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What makes renewables special?

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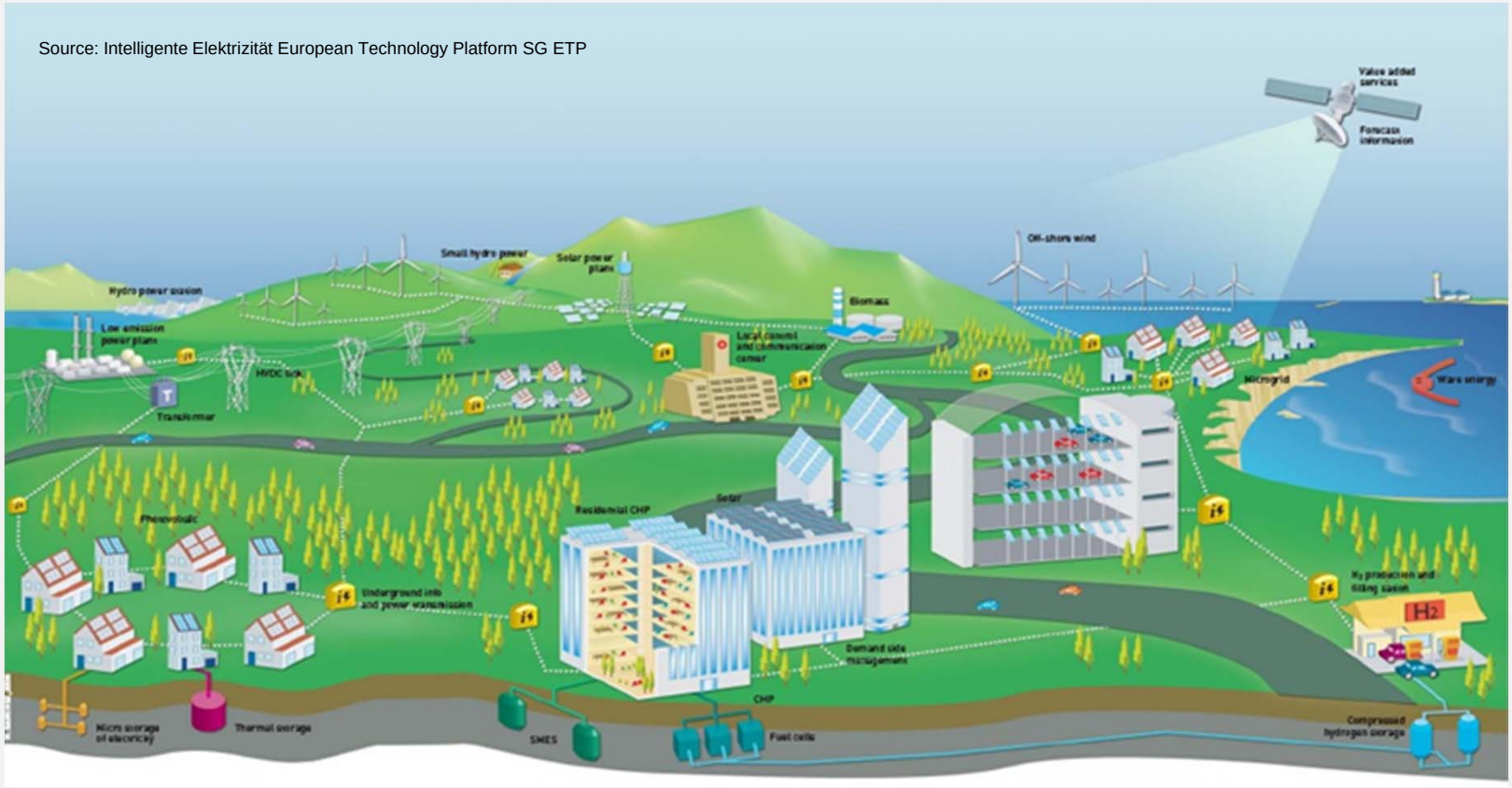
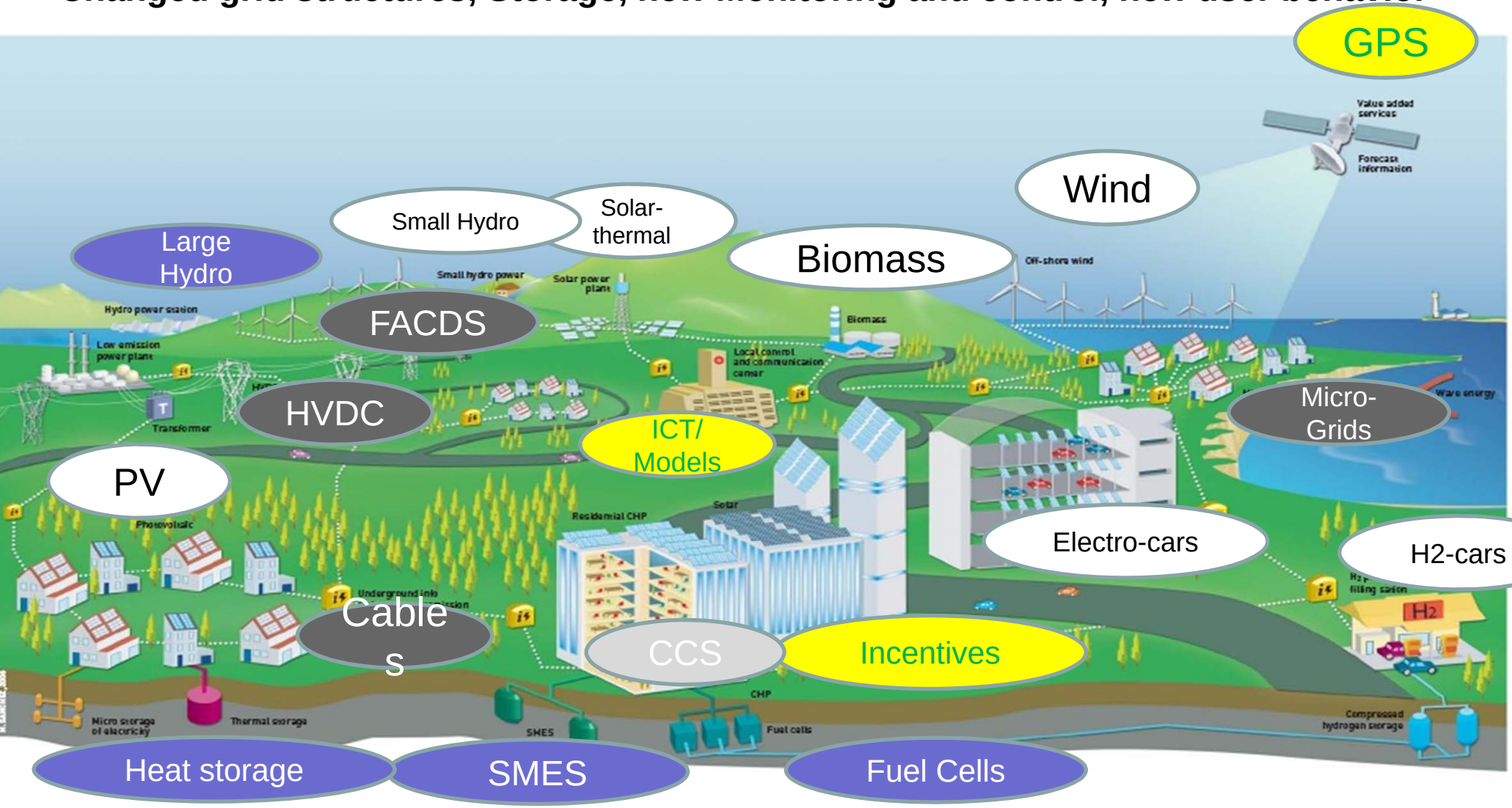


What makes renewables special?
(Dr. Rainer Bacher, Bacher Energie AG)

When many renewable sources feed electricity into the distribution grid, the grid is exposed to a great number of electricity producers, each with its own special properties which traditionally may not have been experienced before. The overall grid based system needs to continue to provide a functionality considering, amongst others, the local and mass effects of these special grid connected devices. This is a systems challenge.

The new electricity system: Renewable electricity infeed, Flexible consumers, Changed grid structures, Storage, new Monitoring and control, new user behavior



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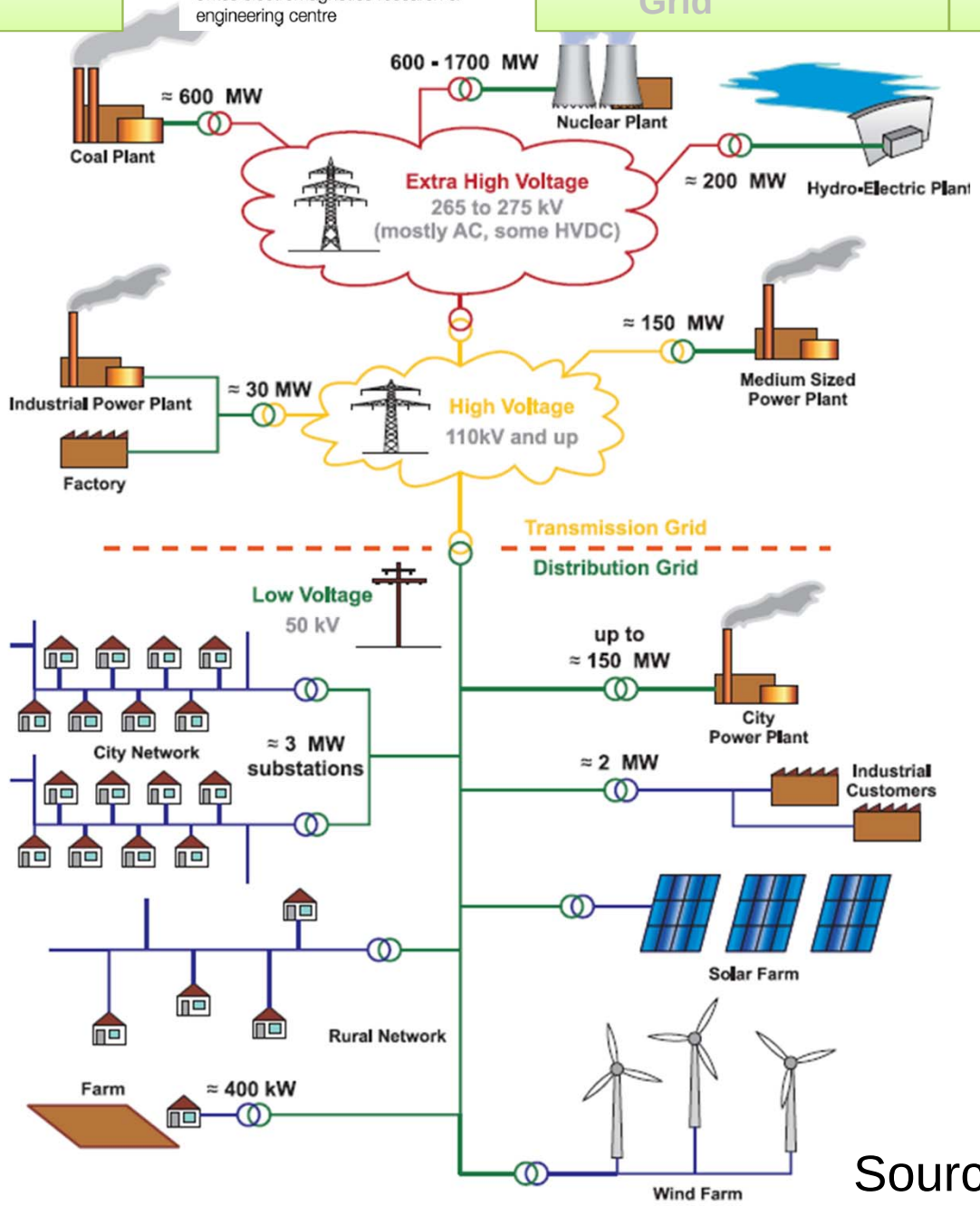
The components of the system: Where are they connected to the grid?

- Producer
- Consumer
- Storage
- Transformators
- Transmission grid
- Distribution grid



Source: Wikipedia

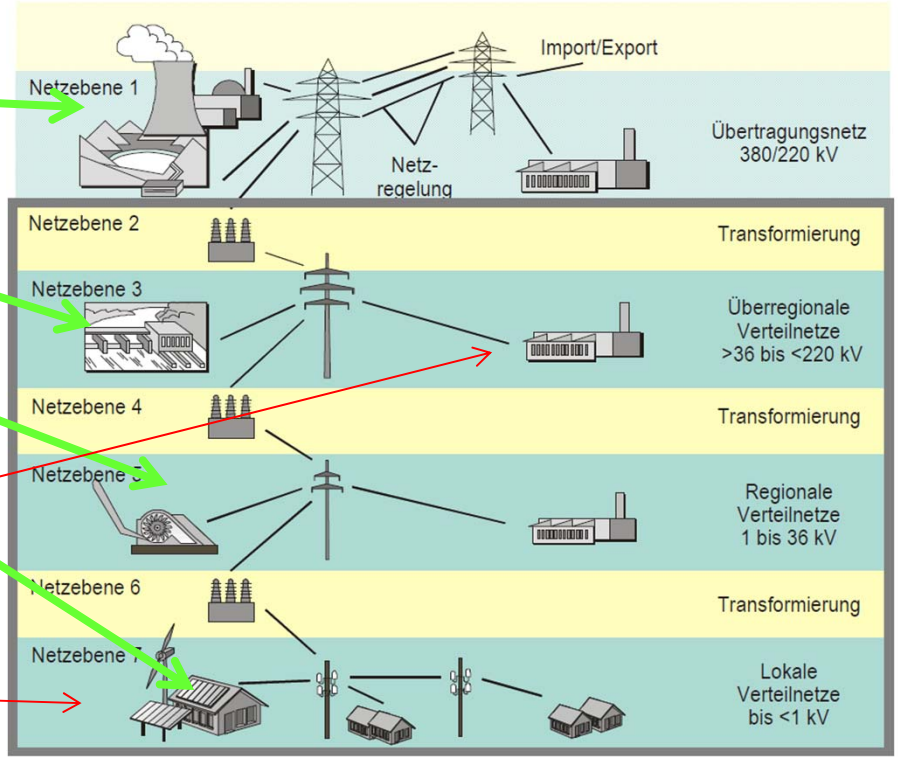
Grid: Each user is connected to a grid level

Producer (renewable)

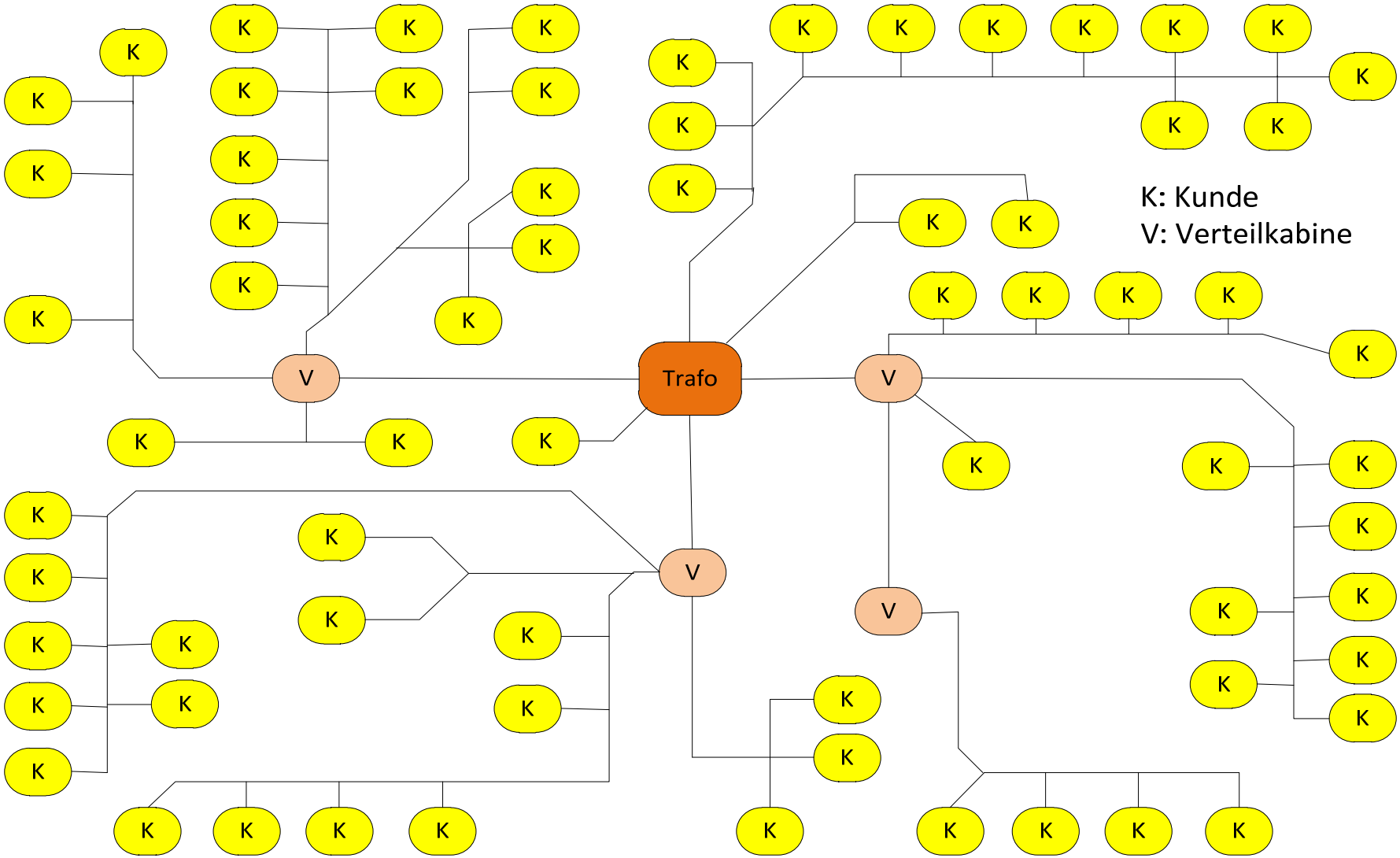
- NE 1: Water storage power
- NE 3: run of river power
- NE 5 (und 3): Wind power
- NE 7 (und 5): PV-producer

Consumer

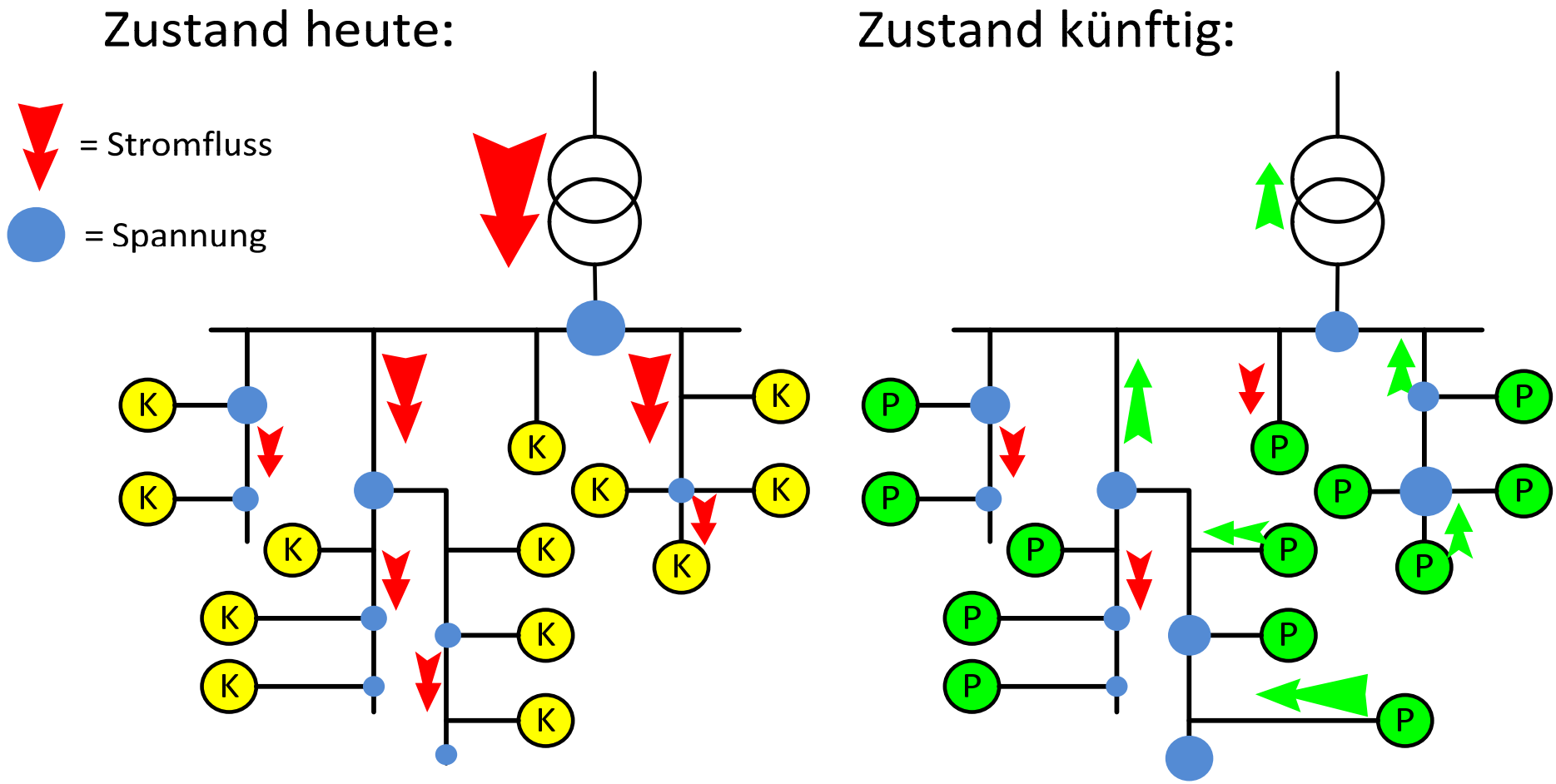
- NE 5 und 3: Industry
- NE 7: Households and services



Typical N7 low voltage grid



Requirements on grids: Dimensioning for secure handling of extreme situations (even outages)

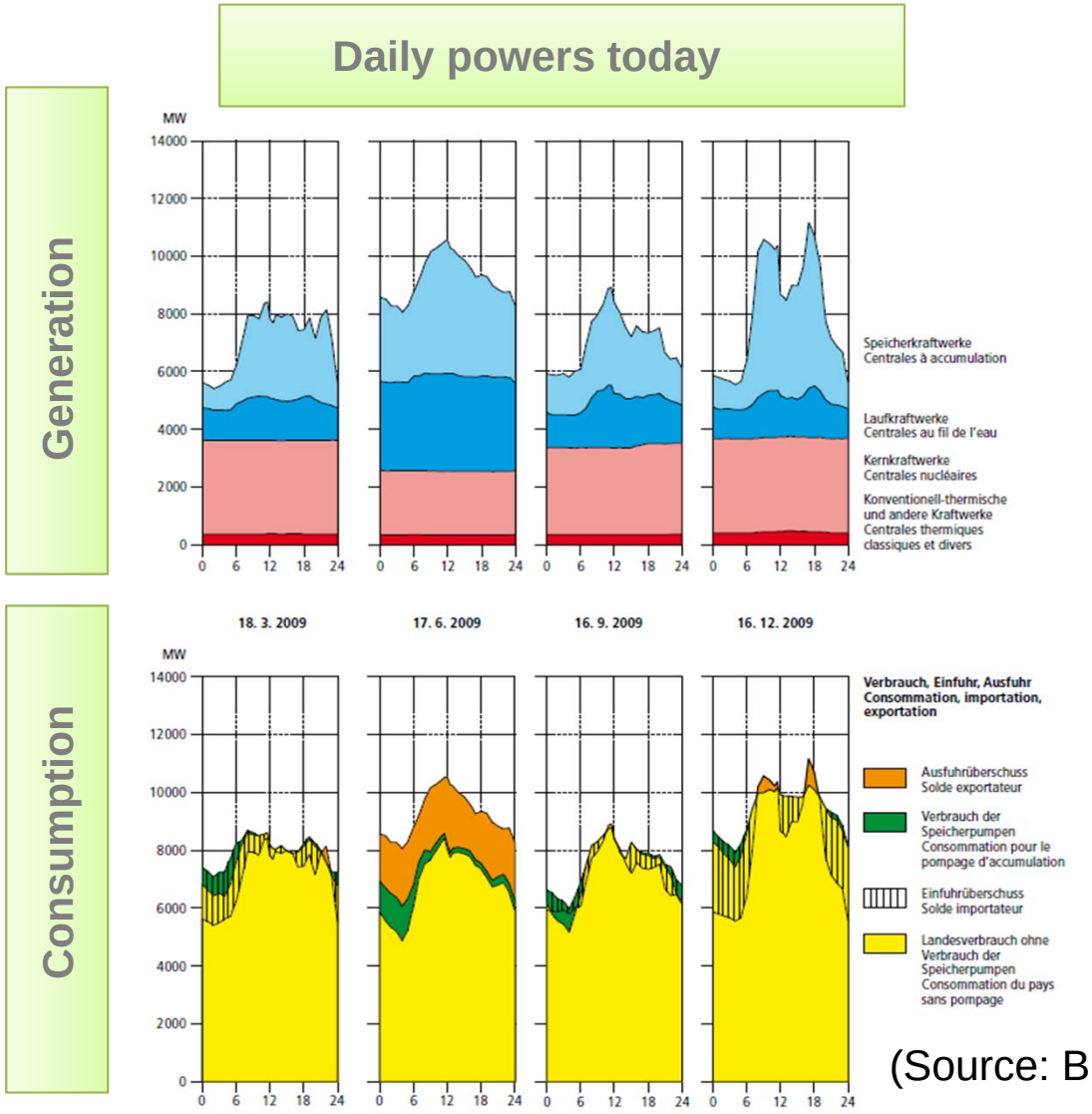


Voltages and currents will change due to new distributed infeeds.

Balancing as key challenge with renewables

Renewables change the pattern of generation during the hours of the day (seasonal)

- What part of total Swiss load can be covered by renewables? What part by other electricity infeeds?
- When during the year down to the day do we have intensified need for balancing power?



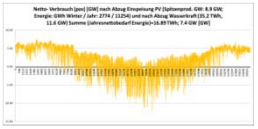
(Source: BFE

Scenario: Same as Year 2010/11

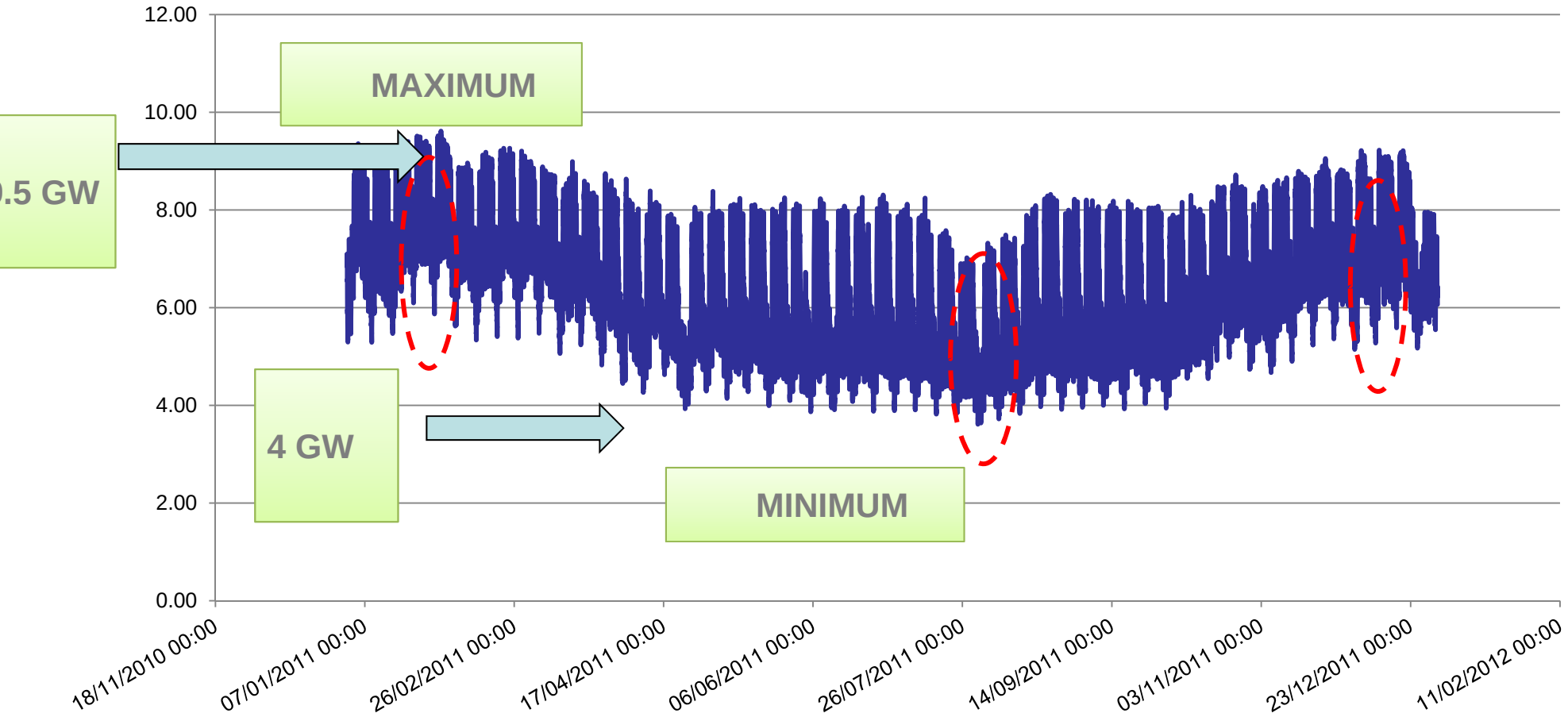
Consumption 63 TWh/a incl Pumping and losses

But the future generation (2035 … 2050) …

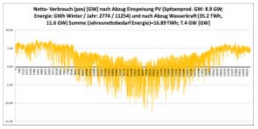
- Hydropower like 2010: 39 TWh/a
- NEW: No nuclear power stations any more
- NEW: Electriticity production by PV: approx. 11 TWh/a with ca. 10 GW maximum Peak-Power
- NEW: ca. 11 TWh/a further electricity production (Wind, Gas, Geothermie, WKK, Import)



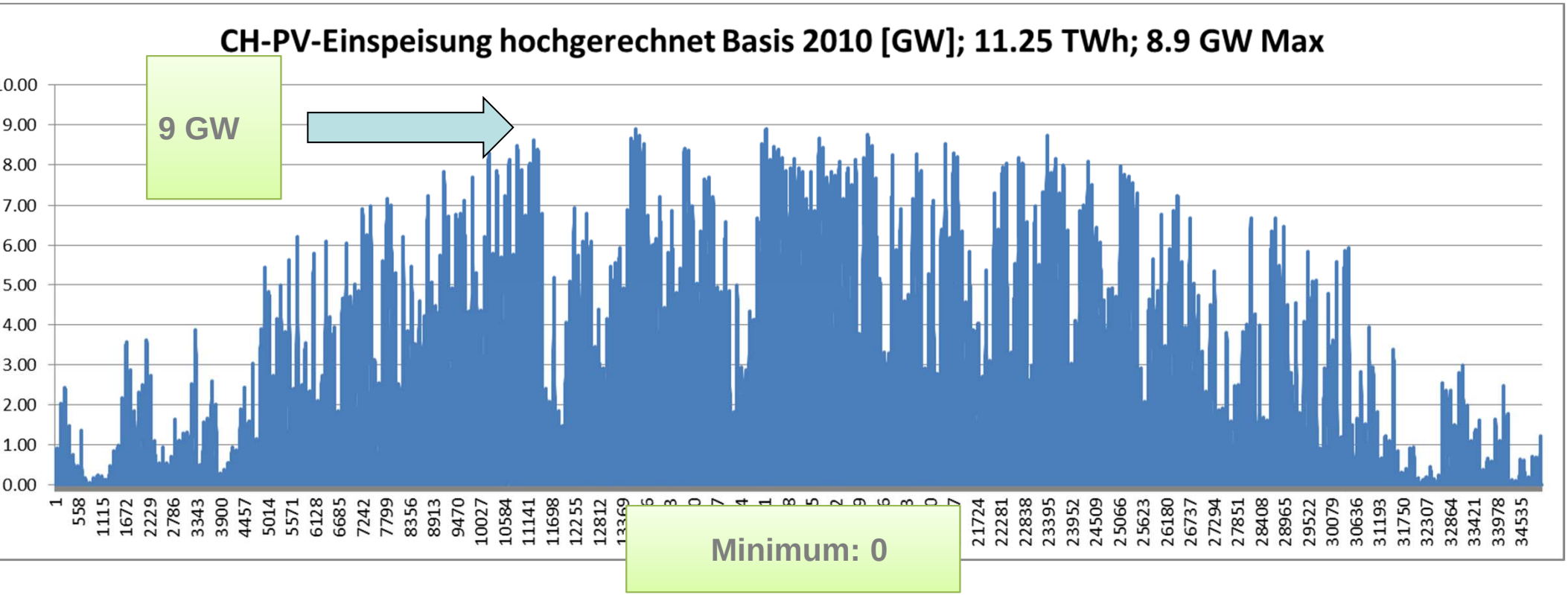
Electricity consumption CH YEAR 2011 in GW (1/4h)



Source:swissgrid)

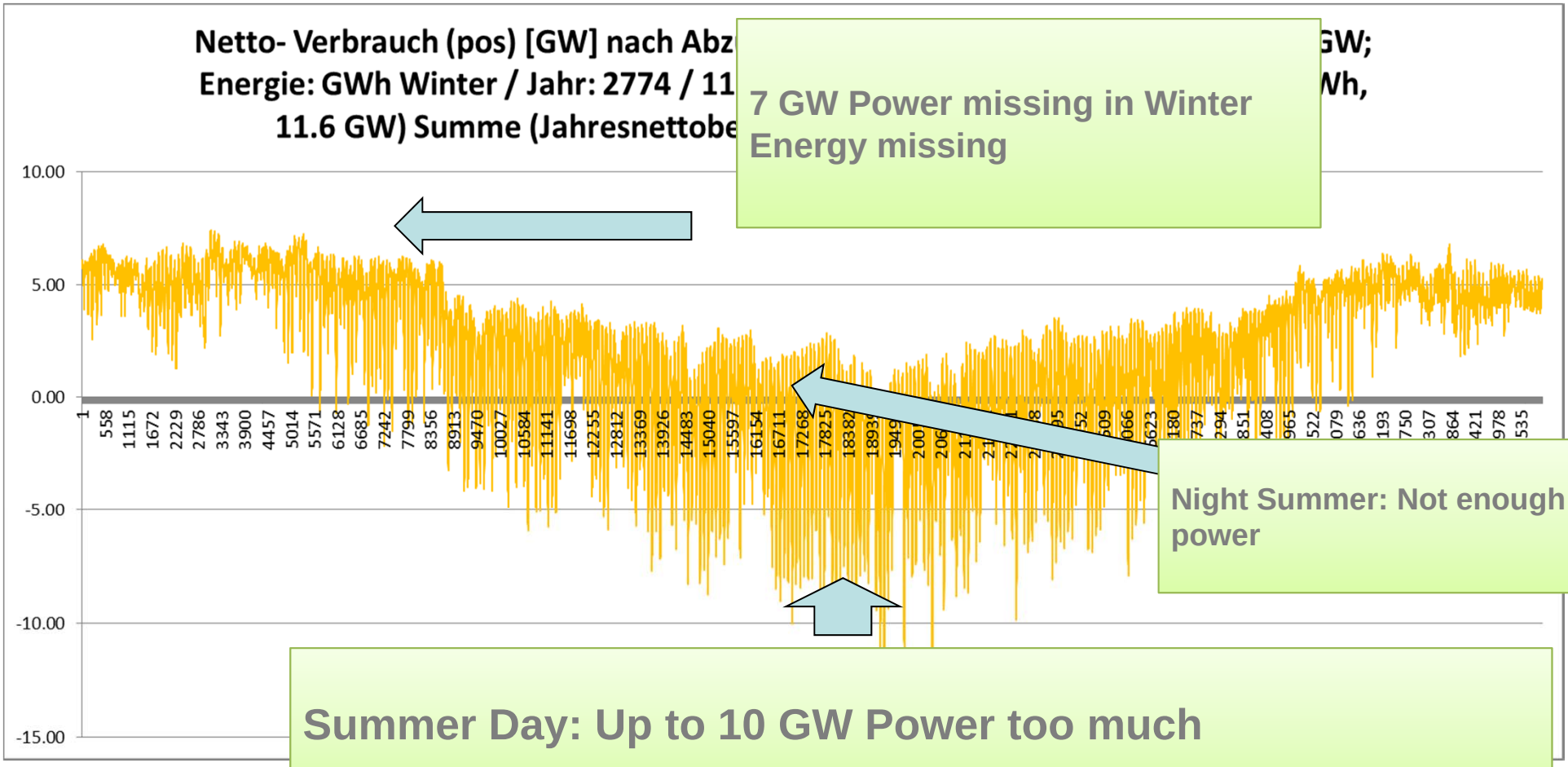


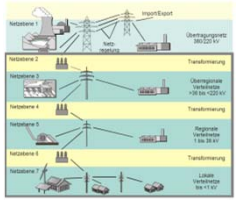
Simulation Solar-PV-Infeed in 15-Minuten-Intervals



(Source:self, data from SFOE)

The remaining hourly balance (11TWh/a still needed after Hydro and PV). (Draft Scenario)





Balancing in Spring 2035+ – Grid level 7

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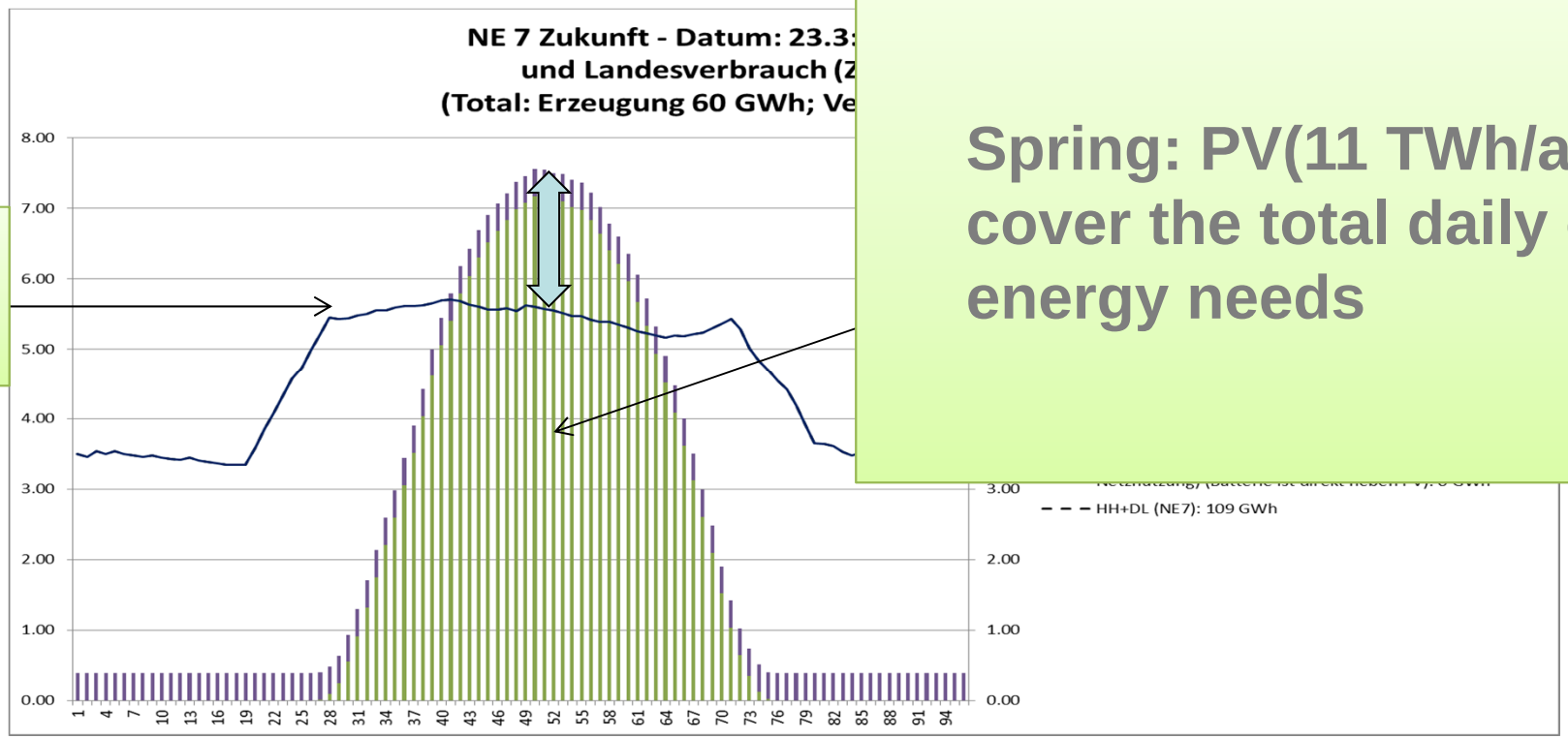
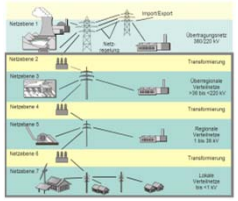
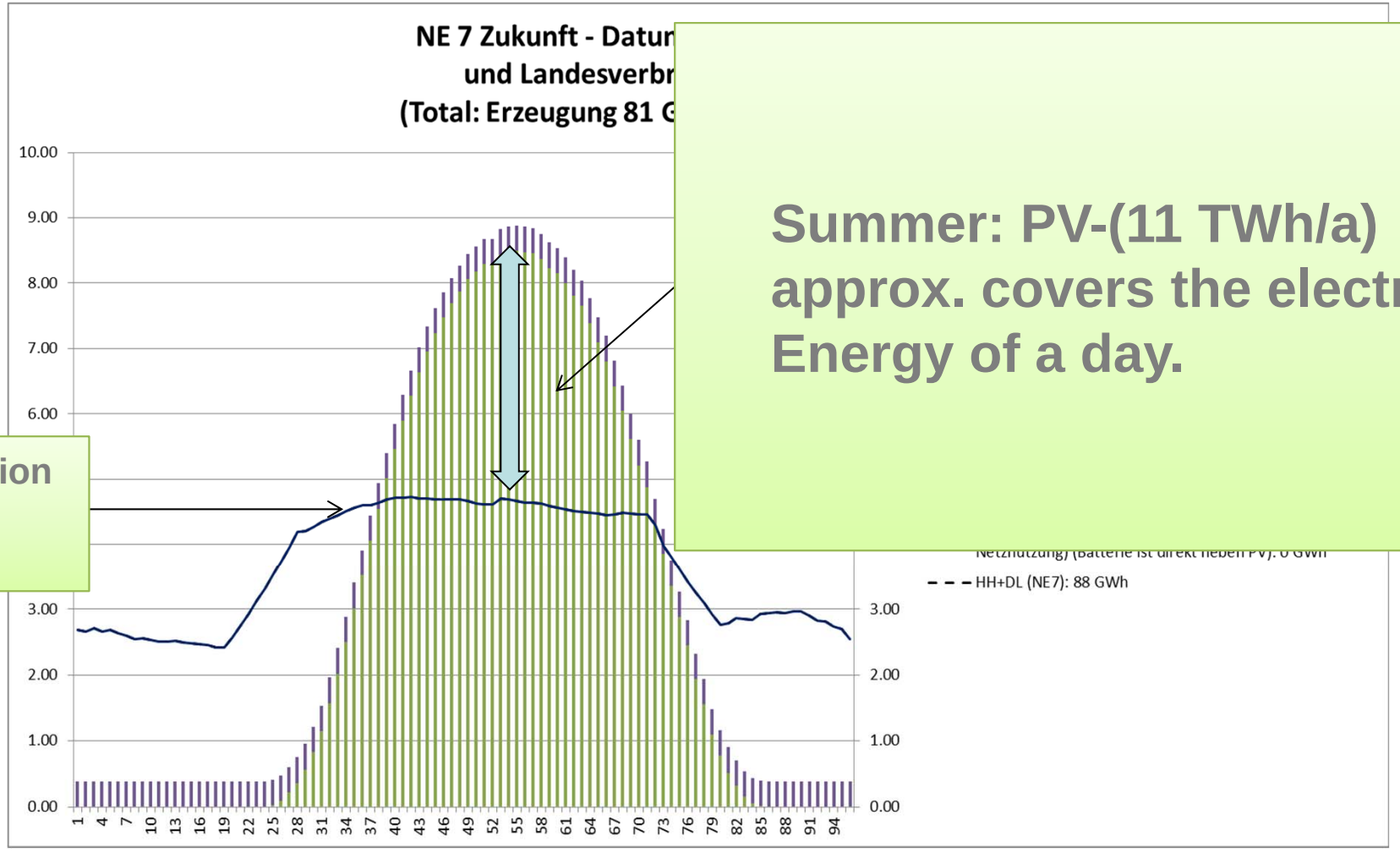


Spring: PV(11 TWh/a) does not cover the total daily electrical energy needs



Balancing in Summer 2035+: Grid level 7

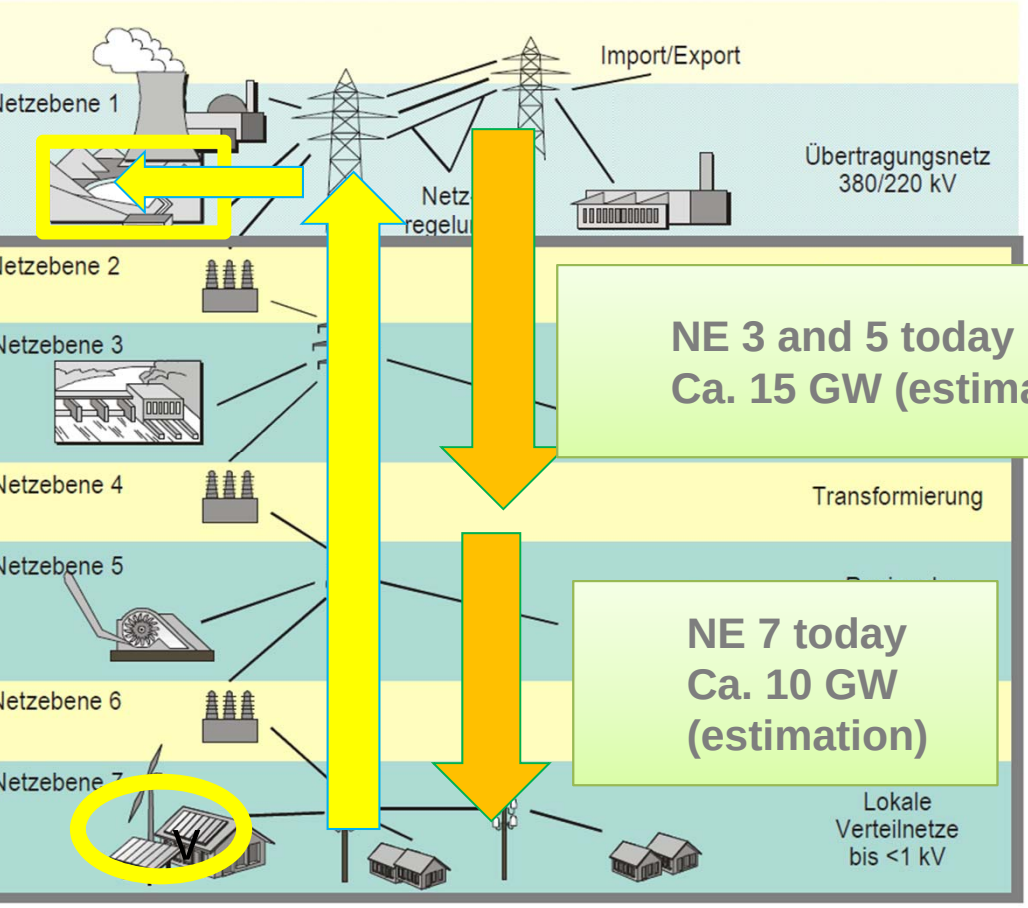


Consumption ca. 4.8 GW

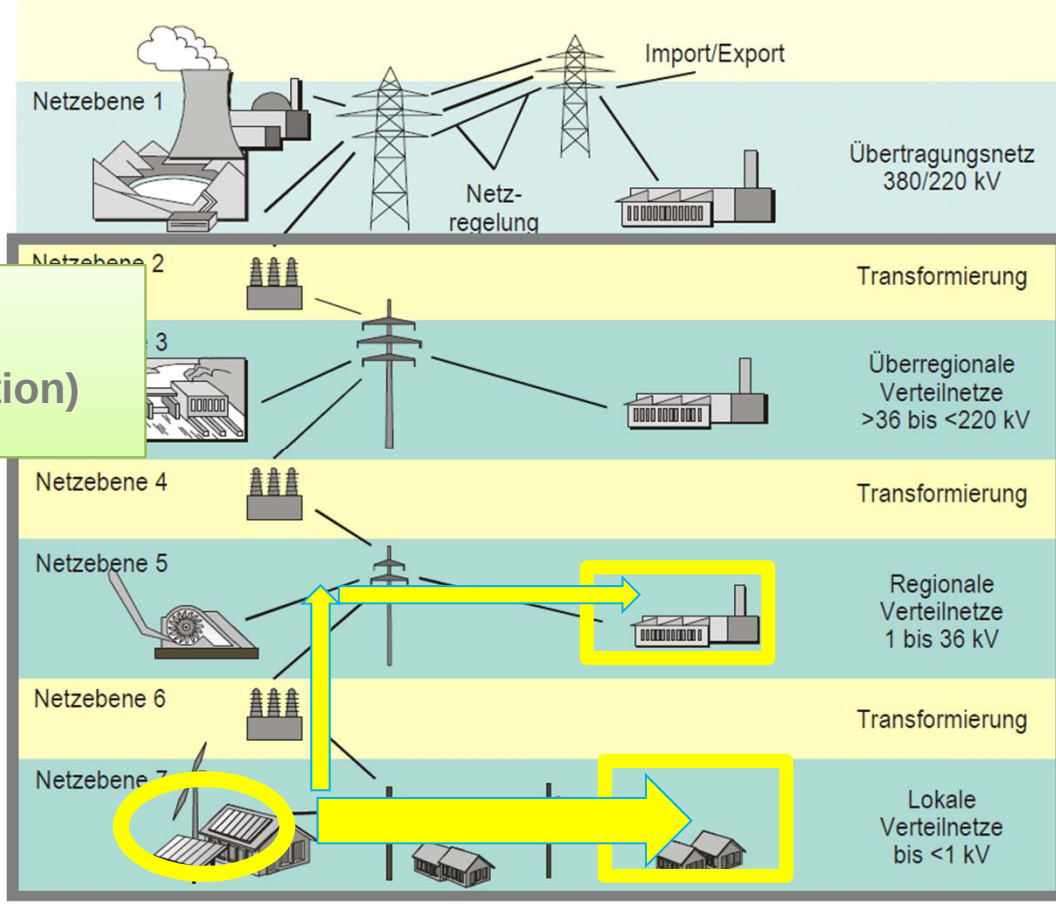
Summer: PV-(11 TWh/a) approx. covers the electrical Energy of a day.

Distribution grids: The excess PV-infeed on a Summer day

Scenario A without distribution grid storage but with hydro reservoir



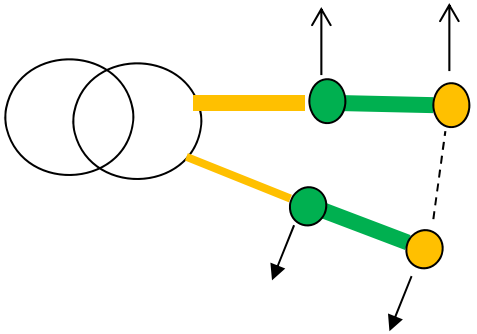
Scenario B with distribution grid connected storage

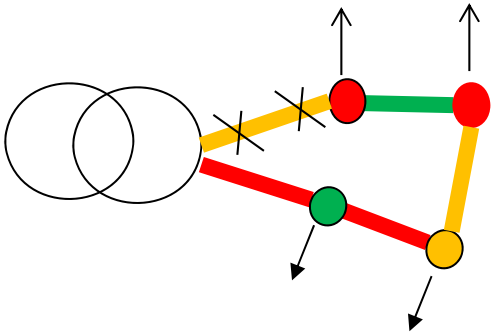


(Source background: VSE)

Distribution grid capacity reserves today

- **Radial distribution grids today: Only consumers are connected (and served)**
  - Priority: easy planning by observing grid capacity reserves
  - Handling of outage of cables
    - In emergency case, use second infeed via a nearby-radial connection



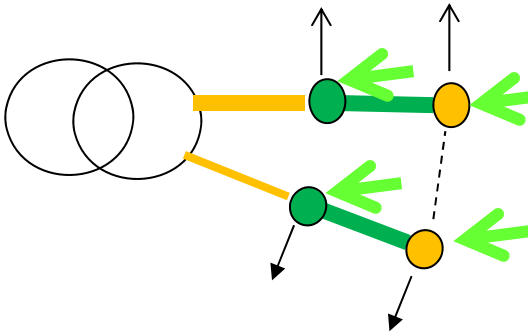


➔ Today‘s distribution grid average loading: below 50%

The future distribution grid

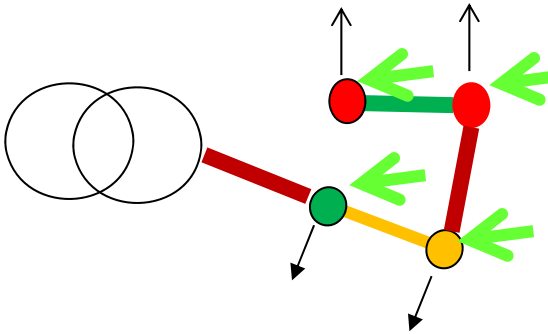
Many distributed generators and flexible consumers

- New short-circuits, new currents, new voltages
- Known grid use patterns not present any more



Outage of cables

- Much more complex situation



➧ Peak grid loading will be very different and change in very short time: High sensitivity to the amount and types of electric cars and PV-Infeeds

Conclusion: What makes renewables special? … Many more issues …

Specialties of renewables	Asset Management	Assets Economics	Legal / Policy	Security of Supply
Sustainability	Life time	Investment time	Market versus subsidy	Reliability, availability
Distributed property	Manage masses of prosumers	Investment size	Duties and rights of many involved	Central, hierarchy, distributed
Generation connected to LV grids	From reserves to assets use optimization	Who pays? Who profits?	Distribution grid use rules	Responsibilities
Hard to control	Kirchhoff and frequency	New Monitoring and control systems	Liability in case of blackouts	Stochastic reserve margins
Cause grid overloads	Asset lifetime, Asset access	Congestion revenue. Market participant risks	Congestion management rules	Capacity reserve versus incentives versus controls
Cause grid voltage violations	Electrical (home) equipment functioning	Industrial voltage quality sensitivity	Rules for grid operator and grid users	Regional security monitoring and coordination
Many others…				