Different Approaches to a 100 % RE-based Electricity Supply (Archetypical Scenarios)

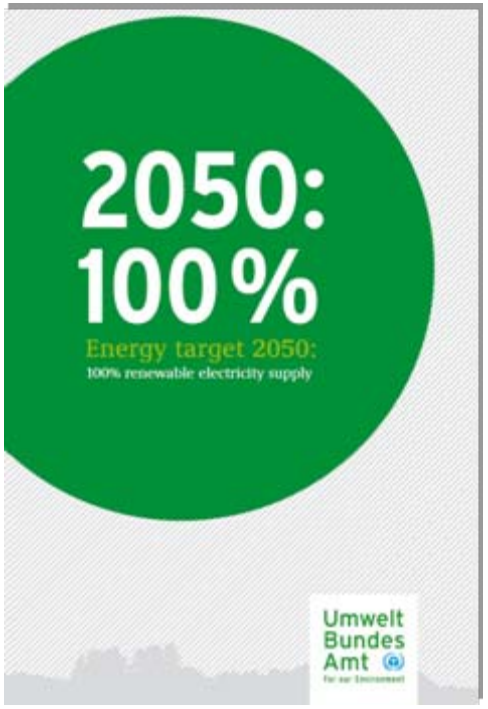
Mark Nowakowski

Section for Energy Strategies and Scenarios

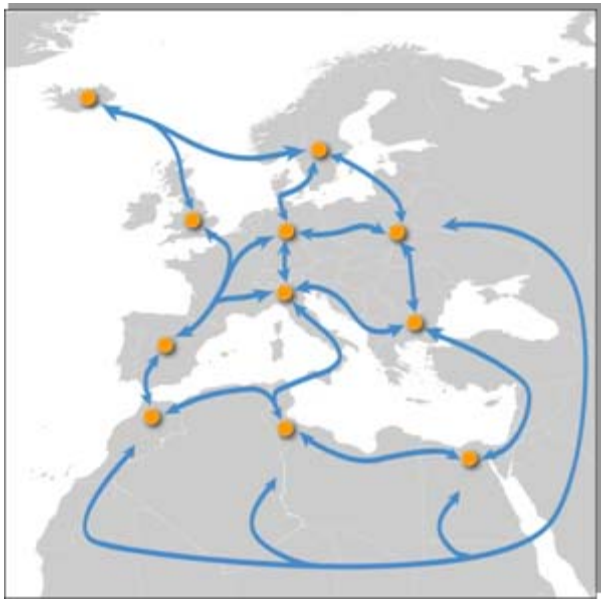
Elements of a Greenhouse Gas Neutral Society, Berlin, Oct. 10th 2013

Three “archetypical” UBA scenarios

“Local Energy Autarky” (2013)

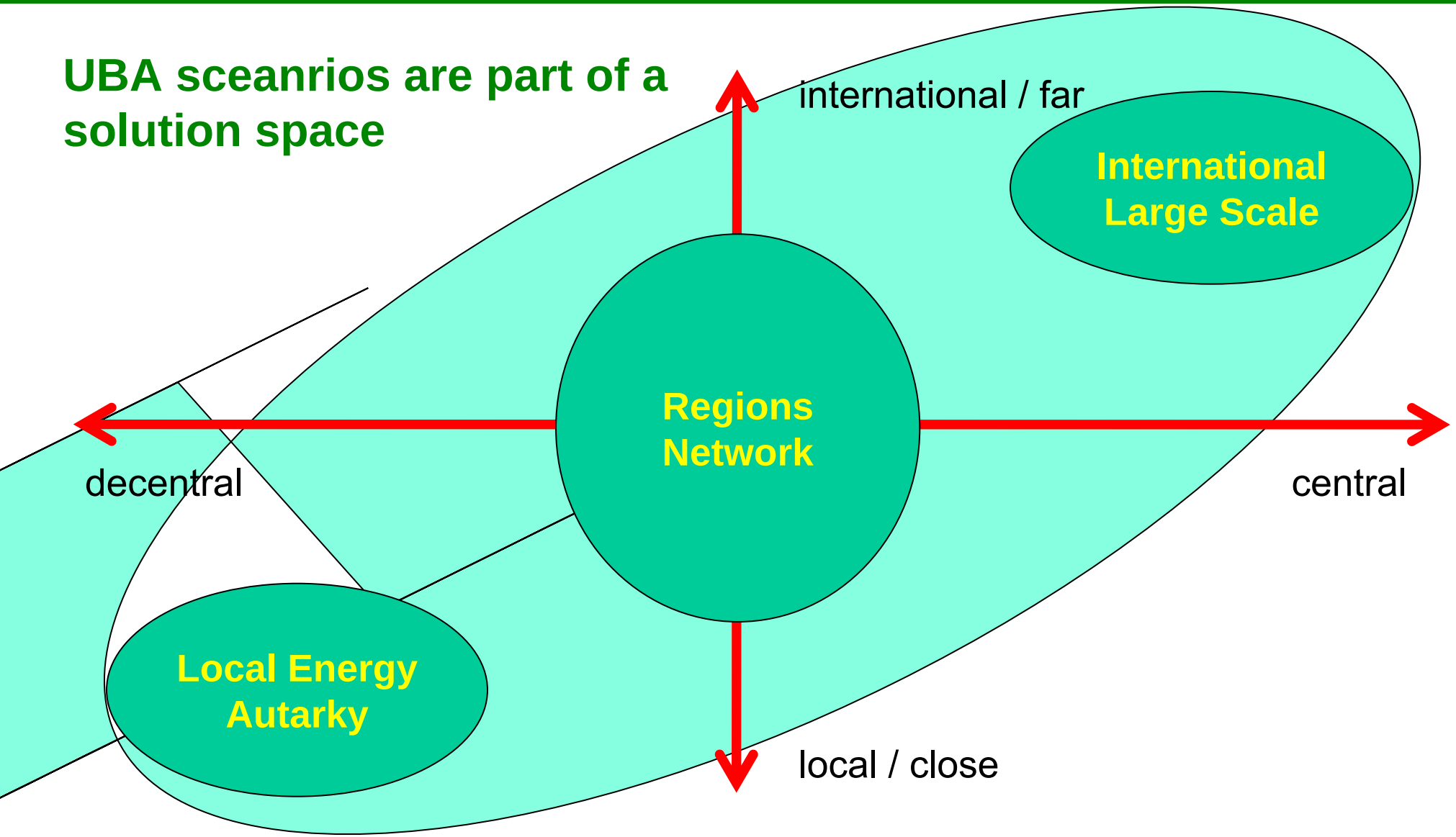


“Regions Network” (2010)



“International Large Scale” (in progress)

UBA sceanrios are part of a solution space



Our central question:

Can a 100% RE System cover

I. Germany‘s complete electricity demand

II. AND the annual peak load?

⇨ Security of supply on today‘s level?

“Regions Network” scenario (UBA, 2010)

(Download from www.uba.de)

Properties “Regions Network”

- All regions in Germany make extensive use of their RE potentials
- Well-developed national electricity transmission grid
- Efficient energy use, storage and demand side management
- Today‘s lifestyle, consumer and behaviour patterns, no technology leaps
- Germany remains a highly developed industrialized country
- High level supply security

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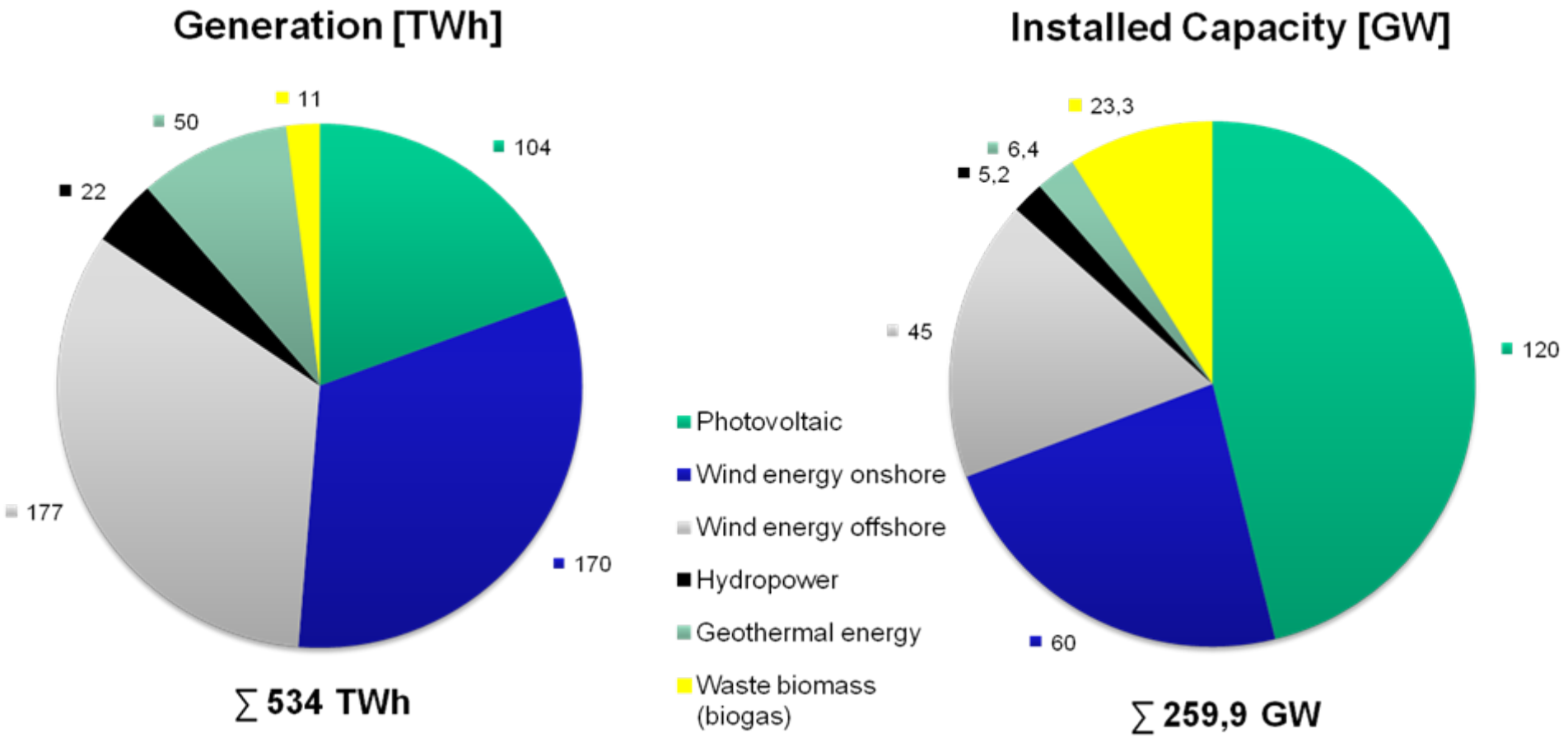
“Regions Network” 2050

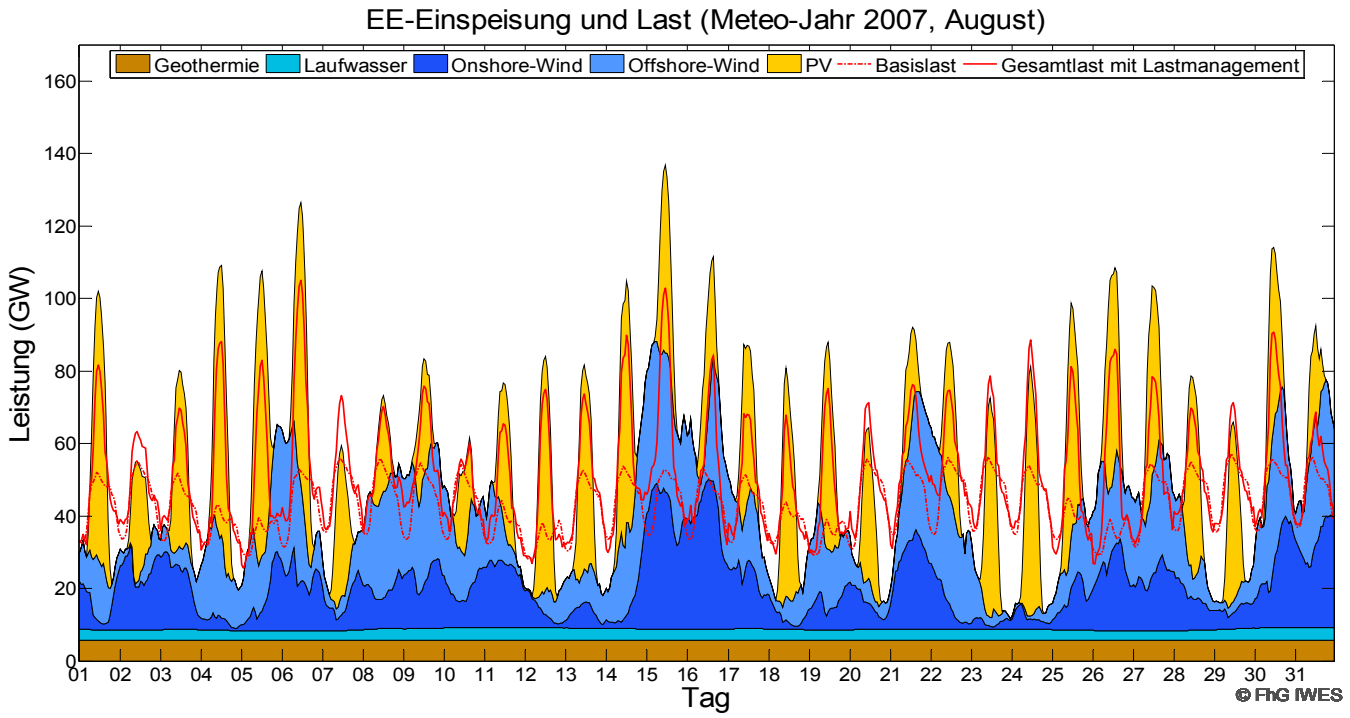


Nowakowski – 100% RE Archetypical Scenarios

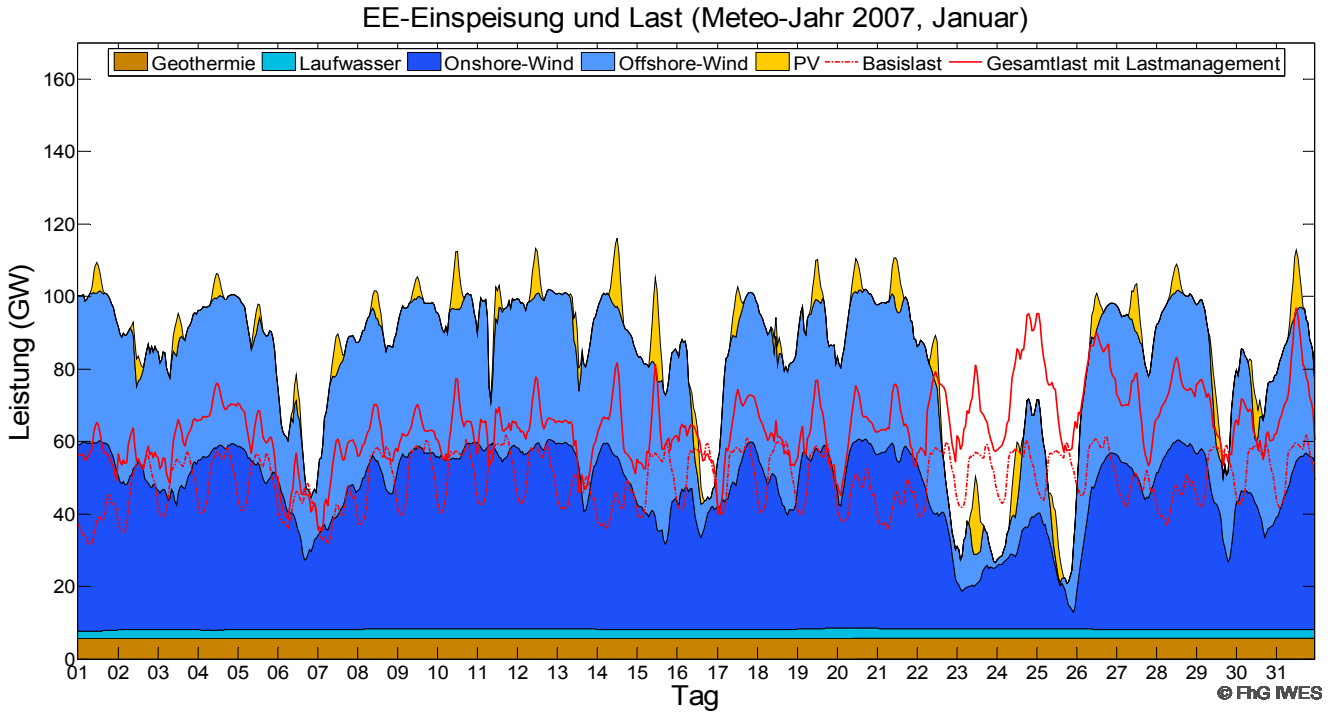
Results “Regions Network”

- 100% RE electricity generation is technically and ecologically feasible by 2050 without questioning Germany‘s existance as a highly developed industrialized country
- Achievable with today’s best available technologies, no technology leaps
- RE potentials can even supply e-mob as well as heating and hot water via heat pumps
- Supply security is ensured all year round
- Fluctuations of RE and load can be balanced out at any time

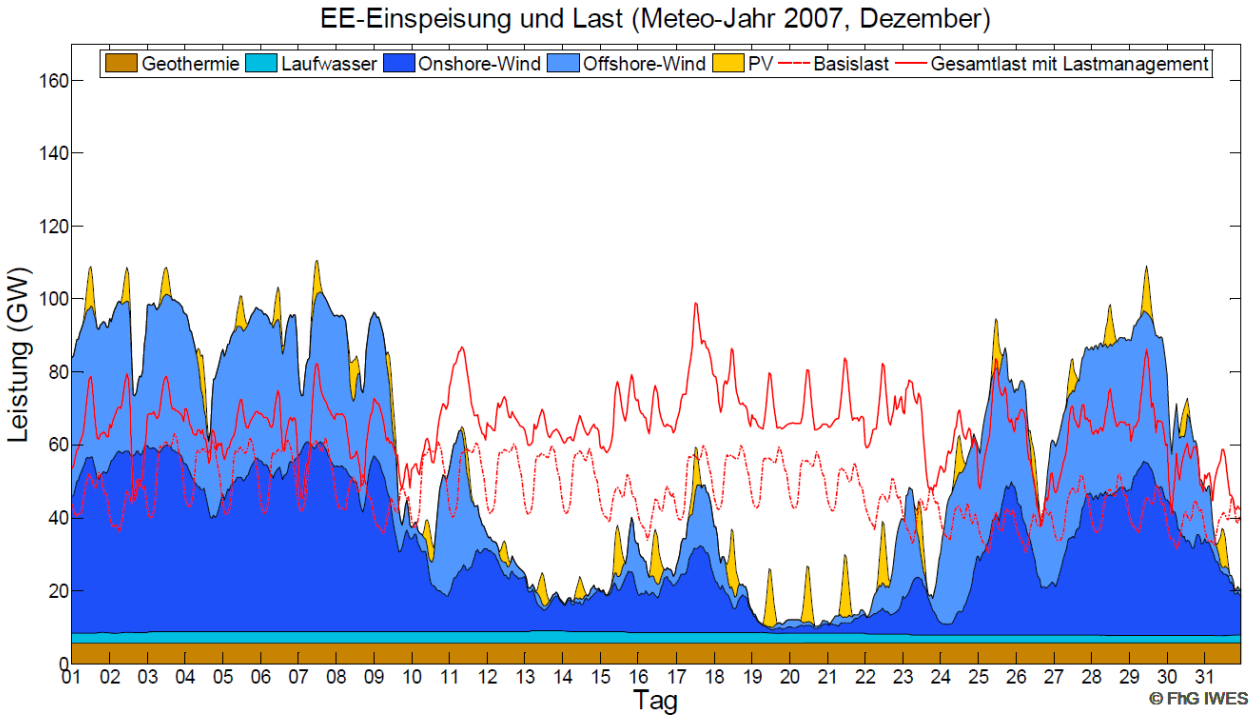
RE feed-in and load – summer month



RE feed-in and load – winter month



RE feed-in and load – winter month

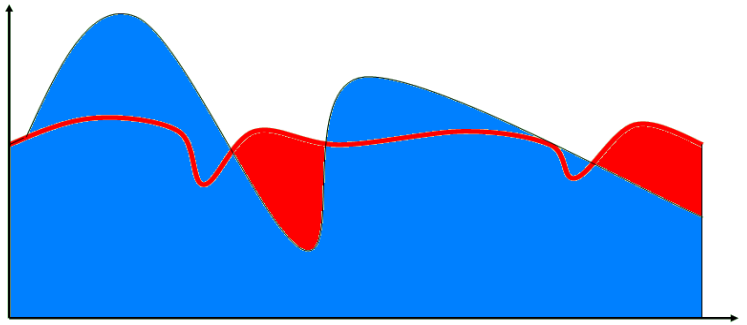


Electricity Storage in 2050

(as in “Energy Target 2050: 100% Renewable Electricity Supply“)

- Can a 100% renewable electricity system satisfy total electricity and load demand at any hour of the year?
- **Yes!** In total: generation of excess supply,

  but also times of shortages



Short-term storage:	**Long-term storage:**
• Pump storage: daily/several days range [Germany: 60 GWh capacity potential] • Load management (all sectors)	• Chemical storages: weeks/months/years range A) renewable hydrogen storage (η=42%) B) renewable methane storage (η=35%) • Re-generation in combined cycle power plants or other use (e.g. as fuel)

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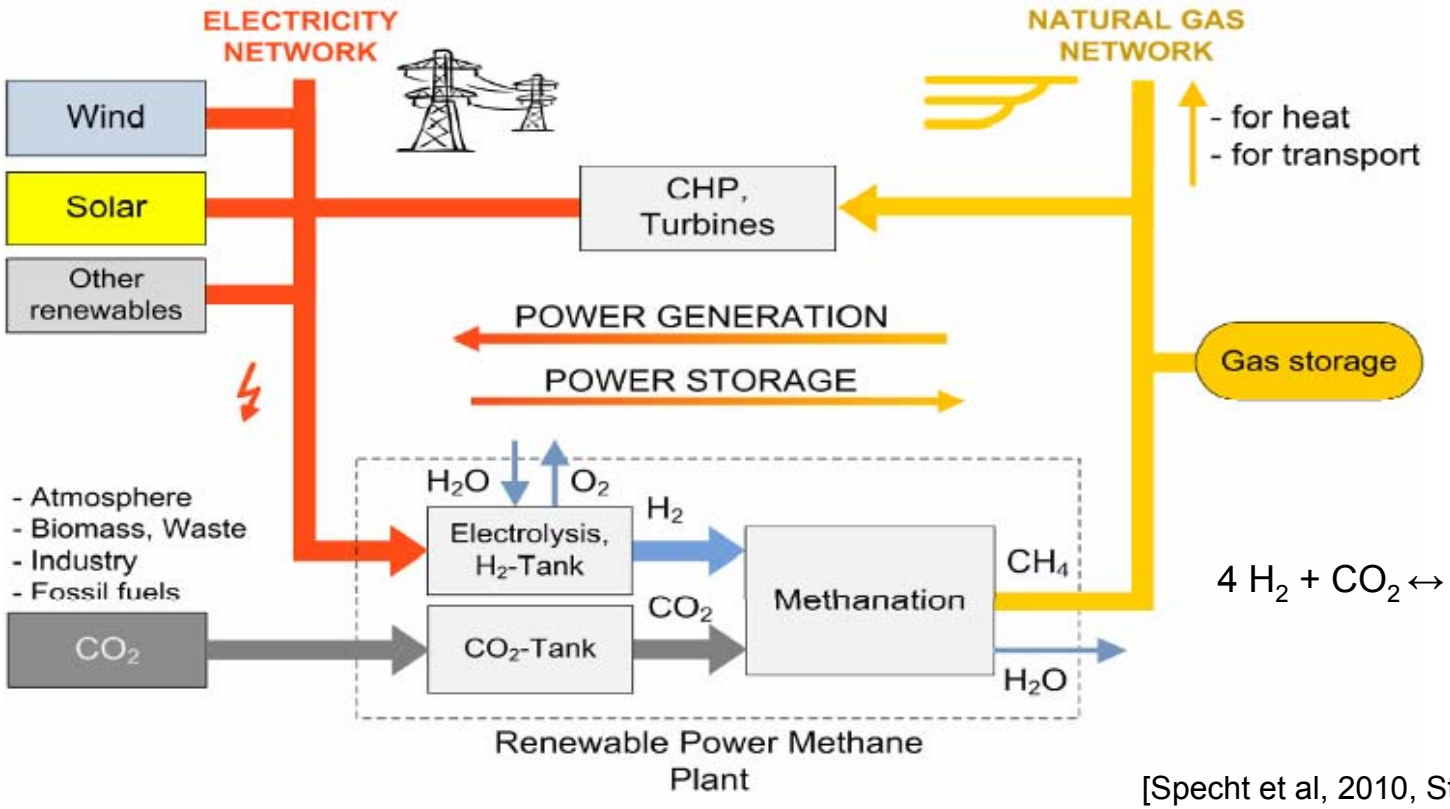
Chemical Storage as Renewable Methane

Energy storage linking the power grid to the natural gas grid

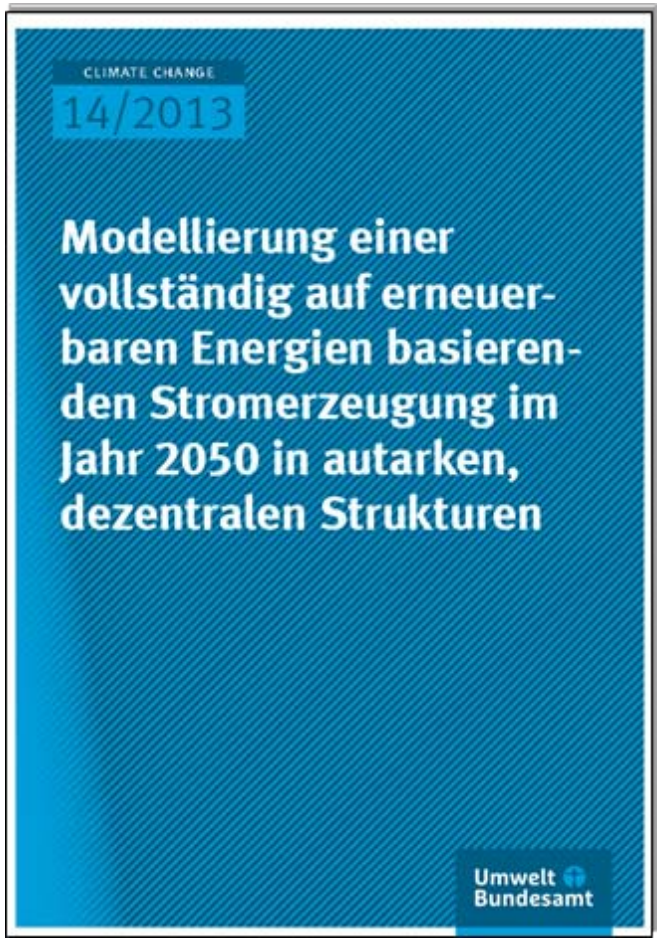


$4\ H_2 + CO_2 \leftrightarrow CH_4 + H_2O$

[Specht et al, 2010, Sterner, 2009]

Generation → Electrolysis (H_2) → Methanation (CH_4) → Reconversion

η = 1 x 0,7 x 0,8 x 0,59 = 33%



“Local Energy Autarky” scenario (UBA, 2013)

(Download from www.uba.de)

Properties “Local Energy Autarky”

- Basic presumptions as in “Regions Network”
- Decentralized, local supply WITHOUT connections with other regions or with outside suppliers (i.e. “energy islands”)
- Simulation of different settlement structures:
  rural community and town district
- Each with and without trade/industry
- At exemplary locations in northern and in southern Germany
- Higher energy efficiency than in “Regions Network”
- Higher utilisation of RE potentials than in “Regions Network”, esp. PV

Results “Local Energy Autarky”

- Local energy autarky or “island solutions” is no feasible option for all Germany
- Without a transmission grid areas with low RE potentials lose out
- No sufficient RE based power supply for cities
- Also, rural communities with trade/industry fail to be self-sufficient

⇨ A transmission grid is important and beneficial in a 100% RE system

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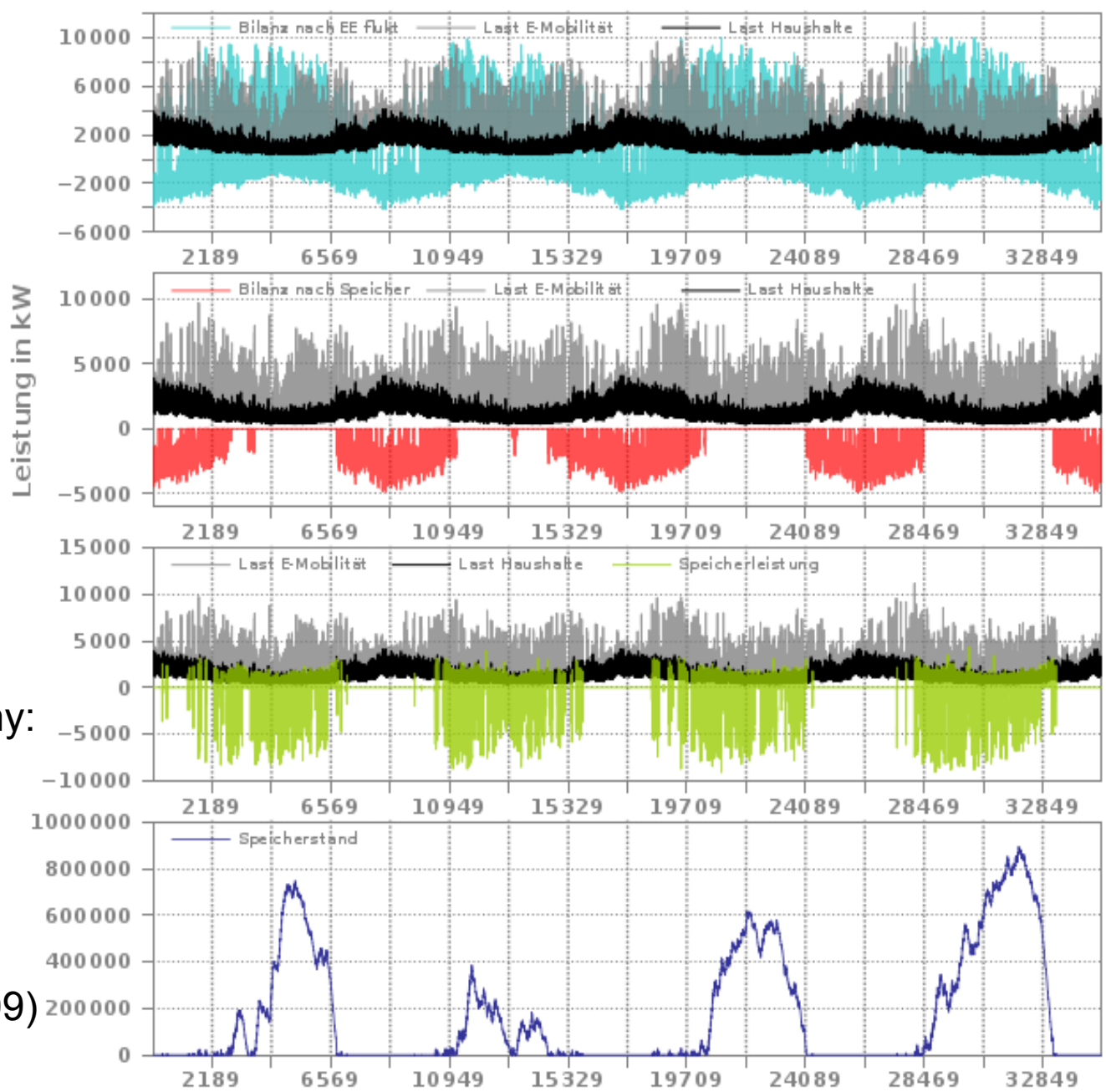
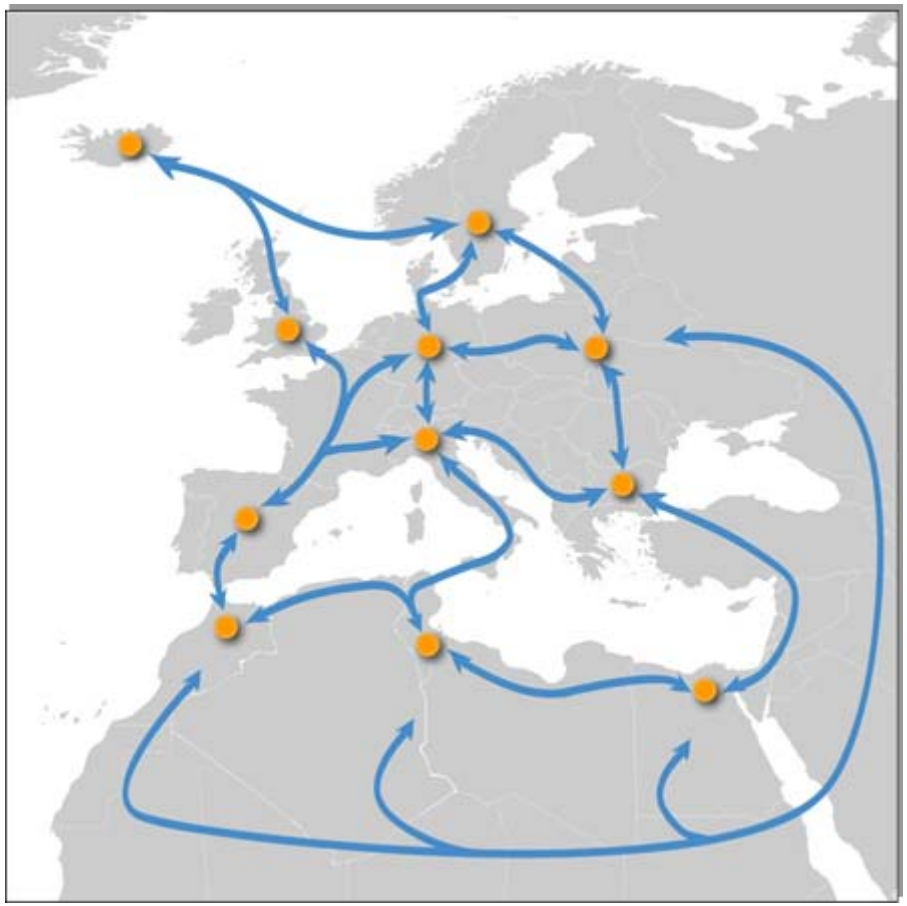
Results “Local Energy Autarky”



City district in northern Germany:
Load of private houses,
50% e-mobility,
Balances after fluctuating feed-in and storage,
Storage activity
(meteorological data 2006–2009)

“International Large Scale” scenario



Source: J. Lillestam, PIK

Properties “International Large Scale”

- Basic presumptions as in “Regions Network”
- Highest RE electricity import share
- Use of those RE potentials in Germany, Europe and its vicinity which can readily be tapped by large-scale technology projects and storage power plants („low-hanging fruit“)
- A well-developed intercontinental transmission grid connects generation centers with centers of electricity consumption.

⇨ **Results expected by end of 2013**

Conclusions from UBA scenarios

- 100% RE power supply is technically and ecologically feasible by 2050.
- Different approaches possible
- Corresponding support schemes are necessary
- Well-developed electricity network appears to be beneficial.
- Expansion of reserve power capacity,
- Application of load management,
- Development of infrastructure for transport and long-term storage of electricity are necessary prerequisites for 100% RE system
- Conjoint, well-coordinated action needed in Europe

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Thank you
for your attention !

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mark.nowakowski@uba.de

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