HydroFlex

Newsletter #3

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In every newsletter we challenge each of the work package leaders to present their vision for the HydroFlex project. We hereby present the team of WP 2 Definition of scenarios and reference:

The European power system is currently facing fundamental changes due to climate policy objectives. Caused by these changes, the transmission grid is meant to be more than just a connection between power plants and consumers. It is a Pan-European interconnected mesh which enables cross-border trade as well as a high security of supply. Thus, many research questions related to the European power system have to be solved from a Pan-European perspective. This applies for hydropower and demands put on hydropower as well.

Power transmission grids are not capable of storing significant amounts of electricity over a long period of time. That is why generation must always follow consumption or vice versa to ensure a fully balanced system. The European energy turnaround – which leads to a higher penetration with volatile feed-in – lets this become a sophisticated challenge. It leads to the fact, that flexibility in the power system must be understood both in spatial as well as temporal terms. Besides hydropower, there are numerous competing options for providing flexibility, such as gas-fired power plants, demand side management or options opened up by the increasing sector coupling to heat, gas and mobility sectors. However, hydropower plants are based on renewable energies and have been part of the electricity supply for over a hundred years. They can flex power generation comparatively easily and also have the ability to shift power generation through their huge amounts of long-term storage capacity. By making hydropower technology even more flexible than today – which is one of

the main goals of the HydroFlex Project – these advantages could be extended and hydropower could play a decisive role in the future European power system.

Within the HydroFlex project, work package 2 aims to investigate the future role of hydropower in the European power system: What is the added value of more flexible hydropower with respect to a system perspective? What requirements will be placed on future hydropower plants? How can flexible hydropower contribute to a safe operation of the European power system?

To answer these questions, we are performing a variety of system studies focusing on flexibility which could be provided to the future European power system by future hydropower plants. To do so, we are in constant exchange with the other work packages. For example, we are using data provided by other disciplines, such as the specific characteristics of the flexible hydro power plants, which can be modelled more precisely in our electricity market and grid stability studies. On the other hand, we provide future feed-in schedules and start-stop cycles of hydropower plants in order to derive specific technical requirements or to be able to investigate local ecological effects. We can proudly say that the strong collaboration between the individual disciplines like electrical and mechanical engineering, biology and social sciences is one of the main advantages of the Hydroflex project. It makes a lively exchange between researchers possible and ensures that research on hydropower is driven forward from all relevant perspectives.

2. PhD Candidates - A status update

Marija Lazarevikj
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HydroFlex pHD candidate

A short status update from our PhD candidates. This newsletter presents Marija Lazarevikj who works in WP 3 Flexibility of turbines:

As a PhD researcher on the HydroFlex project, the study visit at the NTNU Waterpower Laboratory in Trondheim with duration of one month and half was a valuable experience which contributed highly to my research. My work was related to development of a Francis turbine guide vanes system design tool by integrating MatLab and ANSYS Workbench with further main aim of achieving structural optimization. By collaborating with academic professionals and researchers at the laboratory such as prof. Ole Gunnar Dahlhaug, Chirag Trivedi, Igor Iliev, Erik Tengs etc. through discussions and knowledge exchange related to my field of research, very good results were produced. Except networking with academic staff, the Waterpower Laboratory offered perfect working conditions with workspace and equipment usage provided.

I am very glad for the established collaboration, profounding my knowledge, meeting different culture and being a part of the activities organized at the laboratory. I am looking forward to repeating the study visit!

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3. WP 4 investigations: How to increase flexibility of hydropower generators

Jose Perez, Henning Lysaker & Ole Gunnar Dahlhaug at Porjus hydropower center.

The goal of HydroFlex WP4 is to investigate how the flexibility of hydropower generators can be increased by the use of power converters. Within the work package, researchers investigate new possibilities as well as the limitations that existing technology imposes on the systems flexibility.
WP4 researchers from Chalmers University of Technology, Uppsala University, University of Strathclyde and from the Norwegian University of Science and technology have access to the Porjus hydropower center facilities. Located in the North of Sweden, the Porjus

hydropower center is the only research and training center in the world with a fully operational hydropower station. Since 1994, the center offers unique possibilities for research and development under realistic conditions [1]. The center is owned by a foundation lead by Vattenfall, HydroFlex partner and the largest energy producer in Sweden. Since its creation, the center has been the host

for exciting and groundbreaking technologies such as the “Powerformer”, a high voltage generator. It is also home to the first magnetic thrust bearing in Scandinavia and to the first “Split-Rotor system”, which is an innovation that balances the magnetic field in the generator despite mechanical imperfections.
Having access to the full-scale hydropower station in Porjus to perform measurements and verify models is an invaluable tool for HydroFlex.

Ref: [1] K. Isaksson, S. Horneman, T. Hagelberg, T. Ottosson, “Forskning i världsklass vid Porjus Vattenkraftcentrum”, ABB Tidning, 1/1999.

4. Hydroflex Headlines / Activities

4.1 HydroFlex Executive Board in Porjus

In September 2019 the HydroFlex Executive Board visited the Porjus Hydropower Center in Northern Sweden. It is a large scale test facility consisting of two turbine-generator sets, where HydroFlex researchers perform tests.

After a tour of the Porjus Hydropower Center, the Executive Board members discussed the progress in the different HydroFlex work packages and made plans for the coming months. Cross-disciplinary understanding and dissemination to stakeholders and the general public were among the issues addressed during the meeting.

4.2 HydroFlex Plenary Meeting May 2019

At the end of May 2019, HydroFlex researchers gathered in Trondheim, Norway for the HydroFlex plenary meeting and public workshop. The plenary meeting, held on May 27’th, close to one year after the initial kick-off meeting, was an opportunity for all the research teams to update each other on the progress of the various work packages.

It is a common challenge for large, multidisciplinary and geographically spread out projects, such as most Horizon 2020 projects, that each researcher and team is isolating their view to one discipline and one work package. Thus, the plenary meeting is an important social and scientific meeting place to ensure collaboration across teams and work packages.

A common language and a common understanding of key challenges for the different teams is important for enabling a good collaboration between the teams. Thus, in addition to the mandatory presentation on the progress for each work package, the program for the day included a number of “popularized” presentations. Popularized is here shown in quotations as one of the feedbacks after the day was that due to the wide range of scientific fields, some of the presentations, even if considered popularized by the presenter, still were too narrow and specialized to really convey their full meaning to the whole audience.

4.3 New publications and conference presentations

Conference Papers:
Inherent damping in a partially dry river. In: Proceedings of the 38th IAHR World Congress / [ed] Lucas Calvo, p. 5091-5100. Burman, A, Andersson, A & Hellström, G (2019)

Experimentally validated model of a fast switched salient pole rotor winding. (Forthcoming in Conference Proceedings of IEEE WEMCDC'2019) Felicetti, R, Abrahamsson, C & Urban, L (2019)

Francis-99: Evaluation of the strain energy density value for welded joints typical of turbine runner blades. Journal of Physics: Conference Series 1296 012007. Foti, P & Berto, F. (2019)

HydroFlex report:
Modelling platform for control design purposes and large-scale power system studies

Webinar:
Overvoltage phenomena in the field winding of a hydropower generator

HydroFlex Poster Exhibition:
Explore the posters of all the PhD projects related to Hydroflex on our website:

5 A final note: The Nordic Balancing Model (NBM)

In parallel with the HydroFlex project, significant changes in the operation of the Nordic power grid is being develop. The work within NBM comprise development of a new common IT platform, design and operation of common regulation markets, as well as new legal framework compliant with European network codes.

The Nordic synchronous region comprise Finland, Sweden, Norway and the eastern part of Denmark. System operation is shared between the four TSO's Fingrid, Svenska Kraftnät, Statnett and EnergiNet DK. Historically the system operation was coordinated through Nordel, founded in 1963. From 2009 all operational task were transferred to ENTSO-E. The NORDEL model was largely based on defining common technical requirements leaving the details of implementing the requirements to each TSO. This permitted local adjustment based on installed base and generation mix.

Over the years changes, including increased share of intermittent renewable energy, more cross border interchange and new consumption profiles have led to operational challenges.

Stronger European integration and the introduction of common Entso-e grid codes have paved the way for stronger Nordic integration as well.
In March 2018 the Nordic TSOs signed a cooperation agreement to develop a new Nordic balancing concept. The practical implementation of the agreement is carried out within the framework of the Nordic Balancing Model (NBM). NBM comprise three focus areas:

- Common IT platform
- Market design and implementation of common markets
- Legal framework

Currently there are plans for introducing a common Nordic automatic frequency restoration reserve market in Q3 2020. A good valuation of the flexibility of hydropower is a prerequisite for a successful implementation of the technical innovations in the HydroFlex project. Accordingly the development in NBM will be of great interest for HydroFlex.