WP1 HydroBalance, CEDREN and scenarios

Connecting HydroBalance and environmental design

All pictures from the Banje hydropower reservoir in Devoll, Albania
What is environmental design?

- Adjusting to future sustainable use of resources

Local adaptations

Holistic thinking on development of renewable energy with a global perspective
Why environmental design?
(defined in CEDREN)

- Strong demand for renewable energy in Europe
- Increasing need for energy storage and use of hydropower for balance
Environmental design and HydroBalance

Why HydroBalance has been at the core of CEDREN:
1. More variable electricity production => A basis in HydroBalance
2. Looking at the future(s) of hydropower => perspectives
3. Expanding the scope from local to regional and global
4. Based on needs expressed by CEDREN management board and researchers
Environmental design and HydroBalance (1)

More variable electricity production =>
The basis of HydroBalance
  – Increased flexibility at the same time as increased needs for energy storage
  – How to achieve even more sustainable use of resources
Environmental design and HydroBalance (2)

Looking at the future(s) of hydropower

– Scenarios
– Potential
Environmental design and HydroBalance (3)

Expanding the scope from local to regional and global

- Connection Norway to the rest of Europe
- Addressing global issues and local challenges
- Adding international research and user partners
Environmental design and HydroBalance (4)

Based on needs expressed by CEDREN management board

- CEDREN Pilot projects
- Integrating multiple research areas
Connecting multiple research areas

Additional HydroBalance and CEDREN targets

1. The connection of different research areas in the study of environmental design
2. The integration of variable renewables and hydropower

CEDREN: Use knowledge and methods from environmental design of “regular” hydropower production to:
- Environmental design and technical challenges of peaking hydropower and balance market operations
- Further develop methods and models for environmental design of all renewables and integrated systems
Connecting multiple research areas (1)

The connection of different research areas in the study of environmental design

The HydroBalance project runs along the three axes of CEDREN: technology, environment, and society.

CEDREN: Use knowledge and methods from environmental design of “regular” hydropower production to:

- Environmental design and technical challenges of peaking hydropower and balance market operations
- Further develop methods and models for environmental design of all renewables and integrated systems
Connecting multiple research areas (2)

The integration of variable renewables and hydropower

Wind
Solar

CEDREN: Use knowledge and methods from environmental design of “regular” hydropower production to:
- Environmental design and technical challenges of peaking hydropower and balance market operations
- Further develop methods and models for environmental design of all renewables and integrated systems
The HydroBalance scenarios

- Anchored in CEDREN board
- CEDREN on a European level

- HydroBalance pilot ->2012
HydroBalance pilot results

- Report and policy brief
The four scenarios

Main scenario characteristics

- High Integration of Norway with grid and markets of Central EU+UK
  - Small storage
  - Nordic storage
  - Niche storage
  - Big storage

- Low Amount of balancing from Norway
  - Small
  - Large

Legend
- Bubble size:
  - Balancing on: all time scales
  - Long time horizons only

CEDREN
Centre for Environmental Design of Renewable Energy
**Scenario building**
- Which role can energy balancing and storage from Norwegian hydropower play in the European electricity market in the year 2050?
- Four scenarios with varying amount and time horizon of energy balancing

**Hydropower in Norway**
- Installed capacity: 31 GW
- Mean annual generation: 130 TWh
- Storage capacity: 84 TWh
- Additional potential using existing reservoirs and dams: at least 20 GW

**Scenarios**
- A – Small battery
- B – Big battery
- C – Niche battery
- D – Nordic battery

**Balancing and storage needs**
- Establish data models with sufficient temporal and spatial resolution
- Analyse the need for storage at different time horizons in a multiple coupled market environment
- Model interaction between day-ahead, intra-day and balancing markets
- Compare alternative solutions for storage

**Business models**
- Investigate where and how energy balancing and storage as a service may enter the markets, and assess economic opportunities
- Identify markets, assess business models and analyse expected payback for investors
- Simulate operation and revenue of hydro storage and pumped storage plants

**Environmental impacts**
- Analyse impacts of frequent, rapid water level fluctuations in reservoirs on abiotic and biotic environment
- Compare ecological effects on fish communities and food webs in reservoirs
- Model hydro-dynamics for different reservoir types
- Develop operational guidelines for mitigation of impacts

**Regulatory framework and public acceptance**
- Identify the main non-technical challenges
- Assess how increased use of energy balancing is perceived among stakeholders at national, regional and local level
- Determine regulatory and policy drivers and limitations

**Roadmap**
- Draw time lines and development steps for alternative options to use hydro storage and pumped storage for providing energy balancing and storage
- Address requirements, recommendations and limitations in relation to the regulatory framework, environmental regulations, public acceptance, business models and investment needs
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