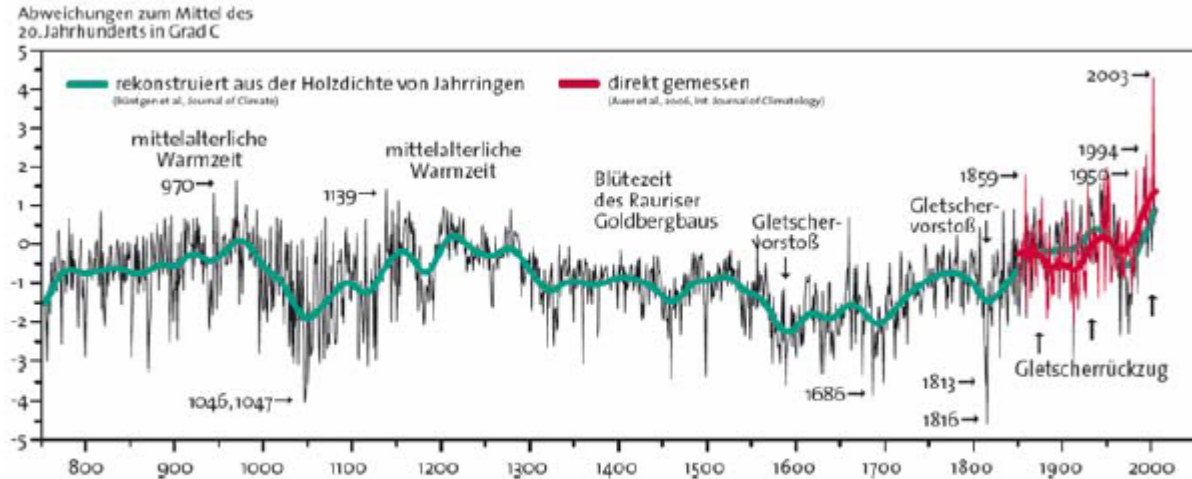


Hydropower in Europe and Climate Change Consequences and Challenges

O. Pirker / VGB Power Tech





Quelle: ALP-IMP Projekt (Büntgen et al., 2006)

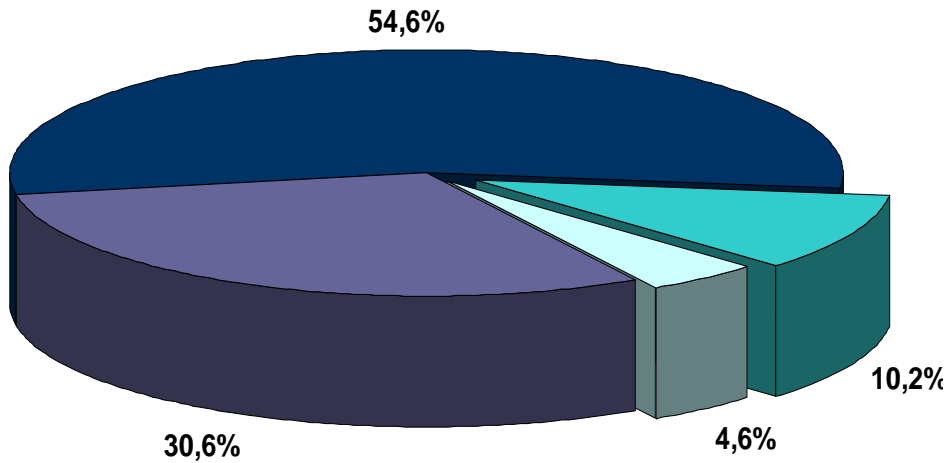
Hydropower and Climate Change

two questions

Hydropower
- Renewable Energy;
contribution of HP;
Avoidance of GGE

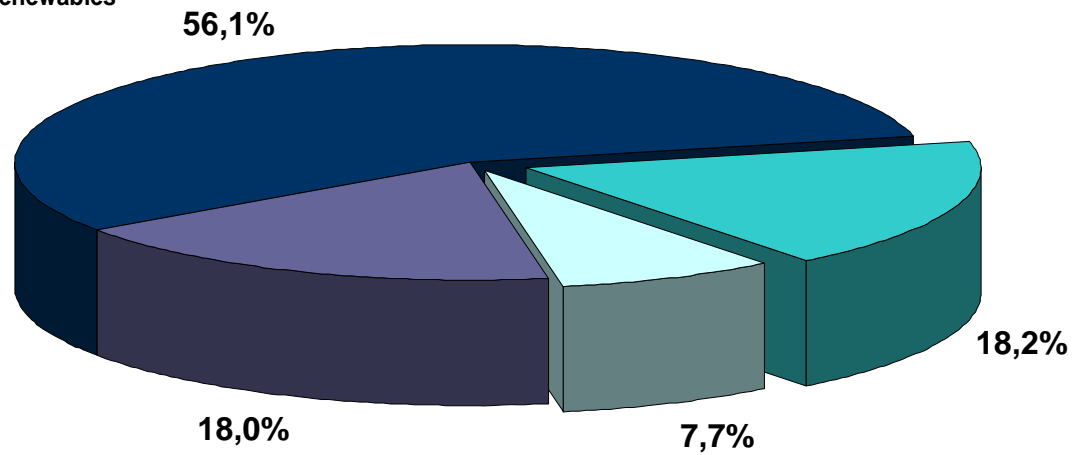
Consequences of
Climate Change Scenarios
on Hydropower

Total Net Electricity Production 2005



Total Net Generating Capacity 2005

■ Nuclear ■ Conventional Thermal ■ Hydro ■ Total other Renewables



1 GWh from Hydropower corresponds to approximately 220 t oil

1 GWh from Hydropower corresponds to approximately 330 t hard coal

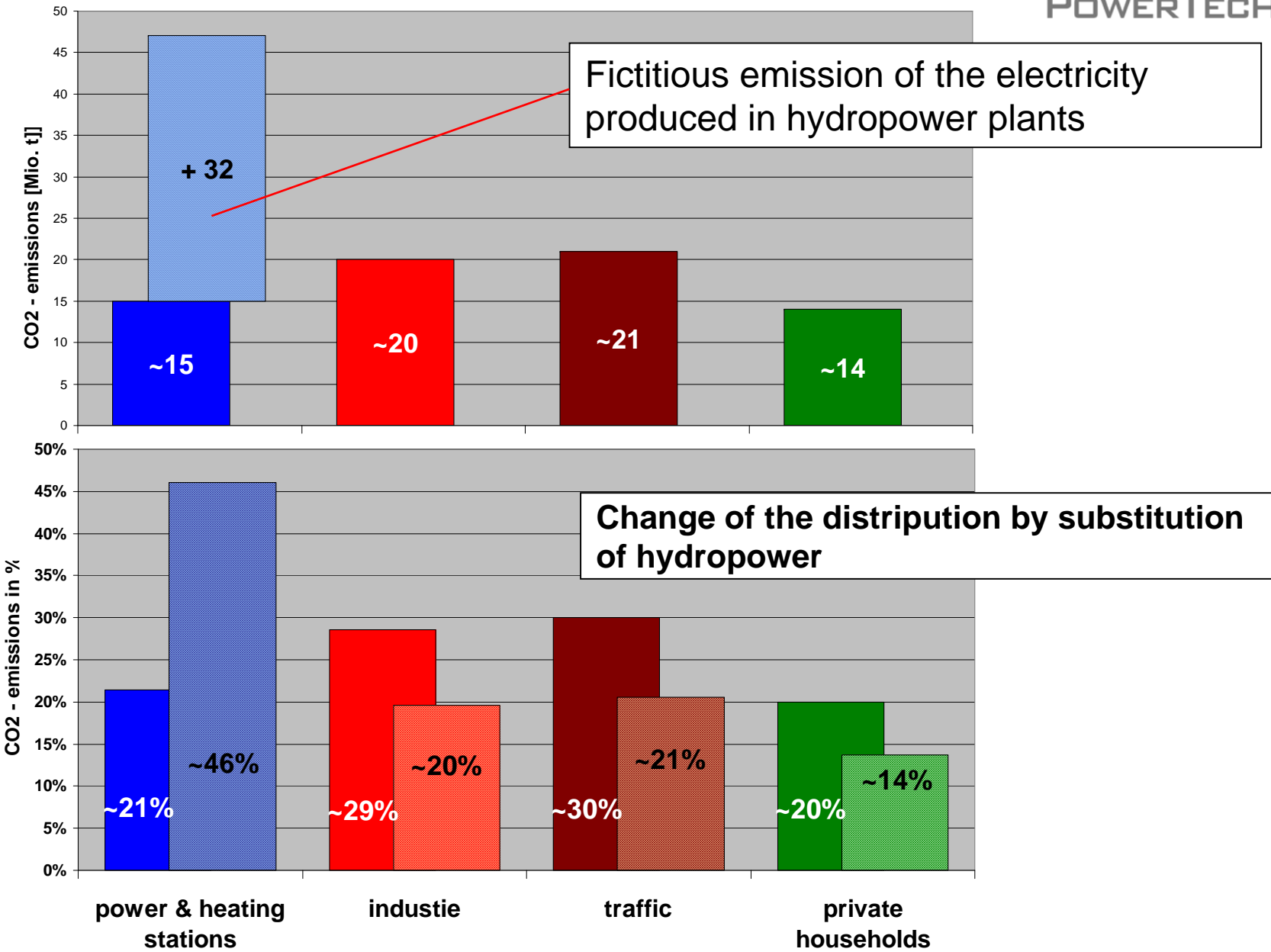
In Europe 2005 (EU 25) 311,2 TWh HP production

Avoidance of 250 Mio. t CO₂ (based on oil fired power plants)

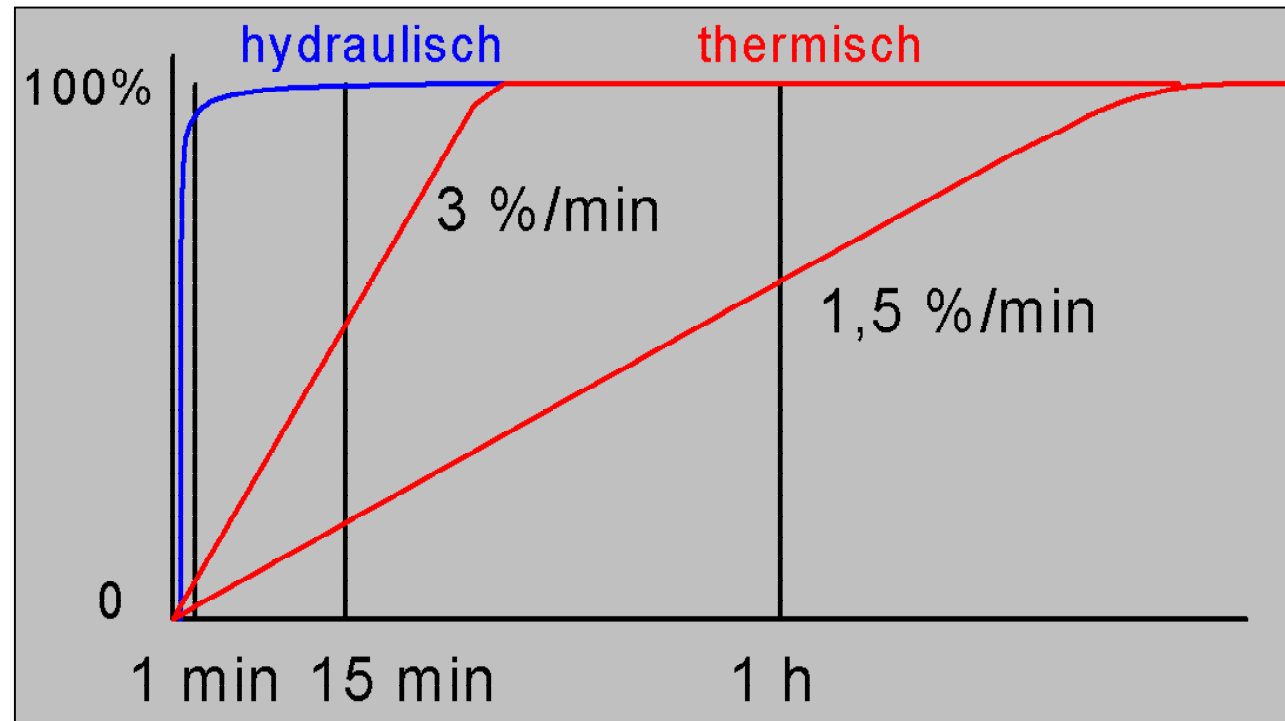
Avoidance of 290 Mio. t CO₂ (based on coal fired power plants)



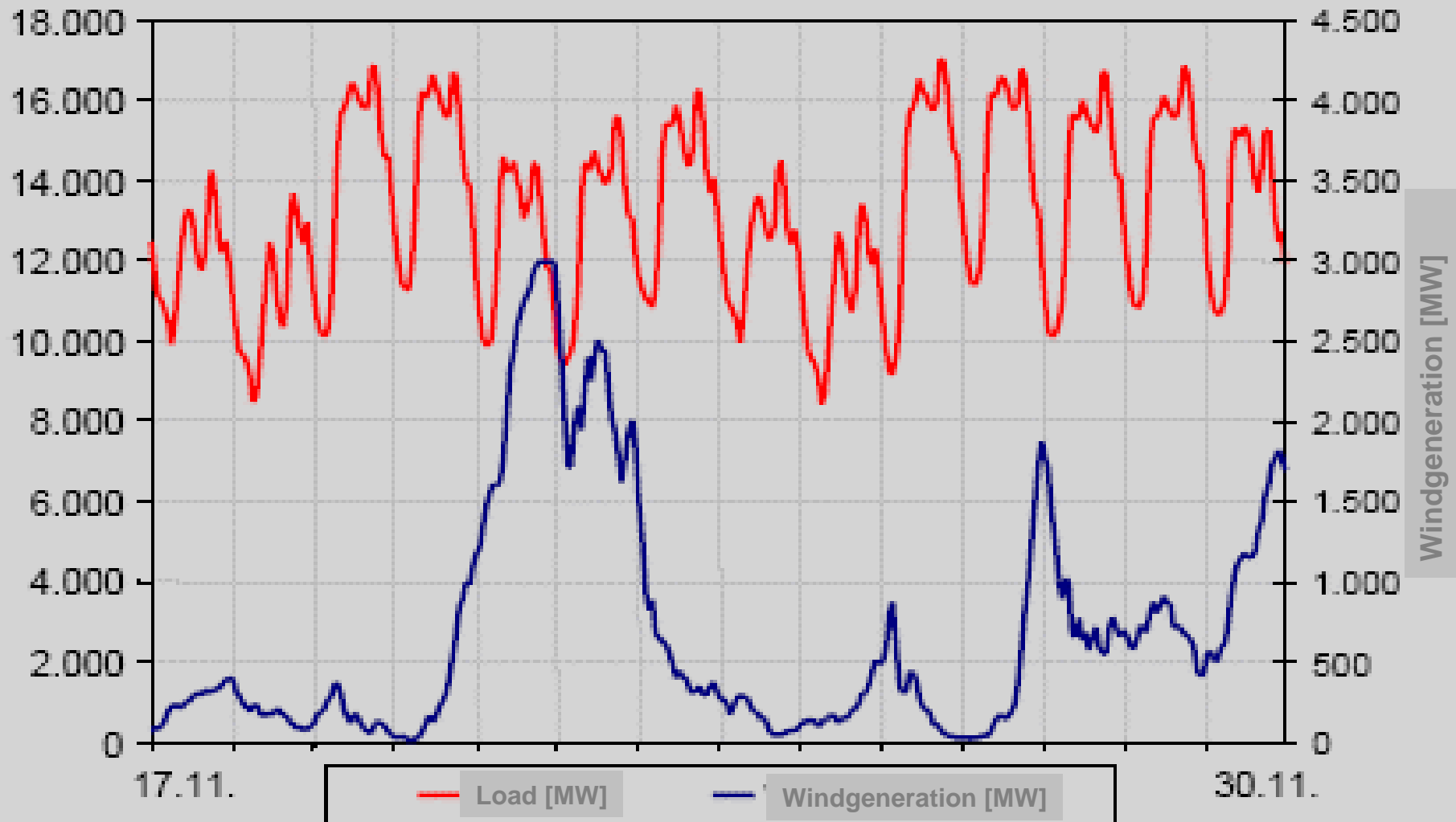
CO2 avoidance by hydropower (example – Austria)



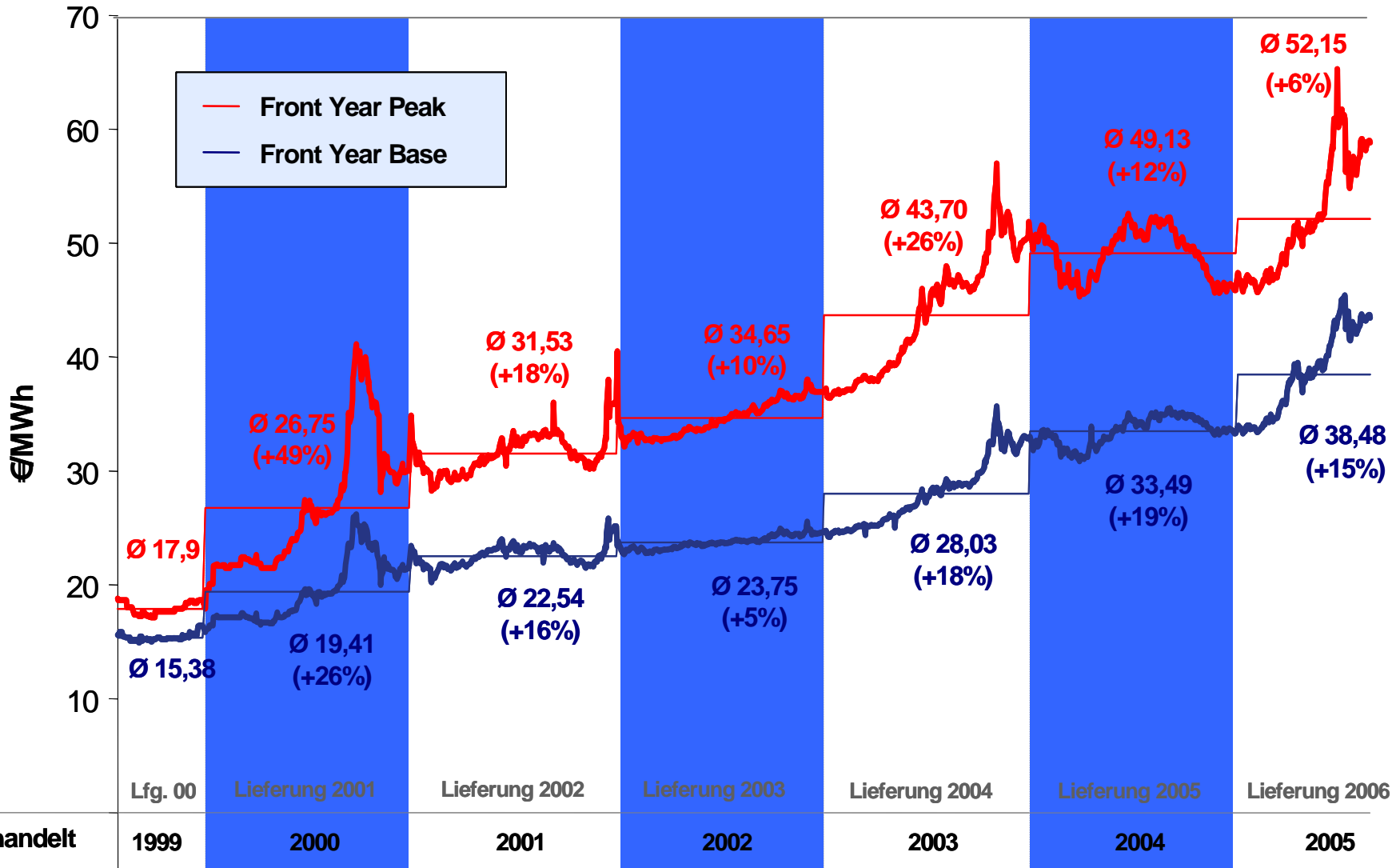
- Increasing peakload-demand
- Increased demand of balancing capabilities
- Ancillary services (grid regulation)
- Integration of non-dispatchable wind energy
- Increasing reserve capacity
- „Black start“ capability



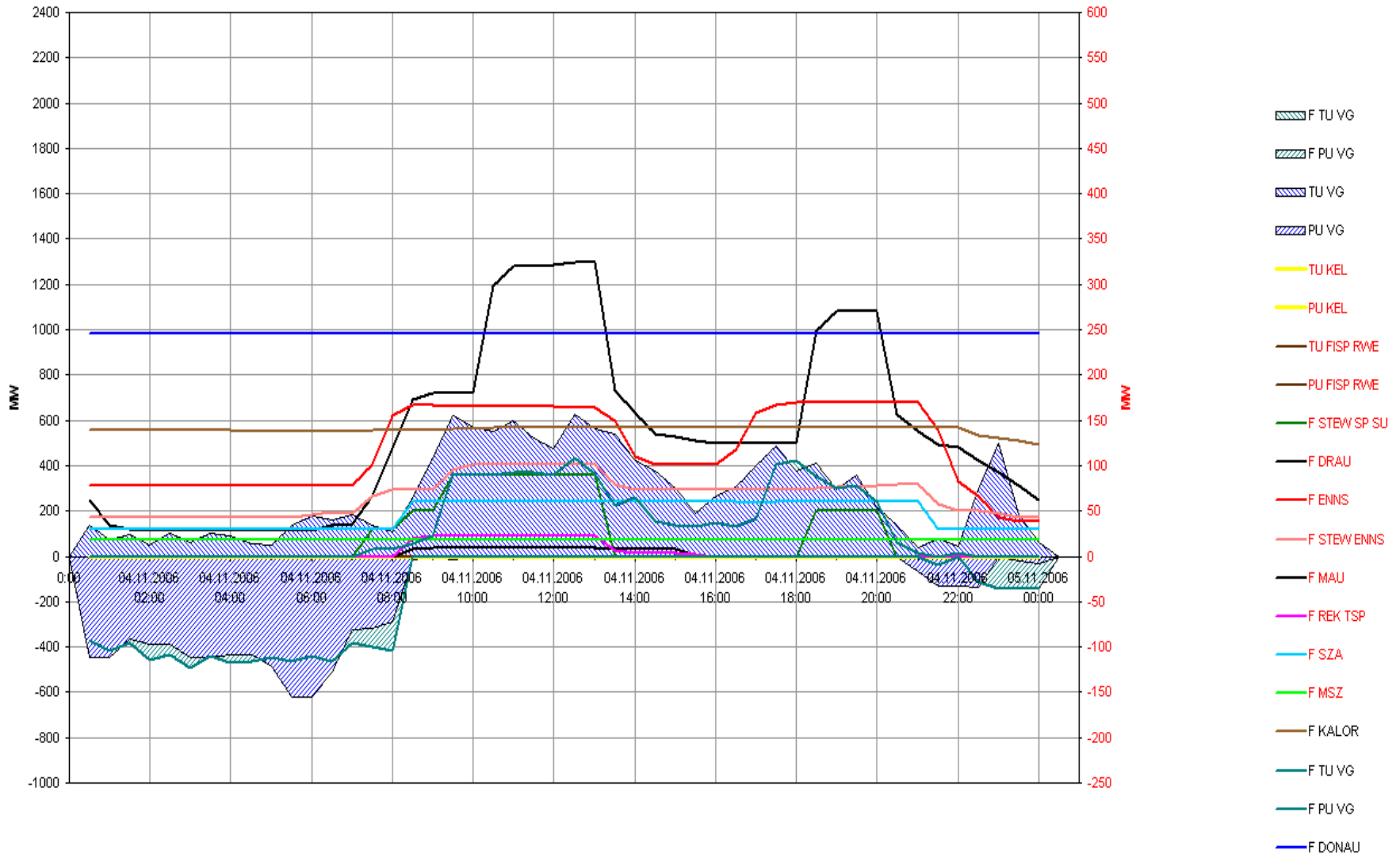
Daily Fluctuation of Available Windpower Generation (not demand oriented)

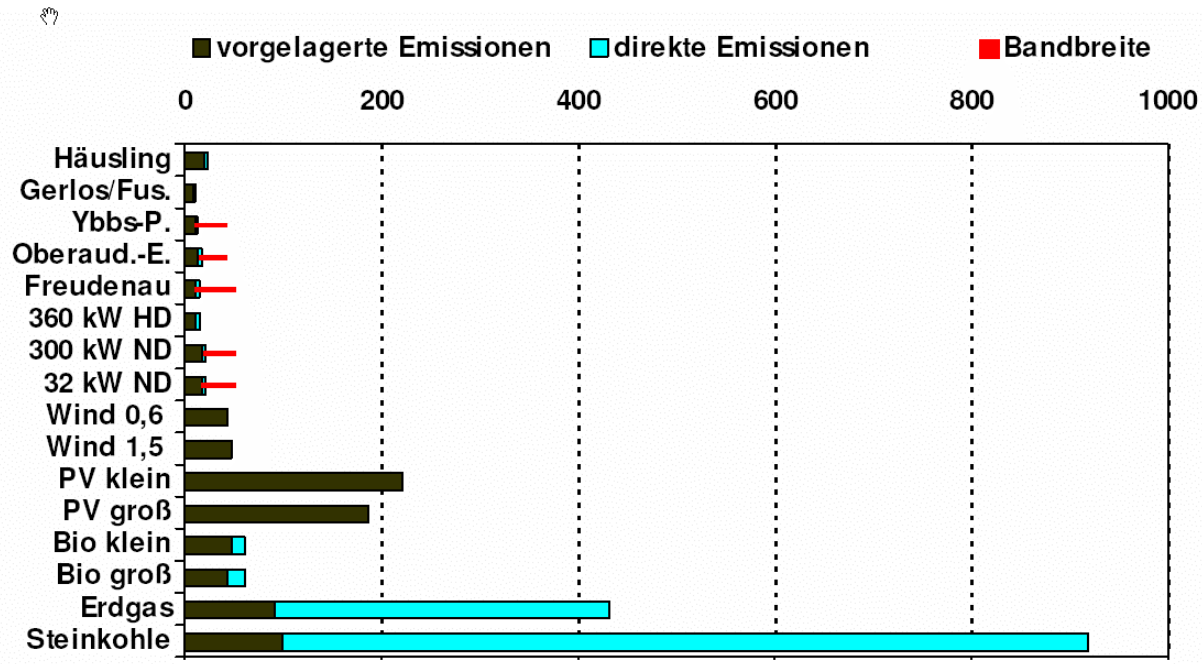


Development of the price for electricity (EEX; Front year; base/peak)

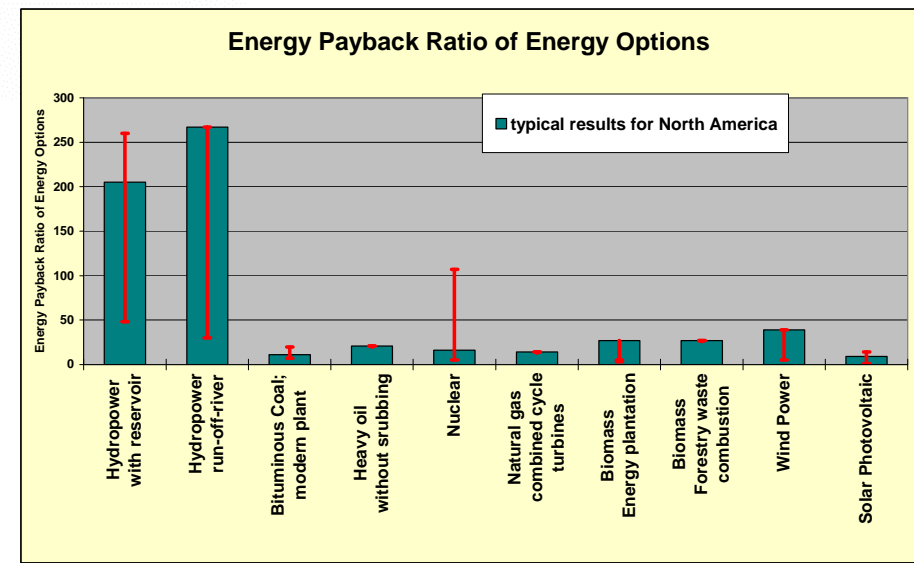


VERBUND
FAHRPLAN KRAFTWERKSEINSATZ Überblick
 Sa: 04.11.2006

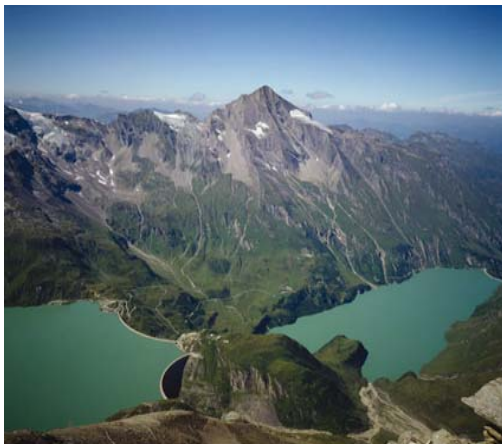




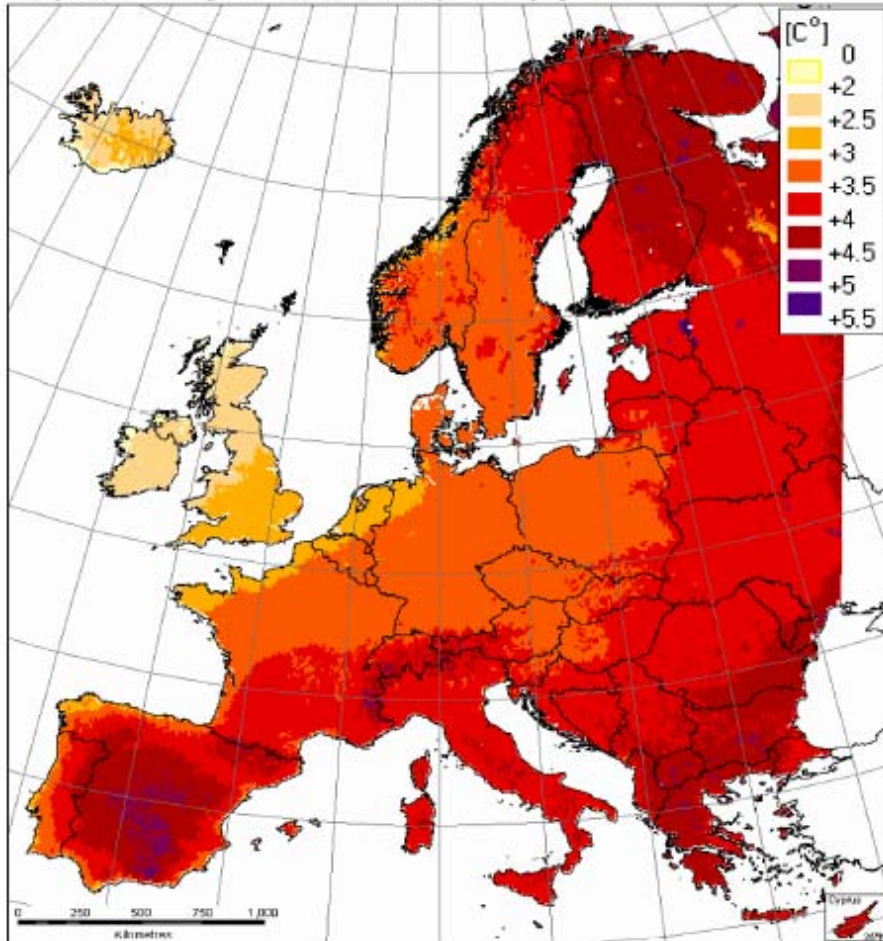
CO₂-Äquivalente in t/GWh



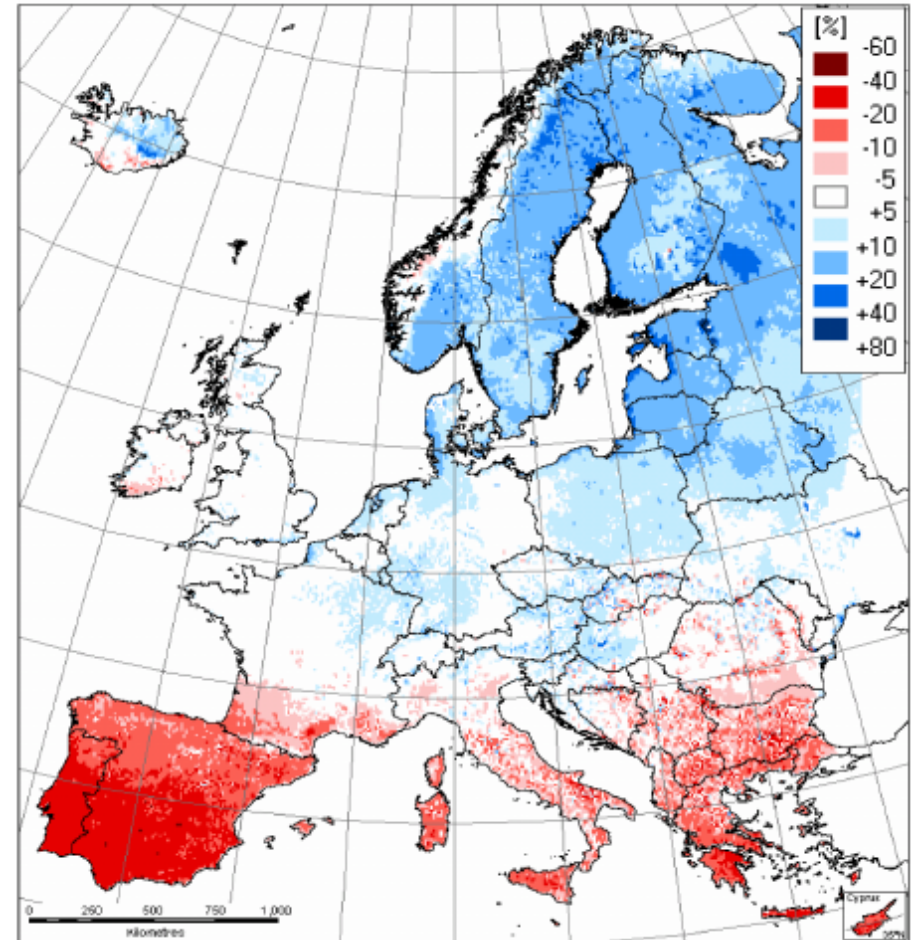
- ❏ **Hydropower is the most important renewable energy source in Europe**
- ❏ **Storage- and Pumpstorage HPP play an important role in the European Electricity Supply (Security of supply)**
- ❏ **Hydropower is the perfect partner for the development of all other renewable energy source (especially for wind power)**
- ❏ **Hydropower is also a partner to challenge Climate Change**



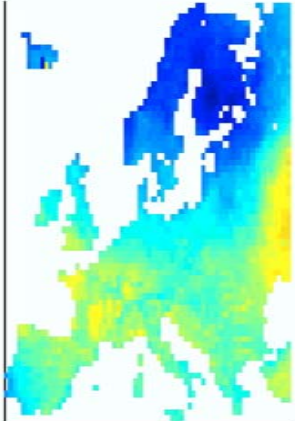
Temperature: change in mean annual temperature [C°]



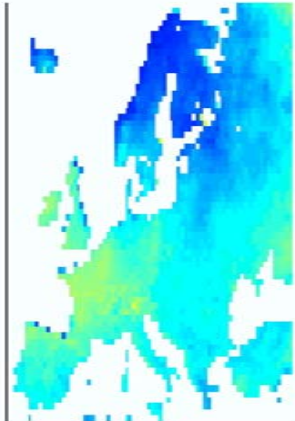
Precipitation: change in annual amount [%]



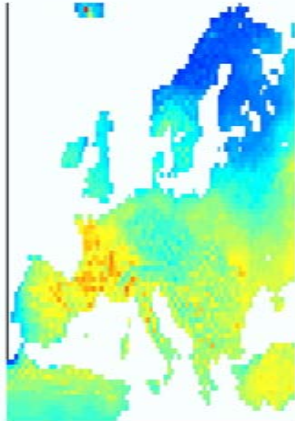
CHRM



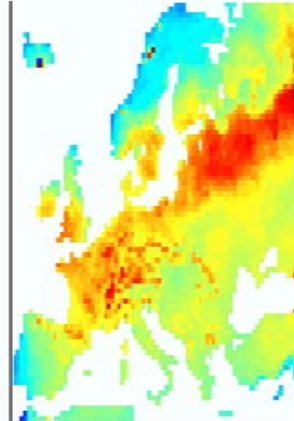
CLM



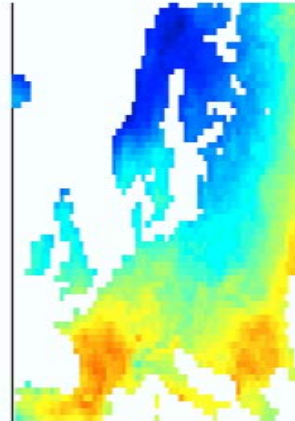
HIRHAM-DK



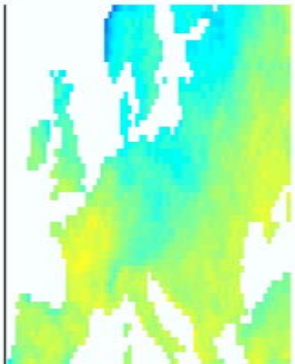
HadRM3H



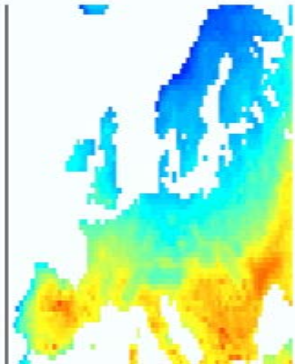
HIRHAM-NO



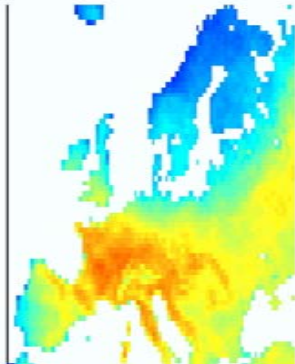
PROMES



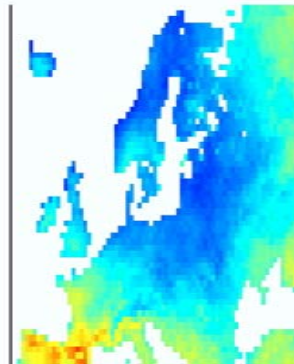
RACMO



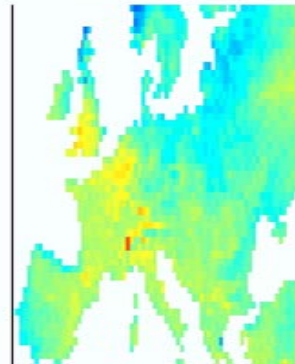
RCAO



REMO



RegCM2



- In general – the effects of the climate change scenarios on the water regime are:
 - very uncertain
 - locally differently
 - at that time it is difficult to have clear strategies
- In alpine areas (most scenarios show)
 - decrease of runoff during summer
 - increase of runoff during winter
 - improvement for the hydropower production
 - decrease of the glaciers
 - importance of the storage capacity will rise
 - increase of extreme events (floods and droughts)???
 - importance of the storage capacity will rise
 - Flood protection by storage HPP on a local scale
 - Positive influence on the run-off during drought periods
 - New rules in connection with dam safety (new hydrological methods)
 - Sediment problems will increase (permafrost level in alpine areas)

■ In South Europe areas

■ decrease of runoff because of climate change?

➡ Reduction of Hydropower production









■ Increase of (catastrophic) drought periods?

➡ Critical situation for run of river HPP production

➡ Importance of the storage capacity will rise
(multipurpose use!)

➡ Restrictions for the operation of thermal power plants
because of a lack of cooling water
or the water temperature is too high

➡ High electricity demand because of air conditioning

-  **Climate Change is a serious issue for the whole electricity industry**
-  **The new Package for Energy by the commission is an important step for future developments in Europe (reduce EU primary energy use by 20% till 2020)**
-  **The role of renewable energy sources will further increase**
-  **Hydropower is still the most important renewable energy source worldwide and in Europe (electricity)**
-  **Quality of Hydropower is an important argument for the integration of all other renewable sources**
-  **Hydropower operators must have a strong focus on climate change**
-  **We have to learn to deal with uncertainty, HP has experience.**
-  **Climate Change is a big challenge for the future!**

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Thank you for yor your attention

