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HYDROMETEOROLOGICAL PREDICTIONS FOR THE HYDROPOWER SECTOR

- POTENTIAL ECONOMIC BENEFITS

New IMPREX approaches increase operational efficiency of the hydropower sector by demonstrating the economic gains of hydrometeorological forecasting combined with efficient management approaches.

The hydropower sector is highly sensitive to meteorological and hydrological extreme events such as floods, droughts and storms. However, hydropower is also characterized by its flexible and reliable electricity production, which is largely due to its capacity to store water in reservoirs. Storing water means storing energy at one time for its use at a later time. This key advantage paves the way for efficient hydropower management through (1) fostering the integration of local and large-scale intermittent renewable sources (e.g. wind and solar photovoltaics) in the energy grid system and (2) by providing water services beyond electricity generation that are in line with different water demands, e.g. for irrigated agriculture and environmental preservation services.

In the face of changing climate and accompanying extreme events with potentially severe impacts on future water resources availability, the demand for accurate weather and climate services in the hydropower sector increases. Weather and climate services are needed for different purposes along the chain of energy generation, management and planning. Long-term planning of energy production and ensuring energy supply security during peak demands are two examples where these services are indispensable.

Optimal weather and climate services also contribute to efficient management of other topics, such as:

- Multi-use reservoir management
- Space-time allocation of water resources for energy generation
- Flood and drought risk mitigation
- Integration with other climate-related renewable energy sources (e.g., wind and solar power)
- Climate adaptation
- Strategic and sustainable energy planning to secure economic growth and environmental preservation

Predicting extreme events is also important to guarantee power plant and dam security for the safety of people, and to reduce or prevent environmental impacts. The economic value of water resources for hydropower production relies on accurately predicting river inflows and ensuring that electricity generation is balanced with demand in real time. It is thus important for electricity companies to anticipate water resources and adequately allocate available electricity in periods of high demand.

IMPREX developed new forecasting products and hydropower management procedures that contribute to better inform decisions on electricity production planning and, as a result, to the optimization of energy production and revenue. Based on these products and procedures, IMPREX investigated the potential economic benefits of improved hydrometeorological predictions, including extremes, at short-, medium-, and long-ranges in the hydropower sector.

Despite the anticipated benefits from using weather and climate services, uptake of state-of-the-art products by practitioners in the hydropower sector is still limited. IMPREX shows that there is space for improving the economic performance of the sector. Guidance is needed in order to adequately use and process data and information in the existing operational and planning procedures.

PRODUCT PRESENTATION

IMPREX developed a robust approach to quantitatively demonstrate the economic impact of climate and water forecasts in the hydropower sector. The approach includes the following components:

- Quantification of the economic value of hydrometeorological predictions in four independent case studies in Europe, representing different climate conditions and hydropower management setups that can be found in current operational settings
- A proof-of-concept on the use of benchmarks and enhanced predictions to identify starting points for system improvement towards better economic performance in hydropower production
- Improved reservoir-based hydropower management strategies at different time scales, adapted to specific needs of local stakeholders
- Guidance on how hydropower optimization can benefit the most from hydrometeorological predictions

COMPETITIVE EDGE

- The approach considers short-term optimised operations, risk-based decision-making and optimisation of management procedures on a longer term, thereby potentially increasing the economic benefits in hydropower reservoir management and planning.
- The methodologies developed, tested and demonstrated within the four different case studies can be transferred to other European locations with similar operational contexts.
- The approach brings together climate- and market-oriented strategic viewpoints, spanning multiple time horizons of sectoral operations and planning.
- The quantitative assessments allow the integration of other interests of water users in the same river basin (e.g., hydropower managed together with irrigated agriculture).

STAKEHOLDER ENGAGEMENT

Electricité de France (EDF) closely accompanied the development and testing of the IMPREX assessments in the case study carried out in France. Operational management and decision-making at EDF strongly depends on river flow forecasts. The company runs an expert-based hydrological ensemble prediction system to monitor the risk of extreme events and to predict inflow to reservoirs located at upstream valley areas on a daily basis.

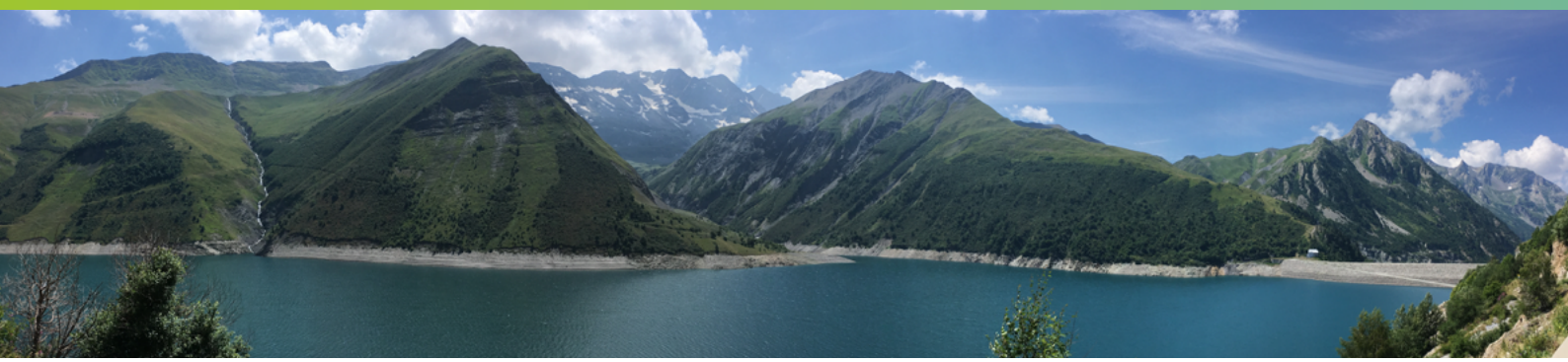
Forecasts and management approaches have been used both by the EDF unit responsible for the optimisation and trading of resources and by the local hydraulic centres responsible for dam security and reservoir management. IMPREX provided a proof-of-concept to quantify the value of hydrometeorological predictions. Therefore, the team linked river flow forecasts for different time horizons to water reservoir management models to optimise energy production. In order to assess the impact of the forecasts used, different calculations were made to quantify both the quality and the sector value of hydrometeorological predictions. Outcomes of the collaboration with EDF confirmed that systematically overestimating reservoir inflows can lead to large economic losses on hydropower revenue when the considered reservoirs have a small storage capacity and short-range (7 days ahead) forecasts are used. An important lesson learned is that flow forecasts which are biased and have the tendency to forecast extremes exceeding the observed values, negatively impact the optimal daily management of a reservoir on the long run.

> *Beyond the question of hydrometeorological forecast's value for the hydropower sector, the modelling work developed in IMPREX provides valuable support to test and demonstrate the decision process it simulates*
> *Rémy Garçon, forecasting and hydrometeorology expert, EDF*

Overall, the science-practice collaborations within IMPREX have shown that it is essential to embed both climate-oriented and market-oriented dynamics in real-time decision-making. It was highlighted that medium- and long-term decisions are mostly driven by climate and hydrology at the local scale, whereas daily and sub-daily decisions are often determined by the energy market.

> *In a society where human resources are limited, it is difficult to show the value of operational hydrometeorological forecasts. The work carried out within IMPREX has taken a decisive step in this direction.* *Rémy Garçon, EDF*

Working with EDF and other hydropower companies in IMPREX has shown that fluctuations of both the climate system and the electricity market need to be considered in scenario analyses for the hydropower sector, and within management procedures and optimization approaches.



POLICY RELEVANCE

The European climate and energy policy aims at building up and sustaining an affordable, secure and sustainable energy system. Within this system, hydropower constitutes an important pillar for all European regions. In 2012, it corresponded to 11.7 % of the European net electricity generation and about 60 % of electricity from renewable resources. As a leading renewable energy resource, hydropower is therefore a key sector in achieving the EU targets for the reduction of greenhouse gas emissions and the transition to a carbon-neutral economy.

IMPREX developed strategies and approaches to enhance the value of reservoir water. By co-assessing forecasts and reservoir operation rules, IMPREX demonstrated how climate and water forecasting systems can be integrated into reservoir-based hydropower management to foster interactions among water users and bring value to climate services and society.

The project results have the potential to contribute to a positive development of European and nationwide strategies to reshape energy systems through reliable demonstration of benefits of improved hydrometeorological predictions and integrated management strategies, both in terms of economic gains (revenues) and societal gains (secure and optimized electricity production).

For further information, please visit www.imprex.eu and check out our interactive product demonstrator!

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IMPREX is designed to help reduce Europe's vulnerability to hydrological extremes by achieving a better understanding of the intensity and frequency of potential disrupting events. Enhancing our forecasting capability will increase the resilience of European society as a whole, while reducing costs for strategic sectors and regions at the same time. The research project brings together 23 partners from 9 countries and has received funding from the European Union's Horizon 2020.