Connecting electrons - Past and future of power in Europe

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Jochen Kreusel, President T&D Europe

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1. Some basics of power systems
2. Where do we come from and where are we heading to?
3. Some words on the grid value chain

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Some basics of power systems

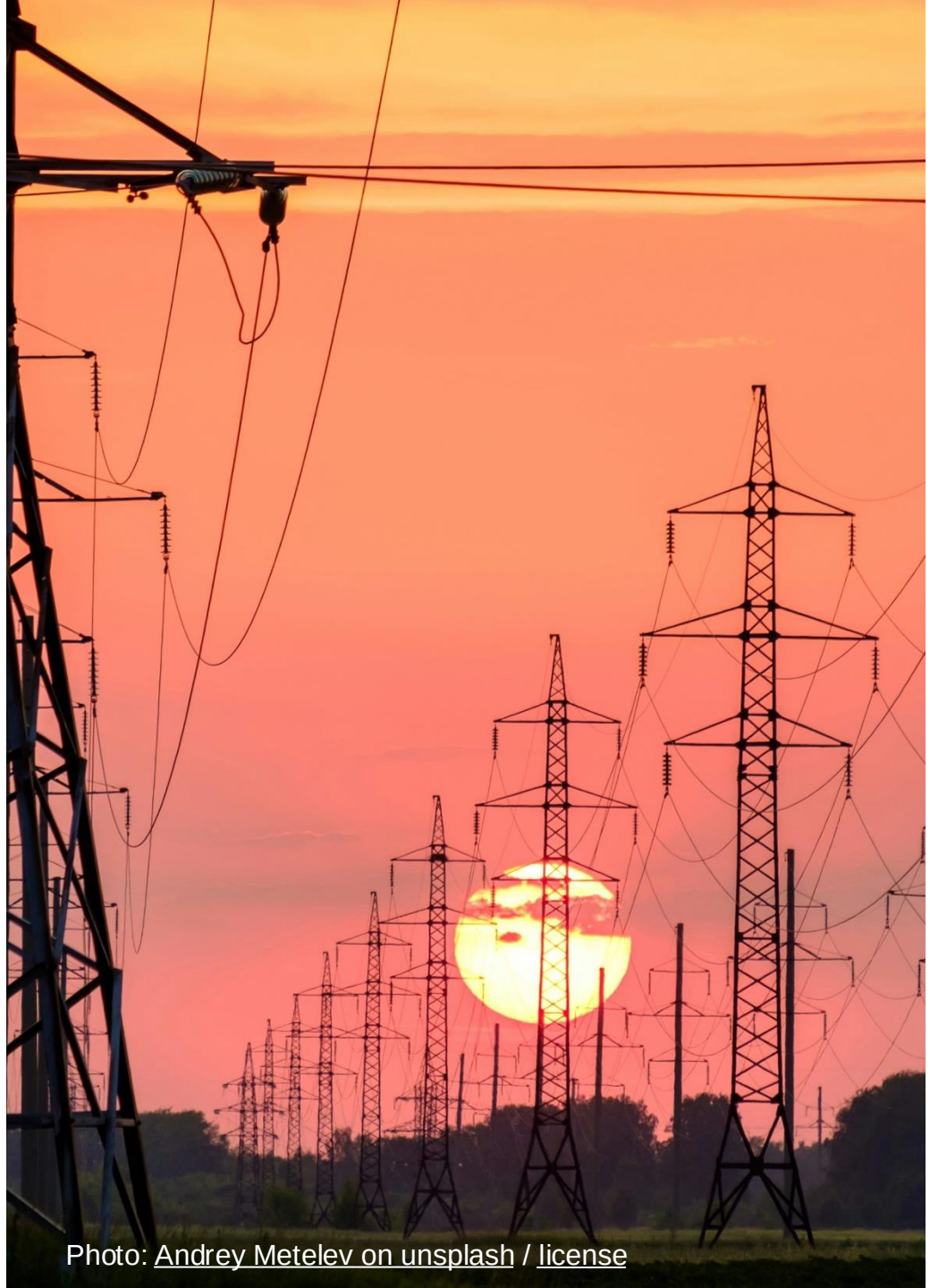
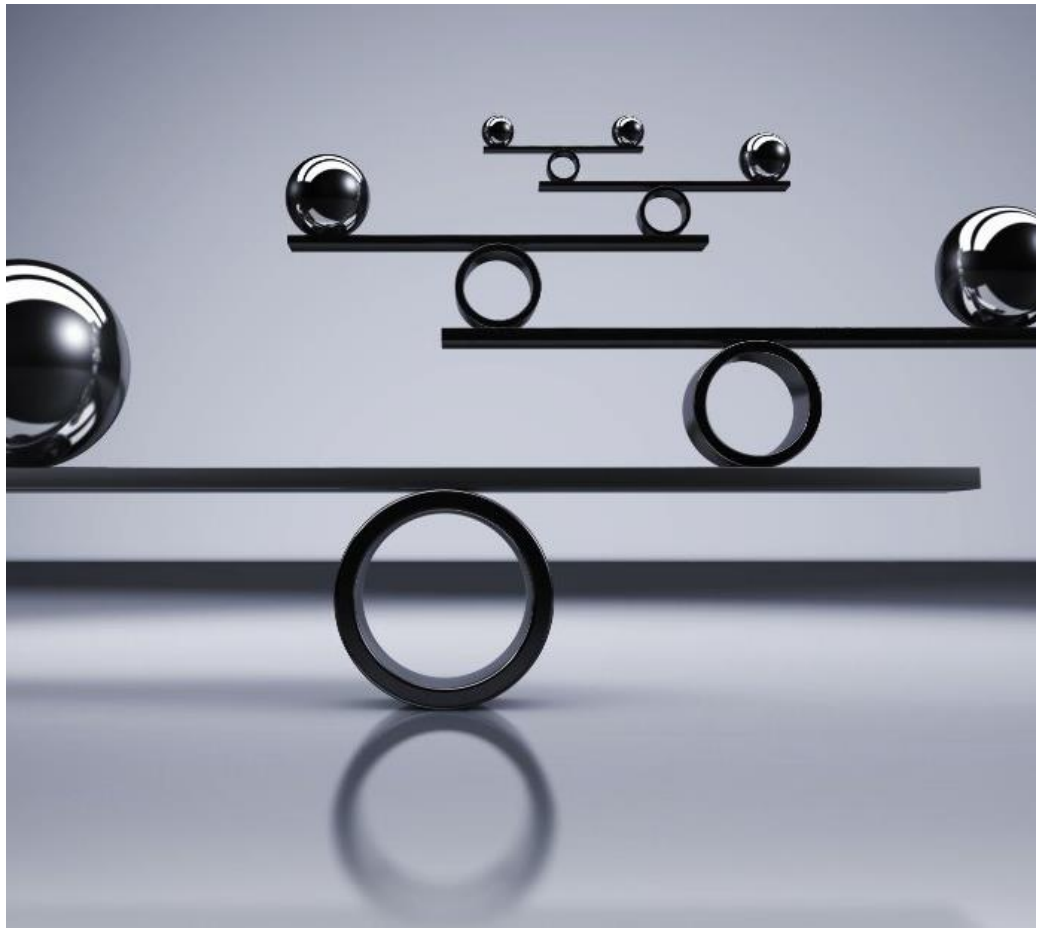


Photo: Andrey Metelev on unsplash / license

Connecting electrons – what is it about?



What is a power system?

- Generators
- Consumers (electrical load)
- Network
- (Maybe) storage

What is the task?

- Balancing load and generation at any time
- Ensuring supply for all consumers at a defined quality
- Ensuring that no element is overloaded

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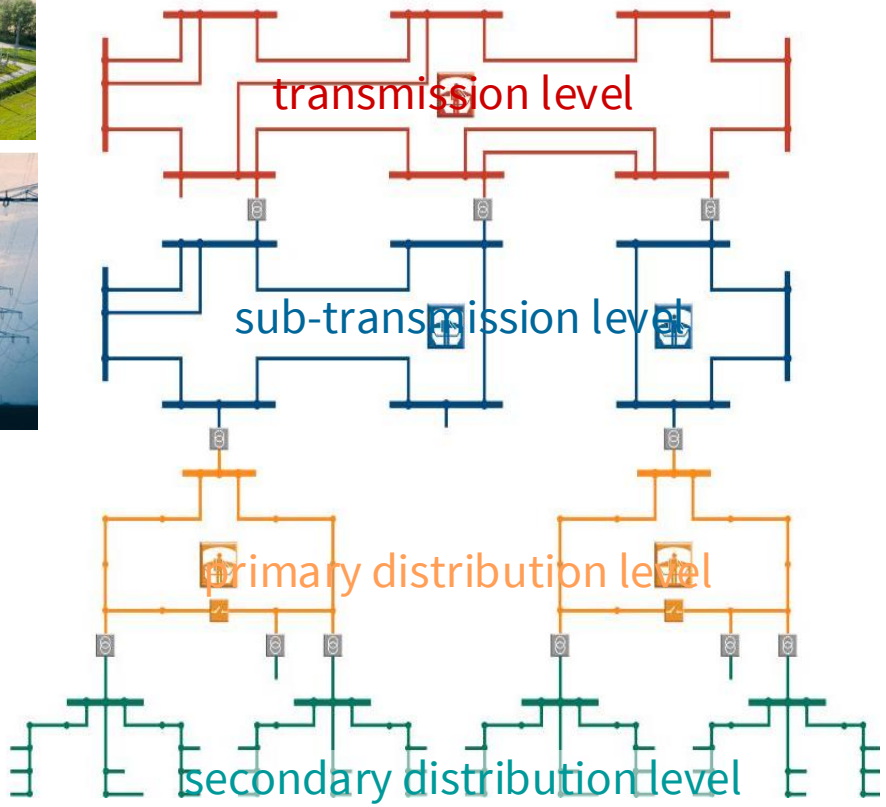
The network(s) – structured to serve different purposes



Transmission grid (EHV[1])

- Backbone, spanning all over the system
- Meshed, redundant (reliability)
- EHV for minimum transmission losses
- Predominantly overhead lines

Sub-transmission (HV[2])

- Regional distribution
- Leveling out regional complementarities
- Meshed, but only regional coverage
- Overhead lines, cables in cities

Distribution (MV, LV[3])

- Connecting consumers with usable voltages
- Primarily radial structure
- Overhead lines or cables

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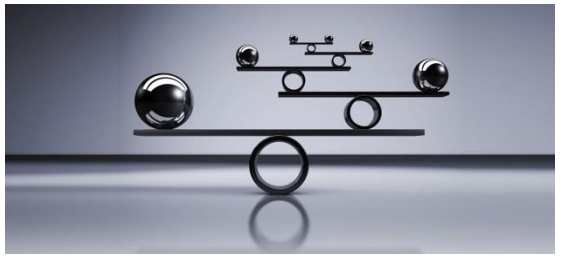
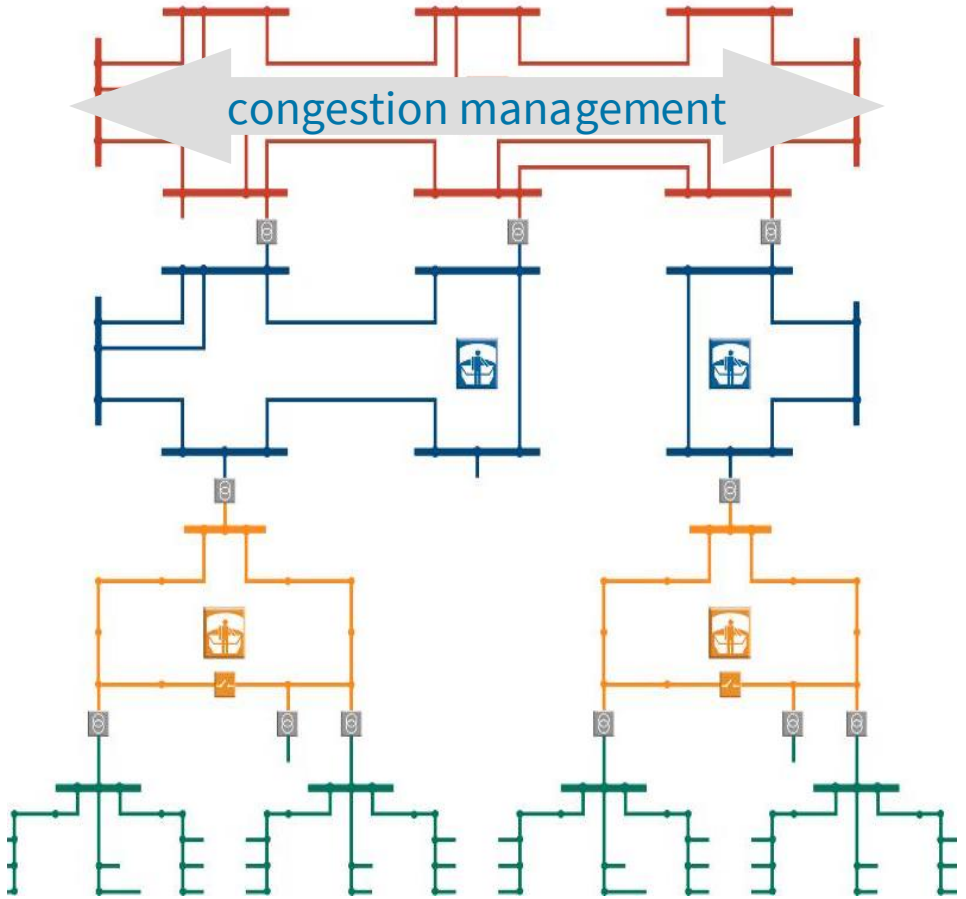
1 EHV: extra high voltage, in Europe primarily 380 kV
2 HV: high voltage, in Europe primarily 110 kV
3 MV, LV: medium (12…52 kV) and low (400/230 V) voltage

Controlling a power system – two main pillars

Active power control

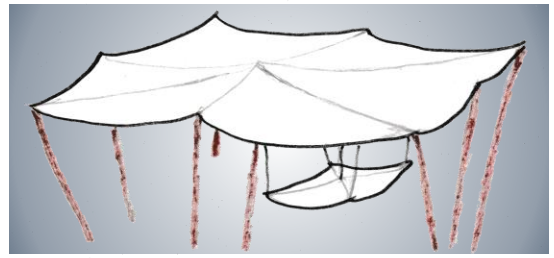
- Balancing load and generation and any time
- System-wide[1]
- Resulting in stable **frequency**[2]





Network control

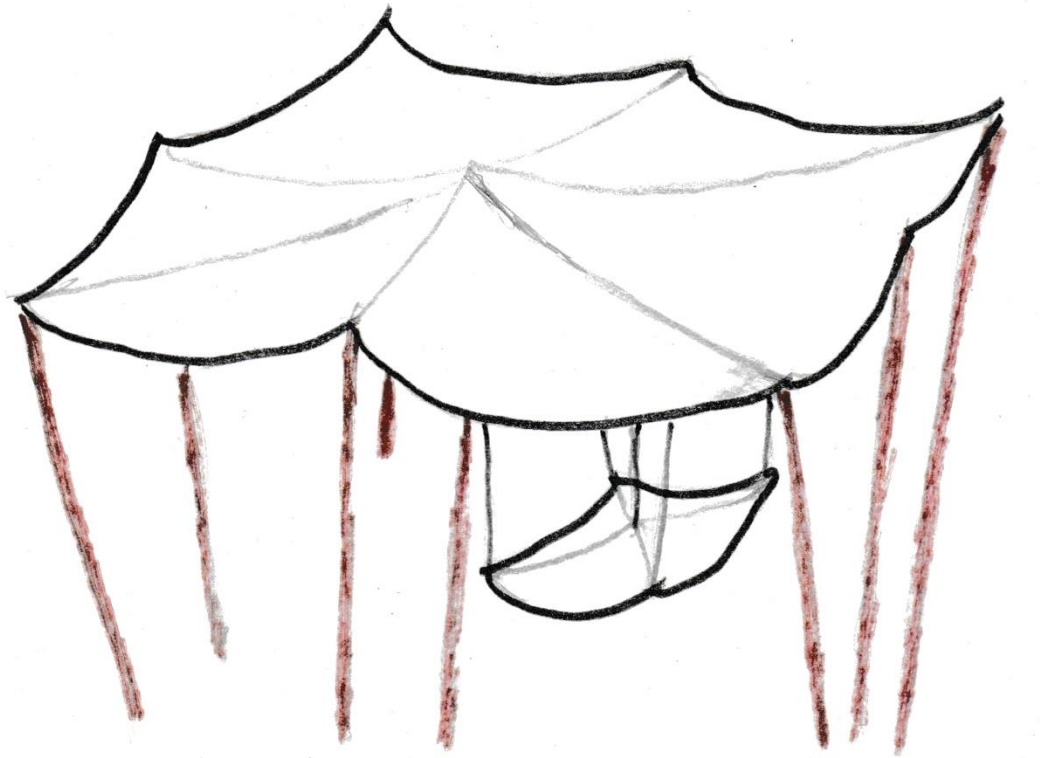
- Ensuring supply at defined quality
  - **Reliability**
  - **Voltage**
  - **Harmonics**
- Preventing overloads



1 System means all installations physically connected by one network. In case of Europe this means the entire continent, including Scandinavia, Great Britain and Ireland, Turkey and some Northern African states.

2 Bold: Main elements of quality of supply from a consumer's point of view

The network(s) – a few words on operation



The task

- Controlling power flow from generators to consumers
- Ensuring the right voltage (and power quality) at all interfaces to the network

Key components

- Transformers
- Reactive power contribution from generators
- Reactive power contribution from network assets (e.g. SVC[1])

Distribution (MV, LV[3])

- Connecting consumers with usable voltages
- Primarily radial structure
- Overhead lines or cables

1 SVC: static var compensator, power-electronics-based asset providing reactive power

A slightly different way to look at it

The journey of electricity

Where do we come from and where are we heading to?

Continental European power of the 20th century

Generation system characteristics

- Primarily thermal generation – big units, mostly feeding into the transmission level
- Hydro power was the only locationally restricted source – small contribution
- Thermal power plants were built close to load centers
- Regionally balanced system

Technical consequences

- Regional balance
  ⇒ no long-distance transmission
- Meshed transmission network as backbone, supporting reliability of supply, but not bulk power transmission over long distances
- 400 kV AC network was the transmission technology of choice

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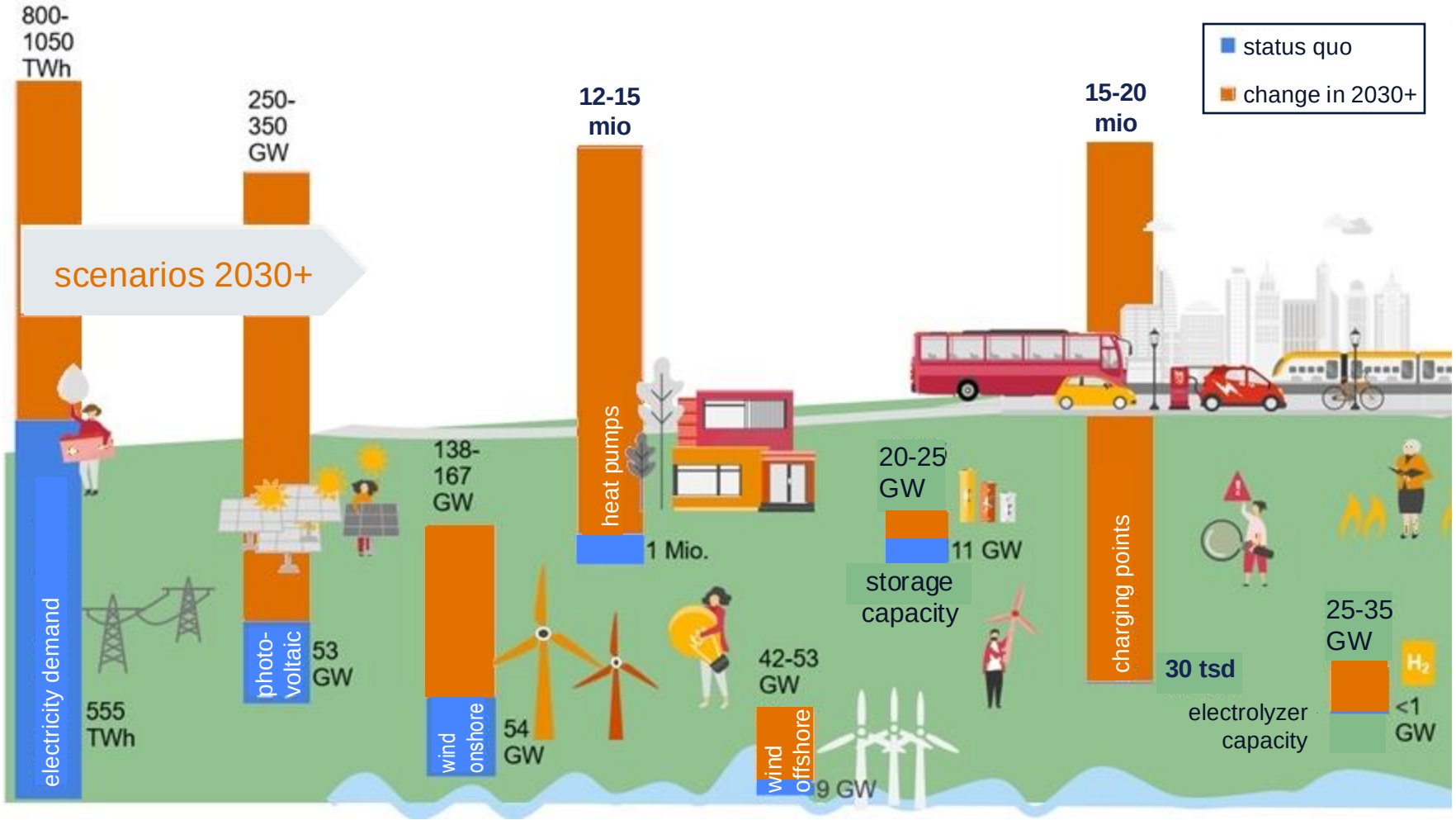
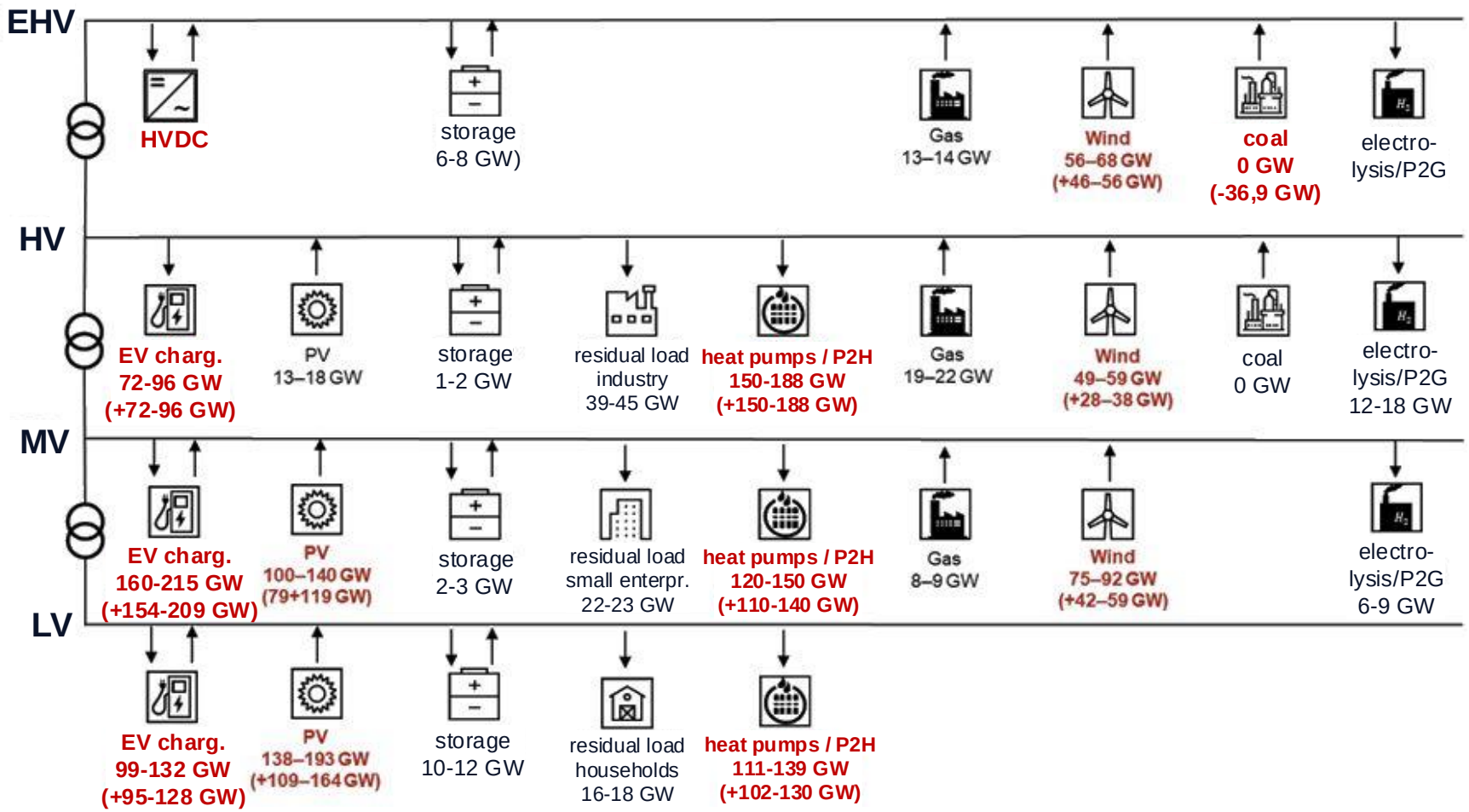
Example Germany: Status quo and development until 2050*



- Installed capacity of wind turbines will triple to quadruple to 180…200 GW.
- Installed capacity of PV systems will increase by a factor of six to 250…350 GW, with around 12…15 mio. PV systems in Germany.
- Number of charging stations will increase 30-fold to 15…20 mio., and the number of heat pumps will increase 14-fold to 12…15 mio.

* ZVEI study “Intelligent, powerful, flexible: electricity grids of the future”

What will the tasks of the grid 2030+ look like?

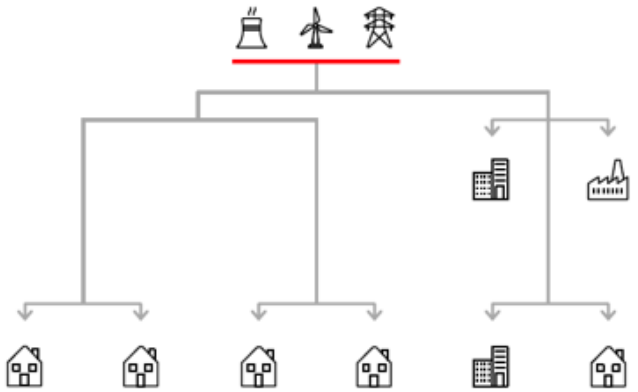


- Enormous expansion of generation and consumption capacities as well as **grid expansion at all levels**
- **Highly distributed generating resources**
- Balancing across voltage levels
- **Flexibilities required** to support grid (locally) and entire system
- Today no transparency in lower distribution levels

* ZVEI study “Intelligent, powerful, flexible: electricity grids of the future”

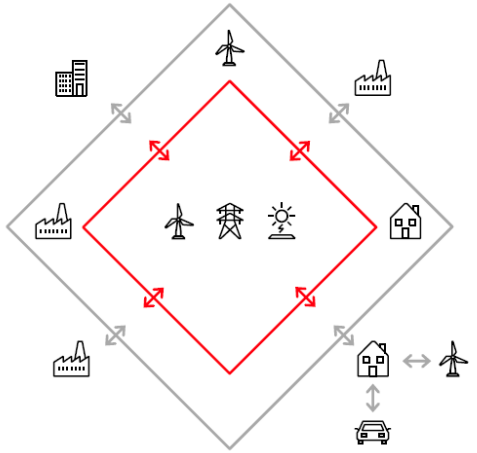
The journey of the transition - summary

Yesterday – a well-known system



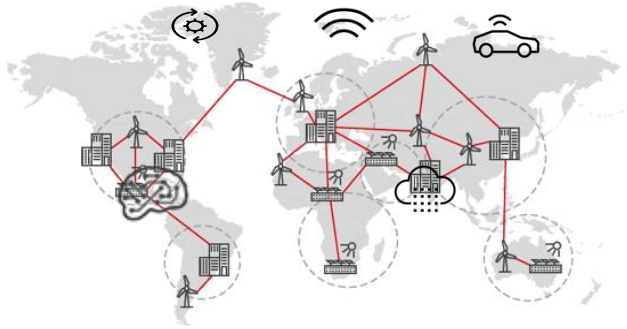
- Limited number of active elements
- Dispatchable power stations
- Limited dynamics, only driven by variations of demand
- Established processes

Today - transition



- Decentralization, increasing complexity
- Increased dynamics driven by wind and solar power
- Neither load nor generation fully under control

Tomorrow – a new world



Graphics © Hitachi Energy

- **Distributed** and **trans-regional**
- **Complexity** as the new normal
- **Accelerated** interactions
- Sector integration

From few, controllable generators to myriads of distributed elements.

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Some words on the grid value chain

Source: Hitachi Energy

What is the supply chain?
Our members – deeply rooted in Europe

National associations

www.afbel.es

www.anie.it

www.animee.pt

www.beama.org.uk

www.emsad.org

www.edet.nl

www.feei.at

www.gimelec.fr

www.swissmem.ch

www.zvei.org

Corporate members

new.abb.com

www.eaton.com

www.ge.com

www.hitachienergy.com

www.kytepowertech.com

www.ormazabal.com

www.schneider-electric.com

www.siemens.com

www.siemens-energy.com

www.ganzelectric.com

Associate members

www.wika.com

www.climalife.com

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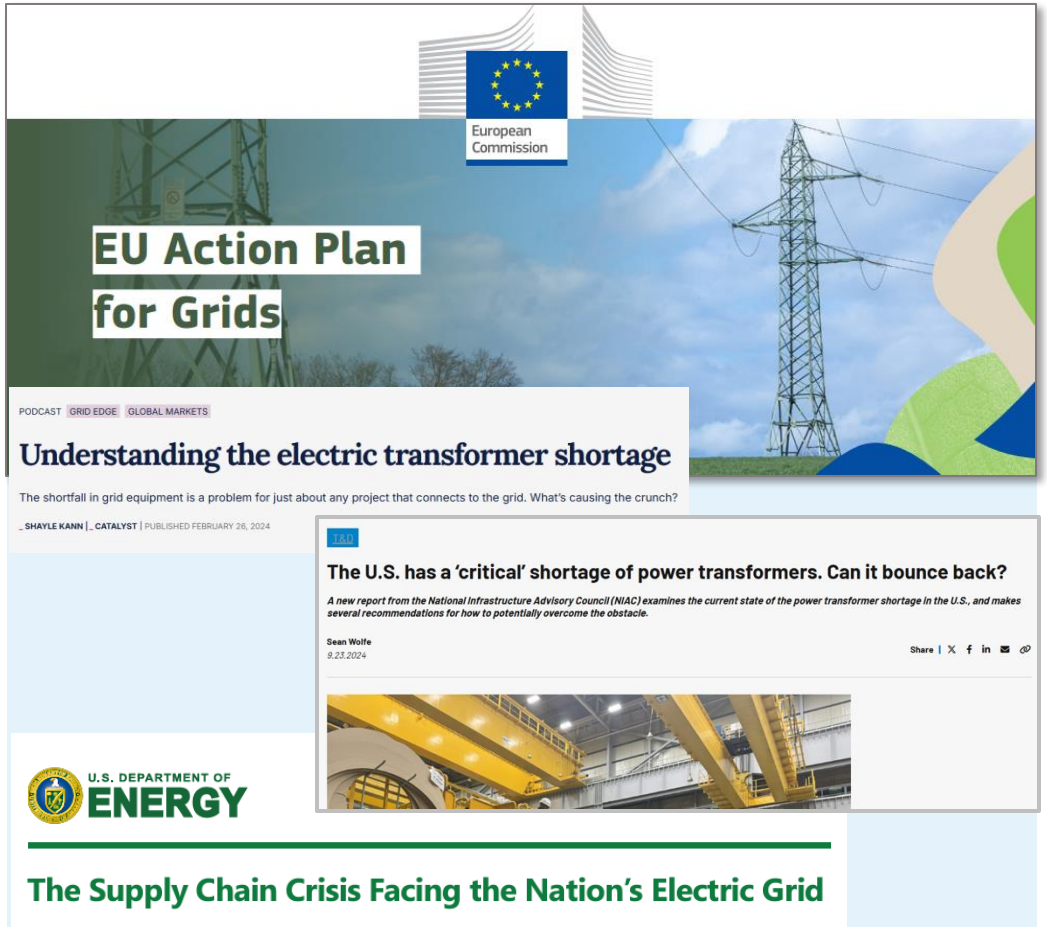
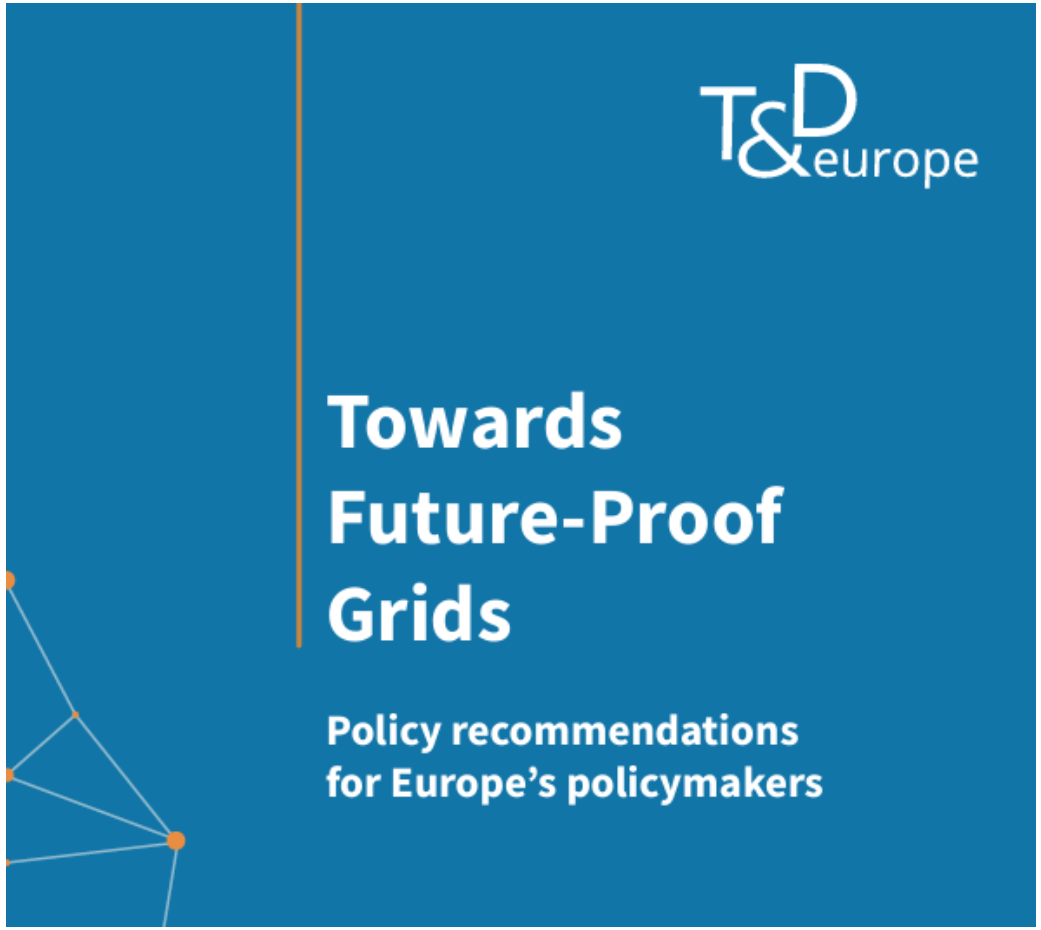
Accelerated transformation needs material



- Political focus has been primarily on generation and demand since the beginning of the transformation.
- Networks could accommodate the changes for a long time.
- But in the meantime, reserves are exhausted, enforcement, expansion and adaption needed on all levels.
- Moreover, networks in North America and Europe are aged and need to be renewed

As a result, we are facing an unprecedented growth in demand for network equipment.

This is an opportunity we need to seize together!



Our key recommendations

1. Europe's grid technology sector is a vital European and national interest and should be treated as such.
2. Clear long-term commitments are pre-requisite for fast ramping up of production capacities.
3. Transmission and distribution grids are equally important.
4. Digitalisation and cybersecurity are a must.
5. Let's make the most of existing capacities, e.g. by new ways of collaboration, by digitalization along the value chain.
6. Recognise sustainability when building Europe's networks.
7. Ensure regulatory coherence.
8. Align transformation of power system and supply chain.

Our commitment

- We are closely working with our customers and their organizations on finding ways to remove bottlenecks.
- At the same time, we are investing: During the past two years our members have announced to invest **more than 12 billion Euro** in capacity expansion globally – and they will continue doing so.

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Want to find out more?
https://tdeurope.eu/position_paper/2630/

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