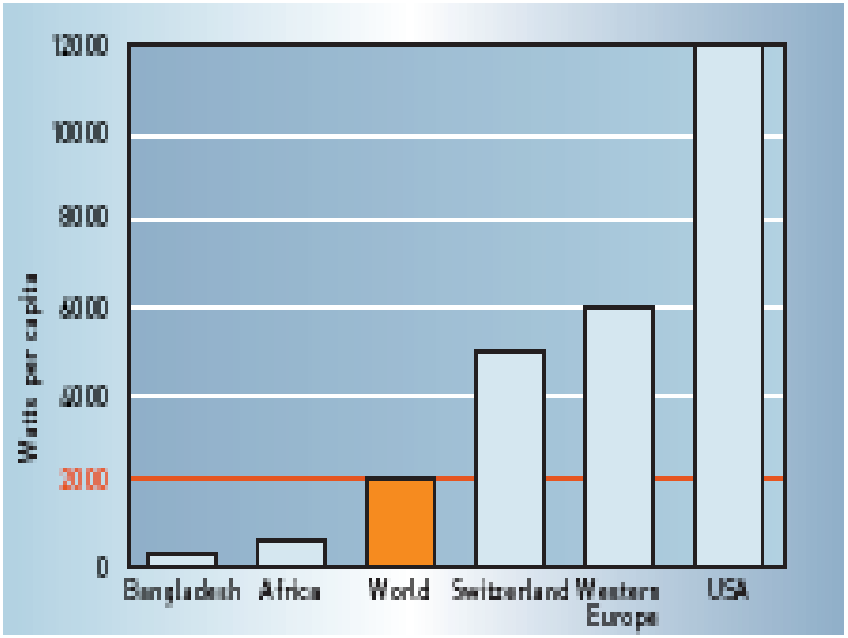
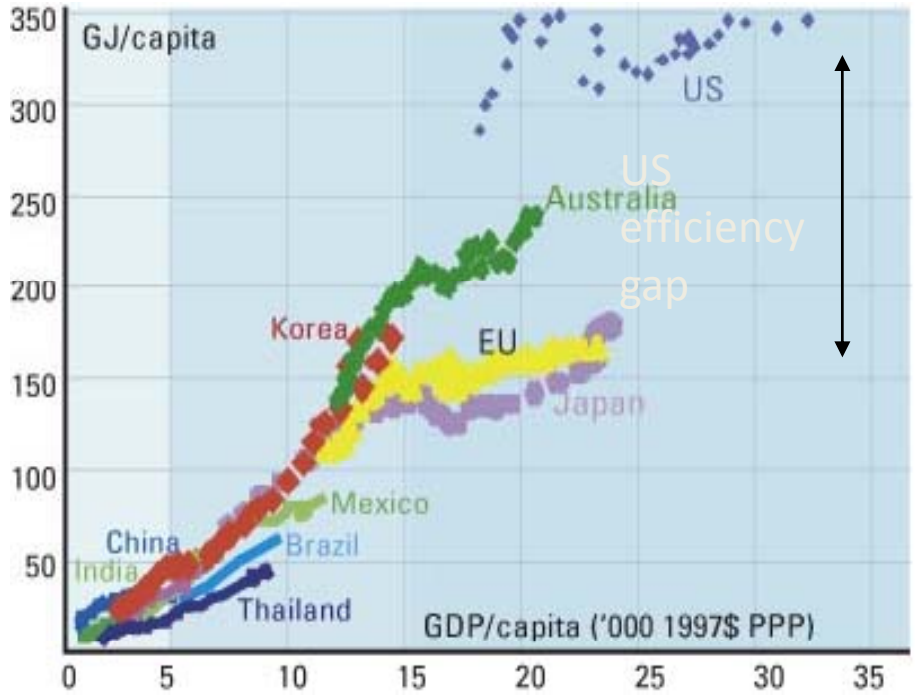
Forecasting future energy scene some constitutive elements

Rudolf Rechsteiner

Switzerland

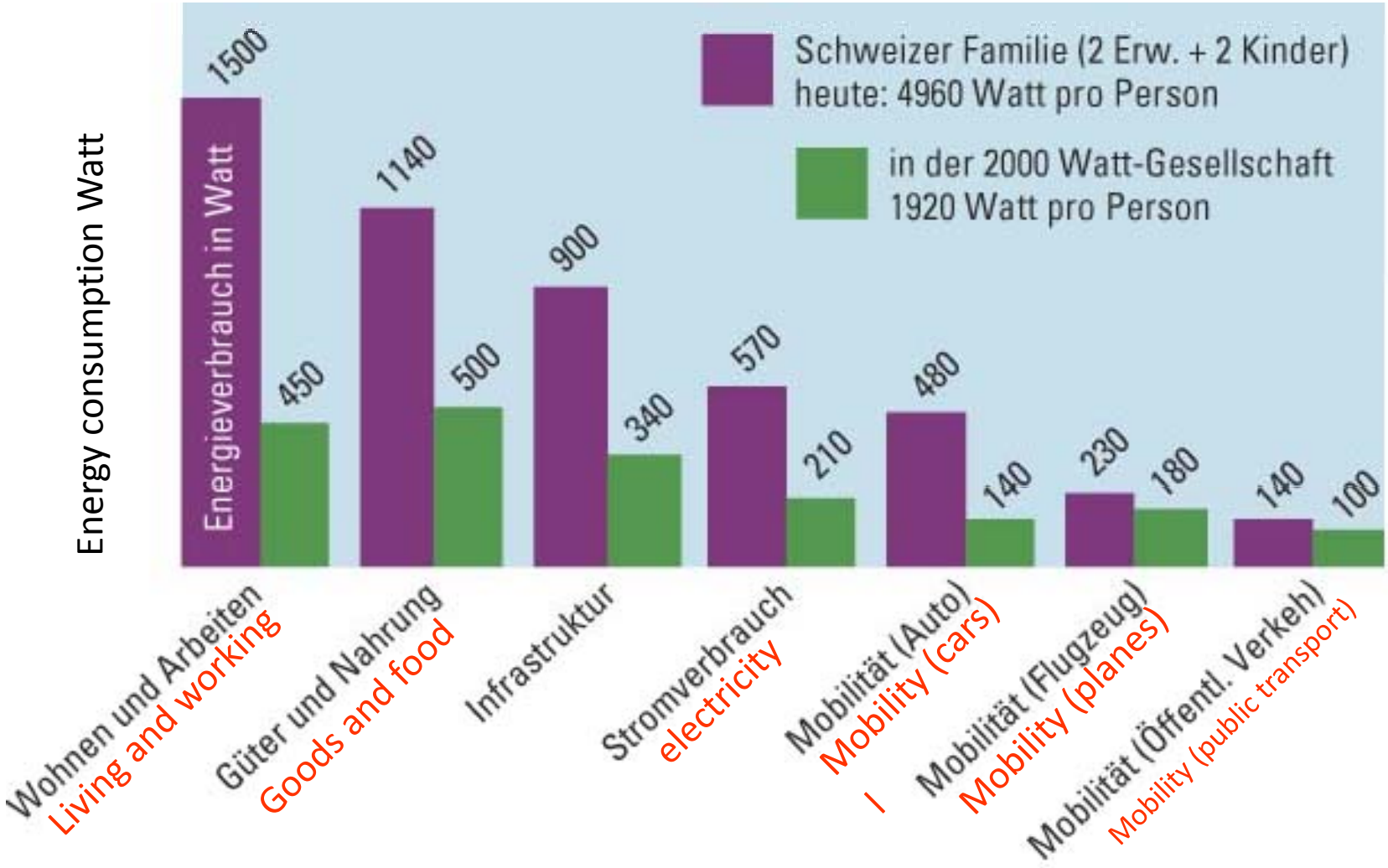
The Swiss Goal:
a 2000-Watt-Society





Efficiency reduces energy consumption

Family of today 4960 W, Family of the future 1920 Watt/person



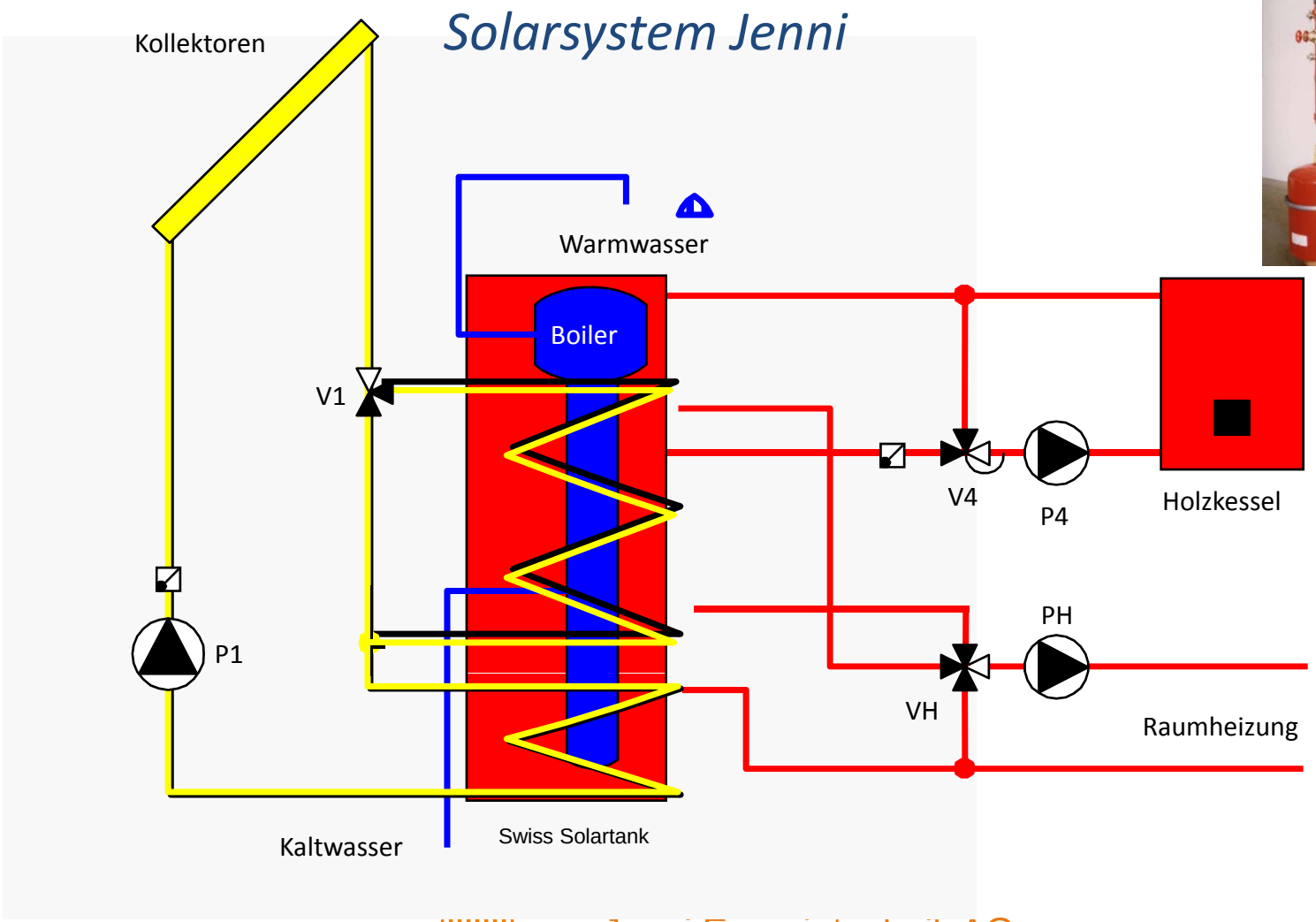
Josef Jenni‘s first house 100% solar (heat and power)

Heat storages within the building‘s basement

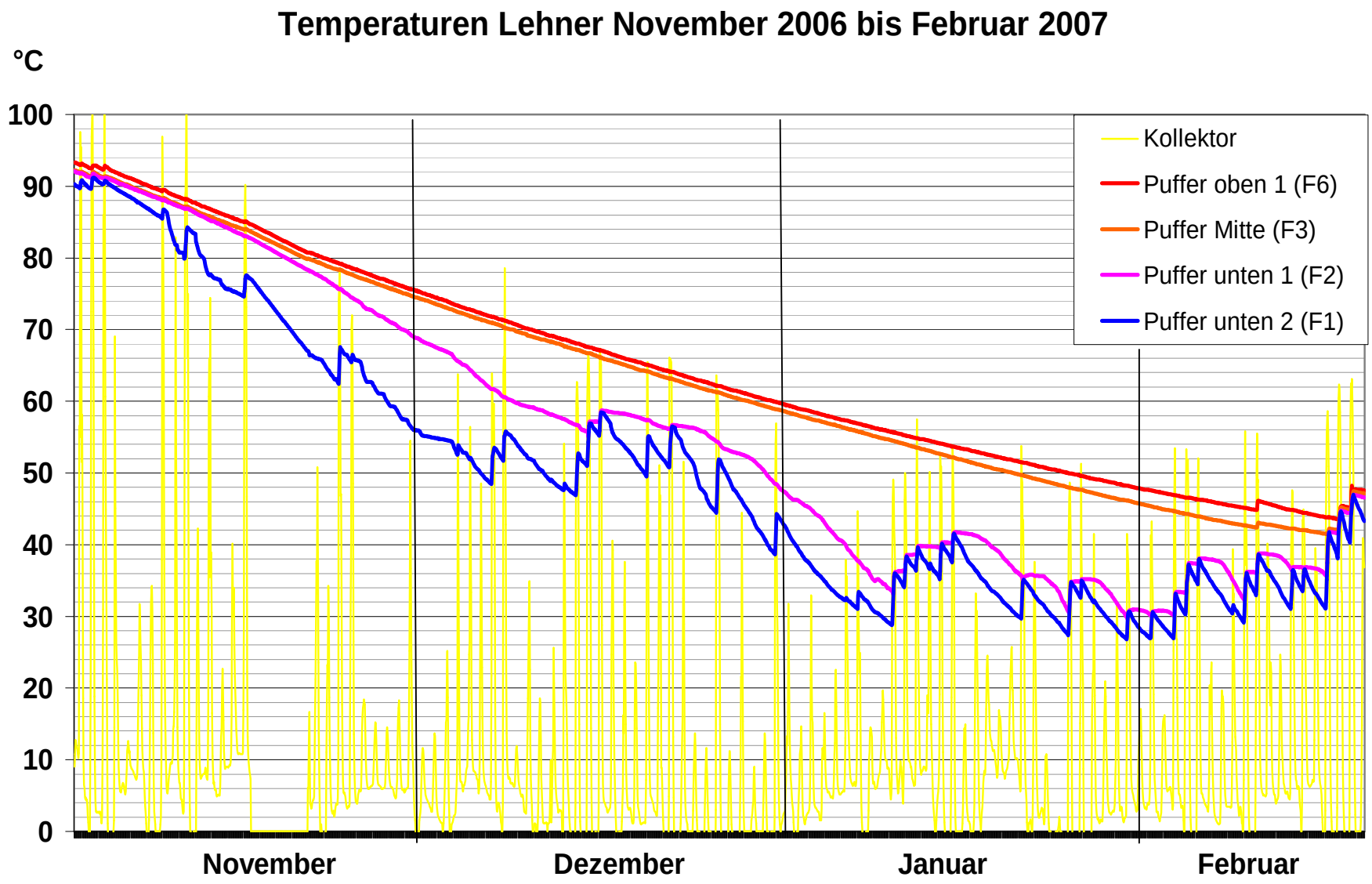
Jenni solar houses: self sufficient

Solar coverage 50-100%:
Solar collector, storage tank, wood stove as a reserve

Swiss Solartank®



Temperatures in storage November 2006 – February 2007



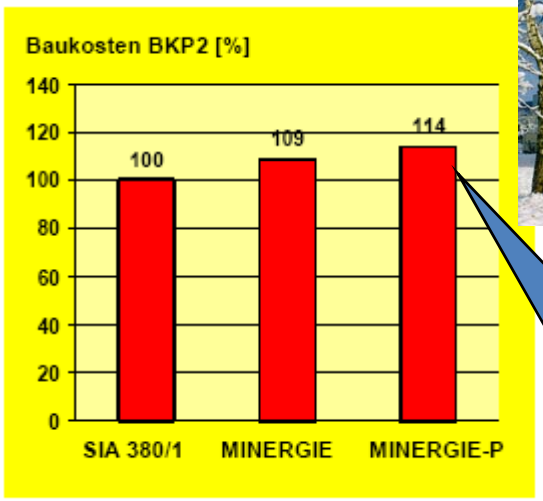
Solarspeicher 2 x 50`000 l

Jenni Solar House (Dresden)

Winner of the German Solar Price

A number of different Swiss techniques for efficient housing

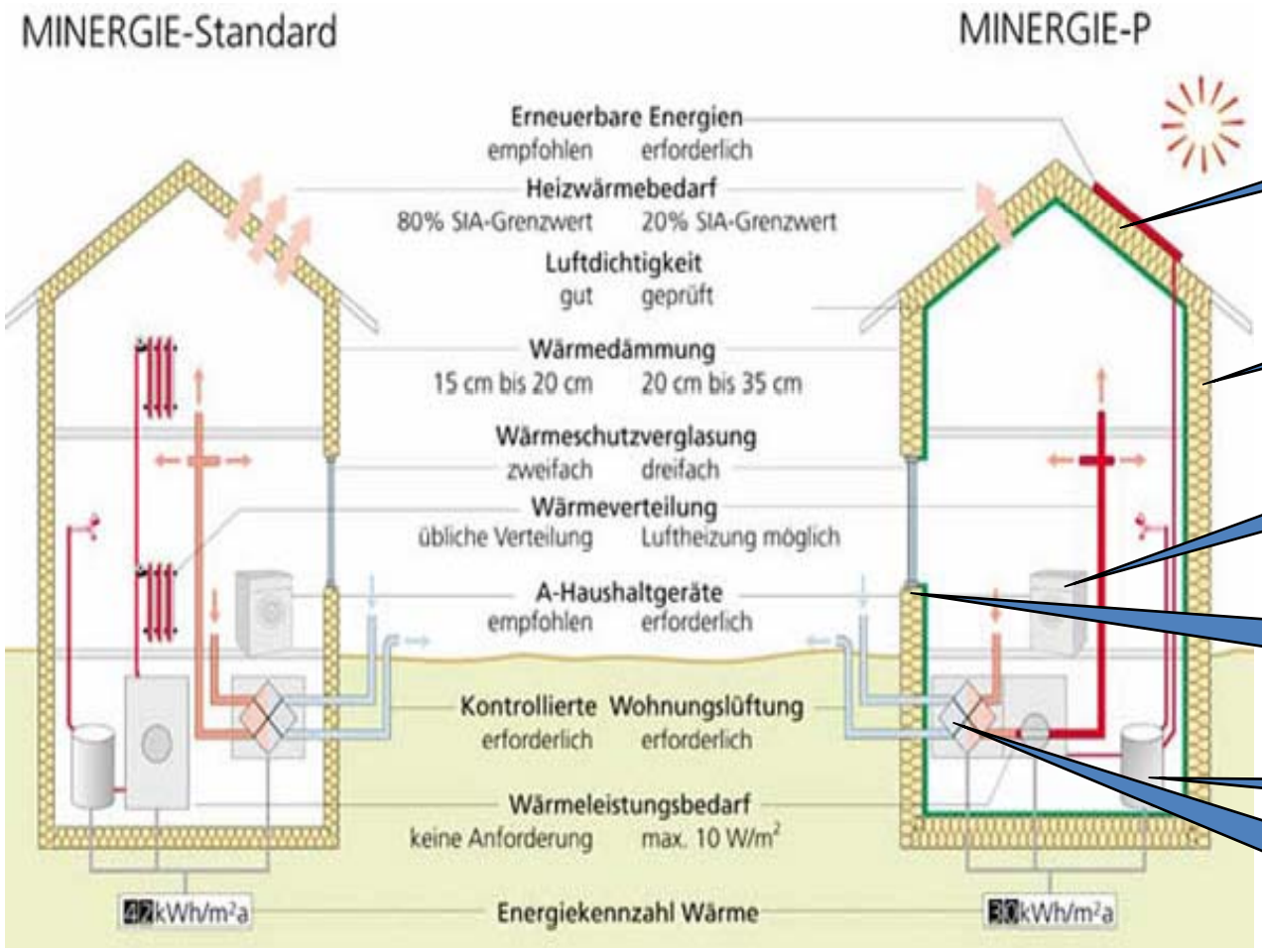
And new standards for energy efficiency



Additional construction costs (+14%) are offset by lower energy bills

New Swiss Building Standards

Minergie(45 kWh/m²/a) Minergie-P (30 kWh/m²/a)



Solar panel

Insulation 20-35 cm

A-Class appliances

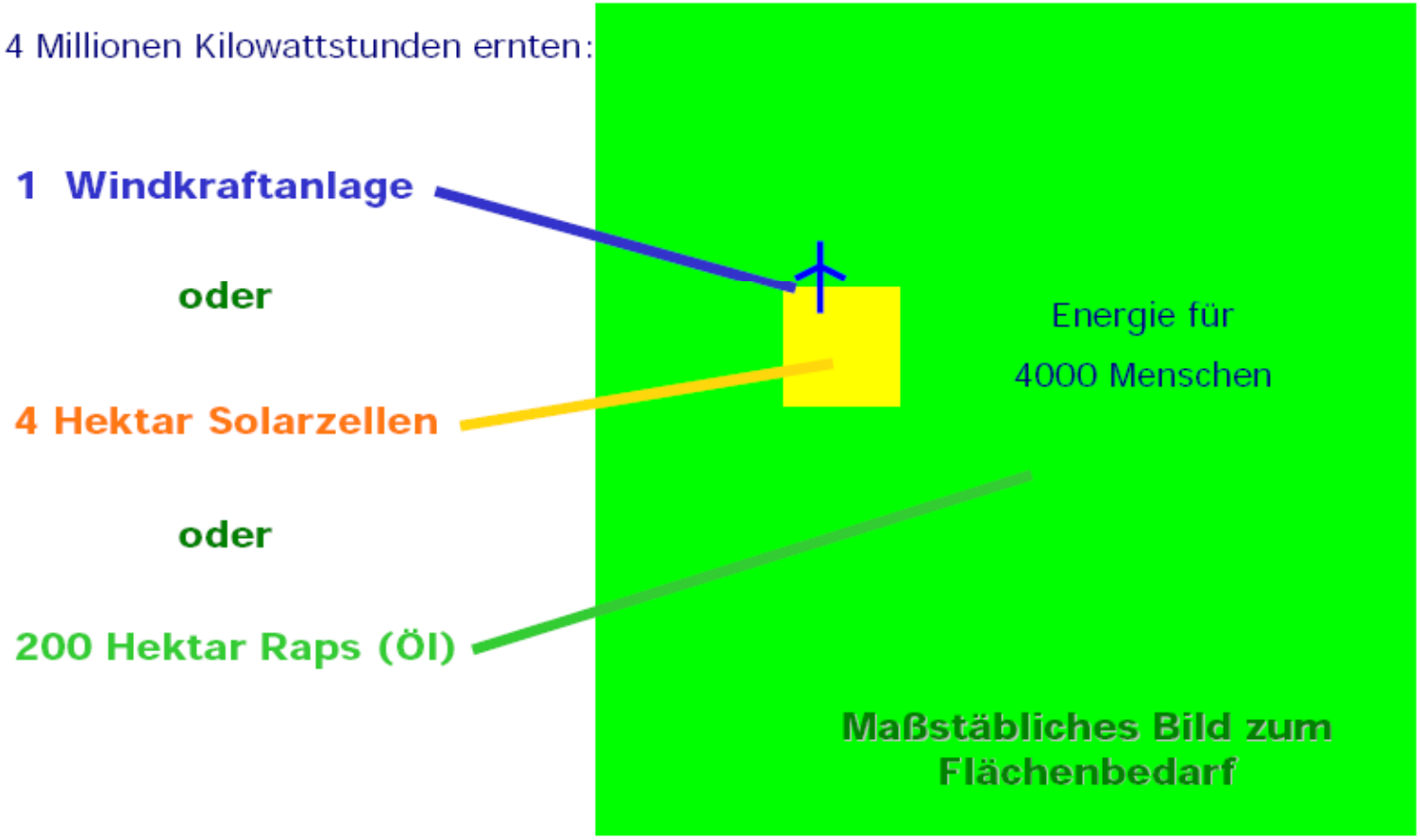
Insulating window
3 layers of glass

Solar storage tank

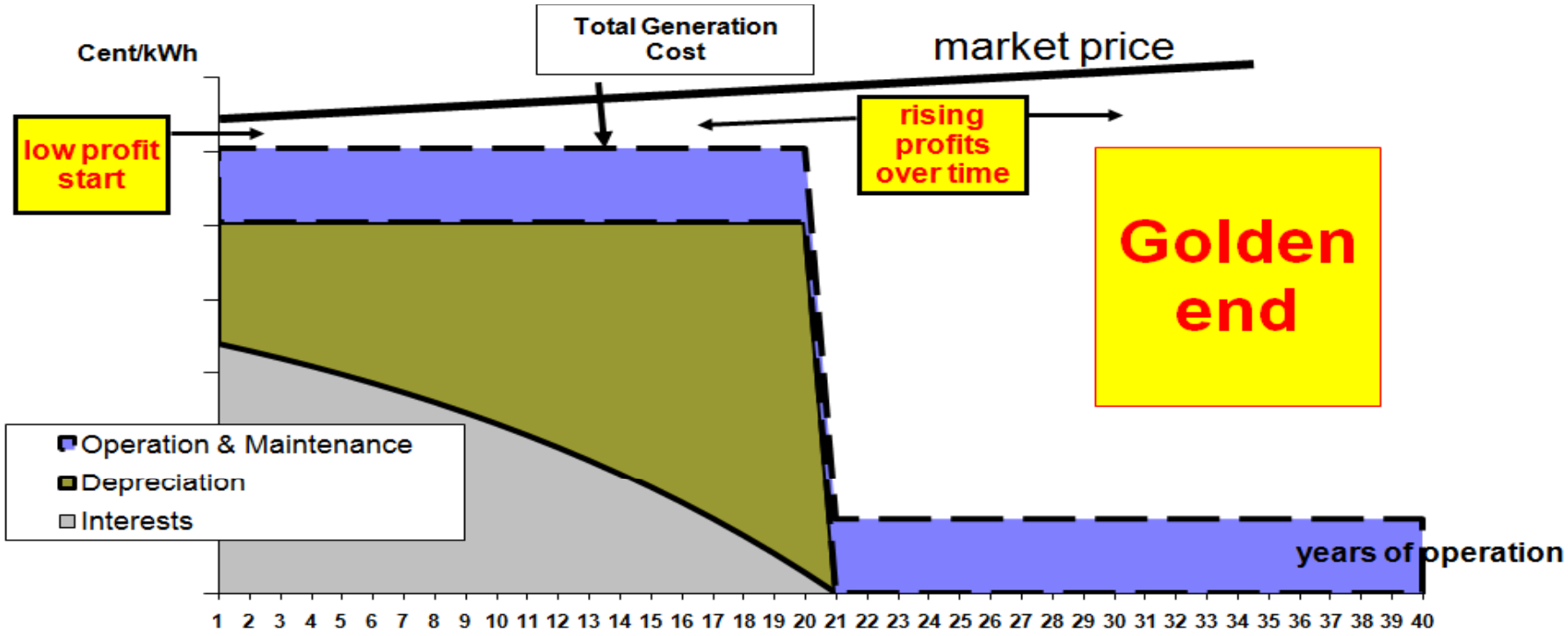
Controlled ventilation with heat recovery = only heating system

Renewable energie- what areas needed?

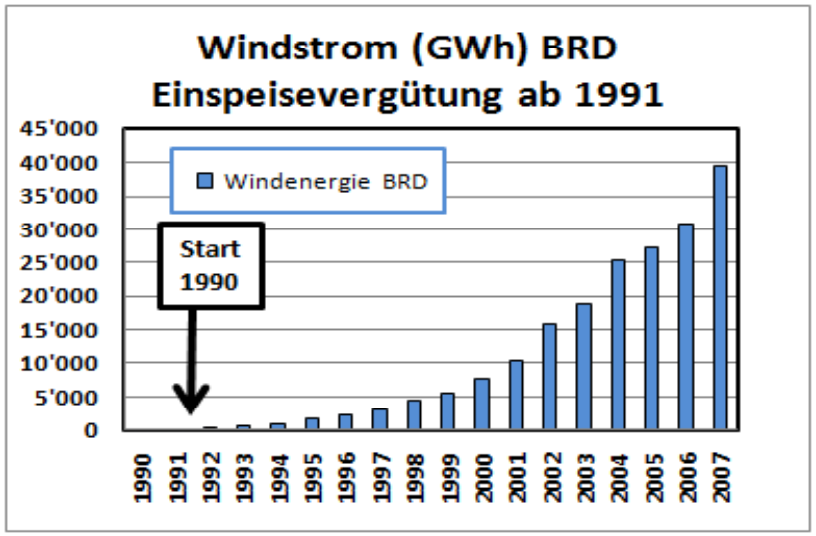
0,01 ha Wind turbine = 4 ha Solar power = 200 ha Raps
Windkraft 20‘000mal produktiver als Raps pro Flächeneinheit

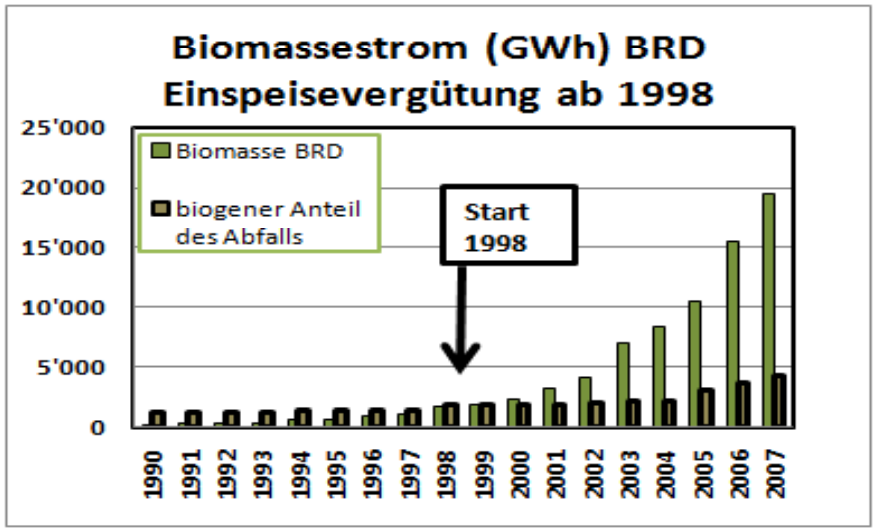


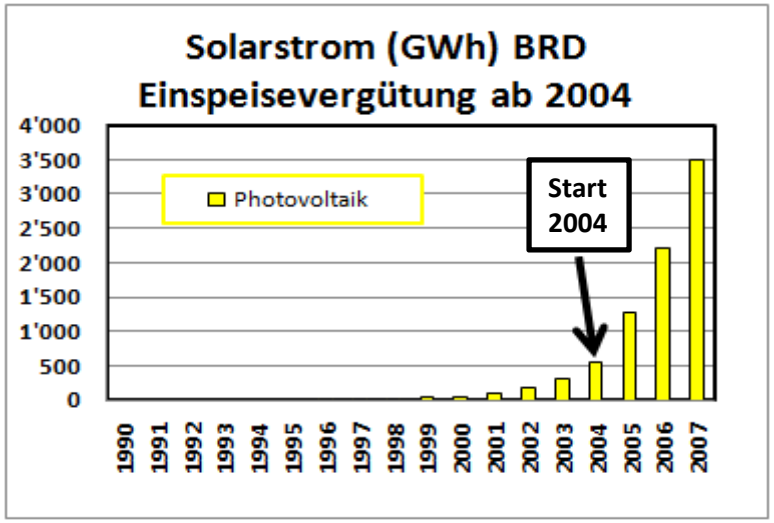
Cost- and pay-back-structure of renewables over time
High initial capital cost, low O&M-costs, no fuel cost bring golden end over life cycle

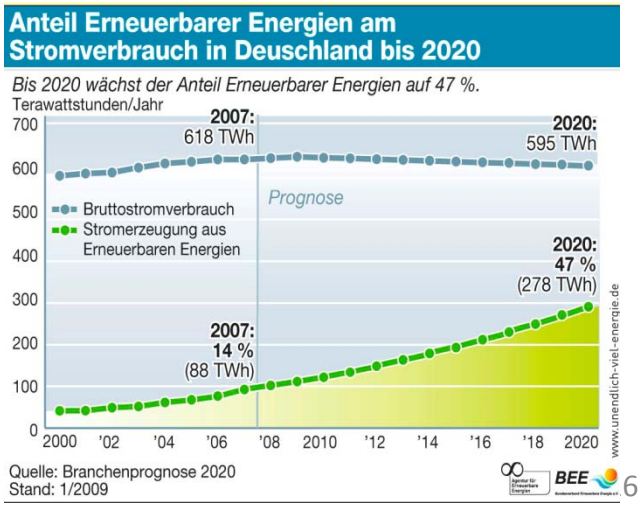


German experience 1990-2008-2020: from 3% to 15 % to 47% renewable



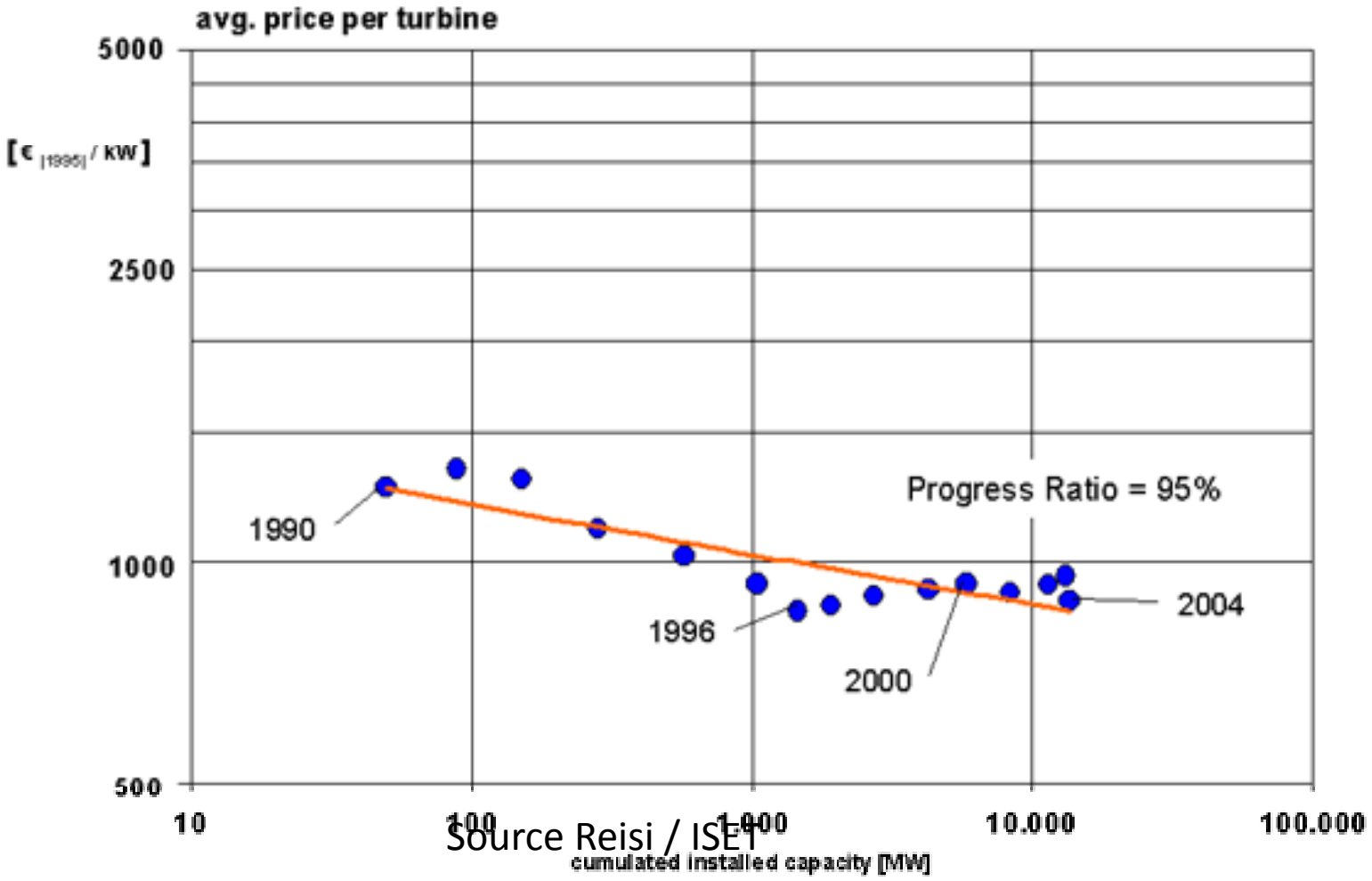






Wind turbines get ever cheaper

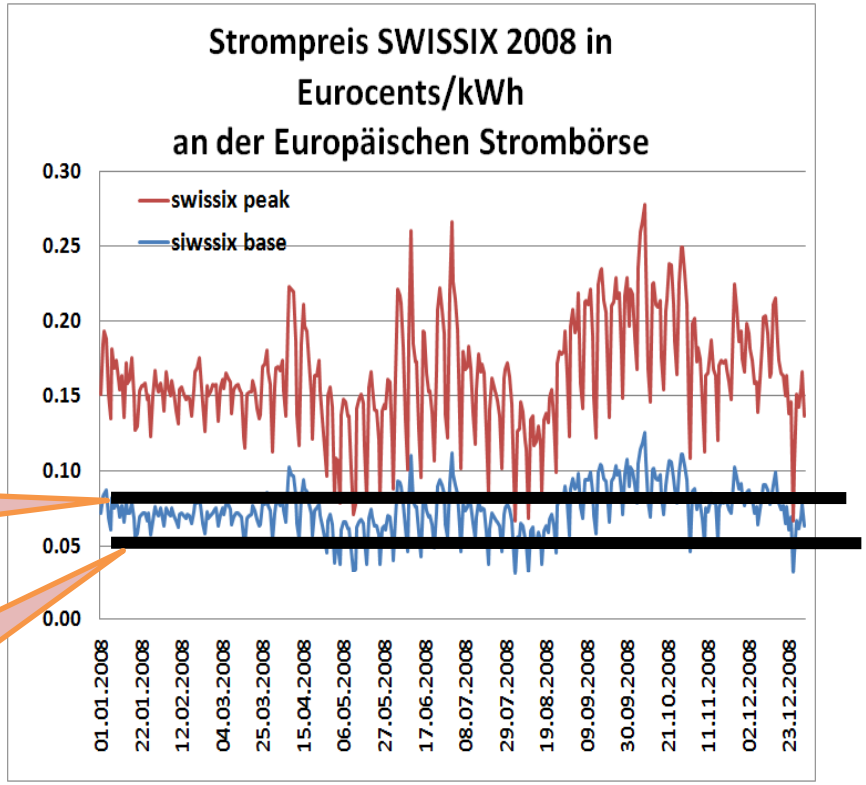
from 1 Euro/Watt today to 0.5 Euro/Watt by 2020



Source Reisi / ISET

European wind power cheaper than market price (2008)

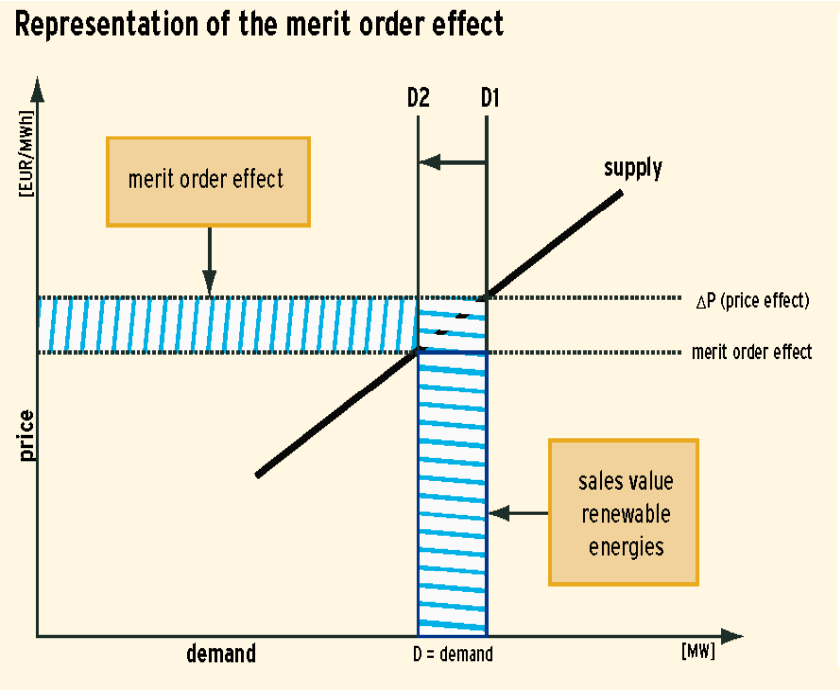
- **Feed in tariff Germany :**
  - **9 Cents/kWh first five years**
  - **5 Cents after 5 years depending on place/productivity)**

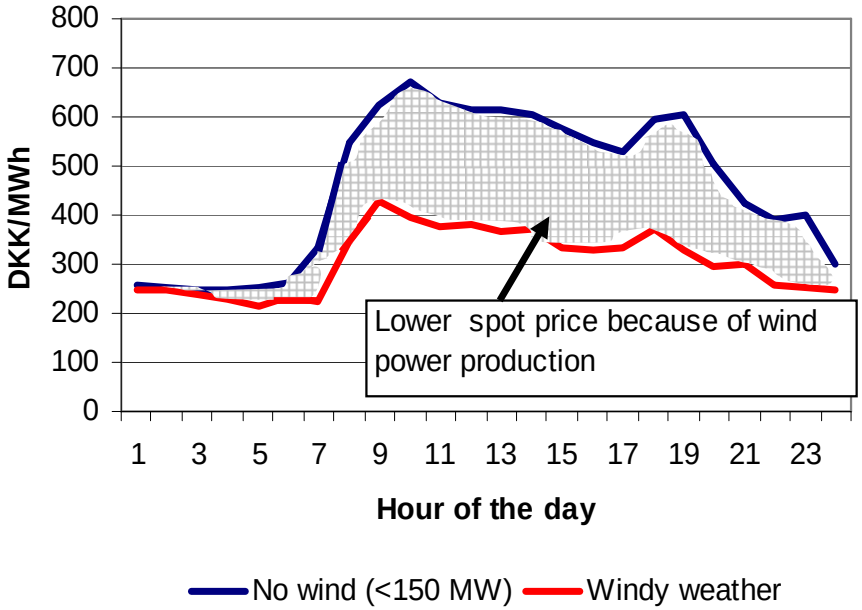


Feed in tariff first five years

Feed in tariff after five years or later Jahren

Wind power is crowding out more expensive technologies

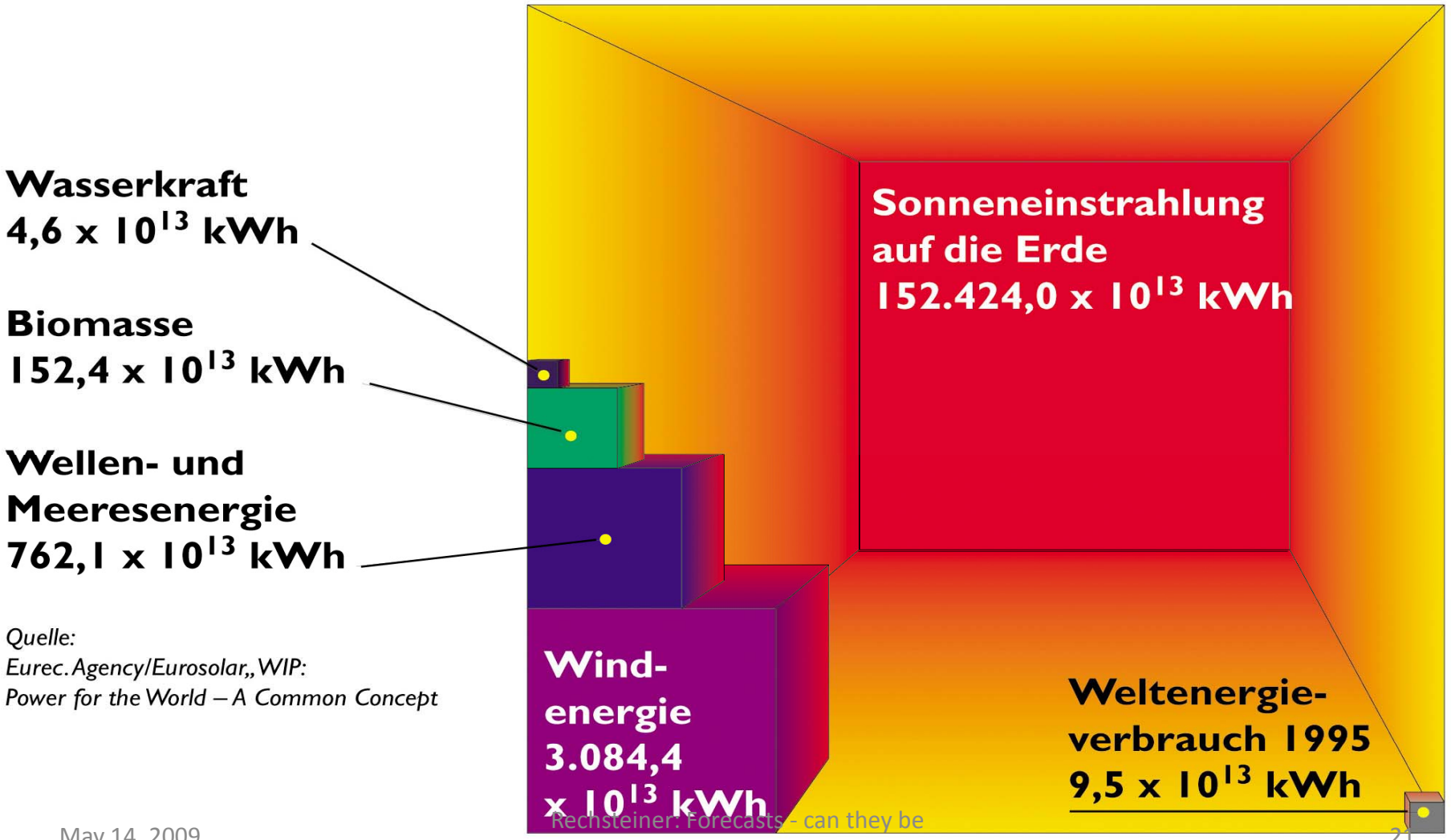




Four recipees for security of supply with a purely renewables system

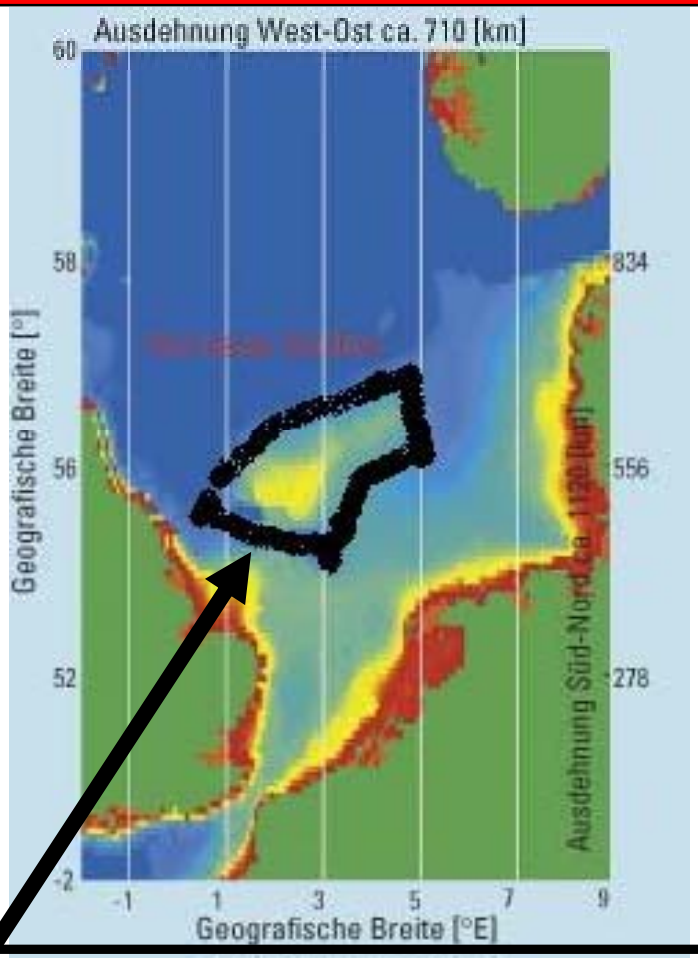
1. Feed in-tariffs
   - Important for rnewables‘ diuversity
2. Diversification of primary sources
   - Wind, solar geothermal for baseload
   - hydro and biomass for peaks
3. Diversification of geographic sourcing
   - Regional structures are cheaper than local ones
4. Storage
   - Batteries, hydro, hydro-pumped, biomass

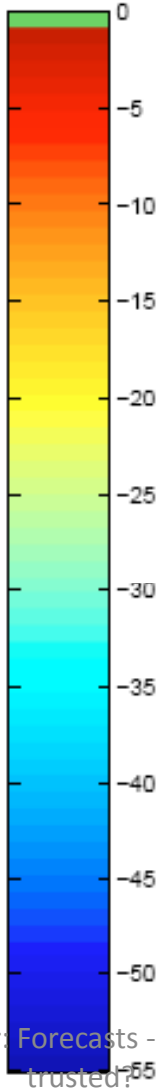
Angebot erneuerbarer Energien- weltweit



Southern North Sea could power the World

250‘000 km²< 45m ≈ 13 Mbd ≈ 7500 TWh



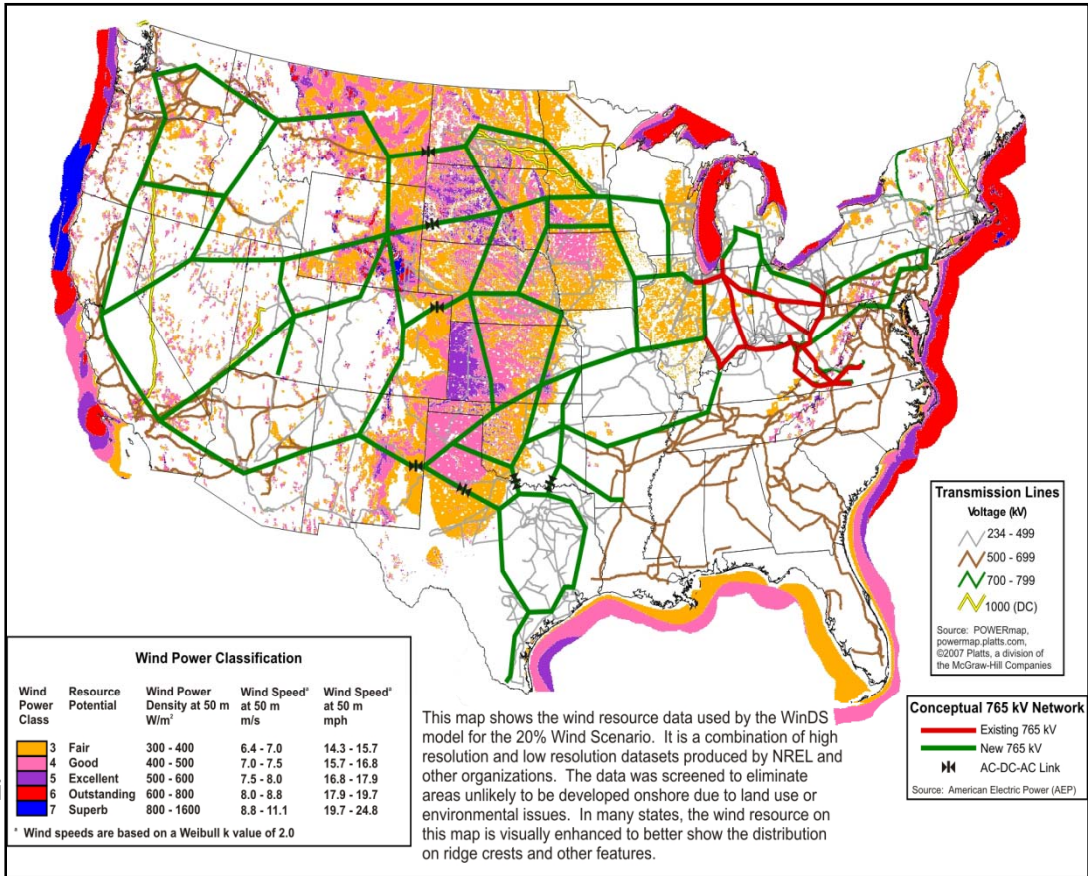


Polygon area can cover EU-electricity consumption
Two turbines / 10 MW per km²

Offshore-projects in Europe:

Thousands of wind turbines projected or in construction

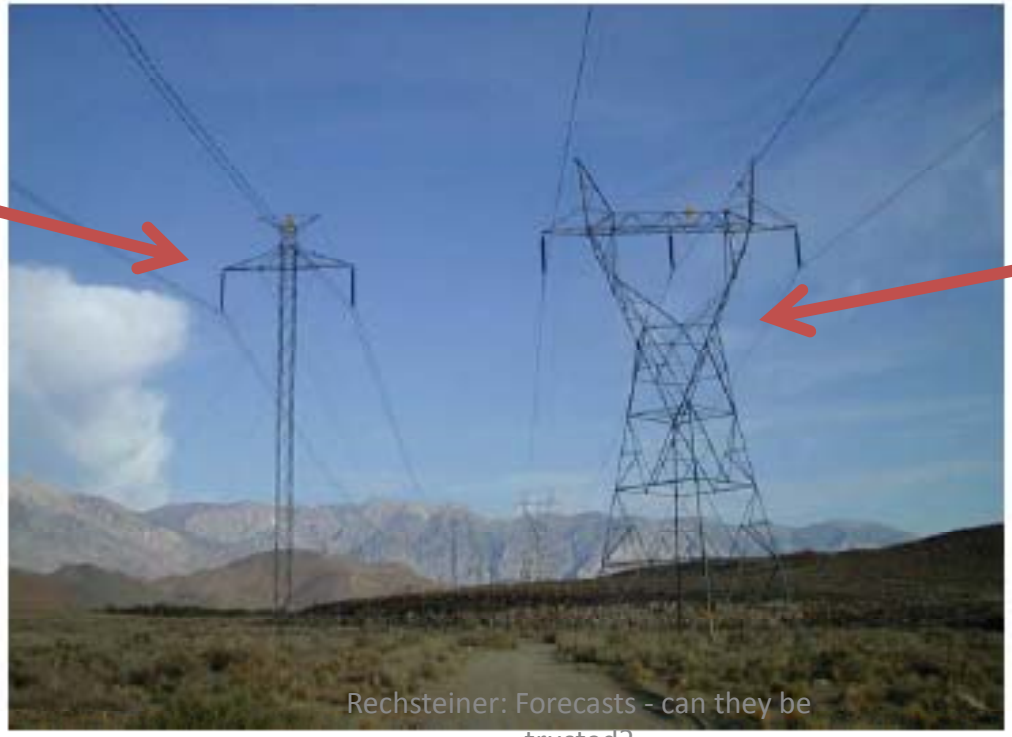
New sources of energy need a new grid!
Renewable energy means de-globalization and regionalisation of energy



HVDC-lines: high power – low losses, no electro smog

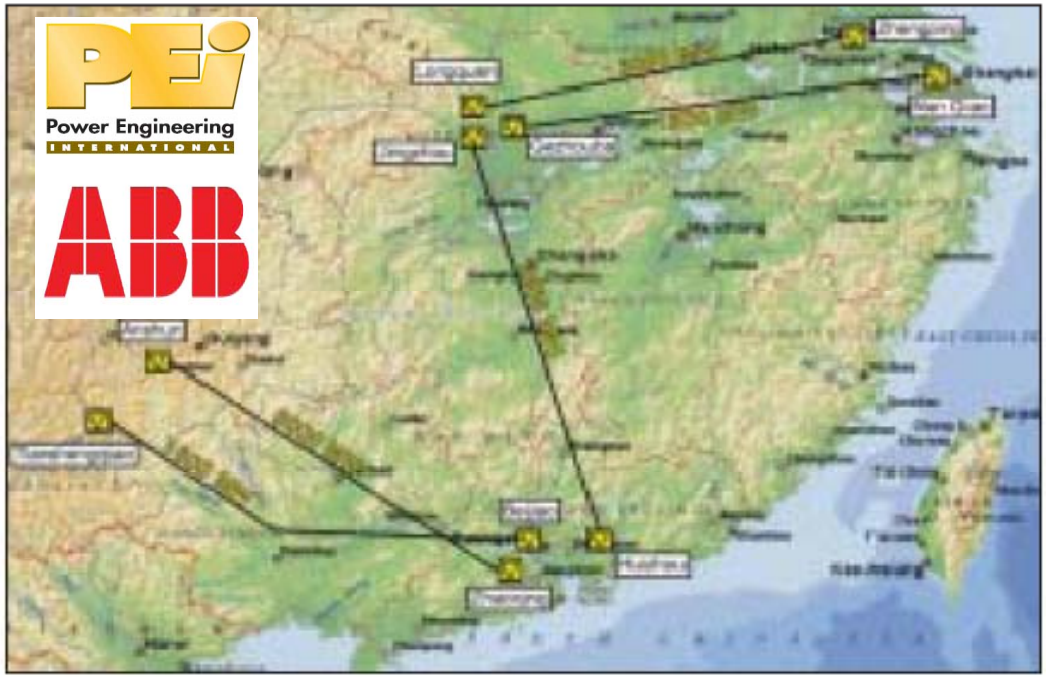
Figure 1-B. Left powerline: The Pacific Direct Current Intertie (PDCI), near Bishop, CA. HVDC, 3,000 MW, +/- 500 kv bipole, 846 miles from Celilo, at The Dalles Dam, OR to Sylmar (NW Los Angeles, CA). Commissioned in 1970 as 1,500 MW line. The right powerline is conventional high voltage AC.

HVDC High Voltage Direct Current



Normal AC grid

state of the art: 1-6 GW capacity in one cable
many new projects – earth cables cheap



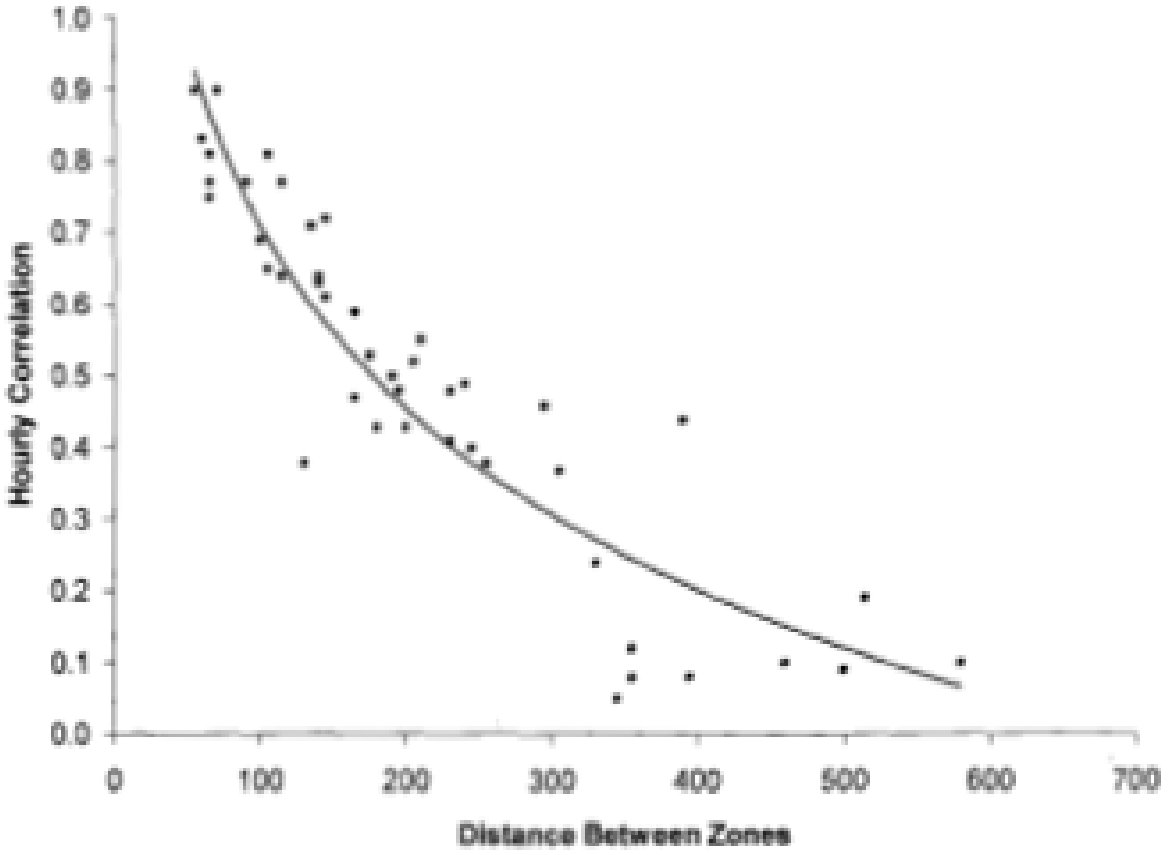
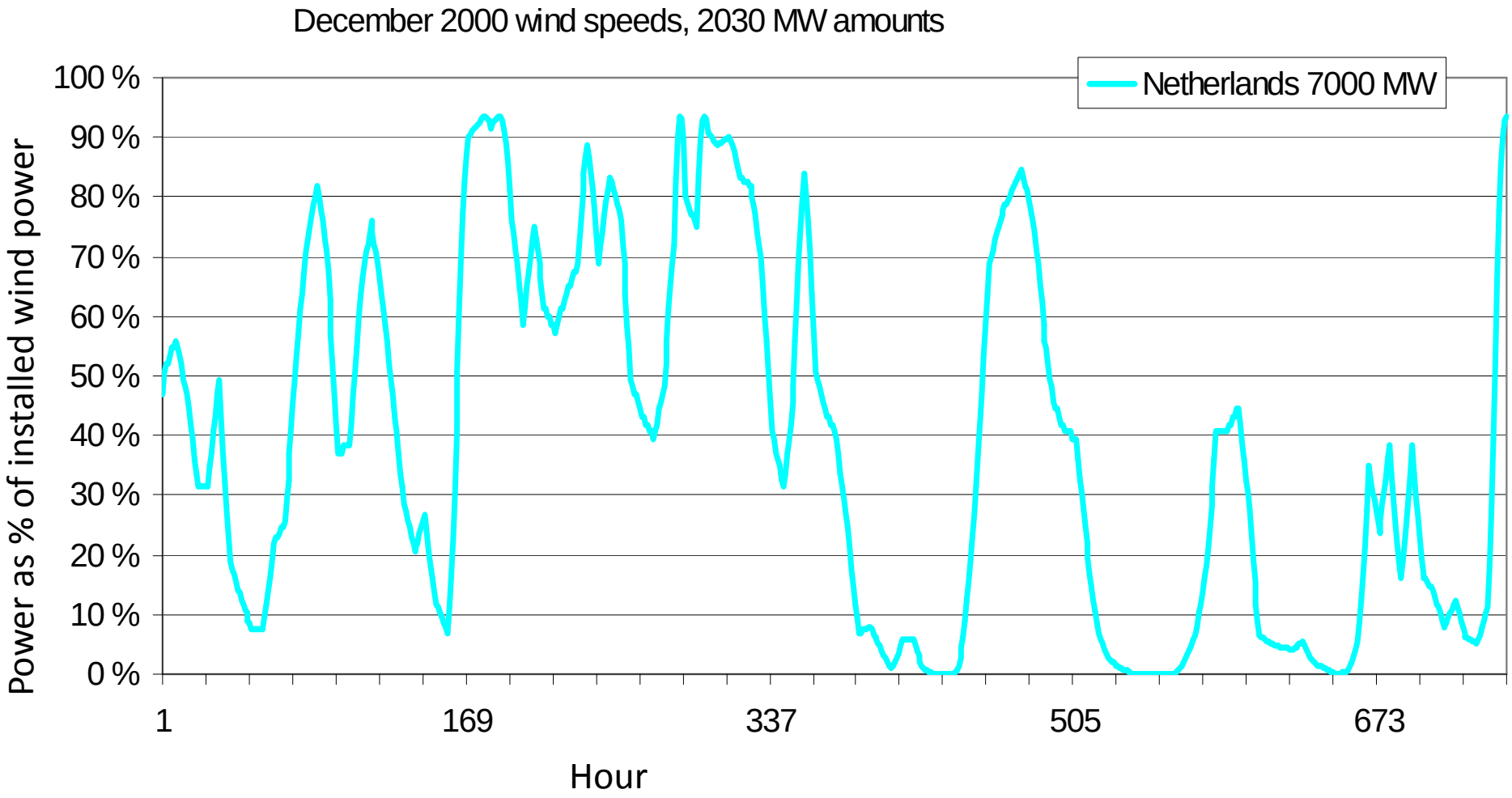
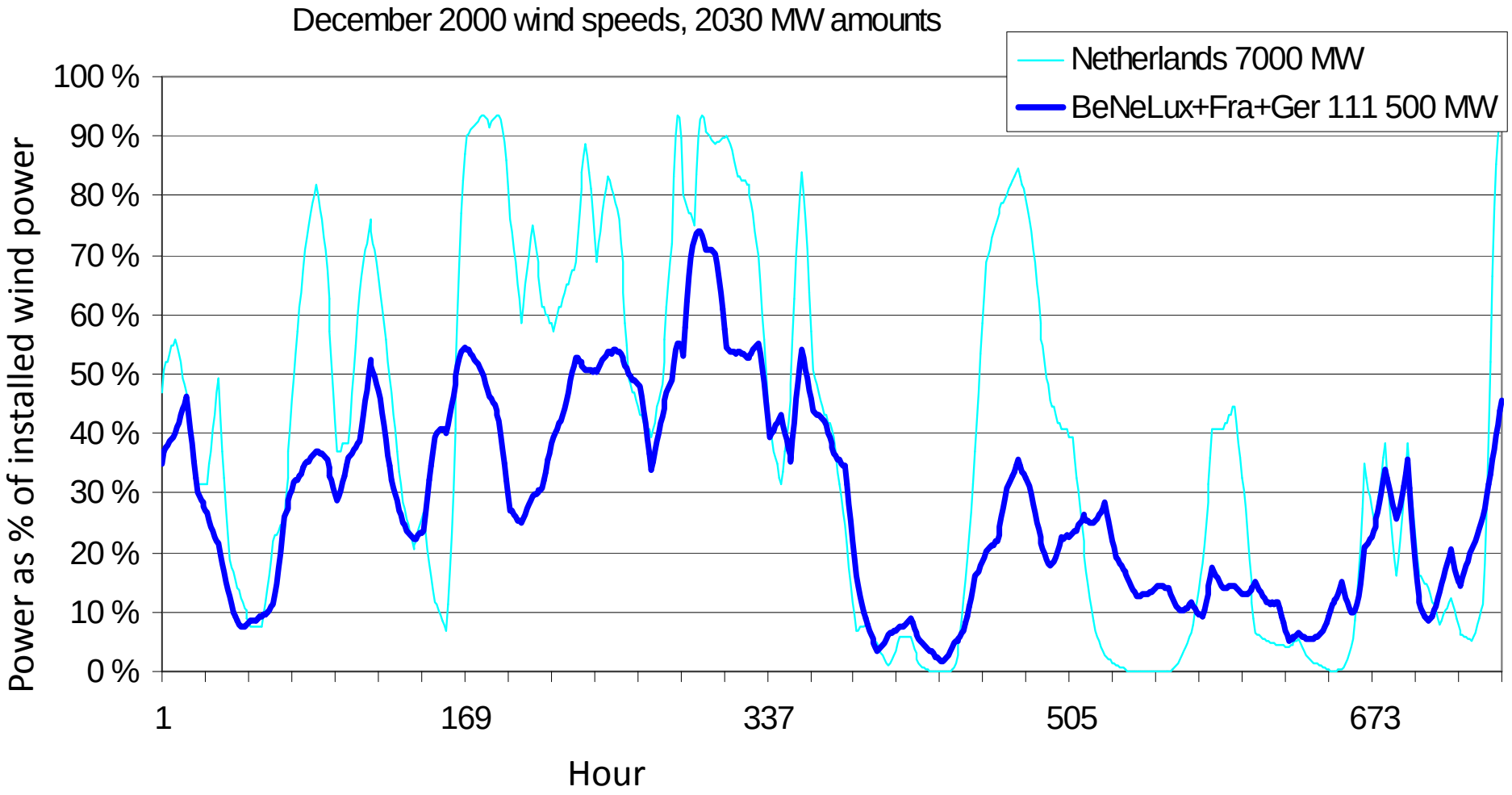


Figure 4 Wind variability hourly correlation drops dramatically with distance between wind zones.

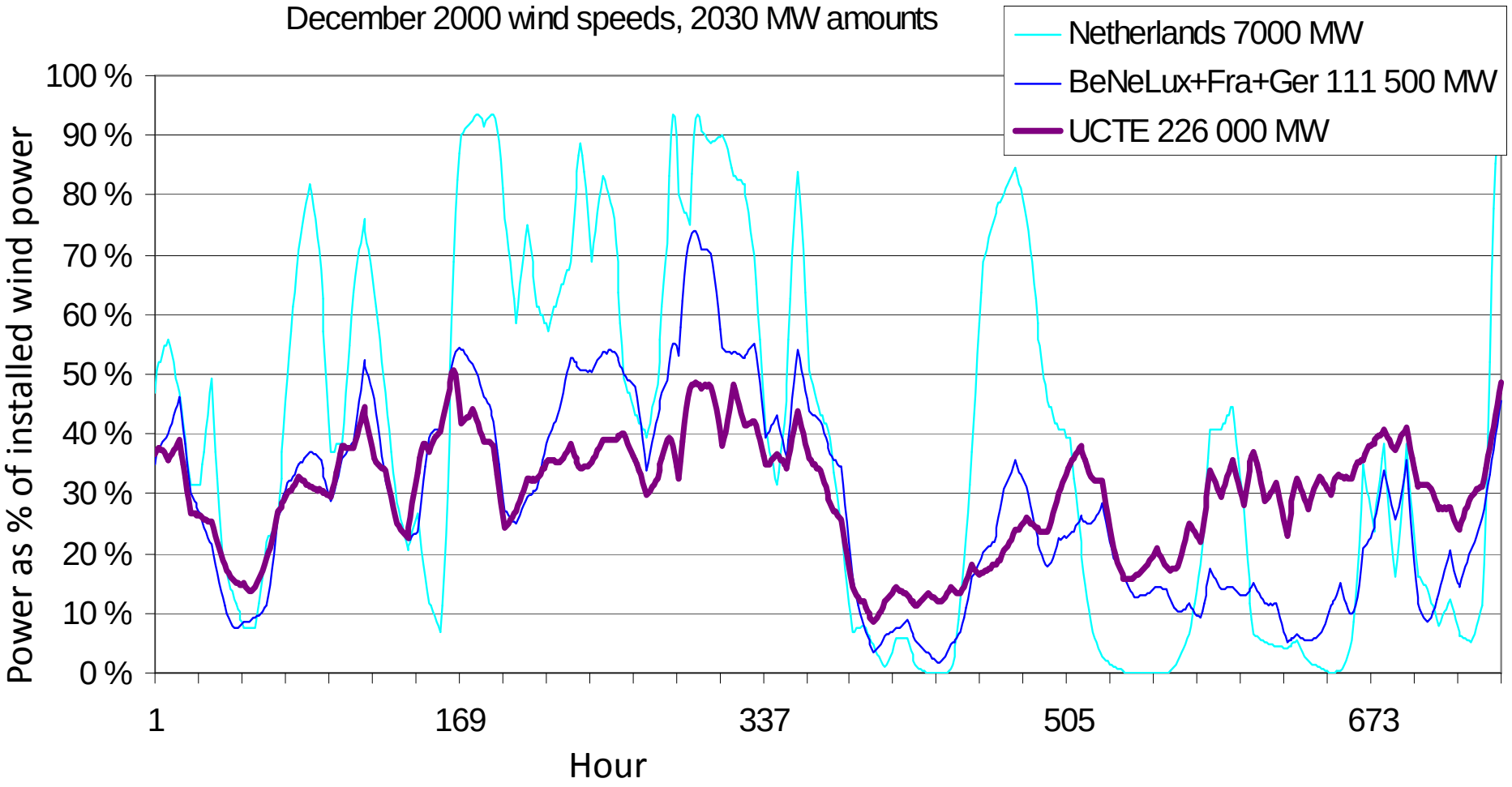
Smoothing effect of large areas (I) Netherlands only



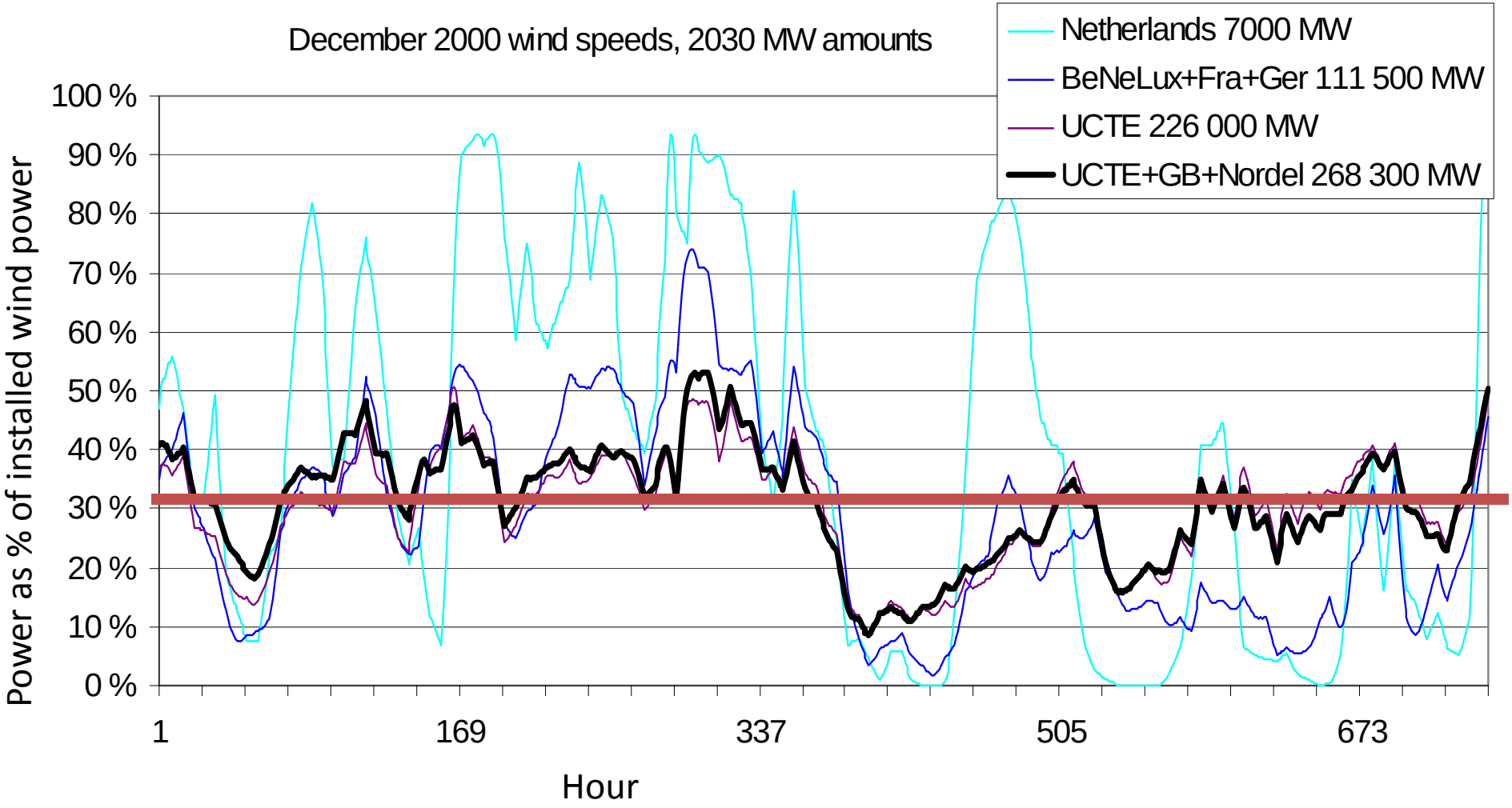
Smoothing effect of large areas (II) Benelux+France+Germany



Smoothing effect of large areas (III)
UCTE



Smoothing effect of large areas (IV) UCTE+Nordel+UK



Europe: Storages exist already: 96 GW power – 180 TWh interconnection insufficient

Storage Hydro Power in Europe:

Rated Power, Storage Capacity and Annual Energy Production

Data of UCTE 1998	Rated Power of Reservoir and mixed pumped Storage [GW]	Storage Capacity of Reservoir and mixed pumped Storage [TWh]	Annual Energy Prod. of Reservoir and mixed pumped Storage [TWh]
Slovenia/Croatia	1.4	1.8	?
Swizerland	8.2	8.4	18.0
Serbia and Montenegro	2.0	2.0	?
Portugal	2.1	2.6	4.2
Austria	5.6	3.2	7.0
Luxemburg	0.0	0.0	0.0
Italy	7.5	7.9	17.6
Greece	1.9	2.4	2.8
France	11.6	9.8	18.2
Germany	1.4	0.3	1.1
Belgium	0.0	0.0	0.0
Spain	7.7	18.4	16.7
Sum of UCTE	**49**	**57**	**86**
Data of NORDEL			
Norway	27.3	84.1	112.6
Finland	2.9	4.9	12.6
Sweden	16.2	33.7	63.6
Sum of NORDEL	**46**	**123**	**189**
Sum of NORDEL + UCTE	**96**	**180**	**275**

G. Czisch 2000

Some 10 % energy backup and some 26 % capacity backup needed