



CEDREN HydroBalance

Feasibility check regarding:

Technology
Environment
Social acceptance

By: Research Manager Michael M. Belsnes & WP-leaders



CEDREN HydroBalance: Facts

- Budget: 24863 MNOK, (17692 from NFR)
- Duration: 4 years
- Research partners (11)
 - SINTEF Energy Research, NTNU: Norwegian university of Science and Technology, NINA: Norwegian Institute for Nature Research, UIO: University of Oslo, University of Waterloo, ECN: Energy Research Centre of the Netherlands, University of Exeter, UMB: Norwegian University of Life Science, NIVA: Norwegian Institute for Water Research, Technical University of Madrid, University of architecture, Civil Eng. and Geodesy, Bulgaria, Univercity of Aachen (E.ON)
- Funding (10):
 - EnergiNorge, Agder Energi, BKK, Sira Kvina kraftselskap, Statkraft, Listerrådet, EdF: Electricite de France, E.ON, RCN: Research Council of Norway

CEDREN HydroBalance: Objectives

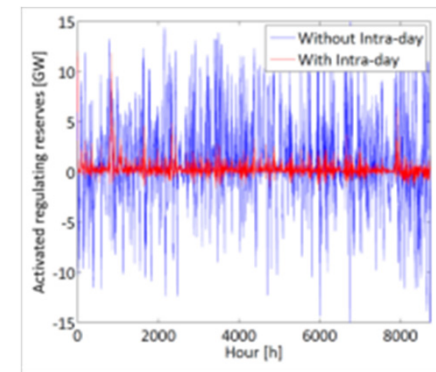
The project will address key questions regarding use of hydropower flexibility and expansion of such flexibility including pump storage development between reservoirs.

The project will draw a picture of the future for hydropower flexibility towards 2050 and assess needs for flexibility, alternatives to hydropower and required transmission capacity. How can and should the hydropower sector respond to the power system development in Europe? The project will assess and suggest business models in a Norwegian-European perspective.

Use of hydropower flexibility must go hand in hand with environmental concerns and the project will in particular contribute with new knowledge about consequences of reservoir level changes.

CEDREN HydroBalance: Technology

- WP 1: Roadmaps for balancing from Norwegian hydropower (Julie Charmasson/Julian Sauterleute)
 - Assess the possibility space for balancing power from Norway towards Europe
 - Timeline for when, how and where Norwegian hydropower should respond
- WP 2: Demand for energy balancing storage (NTNU: Prof. Magnus Korpås)
 - Establish data models with
 - Short- long-term storage, interaction between markets
 - PhD: Ingeborg Gråbak
- WP 3: Analyses to develop relevant business models (Ove Wolfgang)
 - Possible business models for operation in different markets for balancing, including cross border possibilities.
 - Analyses of possible capacity projects, profitability and operation
 - Includes a substantial research cooperation with ECN and EON

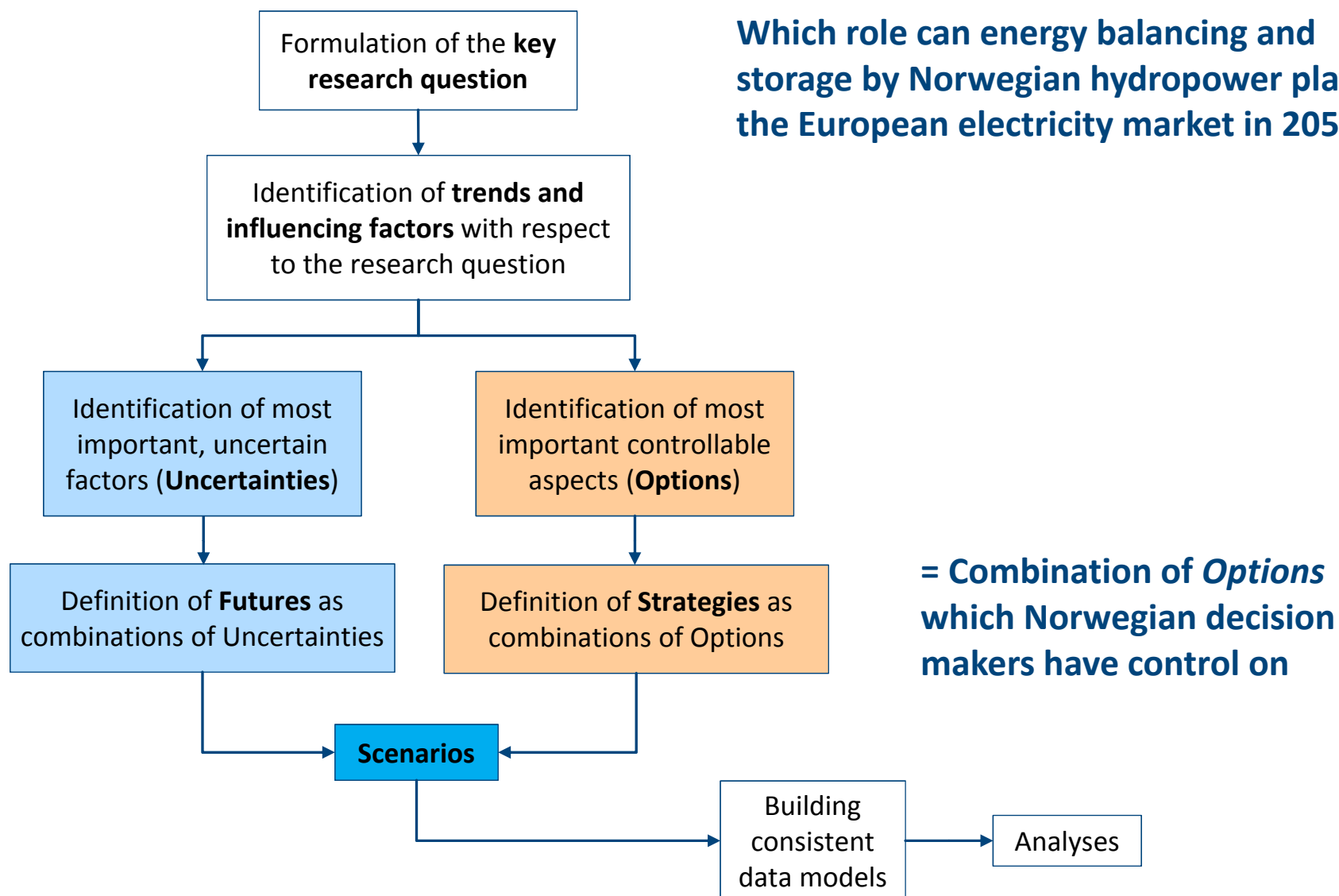


CEDREN HydroBalance: WP's

- WP4: Environmental impact of operation schemes for balancing (NINA: Ingeborg Helland)
 - Research task regarding environmental impact on reservoirs, size and type
 - Use CEDREN results for broad analyses of environmental impact and mitigation.
 - Postdoc: Antti Eloranta
- WP 5: Social acceptance and regulatory framework (Marte Qvenild)
 - Political barriers and success criteria for balancing power
 - Income distribution and socialization of cost, non technical challenges.

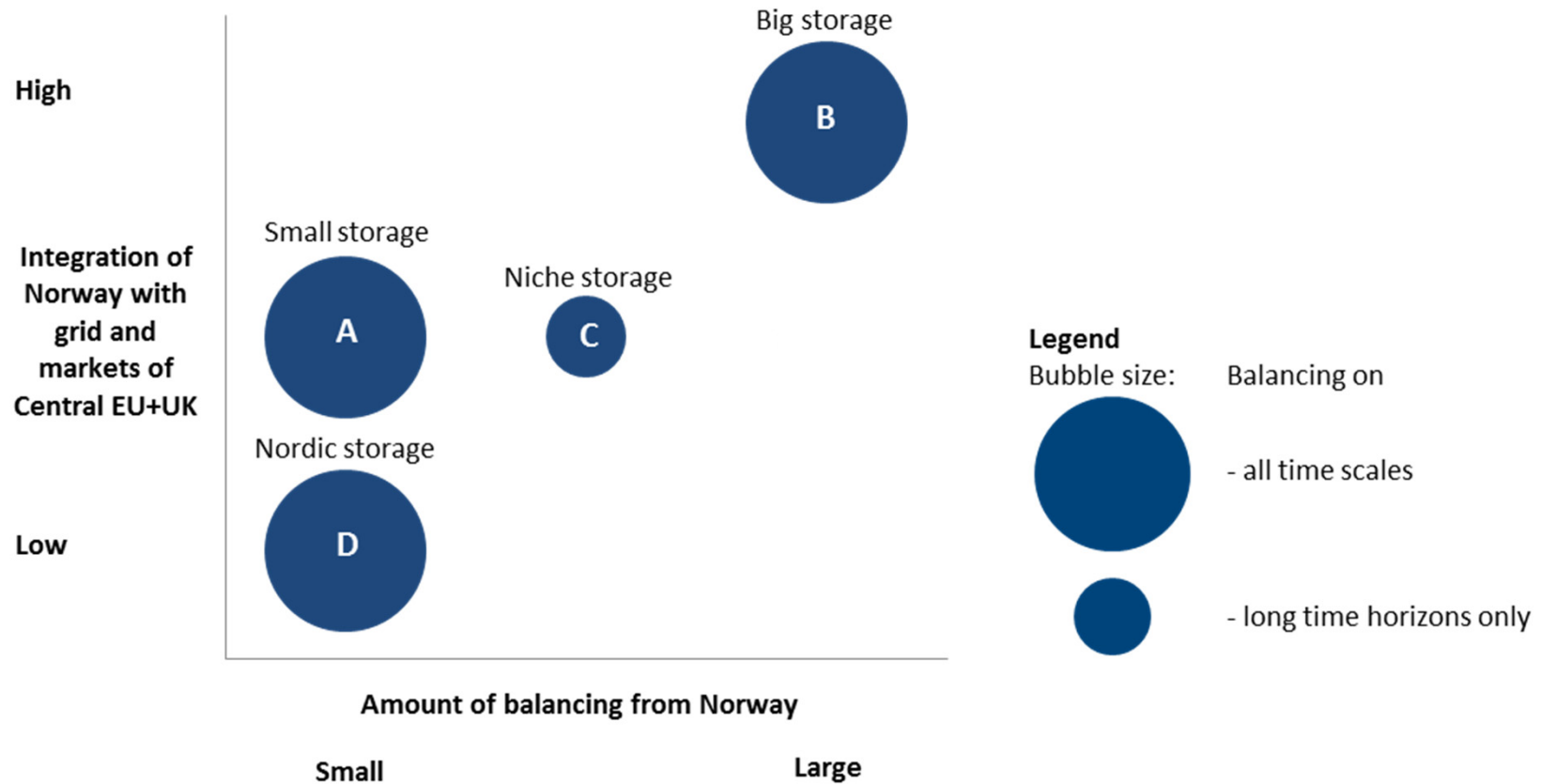


Scenario building approach



Four scenarios with tree dimensions

Main scenario characteristics



Scenarios

Small Storage

- Middle integration
- Small volume
- All horizons

Big Storage

- High integration
- Large volume
- All horizons

Uncertainties in Future 1	Medium Demand	Various flexibility
Technology		
Variable RES share of electricity generation	Medium	High
Expansion of European transmission grid	Moderate	Strong
Deployment of CCS	Yes	No
Market		
Competition from alternative flexible technologies	Low	Low
EU regulatory framework and market integration	Fully integrated	Fully integrated
Policy		
Ambitions of countries to connect to Norway	Moderate	Strong
Options in Strategy 2	Moderate expansion	Active climate policy
Expansion of Norwegian transmission grid	Moderate	Strong
New and upgrade of existing hydro plants	Moderate	Strong
Support of variable RES in Norway	Moderate	Strong
Ambitions of Norway to build interconnectors	Moderate	Strong

Scenarios

Niche Storage

- Middle integration
- Middle volume
- Long horizon

Nordic Storage

- Little integration
- Small volume
- All horizons

Uncertainties in Future 1	Niche market	Critical supply
Technology		
Variable RES share of electricity generation	High	High
Expansion of European transmission grid	Moderate	Limited
Deployment of CCS	No	No
Market		
Competition from alternative flexible technologies	High	Low
EU regulatory framework and market integration	Day-ahead only	Day-ahead only
Policy		
Ambitions of countries to connect to Norway	Moderate	Strong
Options in Strategy 2	Value creation	Nordic only
Expansion of Norwegian transmission grid	Strong	Strong
New and upgrade of existing hydro plants	Strong	Limited
Support of variable RES in Norway	Limited	Strong
Ambitions of Norway to build interconnectors	Strong	Weak