

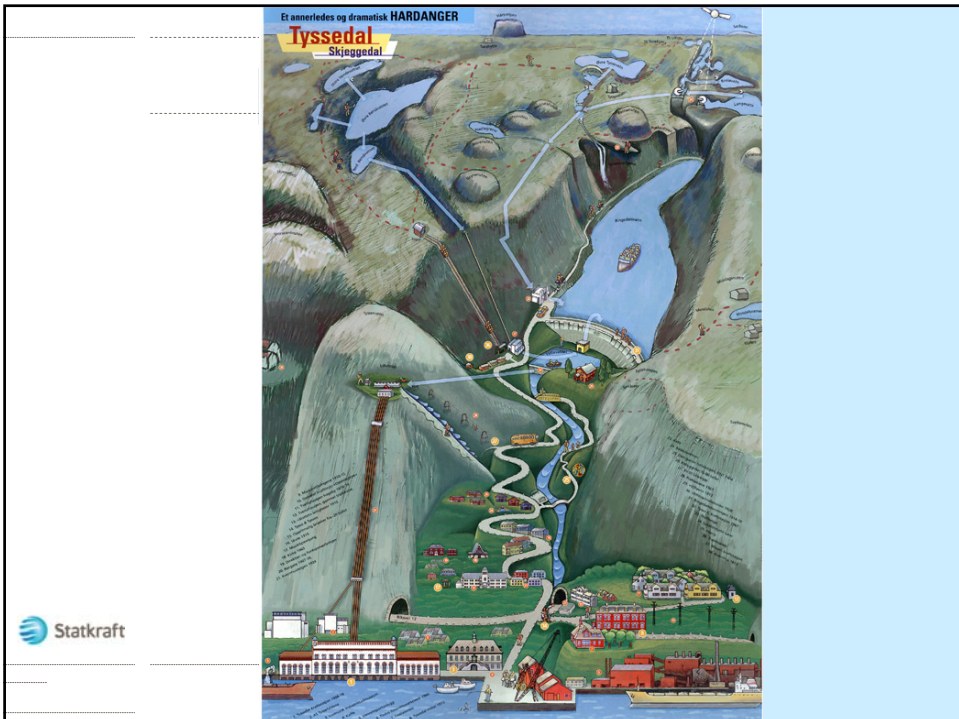
**Offshore Wind Energy Storage in Norwegian Power Plants**  
From an electrical island in Tyssedal to "swinging" business with Europe

Jan Alne – Statkraft Energi AS

-Senior Vice President – Director Western Norway



German Norwegian Offshore Wind Energy Conference-  
Bergen, 4th of May 2010



## A CENTURY OF EXPERIENCE

- Statkraft's history is inextricably linked with the development of hydropower generation in Norway
- Power plants and business operations date back as far as the end of the 19th century



1863 HIRSDANGER  
1865



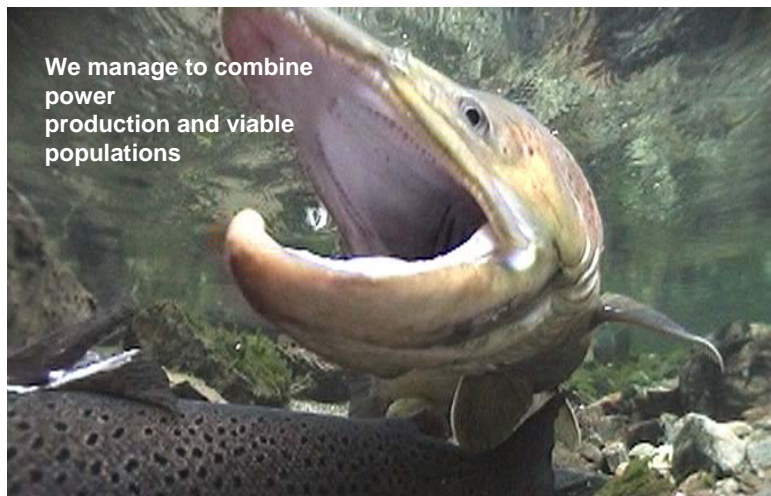


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## HYDRO POWER PRODUCTION AND VIABLE POPULATIONS

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We manage to combine  
power  
production and viable  
populations



## Statkraft: Growth with pure ENERGY

- Head office
- Offices
- Subsidiaries
- Production facilities
- Baltic Cable



## Growth in three DIRECTIONS

### Industrial developer in Norway



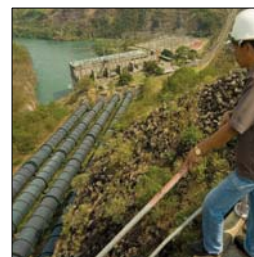
” Statkraft shall be a driving force in the development of Norway's energy industry, and by doing so create jobs and help meet the need for more clean energy

### European swing producer



” Statkraft shall increase its flexible power generation capability in western Europe and further expand its market operations

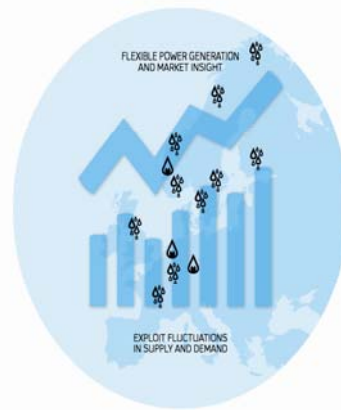
### Green global developer



” Statkraft shall carve out strong niche positions within hydropower internationally and within new, renewable energy sources in Europe

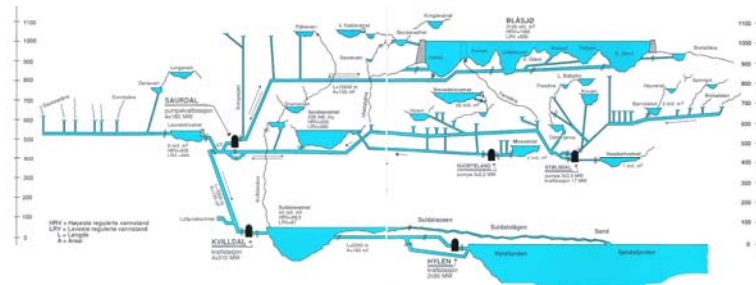
## European swing producer

- Increased flexible power generation and first-class operations
- Market insight and expertise within power optimization and trading
- Supply the market with environment-friendly power when fluctuations in demand and prices make this attractive



## Ulla Førre – the biggest hydro power scheme in Europe- cost 1 bn Euro ( reference year 1988)

- Ulla-Førre Hydropower system. Complex water conveyance system

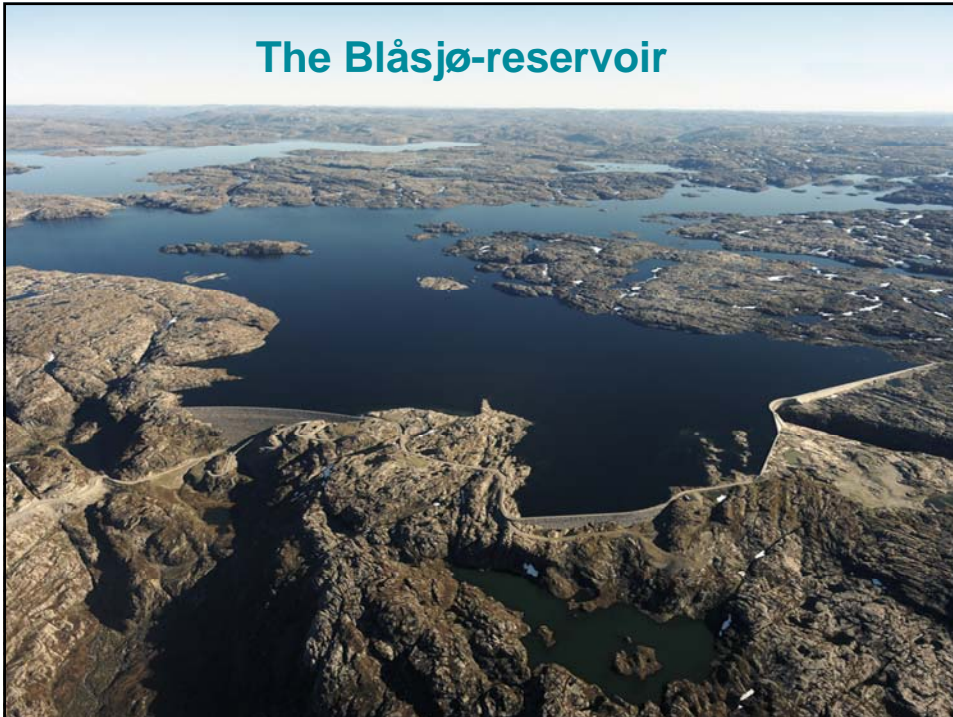


- Complex Storage Scheme:
  - 1 Major reservoir, contains water for multi year production (in case of dry year(s))
  - 34 intakes of streams plus 24 smaller reservoirs that are channeled in to the system
  - 3 Major Power plants (all underground), and 2 pumping stations
    - Saurdal Pumped storage plant 2 x 160 MW Francis turbines + 2 x 160 MW Pump-turbines, 460 m head
    - Kviteldal Powerstation, 4 x 310 MW, 530 m head
    - Høylen Powerstation 2 x 80 MW, 60 m head

**KVILLDAL- HIGHTECH “Formel 1-car”-1.7 mill horse-powers(1240 MW )**



**The Blåsjø-reservoir**



## Blåsjø - General facts

- A number of lakes have been regulated to one large reservoir – Blåsjø
- Blåsjø is situated about 1000 metres above sea-level
  - Max water level = 1055 m.a.s.
  - Min water level = 930 m.a.s.
- The reservoir is established by construction of 14 dams of various size
- When full it holds 3,1 billion m<sup>3</sup> water or about 7,8 TWh
  - Enough energy to supply the city of Stavanger (pop 120 000) for 4 years



Statkraft → The 10th largest lake in Norway

side 13

## Storvass dam - Facts

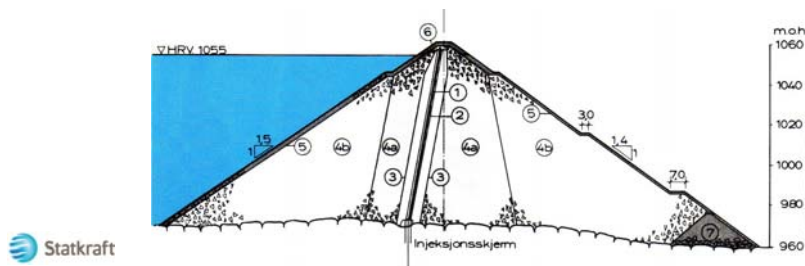
- Rockfill dam with asphaltic concrete core
- Height: 88 metres
- Length: 1460 metres
- Volume: 9,6 mill m<sup>3</sup>
- Construction period: 1981-1988
- Norway's largest dam



side 14

## Storvass dam

- Total volume: 9.600.000 m<sup>3</sup>
  - Asphaltic concrete 48.200 m<sup>3</sup>
  - Filter 241.000 m<sup>3</sup>
  - Rockfill 9.299.700 m<sup>3</sup>



side 15

## Hydro for balancing intermittent sources

- Norway has 50 per cent of all European hydro storage capacity (85 TWh)
- Installed capacity today: 30 GW- can be doubled !
- Need for better tools and more studies
- Environmental impacts
  - Erosion and sediment transport
  - Water temperature and ice
  - Impacts on the ecosystem
  - Social acceptance



Statkraft

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## Centre for environmental design of renewable energy – CEDREN



The main objective of CEDREN is to develop and communicate design solutions for renewable energy production that address environmental and societal challenges at local, regional, national and global levels.





Technology development for the future hydro system  
Hydropower development



Increased power and salmon production



Environmental impacts of flow fluctuations – methods and tools

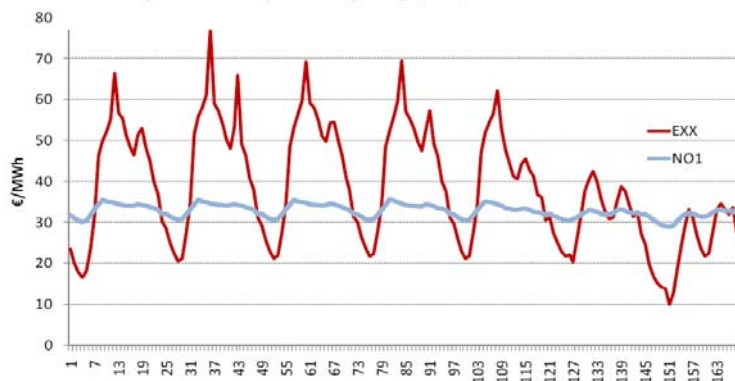
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## Kjartan Haualum. Statnett: Vision for NoPrisforskjeller mellom EXX og NO1

Statnett

❖ Prisvarisjoner er driveren for utenlandskabler

Snitt ukepris mellom Tyskland og Norge, No1, 2002-2008

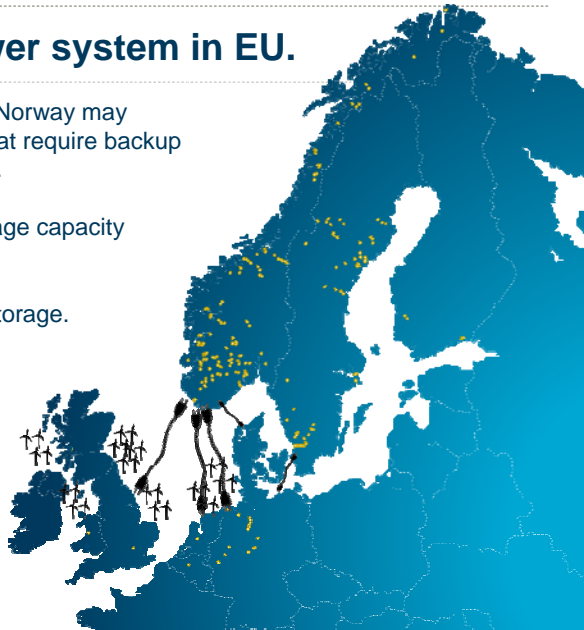
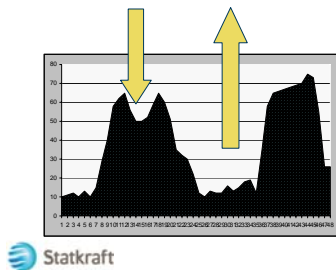


26. september 2009

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## Supporting the power system in EU.

- Due to the regulating capacity, Norway may support other power systems that require backup solutions and storage of energy.
- Close to 50% of European storage capacity is located in Norway (82 TWh)
- Possibilities for large pumped storage.



## Salmon caught in Alta River Oct 07 – 30 kg

Thank you  
for your  
attention!

