eurelectric
powering people

Water Framework Directive: Experiences & Recommendations from the Hydropower Sector

eurelectric position paper

May 2018

in cooperation with VGB POWERTECH

Eurelectric represents the interests of the electricity industry in Europe. Our work covers all major issues affecting our sector. Our members represent the electricity industry in over 30 European countries.

We cover the entire industry from electricity generation and markets to distribution networks and customer issues. We also have affiliates active on several other continents and business associates from a wide variety of sectors with a direct interest in the electricity industry.

We stand for

The vision of the European power sector is to enable and sustain:

- A vibrant competitive European economy, reliably powered by clean, carbon-neutral energy
- A smart, energy efficient and truly sustainable society for all citizens of Europe

We are committed to lead a cost-effective energy transition by:

investing in clean power generation and transition-enabling solutions, to reduce emissions and actively pursue efforts to become carbon-neutral well before mid-century, taking into account different starting points and commercial availability of key transition technologies;

transforming the energy system to make it more responsive, resilient and efficient. This includes increased use of renewable energy, digitalisation, demand side response and reinforcement of grids so they can function as platforms and enablers for customers, cities and communities;

accelerating the energy transition in other economic sectors by offering competitive electricity as a transformation tool for transport, heating and industry;

embedding sustainability in all parts of our value chain and take measures to support the transformation of existing assets towards a zero carbon society;

innovating to discover the cutting-edge business models and develop the breakthrough technologies that are indispensable to allow our industry to lead this transition.

Dépôt légal: D/2018/12.105/15

WG Hydro

Contact:
Martin SCHOENBERG, Advisor Hydropower –
mschoenberg@eurelectric.org

Water Framework Directive: Experiences & Recommendations from the Hydropower Sector

A Eurelectric position paper May 2018

KEY MESSAGES

Hydropower provides more than 36% of the renewable electricity generated in the EU-28[1] (representing almost 50% of renewable generation in the EU-28 plus Norway and Switzerland). Due their flexibility and large storage capacity, hydropower plants of all sizes facilitate the integration of variable renewables such as wind and solar power. Hydropower plays a key role in supporting Europe's clean energy transition, reaching its international climate objectives and delivering crucial services for European citizens. Hydropower is the only renewable technology providing all the necessary system services that are essential for security of supply and a stable grid operation (e.g. back-up and reserve capacity, quick-start and black start capability, regulation and frequency response, voltage support to control reactive power and inertia). In addition to its valuable electricity generation, it also plays an important role in terms of water management, flood protection and prevention of water scarcity.

All hydropower installations and projects, small and large, are subject to strict environmental legislation to ensure their sustainability. The Water Framework Directive (WFD) is a central legislation piece in this regard. A holistic approach of European environmental, energy and climate policies is necessary to balance ecological, human and economic aspects and promote a sustainable use of water.

Eurelectric recommends considering the following when evaluating the directive and assessing its implementation:

- Involve all relevant stakeholders in the development of the WFD to ensure a fair sharing of responsibilities and costs when defining and implementing mitigation measures to reach the Directive's goals.

- Fully recognise the subsidiarity principle and allow Member States to take into account their specificities when implementing the WFD. Therefore, propose best practice procedures rather than unspecific standard solutions especially within guidance documents like those of the Common Implementation Strategy.

- Improve the implementation and governance of the WFD by using existing tools in a pragmatic and integrated manner and by systematically assessing the impacts of the River Basin Management Plans (RBMP) and their measures on the existing and future renewable power systems.

- Keep Heavily Modified Water Bodies (HMWB) designation as a key category for the integration of ecological, human and economic aspects.

---

[1] EUROSTAT 2017, excluding pumped storage

- Keep hydromorphological quality elements as supporting criteria since they serve as points of reference for the classification of water bodies.

- Implement the “non-deterioration” principle in a practicable and integrated way when applying the WFD exemption for projects, systematically considering hydropower generation’s role in fulfilling EU’s priorities in terms of energy and climate objectives.

- Only implement cost-effective measures to prevent ecologically unsatisfactory solutions and unnecessary costs.

- Weigh the costs and benefits of implementing measures to avoid disproportionate costs.

- The cost-recovery principle should focus only on specific water users (“water services” not including hydropower), in order to be considered an effective and efficient element of the WFD.

- Close the knowledge gap by increasing integrated expertise on all scientific questions arising from the WFD, such as river ecology and mitigation measures.

Water Framework Directive: Experiences & Recommendations from the Hydropower Sector

Hydropower's contribution to a successful energy transition

The European energy system is undergoing a significant transformation (decarbonization, security of supply, deployment of renewables and their integration into the market) creating big opportunities and challenges for all stakeholders. Despite all energy efficiency efforts, overall demand for decarbonized electricity is set to be significantly higher in 2050 than today due to the decarbonization of the heating, cooling, transport and many industrial sectors, which can only be achieved via efficient and smart electrification[2].

Hydropower is a key technology in supporting the European pathway to a decarbonized energy system and to achieve global leadership in renewable energy generation. As a renewable and highly sustainable source of electricity hydropower supplies the European power system with stability and valuable flexibility. In addition, hydropower contributes with 38 billion Euros[3] to EU's GDP and reduces EU's dependency on fossil imports to an extent worth 24 billion euros. It also renders multiple extra benefits for society in the river basins such as support to irrigation, water supply and flood control.

Examples of hydropower generation in EU Member States and possible consequences of the WFD mitigation measures

SWEDEN

Hydropower generation represents 40% of total share of electricity and 73% of the renewable share. The originally proposed[4] WFD mitigation measures could have decreased annual hydropower generation by 15-20% and affected flexibility of hydropower significantly.[5]

AUSTRIA

Hydropower generation (including pumped storage) represents more than 2/3 of overall electricity generation, of which 23% are highly valuable peak load helping to integrate other renewables. In the first implementation period, more than 130 WFD mitigation measures have been completed with a total investment of nearly 190 Mio € and have led to yearly generation losses equalling the consumption of 45,000 households.[6]

SPAIN

Hydropower generation represents approximately 12% of the total share of electricity and around 40% of the renewable share. The WFD mitigation measures could have decreased annual hydropower generation by 3%.[7]

ITALY

Hydropower generation represents approximately 15-20% of the total share of electricity and around 45% of the renewable share. The originally proposed WFD mitigation measures could have decreased annual hydropower generation by around 10%.[8]

[2] For example in Germany the decarbonization of the heat and transport sector could lead to a massive additional demand for renewable electricity. Even in a scenario including ambitious energy efficiency measures could lead to more than a doubled electricity demand, without efficiency measures even quintuple to 3,000 TWh (see HTW 2016: Sektorkopplung durch die Energiewende).

[3] DNV GL 2015: Macroeconomic study on hydropower

[4] The original proposals in the draft Programmes of Measures (PoM) would have had the specified effects. Though, the measures have been reduced and/or PoM has not been fully implemented (yet).

[5] According to Vattenfall AB 2014

[6] Losses of 160 GWh. http://oesterreichsenergie.at/der-nationale-gewaesserbewirtschaftungsplan-2009-umgesetzte-massnahmen-der-oesterreichischen-wasserkraft.html

[7] According to Asociación Española de la Industria Eléctrica (UNESA) and to Iberdrola S.A. 2018

[8] According to Edison SpA 2018

Hydropower as key technology in the EU's future climate and energy policies
Hydropower is renewable, controllable, flexible as well as storable and perfectly fits the future power demands. Thanks to its flexibility, hydropower ideally complements variable sources such as wind and sun (Figure 1).

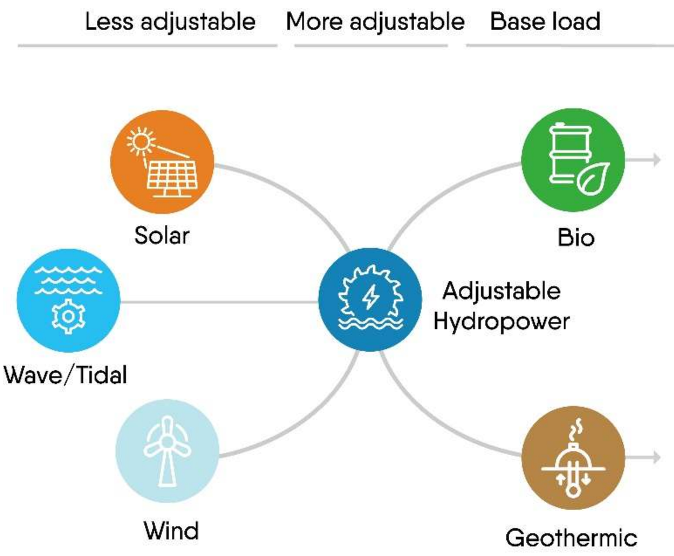


Figure 1: The flexibility of hydropower compared to other renewable sources

Even though today's predictions foresee hydro power generation to remain roughly constant, the importance of hydropower will rise as the deployment of variable renewables (wind and solar) is accelerating (Figure 2).

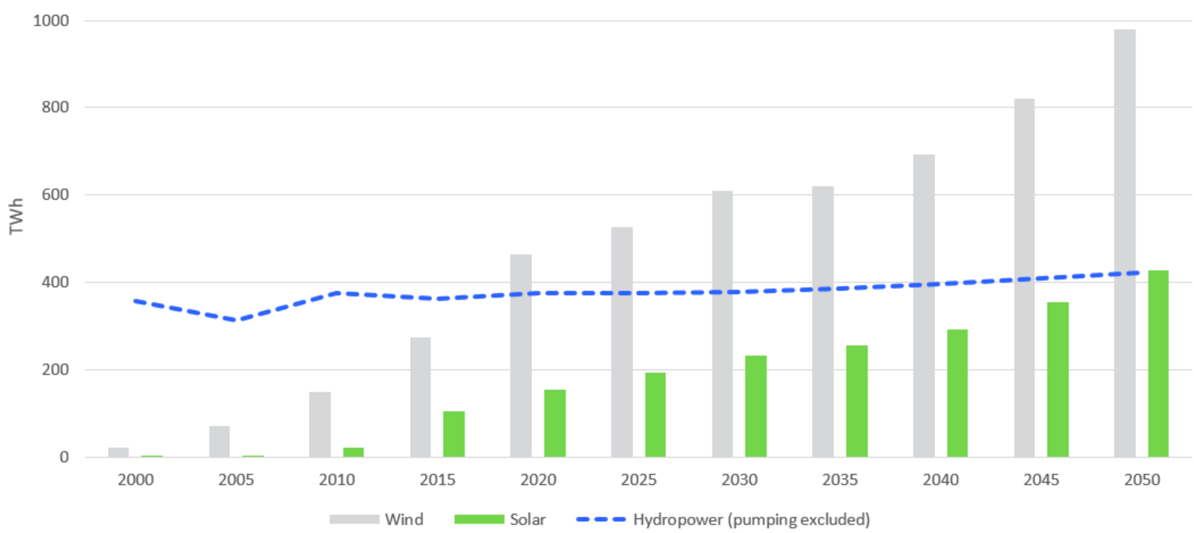


Figure 2: Accelerated deployment of variable renewables: historical and projected net electricity generation in the EU-28[9]

[9] EU Reference Scenario 2016 based on PRIMES, GAINS

In addition, although other technologies are developing, hydropower remains the most efficient large-scale technology to store electricity over significant periods and to supply consumers on demand.

Furthermore, hydropower serves as reliable and well predictable base-load generation. These services are highly needed to ensure a safe, affordable and stable security of supply for EU's citizens and industry.

Today, about 30% of the total gross electricity generated in the EU-28 plus Norway and Switzerland (3.291 TWh) comes from renewable sources (Figure 3).

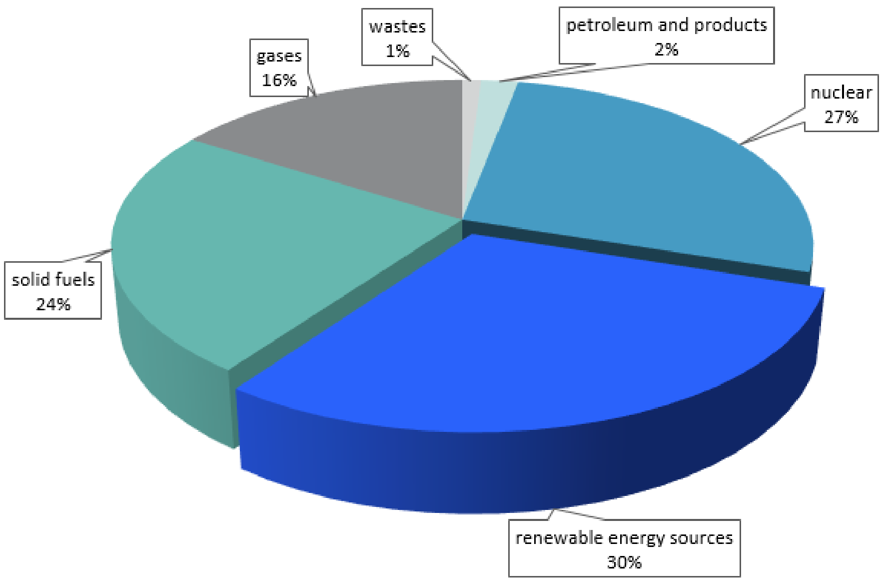


Figure 3: Shares of Gross Electricity Generation in the EU-28 (plus NO and CH) in 2015

According to the most recent Eurostat data available[10] (for the year 2015), hydropower is the largest source of renewable-based electricity generation in Europe. With a total generation of more than 341 TWh per year (generation of run-of-river and storage plants) equalling to about 36% of the total electricity generated from renewable energy sources and 10% of the entire electricity generation in the EU-28, hydropower contributes significantly to achieve the EU targets. Adding the hydropower generation of Norway as well as of Switzerland[11] to the EU-28 values, together, a total hydro generation of 515 TWh can be reached (excluding 33 TWh generated by pumped storage power plants). This is close to half of the total renewable electricity generation of 1,150 TWh in the EU-28 plus NO and CH (see Figure 4).

[10] EUROSTAT 2018, Energy Overview

[11] Norway and Switzerland are not members of the EU but important partners in the European electricity grid with a high share of renewable generation. Both countries are included in the analysis as Norway has to formally comply with the WFD and Switzerland has passed national legislation setting similar requirements as the WFD.

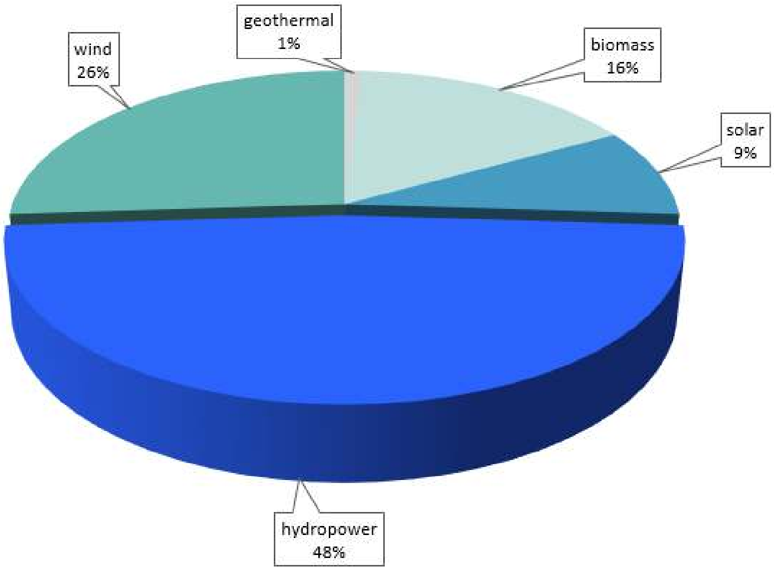


Figure 4: Renewables Electricity Generation Shares in the EU-28 (plus NO and CH) in 2015[12]

However, hydropower generation and its share among all forms of renewable electricity generation vary considerably across Member States as shown in Figure 5.

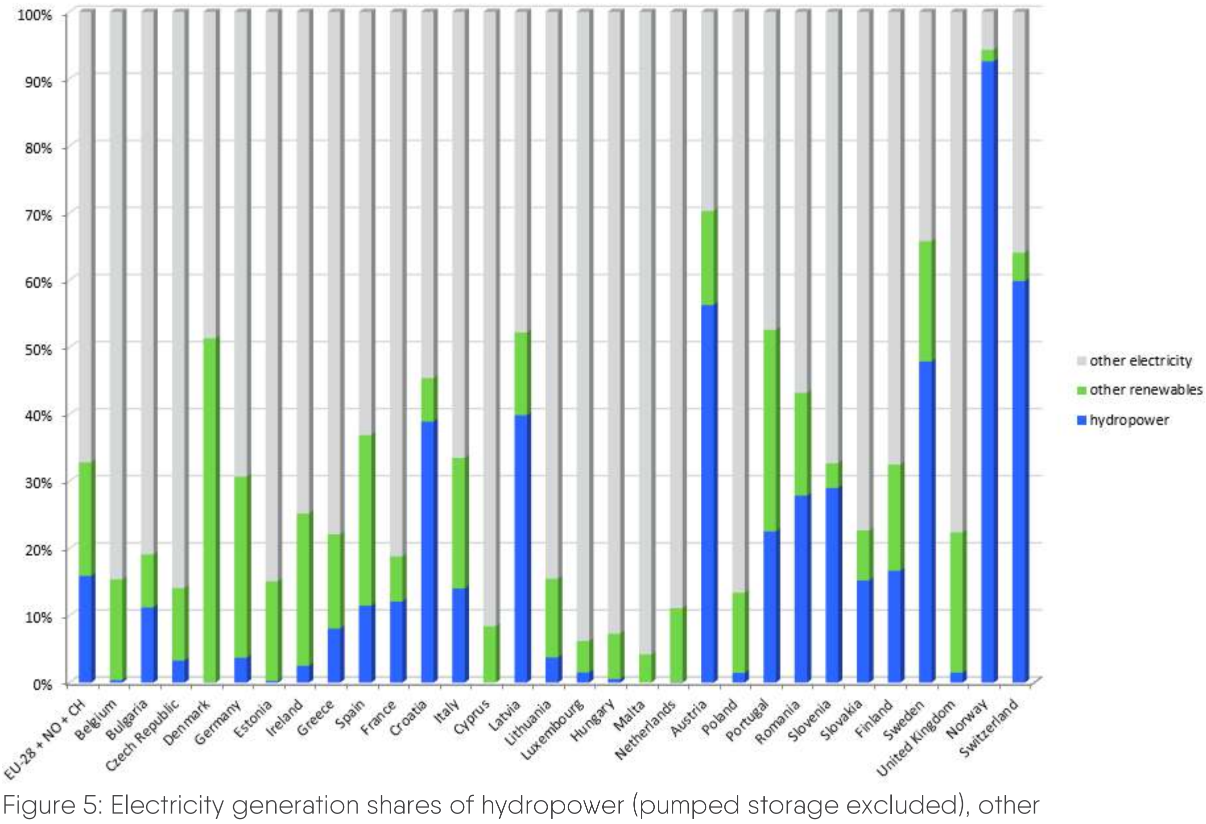


Figure 5: Electricity generation shares of hydropower (pumped storage excluded), other renewables, and other electricity sources, in the EU-28 plus Norway and Switzerland in 2015[13]

[12] Directorate-General for Energy (European Commission) 2017: EU energy in figures - Statisical Pocketbook 2017; ENTSO-E Data; Schweizer Bundesamt für Energie (BFE): Schweizerische Elektrizitätsstatistik 2015.
[13] Eurostat 2018; Schweizer Bundesamt für Energie (BFE) 2018

Hydropower as a renewable provider of all system services
A higher share of wind and solar power generation increases the need for ancillary services that contribute to maintaining secure and stable grids. For this purpose, hydropower is able to deliver:

- back-up and reserve capacity
- quick-start and black start capability
- regulation and frequency response
- voltage support to control reactive power
- inertia

In addition, hydropower provides significant amounts of balancing power helping the efficient integration of variable renewables such as wind and solar power.

Hydropower as a cost efficient source of low carbon energy
Hydropower is one of the most competitive sources of low carbon electricity with a life cycle of 80 years and even longer. Despite low operational costs, the high investment for the construction of hydropower infrastructure requires a clear and stable regulatory framework.

Hydropower generation contributes significantly to the efforts to reduce GHG emissions. Indeed, hydropower technology avoids more than 180 Mio t of CO2 - emissions per year equalling to 15% of the total CO2 - emissions in the EU-28 power sector[14]. According to the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, hydropower has the smallest carbon lifecycle footprint of all electricity generation technologies[15].

Hydropower as a provider of multiple benefits
Hydropower offers benefits to society such as drinking water supply, flood protection, irrigation, navigation and recreation.

Water supply, waste water management, flood control and hydropower facilities have influenced the original state of watercourses for centuries and have changed them to "man- made" nature. In many cases, rich ecosystems have been (re-)created through careful local management around these hydropower infrastructures. Very often, these habitats close to and around hydropower infrastructures are well-known for their biodiversity and are home to protected species. In many cases, these ecosystems have been even designated as nature protection areas including Natura 2000 status.

[14] DNV GL 2015: Macroeconomic study on hydropower
[15] IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation – http://www.ipcc.ch/pdf/special-reports/srren/SRREN_Full_Report.pdf

The WFD in the light of hydropower: challenges and recommendations

Hydropower is constantly interacting with the environment. Hydropower operators spend significant resources to mitigate impacts on the river basins throughout Europe. Legislation and policies for environmental protection and sustainable water management have a significant influence on the current operations and future development of hydropower.

The Water Framework Directive (WFD) is a crucial piece of this legislation and a suitable instrument for a consistent European water policy. **Its purpose is not only "to establish a framework for the protection of inland surface waters […]" but also to "promote sustainable water use" (Art. 1).** This means that besides environmental objectives, the WFD also takes the need for economic development into account and acknowledges social effects as well as geographic and climatic conditions.

As it is the purpose of the WFD to strike a balance between environmental, climate and socio-economic goals, it should not unduly hamper the operation of existing hydropower plants, or create obstacles to upgrading or developing of new hydropower:

- Most hydropower plants have been in place for decades and serve as a crucial backbone both for the power system and for water management. Ensuring the further operation of these existing assets should be a priority for long-term climate protection and sustainable water management planning.

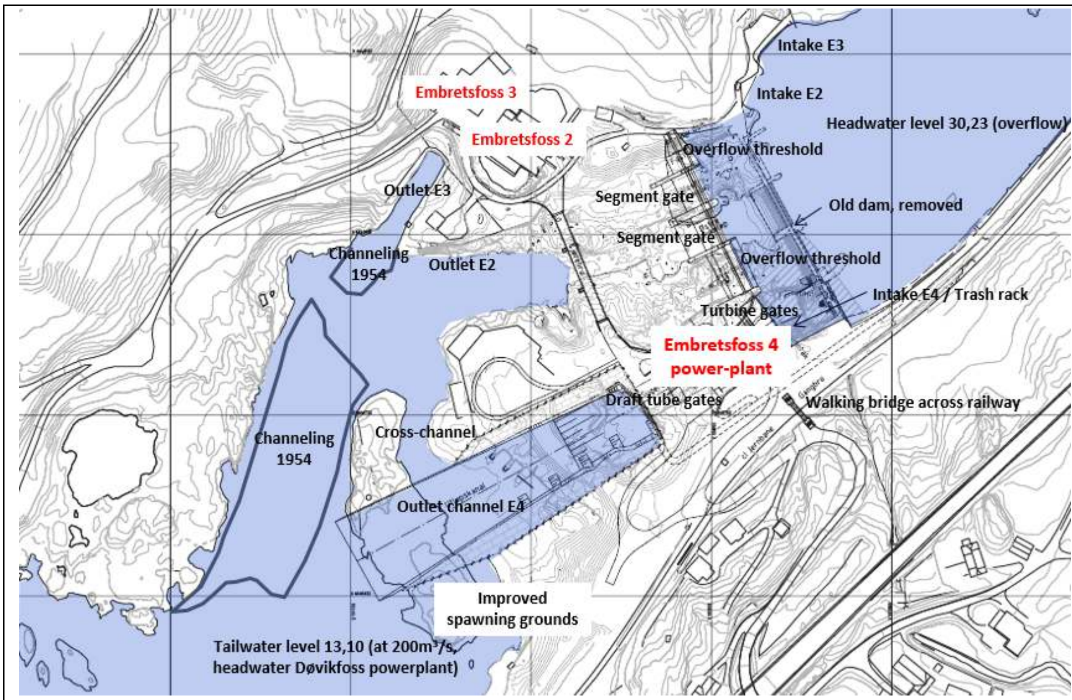
- Hydropower is able to deliver additional new renewable generation as well as to provide supplementary flexibility and storage capabilities to achieve renewable targets by up-grading and optimizing the existing facilities as well as by building new plants. The technically feasible hydropower potential[16] in the EU-28 plus Norway and Switzerland has been estimated to approximately 1,000 TWh/year[17].

Examples for the achievement of renewable targets by up-grading and optimizing existing hydropower plants

NORWAY

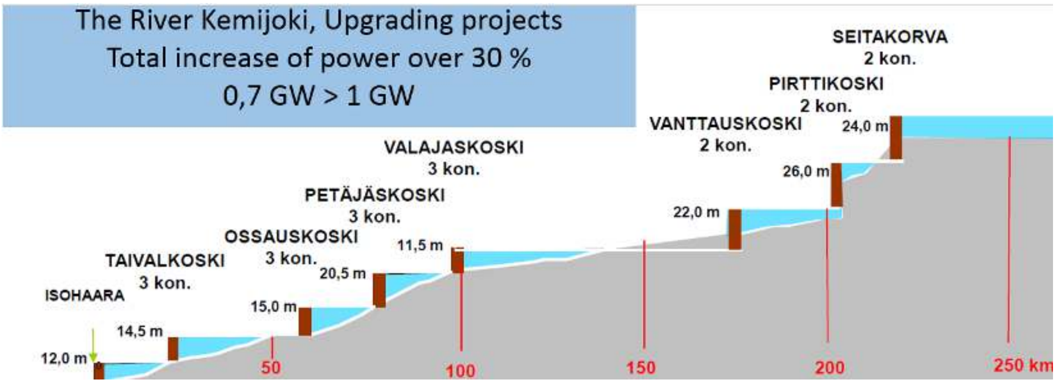
Near Drammen in Norway the environmental performance of the hydropower station Embretsfoss was significantly improved while annual generation was simultaneously increased from 214 GWh to 354 GWh. The project included a major clean up after 100 years of industrial activities. Feeding and spawning grounds for fish were improved as well as the habitats for fresh water pearl mussels and crayfish. In addition, special measures were implemented to make migration safer for eel.

[16] The technically feasible hydropower potential includes the already realised as well as the additionally technically feasible potential.
[17] Hydropower & Dams World Atlas 2017



FINLAND

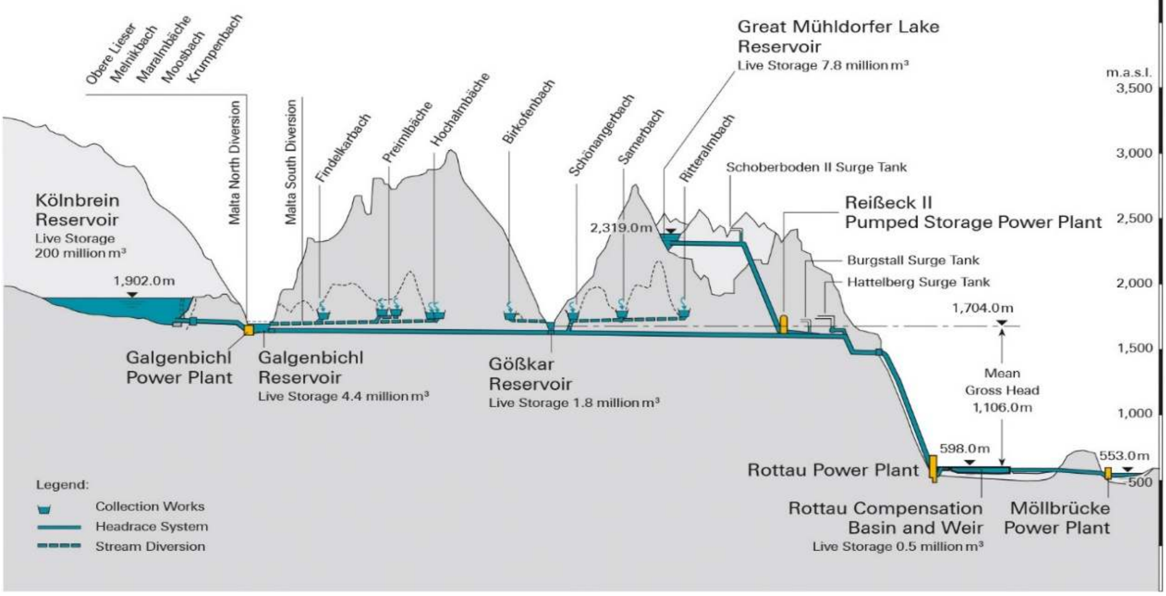
Normally, the replacement of old hydropower plant turbines by new ones increases efficiency by 2-5%. In some cases, new turbines can even have bigger discharge capacities and therefore the efficiency of the plant will increase remarkably. For example, upgrading projects of the HPPs of the River Kemijoki, the main flexible hydropower source of Finland, increased the power capacity over 30% from 0,7 GW to almost 1 GW.



AUSTRIA

In 2016, VERBUND commissioned the new pumped storage power plant “Reisseck II” in the province of Carinthia in southern Austria. The hydraulic systems of two existing power plant groups and their reservoirs were combined by a newly built headrace tunnel of more than 3.5 km length and a tailrace tunnel with nearly 1.5 km length. The heart of the new power plant consists of the powerhouse and the transformers in a cavern, completely realized within the mountain. Hereby, the natural heads in this Alpine region can be used to store and generate electricity when needed. The head of Reisseck 2 scheme is approximately 600 m. Two pump-turbine machine units with 215 MW each increase the capacity of the turbines of the existing scheme by more than 40%. The pump capacity of the power plant group was more than doubled. Now, the entire system shows an installed capacity of nearly 1,320 MW in turbine mode and more than 840 MW in pumping mode.

Altogether, the investment for Reisseck 2 power plant was about 400 mio. Euro. The system is connected to a 220 kV transmission line. By this grid connection, the pumped storage power plant can deliver highly valuable balancing energy in both directions: pumping water up into the reservoir – in case of excess wind and solar generation – and in turbine mode when wind and solar don't deliver electricity. Furthermore, Reisseck 2 is an outstanding example of upgrading an existing hydro storage power plant into a pumped storage power plant that is able to deliver flexibility in addition to its storage potential.



A clear and stable legislation is required that comprises a holistic view on European water bodies including all impacts. This will lead to a fair balance between environmental and socio-economic targets.

Building on these facts, Eurelectric calls on the Commission to:

Improve the implementation and governance of the WFD

The share of hydropower in the national generation mixes as well as the national implementation of the WFD differ among Member States. Experience shows that the implementation of the WFD is a challenge for the hydropower sector in many Member States, both, technically and economically.

A main problem is the missing or incomplete evaluation of cost-efficiency and benefits of implementation measures. In some Member States, generation losses and maintenance costs are often not duly taken into account in the estimated overall costs in the Programme of Measures (PoM).

Example for the incomplete evaluation of cost-efficiency and benefits of implementation measures

GERMANY
The consolidated Programme of Measures (PoM) of the State North Rhine-Westphalia[18] is an example for the cost estimates within the PoM in Germany. The cost estimates for the second management period are outlined in Chapter 9, also in regard to the restoration of river continuity (p.9-14). There, costs are estimated based only on documented experiences which apparently only refer to construction costs of up- and downstream fish passage. In this context, the loss of energy generation and its revenues is not even mentioned qualitatively even though this constitutes significant economic costs of such measures. In addition, management and maintenance costs for the mitigation measures are not taken into account.

Due to the water-energy nexus, Eurelectric calls for a systematic assessment of the impacts of the RBMP and their implementation measures on the existing as well as on future renewable power systems. Eurelectric proposes to systematically assess the impacts of each PoM according to Art. 11 WFD and of each River Basin Management Plan (RBMP) according to Art. 13 WFD in terms of renewable electricity generation and its contribution to climate and energy policy objectives.

In order to consider different national situations, it is at the same time necessary to fully recognize the subsidiarity principle and allow Member States to implement the WFD taking into account their specificities.

Moreover, Eurelectric calls for full consideration of the roles and responsibilities of all relevant stakeholders in the designing and the implementation of PoM.

Keep Heavily Modified Water Bodies (HMWB) as a necessary category for a balanced WFD implementation
The designation of HMWB is a central cornerstone of the WFD to allow sustainable reconciliation of water protection and water management in the context of overall societal objectives and welfare.

It is essential that Member States keep the flexibility to address all activities that are deemed beneficial in their national or regional context. In addition, the boundaries of a HMWB should be consistent with the impacted area. Otherwise, too narrow boundaries will directly result in the need of formal derogation ("less stringent objectives") in adjacent "natural" water bodies. Eurelectric therefore proposes to consider the following points:

a) HMWB is a water body category of its own. The evaluation and designation of HMWB should be done on a case-by-case approach on the basis of a common methodology instead of relying on exemptions to general rules.
b) Eurelectric recommends clarifying that physical alterations include morphological and/or hydrological alterations.
c) Water bodies with all kind of hydropower plants can be considered for designation as HMWB including storage, pumped storage as well as run-of-river.

[18] https://www.flussgebiete.nrw.de/system/files/atoms/files/bwp-nrw_2016-2021_massnahmenprogramm_final.pdf

d) To follow the logic of the designation, the resulting goal of “good ecological potential” must in turn avoid significant adverse effects on beneficial activities. Adverse effects include financial effects of the restrictions of operations (e.g. generation or flexibility losses) as well as the costs of mitigation or restoration measures.
e) These significant effects have to be judged “case by case” and locally on a site/water body level, not on a macro-economic level. In order to be comprehensive, criteria should cover both quantitative and qualitative impacts.
f) To ensure policy integration, while Member States consider designating HMWB, they should take into account ambitions stemming from other EU legislation in order to reach EU energy & climate targets.
g) The term “Heavily Modified Water Body” carries a notion of a “not desired defective state” although its very purpose is to appropriately balance environmental targets with human development in the overall context of societal objectives and welfare. It should be recognized that the designation as HMWB is the intended and legitimate outcome of the classification based on thorough evaluations.

Keep the supporting role of hydromorphology in classifying water bodies
The overall target of the WFD is to reach a “Good Ecological Status” for natural water bodies and a “Good Ecological Potential” for HMWB. The classification of water bodies should (according to Annex V 1.4 (i) of WFD) be made by analysing monitored values of biological quality elements. In general, hydromorphological quality elements have a supporting role in classification. Hydromorphology has a classifying role only for natural water bodies helping to distinguish between high and good status (Figure 6).

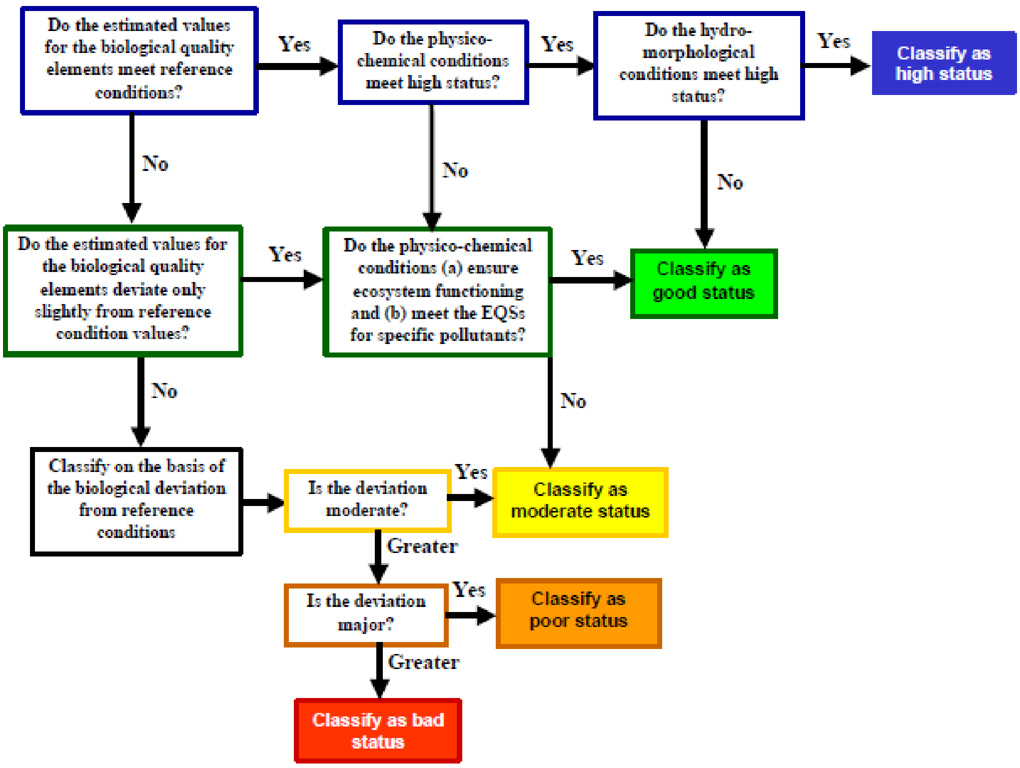


Figure 6: Indication of the relative roles of biological, physio-chemical and hydromorphological quality elements in ecological status classification according to the normative definitions in WFD Annex V: 1.2

There have been discussions and proposals on obligatory hydromorphological measures needed to meet "Good Ecological Status" (GES) or "Good Ecological Potential" (GEP). E-flow guidance (Common Implementation Strategy – CIS – Guidance document No. 31[19]) proposes ecological flows and the JRC Technical Report on Water Storage[20] calls for developing minimum hydromorphological criteria for GEP.

Eurelectric supports the classification according to the WFD, which means that monitored values of biological quality elements are the basis for classification and that hydromorphology has a supporting role.

In particular, the water bodies designated as heavily modified due to hydropower should continue to be classified on a case by case basis as the possible improvement of ecology by hydromorphological measures is always site specific. Moreover, the reference conditions (maximum ecological potential) of HMWB are site specific and differ among Member States. The assessment of reference conditions shall be done considering only those measures which do not have significant harmful effects on specific activities. Mitigation of similar impacts can have quite different effects on hydropower. For example, the loss of generation caused by the same bypass flow is doubled for a hydropower plant with a 20 metre head compared to a hydropower plant with a 10 metre head.

Eurelectric fully supports the ongoing work to harmonize the process to define reference conditions for GEP in HMWBs. An essential part of this work is to develop a toolbox of mandatory measures to be considered. However, it is important that these measures shall be taken into account during the consideration process, but must not be implemented necessarily. Examples show that hydromorphological measures have been implemented without any improvement of ecology. The effect of each measure on values of biological quality elements (BQE) shall be assessed carefully before deciding precise implementation measures. Therefore, Eurelectric recommends case-by-case analysis.

In ponded rivers, the need to enable fish migration depends on existing breeding grounds upstream. There are examples of ponded rivers where there are only slight changes in the composition and abundance of local fish and there are no breeding grounds for long distance migratory fish upstream. The status of fish compared to the natural river is moderate and therefore the water body is classified as HMWB. In this case, no mitigation measures can improve fish population more than slightly. For this reason, good ecological potential has already been met (Figure 7).

[19] European Union 2015: Ecological flows in the implementation of the Water Framework Directive 2015. https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20%28final%20version%29.pdf

[20] European Commission JRC Technical Report 2016. https://ec.europa.eu/jrc/en/publication/working-group-ecostat-report-common-understanding-using-mitigation-measures-reaching-good-ecological)

Figure 7: Part of river Oulujoki (Finland) designated as HMWB reaching good ecological potential

Facilitate the development of sustainable hydropower when applying the non-deterioration principle and its exemptions

The objectives of the WFD are binding unless exemptions are applied (e.g. Article 4.7). Member States have different interpretations of these objectives, especially of the non-deterioration principle. ECJ-jurisdiction[21] has shown a restrictive interpretation leading to potential difficulties for the development of future economic activities for all stakeholders involved.

The Court has held that there is a deterioration of the status of a surface water body as soon as the status of at least one of the quality elements falls by one class, even if that fall does not result in a fall in classification of the water body as a whole, or any deterioration if the quality element is already assessed in the lowest class ("bad"). This interpretation will lead to a more extensive need for exemption requests.

In another ruling[22], the ECJ has stated that a certain degree of discretion may be granted for Member State's decision whether a particular project is of public interest. This can assist in demonstrating that the preconditions for an exemption are fulfilled in a specific project setting. However, legal uncertainties remain and significant additional effort is necessary to demonstrate and document that all preconditions for an exemption have been met, e.g. the benefits of the new modification outweighing the benefits of achieving the WFD objectives.

Hence, Eurelectric recommends:

a) Streamlining the exemption process by viewing hydropower generation development as an efficient source of renewable energy which is of very high public interest and in line with Europe's energy and climate policy objectives[23], thereby implementing the ECJ Schwarze Sulm ruling[22].

[21] Weser Case, ECJ Case C-461/13

[22] Schwarze Sulm Case, ECJ Case C-346/14

[23] Article 194 of the Treaty of the European Union provides a legal basis for an EU energy policy at the same level as Article 191 does it for environmental and climate policy.

b) Considering an application of the non-deterioration principle (class deterioration, de-minimis thresholds) in a way which maintains a high level of protection of water bodies but does not apply in cases of non-significant impacts.

Implement only cost-effective measures
Art. 4 WFD requires that measures to reach the goals of good ecological status or good ecological potential should be technically possible, economically reasonable and lead to a significant, measurable improvement. However, the methods and tools to evaluate these variables are still not sufficiently developed or not implemented. This leads to ecologically unsatisfying solutions as well as to unnecessary costs. Eurelectric recommends taking the following aspects into account:

a) Only cost-effective measures should be implemented (as prescribed by Annex III of the WFD).
b) Before implementation, the expected effect of measures on biological quality elements should be evaluated on scientific basis.
c) Hydromorphological measures (which are often very costly) might be the right instrument in some cases (in addition to fish passes or minimum flow requirements). However, they should not be obligatory for each water body without detailed case-by-case analysis. Measures should be decided on an adequate scale of the ecosystem (river basin for example) and should be based on scientific evidence.
d) The requirement of WFD Art 4.3 and CIS guidance document number 4 has to be respected clarifying that measures affecting HMWB shall not have significant harmful effects on hydropower.
e) When conducting a comprehensive economic analysis under the context of the WFD the following elements should be taken into account:
    - Balance between water use and protection of water resources
    - Reduced hydropower generation and loss of flexibility due to the implementation of minimum flows, ecological flows, fish upstream and downstream passages
    - Environmental impacts and overall cost of alternative generation and flexibility of supply

Apply cost-benefit analyses (CBA) to evaluate disproportionate costs
Economic analysis is required for the justification of exemptions or less stringent environmental objectives. However, the WFD does not give any guidance. Annex III of the WFD on economic analysis addresses only the issue of cost-recovery of water use and the combination of the most cost-efficient measures. CIS guidance documents number 1 and 20 give some interpretation about the justification of disproportionate costs or disproportionately expensive alternatives or measures. They are all based on CBA, but the methodology is not sufficiently developed and applied. Eurelectric therefore points out the following aspects:

a) The use of CBA is the right method for assessing disproportionate costs in all cases (articles 4.3, 4.4, 4.5 and 4.7).
b) It should be acknowledged that large investments require profound CBA and long-term security of investment.
c) CBA should also be used to evaluate disproportionate costs properly and to address questions of affordability regarding the actor in charge of implementing a specific measure.
d) CBA of environmental measures which will cause losses of power generation or flexibility must include the long term value of the generation and/or flexibility lost as a cost of the measures. Fluctuating short and medium term power prices do not entirely depict such long term values of renewable power to society.

e) Short and medium term power prices do however impact the ability of hydropower operators to bear the burden of measures and must be taken into account when the affordability of measures is estimated.

Eurelectric is ready to provide input to develop good practice CBA studies in relation to hydropower.

Concentrate the focus of the cost-recovery principle on specific water users
Economic incentives for water users may be an appropriate instrument to reach environmental objectives in certain user contexts. For instance, if over-abstraction of water leads to resource depletion in a water body or command and control instruments prove to be ineffective or inefficient to address a large number of users.

The ECJ held in a recent ruling that "water services" can be defined as water supply and waste water management only[24]. Eurelectric fully supports this view and would like to point out additionally:

a) A formalized concept of cost-recovery should be focused on specific water use contexts in order to be an effective and efficient element of the WFD. This is the case, when the concept is able to fulfil its incentive function to have a more efficient use, such as water supply and waste water management.
b) In general, hydropower does not contribute to water scarcity or pollution.
c) With regard to hydropower, the concept of cost recovery/water pricing is not an appropriate instrument to reach the objectives of the WFD.
d) Even though the cost–recovery-principle is a requirement to internalize external costs, to date, no mechanisms are in place to internalize or reward external benefits of hydropower such as for irrigation, navigation, flood protection or recreation.
e) The polluter-pays-principle is already applied to the hydropower sector through the measures taken to fulfil the WFD objectives and is in most Member States embedded in the national approval procedures as well as in the taxation systems.

[24] Judgment of the Court on recovery of the costs for water services - concept of 'water services' (Case 525/12), 11.09.2014.
http://curia.europa.eu/juris/document/document.jsf?text=&docid=157518&pageIndex=0&doclang=EN&mode=req&dir=&occ=first&part=1

Our continuous commitment

Over the last decades, Eurelectric members have shown their continuous commitment to research and development (R&D) to improve the scientific basis for the definition of measures implementing the WFD.

Since the very beginning of the implementation of the WFD, considerable progress has been made regarding the increase of scientific knowledge. This is also due to quantitatively and qualitatively valuable input from hydropower companies. Moreover, R&D has been playing a central role in the optimization of cost-efficient measures.
Undoubtedly, there is still demand for additional research, e.g. on the integrated impacts of environmental measures or on the understanding of their benefits versus costs. Further scientific work is therefore needed to determine the efficiency of those measures but also to develop innovative solutions to meet the WFD targets.
In some cases, the intended aim of measures has not been achieved due to poorly engineered or the lack of technically and scientifically proven methods. Nevertheless, Eurelectric members remain committed to further R&D, which will require significant resources as well as considerable financial contributions from hydropower companies.

Examples of R&D improving the scientific basis for the definition of measures implementing the WFD

FINLAND
Fish migration was studied in the so-called Umbrella cooperative research project between 2010 and 2017 in Finland. The fish authority, the responsible ministry and all main hydropower plant owners participated in financing this project. The main focus of this scientific research covered fish-way-efficiency, downstream migration of smolts (juvenile salmon) and fish population models. Moreover, possibilities of sustainable self-reproduction of migratory fish in rivers with several hydropower plants were studied.

- New knowledge about the behaviour of upstream migrating fish in the changing flows and water levels of tail-water channels has proven to be useful for better planning of fish-way mouths and attraction flows. The mouth should be adjusted according to water levels and attraction flows according to discharge. Three dimensional modelling of flow velocities and turbulence together with online monitoring provide a basis for developing "intelligent fish-ways".

- The downstream migration of smolts turned out to be very challenging in the ponded river. Probably, the losses have mainly been caused by predation in the reservoirs upstream of hydro power plants. The direct turbine mortality was not significant. However, a large number of smolts does not find its way downstream or hesitates to swim to turbines representing a catch for predators in the upstream ponds.

- Currently, there is no technically and economically feasible solution for big rivers to guide smolts downstream past hydro power plants. The focus of further research (already agreed to continue) will be in testing and developing feasible solutions.

- The population model calculations showed that sustainable self-reproduction of salmons in rivers with several hydro power plants is extremely challenging. If there are more than 2 to 3 plants between breeding areas and sea, it is unlikely that sustainable self-reproduction can be achieved. In these cases, the transformation of possible breeding areas to partly natural reproduction requires the whole set of mitigation tools including supporting fish releases, traps and transport programs.

NORWAY

The "Handbook for environmental design in regulated salmon rivers" is the most important result of the project "EnviDORR" (Environmentally Designed Operation of Regulated Rivers), popularly referred to as "more salmon, more power". Highly specialized research teams in the fields of salmonid biology, hydrology and engineering working with hydropower companies in Norway have developed new knowledge about the complex relationships between power production, environmental factors and salmonid population dynamics. The handbook will be an important reference when designing environmental measures to improve fish populations without reducing or even increasing hydropower production. The handbook is available in English, Chinese and Norwegian.

AUSTRIA

Three possible hydropeaking mitigation measures have been examined in Austria: diversion power plants, operational restrictions and retention basins.

- Hydropeaking **diversion power plants** entirely prevent flow fluctuations providing an ecologically appropriate residual flow and a suitable location for re-introduction in the water body. At business level, new diversion power plants are often not economically viable. Nevertheless, they provide significant positive economic effects at macroeconomic level.

- **Operational restrictions** of existing hydropower storage plants can lead to the same positive ecological impacts as retention basins. From a macroeconomic or a business-level perspective, operational restrictions have distinct negative impacts.

- Compared to operational restrictions, **retention basins** have limited impacts on business-level and no negative system-relevant or macroeconomic consequences. However, strict topographical conditions limit the possible construction of (big) retention basins.

This integrative evaluation of measures to mitigate the impacts of hydropeaking also demonstrates that the greatest contribution to achieving the target of “good ecological potential” can be expected from reductions in hydrological impacts in combination with morphological rehabilitation measures. However, the precise quantification of the potential for improvement arising from hydrological and morphological measures requires a detailed case-by-case evaluation of the specific case.
Based on these outcomes, specified packages of measures will be designed and adapted to the local conditions of selected hydropower plants in the coming years.

It is crucial, that the measures that have to be set in implementing the WFD are based on proven scientific results, with CBA at the centre of the decision. Eurelectric recommends taking the demands of the various water bodies regarding fish species, etc., as well as the diverse national focuses (resulting in different constraints on hydropower) into account when developing, evaluating and setting WFD-measures.

Over the last decades, the hydropower companies have been pursuing multi-fold research targets concentrating on the improvement of the scientific basis for defining measures implementing the WFD as well as on topics with a different focus, such as storage, flexibility, markets, ancillary services as well as technical issues.

Based on this research and long-term experience, Eurelectric and its members are looking forward to engaging in the discussions on future EU water policies. Comprehensive policy coordination is needed to achieve environmental, energy and climate targets efficiently. Given the complex nature of the WFD and its implications, we call on the Commission to include Eurelectric together with its members in the development of future EU water policies as we are experienced stakeholders, fully committed to sustainable resource management.

Eurelectric pursues in all its activities the application of the following sustainable development values:

Economic Development

- Growth, added-value, efficiency

Environmental Leadership

- Commitment, innovation, pro-activeness

Social Responsibility

- Transparency, ethics, accountability

Union of the Electricity Industry - eurelectric aisbl
Boulevard de l'Impératrice, 66 – bte 2 - 1000 Brussels, Belgium
Tel: + 32 2 515 10 00 - VAT: BE 0462 679 112 • www.eurelectric.org
EU Transparency Register number: 4271427696-87