Nordic study on pumped storage

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Oslo

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Agenda

- Background and purpose
- Selection criteria for sites
- Techologies and solutions
- Scenarios and modelling
- Conclusions
- Lessons learned

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Background and purpose

- Objective: to assess concrete options for implementation of pumped strorage as a means in the transition towards sustainable energy supply in isolated or remote areas

- Pumped storage is seen as the technology that would make implementation of a high share of renewable energy possible, by transforming e.g. fluctuating wind power to well-known stable hydro-power

- The increased use of renewable energy would reduce the consumption of diesel for power generation, reduce the need for reserve capacity and increase security of supply.

Project structure

- Phase I – Criteria for selection of localities
- Phase 2 – Assessment of technical solutions with max. renewable energy share and nomination of potential sites
- Phase 3 Modelling of selected options for concrete sites and cost benefit analysis

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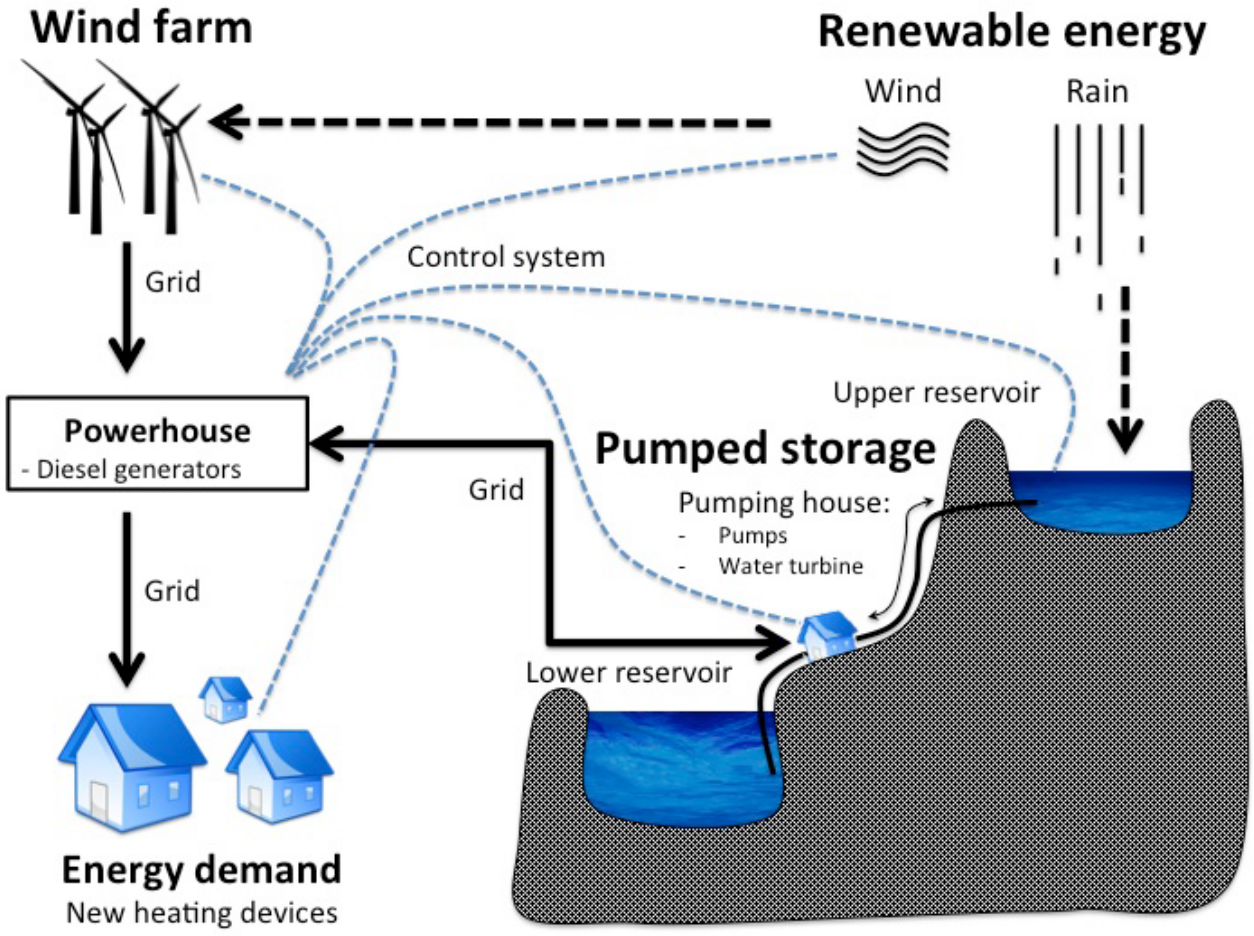
Pumped storage - wind/hydro/diesel hybrid



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Need for pumped storage ?

- Energy demand and distribution over time
- The technologies that need to work together
- Demands on security of supply and need for balancing power
- Options for reservoir and head
- Costs of reservoir and installation

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Criteria for selection of localities

- Option for replacing fossil fuels
- Renewable energy resource
  - Wind, hydro, solar
- Options for reservoir
  - Natural
  - Artificial
- Salt or fresh water
- Environmental considerations
  - Drinking water
  - Need for establishment of dam
  - Risk of contamination if salt water

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Localities

- Faroe islands
  - Vestmanna, **Suðuroy**
- Greenland
  - Qorlortosuaq, Tasiilaq, **Sarfannguaq**, Nanortalik, Qassiarsuk, Sisimiut, Upernativk, Igaliko
- Western Norway
  - Trollfjorden
  - Søroya

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Characteristics

Sarfanguaq

- 126 inhabitants
- Electricity demand around 418 MWh based on diesel
- Heating is based on individual oil boilers.
- Natural reservoir options
- Experience with micro wind turbine
- Moderate wind
- Good options for solar

Suðeroy

- 5,000 inhabitants
- Electricity demand around 26.600 MWh, based on diesel and hydro
- Heating is based on individual oil boilers.
- Natural reservoir options
- Fantastic wind regime

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Technologies and solutions

Renewable options:

- Hydro/pumped storage
- Solar PV – grid connected
- Wind turbines – 35 kW, 50 kW and 100 kW
- Heat pumps for space heating

Sarfanquaq:

- Solar PV – diesel scenario to cover as much as possible of electricity consumption
- Wind - pumped storage – diesel scenario
- Wind – solar - diesel – heat pump for max renewable coverage of heat and electricity demand

Challenges in a small island system

- Availability of small commercial technology
- Fluctuating power generation AND demand challenges the frequency control of the grid
- Regulation of turbine and sensitivity to frequency
- High risk of overloading the electric system
- Artic conditions and costs

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Scenarios and modelling

- Modelling tools available focus on larger systems and cannot easily handle pumped storage and frequency issues
- Systems become very complex when high shares of renewable energy
- Coverage with renewable energy will only be moderate as diesel is still needed for regulation and balancing

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Conclusions

Suderoy:

- has excellent and cost effective options for large wind turbines in combination with existing hydro and diesel
- Good options for converting heating demand to as well by using heat pumps
- Transport by electric vehicles should be investigated further

Sarfanquaq

- has good options for solar PV
- Technical solution with wind and pumped storage is complicated and expensive.
- Frequency regulation is challenging
- Heat pumps for heating require stable supply of cheap electricity.
- Battery and frequency stabilising technologies should be investigated further

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Lessons learned

- Focus on identifying options for reducing fossil fuel demand instead of potential for a specific technology
- Dialogue with working group is important - also face to face.
- Think future partners for implementation in from the outset.
- Look at the total energy demand, not just the electricity demand.
- Tools for easy assessment of RE potential in small systems require specialist knowledge.

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