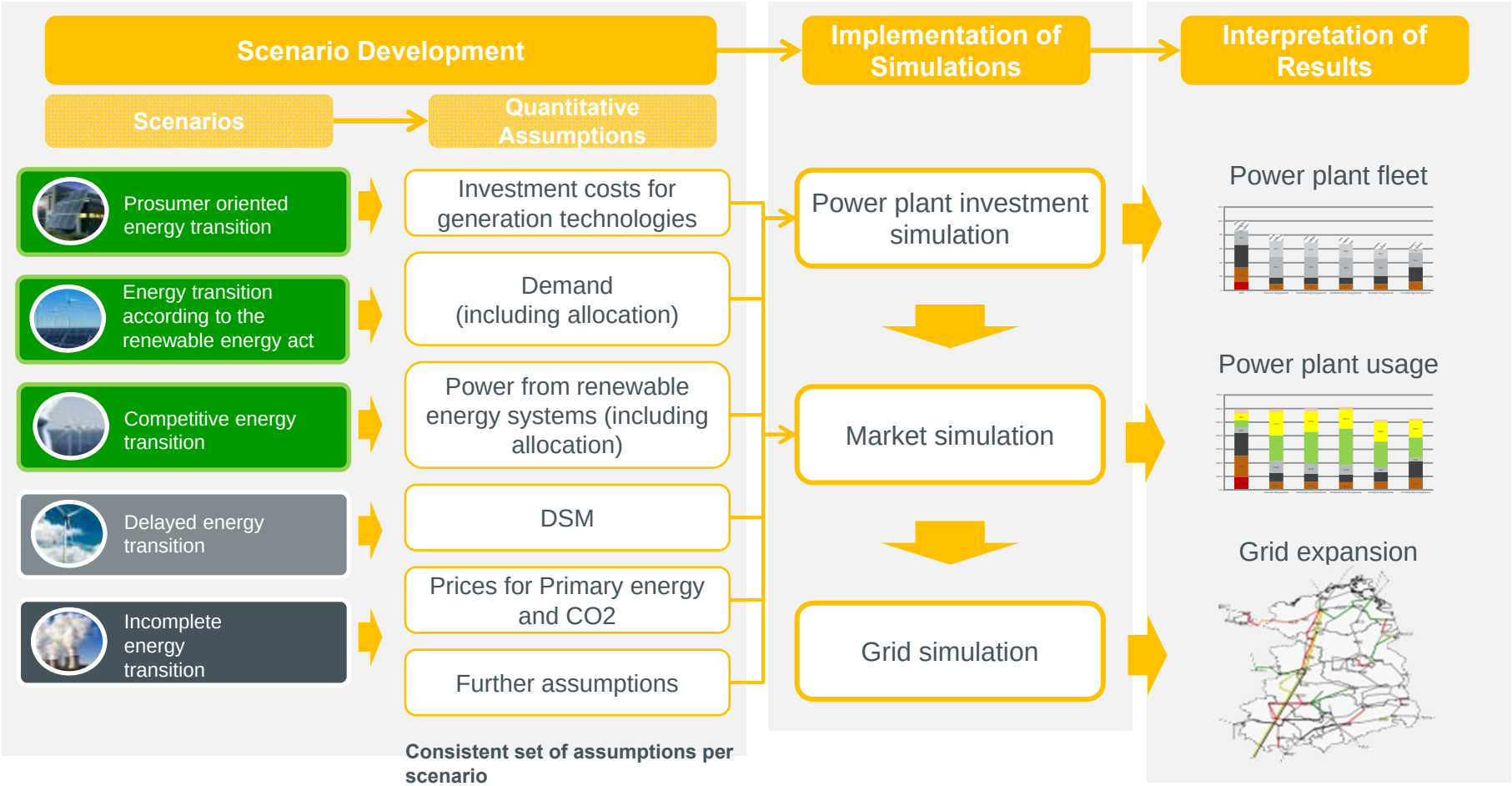
… a combination of various technologies.

… large wind energy systems in profitable locations.

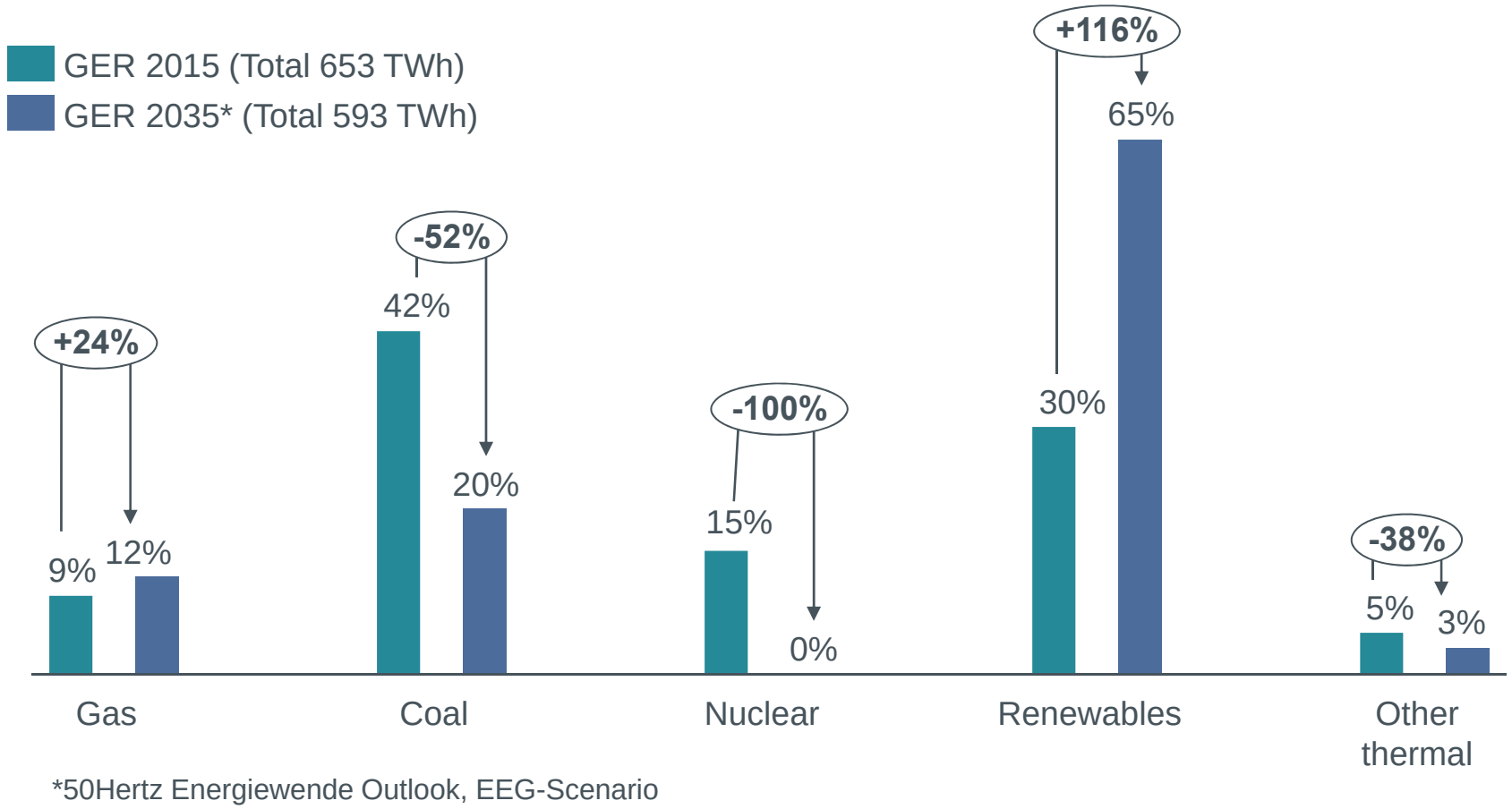
... planned implementation of various technologies is delayed.

… insufficient acceptance due to, for example, high costs, prevents a complete energy transition.

… and the methodological approach provides detailed results

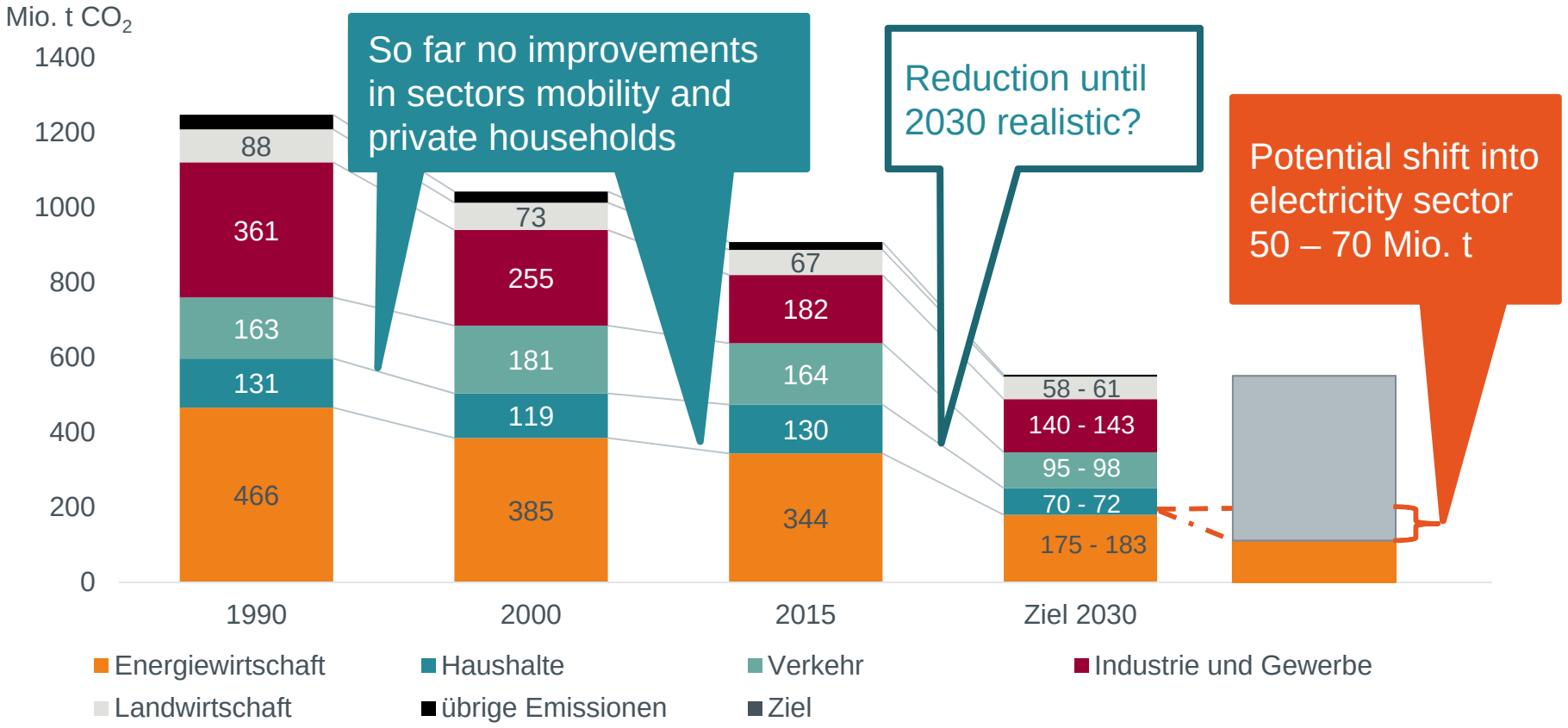


German energy mix will change dramatically till 2035



*50Hertz Energiewende Outlook, EEG-Scenario

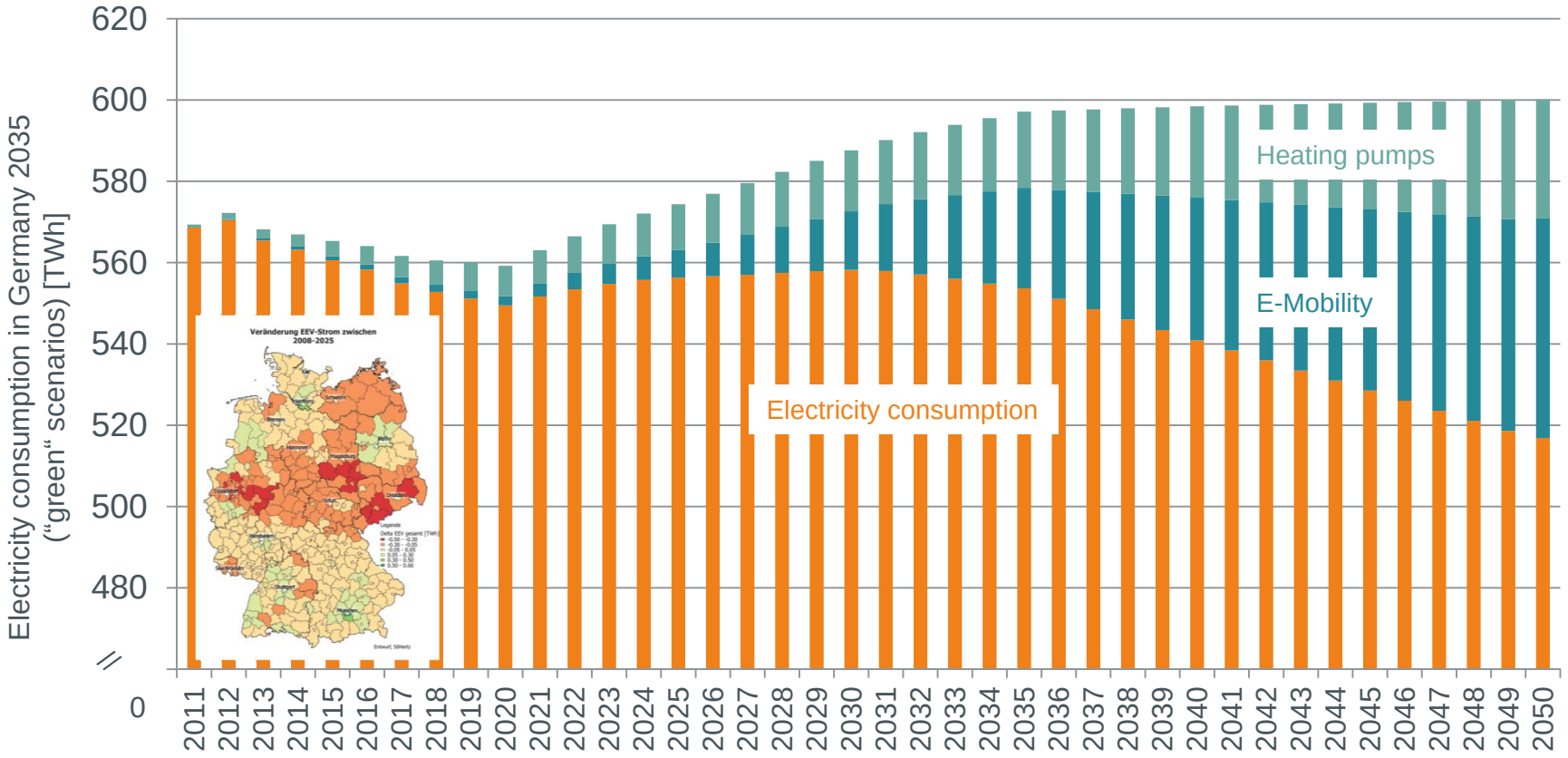
Greenhouse Gas Emissions in Germany



Quellen: Umweltbundesamt Januar 2016; Klimaschutzplan 2050 der Bundesregierung November 2016

Through the electrification of the heat and transportation sectors, electricity consumption will rise in the long-term

- Electricity consumption increases despite improvements in efficiency due to the increase in heating pumps and the increased use of electric cars.



We currently make the following observations around the development of electric vehicles

Worldwide subsidy programmes for EVs

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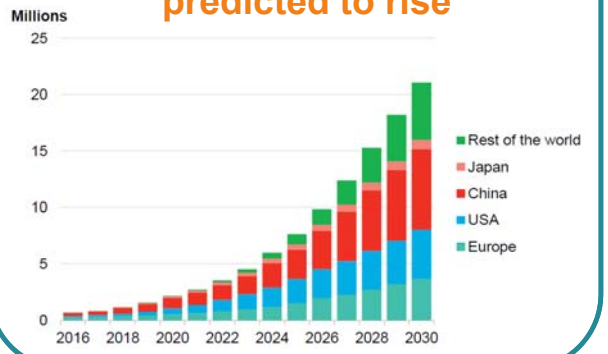
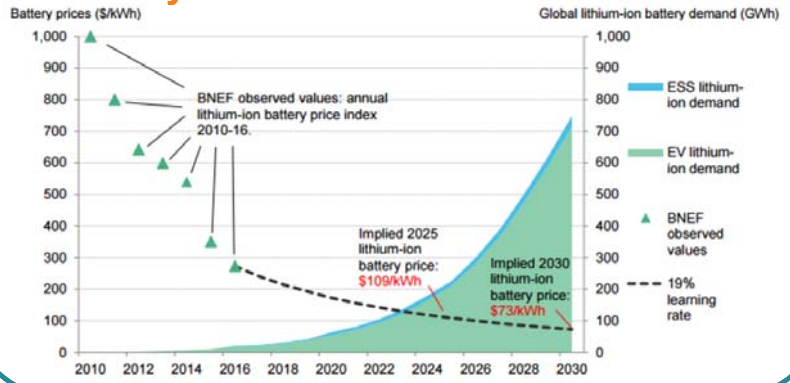
...

Global EV Sales predicted to rise



Li battery pack prices will drop another 75% by 2030



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Strict fuel & emissions regulations

These were the 50Hertz assumptions made for the following analyses

10 Mio. EVs by 2035 in Germany:

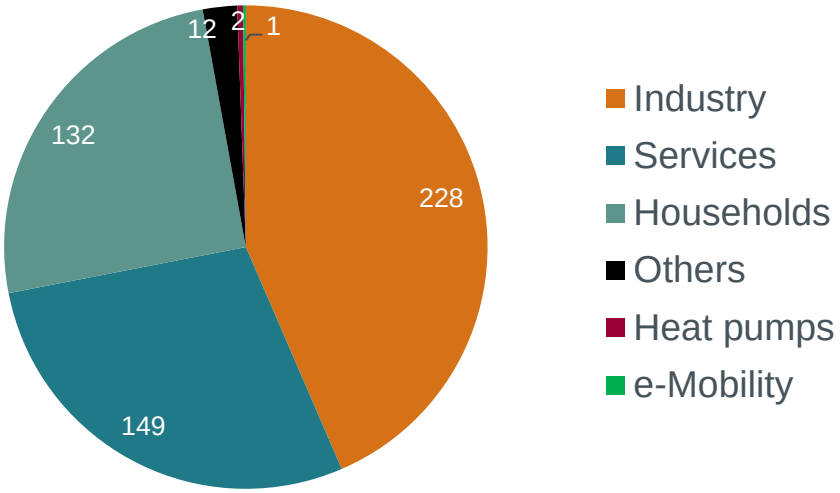
- Average EV range: 500 km
- Average EV mileage: 10,000 km/a
- Average consumption: 15 kWh/ 100km
- Average battery capacity: 75 kWh
- Average yearly electricity consumption: 1,500 kWh / EV * a

Very simplified approach

Energy consumption of EVs is insignificant compared to the total energy system

2015 [TWh]

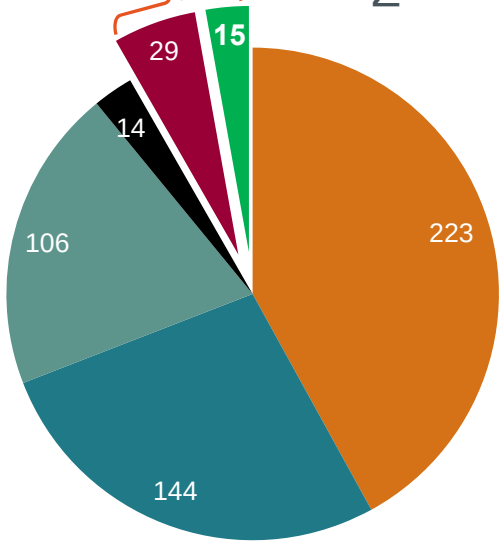
∑ 524 TWh *



2035 (10 Mil. EVs) [TWh]

Impact of sector coupling

∑ 531 TWh **

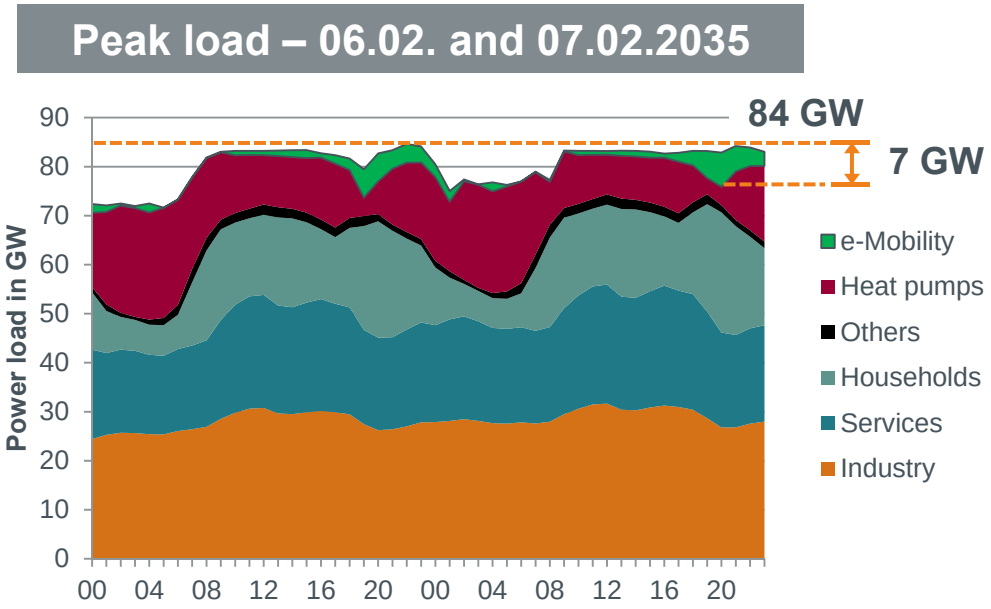


** Based on Umweltbundesamt, excl. grid losses*

*** Based on NEP 2035B, excl. grid losses*

- High uncertainty on amount of EVs in 2035 in Germany
- Altogether, the relevance of EV power consumption on overall electricity demand is expected to stay low.

Peak load capacities of EVs is limited compared to the total energy system, too



Based on NEP2035B with scaled EV amount, incl. DSM
** EV load curve in NEP was contributed by Fraunhofer ISI*

- EV charging load profile contains 20% flexible devices (smart strategy) and 80% simple charging behaviour (work & home charging)*
- Peak of EV load (7 GW) and overall electricity peak demand (84 GW) during a week day in coldest winter week
- Flexibility in the system can limit increase in peak load

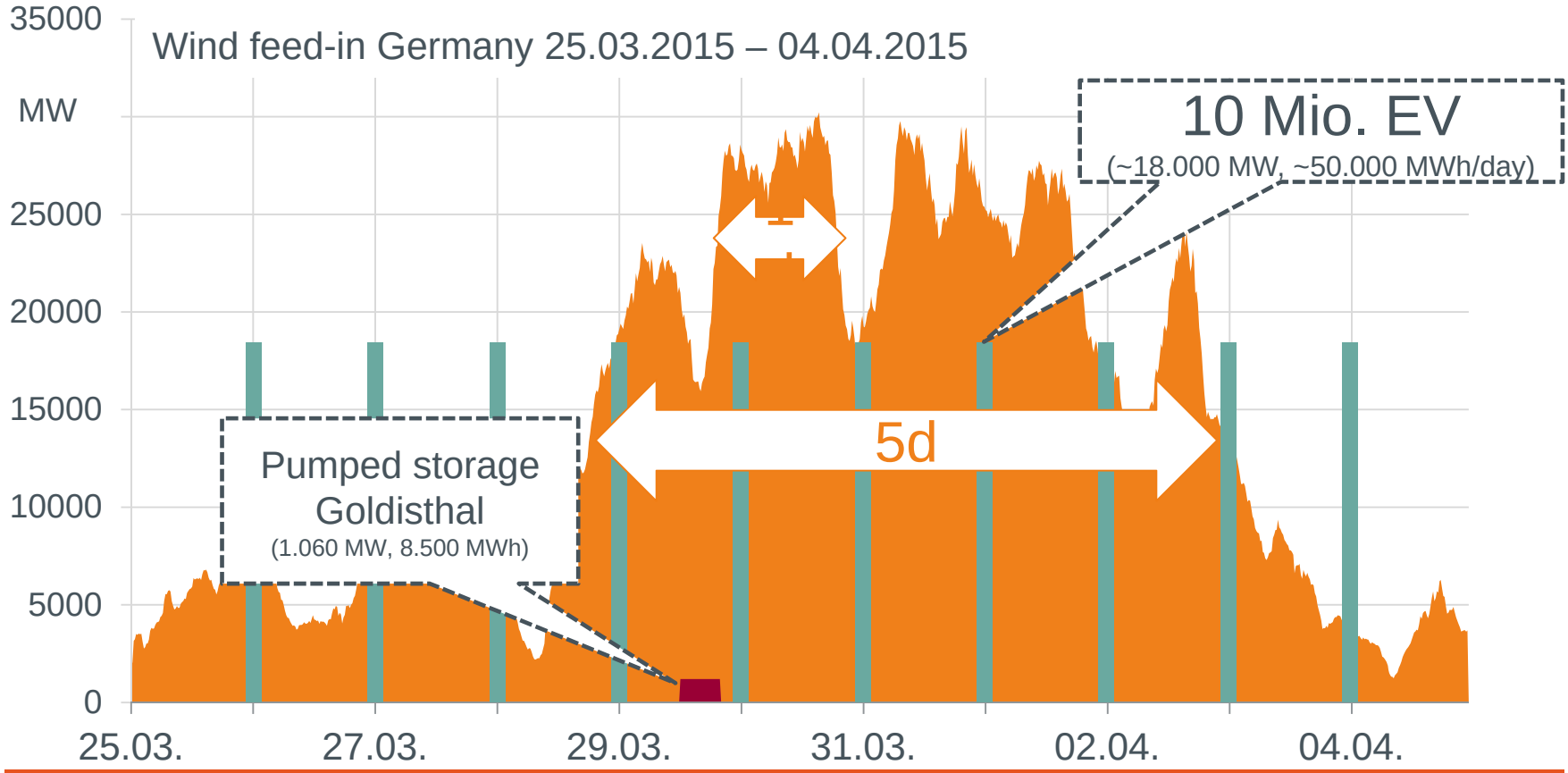
- Overall German peak demand affected by Evs with “smart charging” is limited
- The combination of the flexibilities from Evs, heating pumps and small strorages is able to potentially reduce peak demand

Conclusion: Relevance for the German electricity grid infrastructure

- **Electricity consumption of EVs is low compared to total energy consumption** (<3%) in 2035
- EVs also could have a **limited impact on peak demand** (~8%), especially with smart charging in place and when looked at in combination with flexibility of heat pumps and other measures.
- However, **smart controlled charging is necessary** as there is potential for negative influence on peak demand otherwise – this will be even more the case when looking at local low voltage level

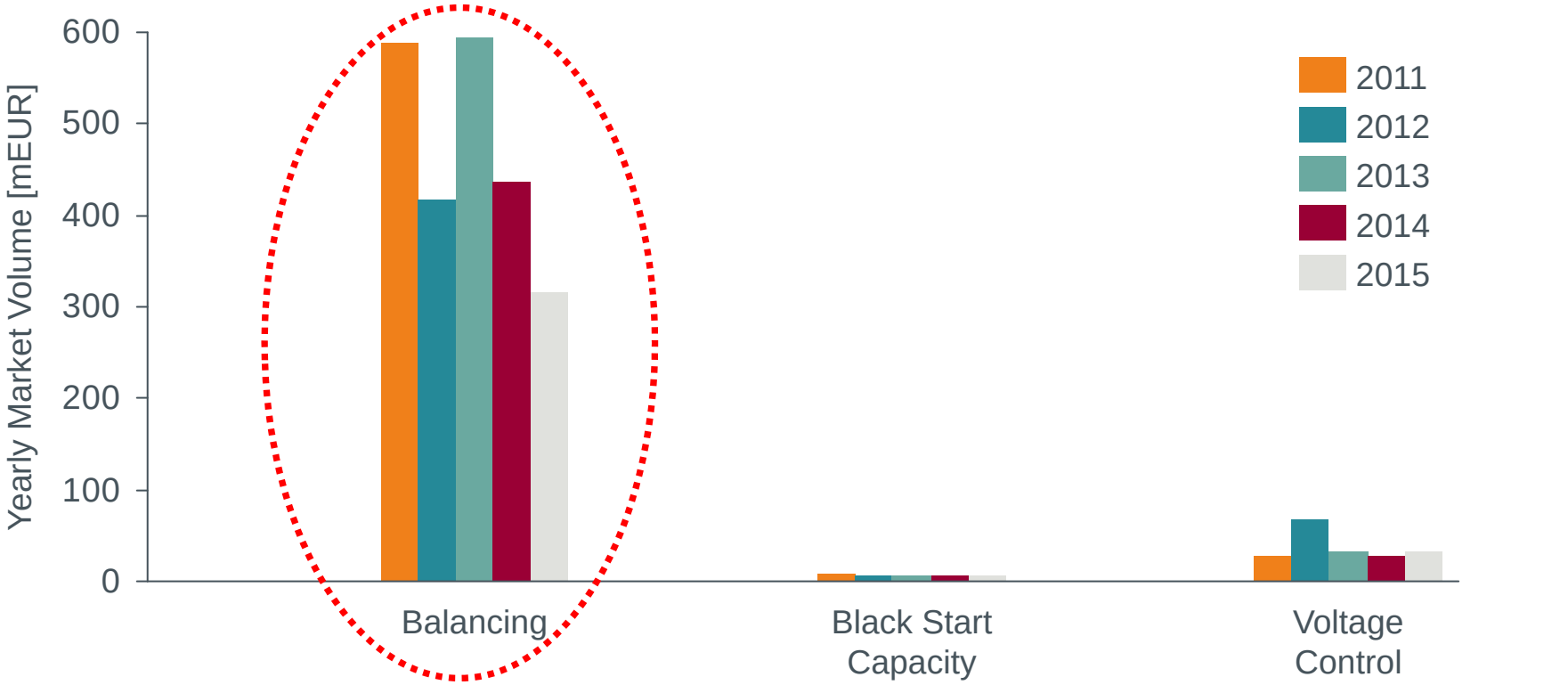
EVs are expected to have a low impact on the overall energy system in Germany in 2035

Electric vehicles as power storage devices cannot cover long-term storage issues



Amongst the ancillary services in Germany, Balancing is by far the most important category (from a financial perspective)

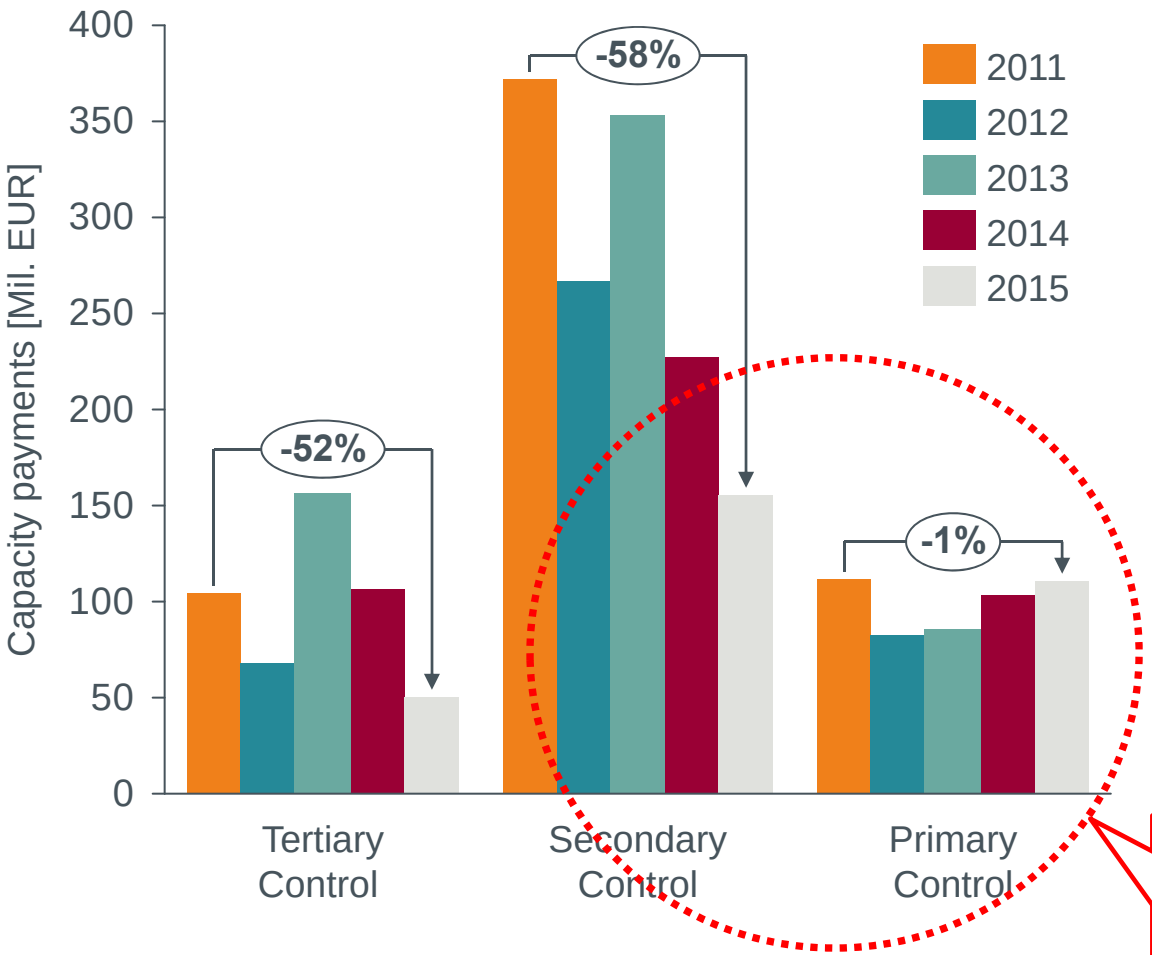
Balancing is the larges of all ancillary services markets in Germany



Amongst the ancillary services in Germany, Balancing is by far the most important category (from a financial perspective)

Source: Monitoring Report BNetzA 2016

Market volumes of balancing market are generally declining – primary control is stable



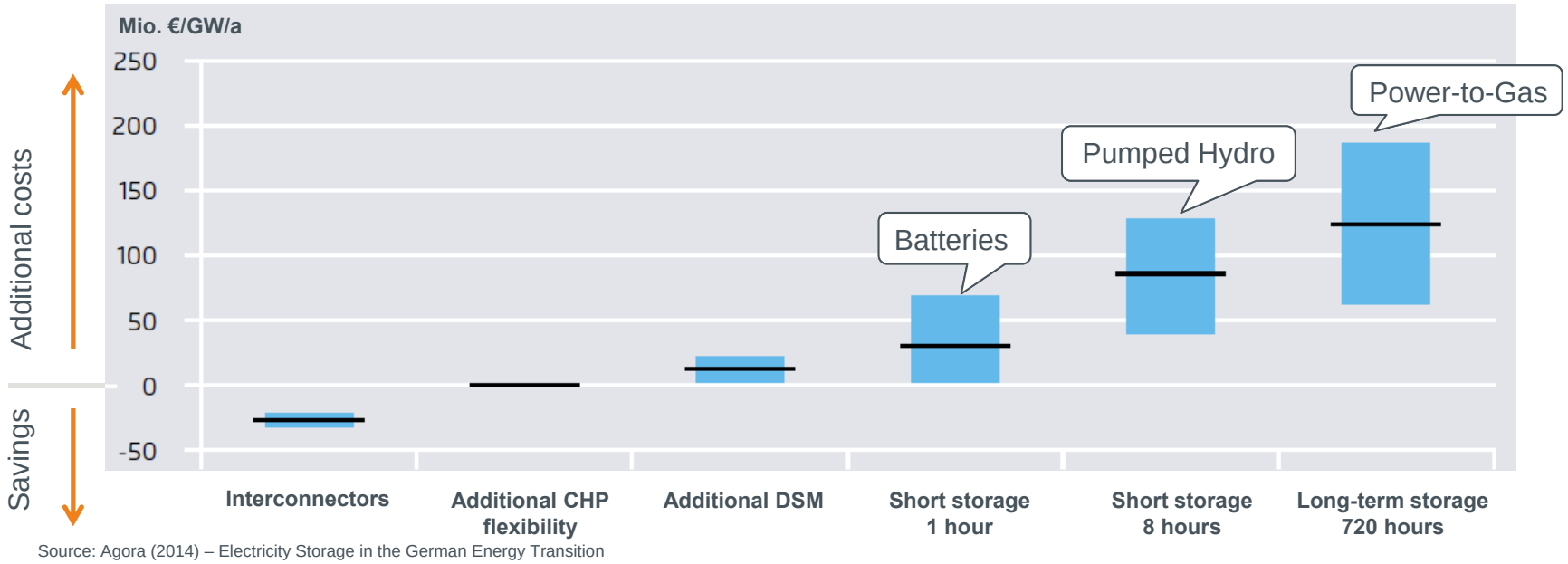
- Within balancing, **primary control is most attractive** for battery storage as it is technically most suitable
- Already some **large stationary batteries in the market, number will significantly increase** in the near future
- Secondary control is a potential market in the mid-term

Market Volume 2015: ~265 Mil. EUR; 10 Mil. EVs with 90% availability →**29 EUR/EV*a**

Flexibility – cheap alternatives to storage do exist

Additional costs/savings of one GW flexibility options in 2023

(43% RES in DE / 22% RES in EU)



Source: Agora (2014) – Electricity Storage in the German Energy Transition

Storage will probably not be a game changer

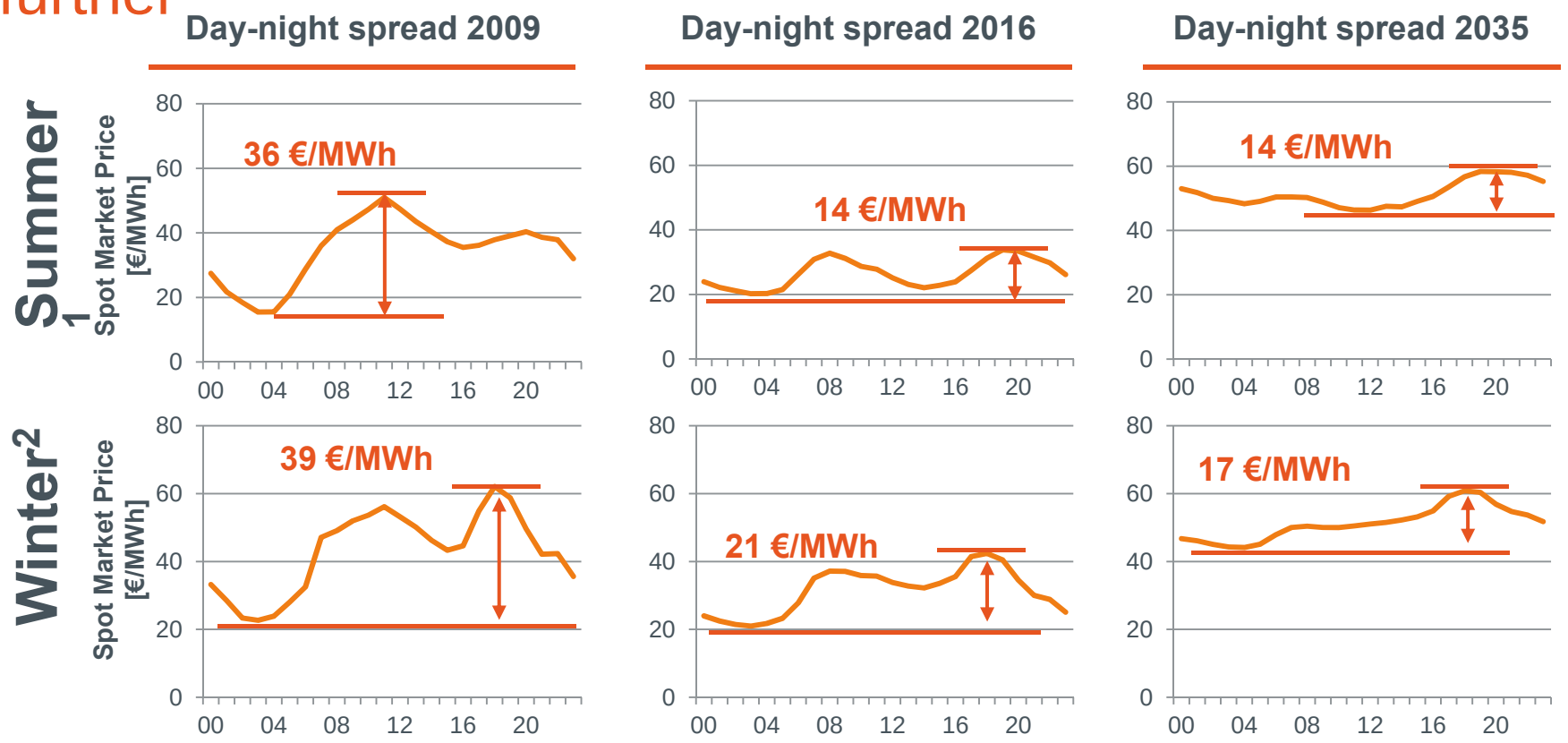
- Long-term storage is far away from profitability even with significantly reduced storage costs
- Short-term storage will be driven less by flexibility than other applications

Conclusion

- **Infrastructure will not limit e-mobility on TSO level**, however, **limitations at DSO level** – especially in residential areas – **might arise**
- **Electricity markets will not hold major business opportunities**, but probably there will be players coordinating EV charging behaviour in the future
- **Ancillary services are limited**; flexibility is currently not that scarce (in Germany) and is not expected to be
- **Services around the coordination of EV batteries** / optimised charging **will be critical** up from a certain scale; who are going to be the players that offer these kind of services?

Surge of EVs will not be limited by energy system, but energy system will also not offer major business opportunities to e-mobility

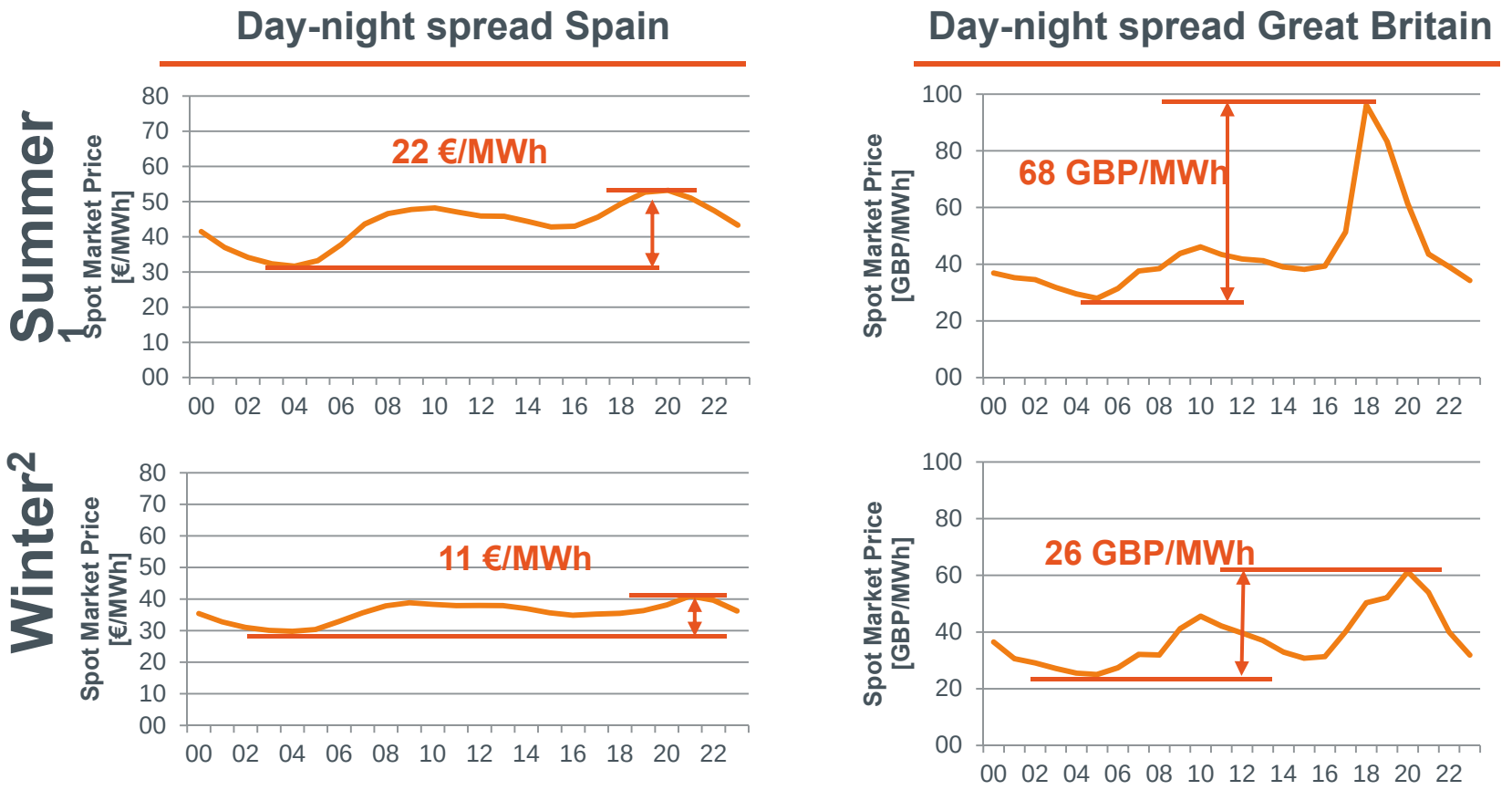
The price spreads in Germany are expected to decrease further



Smaller price spreads because of PV generation at day time reduced attractiveness of storage (even pumped storage) significantly in recent years

([1]) average day ahead prices from April to September in Germany and from ([2]) October to March

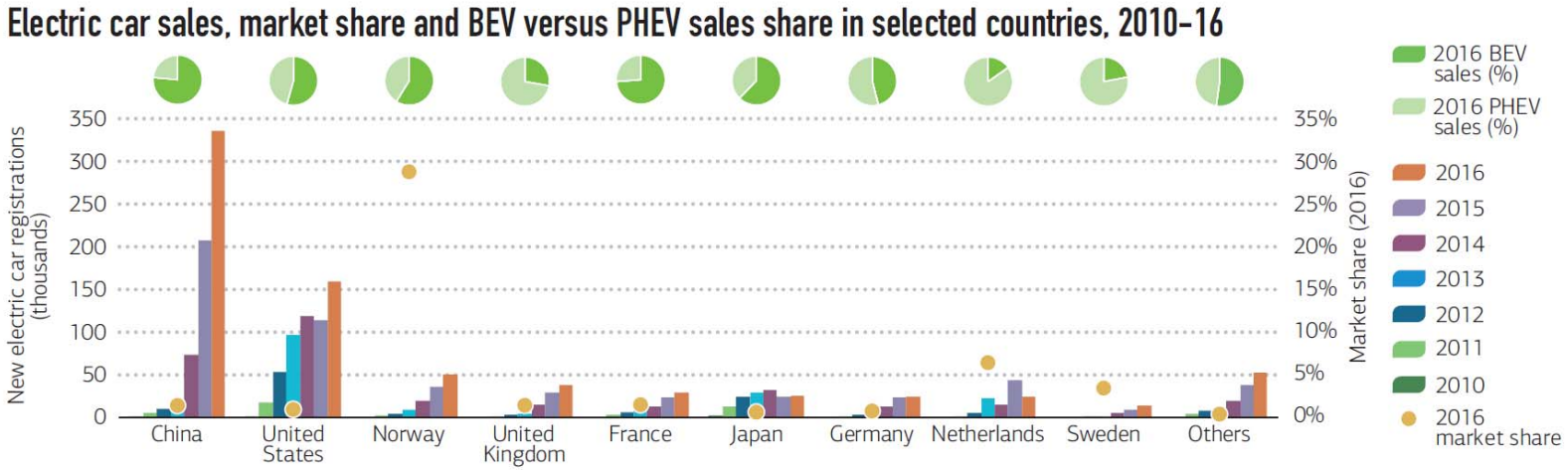
…the same applies for countries in Europe



([1]) average day ahead prices from April to September and from ([2]) October to March

Part II - DEVELOPMENTS IN OTHER COUNTRIES

Status-quo 2 Million: global electric vehicle uptake



Key point: The two main electric car markets are China and the United States. Six countries have reached over 1% electric car market share in 2016: Norway, the Netherlands, Sweden, France, the United Kingdom and China.

Source: Global EV Outlook 2017 (IEA)

*BEV: Battery Electric Vehicles

*PHEV: Plug-in Hybrid Vehicles

The rapid electric vehicle uptake is facilitated by support policies deployed by governments and cities to reap their multiple benefits in the fields of transport decarbonisation, air pollution reduction, and energy efficiency and security.

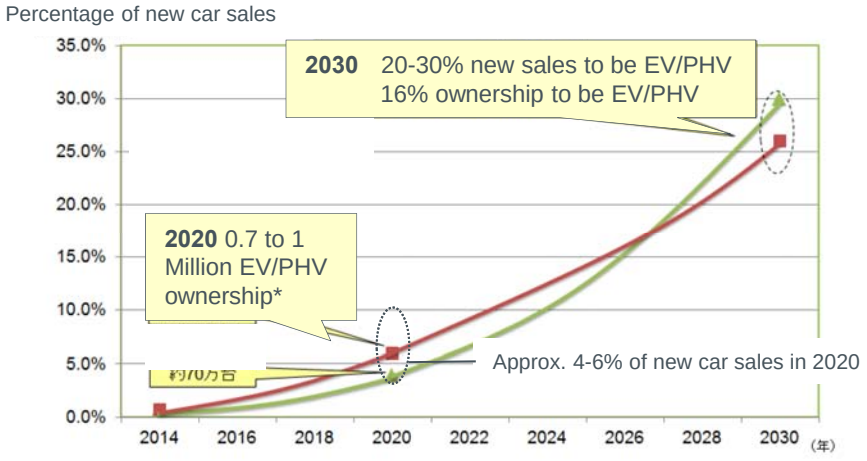
Case studies: status quo and targets in Qatar and Japan

Qatar: 2022 and 2030 targets for EV/PHV penetration

- Qatar currently has less than some hundreds of EV/PHVs on the roads
- Qatari government set-up "Green Car Initiative" as joint effort of the ministries of transport and energy as well as the state utilities provider Kahramaa
- Aim to replace conventional vehicles with EVs and EHVs so that it makes up 4% of the total number of cars on the road by 2022
- Target for 2030 is to reach 10%

Japan: 2020 and 2030 targets for EV/PHV penetration

- Japan currently has over 150 thousand EV/PHVs in stock (2016)
- Aim is1 Million EV/PHV ownership by 2020
- By 2030, target is 20-30% of EV/PHV sales volume for new passenger cars



Source: Report by The Study Group on the Road Map for EVs and PHVs (METI)

***Based on comparison with IEA scenarios:** IEAETP (Energy Technology Perspectives) 2012

Case studies: strategies for rollout of charging stations in Qatar and Japan

Qatar: growth concentrated in city, but challenges for residential charging

- Most residents live in Greater Doha: there will be a high concentration of EVs in the capital
- However, over 80% are expatriates in rental properties: lack of willingness or capability to install charging stations in their homes.
- Not typical for apartment complexes to have charging facilities
- Public charging catering for range anxiety: in Qatar, the furthest point from Greater Doha is ~200 km (Wakrah to Al-Ruwais)
- Qatar works towards the deployment of charging infrastructure to supply sufficient power to the vehicles expected to be deployed, mainly through support of research activities.

Japan: roadmap with specific actions for installation of charging stations

- Specific targets and action plans have been developed to support the integration of 30% EHV/PHV by 2030 based on detailed analysis.

Public charging	**On-route charging**: Fast charging	•6,100 stations (at 30 km intervals)
	Destination charging: Convenient "top-up" charging	•20,000 stations by 2020
Basic charging	**Home charging**: Slow charging	•2,000 stations by 2020
	Workplace charging: Slow charging	•9,000 stations by 2020

Example from Japan: considerations in detailed analyses for rollout of charging stations

On-route charging: Long distance driving / fast charging	• **Simulation** results: charging station required every 30 km to address range-anxiety • **Survey** of status-quo installation volume and locations, **gap analysis** (currently 5,971 but geographically concentrated) • **Development of optimal deployment strategy** considering distribution, easy-to-identify location, strategies to avoid congestion at one station • **Synergy** with existing initiatives by and collaboration/coordination with regional authorities
Destination charging: Convenient "top-up" charging	• **Priority** on large destinations with high number of visitors: large-scale commercial centres, hotels, tourist attractions, leisure centres, public spaces. • **Survey** of status-quo of number of facilities and parking occupancy rate • **Targets** are set for each facility category
Home charging: Short distance driving / slow charging	• **Survey** of status-quo of number of detached houses and communal living quarters: parking availability, timing of new construction and renovation • **Targets** are set for installation, and **recommend** realistic implementation methods • **Provision of information** about costs and guidelines for installation to residents and construction companies
Workplace charging: Short/medium distance driving / slow charging	• **Survey** of number of vehicle commuters, number of workers per commuting time • **Targets** are set for installation, and **recommend** realistic implementation methods • **Provision of information** about benefits for businesses to invest in charging infrastructure

Case study: value of TSO leading investment in charging infrastructure

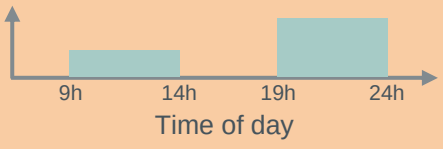
Scope

- Analysis of current and future business cases for **charging infrastructure in BE**
- Identification of Elia's role in electric mobility value chain
- Build-up of argumentation for the proposed role

Take Aways

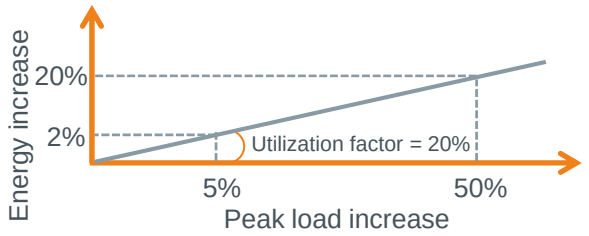
- There is a certain political willingness to increase EV uptake on EU & BE levels
- Two main barriers for EV uptake: **Range Anxiety** & **Upfront Costs**
- No business case now or in a foreseeable near future for TSO investment in Charging Infrastructure
- Monitor market development of charging infrastructure and steer direction regarding standardization of technologies

Case study findings: impact of EVs on the power system in Belgium

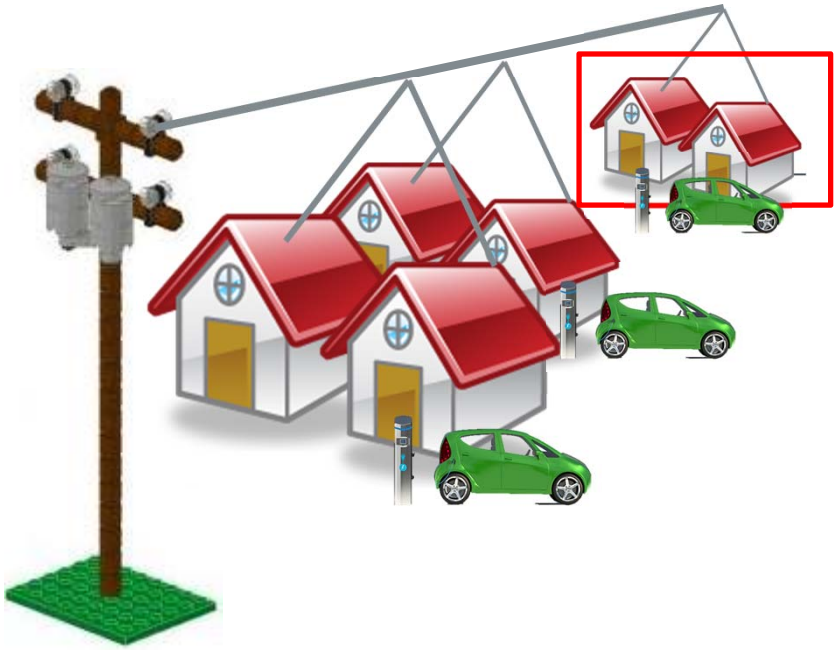
Additional peak load / EV uptake rate	Unmanaged offtake	Managed offtake
		
1%	60 MW	20 MW
10%	600 MW	200 MW
100%	6 GW	2 GW

- Non negligible impact on grid infrastructure
- New investments needed
- Low utilization rate would result in **higher tariffs**
- In 10% uptake case, managing the offtake towards a flat profile **can save up to 400MW on peak capacity**
- **Additional reduction** of grid impact can be achieved with a smarter charging algorithm

Low utilization factor

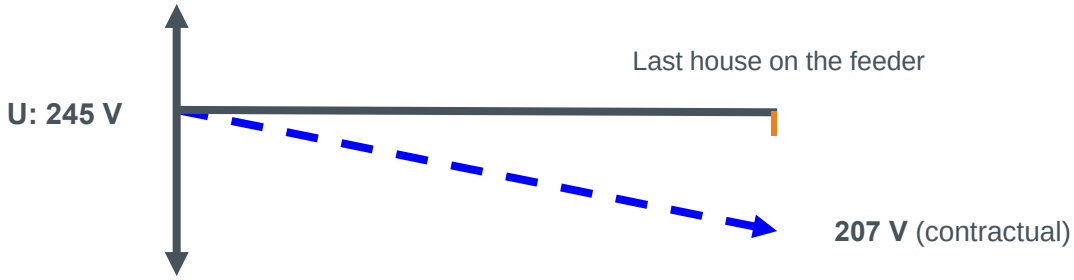


Challenges of PV and EV high penetrations



EV once reaching certain penetration levels result in :

- **Power quality issues (low voltage)**
- **Feeders overloading (higher demand and current)**
- **Problems occurs during evening peak**



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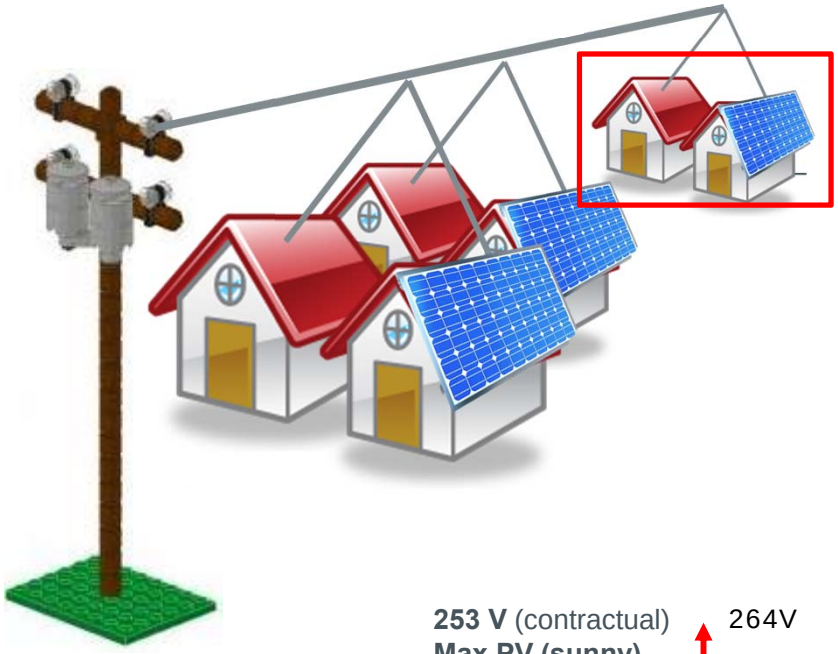
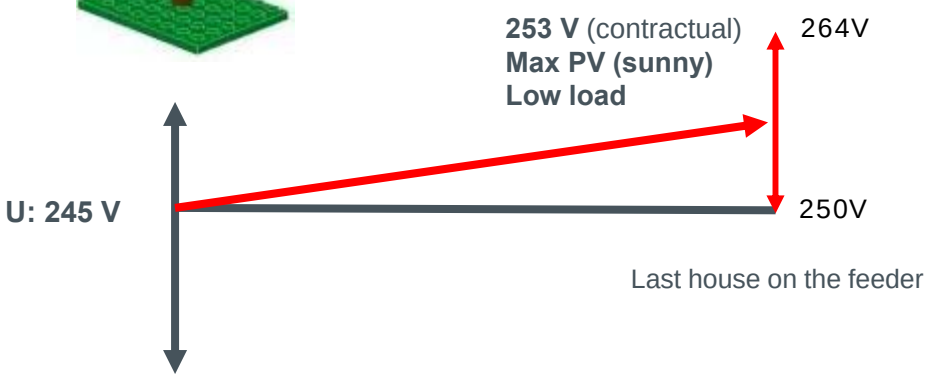


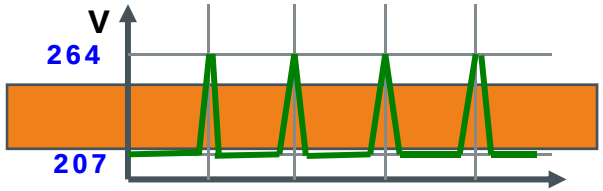


EV once reaching certain penetration levels result in :

- **Power quality issues (low voltage)**
- **Feeders overloading (higher demand and current)**
- **Problems occurs during evening peak**

PV once reaching certain penetration levels result in :

- **Power quality issues (high voltage)**
- **Feeders overloading (via reverse flows)**
- **Problems occurs during noon**



Conclusions

- Globally, **EHV/PHV uptake** is on an increasing trend
- Increased uptake goes hand-in-hand with **availability of charging infrastructure**
- Countries with **targets** supported by **concrete measures for implementation** of both of these are leading development
- Grid operator's interest is to **anticipate the impact on grid** capacity requirements and operation security: so far major impacts not observed but…
- Important to **identify potential threats** for your system: Elia Group studies demonstrate analysis methods
- Threats will be mitigated if the charging of EVs is controlled: R&D projects provide solutions
- **Synergy with PV** growth should be considered

Grid operators can start with asking basic questions to survey the status-quo and gain insights into potential threats

Thank you for your attention

Elia Grid International

Rue Joseph Stevens 7 Joseph Stevensstraat
1000 Brussels – Belgium
Tel. +32 2 204 38 11
Fax +32 2 204 38 10

Heidestraße 2
10557 Berlin – Germany
Tel. +49 30 5150 37 11
Fax +49 30 5150 37 10

www.eliagrid-int.com

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