100% Renewable Electricity by 2050

DLR-Scenarios for the SRU

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Thank you for invitation;

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Overview

- The SRU and its task
- Why 100% renewable electricity by 2050?
- Methodology: Potential, Scenarios
- The potential
- Hourly results for 2050
- The transition
- The costs in comparison
- The bottlenecks
- Conclusions

The German Advisory Council on the Environment: Scientific Policy Advice since 1971

- Independent, scientific Council nominated by Federal Cabinet
- 7 University Professors (Natural Sciences, Engineering, Economics, Law, Political Sciences)
- Broad Mandate: Early warning on negative trends, new ideas for environmental policy, inform the wider public
- Active Member of EEAC

The German Advisory Council on the Environment

My Council is an

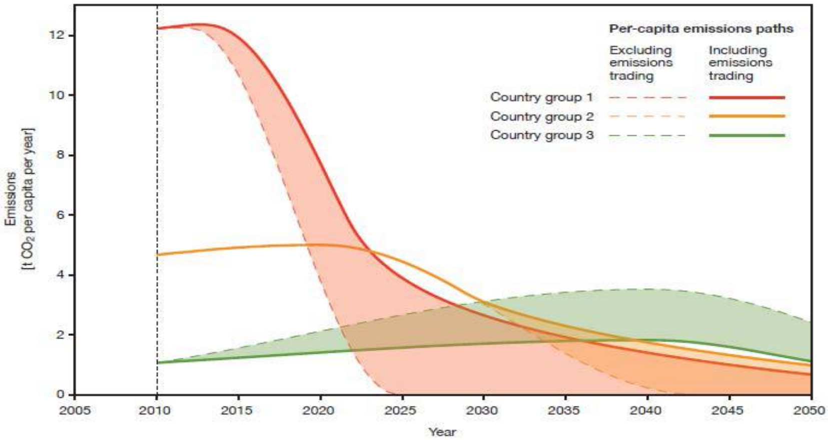
Independent, scientific and interdisciplinary Council

Consisting of 7 university professors and a scientific staff of 20 scientists,

The Council is established by the Federal German Govenent

As watchdog, with an early warning function and as science based “judge” in the political debate on environmental issues;

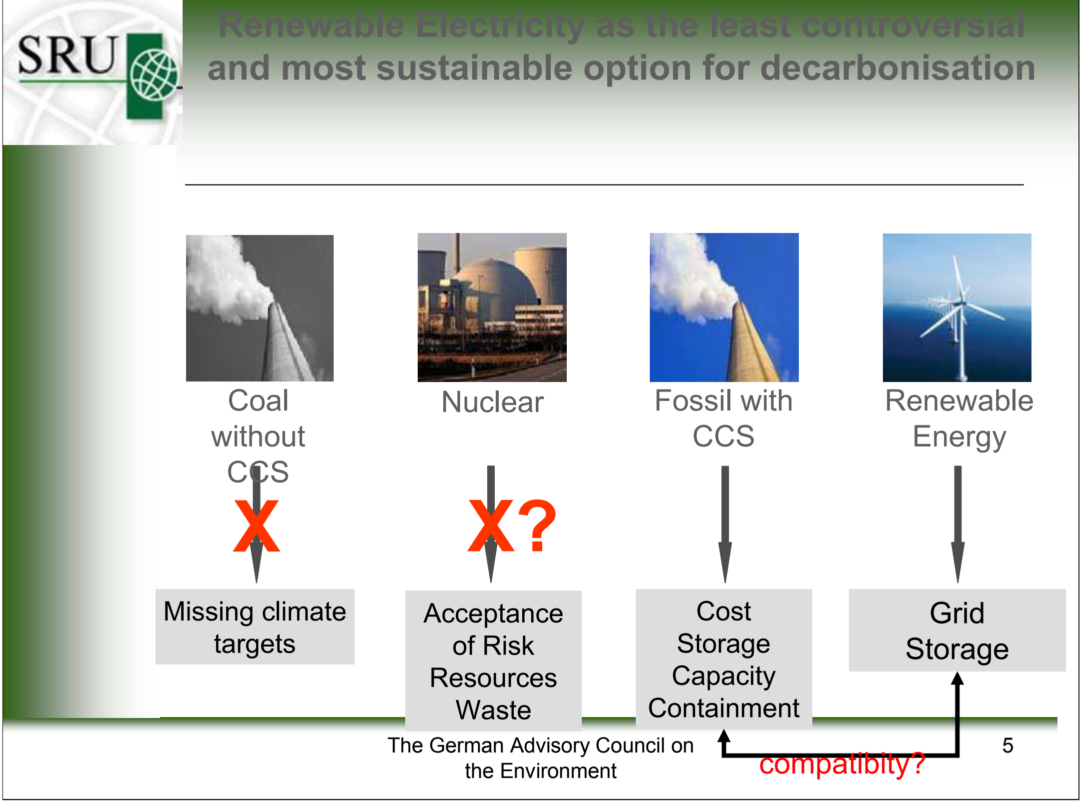
The Challenge: full decarbonisation



WBGU, 2009: Solving the Climate Dilemma: the Budget Approach

If we take the 2 degrees guardrail as starting point □ and fair distribution of per capita emissions □ we come to radical transformation needs;

Electricity Sector easiest to switch to low carbon sources ; sector with long lead-times; early decisions necessary in order to avoid lock-in



Starting point of our scenarios:

Other technological options for decarbonisation have serious shortcomings

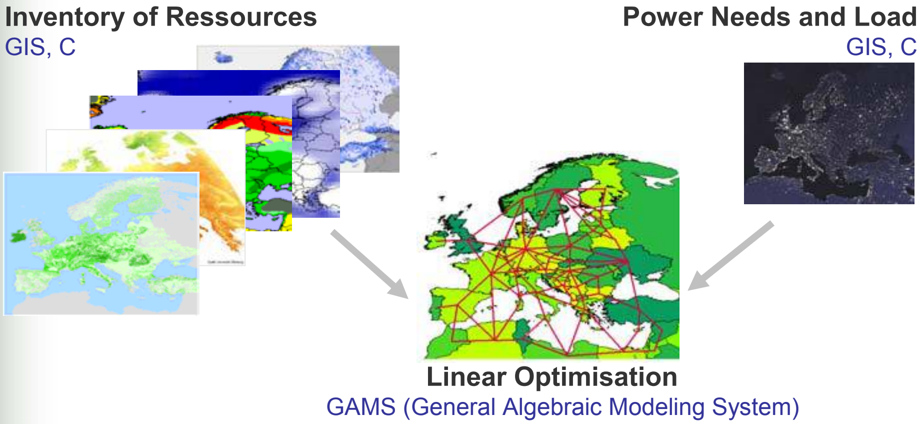
At best: intermediate options

Only sustainable solution: Renewables

Therefore question: can they manage?

Methodology of DLR Scenarios for SRU: a backcasting approach

REMix-Europe
(**R**enewable **E**nergy **Mix for Sustainable Electricity Supply in Europe)**



Key point: adopt a backcasting approach;

Design an optimal REN Mix in 2050

3 Key Elements:

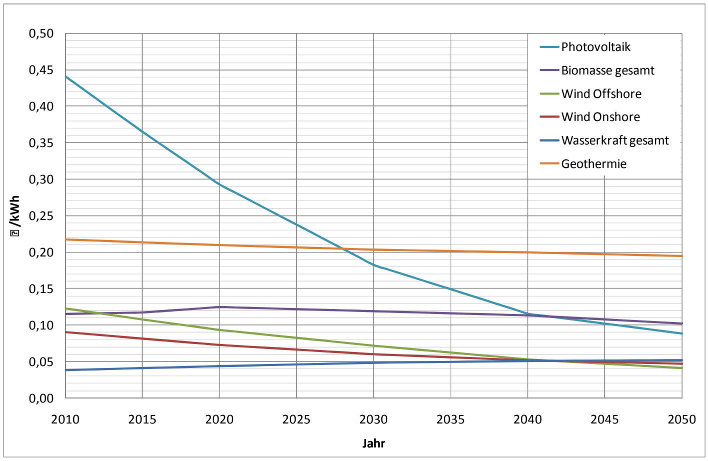
-GIS based Potential analysis for EUNA: identification of must suitable areas/

Identification of excluded areas/ assumption on max . Use of remaining areas

-An hourly model of demand in 2050

- A linear optimisation model: aiming at most cost-effective combination of ren sources and storage options for fluctuating demand

Key Assumption: Learning Cost Curves in the middle range of literature (Abbildung 4-27)



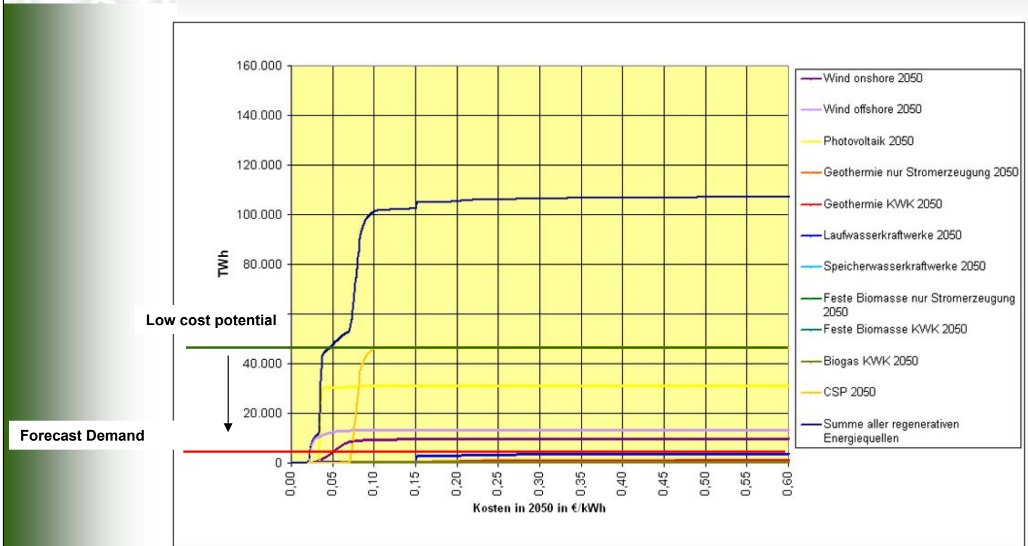
Key Component:

Learning cost curves:

-Cost for many ren reduce with market penetration as result of ECS and learning effects;

- Assumptions on learning cost curve in the middle range of estimates in literature, partly even conservative

Low cost potential (<5ct/Kwh) at 45 000 TWh in EUNA (ca. factor 8-10 of forecast demand)



A first result:

Low Cost Economic Potential in EUNA is high

100% renewable electricity
8 scenarios

	Demand Germany 2050: 500 TWh	Demand Germany 2050: 700 TWh
Self-Sufficiency	Scenario 1.a DE-100 % SS-500	Scenario 1.b DE-100 % SS-700
Net self-sufficiency including trade with DK/NO	Scenario 2.1.a DE-NO/DK-100 % SS-500	Scenario 2.1.b DE-NO/DK-100 % SS-700
Max 15% Net import from DK/NO	Scenario 2.2.a DE-NO/DK-85 % SS-500	Scenario 2.2.b DE-NO/DK-85 % SS-700
Max 15% Net import from EUNA	Scenario 3.a DE-EUNA-85 % SS-500	Scenario 3.b DE-EUNA-85 % SS-700

8 Scenarios:

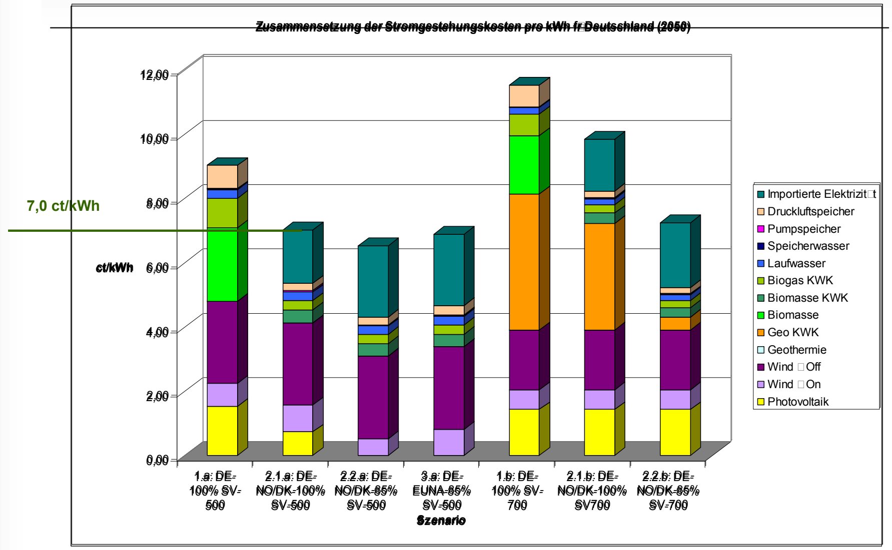
Logic: start with an extremely conservative and restrictive theoretical assumption:

Electrical Island Germany as theoretical reference than gradually open to European Market

Check both cost for an efficiency world and for a high demand world allowing for the electrification of other sectors

System Cost can be kept below 7ct/Kwh,

if stabilisation of electricity consumtion and/or some trade



Interesting results:

Electricity Island Germany is technically feasible but expensive

High demand can be met but it is expensive

Major leap forward by Nordic cooperation:

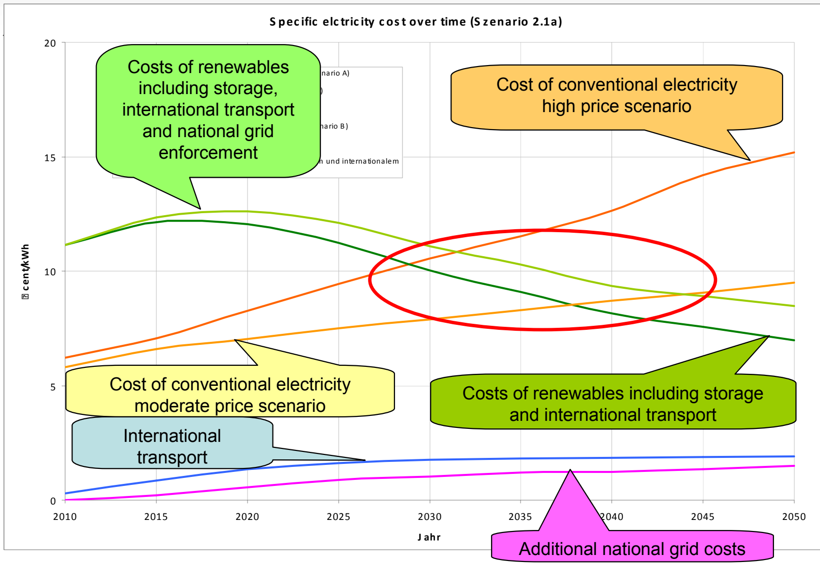
Reduces considerably cost

and

Is less cost-elastic to high demand

A Nordic Scenario is slightly cheaper than the European Scenario: if all countries make use of the nordic storage potential □ some additional storage takes place on basis of more expensive technologies (CAES)

The cost in comparison to a conventional supply scenario (Germany)

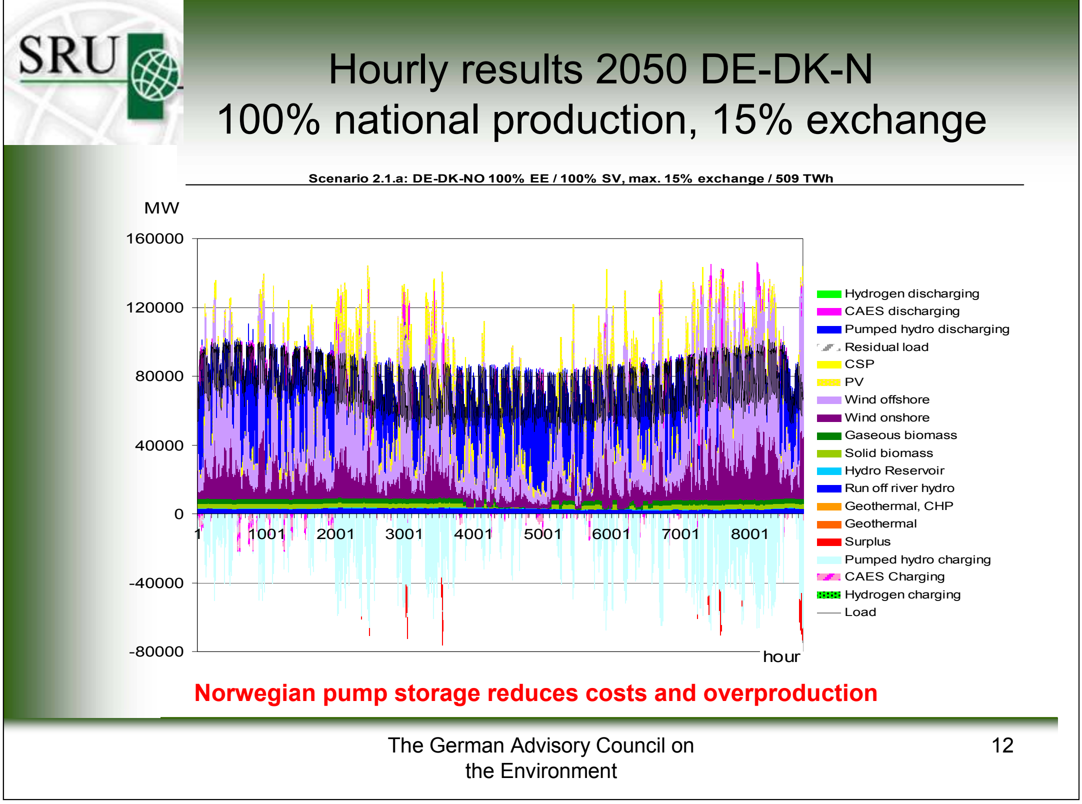


Overall cost for REN may be lower than for conventional power:

Simple reason: no fuel demand □ as fuel becomes more expensive over time, c□nventional power becomes more expensive

Whereas REN cost go down as consequence of learning cost curve

So early decision in REN future is investment for a low cost future ..



□ also security of supply is ensured: at each our fluctuationg supply meets demand

As you see from scenario 2.1: key role plays norwegian pump storage capacity

See good preconditions:

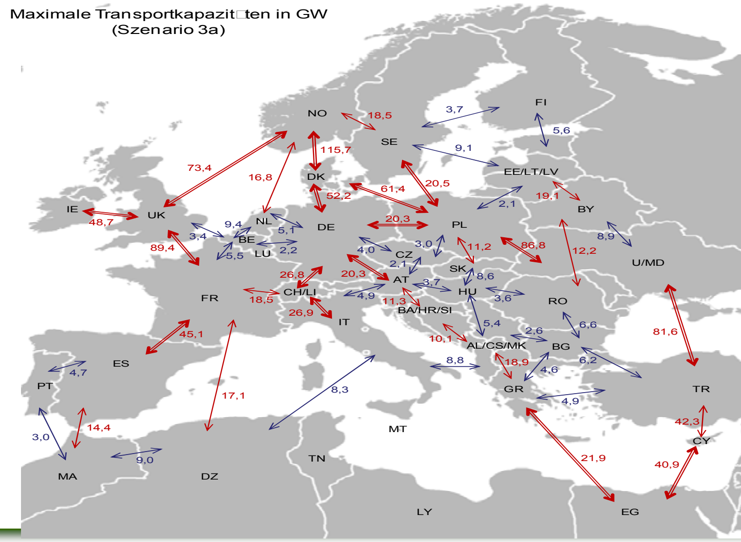
Conventional hydropower: 84 TWH in Norway

Many cascade types of lakes □ easy conversion □

Bottleneck is: grid and planning security

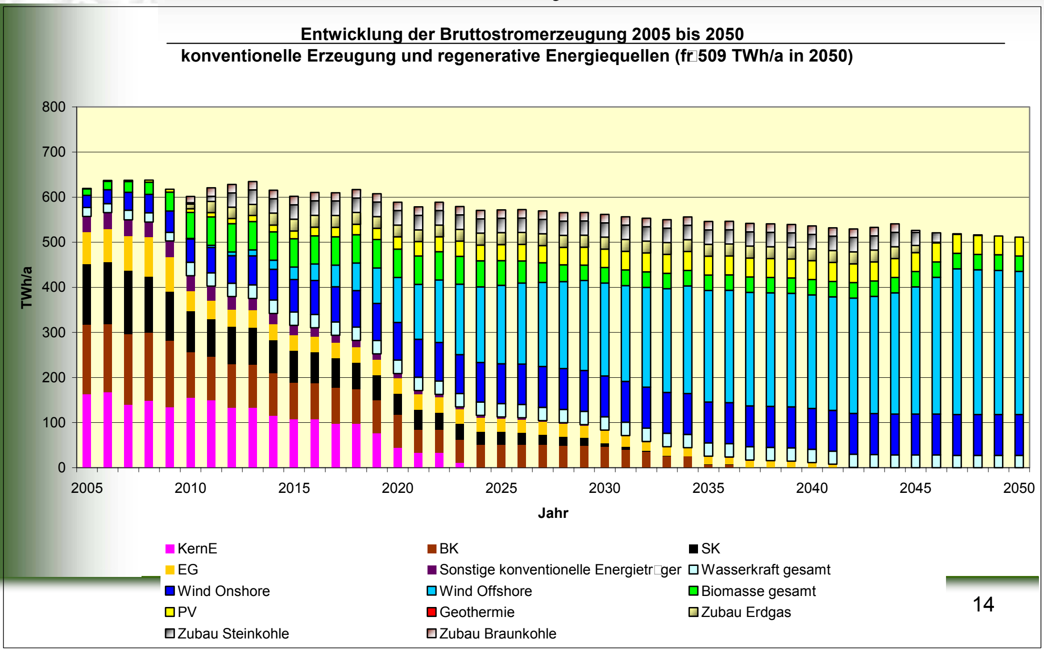
Little doubt: interesting business concept for Statkraft!

TEN-E Needs by 2050 and the key role of the nordic "power house"



This gives you an impression of the GRID needs for the EUNA Scenario – only assuming for all EU countries the same trade-intensity as for Germany

Development of renewable energy mix in Germany until 2050



Modelled Transition for Germany:

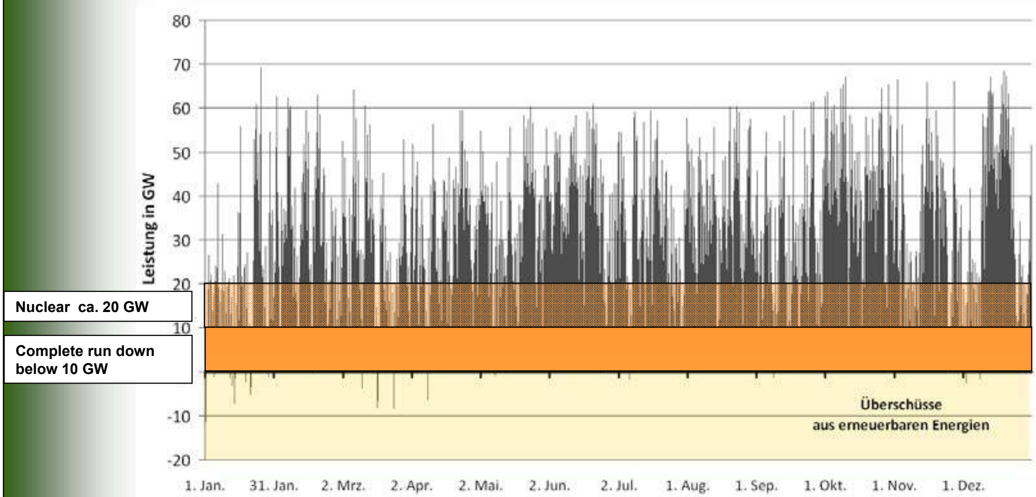
Simple intrapolation □ no economic optimisation:

Assumption: 35 years of economic life time of a power installation

Result: continue capacity growth rate of last decade for next decade

If Meseberg targets are assumed: less than 6 GW capacity increase annually . This can be managed;

Fluctuating supply overstretches nuclear plant flexibility already in 2020



A final remark to the compatibility of conventional power with renewables:

This is a 2020 situation:

What you see here maximum nuclear flexibility (10GW will be) very frequently needed but quite offen full nuclear capacity has to be run down:

If you stick to priority REN access frequent run downs of nuclear plants may eat up parts of the lifetime dividend and also may cause safety concerns;

An attractive solution for nuclear power might be to stop volatile renewables at peak supply hours

In any case there will be at least an economic problem from 2020 onwards and later certainly a technical problem to maintain coexistence between intermitting and conventional sources

6 Conclusions

- 100% renewable electricity is achievable by 2050, while ensuring security of supply at competitive cost
- Transitional higher cost compared to conventional system is investment in the least cost solution
- (Offshore) Wind energy will be the most important single contributor
- Pumpstorage capacities in Scandinavia will play a critical role in balancing supply and demand
- A transition without new coal and without longer nuclear lifetimes can be modelled
- High shares of conventional baseload power will conflict with intermitting renewable energy from 2020 onwards

That are some key conclusions of our scenarios!

In late autumn we will publish our special report, which then assesses econonmic instruments and policy approaches to steer the transformation within a European context.

Pumpstorage in Norway: Load Management needs are anticyclical to natural fluctuation of hydropower capacity