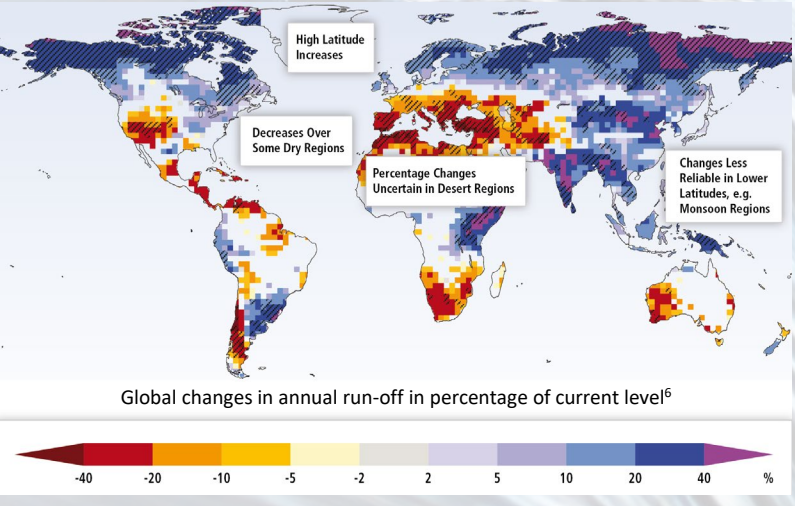
EERA JP Hydropower Policy Brief 1/2020

Hydropower as enabler of the clean energy transition: Future priorities for European hydropower research

A new role for hydropower in the electrical energy system

The layout of the electrical energy system in continental Europe was initiated many decades ago. The energy providers were thermal power plants, where operation was maintained at a constant level. Some run-of-river hydropower added slowly fluctuating amounts of non-dispatchable power, and pumped storage power plants and some storage hydropower plants were used to balance the consumption and production on short time-scales. The future will look very different from this.

The European Green Deal's ambitious target of climate neutrality by 2050 will inevitably reduce the number of thermal units, replacing the energy they provided with emission free renewables such as intermittent wind and solar PV. This will make the job of balancing the consumption and production much harder as fluctuations are high on both production side and consumption side. New technology and inventions are needed to make this possible, however, the fleet of existing hydropower units can contribute to this in a much higher degree than what is currently the case. They are optimized for the electrical system and by technology of the past, and their performance can be improved and redesigned for the future electrical system.



Global changes in annual run-off in percentage of current level[6]

In EU (2018, EU 28) hydropower accounts for around 360 TWh produced annually[1], approximately 43% of the total renewable electricity production[2]. In Europe, hydropower provides approx. 180 TWh of storage[3] and more than 200 GW of power[4] in synchronous generators to stabilise the continental European electrical grid. Of this, approximately 155 GW is conventional hydropower and approx. 45 GW Pumped Storage Hydropower (PSH)[5].

Hydropower and climate adaptation

Adding to the importance of redesigning the existing hydropower system based on energy considerations is the projected need for altered future water management. Precipitation patterns are likely to change, and in some regions the changes are foreseen to be dramatic. Managing the water resource will to a greater extent be determined by handling of flood and drought events. In such cases the hydropower installations, technologies and operation need to be redesigned to obtain an optimal benefit to society.

Flexibility enabling energy transitions

Hydropower is identified as a technology with a huge potential of becoming a much more important asset for the electrical system than is currently the case. The flexibility envisioned will be an enabler for the transitions needed to reach the goals of the Paris agreement. This flexibility will be available after overcoming some fundamental challenges related to technical, social, environmental and economic aspects.

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The EERA JP Hydropower has identified the following focus areas for hydropower research:

- Development of new and innovative methods for designing, engineering, constructing, installing and operating flexible hydroelectric units featuring high grade efficiency, reliability, safety and sustainability
- Using and further developing the latest technology regarding hydraulic scale models, numerical methods, and field investigations. By developing advanced hybrid modelling strategies combining laboratory, numerical and field studies to make full use of the advantages of the different modelling strategies to minimize associated uncertainties
- Value and operational requirements of hydropower in the future power system
- Open source hydropower data and models for energy system analysis
- Investigation of the impacts of climate change on water resources and subsequent impacts on power production and freshwater ecosystems
- Assessing and compensating environmental impacts, lost ecosystem services and biodiversity in reservoirs and downstream rivers
- Assessing factors promoting social acceptance, improved public engagement and increased uptake of hydropower in consumers` energy portfolios
- Investigating supportive and limiting effects of national and European policies, policy mixes and regulations on the environmental upgrading of existing hydropower infrastructure, new hydropower development and increased operational flexibility
- Transformation of hydropower asset maintenance from interval-based to prediction based by use of new sensors and measurements
- Integration of cross-domain knowledge into new and established business processes in the hydropower sector

A detailed description of these research objectives is available in the Strategic Research Agenda of the EERA JP Hydropower.

Hydropower provides energy and power needed to cover end-user consumption on many time scales. Hydropower generation is made possible by synchronous generators, which also provide very important stabilising services to the power grid. Solar PV and wind energy has a limited capability to provide these services. In a future electrical system where thermal synchronous generation has been replaced by these renewable sources, the stability of the grid will be jeopardized. Developing hydropower technologies that enable to keep hydropower units on-line, with larger operational range or even being on-line when not producing power, will relieve this situation.

A new role for hydropower as flexibility provider to the energy system requires new forms of governance and policies that include environmental and socio-economic perspectives. Hydropower production must be balanced with the potential negative impacts on the local environment, local communities and other business sectors. Developing solutions for cost-efficient hydropower production without jeopardizing natural resources and hampering crucial ecosystem services for the society is key.

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[1] EU 28 2018 (363 TWh) [1]
[2] Total renewable electricity generation is 856 TWh for EU 28 2018 [1]
[3] https://www3.eurelectric.org/media/75067/fact_sheet-hydropower-web-2013-160-0002-01-e.pdf
[4] All Europe HP (251 GW) - Nordic countries HP (49,6 GW), including PSH [1]
[5] 200 GW HP presented previously – ~45 GW of PHS in Europe [2]
[6] Kumar, A. et al. Hydropower.In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Available online: https://www.ipcc.ch/site/assets/uploads/2018/03/Chapter-5-Hydropower-1.pdf (accessed on 25 October 2019).

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_generation_statistics_%E2%80%93_first_results#Production_of_electricity
[2] https://setis.ec.europa.eu/publications/setis-magazine/power-storage/europe-experience-pumped-storage-boom