Centre for environmental design of renewable energy – CEDREN

SINTEF

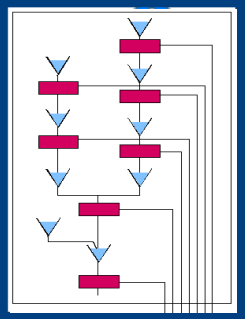
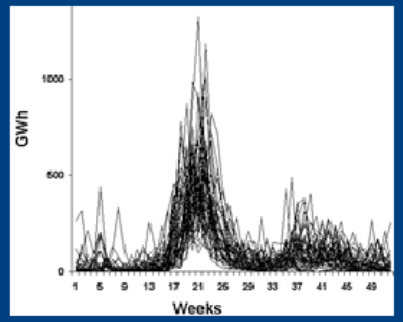
NTNU
100 skapende år

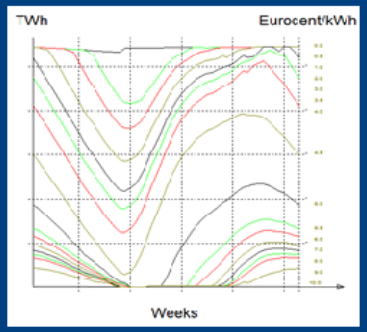
NINA
Norsk institutt for naturforskning

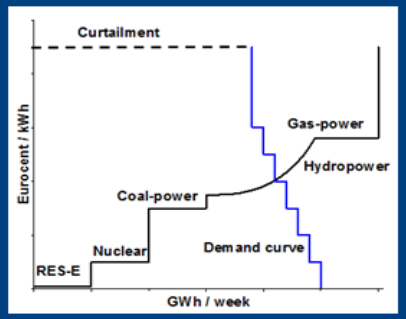
NATURHISTORISK MUSEUM
UNIVERSITETET I OSLO

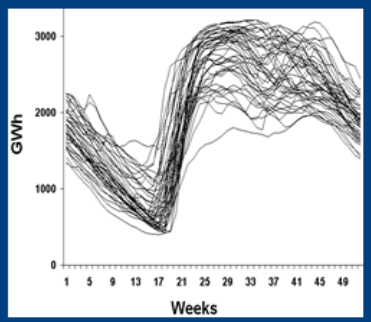
NIVA

uni Research







CEDREN HydroBalance

Michael M. Belsnes
Research Manager: Generation scheduling
Coordinator: CEDREN HydroBalance

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.
- Funding (10):
  - EnergiNorge, Agder Energi, BKK, Sira Kvina kraftselskap, Statkraft, Listerrådet, EdF: Electricite de France, E.ON, RCN: Research Council of Norway

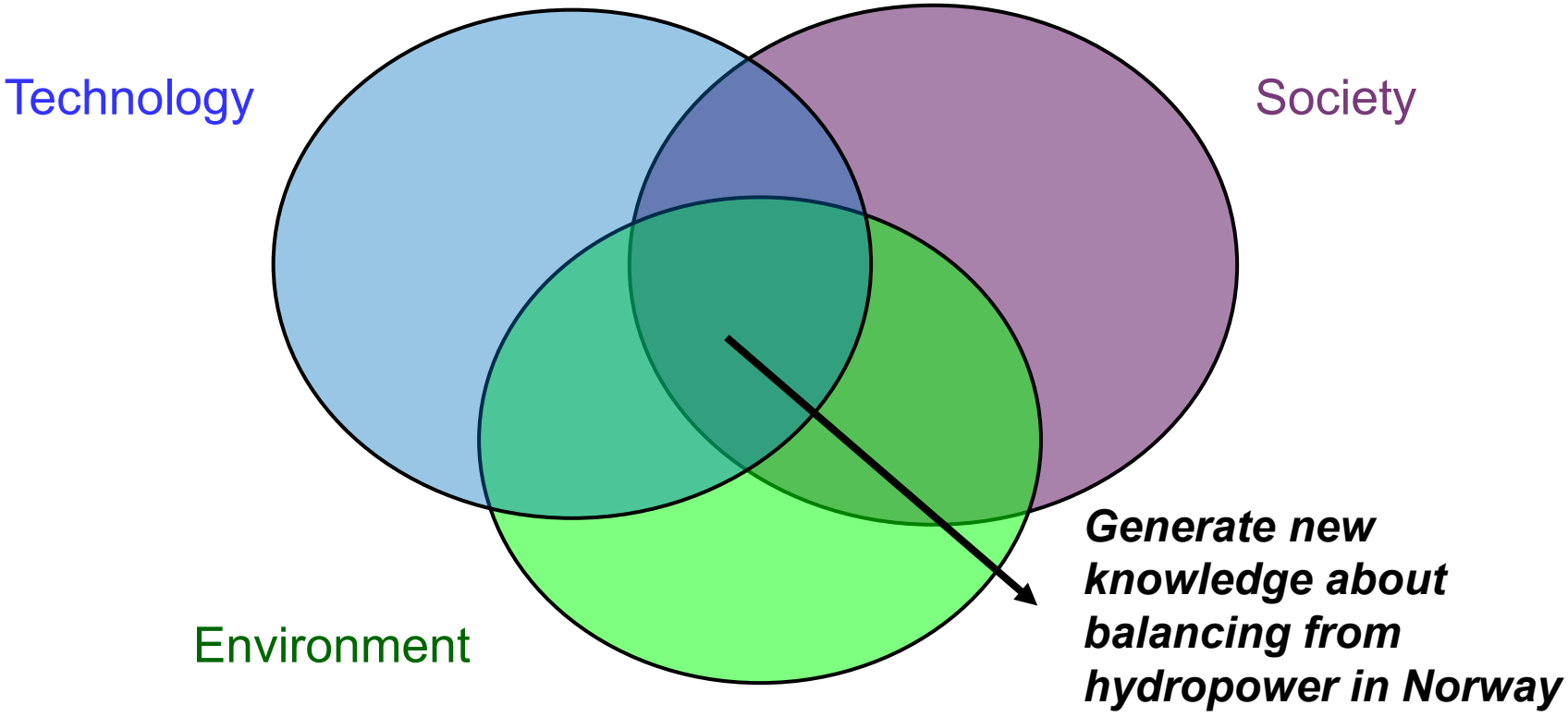
CEDREN HydroBalance: Objectives

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: Objectives



… and with CEDREN and the combined consortium = true

CEDREN HydroBalance: Technology

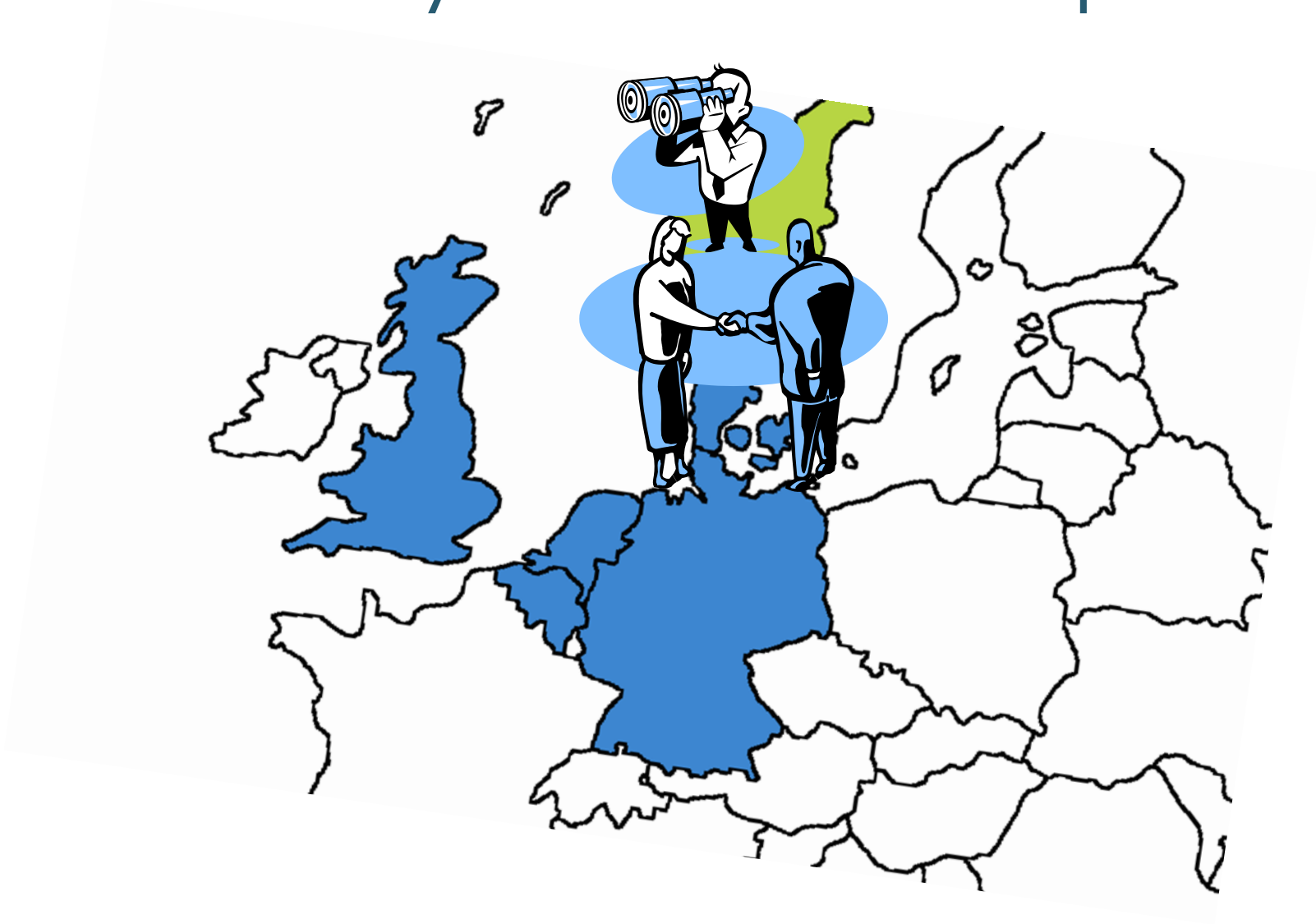
- WP 1:Roadmaps for balancing from Norwegian hydropower
  - Assess the possibility space for balancing power from Norway towards Europe
  - Timeline for when, how and where Norwegian hydropower should respond
- WP 2:Demand for energy balancing storage
  - Establish data models with
  - Time horizon for storage needs, interaction between markets
  - Includes a PhD scholarship
- WP 3: Analyses to develop relevant business models
  - 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

CEDREN HydroBalance: WP's

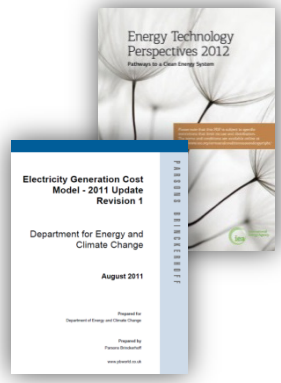
- WP4: Environmental impact of operation schemes for balancing
  - Research task regarding environmental impact on reservoirs, size and type
  - Use CEDREN results for broad analyses of environmental impact and mitigation.
  - Includes a Postdoc scholarship.

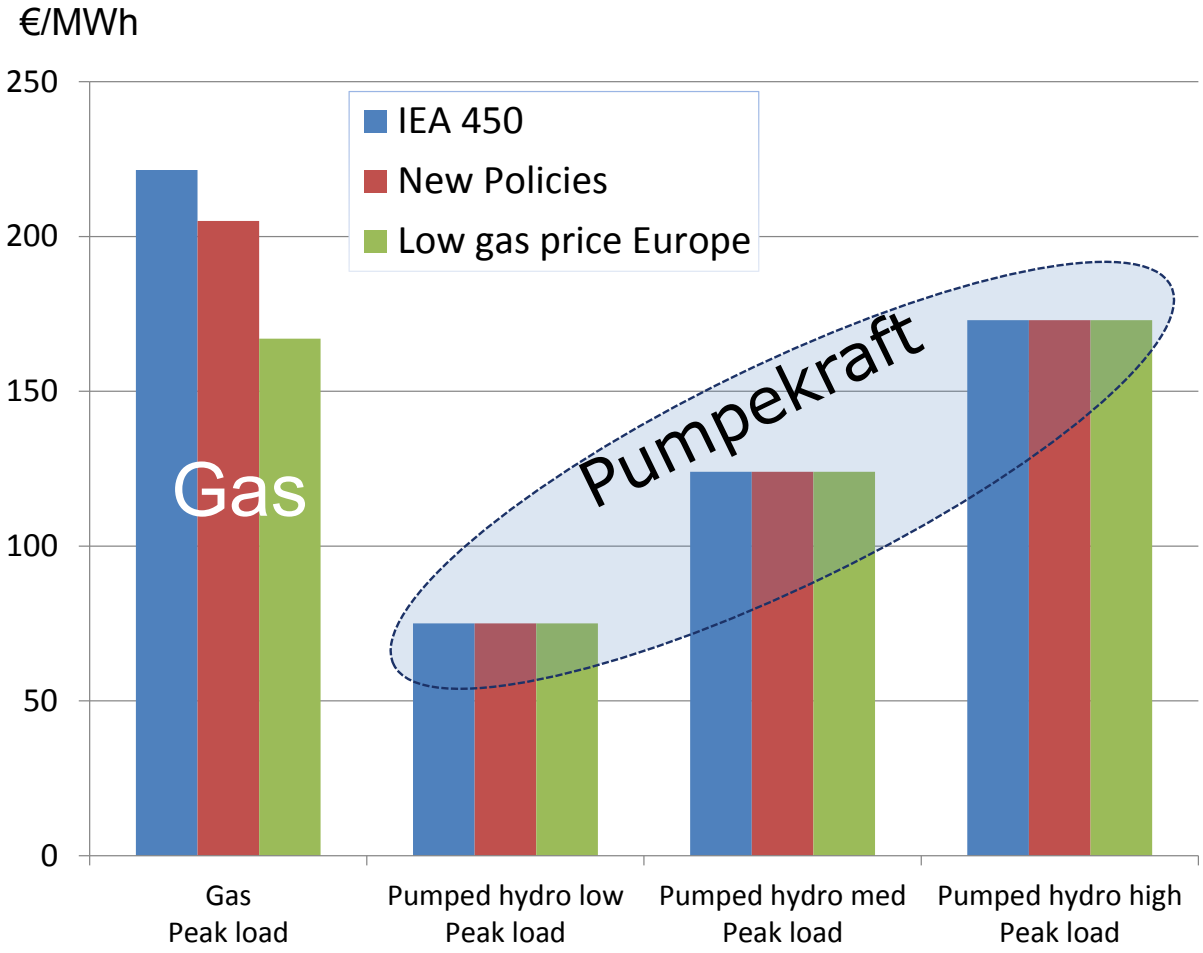
- WP 5: Social acceptance and regulatory framework
  - Political barriers and success criteria for balancing power
  - Income distribution and socialization of cost, non technical challenges.

CEDREN HydroBalance: Perspective



WP 1: Pump-storage is competitive for balancing in Europe

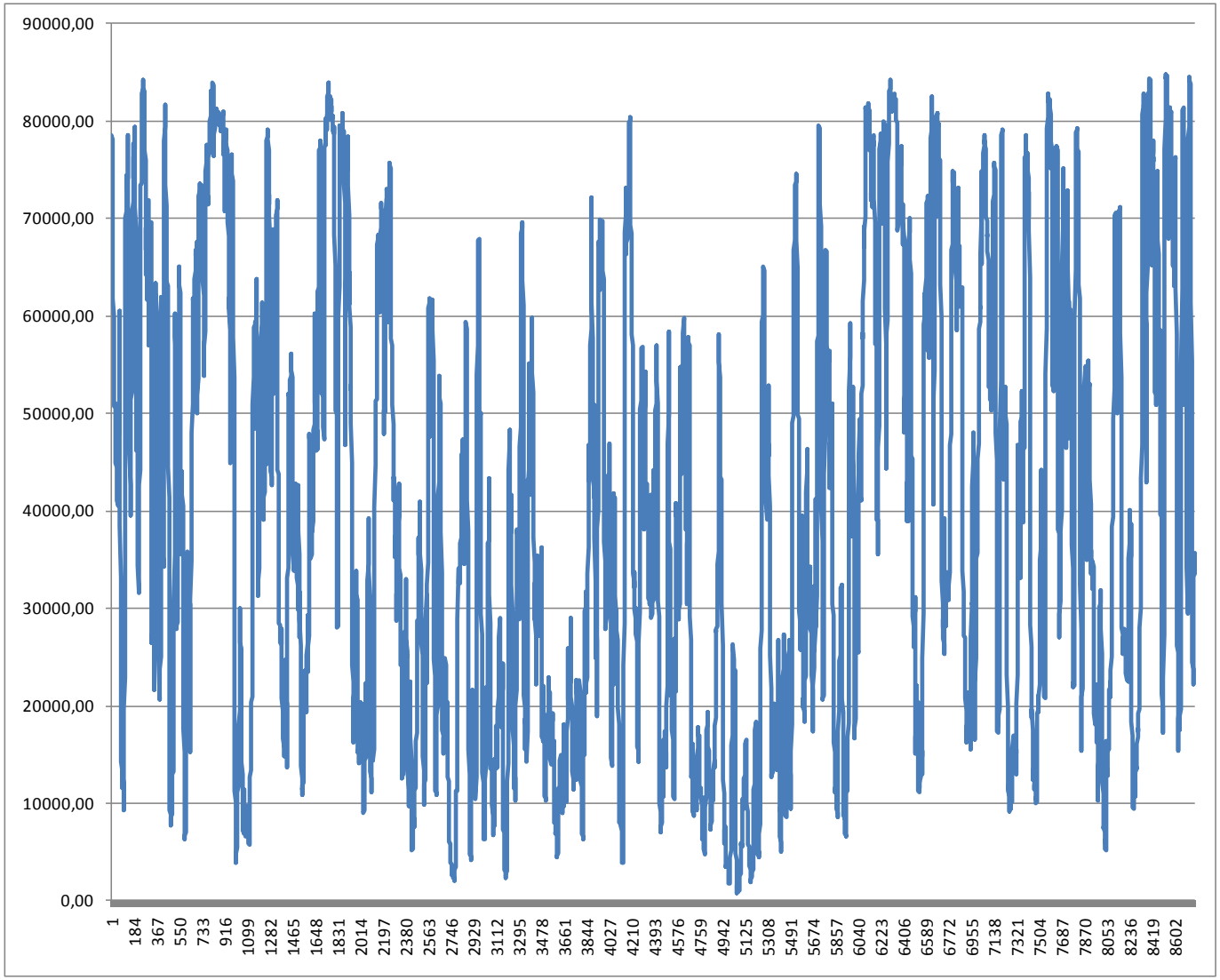




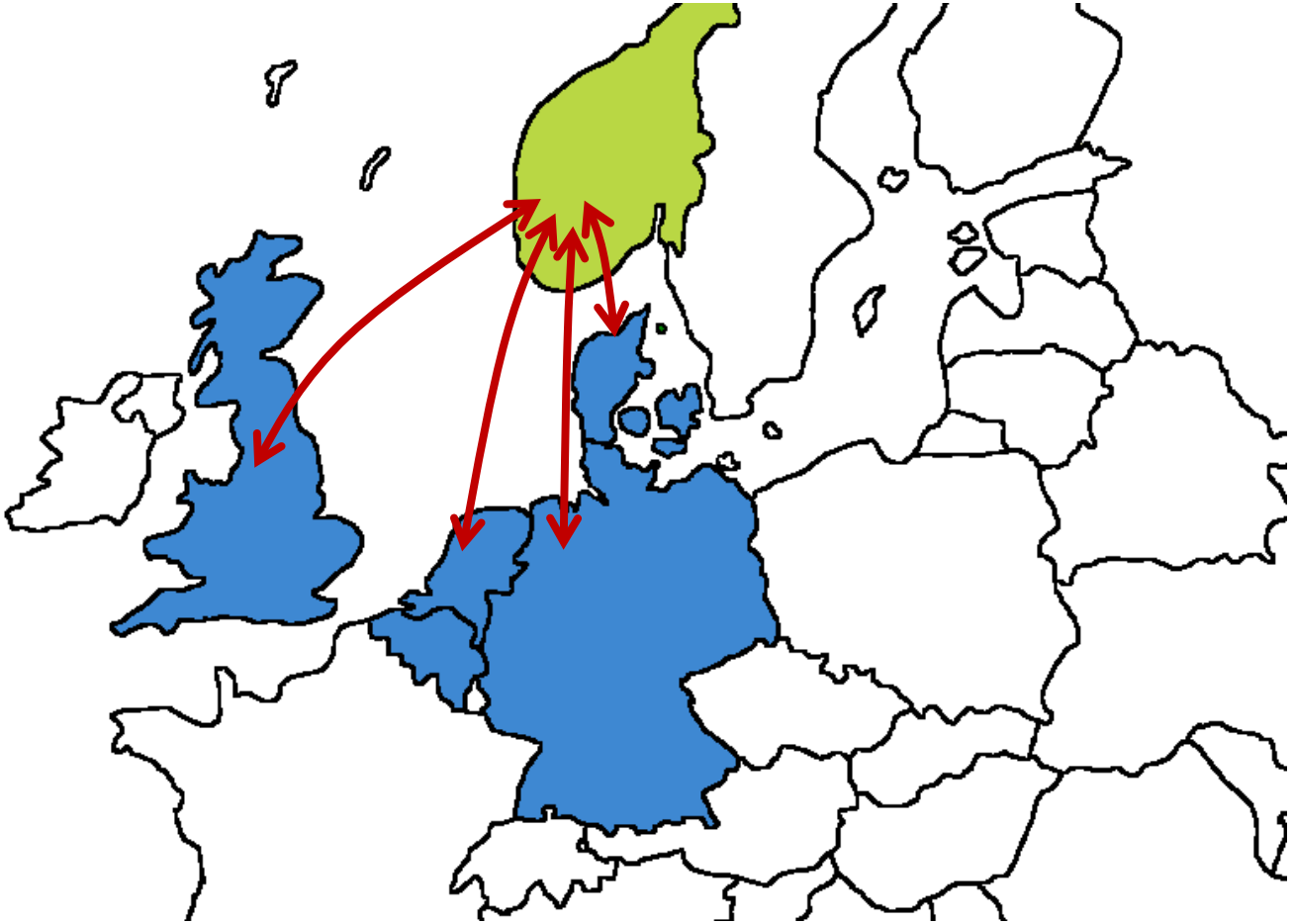
Internal study of balancing cost alternatives in Europe towards 2050

- Performed by senior experts, Sverre Aam, Magnus Korpås, Now 2012-Feb 2013.
- Based on EIA ETP 2012 scenarios and figures.
- Gas, coal and nuclear cost from "UK Dept. of Energy and Climate Change"
- Norwegian pump-storage data from Statkraft, Statnett and NVE

WP 2: Simulated power generation from wind in the North Sea area: 2030 – 100 000 MW

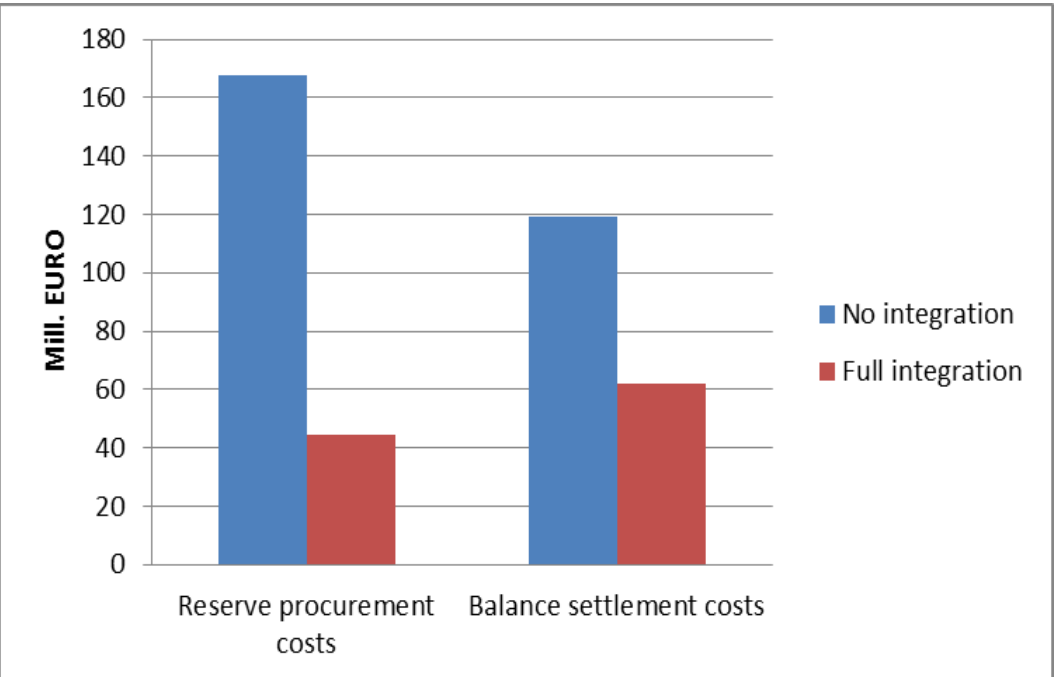


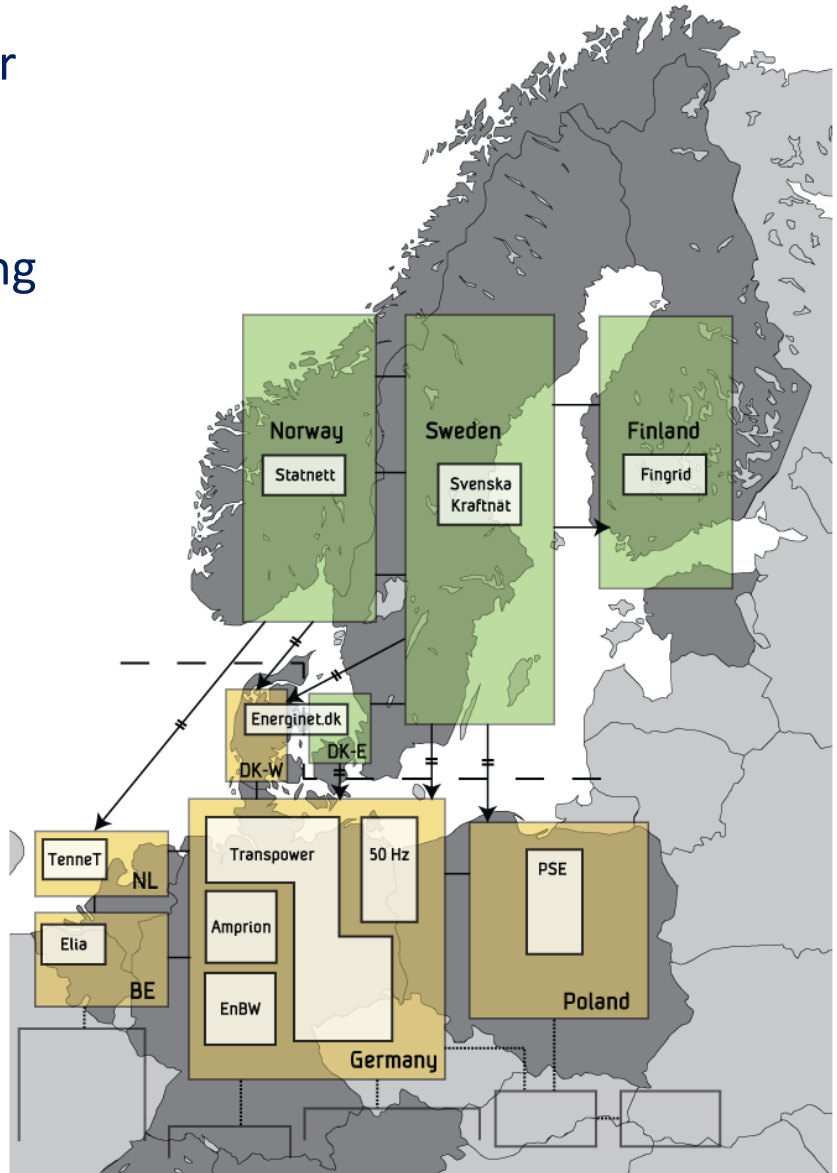
WP 2: Germany is not the only with a balance request



WP 3: Business models

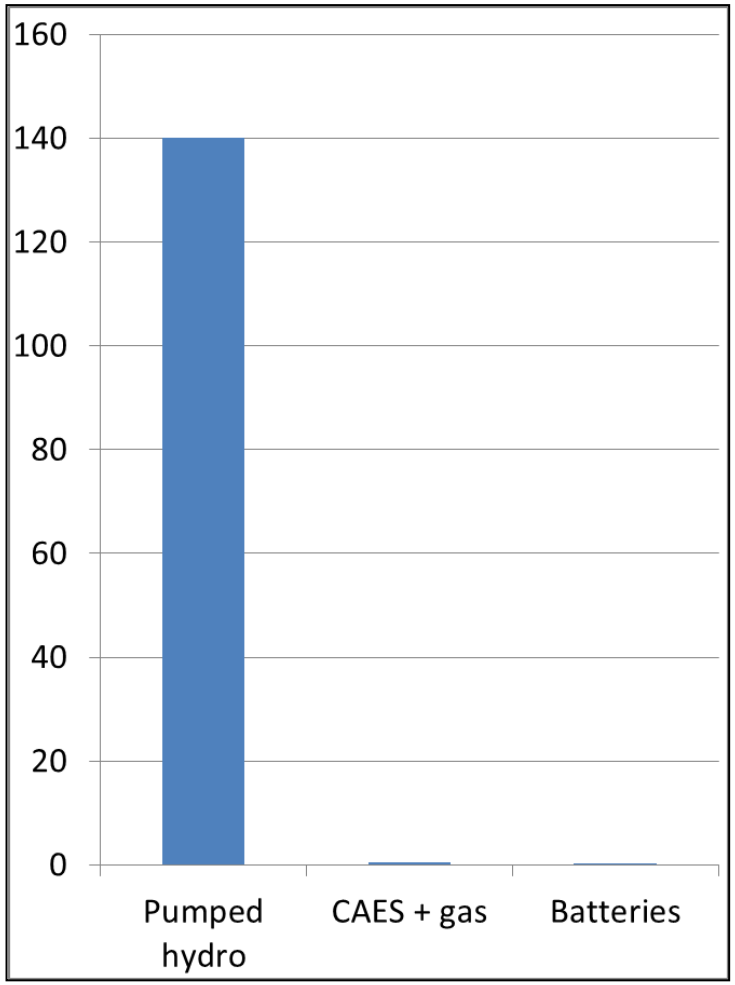
- Does it make sense to optimize cross-border balancing services?
- Large gains can be achived by market integration, shared between energy, balacing and system services.
- **Cross-border cooperation pays of.**



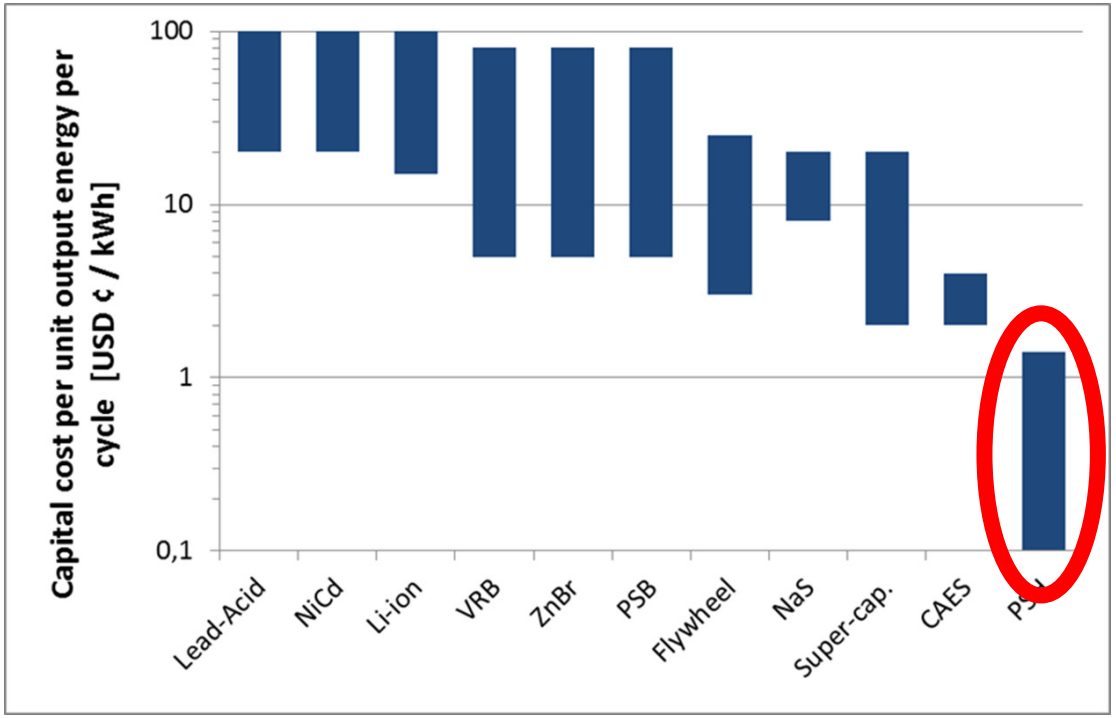


WP 3: Storage capacity and cycle cost

Existing storage capacity in GWH

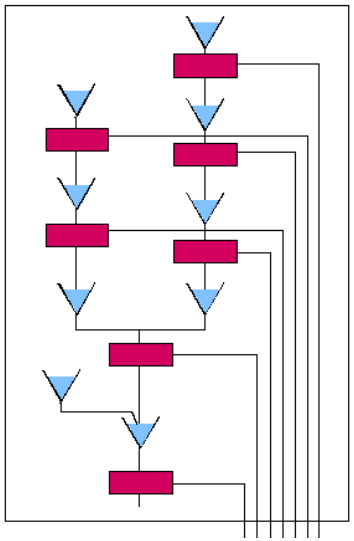


Comparing cycle cost

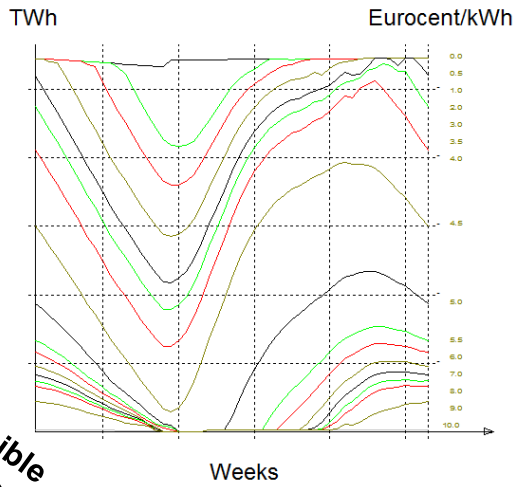


WP 3 & WP 2: Profitability in a larger perspective

Storage possibilities



Strategy by (SDP/SDDP)

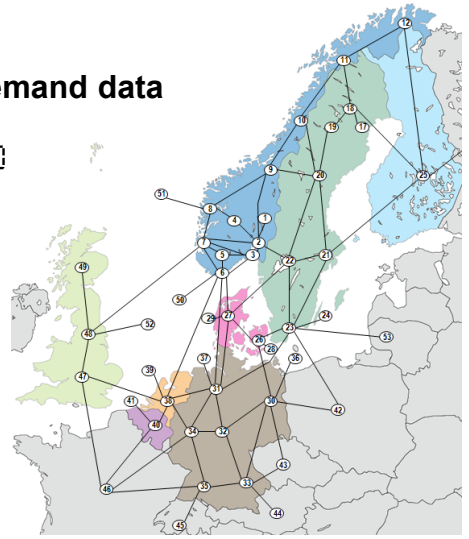


Feasible solution

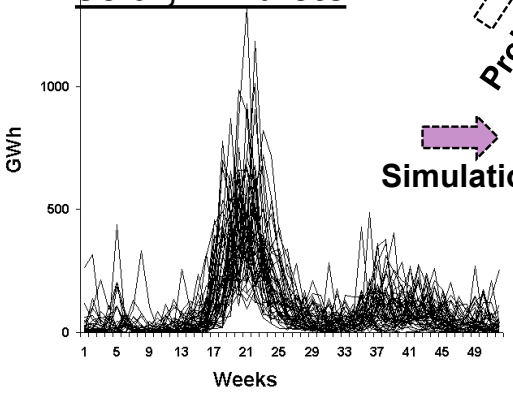
Vannverdi

Markets and prices

Supply/demand data



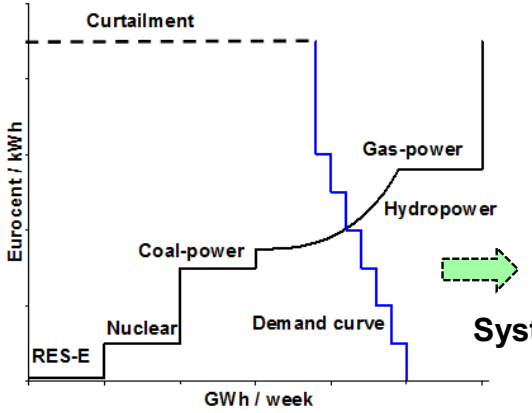
Stochastic, inflow solar, wind etc



Probability

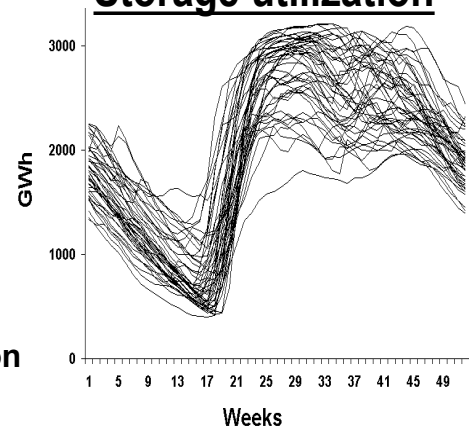
Simulation

Simulating markets (LP)



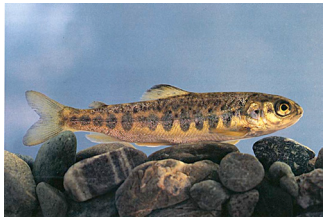
System operation

Storage utilization



WP 4: Environmetal impact

How much water is enough?

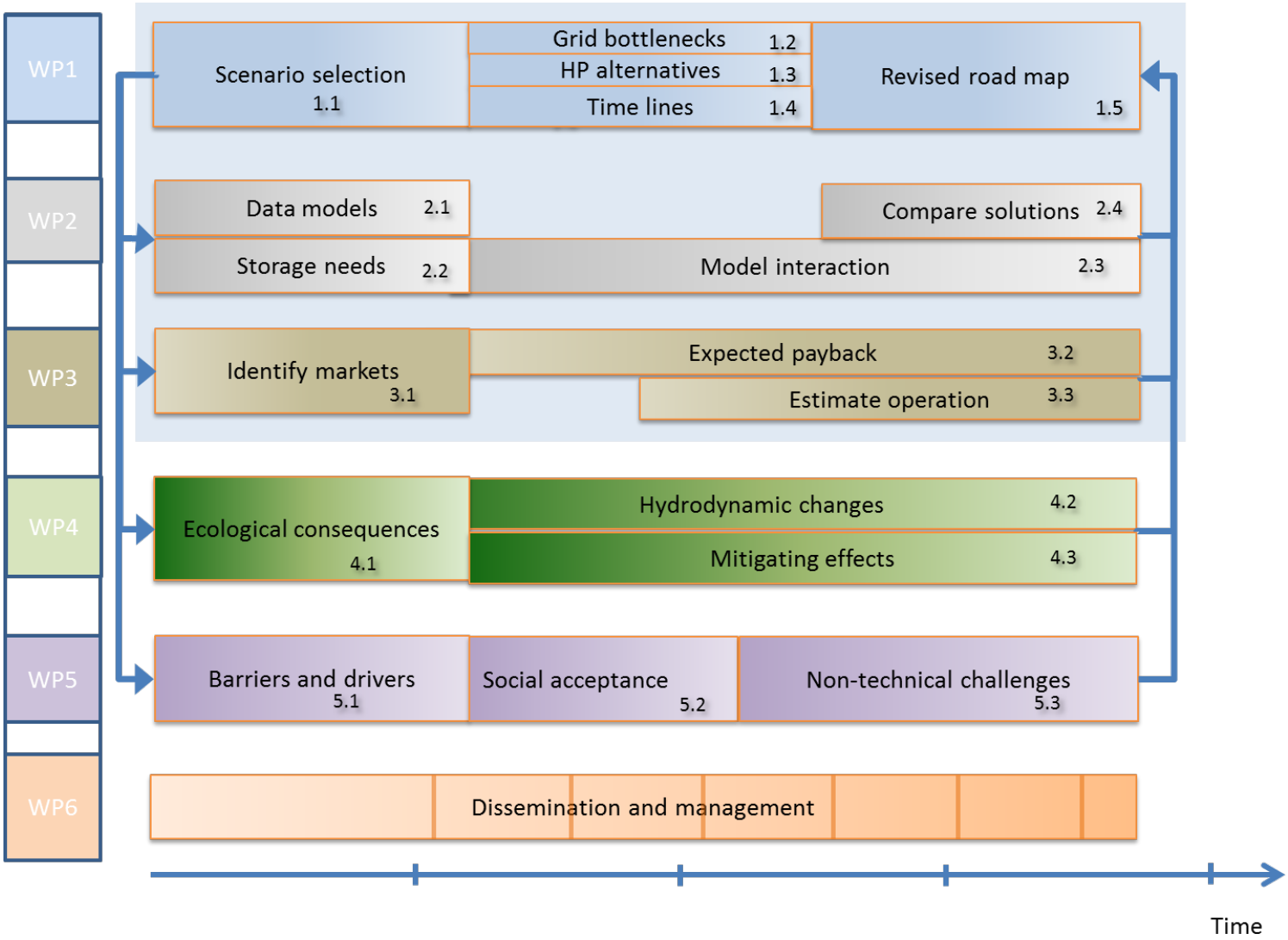


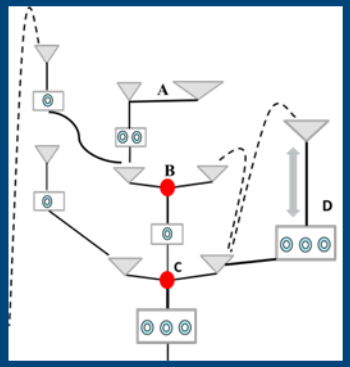
How fast can we regulate?

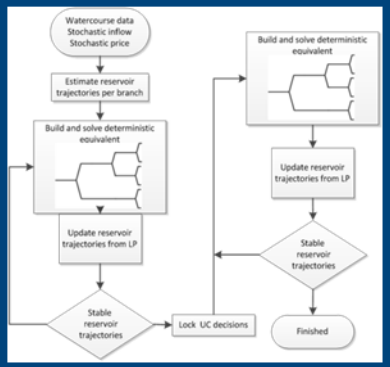
WP 4: Connecting environmental impact and economy

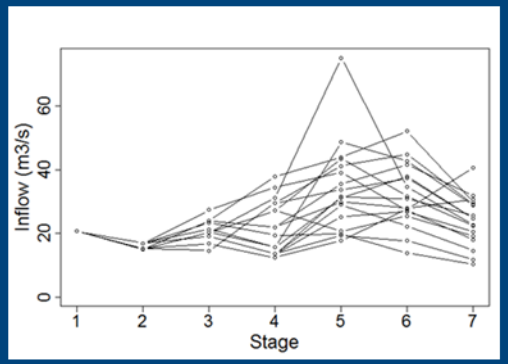
WP 5: Social acceptance and regulatory framework

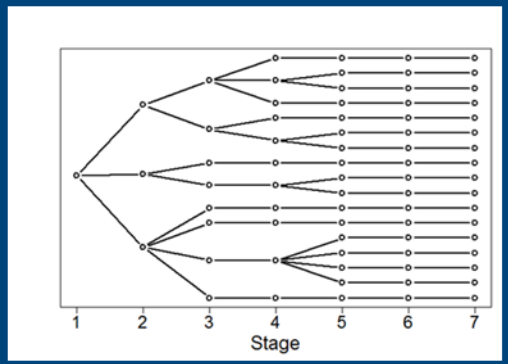
Workflow in CEDREN HydroBalance











Thanks for your attention

Questions?