The three pillars for a 100% electricity supply with renewable energies

and the role of hydrogen

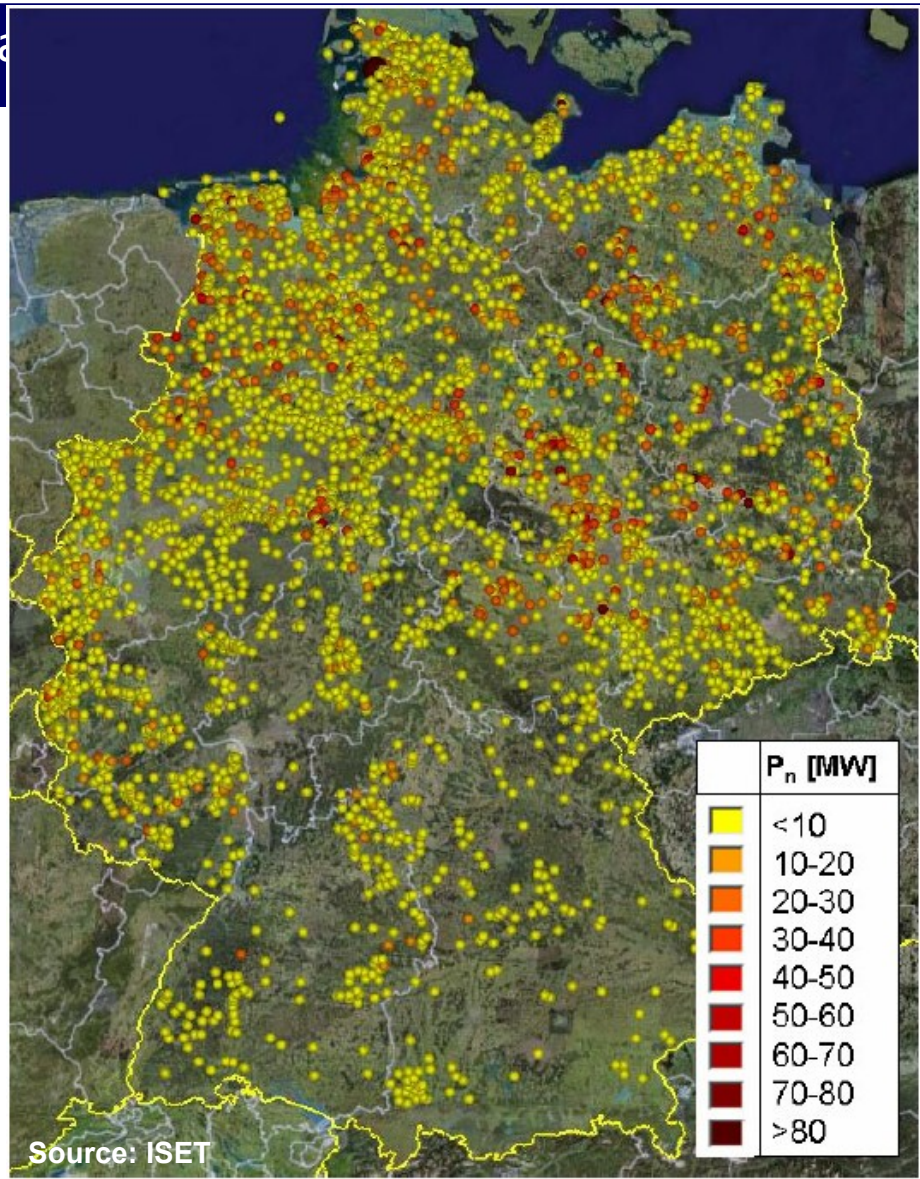
Contents

- Why discussing storage on the grid?
- Our electricity supply – is it a bone?
- Role of demand response / demand side management and its limitations
- Alternatives with high storage capacities
- Are large interconnected systems an alternative for energy storage?
- Conclusions

Motivation: e.g. Wind parks in Germa

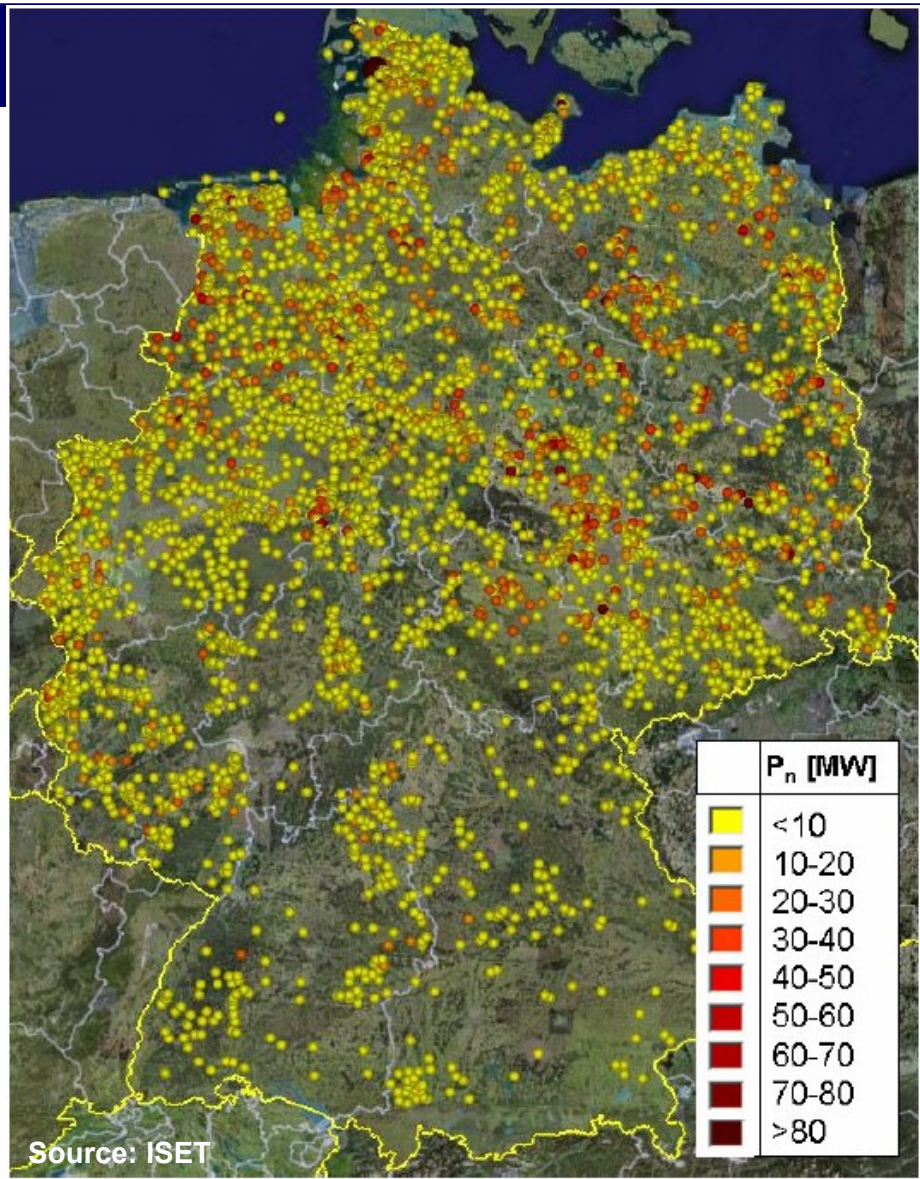
- **All technologies for a change to a sustainable energy supply already exist!**
- **How to integrate all the wind (and solar) energy into our grids?**
- **What to do when there is no wind?**
- **What to do when there is too much wind?**

What are the questions to answer?



Questions to answer

- Power Balancing
  - Primary Control Power
  - Secondary Control Power
  - to react on deviations between forecasts and reality in consumption and wind power generation
- Energy Balancing
  - in times of low / high wind load periods
- The answer has a lot to do with energy storage!



Our Electricity Supply System – it‘s a Bone

Coal Production → Coal Storage → Coal Transport → Coal Dump

Natural Gas Production
Desulfurization, CO2-Separation
Gas Distribution
Gas Storage

Oil Tank
Refinery
Oil Pipelines, Oil Tanker
Oil Production

Storage → Fuel Element Production ← Fuel Element Storage

Uraniu m ore → Uran-235 → Enrichment

Pumped Hydro

Generatio n

How does an underground hydrogen storage system look like?

Source: stunksitzung.de

Our Electricity Supply System – it‘s a Bone

Coal Production → Coal Storage → Coal Transport → Coal Dump

Natural Gas Production → Desulfurization, CO2-Separation → Gas

Pumped Hydro

Compressed Air Storage

Cold Applications

Heat Applications

Storage Heating

Consumption

Circulation Pumps

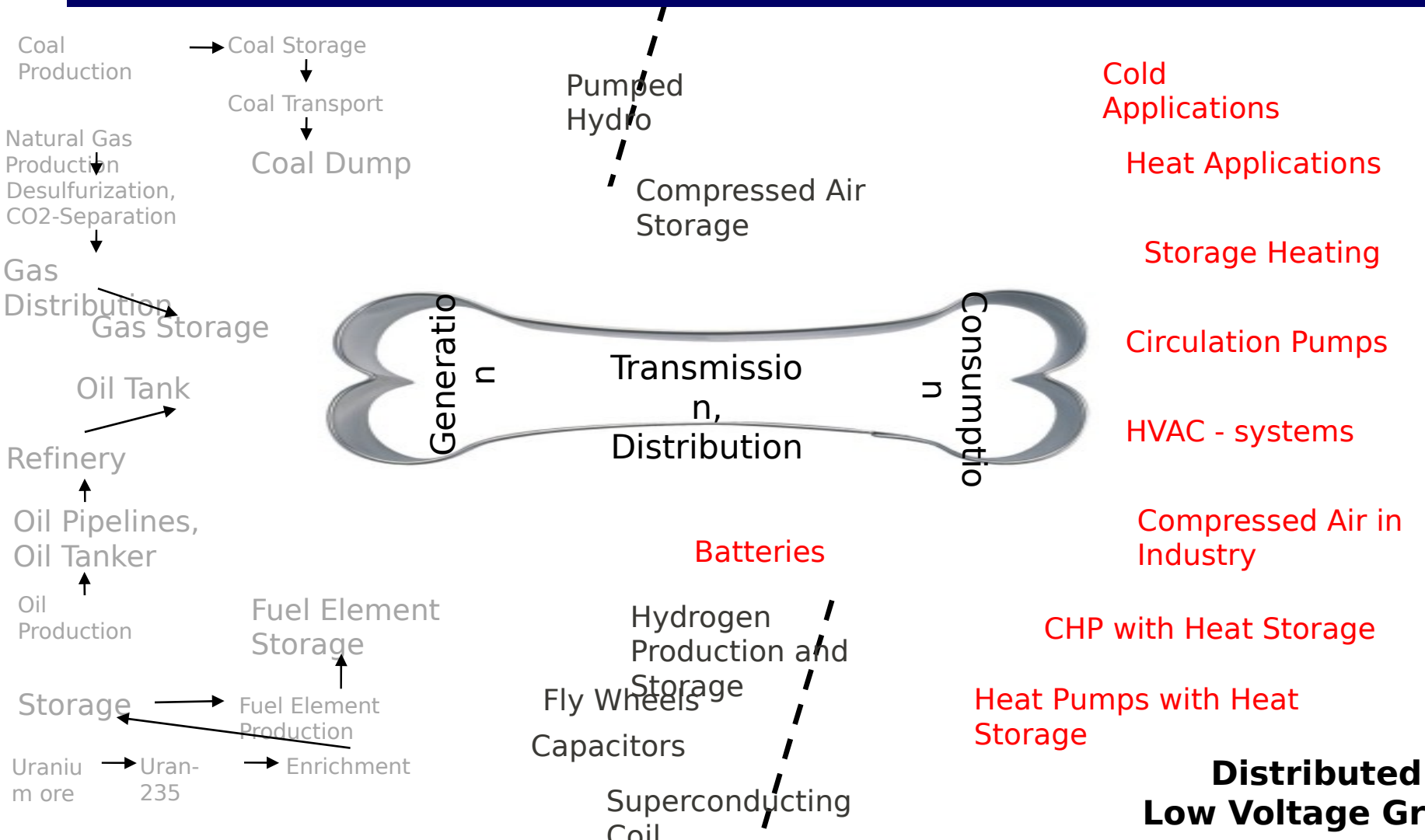
HVAC - systems

Compressed Air in Industry

CHP with Heat Storage

Heat Pumps with Heat Storage

Our Electricity Supply System – it‘s a Bone



Smart Metering

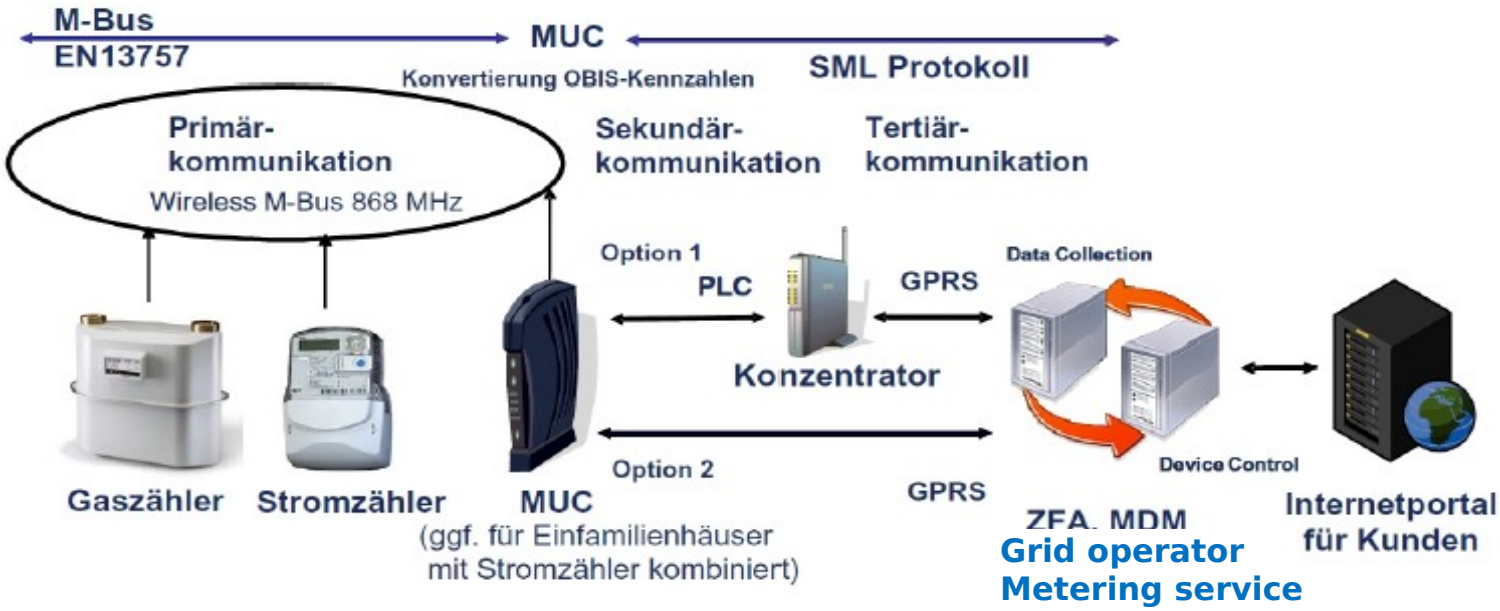
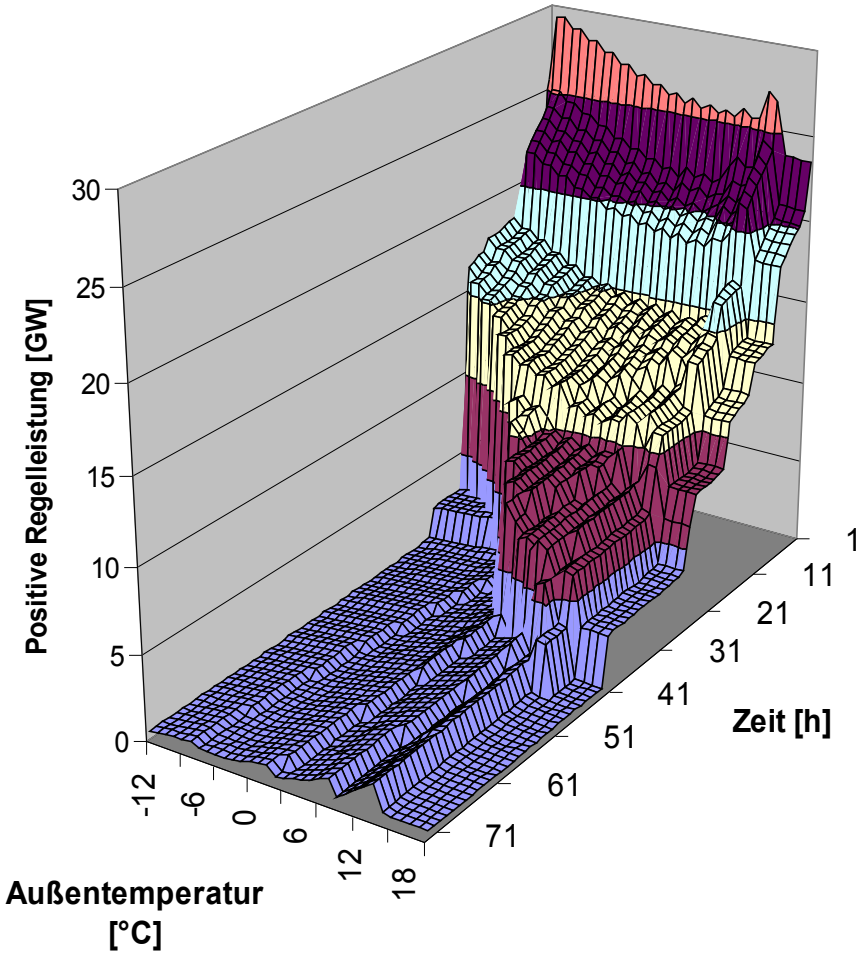


Abbildung 5.3: Beispiel für ein System, angelehnt an OMS [Quelle: DVGW] **Source: DVGW**

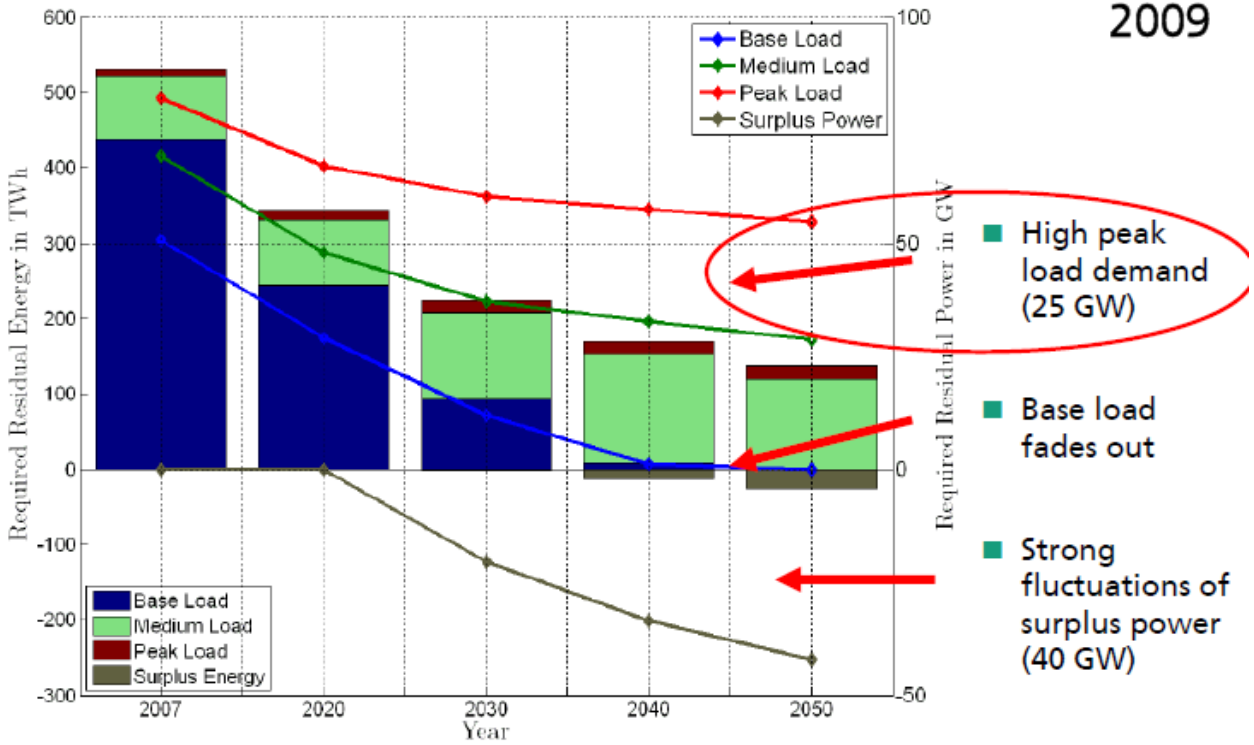
- … brings communication infrastructure to every household (and industry building)

Potential of Demand Response – only in



Power and Energy type according to German Ministry for Environment Lead Study of 2009

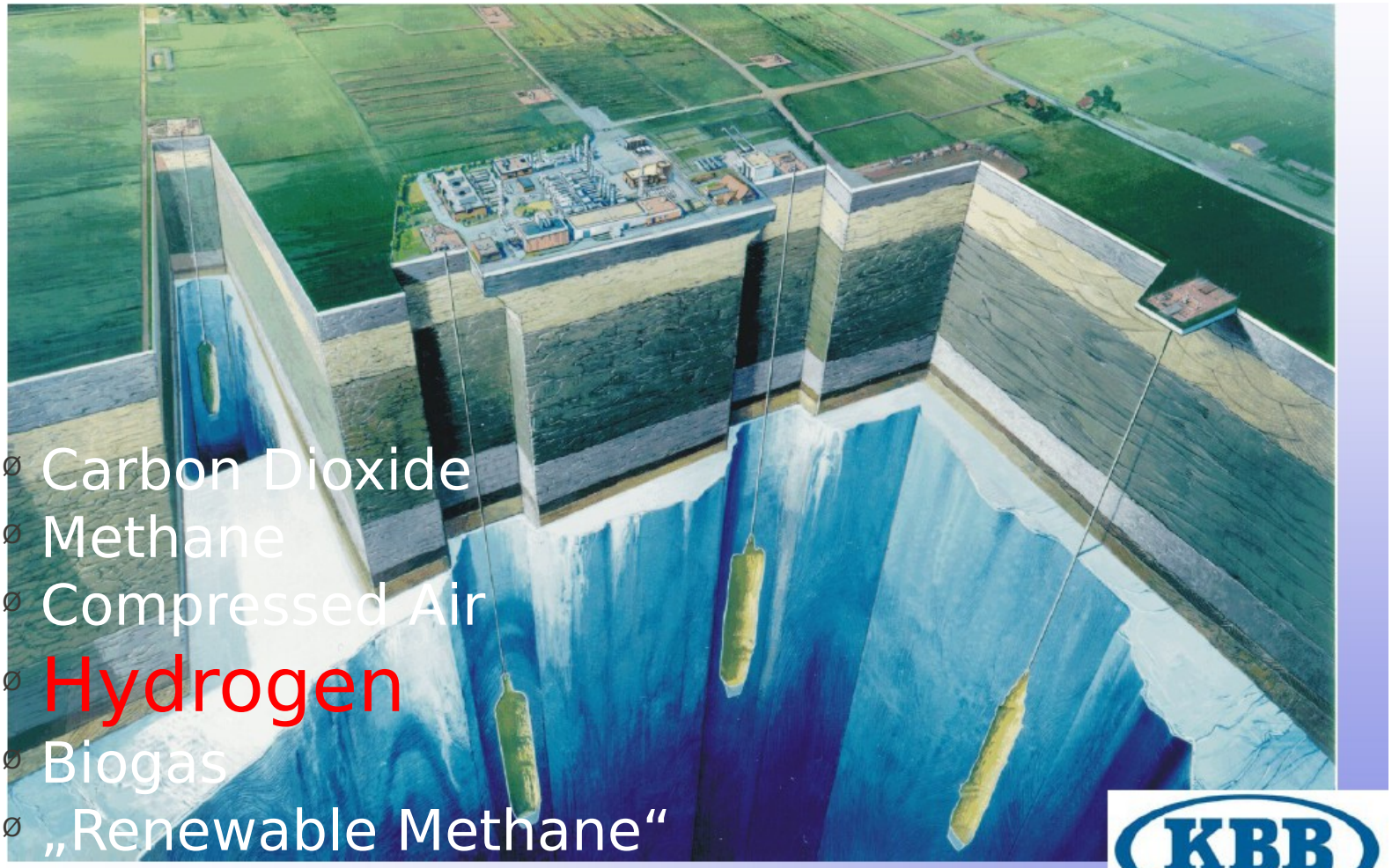
Required Residual Power & Energy in the BMU Lead Study (LS) 2009



Challenge: match surplus fluctuations with peak demand

SOLARFUEL ZSW Fraunhofer IWES

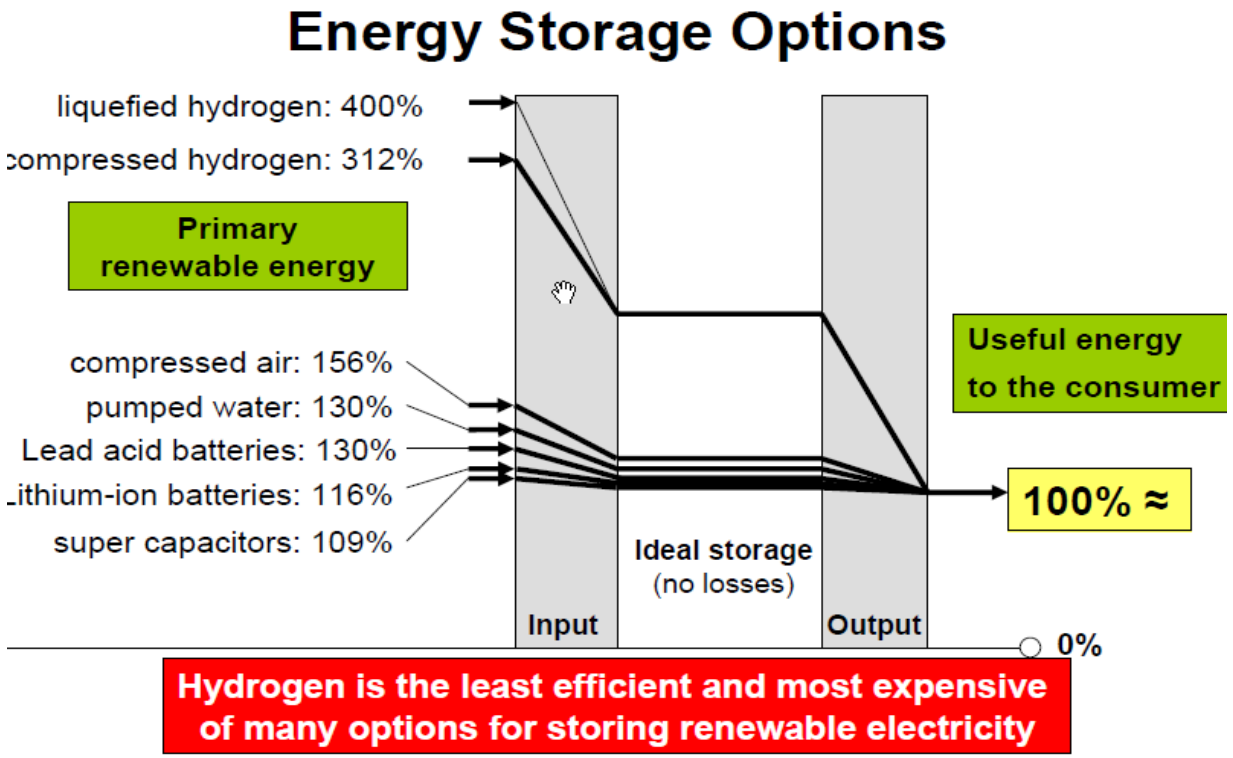
Large storage volumes in salt caverns



- Carbon Dioxide
- Methane
- Compressed Air
- **Hydrogen**
- Biogas
- „Renewable Methane“

KBB UNDERGROUND TECHNOLOGIES

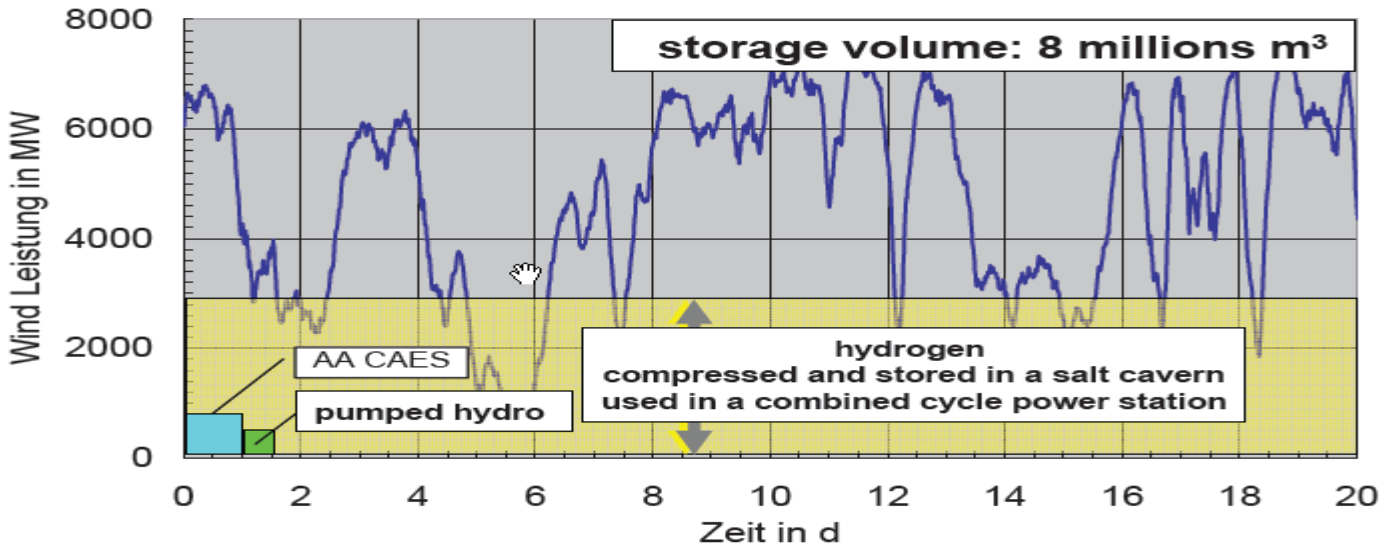
Hydrogen Storage – really bad system



Source: Ulf Bossel

Hydrogen Storage – but excellent energy

Comparison of Storage Capacities

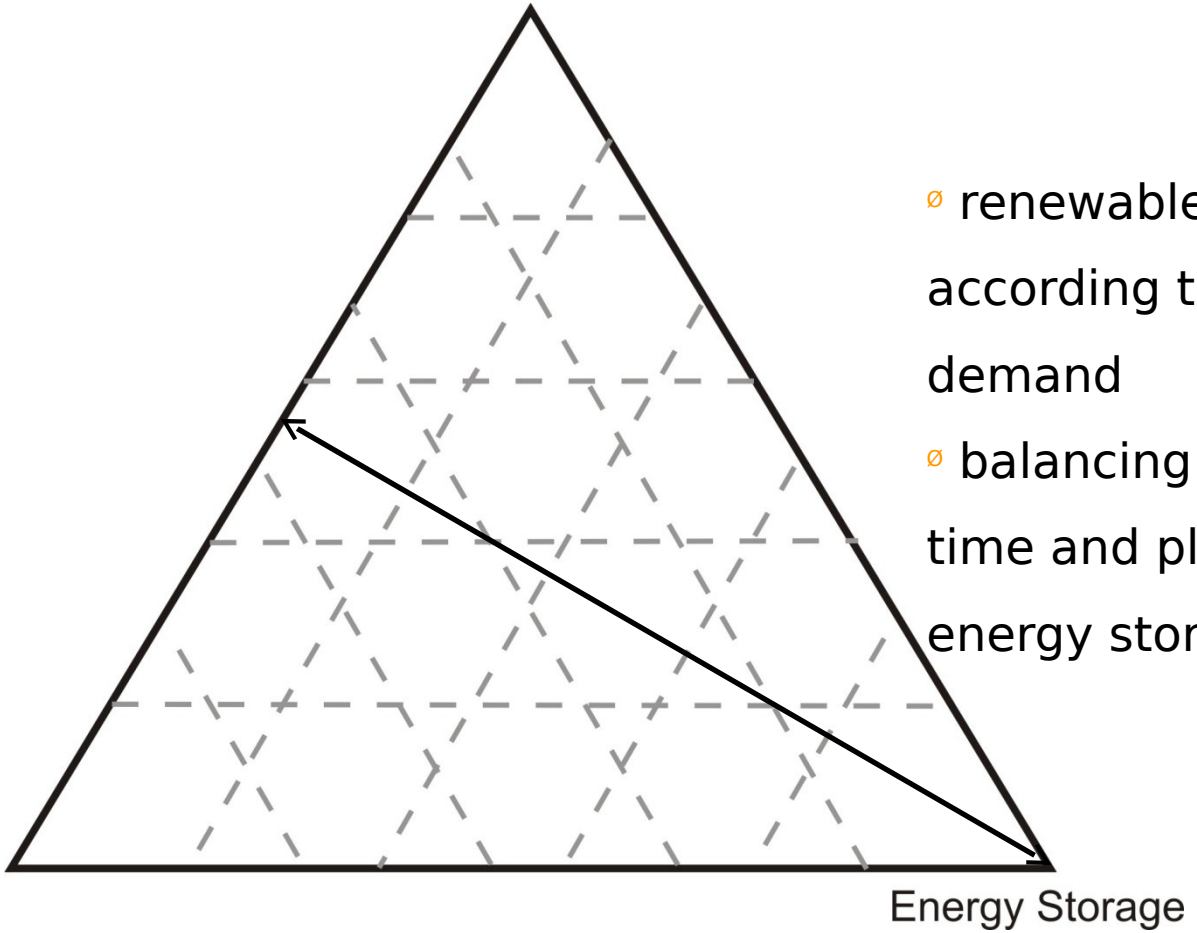


VDE

Source: Kleimaier

- … and long-term storage has a lot to do with hydrogen!

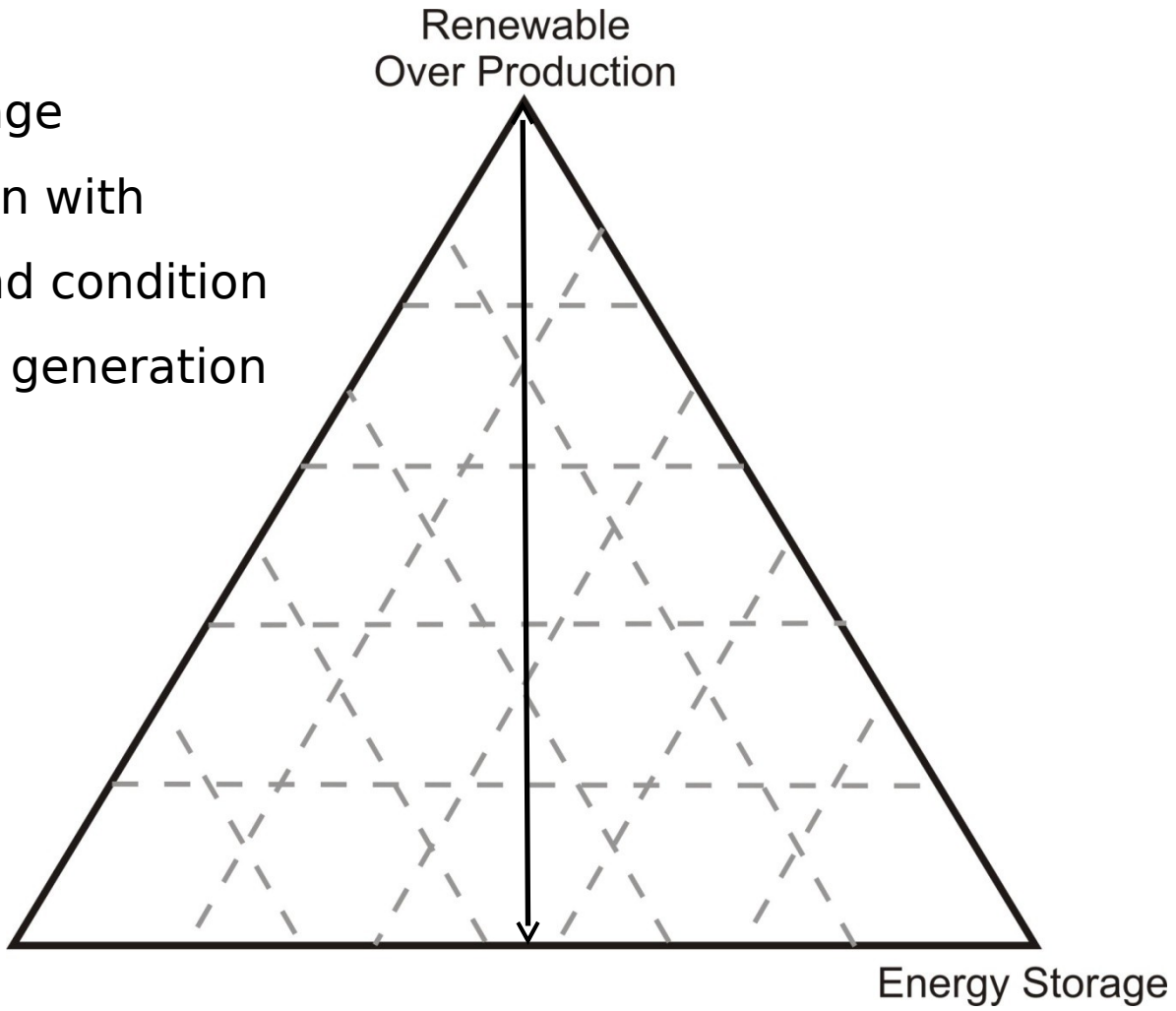
Ways to achieve 100% renewable electricity



- renewable production according to mean demand
- balancing according to time and place by energy storage

Ways to achieve 100% renewable electricity

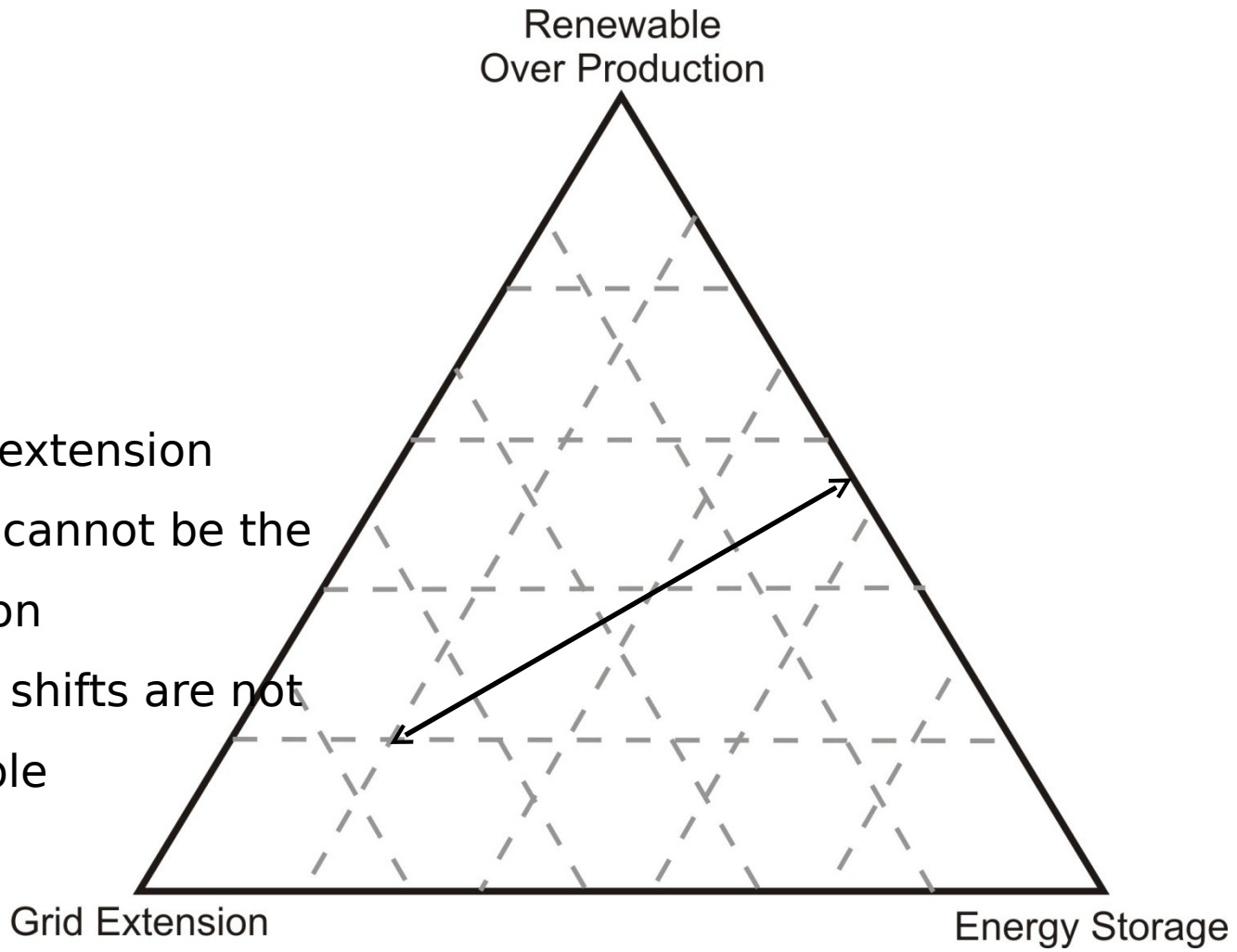
- no storage
- e.g. even with worst wind condition sufficient generation capacity



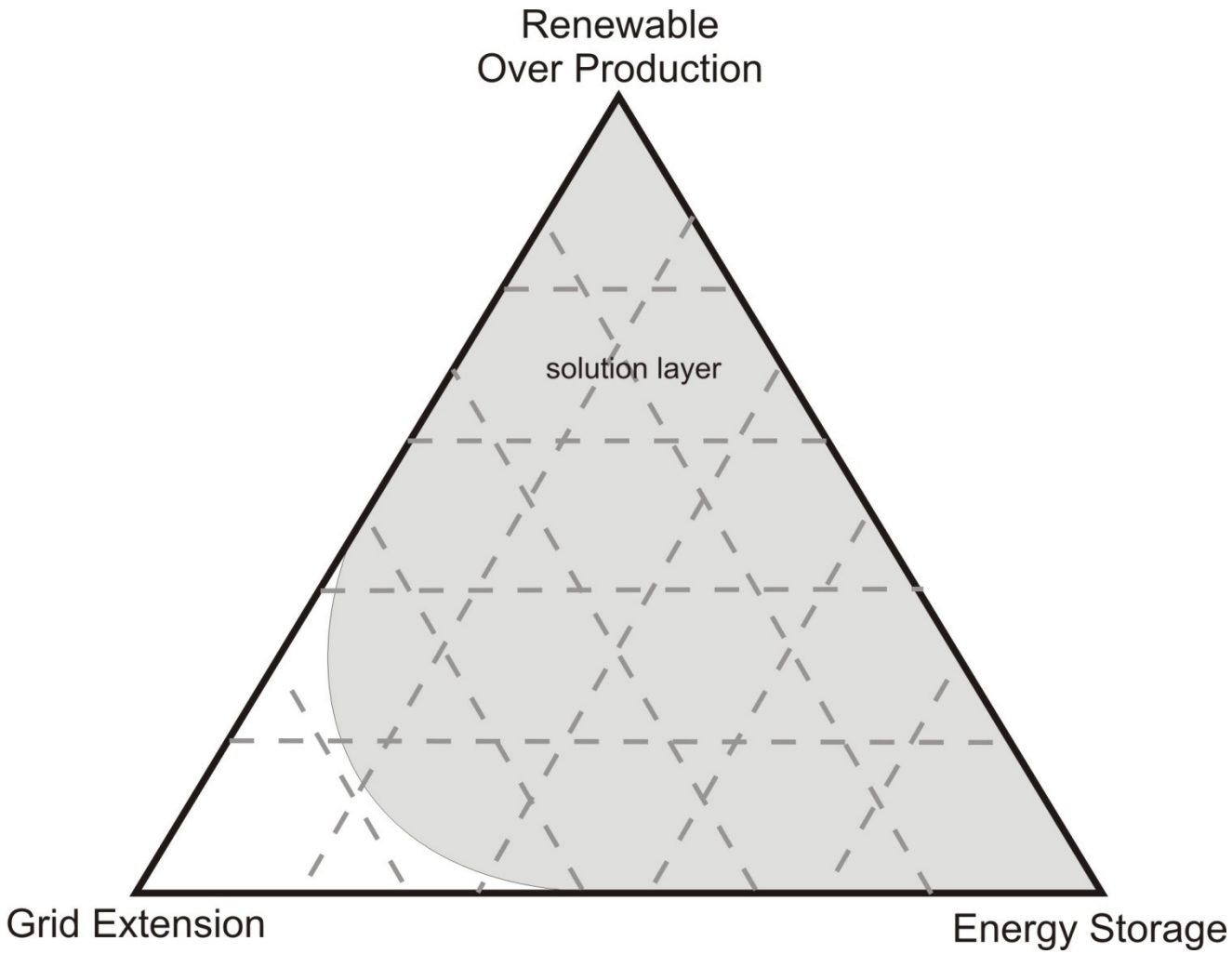

100 %
Renewable
Storage
overproduction

Ways to achieve 100% renewable electricity

- grid extension alone cannot be the solution
- time shifts are not possible

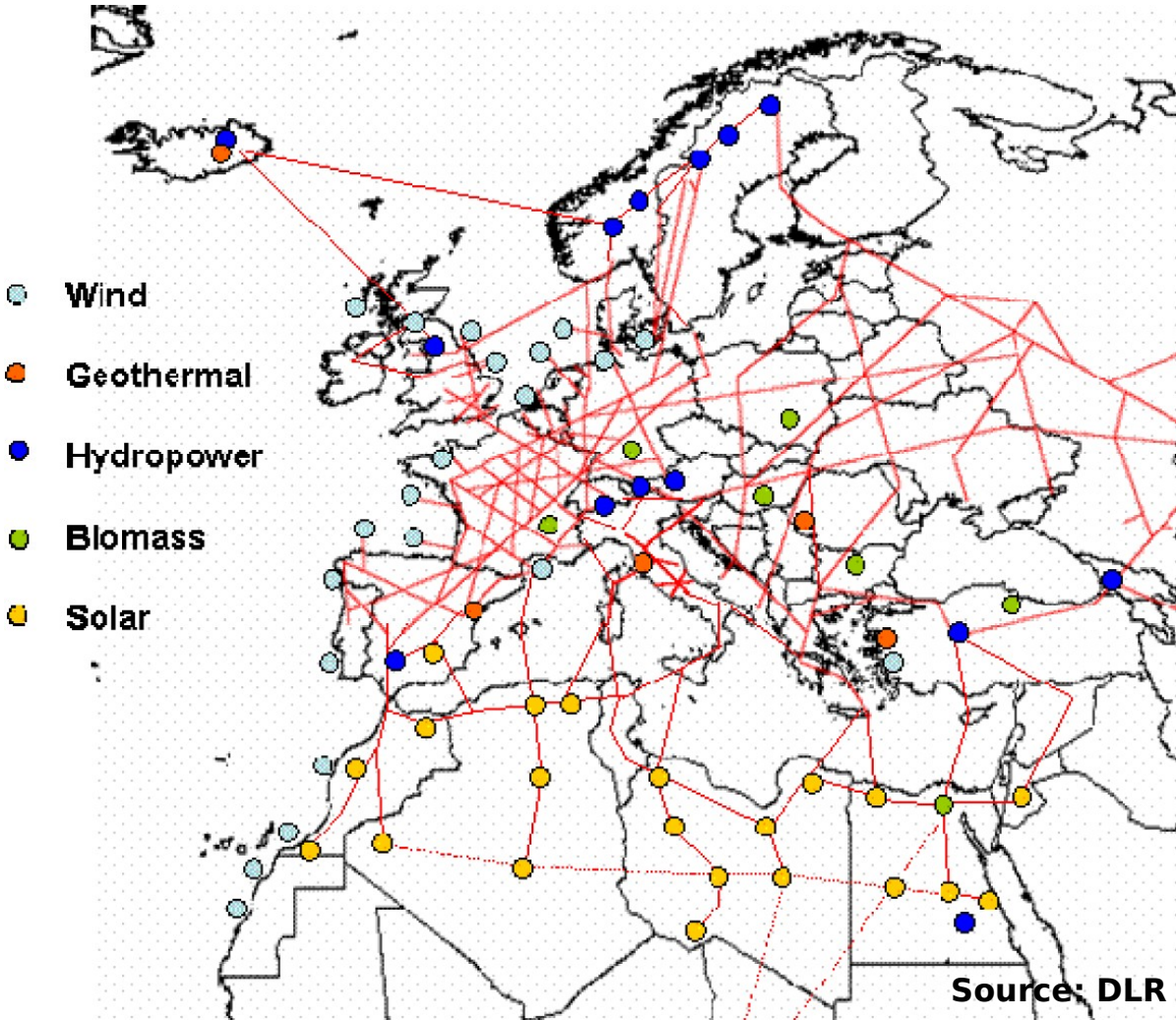


Ways to achieve 100% renewable electricity



Do we need all that smart-grid activities?

- … when aiming for large interconnected electricity supply systems



Wind production in different regions

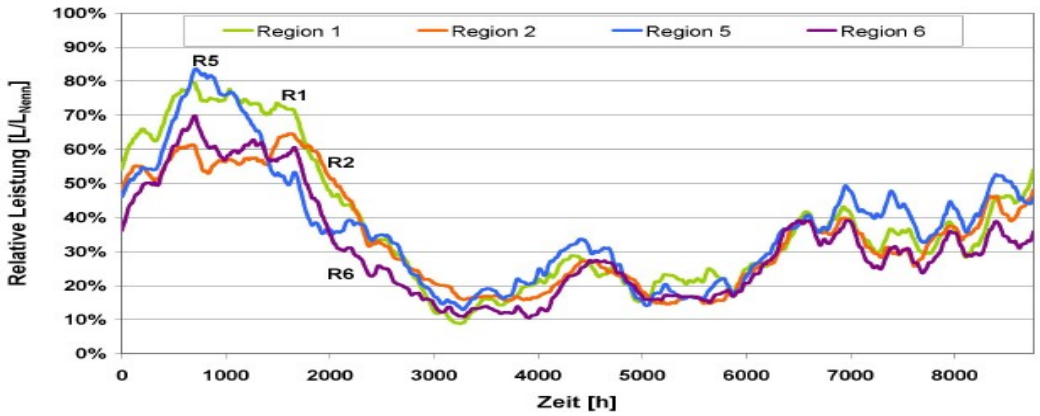
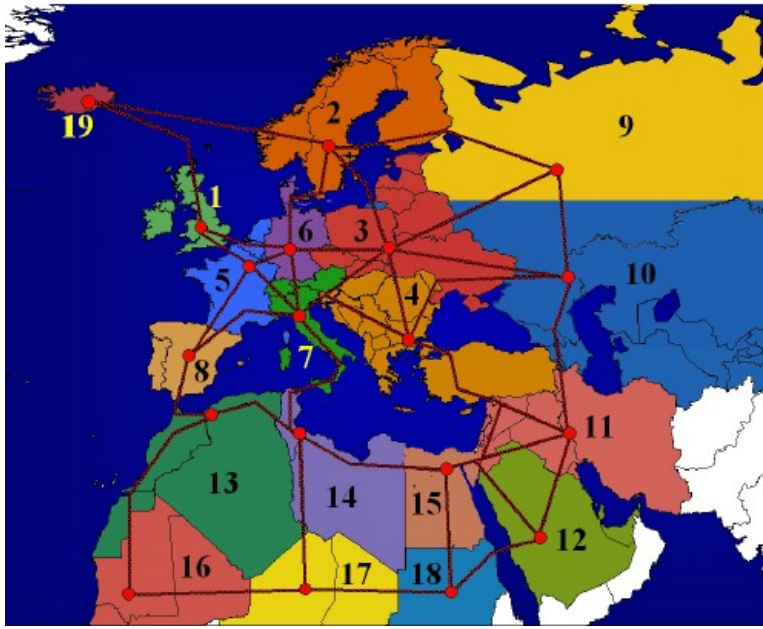


Abbildung 5.14: 30–Tage–Mittelwerte der in den Szenarien berücksichtigten potentiellen Stromerzeugung aus Windenergie in den vier Nordseeanreiner–Regionen (Regionenzuordnung s. Abb. 21.1).



Source: Gregor Czisch

Wind production in different regions

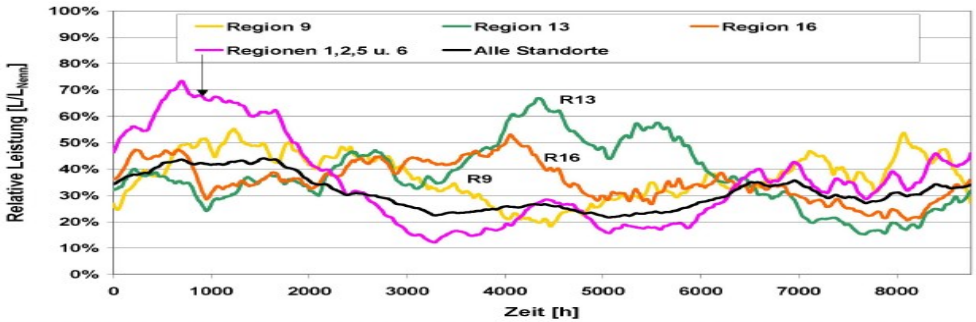
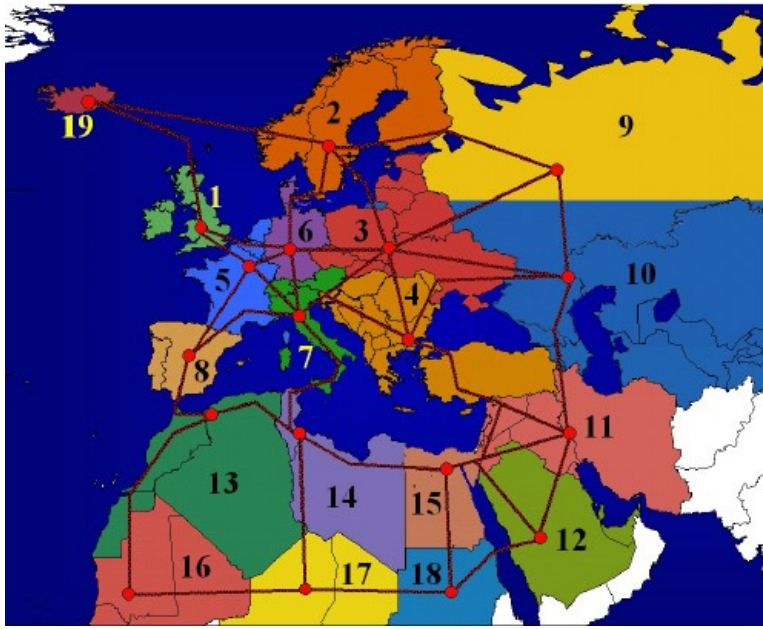


Abbildung 5.15: 30–Tage–Mittelwerte der in den Szenarien berücksichtigten potentiellen Stromerzeugung aus Windenergie ausgewählter außereuropäischer Regionen und gemeinsamer Nutzung aller Nordseeanrainer–Regionen (1, 2, 5 und 6) sowie bei gleichverteilter Nutzung in den Regionen aller ”Summenstandorte” on– und offshore im Versorgungsgebiet (Regionenzuordnung s. Abb. 21.1).



Source: Gregor Czisch


100 %
Renewable
Storage
Grid Extension
overproduction

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