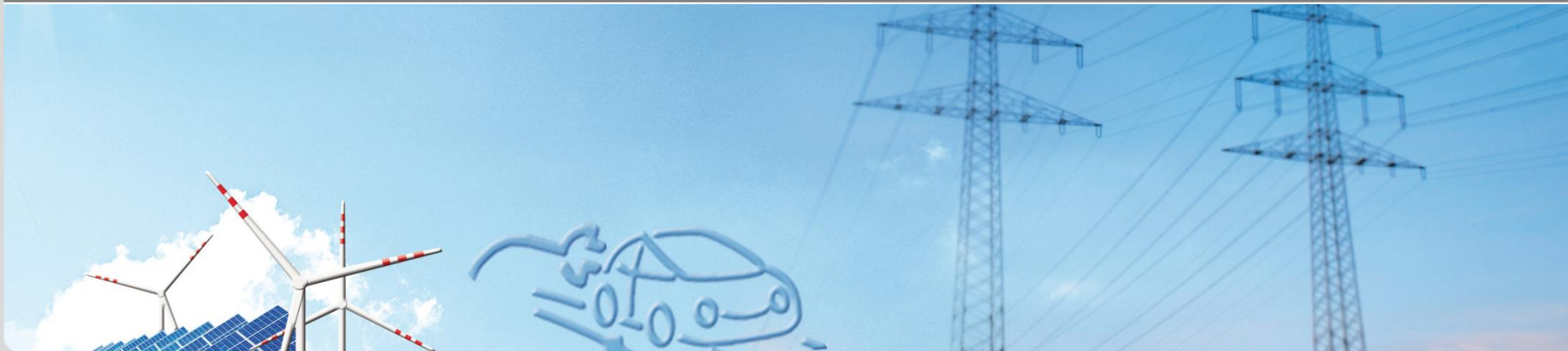


# Lessons from European/German Energy Transition: Is the Disruption Potential Real?

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# European Energy Transition

## March 2007: **Strategic Energy Technology Plan 20-20-20** (for 2020) :

- 20% reduction of EU greenhouse gas emissions relative to 1990)
- 20% share of renewables of overall EU energy consumption
- 20% increase in energy efficiency (relative to 1990)

## Fall 2010: **More ambitious targets of Germany** :

**30%** renewables by 2020,  
**50%** by 2030,  
**80% (??)** by 2050

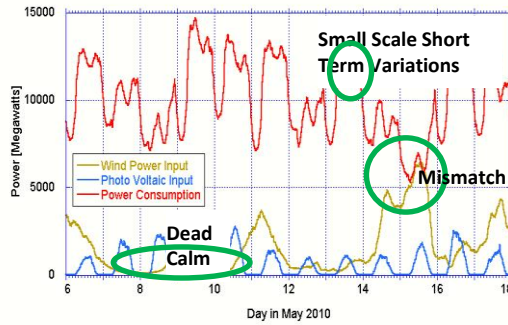
## Spring 2011: **“Energiewende”**

Fast replacement of nuclear power with renewables (by 2022)

**2010: 140 TWh (22 % of total) → 2012: 90 TWh → 2022: 0 TWh**

# Major Challenges

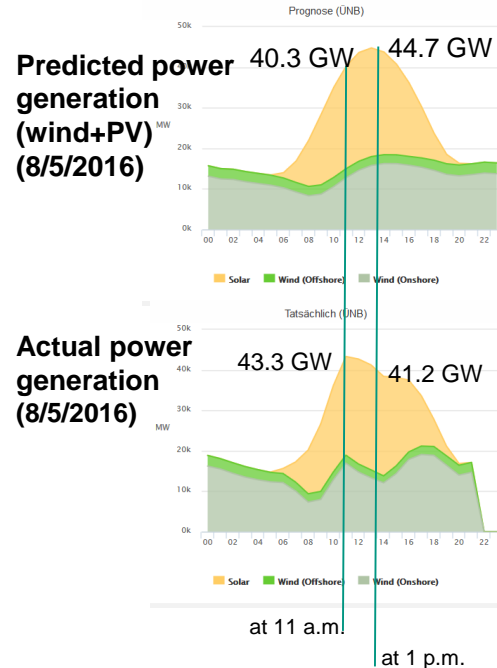
## Volatility



Strong need of:

- Flexibility
- Storage
- Demand side management

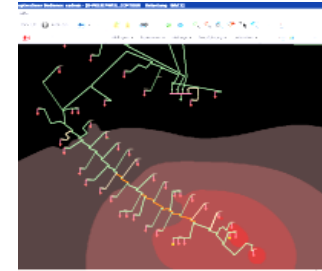
## Uncertainty



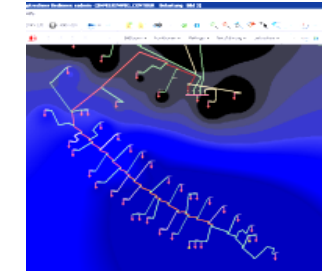
(Source: <http://www.transparency.eex.com/>)

## Decentralisation

Voltage increase in low voltage grid due to PV

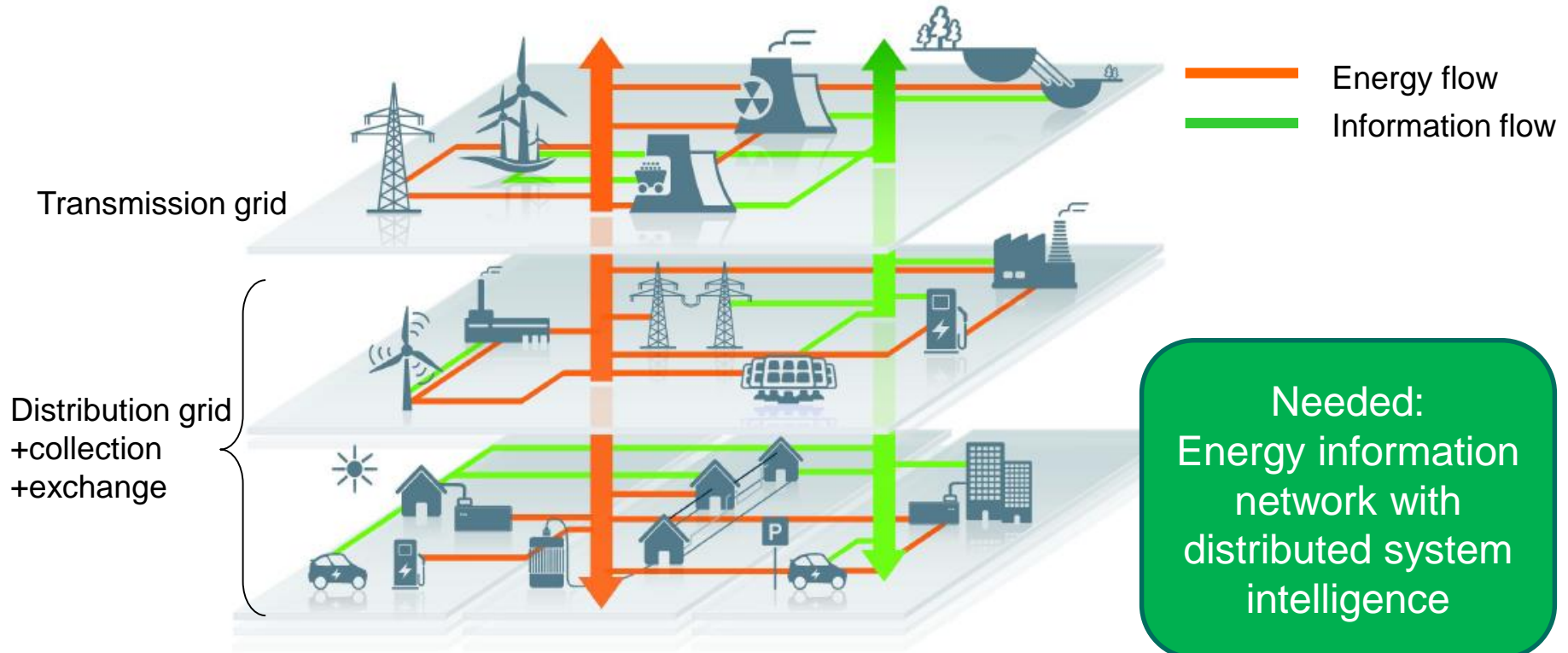


Voltage decrease due to EV



→ New stability problems in distribution grid

# Consequences for the grid

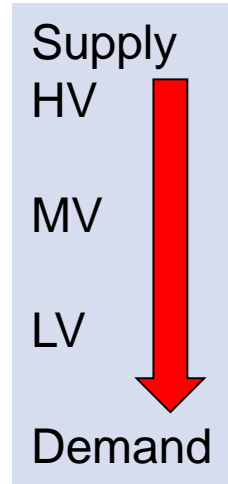


# Consequences for Energy Management

## Traditional

- Demand cannot be controlled.
- Electricity cannot be stored (in the grid)

→ **Principle:**  
**Supply follows demand**  
(Spinning reserve:  
Primary, secondary, ...)

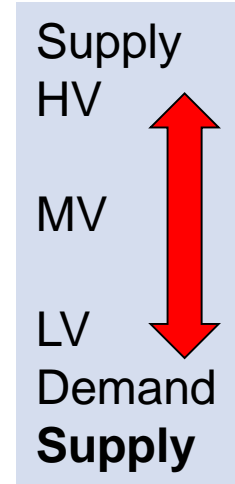


## Future

- Supply only partially controllable and mainly decentralized
- **Potential reversal of power flow**

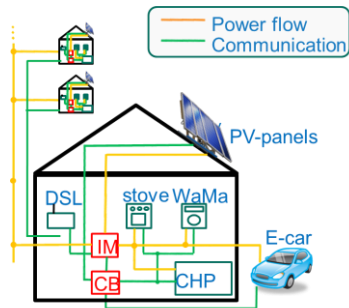
→ **New Principle:**  
**Demand has to follow supply!**

→ **Requires more flexible demand (and supply)**

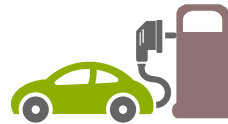


# Looking for Flexibility ...

## Smart homes and buildings

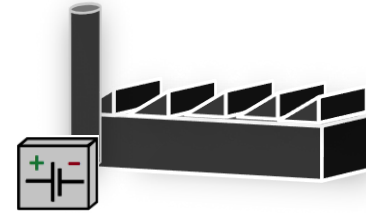


## Electric vehicles



- G2V and V2G
- Most of the time parked somewhere
- Recharging process offers high potential for flexibility

## Industrial processes



- Exploit flexibility potential without reducing productivity
- Utilize HVAC for power system services

# Disruptive Innovations: Challenges for the existing network

- Power generation from the rooftop will beat the utility tariff (predicted to go down to around 5 ct/kWh).
- Battery costs are declining faster than predicted.
- Power generation will become strongly decentralized.

## Hence:

- Electric vehicles will become cheaper and more numerous. This will lead to additional local power demand with a large potential for flexibility and to distributed mobile power storage.
- Low cost local power generation and stationary batteries provide potential of becoming independent of the power grid.

# Will prosumers proliferate?

- Yes, there will be millions of prosumers
  - Actually, they are there already in Germany and some other countries
  - Prosumers will be
    - Private home owners
    - Community cooperatives
    - Small and Medium Enterprises
    - Shopping Malls
    - Industry
- ... and they will try to become independent of the utilities.



# Is the state of technology mature enough?

## No!

- In particular, we do not know whether we will be able to stabilize the power grid (frequency control), if the rotating masses are disappearing.
- We just had a black-out because of that in Australia!
- The current information technology in the power grid is not sufficiently secure, it is still too vulnerable.

## Yes (partially)!

- Batteries are sufficiently cheap and safe meanwhile for widespread use in private homes and commercial buildings
- There are numerous products available to provide Home and Building Energy Management Services.

# Is there a real threat of stranded assets?

## Yes!

- Traditional power plants will be turned into “shadow plants” to be used in bottleneck situations only.
- Business models for hydro pumped storage do not work any more due to more dynamic price structures, it will become more difficult to earn money with storage plants, but we need them!
- It is not clear to what extent the transmission system will keep its central role for guaranteeing grid stability, or whether the distribution system has to take over.

# Major research programs and projects

- **Helmholtz program**  
„Storage and Cross-linked Infrastructures“  
(400 FTEs, 2015-19);
  - Batteries
  - Electrolysis & hydrogen
  - High temperature storage
  - Networks and system integration
- **Kopernikus Projects**  
2016-2019 (-2025)
  - New grid structures
  - Power-to-X
  - Industrial processes
  - System integration
- **Federal programs**
  - E-Energy model regions (2008-12)  
(6 regions, several 1000 households,)
  - ICT for E-mobility (2009-2015)
  - Leading Edge Cluster E-mobility (2011-2017)
  - Several pilot regions on local batteries, microgrid operation etc.

## Essential characteristic:

**Strong collaboration between power & control engineering, informatics, energy economics and markets, socio-economics, and law.**

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