Managing variations in wind power through storage

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ENERGY SECURITY
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PURE ENERGY

No. **1** WITHIN RENEWABLES IN EUROPE

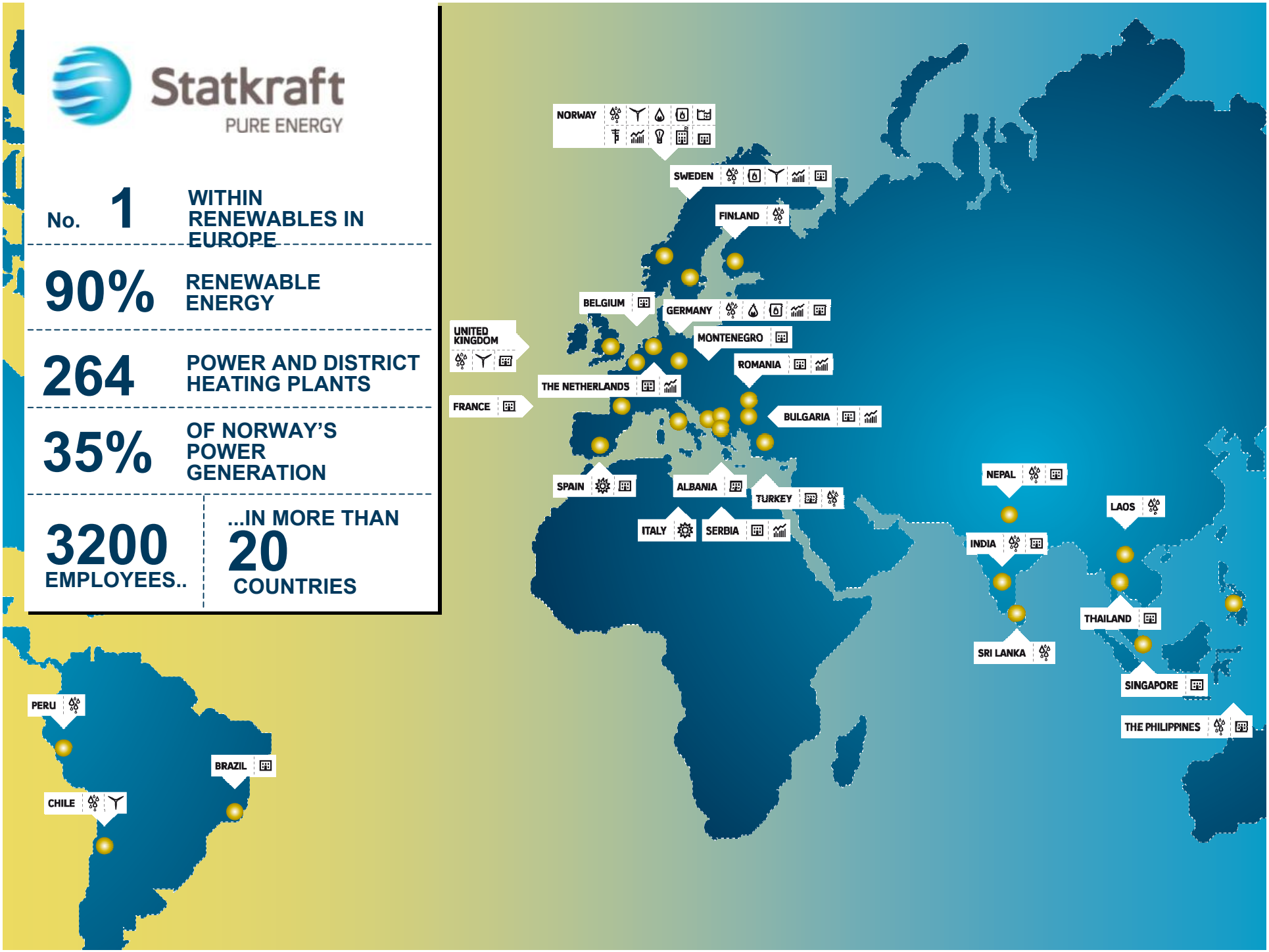
90% RENEWABLE ENERGY

264 POWER AND DISTRICT HEATING PLANTS

35% OF NORWAY'S POWER GENERATION

3200 EMPLOYEES..

...IN MORE THAN **20** COUNTRIES



FROM STATKRAFT'S KEY AREAS

European Flexible Generation and Market Operations

--> Develop and optimize hydro portfolio in Norway and Sweden

--> Evaluate European growth opportunities for flexible hydropower

--> Build and upgrade gas fired power plants in core markets (Continent/UK)

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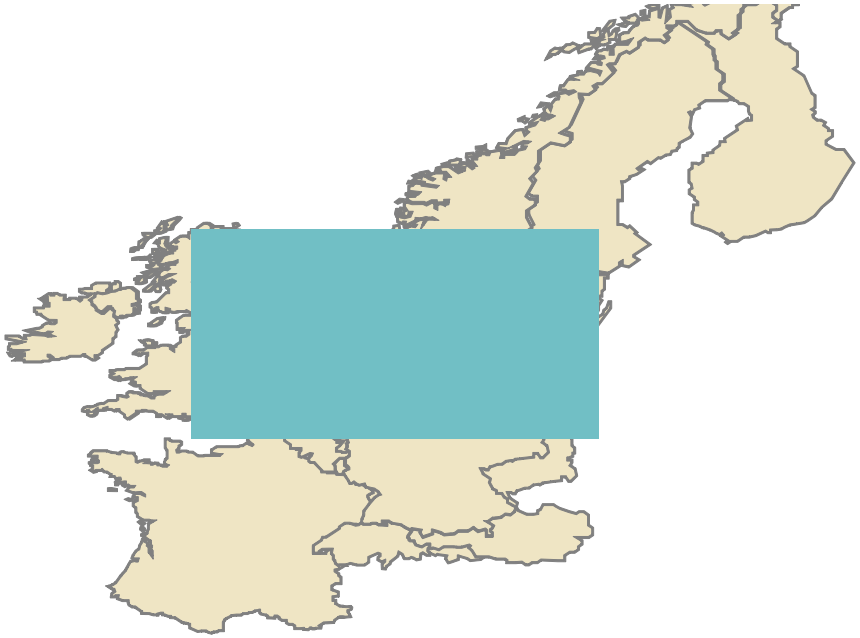
THE NORTH SEA AREA
WIND POWER DEVELOPMENT – 2020 SCENARIO

--> Offshore:
40 000 MW

--> Total onshore/offshore:
100 000 MW

--> Creating a Wind Belt onshore/offshore from UK via France, Belgium, The Netherlands, Germany, Denmark and Southern Sweden



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GREAT CHALLENGES

--> Infrastructure Development

- -- Connecting VarRES to
  - Load centres
  - Flexibility options
  - Storage facilities
- -- Necessary for enabling market development

-->Handling the wind production's variability

-->Wind power developing from a minor to a main part of the production portfolio with dispatch priority, means a total new situation – a paradigm shift

-->Creates need for huge flexibility in the other parts of the electricity system

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INFRASTRUCTURE DEVELOPMENT I

The Commission's Communication of 17.11.2010

4.1.1. Making Europe's electricity grid fit for 2020

Focus upon four priority corridors:

1. Offshore grid in the Northern Seas and connection to Northern as well as Central Europe
2. Interconnections in South Western Europe
3. Connections in Central Eastern and South Eastern Europe
4. Completion of the Baltic Energy Market Interconnection Plan

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INFRASTRUCTURE DEVELOPMENT II

The Commission's Communication of 17.11.2010

Further details of the first priority corridor:

Offshore grid in the Northern Seas and connection to Northern as well as Central Europe –

to integrate and connect energy production capacities in the Northern Seas with consumption centres in Northern and Central Europe **and hydro storage facilities in the Alpine region and in the Nordic countries**

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FROM THE GERMAN GOVERNMENT'S ENERGY CONCEPT

--> Für ein hohes Maß an Versorgungssicherheit müssen auch in Zukunft genügend Ausgleichs- und Reservekapazitäten bereit stehen

--> Der massive Ausbau der erneuerbaren Energien im Strombereich (insbesondere offshore) macht die Planung eines deutschen Overlay-Netzes erforderlich, das in einen europäischen Verbund integriert wird

--> Langfristig ist der Ausbau von Speicherkapazitäten wichtig und geboten

--> Wir wollen mittelfristig die verfügbaren deutschen Potentiale für Pumpspeicherkraftwerke im Rahmen der technischen und wirtschaftlichen Möglichkeiten erschließen.

--> Langfristig werden diese Potentiale allein aber nicht ausreichen. Deshalb ist die Nutzung ausländischer Pumpspeicher für Deutschland von großer Bedeutung. In Norwegen gibt es dafür ganz erhebliche Potentiale, aber auch in den Alpen lassen sich weitere Potentiale erschließen.

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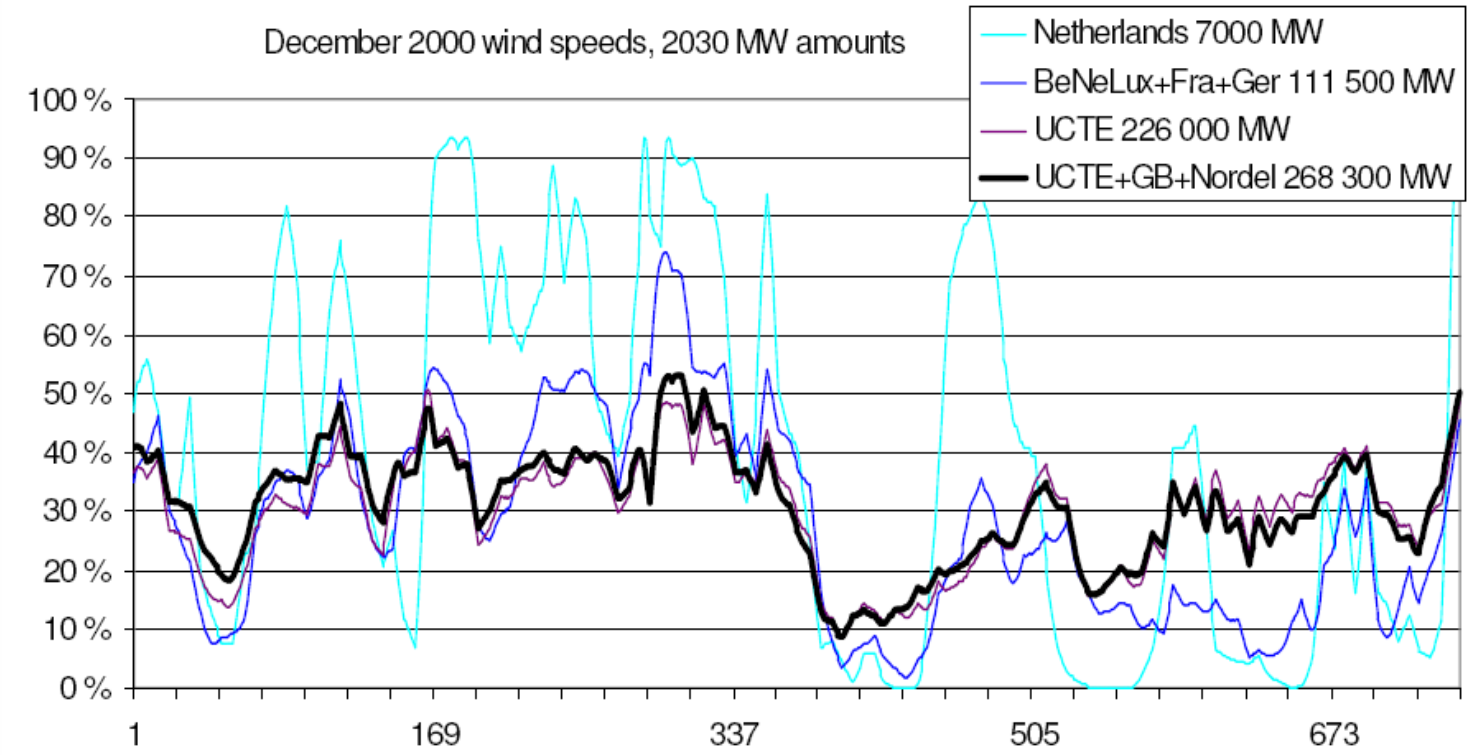
THE WIND PRODUCTION'S VARIABILITY

TradeWind

Smoothing effect



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Intelligent Energy Europe

FLEXIBILITY CHALLENGES
Ref. TradeWind 2020

--> Variations in wind power production

- Europe looked upon as one bus bar
  - Max. 54 % of installed capacity
  - Min. 9 % of Installed capacity
  - Difference 45 % of installed capacity or 95 GW
  - Less than four days between top and bottom

- Regional example: The Netherlands as one bus bar
  - Max. 93 % of installed capacity
  - Min. 0 % of installed capacity
  - Rises from 7 to 90 % of installed capacity (6 GW in 2030) in six hours (time resolution for wind data)

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FLEXIBILITY OPTIONS

--> Production
- -- Nuclear
- -- Fossil fired, gas and coal
- -- Reservoir based hydro

--> Storage
- -- Pumped Storage
- -- CAES
- -- Batteries/EV

--> DSM/Smart Grids

--> Connecting and further develop the Norwegian hydro resource to deliver a significant part of the needed flexibility?

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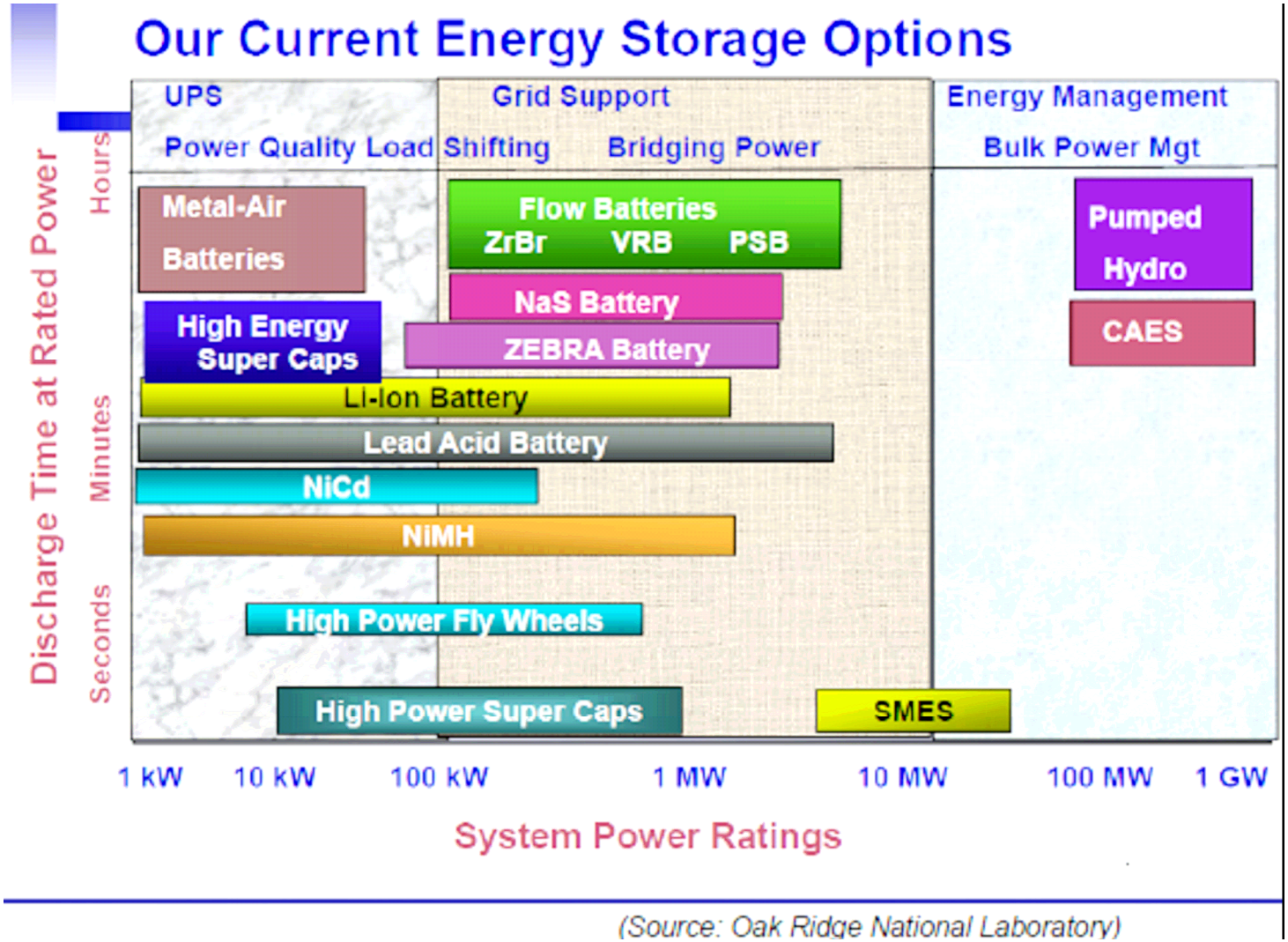
Stationary Utility Energy Storage Technologies



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EUROPEAN HYDRO FLEXIBILITY

- Reservoir based Hydro Power in the production mix:
  - In general used for Storage and Peak Power production
  - In Norway developed for Storage and Base Load production
  - Hydro Storage Capacity and Rated Power (1998)

UCTE	57 TWh	49 GW
Norway	84,1 TWh	27,3 GW
NORDEL, ex.NO	38,6 TWh	19,1 GW

  - Developed as the UCTE hydro, Norwegian hydro should have had 72,3 GW installed
  - This means there is a huge possibility to expand the installation in Norwegian hydro to serve peak power needs

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NORWEGIAN HYDRO STRUCTURE

- Built in caverns inside the mountains
- Upper reservoir is connected to the power station by tunnel
- Outlet is also by tunnel
- Outlet is either
  - direct into downstream reservoir or
  - direct into the sea
- This structure makes Norwegian hydro special well suited for expanding the capacity and also for development of pumped storage

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NORWEGIAN HYDRO FLEXIBILITY OPTIONS

- --> Norway has alone close to 50 % of the hydro reservoir capacity in Europe
- --> To take advantage of this huge flexibility resource it is necessary to connect it to nodes in the wind belt
- --> Physical, technological and environmental is it possible to realise a flexible capacity of 20 GW from Norway before 2030
- --> It is not necessary to build new reservoirs
- --> Necessary business models have to be developed
- --> It may be necessary to revise some regulatory frames to make it possible
- -- Cable and pumped storage facilities in the same package?

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BENEFITS COMBINING WIND AND HYDRO

--> Storing excess wind power production otherwise lost

--> Economic benefit

--> Delivering peak power from sustainable resources instead of fossil fired

--> Reduction of CO2 emissions

GERMAN WIND RESOURCES AND NORWEGIAN HYDRO

A PERFECT MATCH?

THANK YOU!

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