

# Climate Change/Water/Energy Nexus

ALPIQ

WBSCD/IEA

Geneva, June, 12th 2014

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# Major challenges facing hydropower sector in Europe

## Economical



## Regulatory



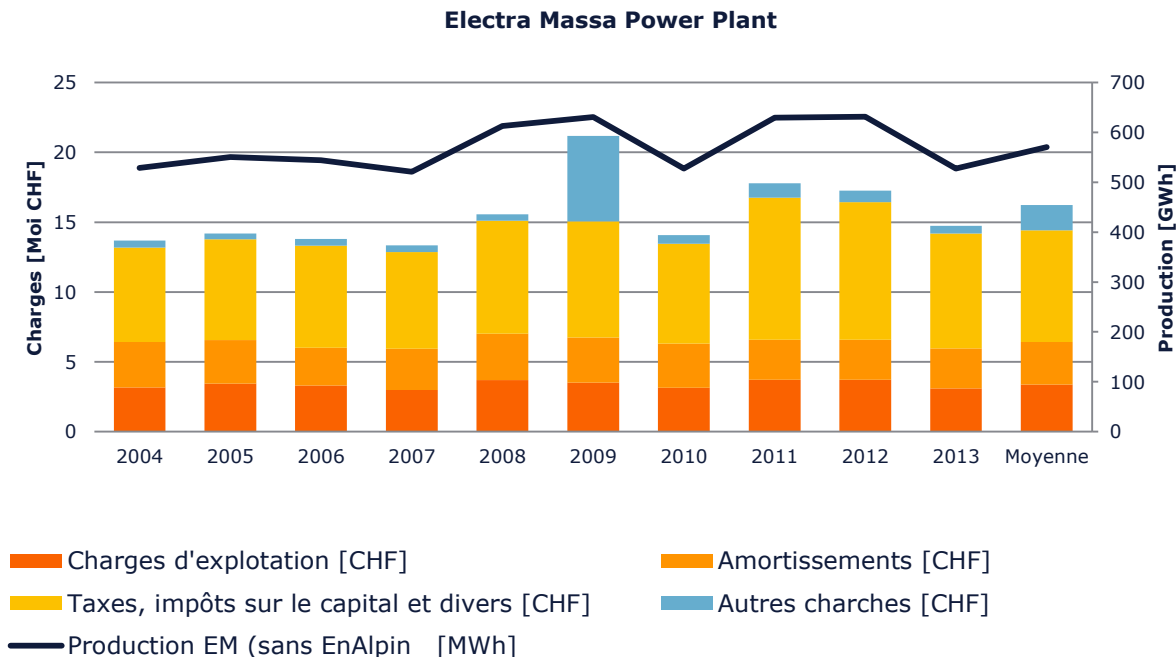
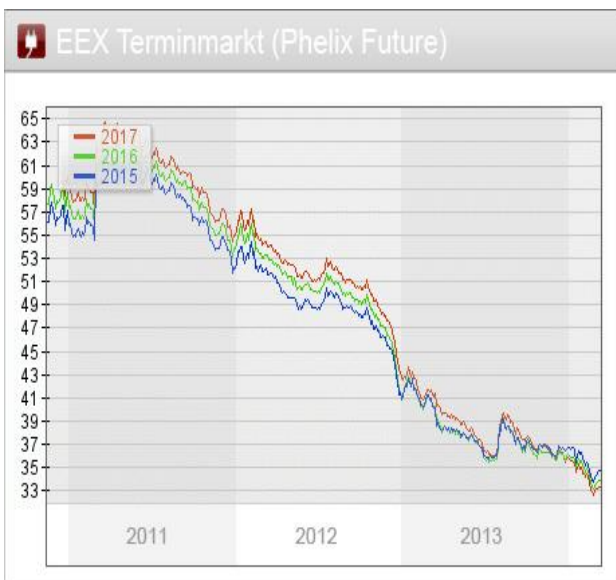
## Environmental



- Historical Low of Electricity prices
- Overcapacity in Europe
- Low gas prices in US lead to low coal prices in Europe

- Subsidy schemes hurt hydro power
- Environmental laws reduce competitiveness further
- No effect of CO2-prices

- Climate Change:
- Retreat of Glaciers
- Changing hydrological regime
- Geomorphological changes

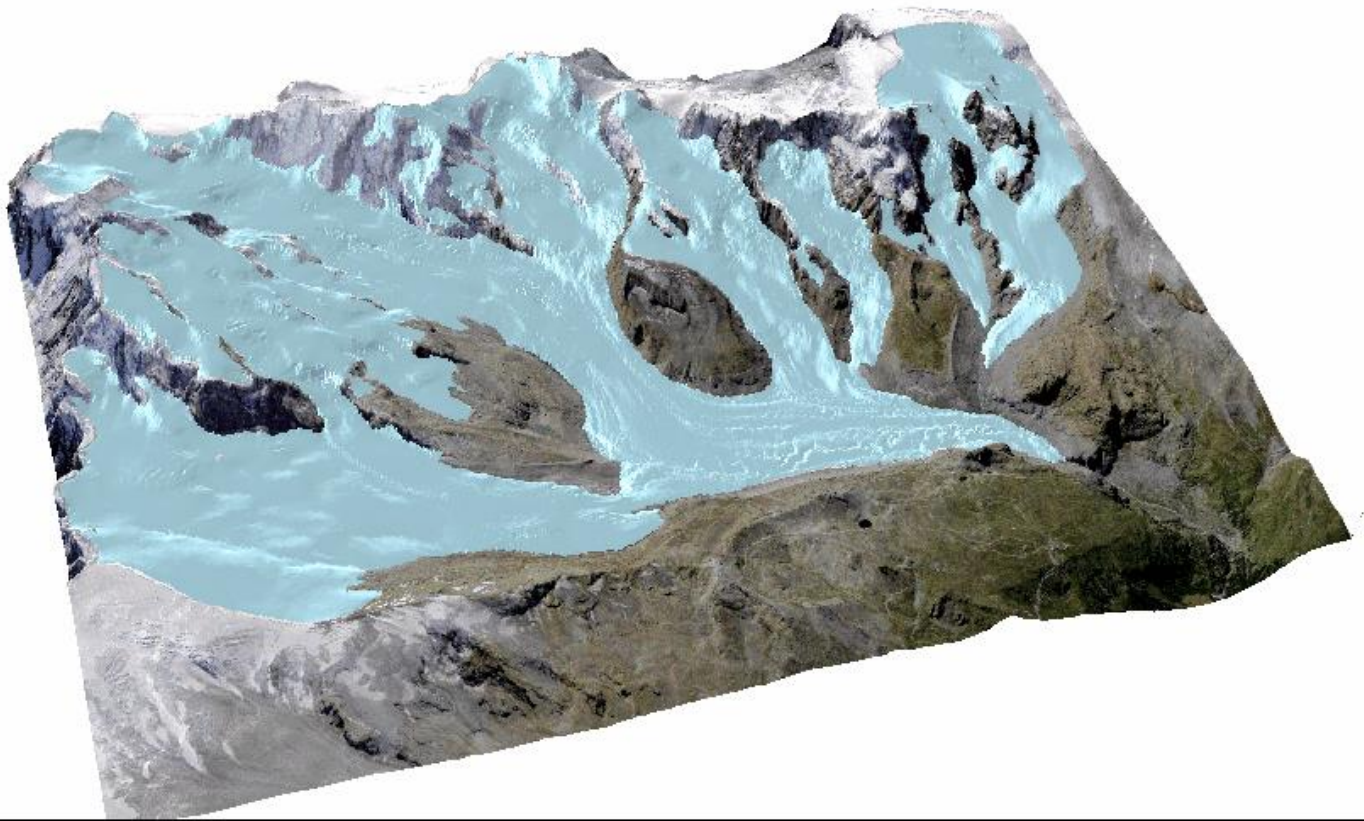


- **Production  $\approx$  discharge**  $\rightarrow$  on current price levels natural variation of discharge has little impact on economical performance
- **Short term economic performance has highest priority**

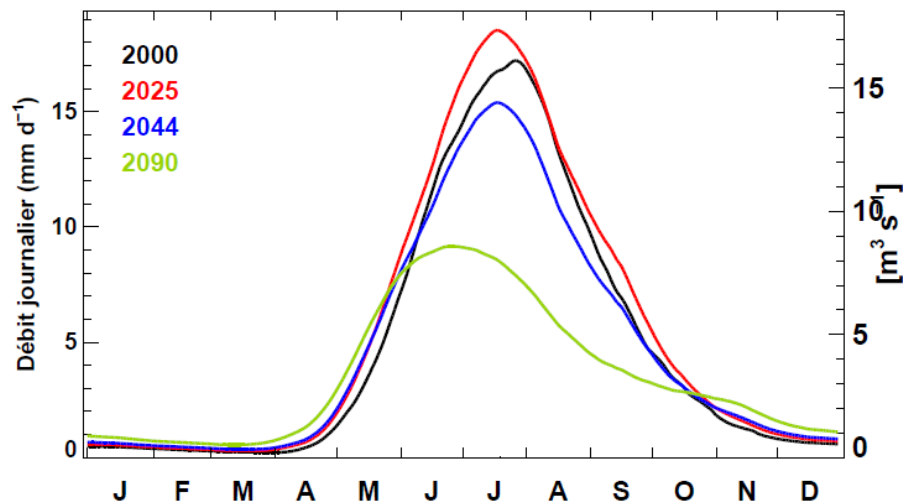
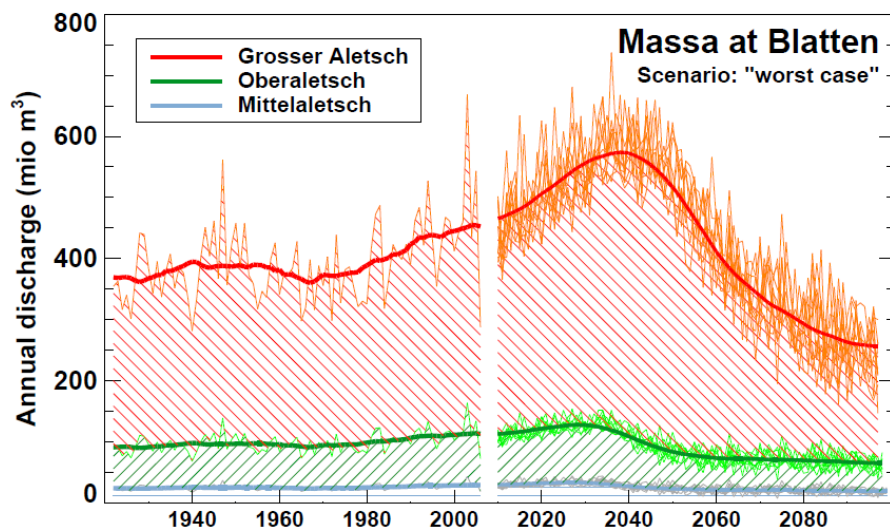


# Glacier retreat affecting operation of hydropower facilities – projected evolution of Gorner glacier (Zermatt)

Year 2006



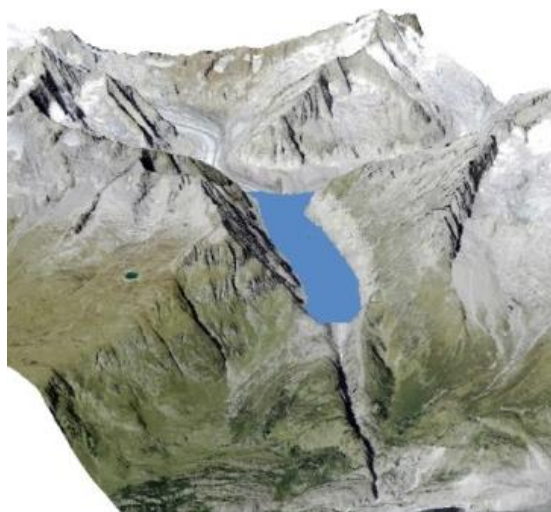
cfsFlow simulation of future evolution of Gorner glacier.



- How does climate change then affect hydropower sector?
  - Change in **mean annual runoff** mainly due to glacier melt (e.g. EM +25% by 2040 and -25% 2100)
  - Change of the **yearly runoff regime** (shift of the runoff peak towards spring, snow melt dominated regime)
  - Geomorphological changes due to **glacier retreat** (emergence of new lakes, increasing instability of hill slopes, floods ...)
  - **Sediment and debris** transportation (siltation, abrasion ...)

Source: Huss et al., 2008

# Climate Modelling is highly important for Investment decisions



- ✓ Modelling of runoff- and glacier evolution based on recent climate **projections** → mid- and long-term planning of (new) facilities (engineering)
- ✓ Supplementary information for decision making on **political or legal issues**
- ± **Demand-side models** coupled to production models based on climate projections (high degree of uncertainty due to market volatility)
- Optimisation of mid-term production by implementation of **forecasts** based on climate models (seasonal to decadal forecasts)