

Importance of hydropower in Europe to mitigate the energy crisis and to serve as a catalyst and enabler for the Green Deal

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Kurzfassung

Die Bedeutung der Wasserkraft in Europa für die Bewältigung der Energiekrise und als Katalysator und Wegbereiter für den Green Deal

Die globale Erwärmung ist die größte bekannte Bedrohung des 21. Jahrhunderts. Die Europäische Union (EU) leistet mit der Ankündigung des Europäischen Green Deal Pionierarbeit im Kampf gegen die globale Erwärmung und setzt damit ein mutiges Zeichen, dem andere Länder und Kontinente folgen können. Die EU hat sich zum Ziel gesetzt, Europa bis 2050 zum ersten kohlenstoffneutralen Kontinent zu machen. Um dieses Ziel zu erreichen, sollen Sonnen- und Windenergie, Öl, Gas und

Kohle bei der Stromerzeugung ersetzen. Solar- und Windenergie sind jedoch unbeständige und nicht planbare Energien. Um diese große Menge an variabler erneuerbarer Elektrizität in das Netz zu integrieren, muss Europa auch bei der Entwicklung und Integration der Speicher- und Flexibilitätskapazitäten der Wasserkraft in das neue Energiesystem führend sein, und zwar effizient und kostengünstig. Um einen wirksamen Beitrag zu diesem beispiellosen neuen europäischen „Green Deal“ auf nachhaltige, effiziente und kostengünstige Weise zu leisten, muss sich der Wasserkraftssektor durch technische und ökologische Innovationen stark entwickeln.

Die aktuelle Energiekrise zeigt, wie wichtig eine unabhängige Stromversorgung mit hoher Verfügbarkeit ist. Hier haben die bestehenden Wasserkraftspeicher bereits einen wichtigen Beitrag geleistet, um die kritische Situation im letzten und auch im kommenden Winter ohne Blackout-Risiko zu überwinden. Neue Mehrzweckspeicher und Pumpspeicherkraftwerke werden in Zukunft für eine sichere, unabhängige und erneuerbare Stromversorgung von entscheidender Bedeutung sein, neben anderen Leistungen wie dem Schutz vor Überschwemmungen und Dürren, um die Auswirkungen des Klimawandels abzumildern. Um die ökologischen, gesellschaftlichen, technologischen und marktwirtschaftlichen Herausforderungen zu bewältigen, muss der Wasserkraftssektor jedoch neue Ansätze für die künftige Entwicklung im Einklang mit den ökologischen und sozialen Anforderungen finden.

variable renewable electricity into the grid, Europe must also lead the development and integration of the high storage and flexibility capacity of hydropower into the new energy system, efficiently and cost-effectively. To provide an effective contribution to this unprecedented new European Green Deal in a sustainable, efficient, and cost-effective manner, the hydropower sector needs to develop strongly through technical and environmental innovations.

The current energy crisis reveals the importance of an independent electricity supply with high availability. Here the existing hydropower reservoirs already played an important role in helping to overcome the critical situation in the last, as well as upcoming, winters without the risk of blackout. New multi-purpose storage schemes and pumped-storage powerplants will be vital in future for a safe, independent and renewable electricity supply besides other services such as flood and drought protection to mitigate climate change effects. Nevertheless, to tackle environmental, societal, technological and market challenges, the hydropower sector needs to find novel approaches to future development in accordance with environmental and social demand.

1 Status of hydropower development in Europe

Today within Europe, including Turkey, almost 650 TWh are generated in an average hydrological year, which equates to about 65% of the economically feasible hydropower potential (see Figure 1). In recent years, the yearly production of hydropower has stabilized near 650 TWh and the total installed capacity close to 230 GW.

It should be noted, however, that the yearly hydropower production is also influenced by the hydrological situation each year.

Figure 2 shows the situation for hydropower use and untapped potential in differ-

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Global warming is the biggest known threat for the 21st century. The European Union (EU) is pioneering the fight against global warming through the announcement of the European Green Deal, bravely setting an example for other countries and continents to follow. The EU aims to make Europe the first carbon-neutral continent by 2050. To fulfil this objective, solar and wind power will replace oil, gas and coal for electricity generation. However, solar and wind are volatile and not dispatchable energies. For integrating this huge amount of

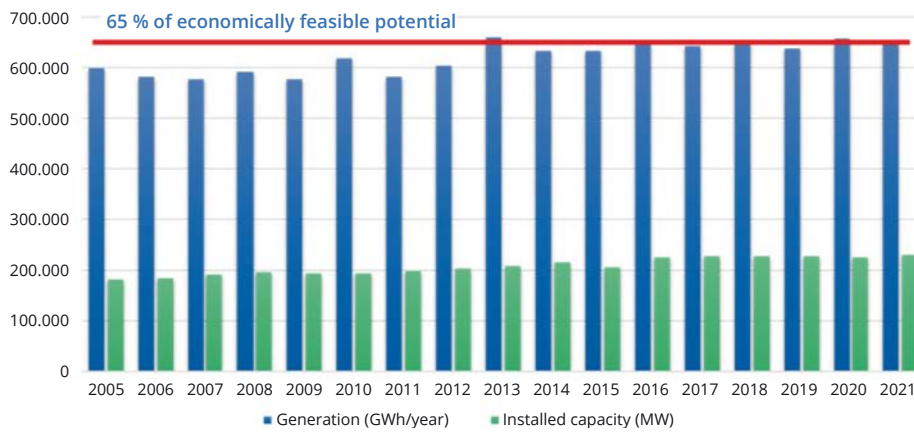


Fig. 1. Evolution of yearly production and installed capacity of hydropower in Europe since 2005 (according to Hydropower & Dams World Atlas 2022).

ent countries within the Europe region. It can be noticed that in many countries there is still considerable potential for development.

In Figure 2, the highlighted countries have developed less than 50 % of the economically feasible potential, assuming that the market conditions would allow for it. For 14 countries the share of hydro in the overall electricity generation is between 25 % and 50 %, for three countries between 50 % and 90 % and for another two countries higher than 90 %.

This demonstrates that in more than half of the countries in Europe (as shown in Figure 2) hydropower represents an important share in the electricity generation, which is important for the success of a safe energy transition.

Nevertheless, relatively little investment has been undertaken over the last 15 years, as can be seen in Figure 3 which shows the installed capacity under construction. In 2012, a quite significant increase in the con-

struction of new power plants reaching almost 10,000 MW can be seen. This may be attributed to the Fukushima catastrophe leading many countries to redefine their energy strategy towards renewable sources such as hydropower alongside the planned phasing out of nuclear energy. Since 2015, however, construction activity has been decreasing to some 3,000 MW with an activity above 5,000 MW in 2019.

The low investment level around 2021 can be attributed to the fact that electricity prices on the European spot market since a decade were very low due to the following reasons:

- Production capacity in Europe was too high (especially via conventional thermal generators using coal)
- The cost of CO₂ certificates was very low
- The market was distorted due to the high subsidies provided for renewable energy sources such as solar and wind

Thus, under such market conditions hydropower generation was strongly penalized.

However, the current energy crisis reveals the important and vital role of hydropower – storage and pumped-storage - to help ensure a safe supply of electricity in the coming winters in Europe. Due to the energy crisis, the attractiveness of the extension and upgrading of existing hydropower plants, with the purpose of making them more flexible through the refurbishment of equipment and increasing storage where possible, together with the construction of new pumped-storage power plants, has increased again strongly in countries with high storage potential.

Furthermore, in many countries, a significant amount of untapped hydropower potential still exists.

However, in view of environmental and socio-economical constraints, the partial use of this remaining potential is extremely challenging and can be reached only through innovative and sustainable solutions for new hydropower plants.

2 Outcomes of the HYDROPOWER EUROPE Forum

The HYDROPOWER EUROPE Forum (<https://hydropower-europe.eu>) was supported by the EC under the Horizon 2020 programme innovative environmental strategies (LC-SC3-CC-4-2018).

The initiative aimed to establish a Forum for conducting an extensive consultation program to support the formulation of a Research and Innovation Agenda, as well as a Strategic Industry Roadmap.

These guides were designed to facilitate the introduction of various innovations

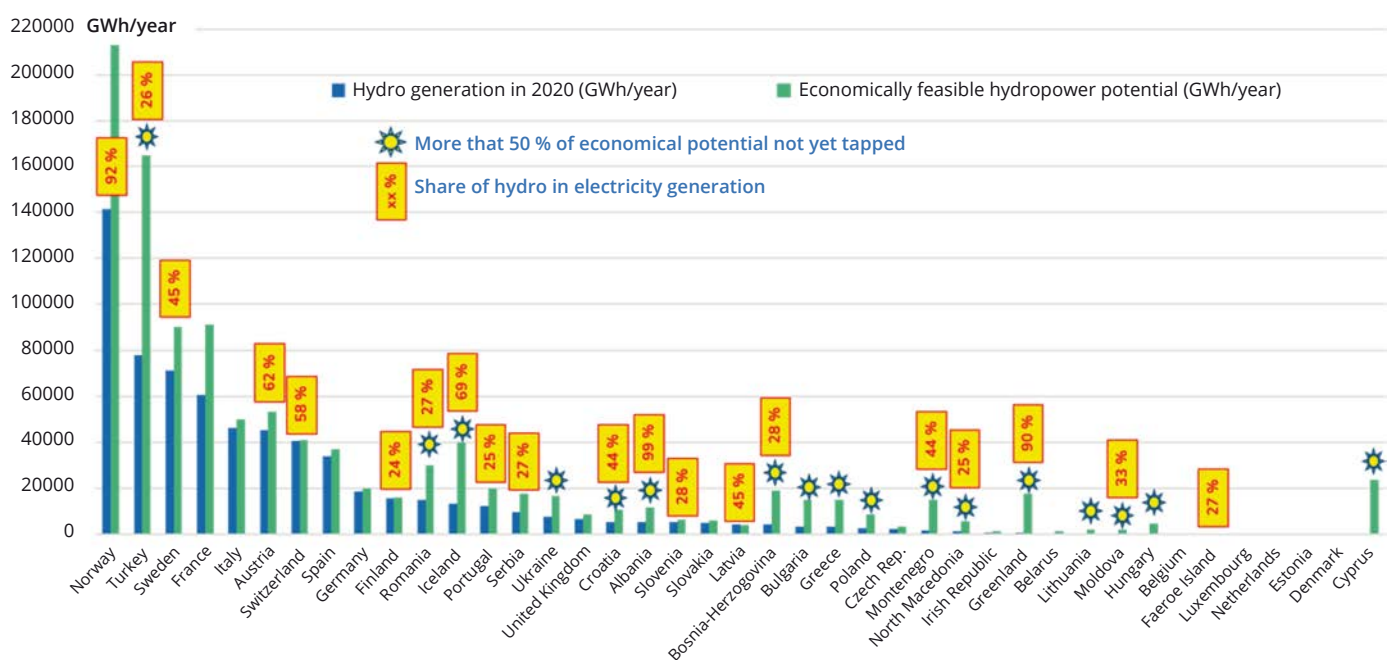


Fig. 2. Generation and extension potential of hydropower in countries within the European region (according to Hydropower & Dams World Atlas 2021). The countries having developed less than 50 % of their economically feasible potential (assuming market conditions have a demand for it) are highlighted. The share of hydropower in electricity generation is indicated for the countries with a share of more than 25 %.



Fig. 3. Installed capacity in MW under construction since 2006 (according to Hydropower & Dams World Atlas 2022 without Turkey).

within the hydropower sector, with the ultimate goal of transitioning towards an energy system characterized by high flexibility and a significant share of renewable energy sources.

The outcomes of the HYDROPOWER EUROPE Forum show the pathway to the vision for hydropower in Europe defined through wide consultation following four directions:

- Increasing hydropower production through the implementation of new environmentally friendly, multipurpose hydropower schemes and by using hidden potential in existing infrastructures.
- Increasing the flexibility of generation from existing hydropower plants by adaptation and optimization of infrastructure and equipment combined with innovative solutions for the mitigation of environmental impacts.
- Increasing storage by the heightening of existing dams and the construction of new reservoirs, which have to ensure not only flexible energy supply but also support food and water supply and thus contribute to the WEF NEXUS and achievement of the SDGs of the United Nations.
- Strengthening the contribution of flexibility from pumped-storage power plants by developing and building innovative arrangements in combination with existing water infrastructure.

This vision was underlined by the Research and Innovation Agenda (RIA) and the Strategic Industry Roadmap (SIR), which also provide an example for hydropower development worldwide. Eighteen research themes comprising some 80 topics were identified in the RIA (see Figure 4) as well as 11 strategic directions including some 40 detailed actions in the SIR, ranging from regulation framework to social acceptance.

In addition, the work done through the HYDROPOWER EUROPE Forum laid the groundwork for the creation of a European Technology and Innovation Platform for hydropower.

3 ETIP HYDROPOWER – Unifying the voices of hydropower

A European Technology and Innovation Platform (ETIP) is a community whose primary purpose is to define R&I priorities for its sector. The secondary purpose is to overcome barriers to the deployment of R&I outcomes: e.g., industrial strategy, market opportunities, exploitation of research results, international cooperation, education, environmental and social impacts. There is a need for a unified industry to be represented and recognized at a European level. The HYDROPOWER EUROPE Forum provided

a first opportunity to gather some 650 stakeholders representing all the sectors of the value chain. Under the ETIP HYDROPOWER project (<https://etip-hydropower.eu>), the hydropower forum will continue to grow and offers an ideal opportunity to help unify the voices of hydropower in Europe.

ETIP HYDROPOWER will further detail the already developed industrial strategies as well as analysis of market opportunities and research and development funding needs, by deepening the understanding of innovation barriers and exploitation of research results, which are in line with the Recovery Plan for Europe and the latest EU climate and energy related policies.

The ETIP HYDROPOWER has the mission to:

- represent a consolidated and strong network of representatives from industry, academia, research centers, civil society and sectorial associations of the hydropower sector,
- enhance and disseminate the RIA and the SIR taking into consideration the future needs of the sector and R&I targets and emerging policy priorities,
- align and coordinate the industry RIA and SIR strategies to provide consensus-based strategic advice to the European Commission and the SET Plan (European Strategic Energy Technology Plan) covering

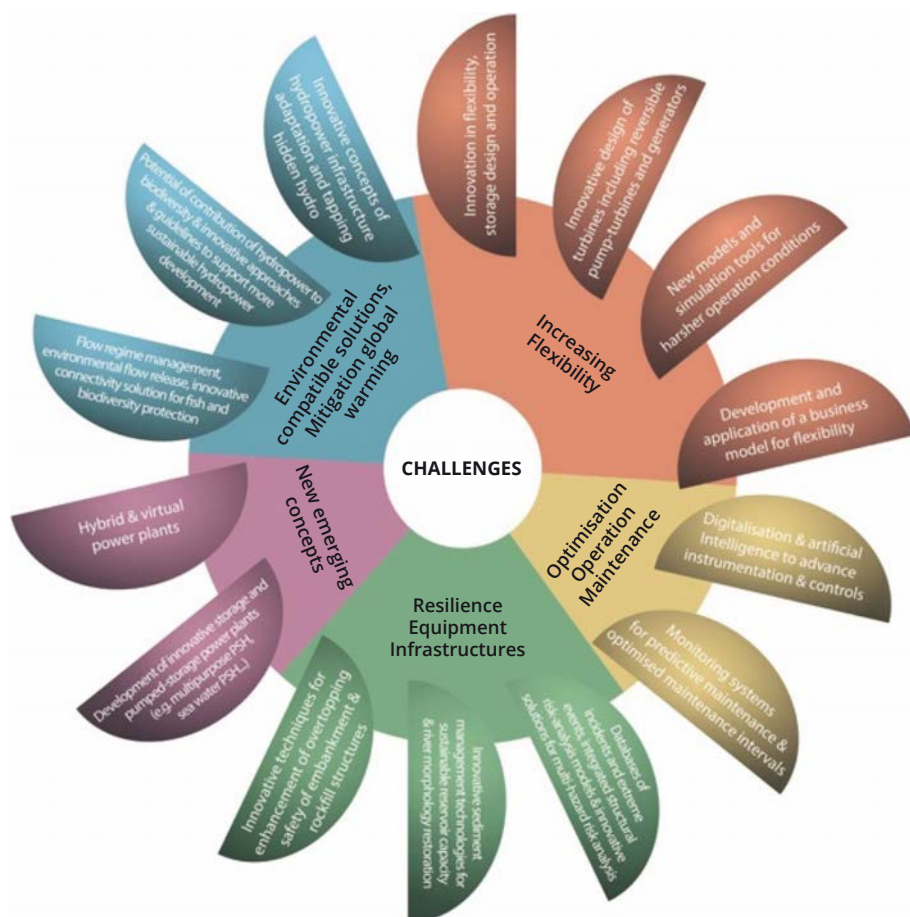


Fig. 4. Suggested research themes by HYDROPOWER EUROPE with high to very high priority grouped according to the challenges which hydropower must address.

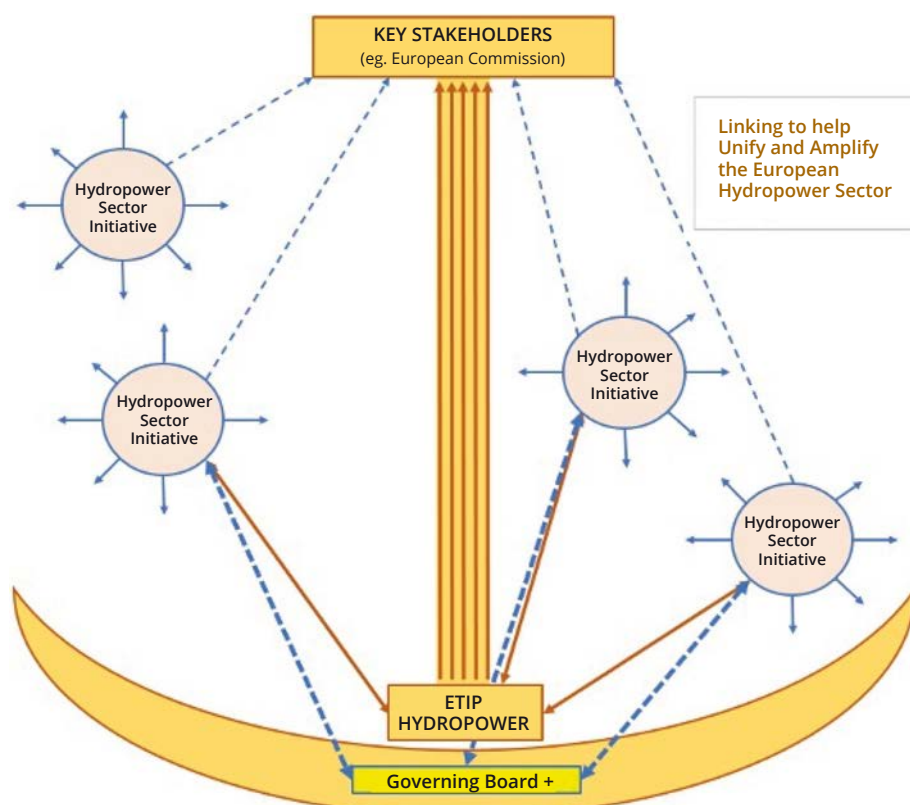


Fig. 5. Generic representation of the mission and activities of ETIP HYDROPOWER at a strategic level within the hydropower sector.

analysis of market opportunities and research and development funding needs, biodiversity protection and ecological continuity,

- and deepen the understanding of innovation barriers and the exploitation of research results in line with the latest EU climate and energy related policies.

Figure 5 provides a generic representation of the mission and activities of ETIP HYDROPOWER at a strategic level within the hydropower sector. As illustrated by the anchor symbol the ETIP HYDROPOWER can

unify and magnify the voice of hydropower to key stakeholders such as the European Commission and other EU institutions. It does not replace existing initiatives; rather it links them, allowing for the presentation of key issues with one voice when appropriate. The job of the ETIP HYDROPOWER is to manage the linking and unified messaging process (arrows in brown in Figure 5). Existing initiatives continue with their own programmes and communications as before as shown in Figure 5 (blue dotted arrows).

The ETIP Hydropower project runs for three years from September 2022 to August 2025 and aims to be a facilitator for unifying the voices of the hydropower sector and to be a recognized interlocutor for the European Commission, Member States and Associated Countries regarding the hydropower sector specific deployment and R&I needs. The purpose of the ETIP HYDROPOWER project is also to prepare for a transition into a sustainable, self-funded organization i.e. association which lasts after the duration of the project.

4 Conclusions

ETIP HYDROPOWER will help to unify the voices of hydropower in Europe and worldwide, to increase public awareness of its catalyst and enabler abilities as well as motivate innovative collaborative research towards environmentally compatible solutions. Besides electricity supply, hydropower can offer other services which are important to help mitigate climate change effects, like water supply, contribution to flood and drought protection with potential for recreational and tourism activities and facilitating navigation on the large rivers.

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Technical-Scientific Report VGB-TW 103Ve

Availability of Power Plants 2012 – 2021, Edition 2022 (KISSY database evaluation) Series VGB-TW 103Ve (2005 ff.)

249 p., fig. and tab., 2023, DIN A4, ebook, this report is published annually since 2005
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Since 1970 vgbe/VGB has collected data based on standardized definitions, calculation methods, and recording procedures. The vgbe Power Plant Statistics Performance Indicators (KISSY) is the tool to deal efficiently with these questions. This report provides information about the availability and utilization for the period 2012 - 2021. The current report provides performance indicators for 589 power plant units plus 162 machine sets of storage and pump storage hydro power plants.

