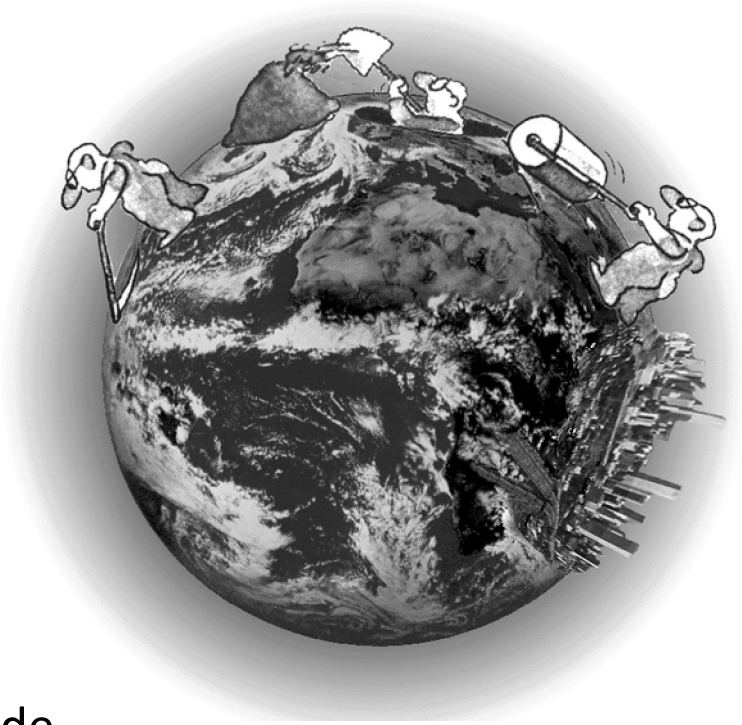
Part 2

100 % EE



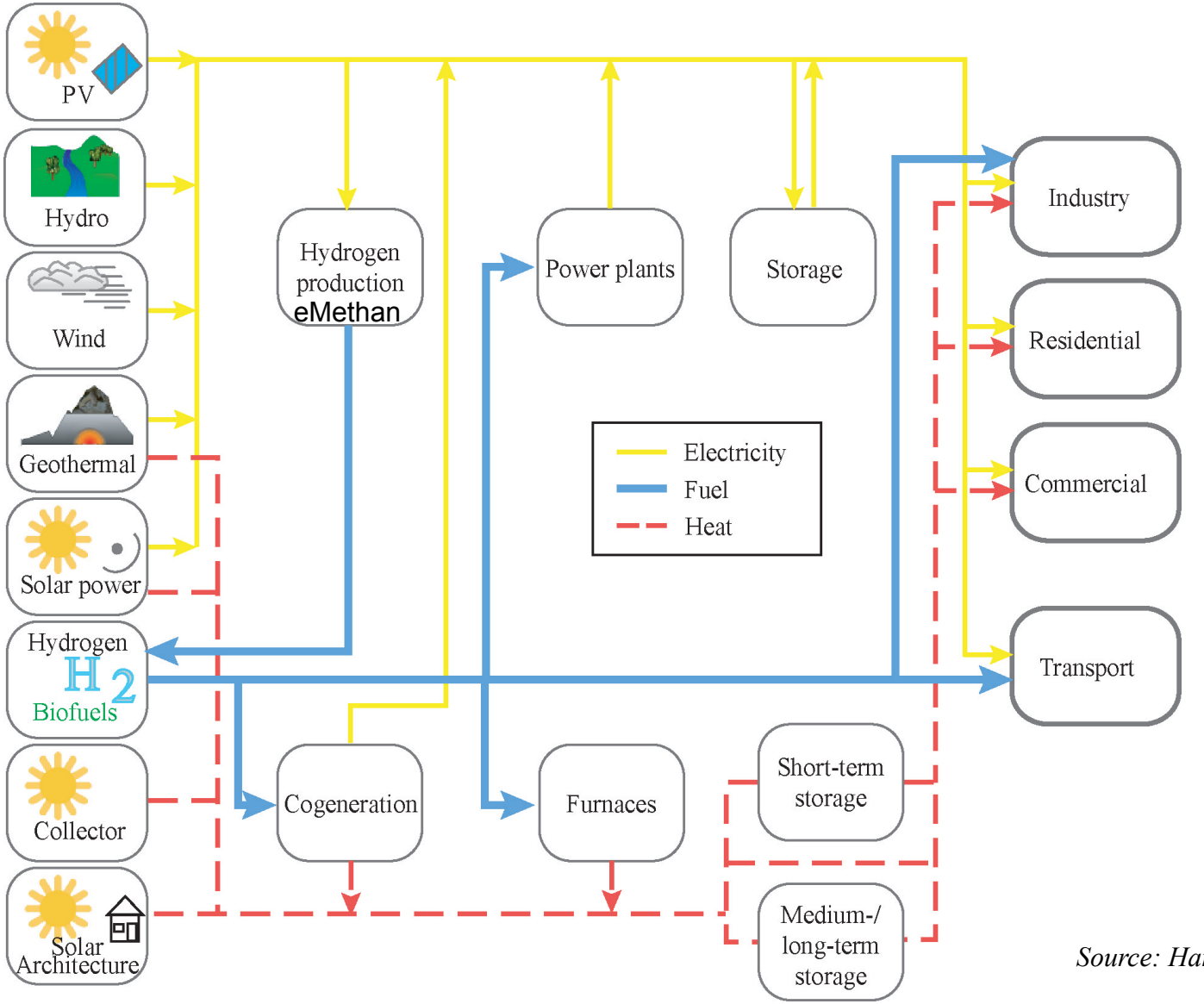
Limits to growth

Source: Harry Lehmann, 1994

harry.lehmann @ uba.de

Energy System based on renewable Sources

Umwelt Bundes Amt
Für Mensch und Umwelt

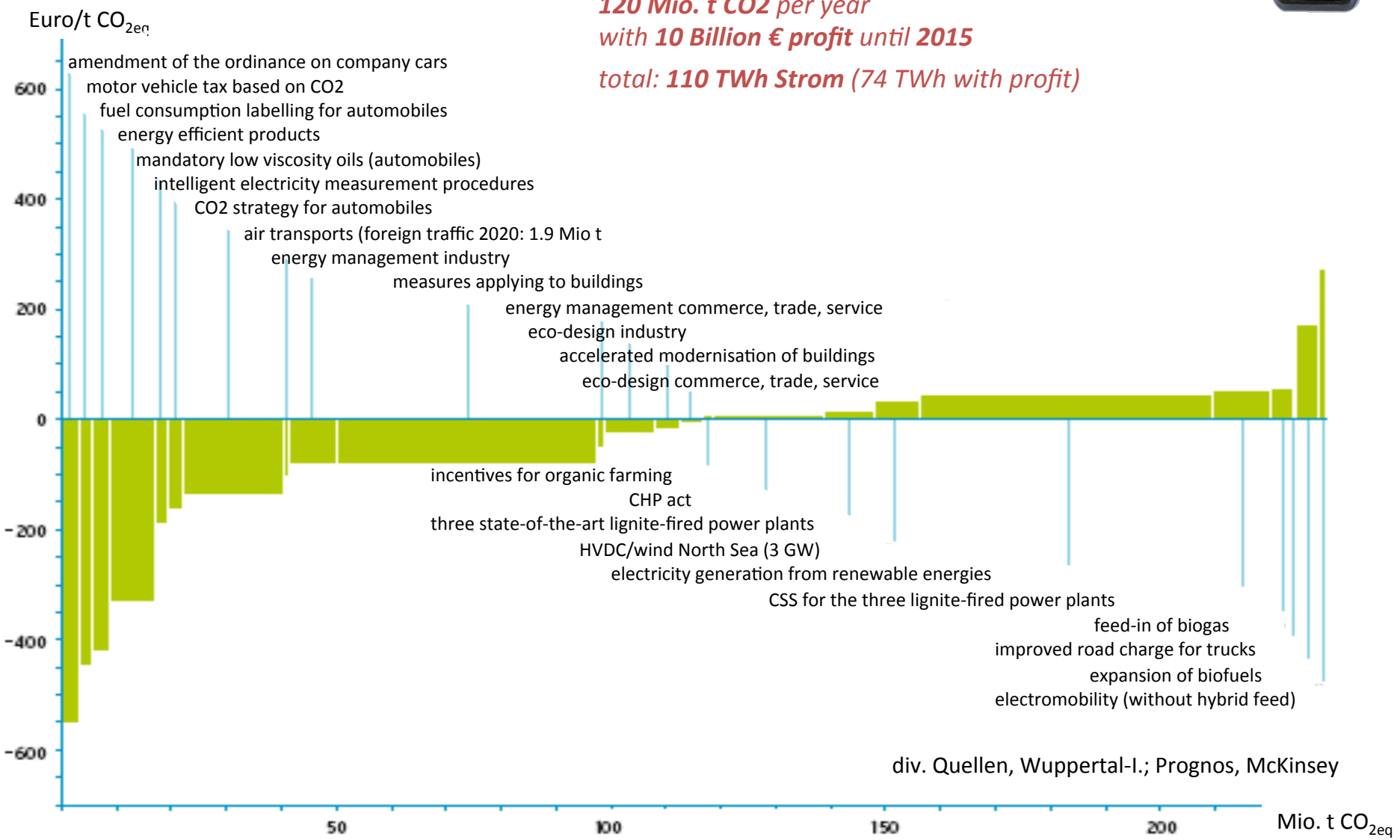


Source: Harry Lehmann, 1996

Cost of efficiency

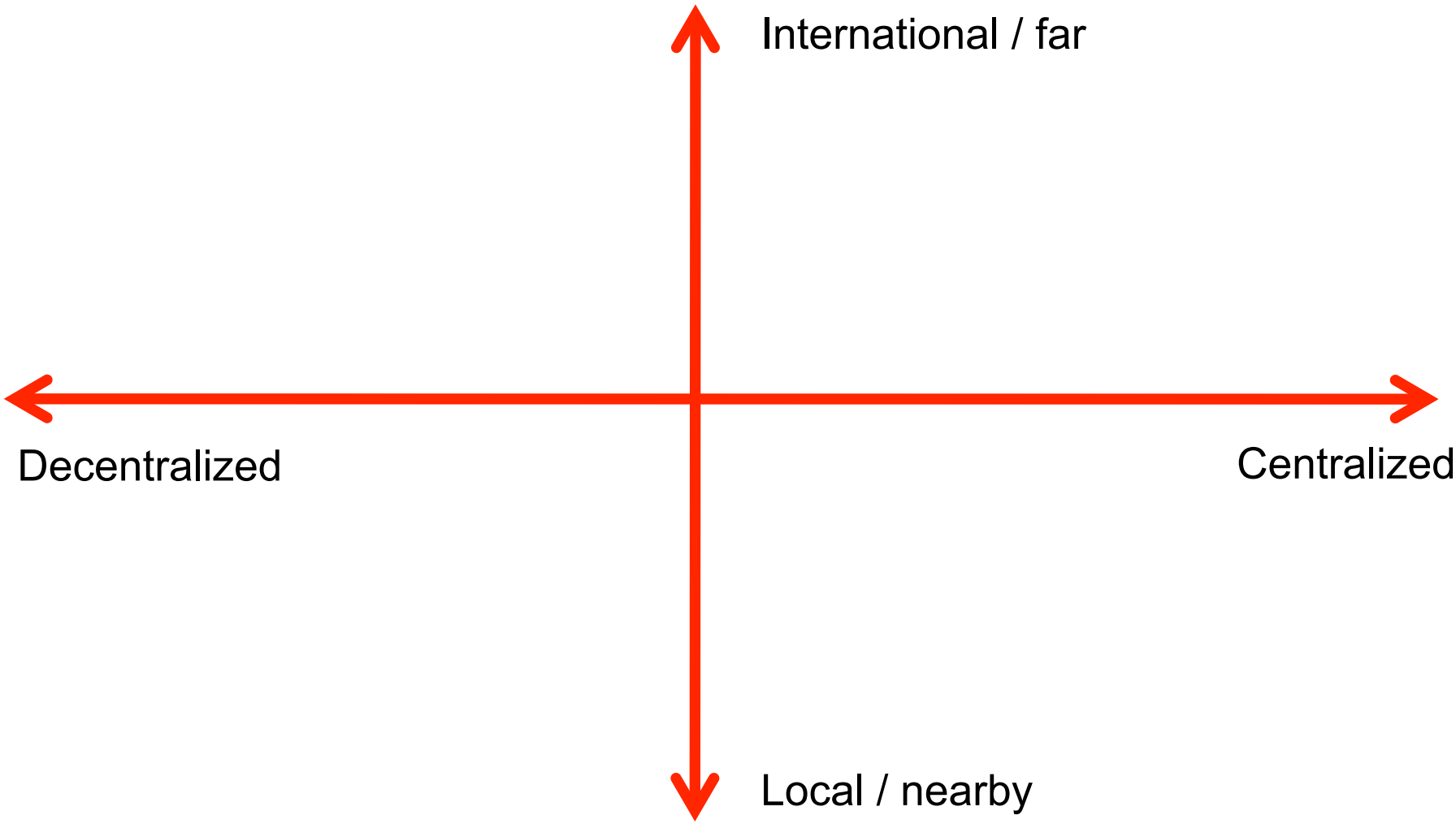
120 Mio. t CO2 *per year*
with ***10 Billion € profit*** *until* ***2015***

total: ***110 TWh Strom*** *(74 TWh with profit)*

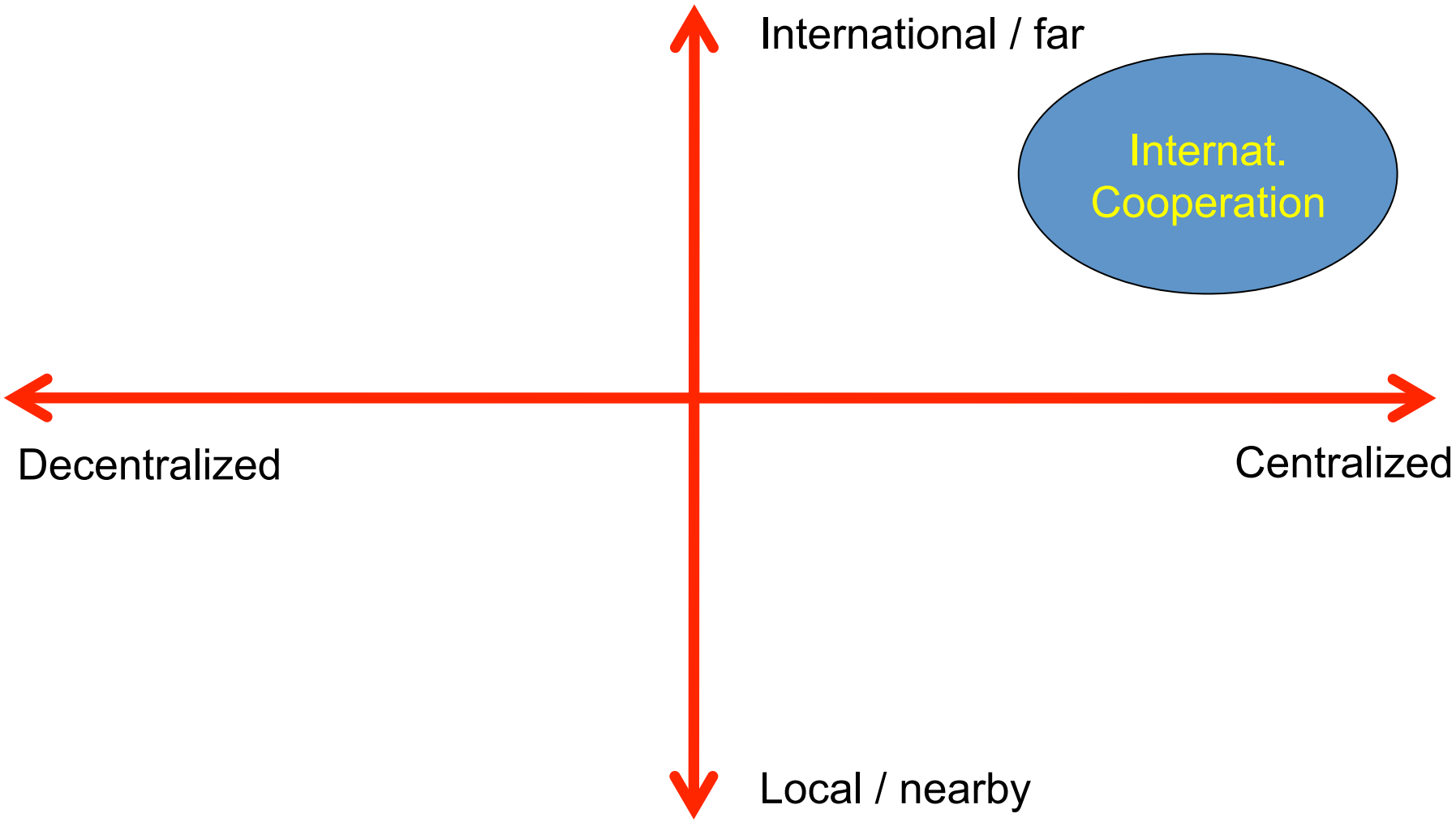


div. Quellen, Wuppertal-I.; Prognos, McKinsey

Archetypes of EE Supply

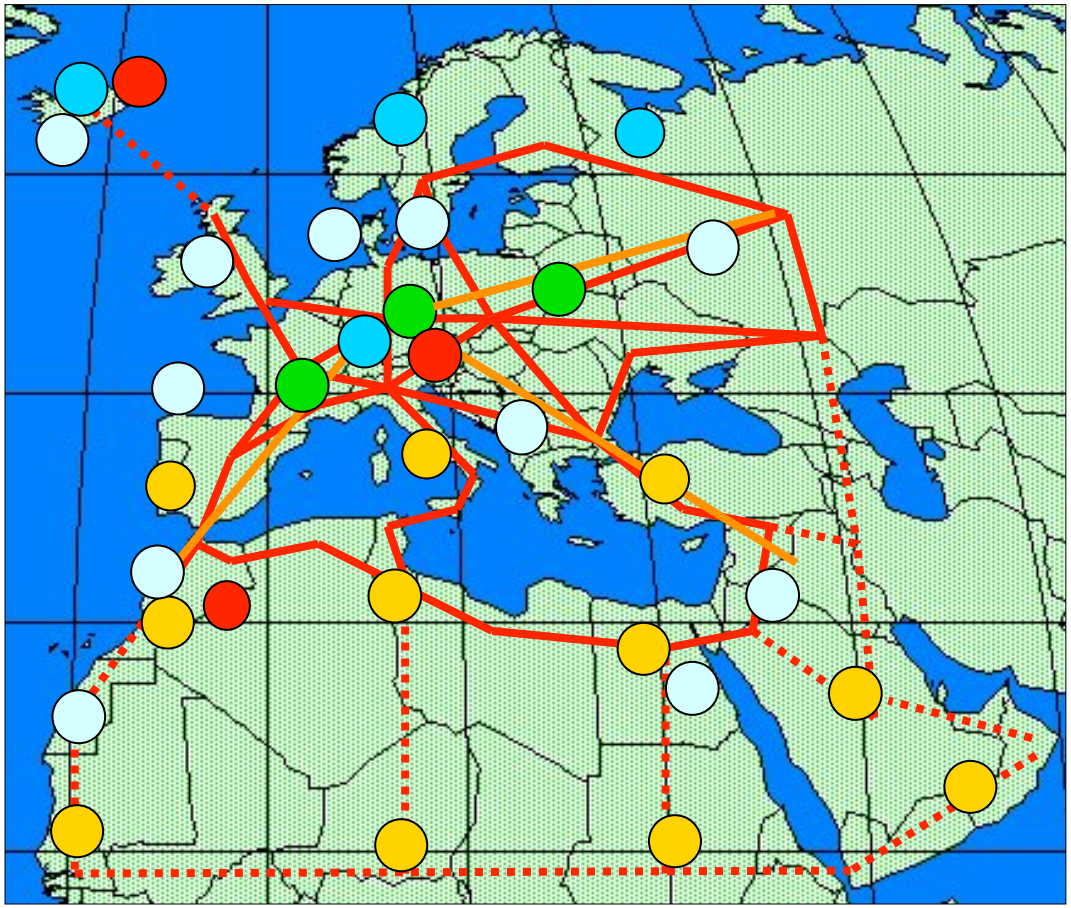


Archetypes of EE Supply



ISuSI

Trans Med Renewable Energy Collaboration - TREC

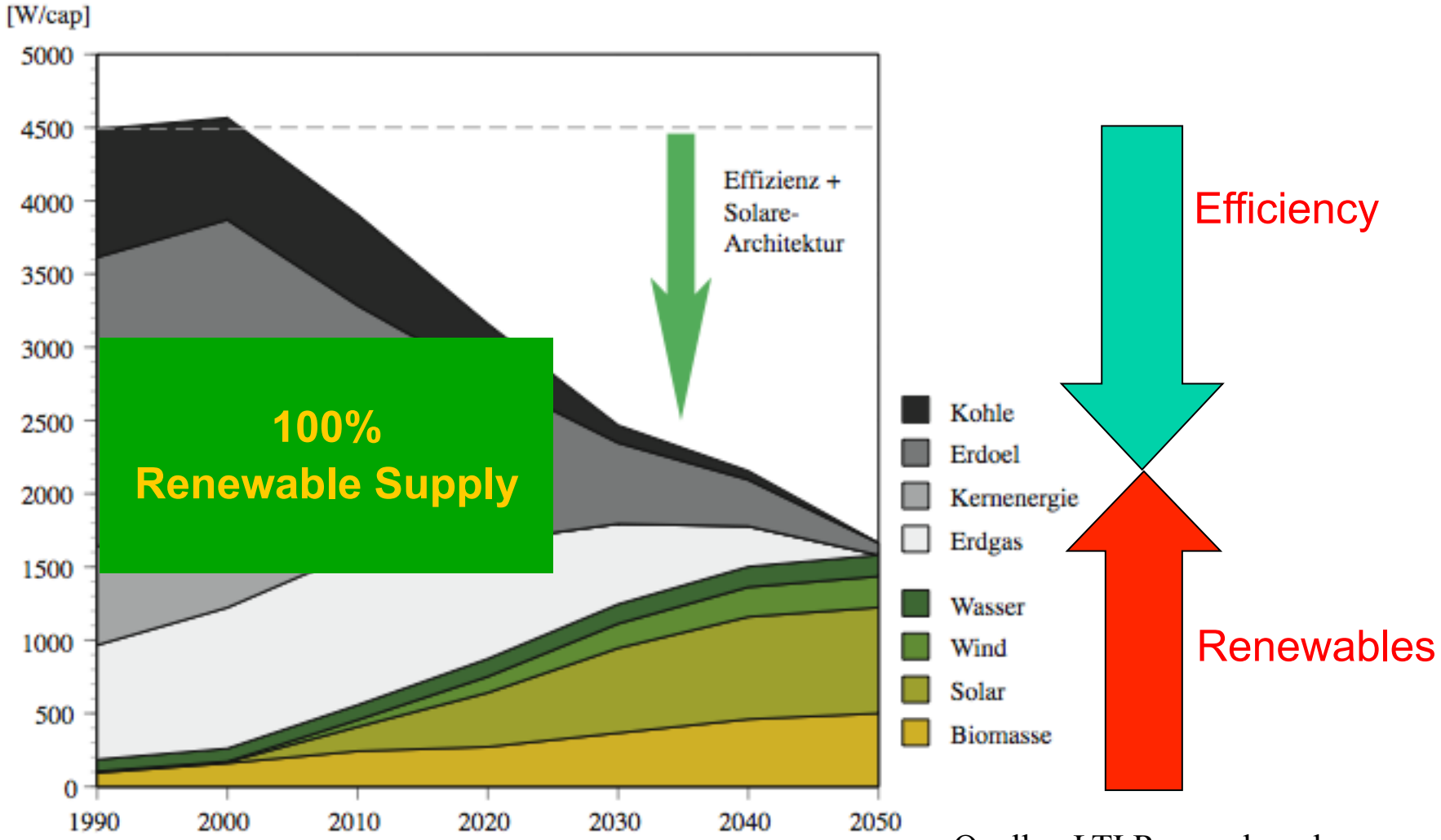


Solar
Wind
Hydro
Geothermal
Biomass

EURO-MED
possible further interconnections
Gas pipelines used for Hydrogen

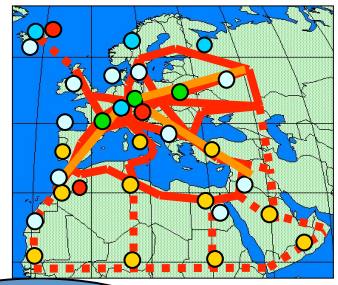
Source: TREC Collaboration und Harry Lehmann, 2004

LTI Scenarios Europe - 100%



Quelle : LTI Research und
H.Lehmann et. al. 1996

Archetypes of EE Supply



International / far

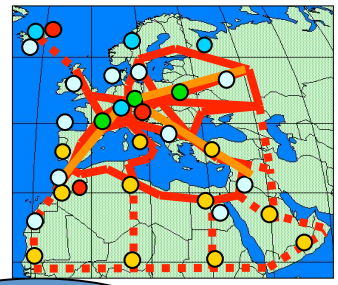
Internat. Cooperation

Decentralized

Centralized

Local / nearby

Archetypes of EE Supply



International / far

Internat.
Cooperation

Decentralized

Centralized

Local
Autarky

Local / nearby

Klimaschutzkonzept Erneuerbares Wilhelmsburg

Wege zur klimaneutralen/ post-fossilen Elbinsel

Das Ziel:

Die IBA als »Stadtlabor« für die Umstellung auf eine nachhaltige Energieversorgung

Vier Säulen:

- Energie sparen!
- Energieeffizienz steigern!
- Erneuerbare, lokale und regionale Energien einsetzen!
- Einbindung und Beteiligung der Bevölkerung!

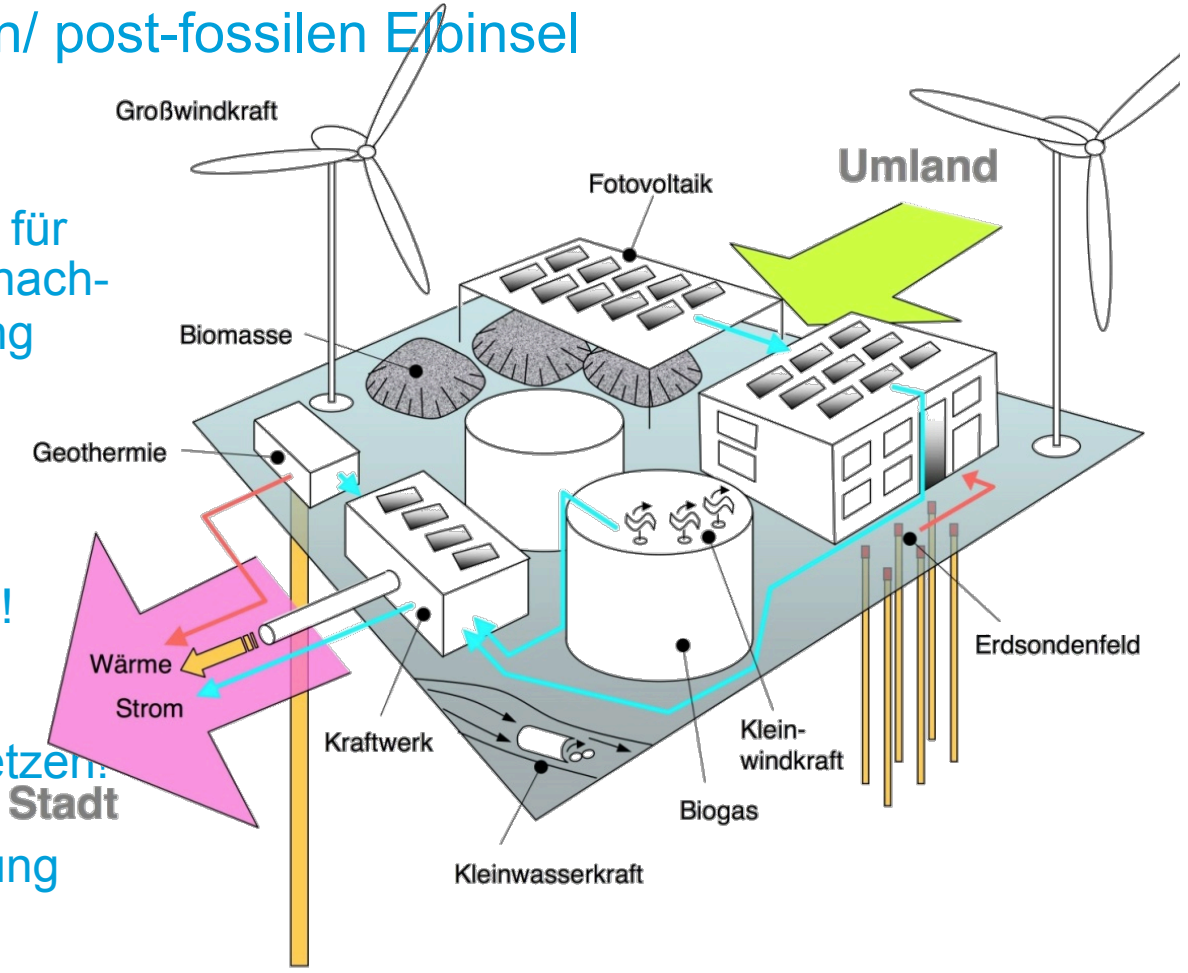
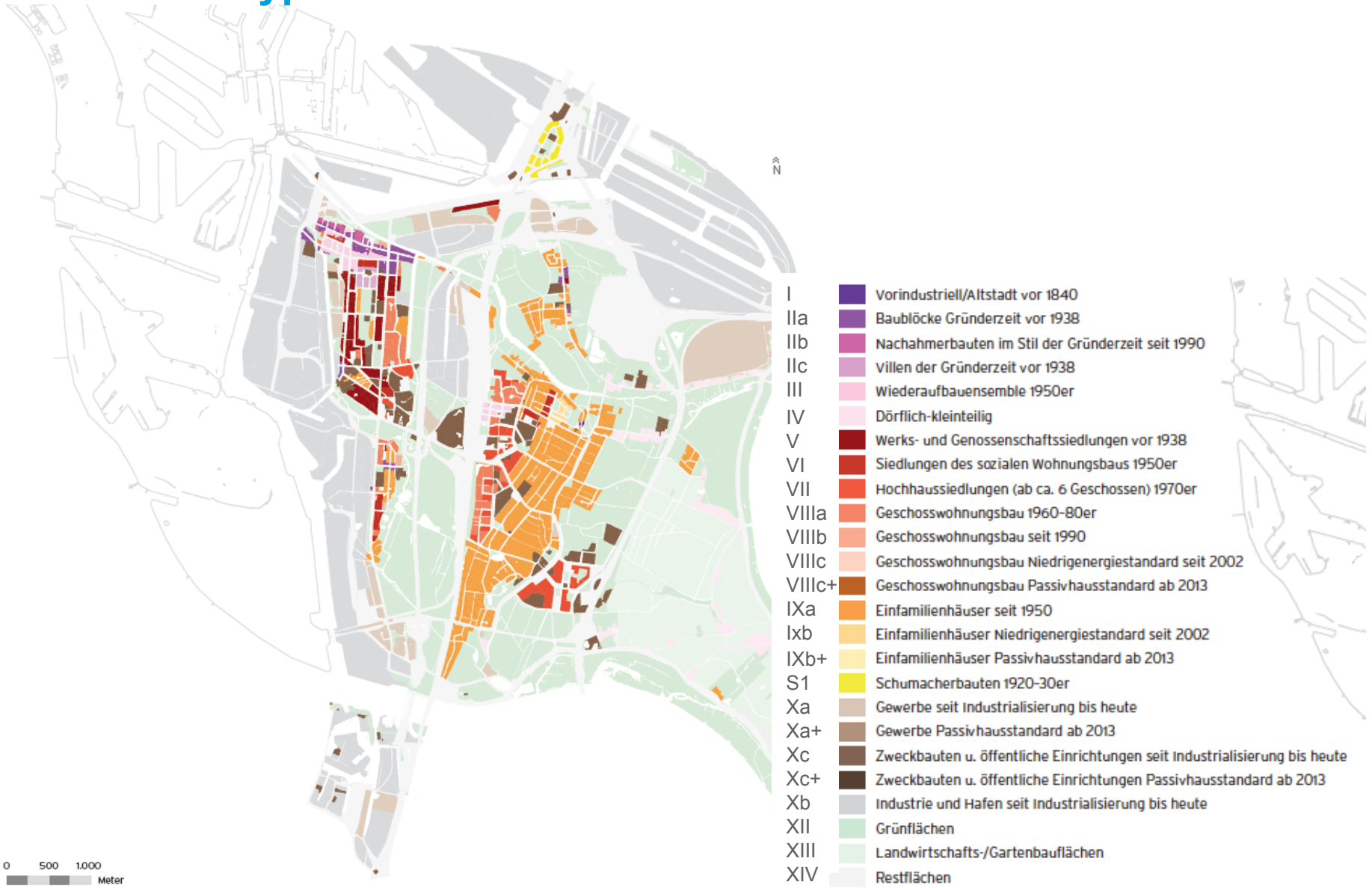
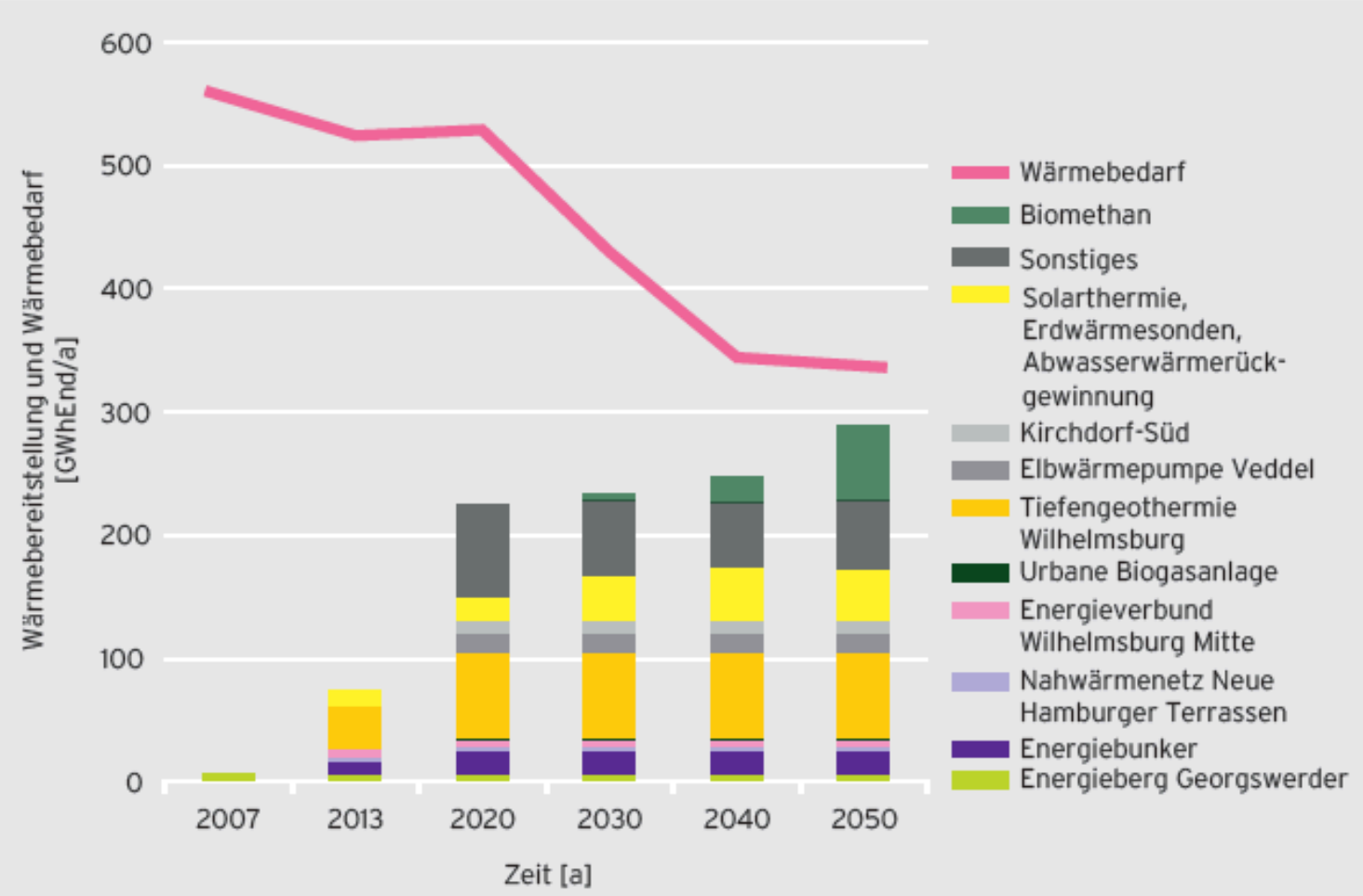


Abb.: ExWoSt - Nutzung städtischer Freiflächen für erneuerbare Energien

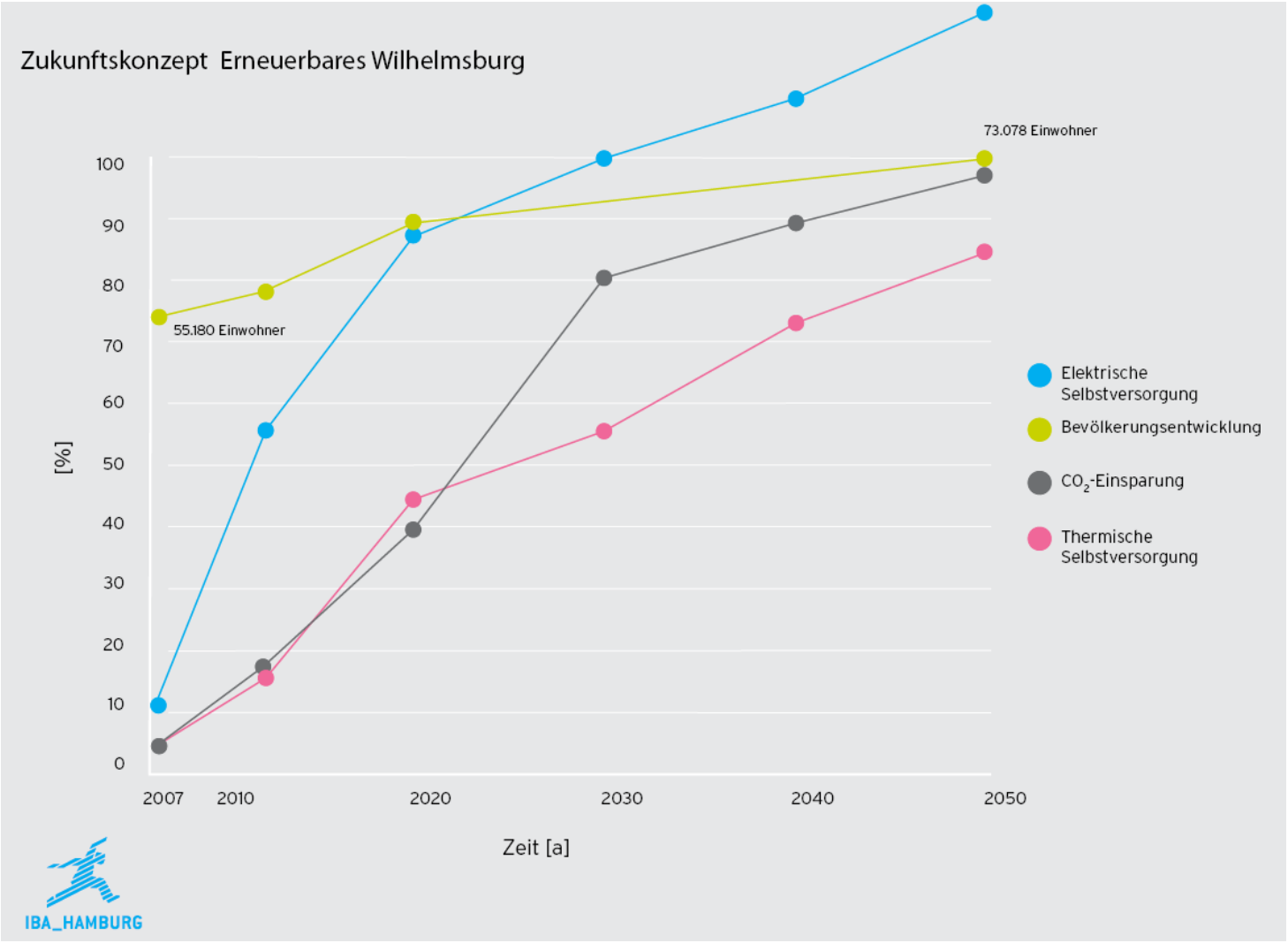
Stadtraumtypen SRT



Regenerative Wärmeerträge und Wärmebedarf im Exzellenzszenario 2

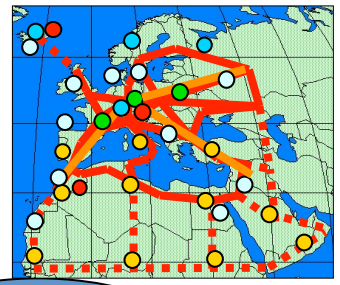


IBA Hamburg – Zukunftskonzept Erneuerbares Wilhelmsburg



Zukunftsbild Erneuerbares Wilhelmsburg 2030

Archetypes of EE Supply



International / far

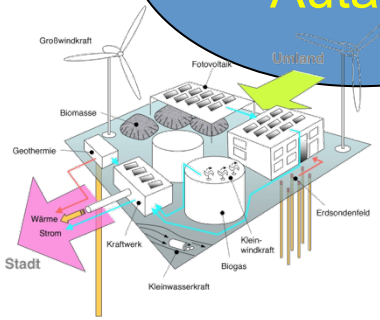
Internat.
Cooperation

Decentralized

Centralized

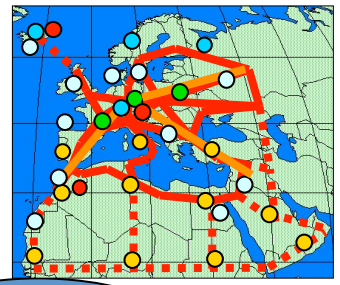
Local

Autarky



Local / nearby

Archetypes of EE Supply



International / far

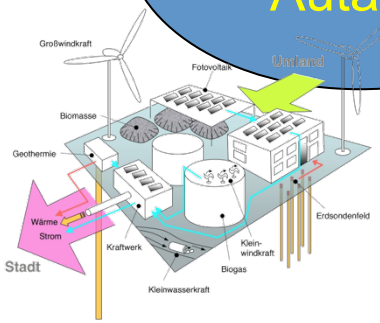
Internat.
Cooperation

Regional
Network

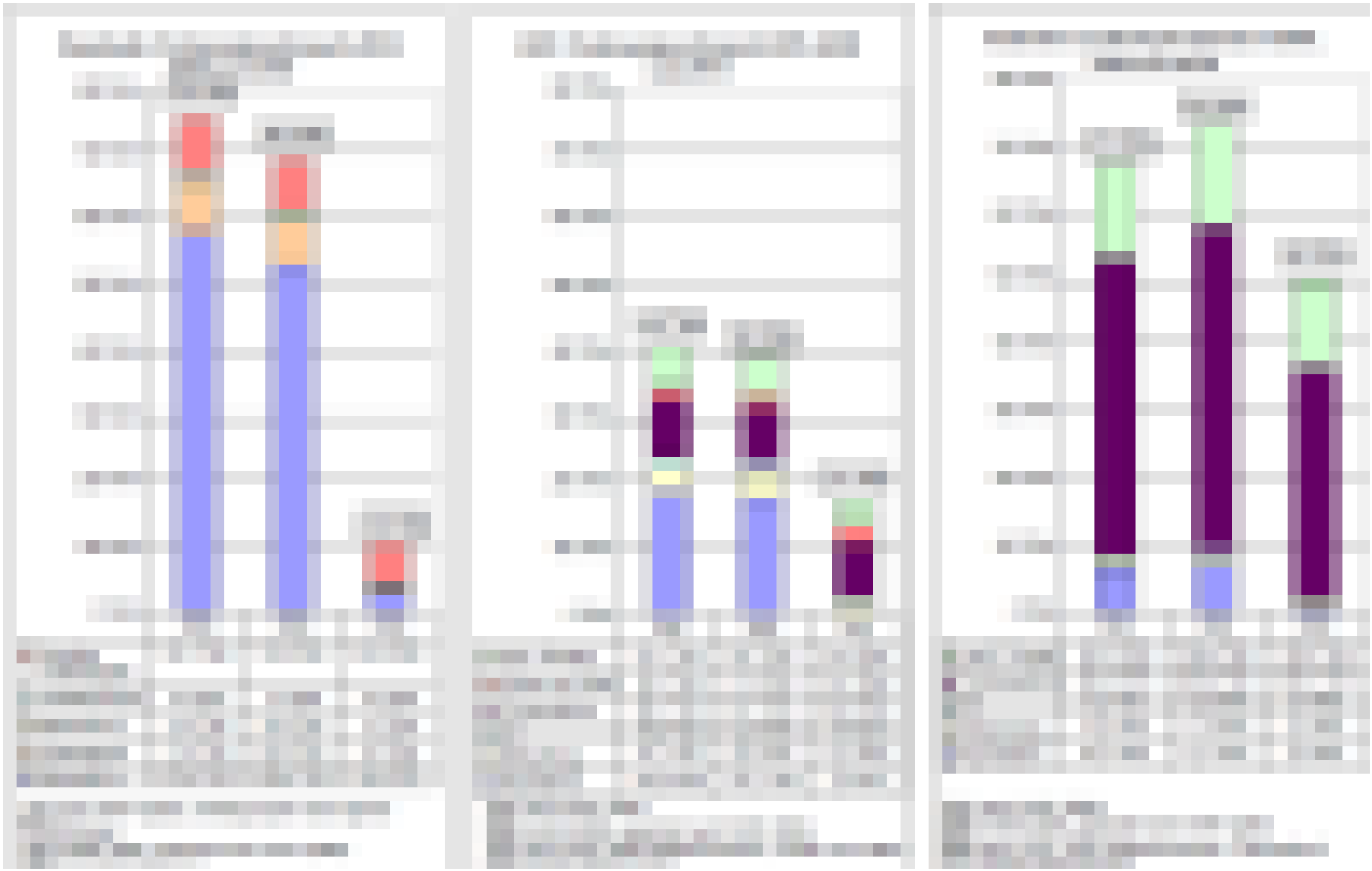
Decentralized

Centralized

Local
Autarky



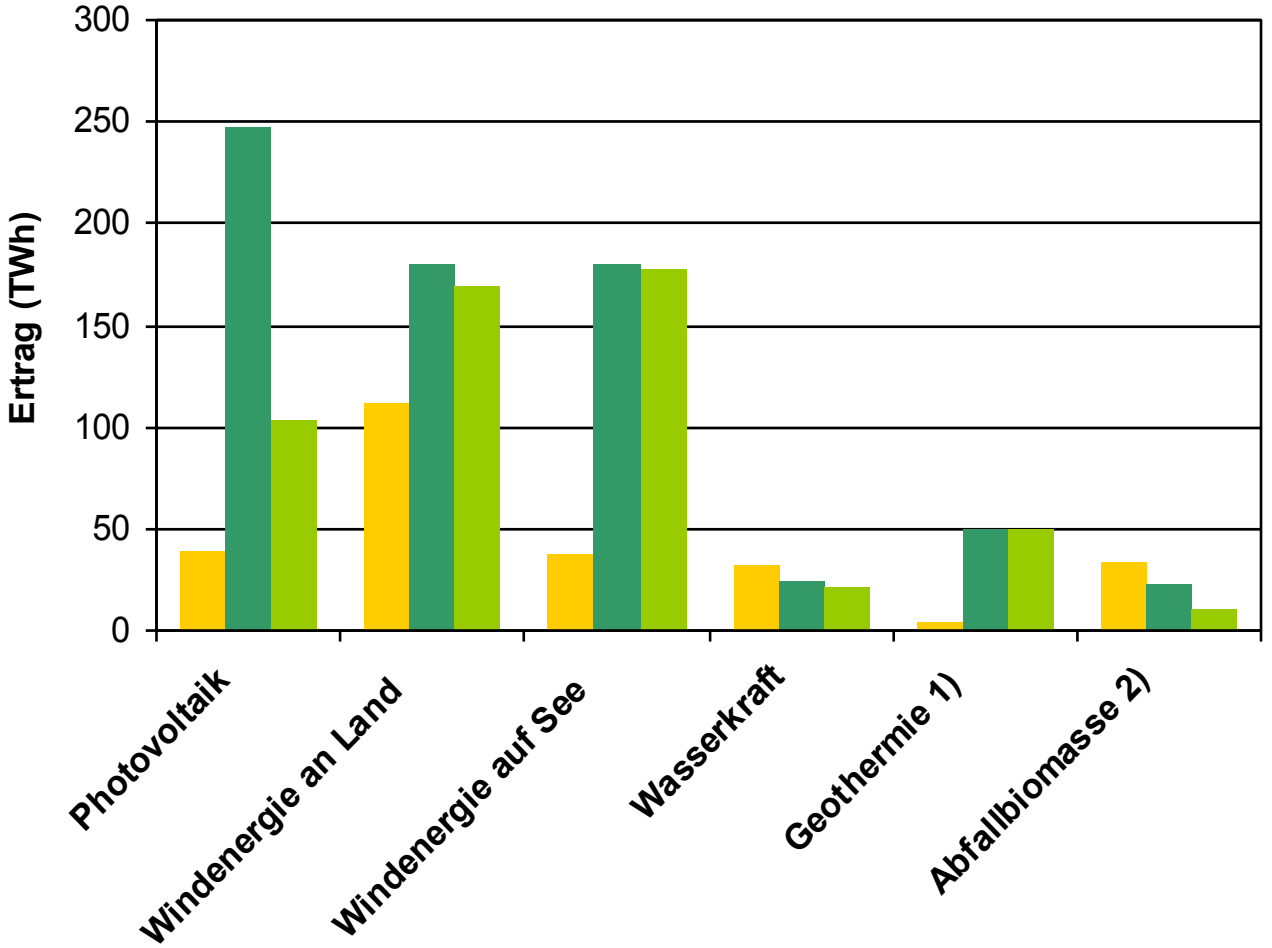
Local / nearby



Energy Demand 2005, 2008 und 2050 für die

Households – SME - Industry

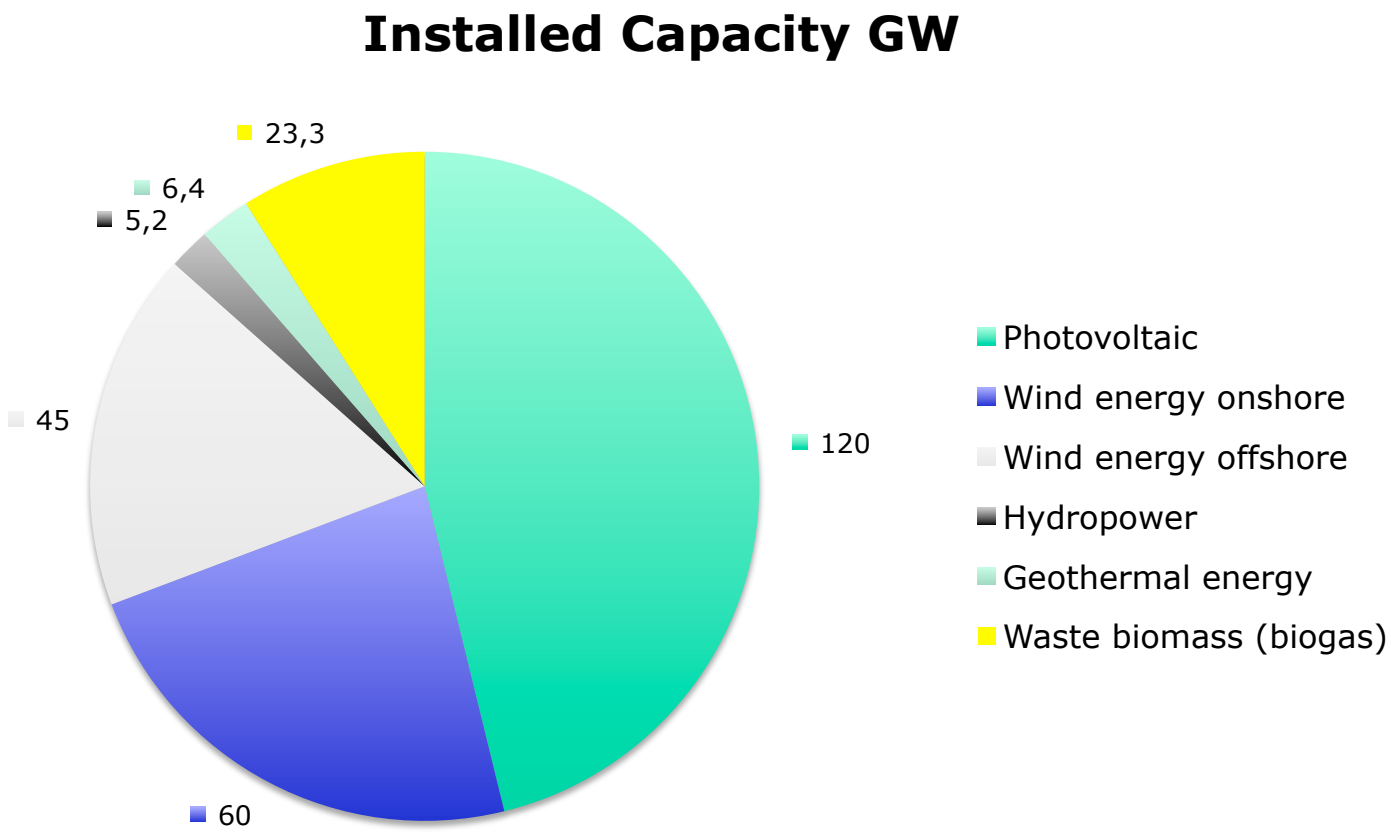
Umwelt Bundes Amt
Für Mensch und Umwelt



- expected electricity from renewables in Germany in 2020 *(Agentur für Erneuerbare Energien)*
- technological-ecological potential in Germany (conservative calculation, *Umweltbundesamt*)
- used potential in Scenario „Regionenverbund in 2050“ *(Umweltbundesamt)*

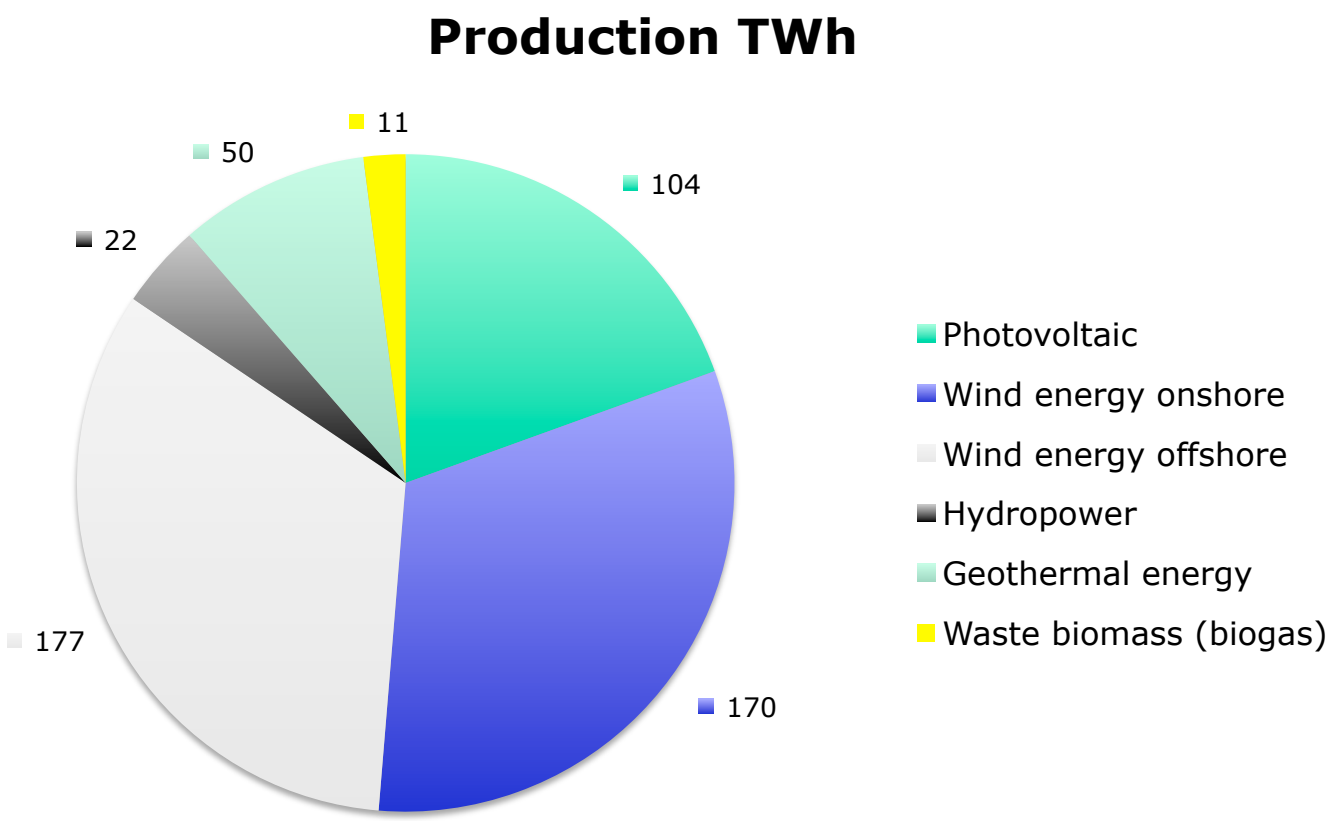
Umwelt Bundes Amt
Für Mensch und Umwelt

Regionen Verbund D - 2050



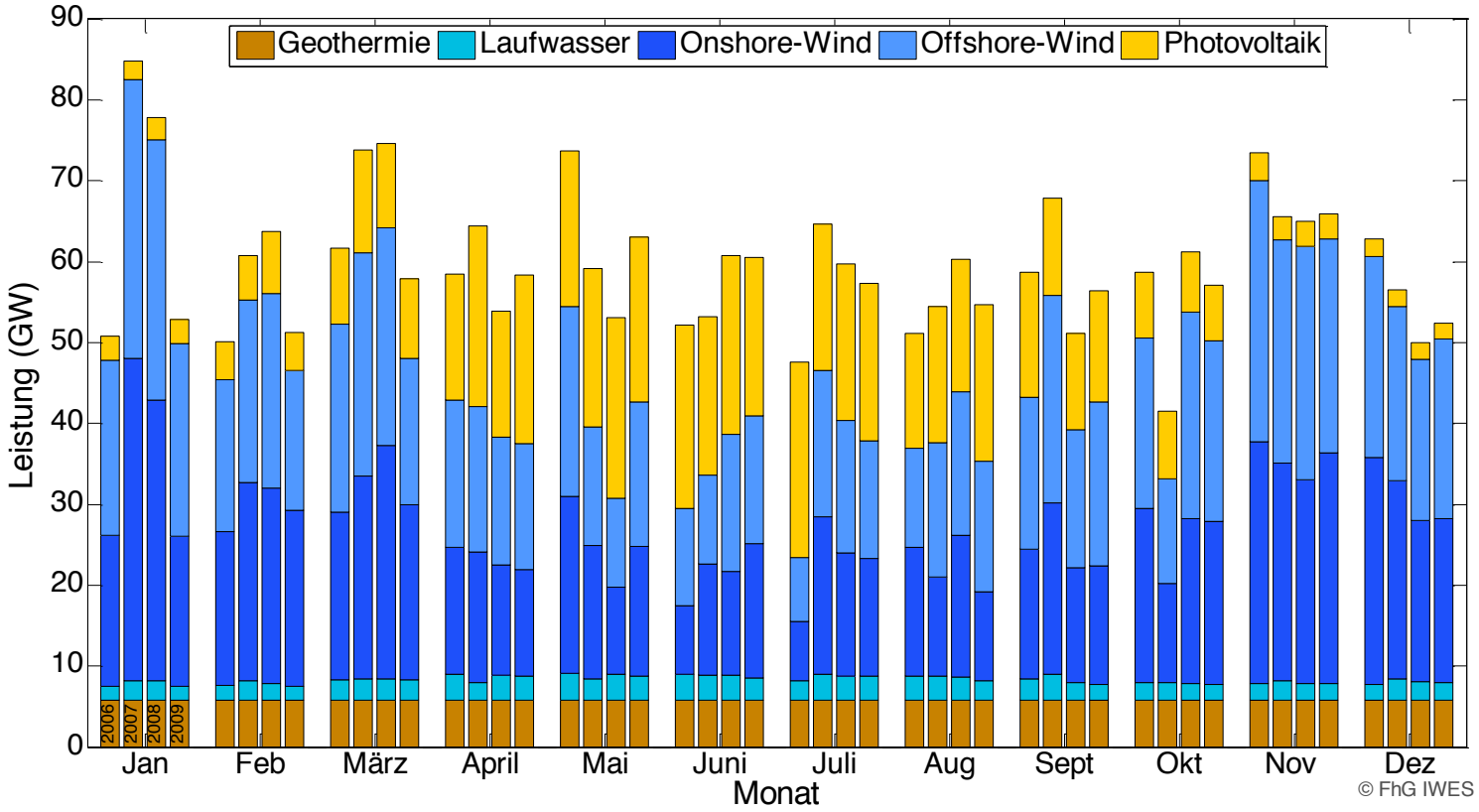
Umwelt Bundes Amt
Für Mensch und Umwelt

Regionen Verbund D - 2050



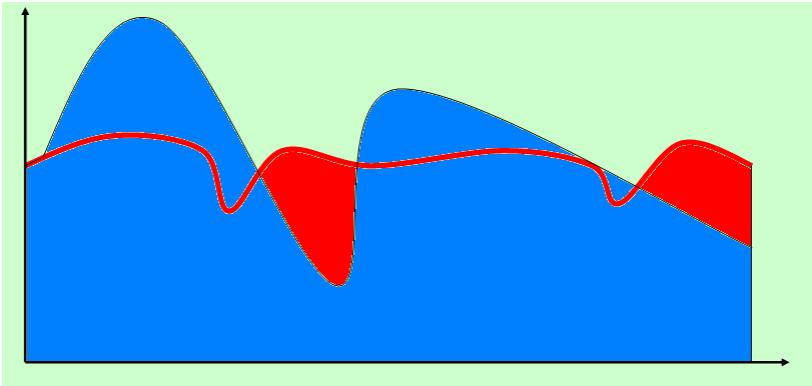
Umwelt Bundes Amt
Für Mensch und Umwelt

Feed-in of the renewable energies (2006-2009)



Average, monthly feed-in of renewable electricity
from generation capacities in 2050
based on the meteorological years 2006-2009

Umwelt Bundes Amt
Für Mensch und Umwelt



Short and long Term Storage needed

pumped storage power stations

(daily/several days range)

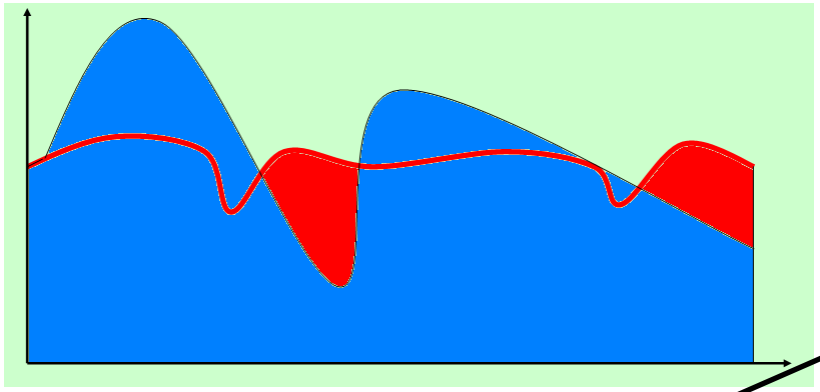
- storage in form from potential energy (upper an lower reservoir)
- used since decades in large-scale power stations
- efficiency up to 80 %
- in Germany 40 GWh starage capacity

chemical storages

(weeks/months/years range)

- elektrolytical **hydrogen** generation
- renewable hydrogen storage
- renewable **methan** storage (in Germany 200 TWh_{th} storage capacity in natural gas grid)
- re-generation in combined cycle power plants or other use (e.g. as fuel)

Umwelt Bundes Amt
Für Mensch und Umwelt



Short and long Term Storage needed

pumped storage power stations

(daily/several days range)

- storage in form from potential energy (upper an lower reservoir)
- used since decades in large-scale power stations
- efficiency up to 80 %
- in Germany 40 GWh starage capacity

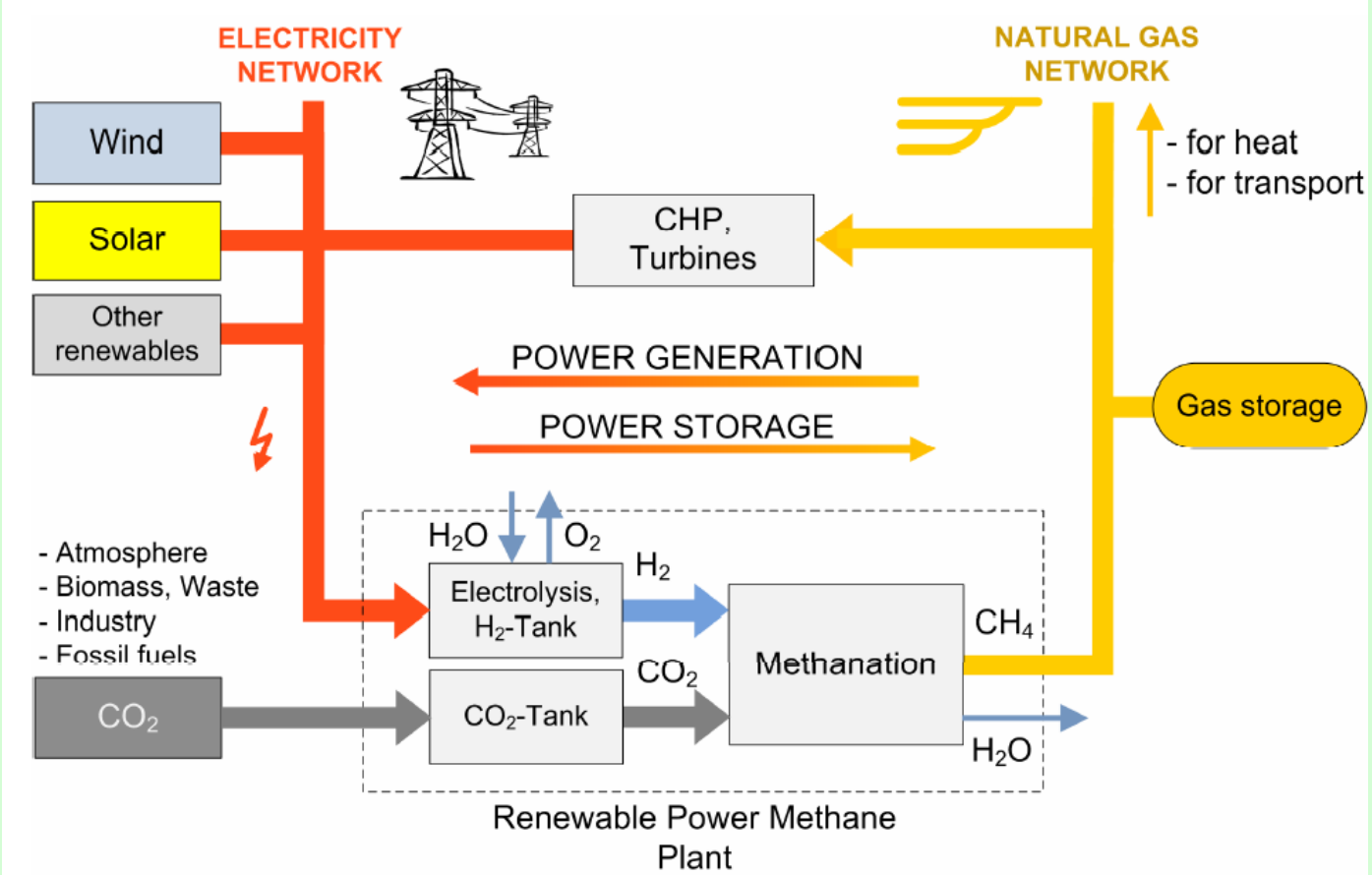
chemical storages

(weeks/months/years range)

- elektrolytical **hydrogen** generation
- renewable hydrogen storage
- renewable **methan** storage (in Germany 200 TWh_{th} storage capacity in natural gas grid)
- re-generation in combined cycle power plants or other use (e.g. as fuel)

Umwelt Bundes Amt
Für Mensch und Umwelt

energy storage by linking the power grid with natural gas grid

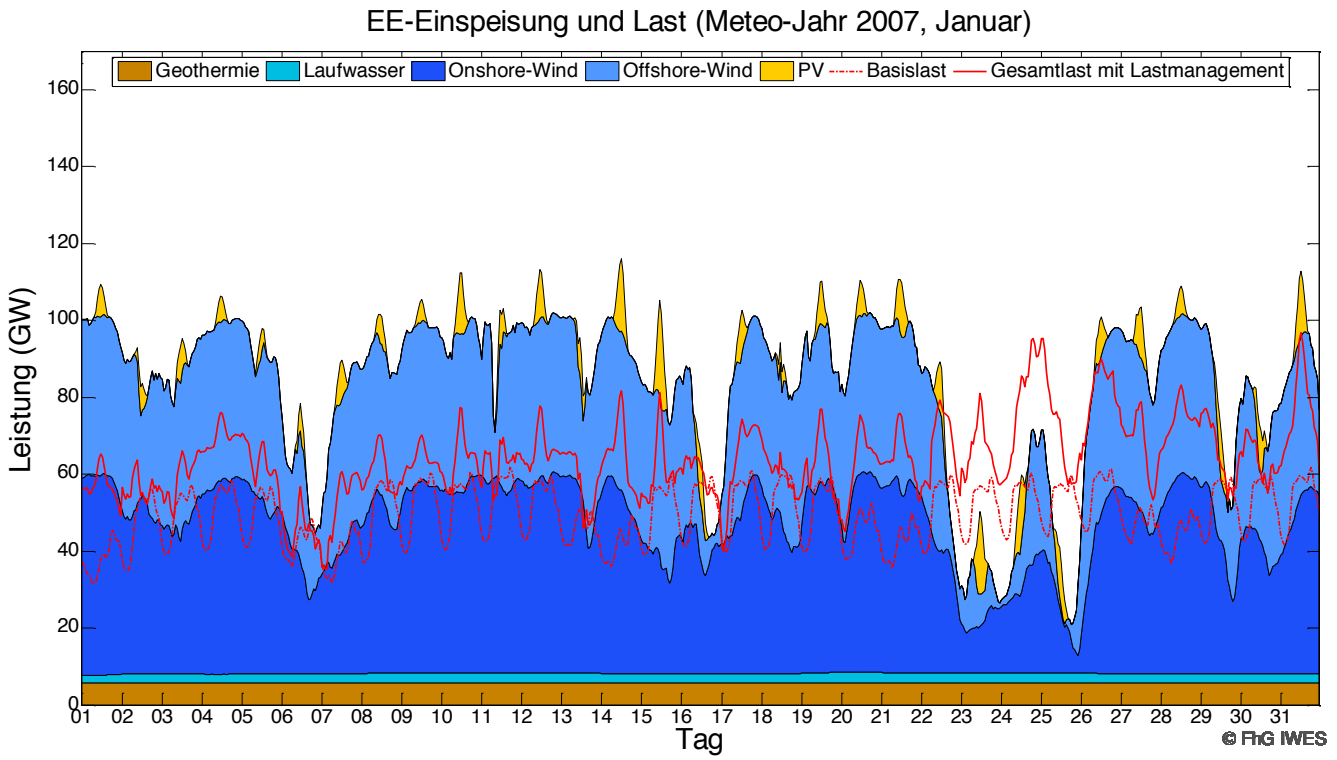


$4\ H_2 + CO_2 \leftrightarrow CH_4 + H_2O$

[Specht et al, 2010, Sterner, 2009]

Umwelt Bundes Amt
Für Mensch und Umwelt

Feed-in of renewable energy and load – per month (winter)

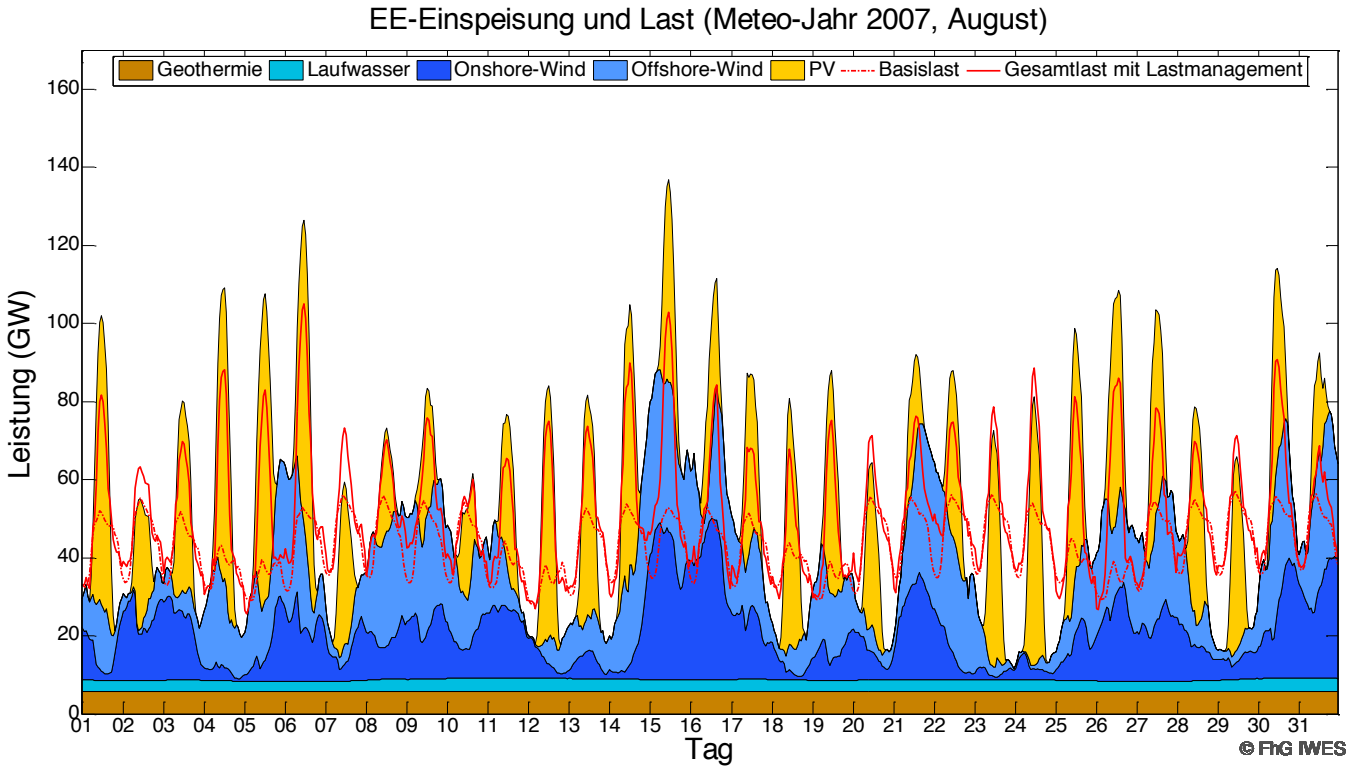


Feed-in [GW] of all RE and the load curve

Example „Winter day“ (December) for the feed-in of renewable energies in 2050, based on the meteorological year 2007

Umwelt Bundes Amt
Für Mensch und Umwelt

Feed-in of renewable energies and load – per month (summer)

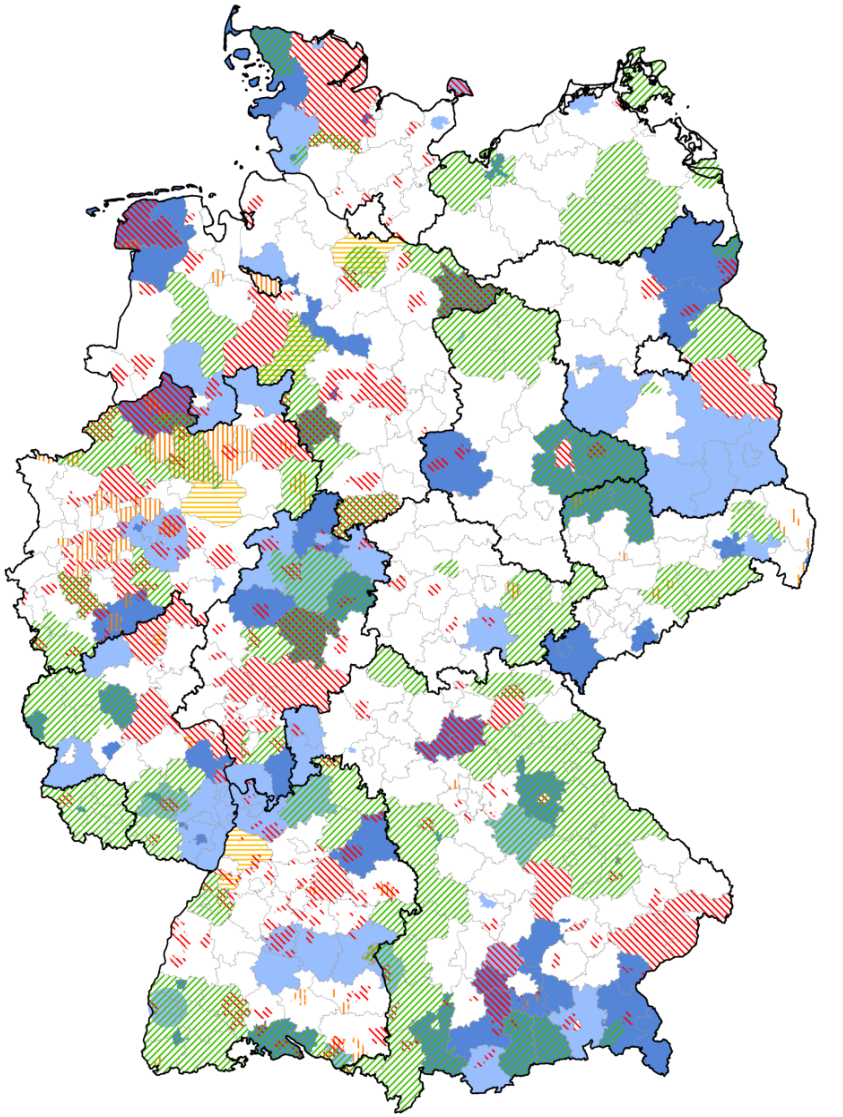


Feed-in [GW] of all RE and load

Example „Summer day“ (August) for the feed-in of renewable energies in 2050, based on the meteorological year 2007

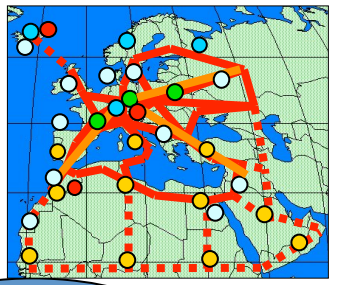
Umwelt Bundes Amt
Für Mensch und Umwelt

Regions Collaborating Towards 100% EE

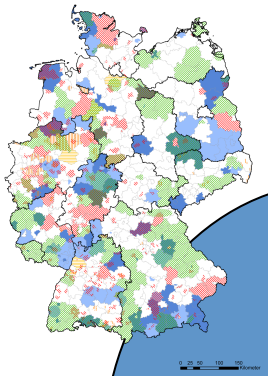


Energie mit System
deENet

Archetypes of EE Supply



International / far



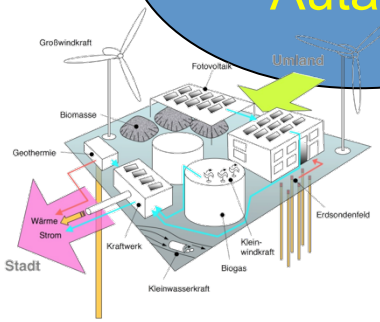
Internat.
Cooperation

Regional
Network

Decentralized

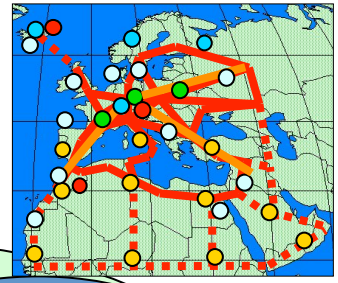
Centralized

Local
Autarky

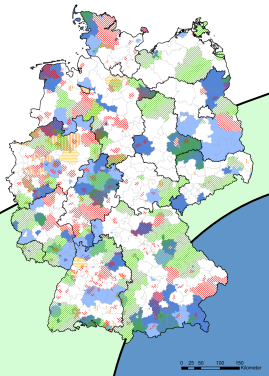


Local / nearby

Archetypes of EE Supply



International / far



Internat.
Cooperation

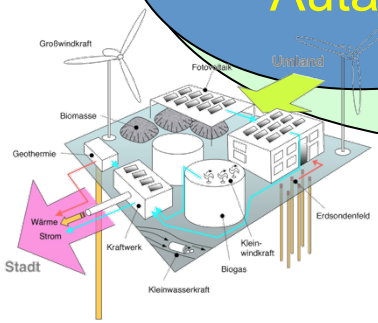
Regional
Network

Decentralized

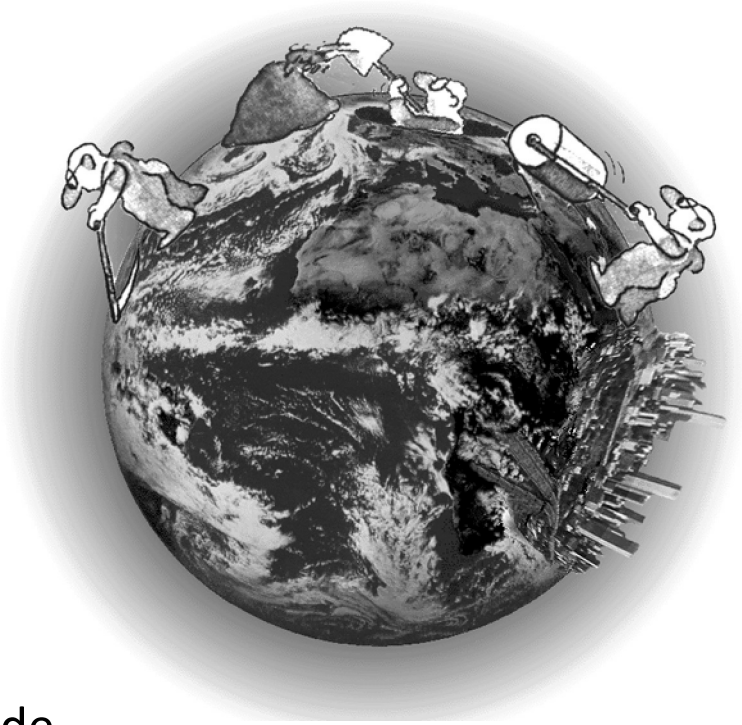
Centralized

Local
Autarky

Local / nearby



... Continue Part 3



Limits to growth

Source: Harry Lehmann, 1994

harry.lehmann @ uba.de