Brukermøte HYDROPEAK

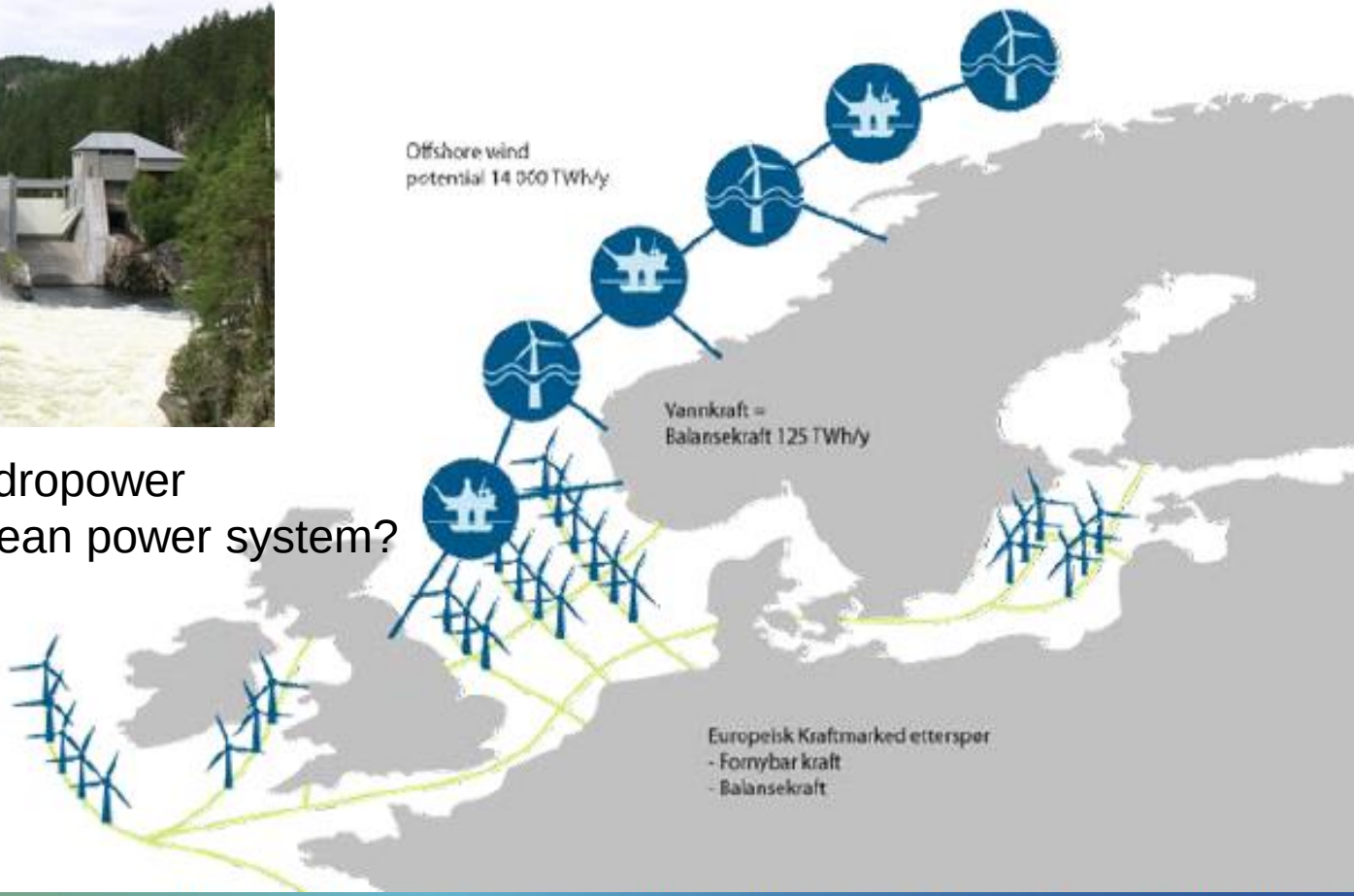
NTNU-IVM 30 Oktober 2014

Ånund Killingtveit

HYDROPEAK

Hydro power development for peaking and load balancing in a European system with increasing use of non-regulated renewables

How will Norwegian hydropower
fit into the future European power system?



HYDROPEAK - Main goals

To study how the hydropower system can support increasing amounts of non-regulated renewables (eg offshore wind power) for Peaking and large scale Power balancing

What type of adaption that are needed (and possible) in the existing hydropower system

Optimal design of the future hydropower system (including adaption to future Climate Change)

Technological evolution and innovation (e.g. for pumped storage, tunnels, …)

Design of environmentally friendly hydropower

Work-packages in HYDROPEAK

WP1	Scenarios and Dissemination	SINTEF/Solvang
		NTNU/Killingtveit
WP2	Hydrology	SINTEF/Kolberg
		NTNU/Alfredsen
WP3	Modelling power system	NTNU/Doorman
WP4	Pumped storage plants	NTNU/Nielsen
WP5	Frequency and load governing	NTNU/Nielsen
WP6.1	Load fluctuation – Tunnels	NTNU/Olsen
WP6.2	Surge chambers	NTNU/Lia
WP7	Load fluctuations – Rivers	NTNU/Ruther
WP8	River ice – Climate change	NTNU/Alfredsen
		SINTEF/Charmasson
Project leader HYDROPEAK		NTNU/Killingtveit

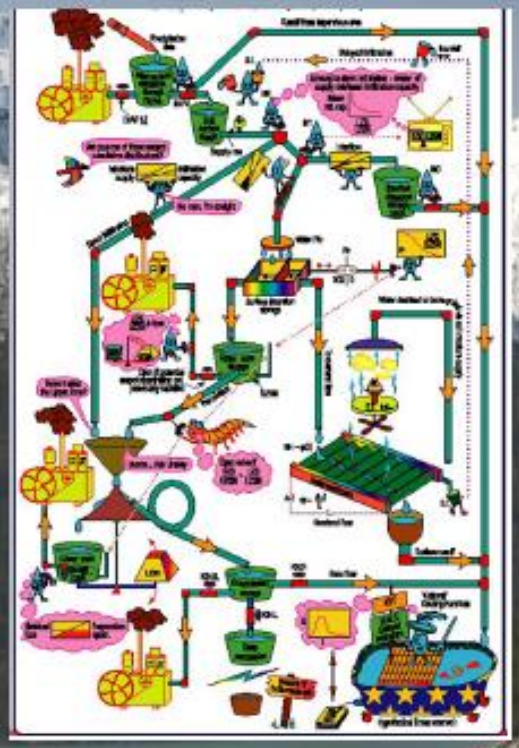
WP 2: Hydrology

Project leader: Sjur Kolberg, SINTEF

1 PhD (NTNU)

2009 – 2013

PhD Candidate identified



WP2: Hydrology

PhD project: Development of inflow prognosis model for short term peaking operation (Improved distributed hourly runoff computation in hydrological models)

PhD Fellow: Teklu T. Hailegeorgis
Nationality Ethiopian
Supervisor: Knut Alfredsen
Department: Department of Hydraulic and Environmental Engineering, NTNU

Start: Januar 2010
Finished: July 2014
CEDREN project: HydroPEAK, WP2: Hydrology

Project description

Due to anticipated increase in energy production from non-regulated sources, management of hydropower reservoirs for peaking or load balancing operation will require improved short time-step inflow prognosis tools for optimal and environmentally friendly reservoir management. The main tasks include:

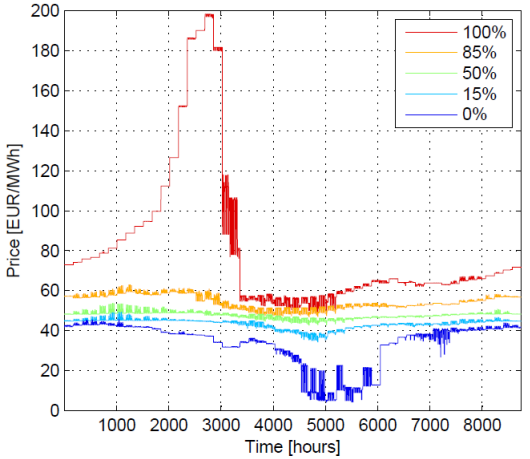
- Developing improved distributed precipitation-runoff algorithms for operational environment;
- Model calibration, validation and application; and
- Model predictive uncertainty assessment.

http://www.wsl.ch/land/products/rhone-thur/en/hydropeaking/welcome.php

WP3: Modelling Power System

Postdoc project: Assessing capacity mechanisms in the European power system

PostDoc Fellow:	Stefan Jaehnert
Nationality	German
Supervisor:	Gerard L. Doorman
Department:	Department of Electric Power Engineering, NTNU
Start:	April 2013
Finished:	April 2015
CEDREN project:	HydroPeak, WP3

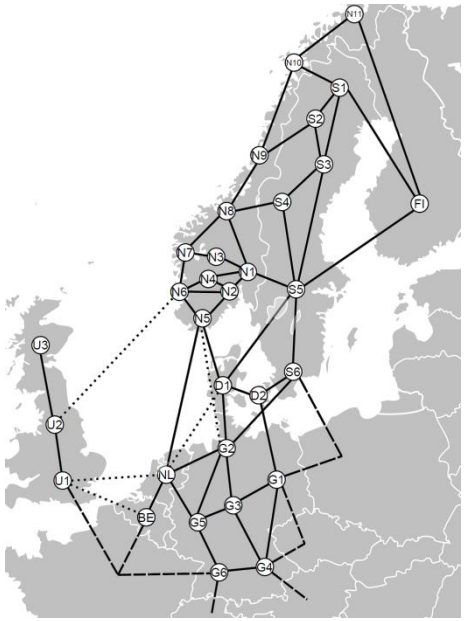


The overall objective of the work is to evaluate challenges and opportunities for Norwegian hydro power production in the course of evolving capacity mechanisms in the European power systems.

In particular the work focusses on the effects of introducing capacity mechanisms in Northern Europe (Germany, Netherlands) on the operation and the development of the Nordic power system.

Furthermore, mutual benefits for the power systems due to the participation of Norwegian hydro production in these capacity mechanisms / markets are assessed.

Finally, the necessary conditions respectively the framework for such a participation is investigated.



WP4: Pumped Storage Plants

PhD project: Dynamic Behaviour of Pumped Storage Plants

PhD Fellow:	Eve Cathrin Walseth
Nationality:	Norway
Supervisor:	Torbjørn Nielsen, NTNU, and Bjørnar Svingen, Rainpower.
Department:	Department of Energy and Process Engineering, NTNU
Start:	August 2009
Finished:	June 2014
CEDREN project:	HydroPEAK, WP4

Project description

The introduction of the free market and increased focus on intermittent renewable energy sources has led to a need for new operating patterns in the Norwegian hydro power system. Reversible pump turbines can increase the flexibility and stabilize the grid with increased production from intermittent renewable energy sources.

The goal of this project is to develop a program suitable for simulating start-up in order to discover instability in a pumped storage plant. With this type of tool available, new start-up procedures can be found in order to handle a more effective alternation between generating and pumping mode.

WP5: Frequency and Load Governing

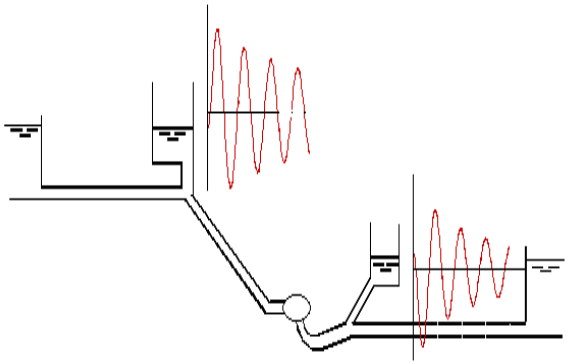
Post.Doc project: Impacts on existing hydro power due to new renewable energy

Post.Doc Fellow:	Pål-Tore Storli
Nationality	Norwegian
Supervisor:	Torbjørn K. Nielsen
Department:	Department of Energy and Process Engineering, NTNU
Start:	September 2010
Finished:	Mars 2014
CEDREN project:	HydroPEAK, WP5

Project description

This project is seeking to investigate the consequences on existing hydro power plants because new power from renewable sources are being added to the grid. This new power can typically not be stored and used later, so these sources must be harnessed when the energy is present. This means that the necessary balance between consumed and produced electrical power must be obtained by governing of existing hydro power plants. This new governing regime will have consequences for the stability of the hydro power plants, as well as undesirable secondary effects such as emptying of sand traps through the turbines, larger forces on waterways and tunnels than originally assumed and designed for, et.c.

The project is likely to be a case study.



WP6.1: Flow fluctuations - Tunnels

PhD project: Effects of load fluctuations on tunnels and hydraulic structures

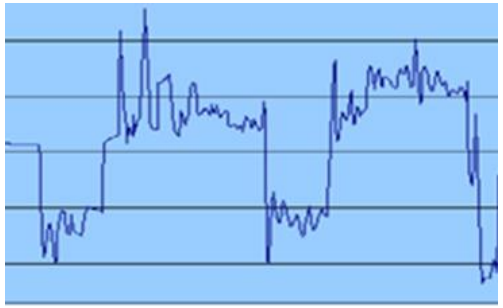
PhD Fellow:	Kari Bråtveit
Nationality:	Norway
Supervisor:	Nils Reidar Bø Olsen and Ånund Killingtveit
Department:	Department of Hydraulic and Environmental Engineering, NTNU
Start:	January 2011
Finished:	January 2015
CEDREN Project	HydroPEAK, WP6.1

Project description:

Transients may destabilize the tunnel roadway and scour deposits from sand traps, resulting in sand transport and turbine damage. In addition, pore pressure variations may loosen weak rock masses and trigger rock falls. Hydropower intakes and tunnels are generally poorly instrumented and monitored, and hence reliable data on loss of water, friction losses, air and sediment problems are virtually non-existent. The main object of the research is therefore to develop methods in order to predict the effects of load fluctuation in hydraulic systems.

Progress steps in detail:

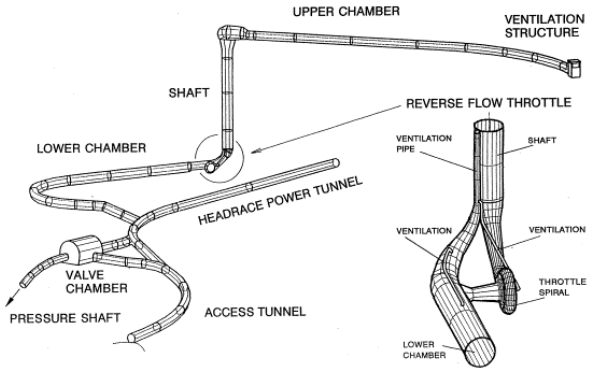
- Develop reliable monitoring methods of critical parameters
- Derivate the magnitude of load fluctuation from collected data
- Evaluate how the different structures are affected by the load fluctuation
- Establish a procedure to predict the consequences of load fluctuation for a given hydraulic system



WP6.2 Surge Chambers

PhD project: Air Cushion Chambers in Waterways for Hydropower Pumped Storage

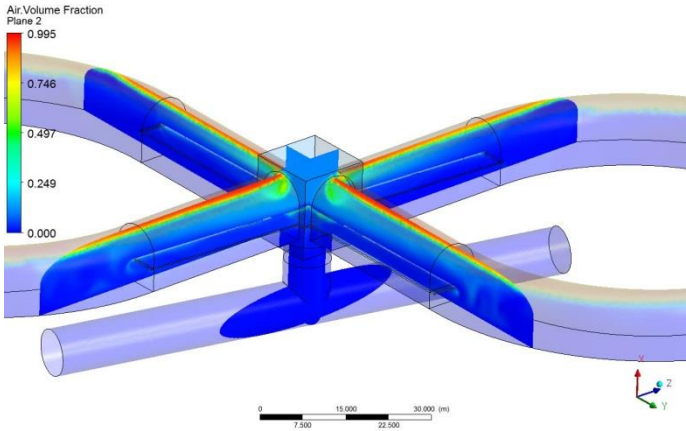
PhD Fellow:	Kaspar Vereide
Nationality	Norwegian
Supervisor:	Leif Lia and Torbjørn Nielsen
Department:	Department of Hydraulic and Environmental Engineering,NTNU
Start:	August 2012
Finished:	August 2016
CEDREN project:	HydroPEAK, WP6.2



The goal of the project is to increase the knowledge about the properties and behaviour of the air cushion surge chamber in hydropower waterways, and further develop and optimize the design of these installations.

In-situ measurements from existing air cushion chambers will be conducted in cooperation with Norwegian power companies. These measurements will be used to program, calibrate and validate numerical models for the investigations.

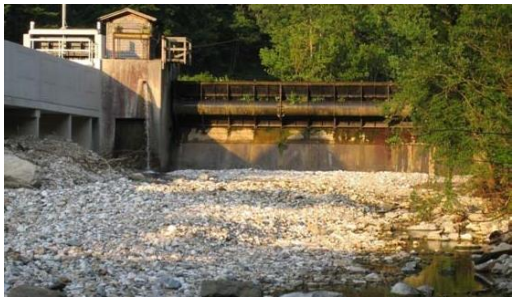
Development of new design and optimization of the air cushion chambers will be conducted with a combination of physical modelling and numerical modelling at the hydraulic laboratory at NTNU.



WP7: Flow Fluctuations - Rivers

PhD project: Physical effects of load fluctuations in rivers and reservoirs

PhD Fellow:	Stephan Spiller
Nationality	German
Supervisor:	Nils Rüther
Department:	Department of Hydraulic and Environmental Engineering, NTNU
Start:	November 2010
Finished:	October 2014
CEDREN project:	HydroPEAK, WP7



Project description

The projects aims for a better understanding of the effects of rapid flow fluctuations is necessary for planning hydro peaking operations and for designing hydraulic structures. The goal of the study is to develop methods for predicting the effects of fluctuating flows, to develop guidelines and to propose mitigation measures.

Progress steps in detail:

- Develop scenarios for hydraulic fluctuations at selected sites.
  (linked to HydroPEAK WP5, EnviPEAK)
- Identify experimental reaches for field monitoring and laboratory testing.
  (linked to EnviPEAK/DORR)
- Analyze the effects of fluctuating loads on bed, banks and structures.
  (linked to EnviPEAK A2)
- Predicting short and long term effects on scour and sediment transport.
- Develop guidelines and propose mitigation measures.

WP8: River Ice – Climate Change

PhD project: About hydropower and its effect on river ice regime

PhD Fellow:	Netra P Timalsina
Nationality	Nepal
Supervisor:	Knut Alfredsen
Department:	Department of Hydraulic and Environmental Engineering, NTNU
Start:	July 2010
Finished:	June 2014
CEDREN project:	HydroPEAK, WP8

Project description

River Ice modeling, to identify the impact of peaking regimes on ice conditions in the regulated rivers. The establishment of 1D dynamic model, Mike 11 with Ice module for simulation of ice formation and break-up. Analyze the future scenarios with climate and operational strategies. Finally, propose mitigation measures and guidelines for peaking operation strategies in ice covered rivers.

HydroPeak Budsjett 2014 (Revidert Sep.)

Totalt	2009	2010	2011	2012	2013	2014	2015	2016	2017
0,00	36 994 754	1 238 426	6 876 037	9 364 856	6 972 236	5 258 192	6 835 007	450 000	0	0

502000131-6 HydroPEAK		CEDREN	SINTEF	NINA	NTNU	LFI	NIVA	Uni	Others
2014		6 835 007	174 503	0	6 660 504	0	0	0	0
01	Administration, coordination	120 000	0	0	120 000	0	0	0	0
02	Information and dissemination	289 997	0	0	289 997	0	0	0	0
03	Meetings, workshops	0	0	0	0	0	0	0	0
10	WP1: Scenarios and dissemination	30 000	30 000	0	0	0	0	0	0
20	WP2: Hydrology	0	0	0	0	0	0	0	0
21	WP2: PhD	212 250	0	0	212 250	0	0	0	0
30	WP3: Impact of short term effects c	50 000	0	0	50 000	0	0	0	0
31	WP3: PhD	500 250	0	0	500 250	0	0	0	0
40	WP4: Pumped storage	150 000	0	0	150 000	0	0	0	0
41	WP4: PhD	0	0	0	0	0	0	0	0
50	WP5: Frequency and load governin	150 000	0	0	150 000	0	0	0	0
51	WP5: Post-Doc	0	0	0	0	0	0	0	0
60	WP6: Hydraulics in tunnels and wa	500 000	0	0	500 000	0	0	0	0
61	WP6: PhD	859 770	0	0	859 770	0	0	0	0
62	WP6: Modellforsøk	1 557 737	0	0	1 557 737	0	0	0	0
70	WP7: Hydraulics in rivers and reser	585 000	0	0	585 000	0	0	0	0
71	WP7: PhD	658 250	0	0	658 250	0	0	0	0
80	WP8: Ice problems in rivers	544 503	144 503	0	400 000	0	0	0	0
81	WP8: PhD	627 250	0	0	627 250	0	0	0	0

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Start:	August 2009
Finished:	June 2014
CEDREN project:	HydroPEAK, WP4

Status:

Eve's PhD utsatt – planlagt ferdig 2015

MSc student Magni Svarstad vår 2014 – målinger for å verifisere Eve's modell

Magni er nå NVKS stipendiat med samme tema – jobber sammen med Eve

Modellutvikling fortsetter (ustabile turbinkurver)

Presentasjon på IAHR konferanse i Montreal i September

Planlegger flere feltmålinger i Sira-Kvina (Duge)