The energy transition and the challenges now facing hydropower

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recharge green
Sonthofen
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BEW
Bayerische
Elektrizitätswerke

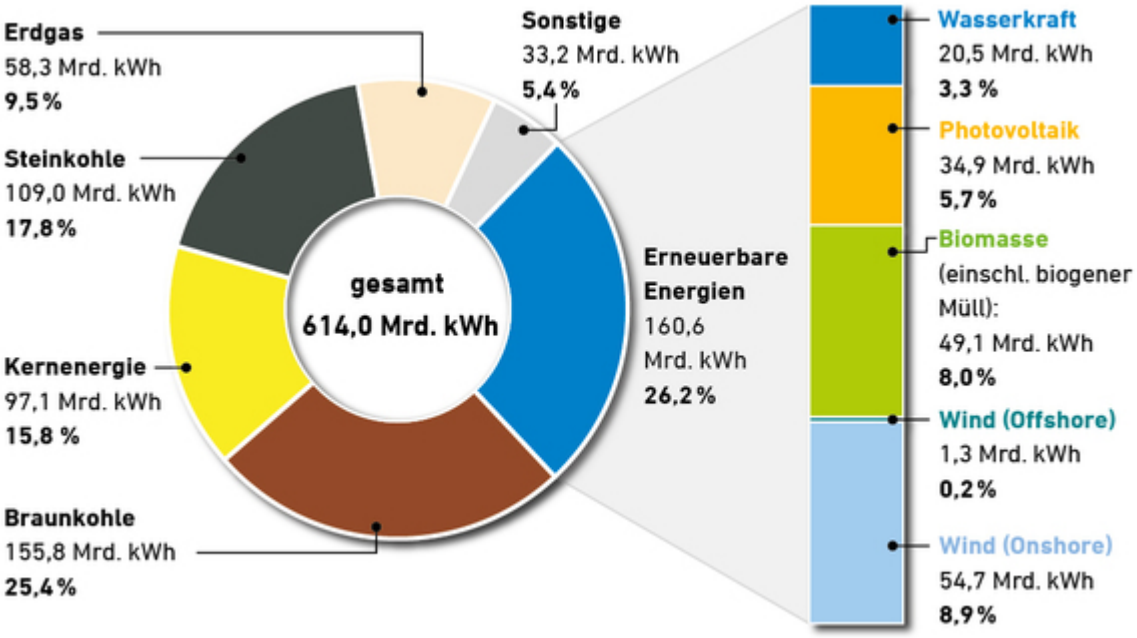
Structure

1. The challenge of the energy transition
2. The meaning of hydropower for power generation and storage
3. Ecology and economics in harmony
4. The BEW strategy – new methods of co-operation

The energy transition in Germany – a success story?

Yes…

Energy mix in Germany, 2014



Agency for Renewable Energy, AGEE-Stat. BDEW
as of 03/2015

Installed capacity renewables (31.12.2014):

93.1 GW **of which**

(3.4 GW hydro > 5 MW)
1.2 GW pumped storage nat. feed)

88.3 GW **supported under Renewable Energy Law**

40.5 GW wind
38.3 GW photovoltaic

8.8 GW biomass
2.0 GW hydropower

of which

79 GW fluctuating wind and photovoltaic capacity

Bundesnetzagentur, BMWi, own research

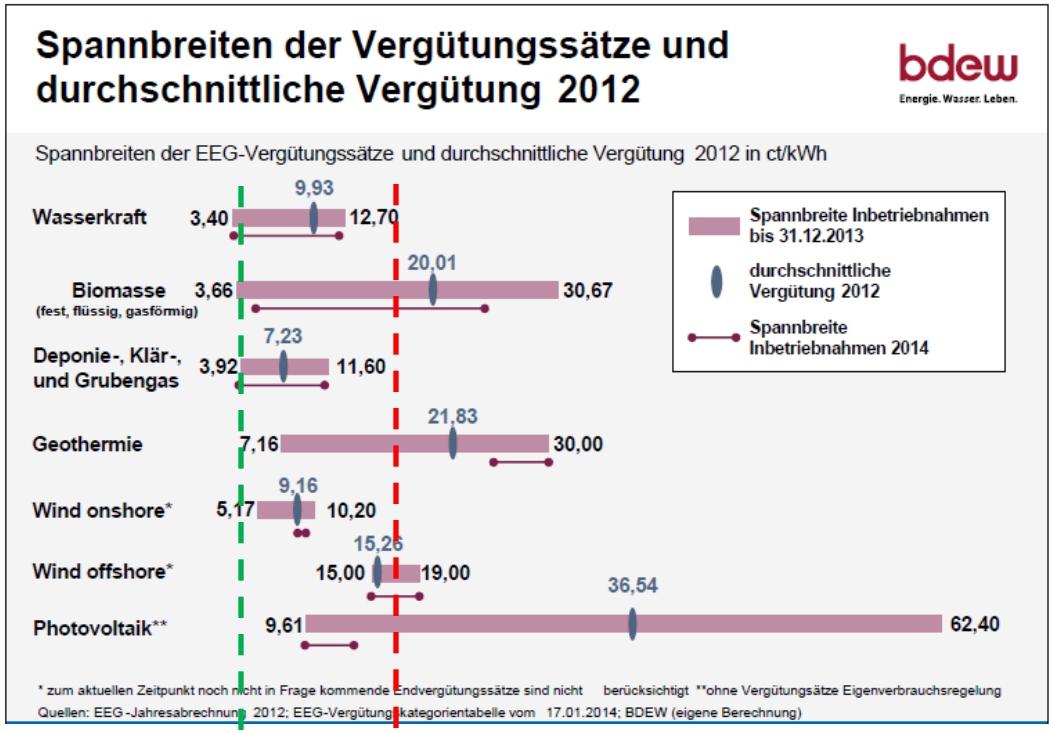
The energy transition in Germany – a success story?

No…

- **Cost explosion in expansion of regenerative production**
  lack of funding efficiency
- **Imbalance between power generation and demand**
  balance of heavily fluctuating supply of renewable energy
- **Delays in necessary expansion of grid capacities**
  in both transmission and distribution grids – grid stability!
- **Distorted power market**
  25% planned economy cancels out functioning of power market
  Conventional power plants are leaving the grid, making grid stability critical
  Lack of investment incentives for necessary “shadow” power plants and storage
- **Insufficient power storage facilities**
- **Etc.**

Only major hydropower plants > 5 MW are currently viable as renewable energy without subsidies…

Abb. 36: Spannbreiten der EEG-Vergütung und durchschnittliche Vergütung 2012



Renewable Energy and the Renewable Energy Law: Figures, Facts, Charts (2014) BDEW, 24 February 2014

Market price 2015

3.3 ct/kWh

+ 450 %

Average tariff under Renewable Energy Law 2012 net of avoided grid charges

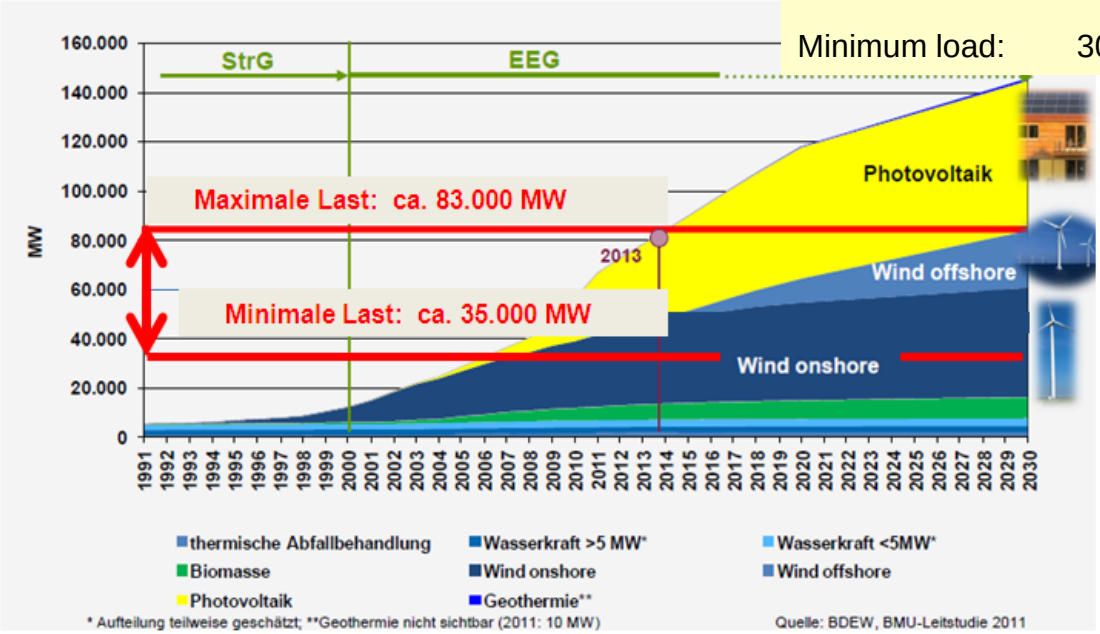
16.16 ct/kWh

The energy transition: a new phase begins

Wind and PV - 2014: 79 GW
2020: 110 GW

Minimum load: 30 - 35 GW!!!

Despite expansion corridor under Renewables Law 2014



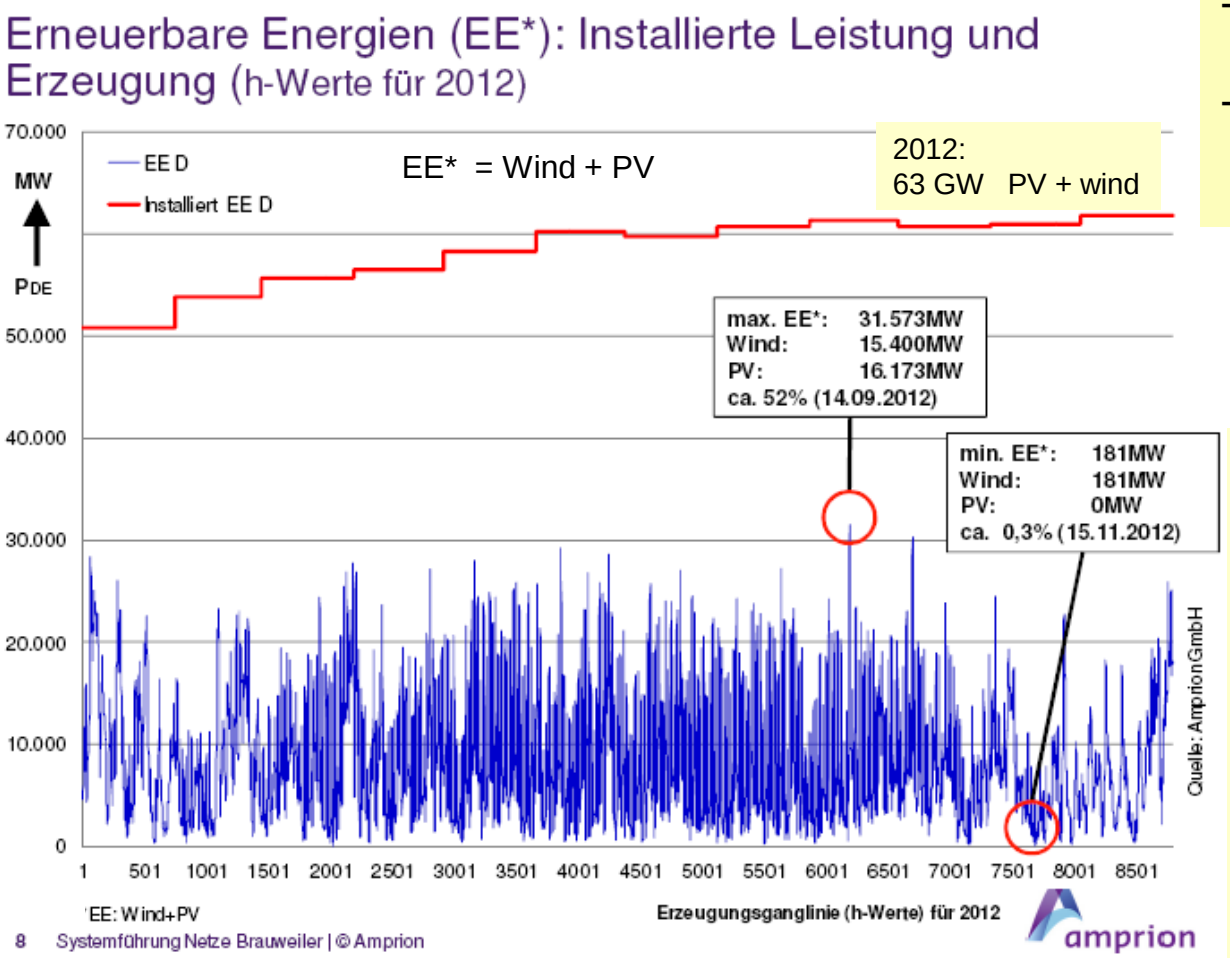
Excess power from fluctuating wind and photovoltaic generation

Mathias Timm, Energy storage – winner or loser in the energy transition? Seminar on unconventional pumped storage, Goslar, 22.11.2013

Dena distribution grid study 11.12.2012, p.16:
Load bandwidth in Germany:
approx. 30 GW – approx. 84 GW

Only in lockstep with Europe!
- expansion of wind + PV
- expansion of grid
- storage

What can we do when wind + PV are not available?



→ **extreme fluctuation** (daily, seasonal)

→ **load differences** within **1.5 hrs up to 10,000 MW** or **6 hrs approx. 26,000 MW**

Needed in parallel to wind and PV:

1. "Shadow" power plants to cover full extent of requirements
2. Highly flexible and reliable power plants for stabilisation
3. Flexible storage facilities

For 2020 as first approximation: all data for 2012 times a factor of 2

Distorted power market

14.0 ct/kWh average cost of power from renewables

25% planned economy (subsidies) cancels out functioning of power market

Conventional power plants are no longer economically viable and are leaving the grid

Applications to Federal Network Agency to shut down 49 KW with 11 GW
(including the 140 MW MarkE pumped storage plant at Rönkhausen)

Grid stability is becoming critical

Lack of investment incentives for necessary “shadow” power plants and storage facilities (new market model required!)

Note:
for gas-fired power plants the fuel costs alone are twice as high as the income from the electricty generated
(without even including operating or capital costs)

Hydropower is essential for power generation in the Alpine area

Germany	21 TWh/a	3.5%	of power generation
Bavaria	13 TWh/a	**15%**	(potential + 1 TWh/a)
Switzerland	36 TWh/a	**56%**	
Austria	48 TWh/a	**66%**	

Pumped storage plants (PSP) – indispensable for the energy transition

The only way to store energy economically in sufficient quantities

Study by RWTH Achen:

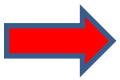
2030 (60% renewables) - additional PSP capacity of **8 GW**

→ Reduction in renewable shutdown (wind + PV) of **72.5%** as compared to situation without PSP

Source: Prof. Moser, Supporting the energy transition in Germany through pumped storage expansion – Potential for improving viability and security of supply, RWTH Aachen, April 2014

Pumped storage plants – indispensable for the energy transition

- Proven technology, high availability, very long service life,
- High storage capacity, low storage loss, high efficiency,
- Low investment and operating costs,
- Rapid commissioning times, high performance gradients, good part-load behaviour
- Provision of balancing energy and reserve and emergency reserve capacity
- Voltage stability (Power Factor Correction)
- Black start possible
- Acceptance???

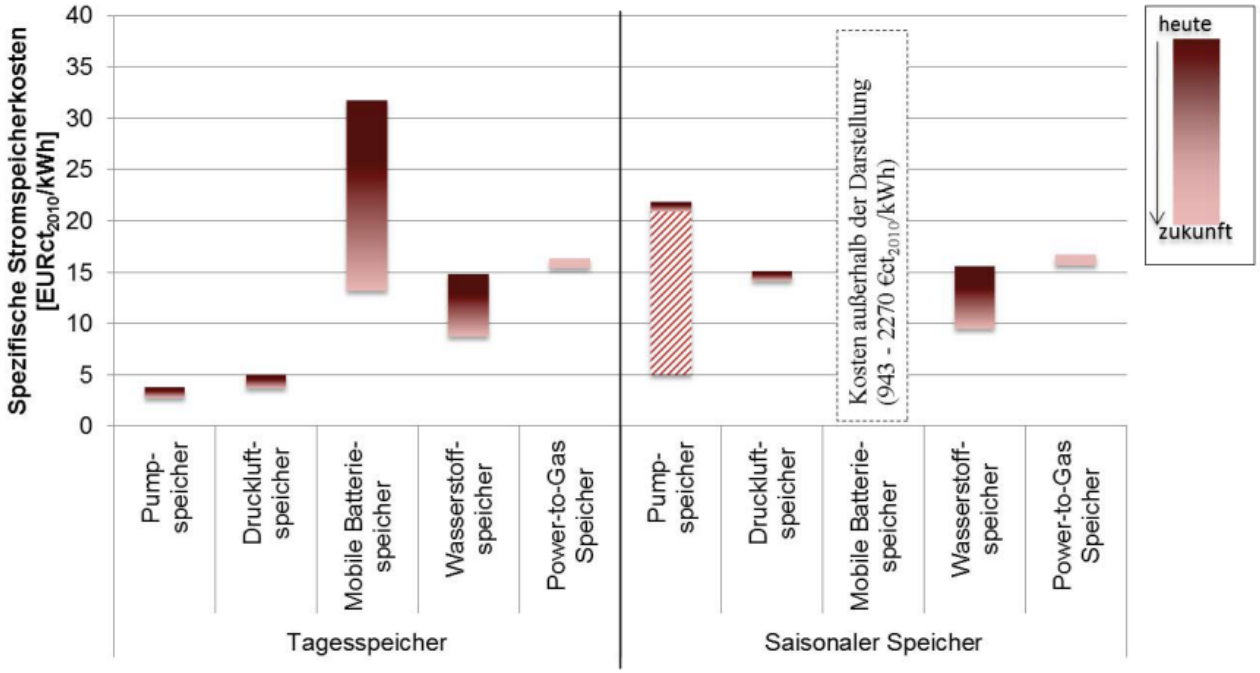


But under current economic conditions
no incentive to invest

Economic conditions

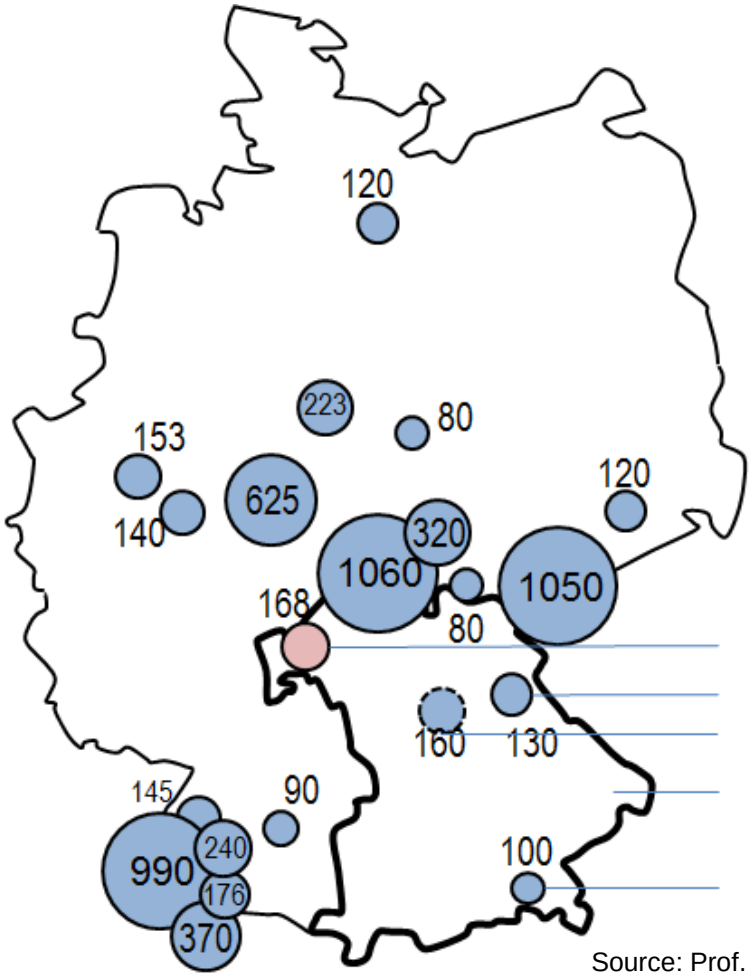
Other energy storage options have little chance under current economic conditions

Specific energy storage costs not including cost of volume of power purchased



Source: Hartmann et al,, Energy storage potential for Germany, Centre for Energy Research, University of Stuttgart, July 2012

PSP in Germany



Pumpspeicher (> 50 MW)

Ausbauleistung [MW]

Bestand

PSW in Deutschland
6.500 MW 37,74 GWh

PSW in Bayern
400 MW 2,07 GWh, davon
240 MW 1,23 GWh verfügbar

Langenprozelten (Bahnstrom 16,7 Hz)

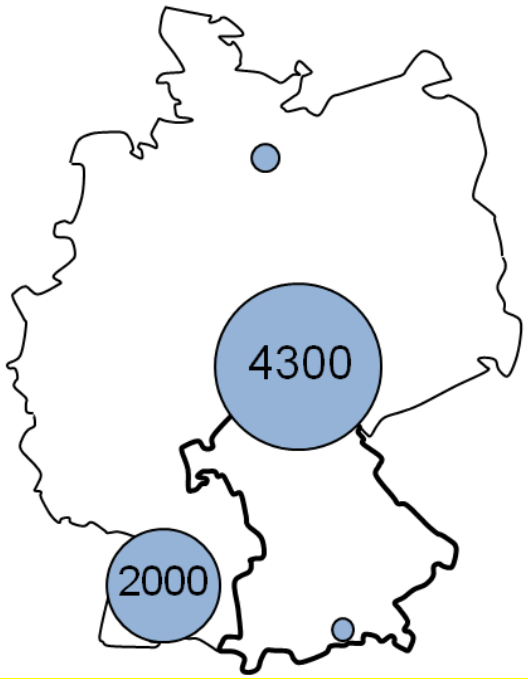
Reisach/Tnzmühle

Happurg (derzeit nicht verfügbar)

Oberberg (8,5 MW)

Leitzachwerk

Source: Prof. Aufleger + own work



plus
approx. 5,500 MW planned

Potential studies of 3 states ~ 35 GW
Bavaria 11,000 MW
Baden-W, 19,000 MW
Thuringia 4,800 MW

PSP Ger./Aus./Sw.

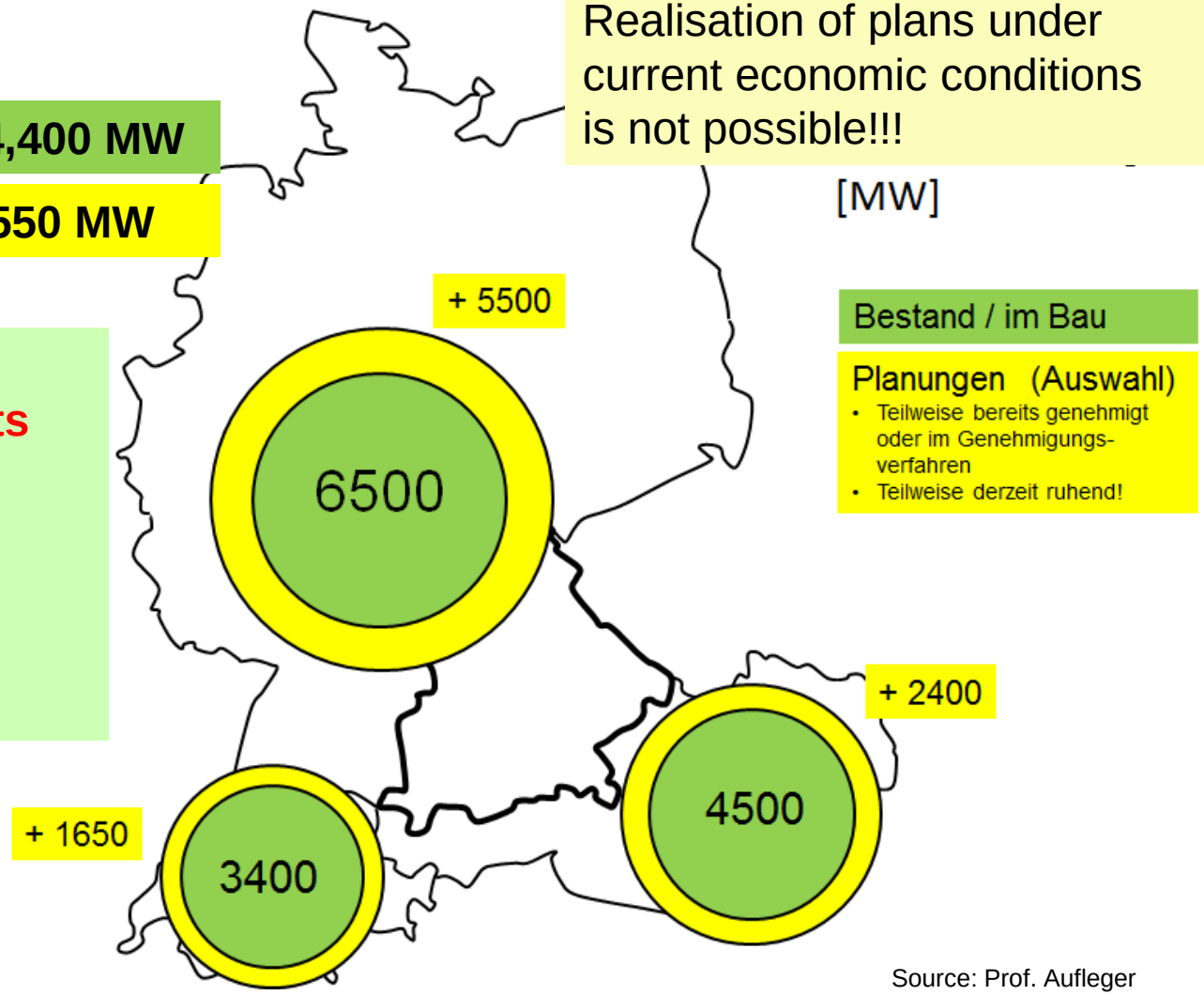
Exist./under const: **14,400 MW**

Planned: **9,550 MW**

Additional existing
Storage power plants
G - A - SW: **12.1 GW**
G: 0.3 GW
A: 3.7 GW
SW: 8.1 GW

Source: Dr. Gruber, Verbund

Realisation of plans under current economic conditions is not possible!!!



Source: Prof. Aufleger

Advantages of hydropower

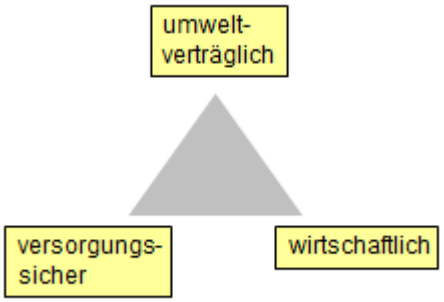
- regenerative, saves resources
- CO_2-free / no harmful emissions
- high efficiency
- long service life
- predictable, reliable, base-loadable

Additional benefits of large-scale hydropower in particular

- flood protection
- river remediation
  - riverbed support
  - raising of ground water level
- ecological developments around dams
  - nature and species preservation
  - infrastructure (local recreation, tourism)
  - river sustenance
- economic viability
  - competitive w/o renewables surcharge

Conflict of aims

- Expansion of sustainable, regenerative and CO_2-free power generation



- EU Water Framework Directive
- Water Resources Law (new)
- DIN 19700
- Biodiversity strategies (UN, EU-Natura 2000, Bund, BY)

Effects on hydropower use

- Reduced regenerative power generation as a result of higher residual water tariffs and greater water consumption on account of fish migration aids
- Limitations on hydropeaking
- High investment costs on account of ecological improvements

Reduction of effects on hydropower use

Implementation of Water Framework Directive must take **appropriate account of all aspects of water use** (ecology, flood protection, power generation, water supply, leisure use, navigation, etc.)

Measures taken under the Water Framework Directive must result from **consideration of water protection compared to the protected aspects of hydropower usage**
(viability, climate protection, significance for energy transition, etc.)

e.g.:

- determining residual water charges on the basis of respective local conditions
- ecologically sustainable use of hydropeaking
- etc.

Bayerische Elektrizitätswerke GmbH (BEW) – active in hydropower

- 36 run-of-river power plants, 71 turbines on the Danube, Günz, Iller, Lech, Wertach rivers
- Expanded capacity 200 MW
- Usual production approx. 1120 GWh / a

Flood protection thanks to BEW:

Weir systems	33
Weir fields	108
Dammed and embanked systems	190 km
Hinterland drainage systems	112 km

Focus:

- economic and ecologically sustainable operation of existing hydropower plants
- realisation of potentials through modernisation and retrofitting

Objectify conflict of aims by establishing similarities between politics and hydropower economics

The 2006 “Key issues paper” is to be consistently applied as a cornerstone of the “Innovative Energy” energy concept of May 2011

Aim:

> Maintenance and expansion of hydropower while at the same time improving aquatic ecology and flood protection
> Production of good ecological potential

Stages and tasks:

Status:

> Migration concept — met
> Hydropower potential study — met
> Implementation concept — pending
> Compensation through package solutions

Nachhaltige Wasserkraftnutzung

an staatlichen Gewässern in Bayern

- Eckpunktepapier -

Vereinbarung zwischen
dem
Bayerischen Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz,
dem
Bayerischen Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie

und

der E.ON Wasserkraft GmbH, der BEW Bayerische Elektrizitätswerke GmbH
und den von ihnen vertretenen Wasserkraftunternehmen,
vom 09. November 2006

Objectify conflict of aims through dialogue and removal of barriers between nature conservation, fisheries and hydropower

Joint projects for the benefit of both sides, but especially for the benefit of nature

Aim:

- Joint development of solutions by integrating the expertise of all partners at the design phase
- Monitoring of measures with regard to effectiveness for the production of good ecological potential
- Development of economic and sustainable solutions that can be generalised
- Efficient use of limited resources

Making partners of those affected

- In developing the environmental strategy and drafting specific environmental projects, BEW emphasises close co-operation with environmental and fisheries organisations and municipal entities and institutions

- **The current environmental strategy includes the following major points:**

  - Permitting migration with the help of fish ladders (to be installed at all LEW/BEW power plants by 2015)

  - Routing current – joint research projects with fisheries experts and Munich Technical University

  - Projects for irrigating riparian forests (UIAG, DonAuwald)

  - Investigation and research programmes to analyse fisheries development and controlling the effect of environmental measures (Günz, Iller rivers)

  - Innovative dam rehabilitation with simultaneous improvement of water structures (Life+ Project “Ökoberme” on the Danube), etc.

Hydropower is not the problem:
it is part of the solution for good water conditions

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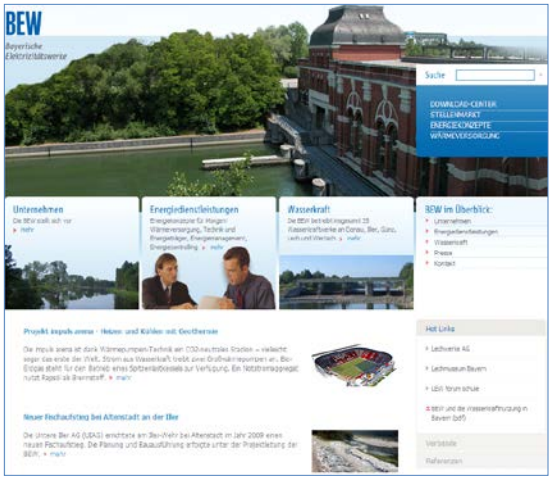

www.bew-augsburg.de

Unsere Zertifizierungen:

Umweltmanagementsystem ISO 14001

Zertifikat berufundfamilie Z1-20100517-1715

Arbeitsschutzmanagement OHSAS 18001