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International Commission for the Protection of the Danube River

Internationale Kommission zum Schutz der Donau

Sustainable Hydropower Development in the Danube Basin

Guiding Principles

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Overview and key recommendations

The requirement of increased production and use of energy from renewable sources in line with the objectives of the EU Renewable Energy Directive constitutes an important step towards meeting the need of reducing greenhouse gas emissions and fostering energy security while representing a significant driver for the development of hydropower generation in the countries of the Danube River Basin. At the same time, Danube countries are committed to the implementation of water, nature and other environmental legislation, the EU Water Framework Directive being the key tool for water policy in the Danube River Basin by specifying water protection targets in balance with economic interests. Further information on these issues can be obtained from the elaborated background document "Assessment Report on Hydropower Generation in the Danube Basin"[1].

Aware of the fact that hydropower plants offer an additional reduction potential for greenhouse gases but recognizing as well their negative impacts on the riverine ecology, the Ministers of the Danube countries asked in 2010 for the development of Guiding Principles on integrating environmental aspects in the use of hydropower in order to ensure a balanced and integrated development, dealing with the potential conflict of interest from the beginning.

The "Guiding Principles on Sustainable Hydropower Development in the Danube Basin" have been elaborated in the frame of a broad participative process, with the involvement of representatives from administrations (energy and environment), the hydropower sector, NGOs and the scientific community. The "Guiding Principles" are primarily addressed to public bodies and competent authorities responsible for the planning and authorization of hydropower but are also relevant for potential investors in the hydropower sector as well as NGOs and the interested public.

The Guiding Principles have the character of recommendations and do not exert any legally binding force. As a follow-up, implementation is recommended to take place on the national level, accompanied by a further exchange on experiences with regard to administrative processes and technical provisions.

In the following, a concise set of key recommendations was extracted from the content of the Guiding Principles, considered as crucial for ensuring the sustainability of hydropower development. They are structured according to the different chapters of the document where further detailed information can be obtained from.

1) www.icpdr.org

General principles for sustainable hydropower development

1 Hydropower development needs to respect the principles of sustainability, taking into account environmental, social and economic factors in an equally balanced way.

2 Renewable energy generation like hydropower should be part of a holistic approach of energy policies (National Energy Plan, including Renewable Energy Action Plans). Untapped renewable energy potential, energy saving and increase of energy efficiency are important elements that should be considered in this approach.

3 In order to ensure a sustainable hydropower development and to weigh the different public interests in a balanced way, national/regional[1] hydropower strategies should be elaborated based on these basin-wide Guiding Principles. These strategies should consider the multifunctional use of hydropower infrastructure (e.g. flood control, water supply, etc.) and impacts (including cumulative ones) on the environment.

4 Weighing the public interests on national/regional level has to be done in a transparent, structured and reproducible way based on criteria and relevant information, involving public participation in an early stage of the decision making process.

5 Renewable energy production as such is not being regarded as overriding public interest in general in relation to other public interests. A hydropower project is not automatically of overriding public interest just because it will generate renewable energy. Each case has to be assessed on its own merits according to national legislation.

6 The role of citizens and citizens' groups, interested parties and non-governmental organisations whose interests are being affected by a certain hydropower project, is crucial to optimise planning processes and to develop a common understanding and acceptance in the practical implementation of new hydropower projects.

7 Hydropower development has to take into account effects of climate change on the aquatic ecosystems and water resources (resilience of river habitats, quantity of flow, seasonal changes of flow, …).

Technical upgrade of existing hydropower plants and ecological restoration

8 Technical upgrading of existing hydropower plants should be promoted to increase the energy production. These types of improvements represent the most environmental friendly actions in relation to environmental objectives (EU WFD, etc.).

9 The technical upgrading of existing hydropower plants should be linked to ecological criteria for the protection and improvement of the water status and promoted as well as financially supported by means of incentives or eco-labels by national energy strategies and instruments.

10 The combination of technical upgrading with ecological restoration of existing hydropower installations implies a win-win situation for energy production on the one side as well as for the improvement of the environmental conditions on the other side.

[1] The regional level in the context of this document is defined as a level of management below the national level.

Strategic planning approach for new hydropower development

11 A strategic planning approach (linked to the Renewable Energy Action Plan and the River Basin Management Plan) is recommended for the development of new hydropower stations; this approach should be based on a two level assessment (including lists of recommended criteria), the national/regional assessment followed by the project specific assessment. This approach is in line with the prevention and precautionary principle as well as the polluter pays principle.

12 In a first step those river stretches are identified where hydropower development is forbidden by national or regional legislation/agreements (exclusion zones). In a second step all other stretches will be assessed using the assessment matrix and classification scheme (Figure 14 and 15).

13 The national/regional assessment is an instrument for administrations in the process of directing new hydropower stations to those areas where minimum impacts on the environment are expected. This can be achieved by an integration of hydropower production and ecosystem demands as well as by supporting decision making through clear and transparent criteria, including aspects of energy management as well as environment and landscape aspects. Danube-basin wide or transborder aspects need to be taken into account where appropriate.

14 The national/regional assessment is beneficial and provides gains for both, the environment and water sector but also for the hydropower sector by increasing predictability of the decision making process and making transparent where licences for new projects are likely to be issued.

15 While the assessment on national/regional level is more of general nature, classifying the appropriateness of river stretches for potential hydropower use, the project specific assessment provides a more detailed and in-depth assessment of the benefits and impacts of a concrete project in order to assess whether a project is appropriately tailored to a specific location. The assessment on the project level is carried out in response to an application for issuing the licence for a new hydropower plant and therefore especially depends on the specific project design.

16 Current and new policy developments, in particular the implementation of EU legislation and the EU Danube Strategy, should be reflected accordingly.

17 In order to support hydropower in the most sustainable way, incentive schemes for new hydropower projects should take into account the results of the strategic planning approach and adequate mitigation measures.

Mitigation of negative impacts of hydropower

18 Mitigation measures have to be set to minimize the negative impacts of hydropower installations on aquatic ecosystems. If foreseen by national legislation losses of hydropower generation from existing HPPs due to the implementation of mitigation measures may be compensated.

19 Ensuring fish migration and ecological flows are priority measures for the maintenance and improvement of the ecological status of waters.

20 Other mitigation measures like improving sediment management, minimising negative effects of artificial water level fluctuations (hydropeaking), maintaining groundwater conditions or restoring type specific habitats and riparian zones are important for riverine ecology and wetlands directly depending on aquatic ecosystems and should therefore be considered in the project design, taking into account most cost effective measures and security of electricity supply.

1. Introduction

1.1 Background

The increased production and use of energy from renewable sources, together with energy savings and increased energy efficiency, constitute important steps towards meeting the need of reduced greenhouse gas emissions to comply with international climate protection agreements. The development of further renewable energy in line with the implementation of the EU Renewable Energy Directive[1] represents a significant driver for the development of hydropower generation in the countries of the Danube River Basin. At the same time, Danube countries are committed to the implementation of water, climate, nature and other environmental legislation. Specifically the EU Water Framework Directive (WFD)[2] plays a leading role and is the key tool for water policy in the Danube River Basin, specifying water protection targets in balance with economic interests.

A considerable number of new infrastructure projects, including hydropower development, are at different stages of planning and preparation throughout the entire Danube River Basin. These projects provoke pressures and can deteriorate water status, but are at the same time beneficial in terms of socio-economic aspects and climate change mitigation. This can be in particular the case for multifunctional use of hydropower plants serving different purposes for people and communities, including the mitigation of floods and droughts and ensuring water resources for different water users by the seasonal and/or multiannual regulation of water flows.

The fact that new hydropower development is one option for reducing greenhouse gas emissions, but at the same time causes negative impacts on the riverine ecology, was recognised by Danube countries, imposing the requirement of a sustainable, balanced and integrated approach.

1.2 Mandate

Acknowledging the challenge of sustainable hydropower development in the frame of the existing legal and policy framework, the International Commission for the Protection of the Danube River (ICPDR)[3] was asked in the Danube Declaration 2010[4], "to organise in close cooperation with the hydropower sector and all relevant stakeholders a broad discussion process with the aim of developing guiding principles on integrating environmental aspects in the use of existing hydropower plants, including a possible increase of their efficiency, as well as in the planning and construction of new hydropower plants". This activity is also supported by the Action Plan of the EU Danube Strategy under Priority Area 2 "To encourage more sustainable energy" including the action "to develop and set up pre-planning mechanisms for the allocation of suitable areas for new hydro power projects"[5].

1.3 Elaboration process

The elaboration of the Guiding Principles was based on a broad participative process as asked for in the mandate, with involvement of representatives from administrations/institutions (energy and water/environment), the hydropower sector, NGOs and the scientific community. Four expert meetings, a workshop and a final conference allowed for the required exchange amongst experts.

As a basis for the development of the document, an "Assessment Report on Hydropower Generation in the Danube Basin"[6] has been prepared, providing key facts and data on hydropower generation in the context of water management, flood protection, biodiversity and nature protection in the Danube Basin. The report is based on replies of Danube countries via a questionnaire.

1) DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

2) DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy

3) International Commission for Protection of the Danube River (ICPDR): www.icpdr.org

4) Danube Declaration adopted at the Ministerial Meeting, February 16, 2010. Available online: http://www.icpdr.org/main/resources/danube-declaration-0

5) Action Plan SEC(2010) 1489 final. Available online: http://ec.europa.eu/regional_policy/cooperate/danube/documents_en.cfm#1

6) Assessment Report on Hydropower Generation in the Danube Basin. Available online: www.icpdr.org

Furthermore, an Annex to the Guiding Principles including case studies and good practice examples was elaborated, offering additional practical information and support for achieving sustainable solutions for hydropower development.

1.4 General objective and scope

The general objective of the Guiding Principles is to create a common vision and understanding on the requirements, the policy framework and issues to be addressed to ensure sustainable use of hydropower in the Danube basin. The document is intended to support a coherent and coordinated implementation of relevant legislation, in particular for the EU Renewable Energy Directive, the EU Water Framework Directive and other relevant environmental and water management legislation.

By helping to ensure a proportionate and streamlined decision-making process, the Guiding Principles aim to provide support towards the timely achievement of renewable energy targets, while at the same time ensuring the achievement of environmental and water management objectives.

Although international coordination requirements are in place, the implementation of respective legislation is within the national competences of the countries. Therefore, the Guiding Principles have the character of recommendations and do not exert any legally binding force. As a follow-up, application is recommended to take place on the national level and might be accompanied by further exchange with regard to administrative processes and technical provisions between the Danube countries.

1.5 Addressees

The “Guiding Principles” are primarily addressed to public bodies and competent authorities responsible for the planning and authorization of hydropower. This includes in particular bodies on the national, regional and local level in charge of energy, environment and water management. Furthermore they also provide relevant information for potential investors in the hydropower sector as well as NGOs and the interested public.

2. General framework

2.1 Policy framework

The following chapters provide relevant background information on policies in the field of renewable energy as well as water management and environmental protection. In particular the EU legislative framework and key facts are outlined.

2.1.1 Renewable energy

The increased importance of renewable energy can be explained by the crucial role of reducing greenhouse gas emissions as well as by diversifying and improving the security of the energy supply[1] and substituting finite and depletive fossil resources. In order to address these issues, the EU Renewable Energy Directive, being part of a package of energy and climate change legislation, provides a framework for increasing the share of energy from renewable sources, the improvement of energy supply and the economic stimulation of this sector.

The EU Renewable Energy Directive commits EU Member States to set binding individual targets, calculated according to the share of energy from renewable sources in its gross final consumption for 2020, taking into account their respective potential for generating renewable energy. Countries are free to choose a specific mix of renewable energy sources, with hydropower as one of different alternatives. Renewable energy sources include wind power, solar power (thermal, photovoltaic and concentrated photovoltaic), hydroelectric power, tidal power, geothermal energy and biomass. The National Renewable Energy Action Plans (NREAPs) required to be elaborated according to the EU Renewable Energy Directive, include information how EU Member States intend to reach their renewable energy targets for the year 2020 and the technology mix planned to be used (see Figure 1).

Also, all non EU Member States in the Danube basin have committed themselves – through their involvement in the Energy Community[2] – to implement the relevant “acquis communautaire”[3] in the field of renewable energy. On 18 October 2012, the Ministerial Council of the Energy Community decided the implementation of the EU Renewable Energy Directive in the Energy Community. With this decision, the Contracting Parties of the Energy Community (Albania, Bosnia and Herzegovina, Croatia, Former Yugoslav Republic of Macedonia, Kosovo[4], Moldova, Montenegro, Serbia and Ukraine) committed to a binding share of renewable energy as part of their overall consumption in 2020.

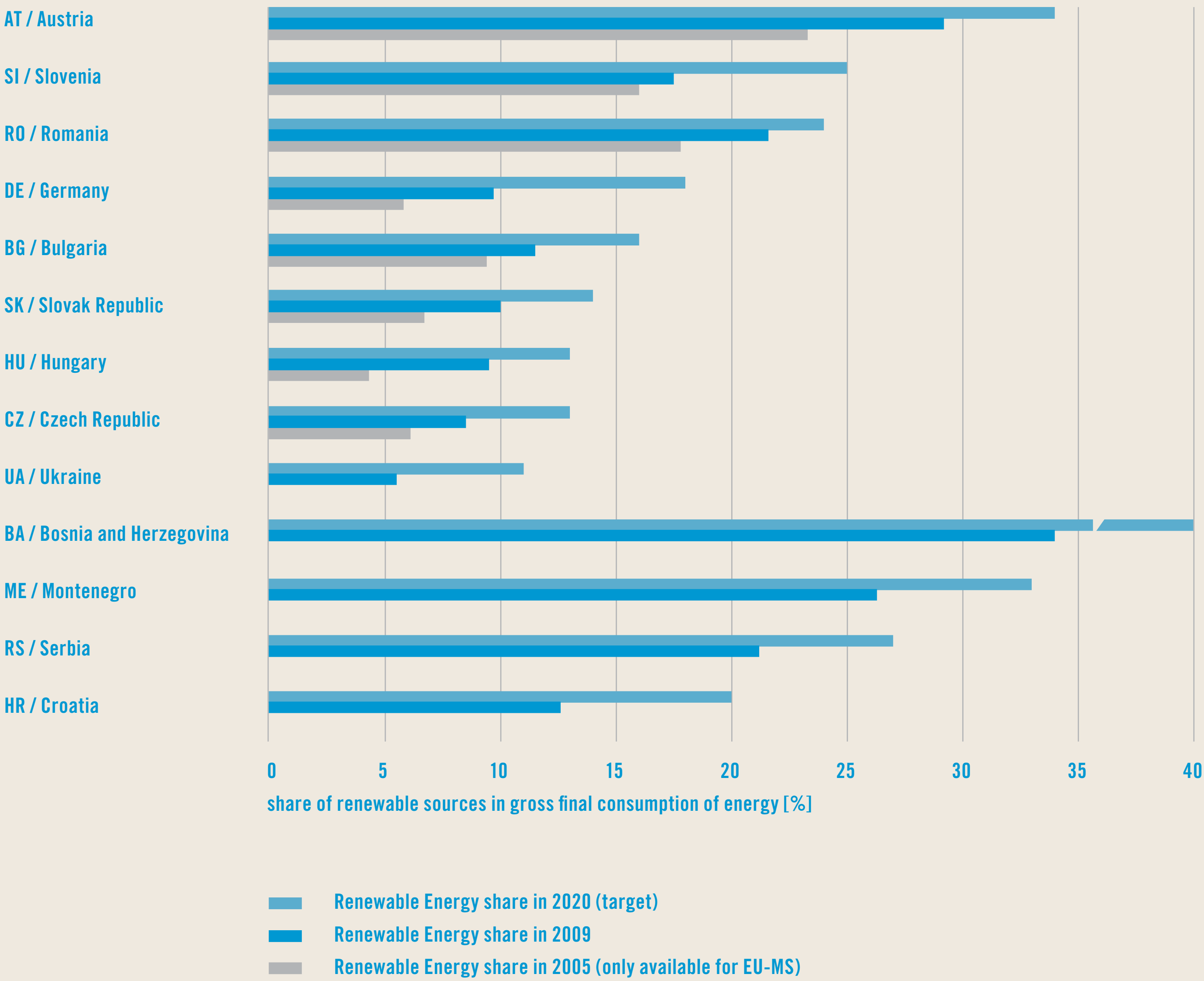
The decision of the Ministerial Council also reflects the amendments needed to the Article 20 of the Treaty establishing the Energy Community, where the adoption of the EU Renewable Energy Directive is therefore repealing the Directives 2001/77/EC and 2003/30/EC. The Energy Community Contracting Parties will have to submit their National Renewable Action Plans by 30 June 2013.

Thus, national and regional planning processes and strategies as regards renewable energy development are in place in all Danube countries, with hydropower as a source of contribution.

1) European Commission (2011): Renewables make the difference. Available online: http://ec.europa.eu/energy/publications/doc/2011_renewable_difference_en.pdf
2) Energy Community: A community established between the European Union and a number of third countries to extend the EU internal energy market to Southeast Europe and beyond: www.energy-community.org
3) Accumulated legislation, legal acts, and court decisions which constitute the body of European Union law
4) This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

National overall share and 2020 targets for energy from renewable sources in gross final consumption of energy*

FIGURE 1



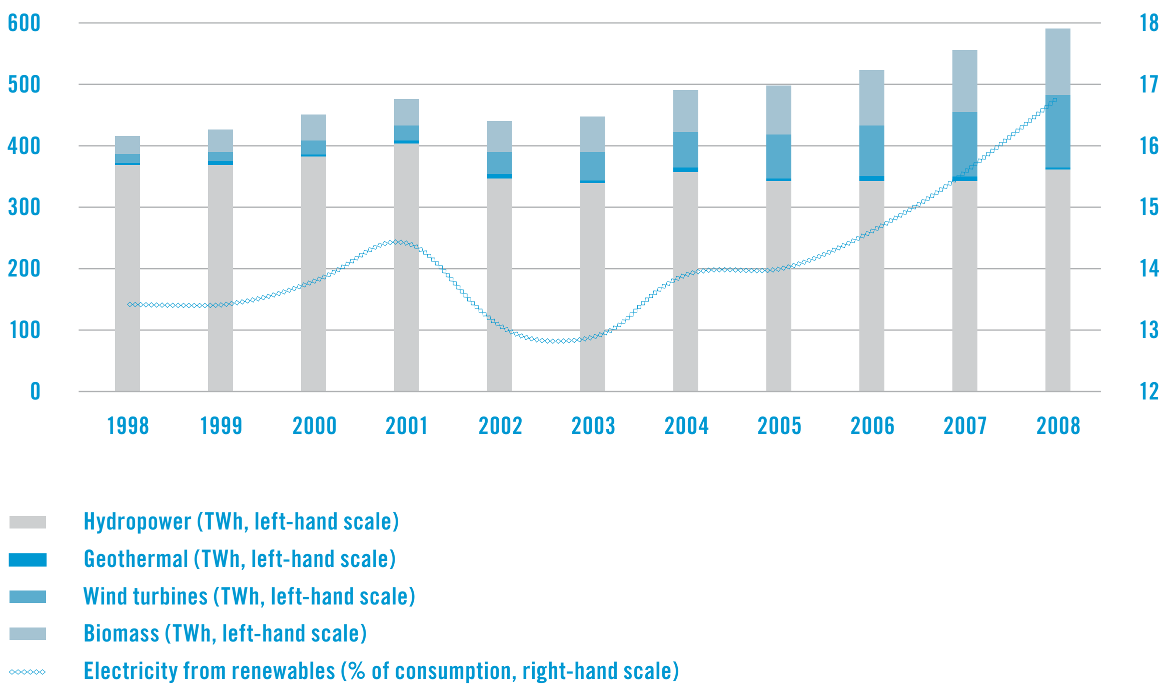
Different sources of renewable energy contribute to the overall share of renewable energy production. Figure 2 illustrates the development of the various renewable sources for electricity generation between 1998 and 2008.

The production of hydropower among renewable energy did not substantially change compared to other renewable energy sources such as wind and biomass, whereas the overall production from renewables increased.

* Retrieved from the Assessment Report on Hydropower Generation in the Danube Basin, including updated Data from Energy Community

Electricity generated from renewable energy sources, EU-27, 1998 to 2008*

FIGURE 2



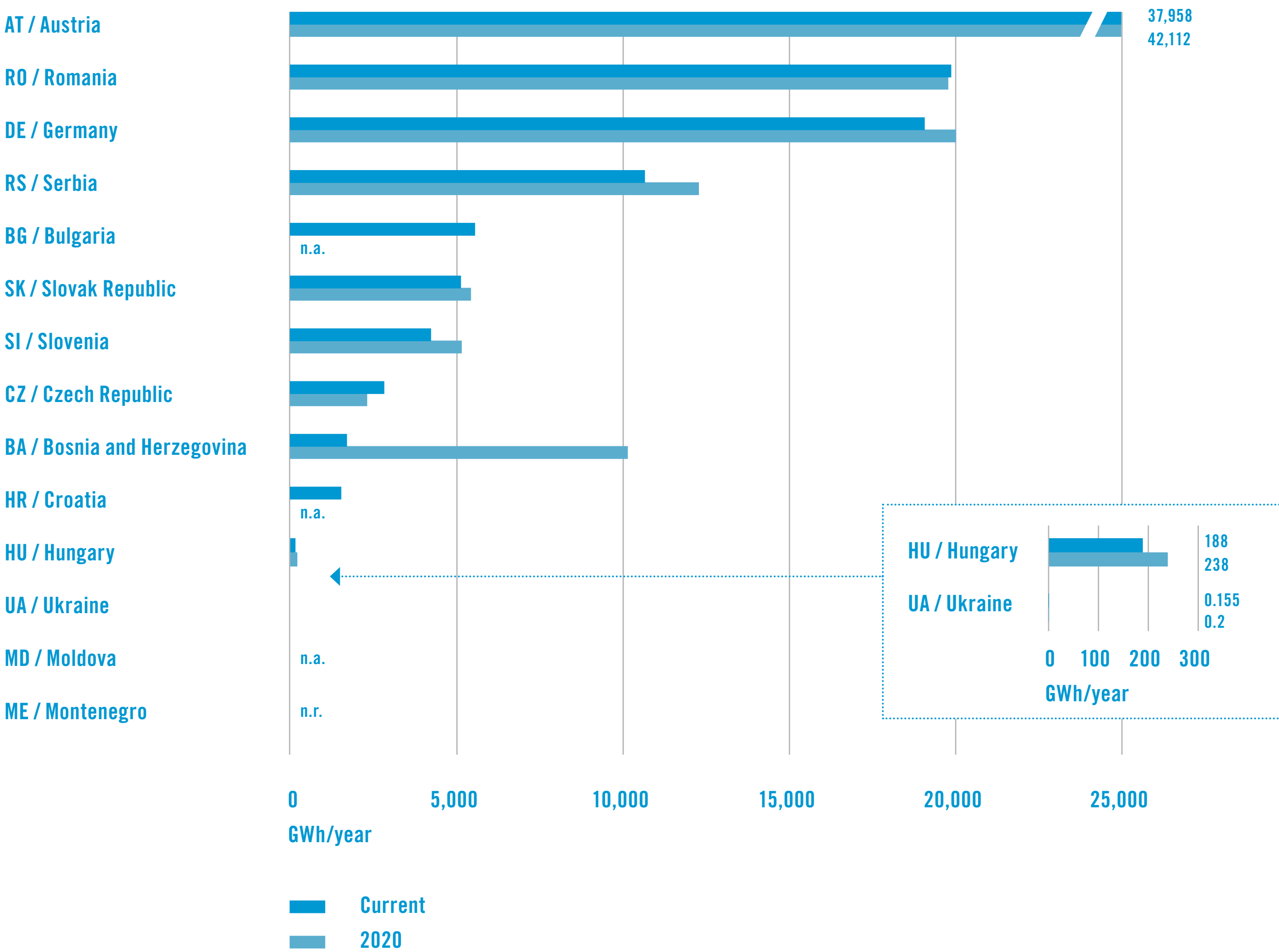
However, in most Danube countries (with the exception of DE, HU and MD), hydropower currently represents the most important component of total renewable energy production by contributing more than 45%. In 4 countries, the current share of electricity production from hydropower to total electricity from renewable energy sources is even above 90% (BA, RS, RO, SI)[1].

In most Danube countries, hydropower will remain a relatively significant contributor of renewable energy through the modernization and refurbishment as well as the development of new hydropower plants. When looking at the absolute figures of the development of hydropower generation in Danube countries, it can be seen from figure 3 that electricity production from hydropower will increase in AT, BA, DE, HU, RS, SK and SI. However the share of hydropower to total renewable electricity production will not increase in the surveyed Danube countries. This is an indication that by 2020 other renewable energy sources are expected to develop more dynamically than hydropower.

* Renewable Energy Statistics (Eurostat, 2008).
Available online: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Renewable_energy_statistics

1) Assessment Report on Hydropower Generation in the Danube Basin

Electricity production from hydropower currently and expected in 2020, in GWh/year (excluding pumped storage)* FIGURE 3



Furthermore, relevant legislation includes also the EU Directive 2012/27/EU on energy efficiency adopted on 25 October 2012. This Directive establishes a common framework of measures for the promotion of energy efficiency within the European Union in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. As a great share of Danube basin countries belong to the group of European states with the highest carbon/ GDP ratio (indicating lowest levels of energy efficiency), the potential for reducing greenhouse gas emissions through energy efficiency measures is high.

* Retrieved from the Assessment Report on Hydropower Generation in the Danube Basin (AT, BG, CZ, DE, HU, MD, RS, SI and SK, RO (relevant also for the Danube River Basin) reported data for the whole country. BA reported data for the current amount of electricity production for the national part of the Danube River Basin, while the figures for the expected amount of electricity production in the year 2020 refer to the whole country. HR and UA reported data for the national part of the Danube River Basin only. For RS, this value includes also Kosovo – a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN. For Romania, the reference year was hydrological exceptional, increase is therefore also expected.

2.1.2 Water management and environmental protection

Water management and environmental protection have a long lasting tradition in the Danube countries. Elements include inter alia the setting of water management objectives, the provision not to deteriorate water status, the reduction of impacts and/or the restoration of water status. These elements comply with the polluter pays, the prevention and the precautionary principle.

Beside the fact that it would be extremely difficult to address in detail all the national particularities with regard to existing legislation, the Guiding Principles have taken the relevant EU legislation as a common denominator and basis due to the following reasons:

- a considerable share of Danube countries is member to the European Union and thus obliged to apply EU legislation;
- many non EU Member States are in the process of accession or association to the EU and have thus voluntarily agreed to apply (elements) of EU legislation;
- in 2000 all countries cooperating in the frame of the ICPDR have agreed to work towards a coordinated Danube River Basin District Management Plan for the whole Danube River Basin according to the EU Water Framework Directive. As one of the most tangible milestones in this cooperation, this Plan has been adopted by the contracting parties of the ICPDR in the end of 2009;
- the basic principles EU legislation is founded on are often similar to those standing behind national legislation of non EU Member States.

The most important piece of water-related legislation is the EU Water Framework Directive 2000/60/EC (WFD). Adopted in the year 2000, the protection of Europe's waters is regulated in this single framework legislation, including the expanded scope of the water protection to all surface waters (rivers, lakes, transitional and coastal water) and groundwater. Water management has to be done on the river basin level as well as "good status" for all waters has to be achieved by 2015.

This objective implies the duty to adopt all measures necessary to achieve the required environmental objectives. Further information on the status of waters and the measures adopted by the Danube countries can be obtained from the Danube River Basin District Management Plan.

One of the further requirements of the WFD is the principle of non-deterioration, which requires the prevention of the deterioration of water status. There exist exemptions to this principle (WFD Art. 4.7) which are of specific relevance for new modifications to the physical characteristic of water bodies (new infrastructure projects, including hydropower). This issue is further explained in chapter 2.3 and 3.3.

Furthermore, the polluter pays principle[1] needs to be considered, requiring that the party (e.g. the hydropower plant operator) responsible for the environmental impact pays for the damage done to the environment according to the costs they generate[2]. With regard to hydropower these can include inter alia impacts on the aquatic ecology (e.g. habitats and species) or hydromorphology (e.g. runoff, water balance, sediment transport and river morphology).

Thus, there should be a clear insight into all costs and benefits of hydropower. This insight will help sustainable decision-making on hydropower projects and implementing the polluter pays principle. Additionally, the precautionary principle including the rule that lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation need to be respected.

The implementation of the EU Water Framework Directive raises a number of shared technical challenges. Furthermore many of the European river basins are international, crossing administrative and territorial borders and therefore a common understanding and approach is crucial to the successful and effective implementation of the Directive.

1) DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy

2) Examples for publications addressing the topic include:
OTT W., BAUR M., ITEN R., VETTORI A. 2005: Konsequente Umsetzung des Verursacherprinzips. Umwelt-Materialien Nr. 201. Bundesamt für Umwelt, Wald und Landschaft, Bern. 182 S.
Mann, Ian (2009): A comparative study of the polluter pays principle and its international normative effect on pollutive processes. Forbes Hare, British Virgin Islands, MS (31 pp.), www.consulegis.com

In order to address the challenges in a co-operative and coordinated way, a Common Implementation Strategy (CIS) for the EU Water Framework Directive was launched following the adoption of the Directive, with participation of the European Commission, EU Member States, NGOs, stakeholders and other parties concerned (including the NON EU Member States Switzerland and Norway). The results of this work, for instance guidance documents[1], tackle these challenges and provide relevant information, also on the issue of hydromorphological alterations and hydropower in relation to the WFD. These documents, by explaining the key principles, state-of-the-art (Best Available Technique, BAT and Best Environmental Practice, BEP), approaches and considerations to be taken into account, are certainly helpful also for countries outside the European Union.

EU countries in the Danube basin also need to take into account the requirements of managing and protecting Natura 2000 sites. Article 6 of the EU Habitat Directive requires that within Natura 2000 EU Member States

- take appropriate conservation measures to maintain and restore the habitats and species for which the site has been designated to a favourable conservation status;
- avoid damaging activities that could significantly disturb these species or deteriorate the habitats of the protected species or habitat types.

Similar to WFD Article 4(7), Articles 6(3) and 6(4) of the EU Habitat Directive lay down the procedure to be followed when planning new developments that might affect a Natura 2000 site.

In addition to the provisions of the WFD and the Habitats Directives, hydropower development also needs to be seen in the context of other environmental legislation, like the EU Birds Directive, the EU Floods Directive[2], the EU Biodiversity Strategy[3] as well as the EU Environmental Assessment Directives[4].

Environmental legislation focuses on prevention, mitigation and compensation of ecological impacts which can be caused by hydropower use. Legislation as regards nature protection foresees the concept of compensatory measures to provide adequate compensation for any loss of wildlife and habitats and to ensure the overall coherence of the network of protected areas.

2.2 Benefits and impacts of hydropower

The following chapters provide brief overview on the main benefits and impacts of hydropower generation. More detailed information can be obtained from the Assessment Report[5].

2.2.1 Benefits

Most of the benefits of hydropower generation are self-evident since the consumption of electricity is crucial to our daily life. Since hydropower is a renewable energy and therefore an almost emission-free form of electricity generation, greenhouse gas emissions can be reduced when substituting non-renewable forms of electricity production. Hydropower – being a domestic source of energy – can also contribute to reduce energy dependency from external sources, thus contributing further to security of energy supply.

Hydropower can cover parts of the base electricity consumption and more particularly can contribute to covering peaks of demand thus contributing strongly to guarantee stability of the transmission grid and to the stability of supply. This contribution becomes even more important as an increasing share of supply comes from other, less reliable but highly potential renewable energy such as wind or solar power with their high variability which has to be compensated in order to avoid "black outs". Hydropower plays a crucial role, as variations in demand can be compensated at very short notice, much faster than thermal power stations may be able to do.

1) https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp?FormPrincipal:_idcl=FormPrincipal:_ id3&FormPrincipal_SUBMIT=1&id=7767c856-6c8d-4948-9596-fc807e6397b2&javax.faces.ViewState=rO0ABXVyABNbTGphdmEubGFuZy5PYmplY3Q7kM5YnxBzKWwCAAB4cAAAAAN0AAEzcHQAKy9qc3AvZXh0ZW5zaW9uL3dhaS9uYXZpZ2F0aW9uL2NvbnRhaW5lci5qc3A=

2) DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks

3) EU Biodiversity Strategy to 2020. Available online: http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm.

4) COUNCIL DIRECTIVE of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment. DIRECTIVE 2001/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

5) Assessment Report on Hydropower Generation in the Danube Basin

Hydropower as a rather decentralized form of electricity generation contributes to the security of supply. Losses stemming from transmission are often low due to the short distances between supply and demand.

Development and manufacturing of hydropower components, planning, construction and operation of hydropower facilities and the transmission grids require considerable technological knowledge and research. This contributes to the creation of new jobs and to the growth of domestic economies as well as bringing a positive net fiscal contribution to national budgets.

Hydropower can play a major role at the local and regional level for socio-economic development, also because hydropower facilities are often built in combination with new infrastructure. For large hydropower facilities additional significant benefits can come from the multifunctional use of reservoirs used for hydropower generation since water stored in reservoirs can contribute to enhance flows for downstream regions (e.g. in periods of low flows or drought). In periods of floods, reservoirs may contribute to water retention and mitigation of floods if properly managed. Reservoirs may be further used for tourism and recreational purposes, as well as for drinking water, irrigation, the improvement of navigation conditions or other needs.

Examples for benefits of hydropower installations (renewable energy, pumped storage – energy storage) *FIGURE 4*

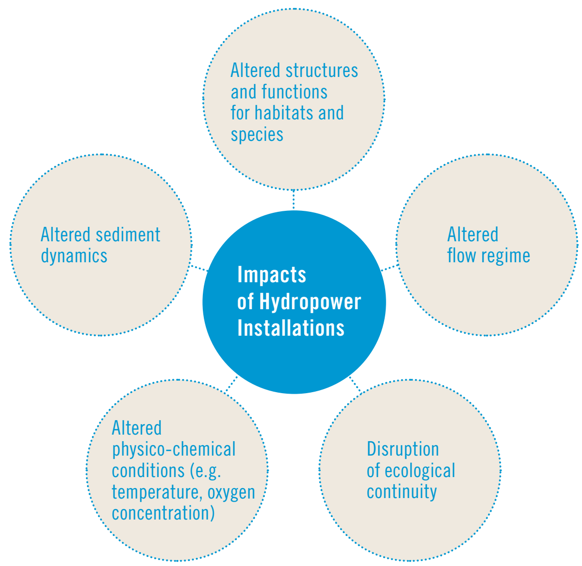
2.2.2 Impacts

Dependent on plant type (diversion hydropower plants, run-of-river hydropower plants, storage hydropower plants and pumped storage hydropower plants), (technical) size, mode of operation and location hydropower generation can have impacts on the aquatic ecology, natural scenery and ecosystems.
In the 1st implementation report of the WFD[1] and the 1st Danube River Basin District Management Plan, hydropower has been identified as one of the main drivers to hydro-morphological alterations, loss of connectivity and to significant adverse effects on fish populations. The possible key ecological impacts in connection with hydropower generation are indicated in Figure 5 providing a non-exhaustive overview.

In the following, some of the possible key impacts are explained in detail. Dams and weirs used for hydropower generation cause an interruption of the longitudinal river continuity resulting in significant adverse effects on the river's aquatic communities. Migrating species like fish in particular are affected by the fragmentation of their habitats.

Furthermore, hydropower plants can change hydromorphology. The morphological degradation affects not only the composition of natural structural elements and the loss of dynamic hydrological processes and sediment transport, but can also cause fundamental changes to the river type or surface water category.

Possible key ecological impacts of hydropower installations – Illustrative range of possible alterations typically associated with hydropower dams* *FIGURE 5*



Disruption of ecological river continuity (diversion hydropower plant), sediment issues (flushing) *FIGURE 6*

[1] COM(2007) 128 final. Commission Staff Working Document accompanying to the Communication from the EC to the European Parliament and the Council.

* WFD and hydromorphological pressures, technical report, Good practice in managing the ecological impacts of hydropower schemes. Figure modified.

In case of impounded rivers the reduction of flow velocity can impact fish due to the loss of orientation. Changed width – depth variations and reduced riverine habitats can shift the species composition from a riverine type (lotic) to a standing type (lentic). Reduction of flow velocity also results in other negative impacts like increase of water temperature and decrease of oxygen concentration, decrease of self-purification capacity, increased deposition of fine sediment in the impoundment as well as disturbed bed load discharges and sediment transport, leading to erosion and deepening processes downstream of the impounded section. A series of impoundments (chain of hydropower plants) have strong cumulative effects on the aquatic ecosystem of the whole (sub-)basin.

In case of hydropower generation by diversion plants, non-sufficient ecological flow in the affected stretches cause a number of impacts on the river ecology, notably: homogenization of the flow character and degradation of habitat, continuity disruptions for migrating fish and changes of the natural temperature conditions.

Another impact stemming hydropower can be hydro-peaking, which is mainly caused by large hydropower plants in combination with reservoirs. Hydro-peaking can have severe ecological effects on a river.

Depending on the rate of discharge acceleration benthic invertebrates and also juvenile and small fish can get washed away with the flush, which results in decimation of benthic fauna, reduction of fish biomass and also changes to the structure of fish populations. During the down-surge benthic invertebrates and fish can get trapped in pools that might dry out later on so the animals either die or become easy prey for predators.

In reservoirs and impounded river stretches the reduced flow velocity leads to an increased deposition of fine sediment that makes periodical flushing of the reservoirs necessary. This can cause a number of negative effects on freshwater ecology.

2.3 Potential conflict of interests and approaches for solutions

The benefits of increasing renewable energy in line with the requirements of the EU Renewable Energy Directive, with hydropower as a significant contributor, and the need to achieve the environmental objectives of the EU Water Framework Directive and related legislation, have been demonstrated in the previous chapters. The impacts of hydropower on the environment result in a potential conflict of interests as also illustrated in Figure 8, which needs to be tackled in an integrative manner in order to strike a balance between the related objectives.

Artificial water level fluctuations (hydropeaking) from storage hydropower plants *FIGURE 7*

Potential Conflict of Interests

FIGURE 8

Mitigate climate change and offer secure and efficient energy supply

Achieving renewable energy and climate protection goals

Increasing the production of renewable energy from hydropower generation

Drivers and Expectations

Potential Conflict of Interests

Good reasons and need for achievement of both objectives!

Important value of ecosystems and landscape

Achieving environmental objectives

Avoiding/minimizing the impairment of the aquatic ecosystem and landscape

How to strike a balance (optimisation task) between these two objectives?

Therefore, a holistic approach addressing the different issues is required. Besides paying respect to general principles and considerations (sustainability, energy policies, etc.), addressing the modernization, refurbishment and ecological restoration of existing hydropower plants is important. For new hydropower development, the application of a strategic planning approach is key for a sound implementation of relevant legislation in place. Accompanying practical mitigation measures help to reduce the impact of hydropower on water body status. Not every hydropower plant necessarily leads to a deterioration of ecological status according to the WFD. However, a new hydropower project deteriorating the ecological status of the river will be in conflict with the no deterioration principle of the WFD, but nevertheless Article 4(7) WFD exceptionally allows the deterioration of water status or failure to achieve good water status provided certain strict conditions are met.

The requirements for exemptions according to Article 4.7 WFD include amongst others that

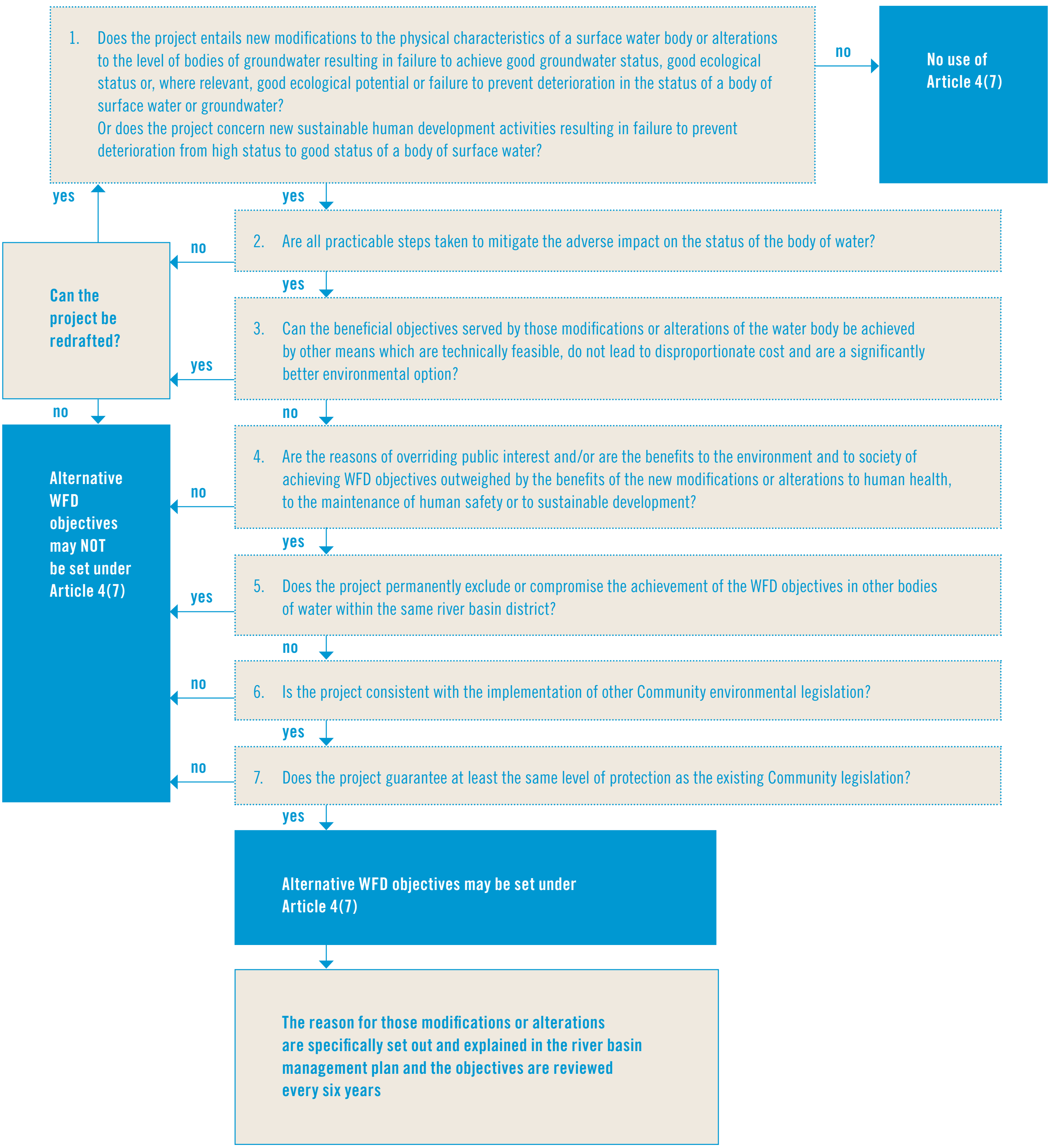
- the benefits of the new infrastructure are of overriding public interests outweighing the benefits of achieving the WFD environmental objectives,
- there are no significantly better environmental options which are technically feasible,
- all practicable mitigation measures are taken to minimize negative effects on the aquatic ecology and
- the projects are reported in the River Basin Management Plans.

Detailed information can be obtained from the EU WFD and CIS guidance documents. A pre-check-list for what to take into account to allow a deterioration or failure of water status is illustrated in Figure 9 taken form CIS Guidance document No. 20[1], where further explanations and descriptions can be obtained from. Since the application of WFD Article 4.7 is key for new infrastructure development including hydropower, the related requirements are incorporated in these guiding principles (in particular in chapter 3.3).

[1] Guidance document on exemptions to the environmental objectives, CIS Guidance Document No. 20

Iterative approach allowing for the identification of a sustainable development activity according to WFD Article 4.7

FIGURE 9



Similar to WFD Article 4.7 Paragraph 6.3 and 6.4 of the Habitat Directive lay down the procedure to be followed when new developments like hydropower might affect a Natura 2000 site.

In addition, also the provisions of the Strategic Environmental Assessment (on regional level) as well as the Environmental Impact Assessment (on project specific level) need to be taken into account for hydropower development.

Complementing the legal and administrative requirements and provisions from EU and national legislation, also other instruments are in place aiming at the support of the implementation of sustainable hydropower development. The Hydropower Sustainability Assessment Protocol[1] from the International Hydropower Association is one framework for hydropower development and operation which enables the elaboration of a sustainability profile for a project through the assessment of performance within important sustainability topics.

1) Hydropower Sustainability Assessment Protocol.
Available online: http://www.hydrosustainability.org/Document-Library.aspx

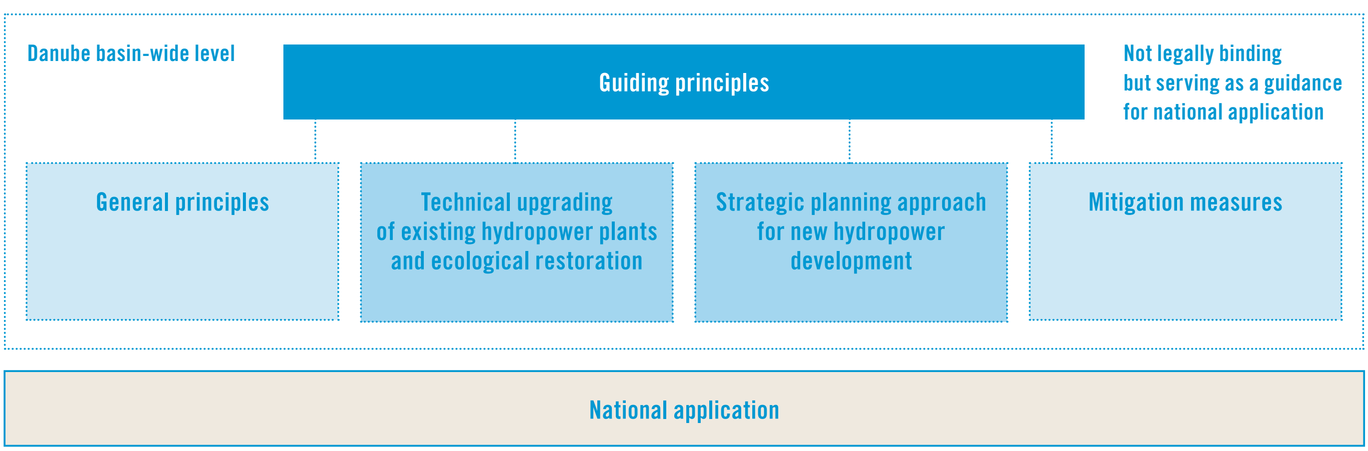
3. Guiding principles on sustainable hydropower development

The following chapter constitutes the core part of the document, outlining guidance for the sustainable use of hydropower.

It is deducted from the challenges and approaches for solutions lined out in the previous chapters and includes the following main elements as also illustrated in figure 10:

- underlying general principles and considerations for sustainable hydropower generation,
- information on modernization, refurbishment and ecological restoration of existing hydropower stations,
- an outline for a strategic planning approach for new hydropower development, including recommended criteria, and
- an overview on practical mitigation measures to avoid and minimize the impact of hydropower on the environment.

Main elements of the Guiding Principles *FIGURE 10*



The Guiding Principles have been elaborated in the frame of an international and intersectoral process on the Danube basin-wide level.

As already outlined in the introduction, as a follow-up, application is recommended to take place on the national level and might be accompanied by a further exchange on experiences with regard to administrative processes and technical provisions between the Danube countries.

3.1 General principles and considerations

3.1.1 Sustainability

The principles of sustainable development require that resources should be managed in a holistic way, coordinating and integrating environmental, economic and social aspects[1] in an equal way. These main elements are also illustrated in Figure 11.

Focusing solely on hydropower production and the conservation of the aquatic ecosystems and directly depending terrestrial ecosystems as well as landscapes is not sufficient to achieve sustainable solutions.

In addition the following aspects have to be considered:

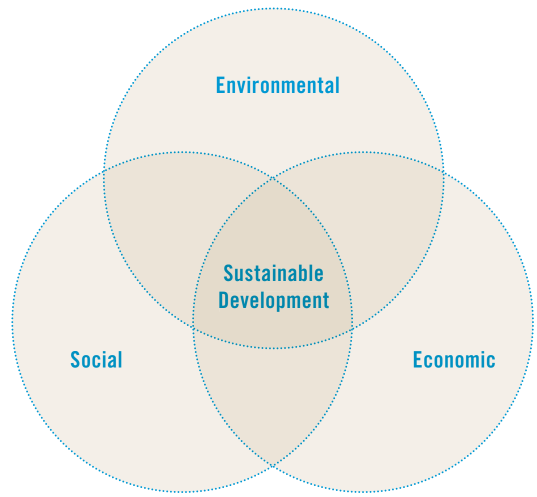
- flood protection and water uses (e.g. water supply, irrigation, navigation, recreation, etc.) for people and communities,
- other national or regional objectives and constraints (social, legal, economic, financial, human health),
- general environmental aspects including changes in freshwater ecosystems on surrounding ecosystems (e.g. forests) and objectives regarding climate protection or adaptation to climate change (e.g. ecosystem services[2]),
- socio-economic aspects – allocation of revenues, decentralized approaches, employment, paradigm of society (sufficiency instead of efficiency and economic growth), and
- regional development.

From the above listed aspects criteria can be deducted feeding into an evaluation or assessment of the sustainability of hydropower development. The hydropower sector contributes towards the achievement of sustainable energy development in case this is carried out in an integrative manner, properly assessing environmental, social and economic benefits and costs.

[1] United Nations General Assembly (2005). 2005 World Summit Outcome, Resolution A/60/1, adopted by the General Assembly on 15 September 2005

[2] Ecosystem services are the direct and indirect contributions of ecosystems to human well-being. They support directly or indirectly our survival and quality of life (Harrison and RUBICODE consortium, 2009). There is no single, agreed method for the definition of all ecosystem services, but the Millennium Ecosystem Assessment framework is widely accepted.

Three dimensions of sustainability *FIGURE 11*

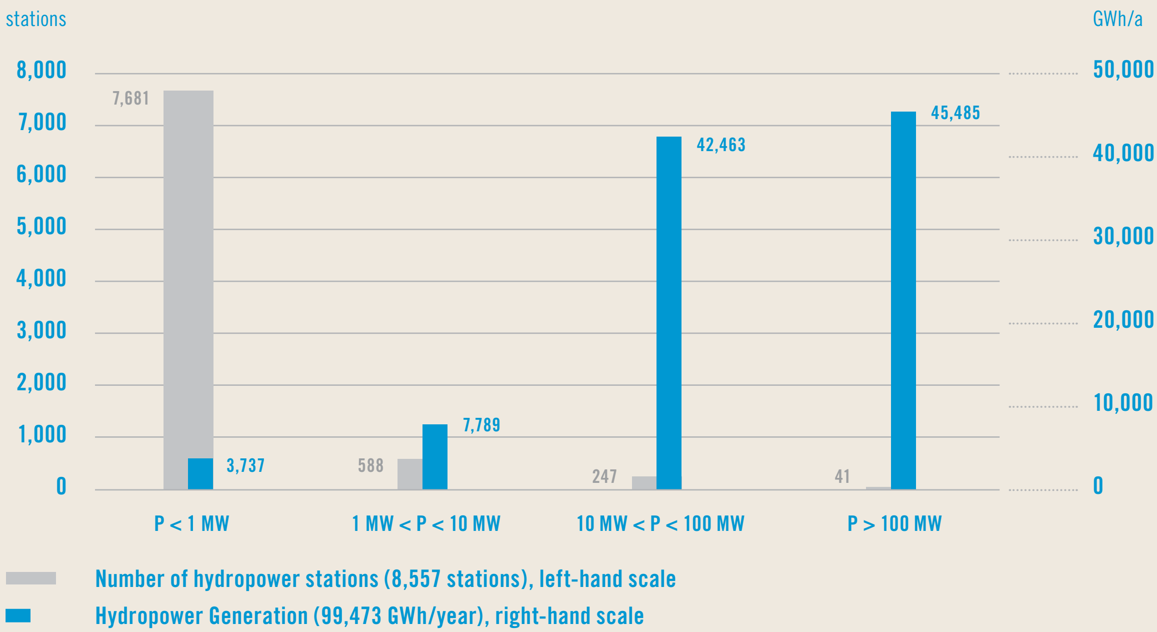


3.1.2 Holistic approach in the field of energy policies

Energy saving, increase of energy efficiency and untapped renewable energy potential should be part of a holistic approach of energy policies. Reduced consumption leads to a reduction of pressures for the provision of energy. Other important aspects to consider are grid stability and supply security as well as related storage capabilities. Energy management policies and goals on national and international level have to be taken into account in the context of renewable energy generation, including sustainable hydropower development.

The issue is also addressed by the EU Renewable Energy Directive which asks for taking into account the effects of other policy measures relating to energy efficiency on final consumption of energy. Furthermore, the Directive requires an assessment of the total contribution expected of the energy efficiency and energy saving measures to meet the mandatory 2020 targets. In addition, the Energy Efficiency Directive 2012/27/EU, addresses the issue more concretely to pave the way for further energy efficiency improvements.

Contribution of different plant capacity categories to electricity generation from hydropower* *FIGURE 12*



3.1.3 Consideration of hydropower types and plant capacities

Different sizes and types of hydropower installations have different impacts on the ecology, what was already addressed in chapter 2.2.2. This fact has to be considered in the assessment of expected impacts of planned hydropower installations on one hand. On the other hand this fact is also relevant for the design and application of mitigation measures at already existing facilities.

Furthermore, different plant sizes contribute with different shares to the overall electricity generation from hydropower depending on their installed capacities. Figure 12 illustrates that at the Danube basin wide level the most significant current share (almost 90%) of electricity is generated by large facilities (representing around 3.5% of the total number of hydropower stations), with installed capacities of more than 10 MW. Small hydropower plants with an installed capacity under 1 MW currently contribute less than 4% to the electricity generation but representing almost 90% of hydropower stations in place.

The predicted ratio between the contribution of new large and new small hydropower plants to the 2020 objectives set for the overall hydropower production varies in Danube countries[1].

In some cases hydropower plants of different sizes (including small) can be compatible with good status in case the required mitigation measures are applied (e.g. fish migration aids, ecological flow). However, deterioration from high to good status requires an exemption from the no-deterioration principle according to WFD Article 4.7. It should be emphasized that assessment of cumulative effects on the aquatic ecology has always to be taken into account in case of assessing the impacts of new hydropower projects on ecology.

Thus, in order to balance electricity generation and river ecology, the type, electricity contribution and the individual and cumulative actual benefits and impacts of various hydropower plants should be considered when elaborating strategies for hydropower development.

* 1) Assessment Report on Hydropower Generation in the Danube Basin

3.1.4 Weighing public interests

Weighing of public interests is required in the decision making process in order to evaluate if the benefits of a planned hydropower project outweigh the benefits of maintaining the environmental conditions. This weighing process should be carried out in a transparent, structured, and on a reproducible criteria based procedure involving public participation in an early stage of the decision making process. Strategic planning is a useful tool for proper assessment of the public interests.

The weighing process is in particular required by EU WFD Article 4.7 in case of expected deterioration or failure of water status due to a planned hydropower project, regardless the size[1], but can also be required by other legislation (e.g. EU Habitats Directive Article 6.3). In this process, it is of key importance to assess different levels of interests including economic (energy), social (consumers, safety) and environmental (water and nature protection) aspects.

Renewable energy production as such is not being regarded as overriding public interest in general in relation to other public interests. A hydropower project is not automatically of overriding public interest just because it will generate renewable energy. Each case has to be assessed on its own merits[2], according to national legislation.

3.1.5 Public participation

The role of citizens and local communities, organisations representing other economic interests, and other relevant stakeholders whose interest will be affected by certain projects, is crucial to optimise planning processes and to develop a common understanding and acceptance in the practical implementation of new hydropower projects at national/regional and project level (see chapter 3.3.1).

In this respect, public participation and access to information as required by the WFD for EU countries as well as by the Espoo and Arhus Conventions[3], is essential and has to start as early as possible in the planning process. It is expected, that with this strategy, the planning and implementation of new and appropriate hydropower projects can be significantly improved in terms of costs, timing and acceptance by different interest groups.

3.1.6 Adaptation to climate change

New hydropower development needs to be seen in the context of adaptation to climate change. The ICPDR developed a Strategy on Adaptation to Climate Change[4], including several indications as regards adaptation measures with relevance for hydropower. In particular the economic viability of new infrastructure projects needs to be considered with a view to altered flow regimes due to climate change.

Technological measures for adaptation of hydropower plants to climate change can be considered, e.g. the investment in energy storage technology or the implementation of technological solutions for low flow / drought situations.

At the same time the ICPDR Adaptation Strategy stresses the need for mitigating climate change impacts on ecosystems, e.g. by avoiding/minimizing the impact of constructions on the flow regime.

1) Final Synthesis of Informal meeting of Water and Marine Directors of the European Union, Candidate and EFTA Countries, Segovia, 27–28 May 2010

2) Conclusions of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011. Available online: http://www.ecologic-events.eu/hydropower2/documents/IssuePaper_final.pdf

3) UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991). Available Online: http://www.unece.org/env/eia/eia.html. UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus, 1998). Available online: http://www.unece.org/environmental-policy/treaties/public-participation/aarhus-convention.html

4) ICPDR Strategy on Adaptation to Climate Change. Available online: http://www.icpdr.org/icpdr-pages/climate_adaptation_study.htm

3.2 Technical upgrading of existing plants and ecological restoration measures

3.2.1 Basic considerations and requirements

Technical upgrading refers to measures which increase the hydroelectric output of existing hydropower plants (e.g. by the installation of new turbines or generators, modification of the control systems, etc.) and can also include measures which increase the installed capacity and electricity production by expanding the existing use of water. Ecological restoration measures aim at mitigation of impacts of the plant on the river and directly dependent wetlands and floodplains. This is an important issue for the achievement of environmental objectives (e.g. EU WFD, etc.). Transition periods for compliance with ecological requirement may be granted.

In order to increase the energy production and energy efficiency of existing hydropower installations, technical upgrading and the re-opening of disused plants (if economically and ecologically appropriate) should be promoted and linked to ecological restoration in order to mitigate the impacts. This combination can imply a win-win situation for energy production and the environment, and may be economically viable in particular for small hydropower.

The possibilities for technical upgrading of hydropower installations and ecological restoration measures have to be evaluated on a case by case basis. In certain cases, even decommissioning of old, inefficient installations located in river sections of ecological importance might be considered[1]. This can in particular be relevant where the benefits for the environment outweigh significantly the benefits of the infrastructure. Ownership rights are an important issue to be considered for such options, because they can be subject to the decision of the (private) owners themselves.

3.2.2 Incentive schemes

In order to trigger and promote technical upgrade as well as the ecological restoration of existing facilities, incentive schemes can be a helpful tool in energy strategies and instruments. Investments in technical upgrade should be linked with ecological restoration since this can in particular support the achievement of the win-win situation for increased energy production next to an improvement of environmental conditions as described in the previous chapter. Furthermore, this can also lead to an acceleration in the fulfilment of legal requirements (for energy, water and environmental legislation) or even to go beyond minimal requirements and leverages the amount of investments which otherwise might not be made.

Different incentive schemes can be applied as for instance subsidies in form of investment incentives or guaranteed feed-in tariffs, or eco-labels[2]. The latter are certified and controlled tools where the consumers pay for specific environmental measures, which can be used by hydropower companies on a voluntary basis to advertise environmentally friendly energy production. These requirements should go beyond the legal requirements.

3.3 Strategic planning approach for new hydropower development

3.3.1 Basic considerations and requirements

As reported by the Danube countries[3], new hydropower development is planned in the Danube basin as part of the increase of renewable energy production. The key challenge is to identify those river stretches which should be kept free from hydropower development and potentially appropriate river stretches for new hydropower plants and their hydropower potential which have the least/minimum possible impact on environment.

EU countries have already adopted their National Renewable Action Plans; non EU countries will adopt them by 30 June 2013 in line with the decision taken by the Ministerial Council of the Energy Community.

1) Conclusion 24 of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011

2) For an example see Ch. Bratrich and B. Truffer (2001): Ökostrom-Zertifizierung für Wasserkraftanlagen, Konzepte, Verfahren, Kriterien, ISBN 3-905484-05-6

3) Assessment Report on Hydropower Generation in the Danube Basin

For new hydropower development, the application of a strategic planning approach is crucial for a sound implementation of relevant legislation due to the following reasons[1]:

- a strategic planning approach is a key opportunity to facilitate the integration of water, environment and energy policy objectives as well as the objectives of other key policy areas;
- it allows linking strategic planning for the aquatic environment and nature conservation with the national energy planning on renewable electricity;
- it allows for the involvement of all interested parties;
- using the planning process helps setting priorities (e.g. with respect to balancing energy, environment and water management priorities);
- good strategic planning can help streamline the authorisation process on proposed new hydropower developments and improve transparency and predictability for hydropower developers;
- strategic planning allows for the proper assessment of best environmental options and overriding public interest of the project
- the approach provides upfront information to developers about where (geographically) gaining authorisation is likely;
- using the policies and criteria established can help to manage risk of cumulative impacts from hydropower plants;
- the river basin management planning process provides an opportunity to integrate a strategic planning approach for hydropower development with water environment objectives.

Based on these considerations, the application of a, criterion based assessment is recommended as a first level for the strategic planning approach on a national/regional level. This is important as well from the legal point of view in cases of deterioration or failure of water status due to hydropower projects where the application of Article 4.7 EU WFD requires to examine significantly better environmental options for the achievement of the same objective (e.g. alternative locations) – see chapter 3.3.2.

Since the benefits and impacts of hydropower installations also depend on the project design, a project-specific assessment is necessary on a second level. This is also due to the fact that the required assessments and acquisition of data is only feasible on the respective levels. Therefore, a two-level assessment is suggested for the strategic planning approach as illustrated in Figure 13.

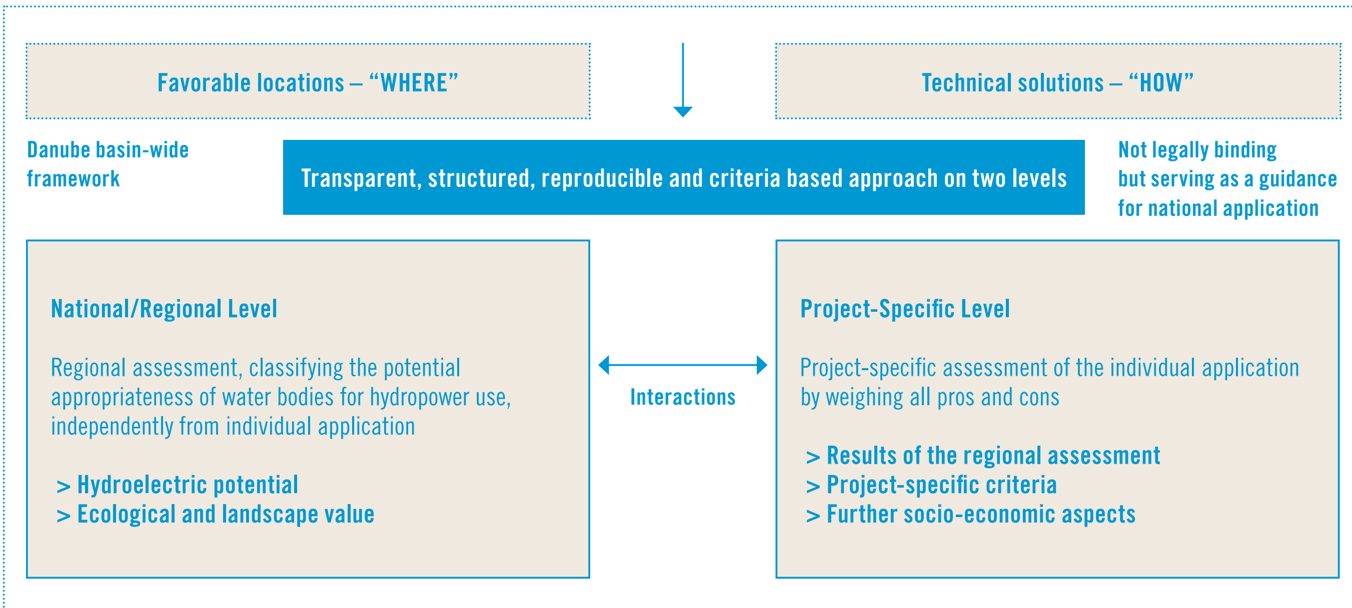
With regard to the appropriate level for the national/regional assessment, the following has to be taken into account:

- The Treaty of the European Union explicitly reserves for the individual Member States the right to determine the conditions for the utilisation of energy resources, the choice between the different energy sources and the general structure of its energy supply.
- There is a close interlinkage between the National Renewable Energy Action Plans according to the EU Renewable Energy Directive and the national/regional planning process as both processes together provide the frame for the concrete amount of hydropower which is intended to be realised in the future, respectively the frame for determining those locations for additional facilities where an additional amount of energy may be generated with the least/minimum possible impact to the environment. Ideally the potential contribution of hydropower in the National Renewable Energy Action Plans should be based on the outcome of the national/regional assessment for hydropower planning.

The national/regional level in the context of this document is thus defined as a level of management below the national level. This is also due to the reason that the implementation of EU legislation (i.e. on environment and energy) is in the national/regional competence of the countries, being compulsory for EU Member States, respectively voluntary for non EU Member States, beside that issues might be covered just by national legislation. However, transboundary coordination of national/regional assessments can be required in cases where this is necessary for the achievement of the environmental objectives of the EU WFD.

[1] Based on conclusion 24 of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011

Strategic planning approach – national/regional and project-specific assessments *FIGURE 13*



While the assessment of new hydropower projects on national/regional level will be more of a general nature, classifying the potential appropriateness of water stretches for hydropower use, the project-specific level will provide a more detailed and in-depth assessment, weighing the pros and cons of the individual application also taking into account the results of the national/regional assessment.

Potential new hydropower installations can be placed either at new sites or at sites with already existing transversal structures (e.g. weirs for river regulation, flood protection or the stabilization of the river bed), which are not foreseen to be removed in the cause of water management planning. Using such structures in addition for hydropower generation can lead to a win-win situation in case also ecological restoration measures are applied. Such considerations can also be integrated in the strategic planning approach.

3.3.2 National/Regional assessment and criteria

The requirement for the application of a national/regional assessment for sustainable hydropower development has been outlined above. Furthermore, the information on the national/regional assessment also can provide basic information for the project-specific assessment (see chapter 3.3.3).

In a first step those river stretches are identified where hydropower development is forbidden according to relevant international agreements*, national or regional legislation/agreements (exclusion zones). Criteria which are in place in some European countries for this category are for example (non-exhaustive list): protected areas, high ecological status stretches, reference stretches, catchment size.[1] Those criteria are principally suitable for basin-wide application. The exclusion category is set for a specific period of time or permanently, including cases where a dialogue between the competent authorities, stakeholders and NGOs has taken place.

* Only binding for those countries which signed this international agreement.
1) According to: "Hydropower Generation in the context of the EU WFD" (Arcadis, Floecksmühle): http://www.arcadis.de/Content/ArcadisDE/docs/projects/11418_WFD_HP_final_110516.pdf
Issue Paper of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011. Available online: http://www.ecologic-events.eu/hydropower2/documents/IssuePaper_final.pdf

In a second step all other stretches will be assessed using the assessment matrix and classification scheme (Figure 14 and 15). Indications on how to practically implement such an assessment can be retrieved from annexed good practice examples.

The criteria and options proposed for both steps should be used in accordance with the national/regional legislation taking into account the national/regional circumstances and specific needs. The results should feed into the River Basin Management Plans and the Renewable Energy Action Plans.

As many river stretches and floodplains in the Danube basin are protected under the Birds and Habitat Directive, the provisions and requirements according to the management and protection of Natura 2000 sites and the need for an appropriate assessment of impacts of possible projects in the concerned areas need to be additionally taken into account. Furthermore the target of the EU Danube Strategy[1] "to secure viable population of Danube sturgeon species and other indigenous fish species by 2020" should be reflected appropriately.[2]

Recommended list for national/regional criteria

TABLE 1

National/Regional criteria	Description
Energy Management	
Hydro-electrical potential (theoretical or line Potential)	Product between quantity of flow and head [GWh/TWh]
Environment	
Naturalness	Status of river stretches/water body in relation to the deviation from type-specific natural conditions regarding hydrology, morphology biological and sediment continuity as well as biological communities
Status of water body with regard to rarity and ecological value	Rarity of the river type, ecological status of a river stretch and sensitivity
Specific ecological structure and function of the river stretch also with regard to the whole catchment/ sub-basin and in relation to ecosystem services	e.g. Particular habitats for sensitive/valuable fish species or other biological quality elements in the riverine ecology (e.g. red list species)
Conservation areas and protected sites	e.g. Natura 2000 areas (Birds and Habitats Directive), Ramsar sites (Ramsar Convention), UNESCO Biosphere Reserves, National, Regional and Nature Parks (IUCN I-IV)
Landscape	
Naturalness	no significant anthropogenic impacts
Diversity	Intact terrestrial ecology with extensive use (e.g. small agriculture with low fertilizer use, sustainable forestry); diverse patterns of land use
Landscape scenery	e.g. aesthetic values, high architectonic and historical quality
Recreation value	Use for soft tourism and recreation, such as organized camping sites, canoeing, etc.
Cultural heritage	Historical buildings and villages or towns Traditional practice such as handicrafts and culturing,
Spatial planning obligations	Legal regulation for different areas and uses

1) COM (2010) 715 final: European Union Strategy for Danube Region

2) EU Danube strategy Priority Area 6 Progress Report, Reporting Period 2011–2012

Hence, the proper application of these principles reflects good practice environmental decision-making and thus contributing to the application of environmental legislation in the countries. This could be further enforced by making the national/regional assessment subject to a strategic environmental assessment.

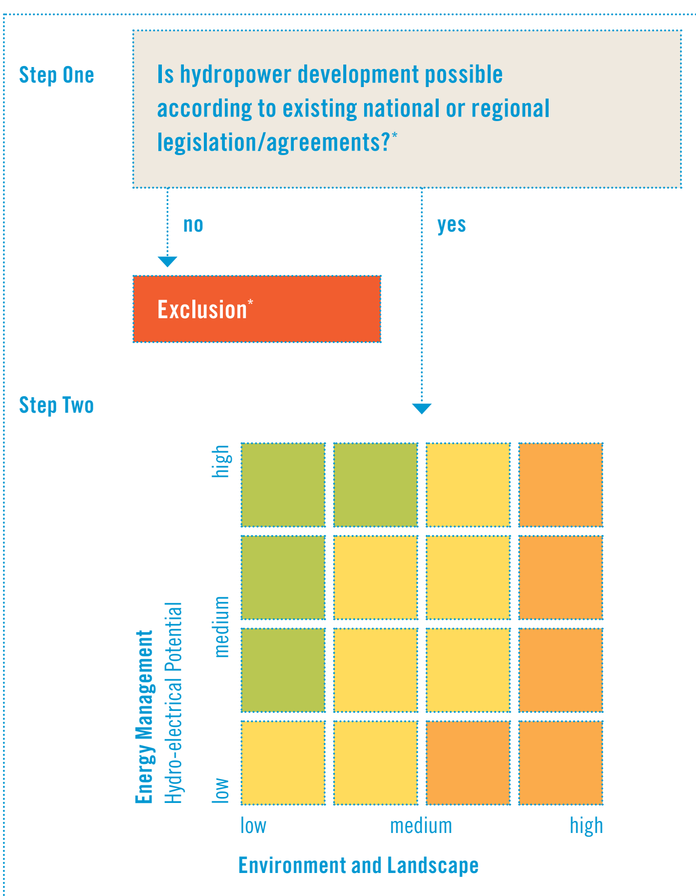
It is important that the assessment on national/regional level is technically feasible and based on data and information possible to be acquired on this level. Table 1 provides a recommended list of criteria for the national/regional assessment including on one side the hydroelectric potential and on the other side criteria with regard to the environment and landscape. Some of the proposed criteria are quantitative, some of qualitative nature, some need expert judgment.

Following a selection of the criteria, as a next step a weighing process between criteria is recommended as well as a determination of classification boundaries, to be carried out by the competent authority for the national/regional level within each Danube country in the frame of a public participation process.

The results of the assessment, stemming from the weighing process based on the recommended different criteria (Table 1), can be displayed in an assessment matrix as illustrated in Figure 14 providing a gross classification for the suitability of river stretches for sustainable hydropower development (Figure 15). The matrix is a decision support tool to provide a balanced achievement of energy and environmental objectives.

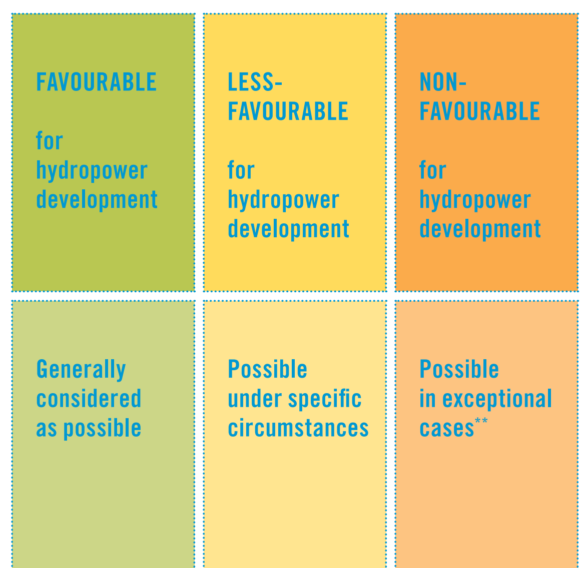
Assessment matrix

FIGURE 14



Classification scheme

FIGURE 15



* Stretches excluded for hydropower development are based on national or regional legislations/agreement in place.

** e.g. Natura 2000 sites due to exemptions according to Article 6.3 and 6.4

3.3.3 Project-specific assessment and criteria

Whereas the evaluation of the appropriateness of sustainable hydropower development at national/regional level is carried out irrespectively of concrete plant applications, the project-specific assessment is necessary only in response to an application for authorisation of a new hydropower plant.

Since the benefits and impacts of hydropower installations depend on the specific project design, project-specific assessment is needed for the final decision-making. This is also due to the reason that the assessment on project level clarifies whether legal requirements are met. In case of WFD it has to be proven if water status is expected to deteriorate or fail and therefore

Recommended list for project-specific criteria *TABLE 2*

Project-specific criteria	Description
Energy Management	
Hydropower plant size	Installed capacity
Hydropower plant type	e.g. run-of-river, diversion, storage, pumped storage
Security of supply	Production and supply of energy (Auto supply),
Quality of supply	Production characteristics – base load/ peak load (storage option, pumping storage)
Contribution to climate protection	lower CO_2 emissions of the energy mix
Technical efficiency	Grid connection, potential use, size of plants
Environment and water management	
Ecological impacts of the project	Longitudinal/lateral/vertical connectivity; impacts on habitats and biota taking into account already existing impacts
Flood control	Protection of sites at flood risk; alteration of flow regime
Irrigation	Positive or negative effects on water availability for irrigation
Sediment management	Reservoir siltation, bedload transport, sediment contamination, plant design
Surface and groundwater quantity	Infiltration and exfiltration, minimum ecological flow,
Surface and groundwater quality	Nutrients, persistent organic substances, hazardous substances, thermal effects
Drinking water supply	Positive or negative effects on quality and service security
Bank protection and restoration	Foster erosive banks
Fisheries	Ensuring natural reproduction and fish migration across dams and residual water stretches
Effects of climate change	Changes in flow regime and impacts on economic feasibility of projects
Effects on water bodies already restored	water bodies restored by public money should not be effected again
Socio-economic criteria	
Conformity with local spatial planning	Compliance with the local regulations
Necessity of further infrastructure for construction and operation	Access, energy grids, etc.
Regional economic effects	Taxes, income for the public; investments in local economy, induced employment
Recreation, tourism	Potential positive and negative effects on tourism
Other socio-political considerations	depending on the local situation

an exemption from the non-deterioration principle (WFD Article 4.7) is required. In case of deterioration or failure of status projects can only be authorized if the conditions of Article 4.7 are met as outlined in chapter 2.3.

The results of the national/regional assessment feed into the project-specific assessment since some of the requirements of Article 4.7 (e.g. alternative locations as better environmental options) can only be applied on the national/regional level. These steps have been demonstrated in the previous chapter. For the project-specific assessment, next to further detailed evaluations on benefits and impacts, it has to be assessed if all practicable steps are taken to mitigate the adverse impact on the status, feeding also into the overall evaluation of the project.

Table 2 provides a recommended list of criteria to be applied for the project-specific assessment including criteria on energy management, environment and water management as well as socio-economic criteria. The recommended list of project-specific criteria should be adjusted in accordance with existing legislation and instruments in the countries.

The evaluation based on the project-specific criteria provides additional information influencing the overall assessment of the project in a positive or negative way, allowing for a final decision whether an authorization can be granted. In this process the involvement of project concerned parties has to be ensured. Finally, also the possible requirement of applying an Environmental Impact Assessment needs to be considered.

3.3.4 Incentive schemes

New hydropower development can be promoted with incentive schemes similar to those for modernization, refurbishment and ecological restoration of existing plants. Incentive schemes for new hydropower projects need to be targeted towards projects where the economic viability is not given. In order to support hydropower in the most sustainable way, incentive schemes for new hydropower projects should take into account the results of the strategic planning approach and adequate mitigation measures.

3.4 Mitigation measures for hydropower

The development of hydropower should be accompanied by an improvement of the present aquatic ecology, through clear ecological requirements for new facilities, or for existing facilities through their technical upgrading as well as the improvement of operation conditions[1]. This is supported by the basin-wide vision for a balanced management of past, ongoing and future structural changes of the riverine environment, that the aquatic ecosystem in the entire Danube River Basin functions in a holistic way and is represented with all native species, as expressed in the Danube River Basin Management Plan from 2009[2].

Mitigation measures are key for a sound implementation of the WFD, aiming to the protection and enhancement of the status of aquatic ecosystems, beside their relevance for other environmental legislation (e.g. Birds and Habitat Directives). The choice and design of mitigation measures should take account of relevant site-specific circumstances, in particular the potential for ecological improvement[3]. For new projects, accompanying mitigation measures are key for reaching higher scores in the project-specific assessment and thus improving chances for positive project evaluation. New hydropower plants should (for example) generally have functional fish migration aids which support reproduction habitats in fish regions. Furthermore they should respect an ecological flow.

In case of existing hydropower plants if foreseen by national legislation losses of hydropower generation due to the implementation of mitigation measures may be compensated.

The following chapter provides an overview on the most important and common measures applied in relation to sustainable hydropower development. Ensuring fish migration and ecological flow were identified as priority measures at European level as well as in the Danube basin for the improvement and maintenance of ecological status.[4] Beside these, other important mitigation measures like ensuring sediment transport or dampening of hydropeaking where relevant, are also addressed, next to others.

1) Final Synthesis of Informal meeting of Water and Marine Directors of the European Union, Candidate and EFTA Countries, Segovia, 27–28 May 2010
2) Danube River Basin Management Plan 2009. Available online: http://www.icpdr.org/main/publications/danube-river-basin-management-plan
3) Conclusion of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011
4) Commission's Third Implementation Report on the Implementation of the Water Framework Directive (http://ec.europa.eu/environment/water/water-framework/implrep2007/index_en.htm)

3.4.1 Enabling fish migration

Fish migration aids for upstream and downstream migration at transversal structures allow migrating fish species to access their habitats, what is important for the natural reproduction and completion of the life cycle. Therefore, the construction of fish migration aids should be executed in fish regions, taking into account the specific hydraulic requirements, fish behaviour and technical targets for migrating fish species.

Example for a fish migration aid at a hydropower station *FIGURE 16*

Vertical slot by-pass channel, hydropower station "Greinsfurth" at the river "Ybbs", Austria. Example for a technical fish migration aid, allowing for a solution in case of limited available space. The fish migration aid bypasses a drop height of 8 meter between the upstream and the downstream section of the hydropower station and was co-financed in the frame of the EU LIFE Program*.

It is of crucial importance that fish passes are functional for all autochthon migratory species and age/size classes present throughout the whole year. Therefore, the function of fish migration aids should be monitored adequately and non-functional existing fish passes must be re-constructed/restored.

In the Danube River Basin, migratory fish, such as sturgeons and medium distance migrators, are particularly affected by dams for hydropower use, being unable to move up or downstream between their spawning grounds and areas used at other times in their life cycle[1]. Therefore, measures have started to be implemented and efforts are taken to restore continuity for fish migration as also outlined in the Danube River Basin Management Plan. Special attention should be given to the highly endangered anadromous Danube sturgeons, as pointed out in the Danube Sturgeon Action Plan. For upstream migration, many solutions are available (e.g. by-pass streams, technical fish passes, fish lifts etc.) to mitigate the negative impact of migration barriers to a certain degree. These fish migration facilities are state of the art and enable migration of fish species to their spawning grounds, although their effectiveness varies and depends greatly on how site specific fish migration behaviour has been taken into account.

Downstream migration is also of great importance but cannot be adequately ensured up to now, even though certain possibilities exist to minimize negative effects on ecology. Fish friendly turbines[2] and other technical solutions (such as new types of turbines and hydropower plants construction[3], bypasses, racks or screens, etc.) are indicated as means to achieve downstream migration. Intensive research leading to technical innovations – especially related to downstream migration in combination with turbine damage – has still to be undertaken or is currently on-going.

The present state-of-the-art about various options and technical requirements for fish migration aids is compiled from relevant literature in the "Technical paper on fish migration at transversal structures"[4]. This technical paper is recommended as a key reference when planning and constructing fish migration aids.

* Further information can be obtained following the link (German language): http://www.life-mostviertel-wachau.at/pages/Greinsfurth.htm

1) Danube River Basin Management Plan 2009
2) http://energy.gov/articles/fish-friendly-turbine-making-splash-water-power
3) See also German Examples provided in the Annex
4) Technical paper on fish migration at transversal structures. Available online: www.icpdr.org

Ensuring ecological flow

FIGURE 17

Ensuring ecological flow at the upper stretch of the river „Isar" in Germany. The pictures show the river before and after measures for ensuring ecological flow requirements were implemented. Water flow which was previously completely diverted to "Walchensee" is now permanently provided through the river to "Sylvenstein" reservoir, also including some seasonal variations.

3.4.2 Ensuring ecological flow

The preservation of the river ecosystem also means that in case of water abstractions or diversion, defined flows are in need to be maintained in the river for ensuring the protection of the structure and the function of the river, in order to enable the achievement of the EU Water Framework Directive objectives.

Therefore, an ecologically optimised river flow, reflecting ecologically important components of the natural flow regime, including a relatively constant base flow and more dynamic/viable flows are recommended as good practice mitigation measure[1].

The methods for determination of ecological flow can be categorised into four groups, reflecting the main attributes of the approach, including hydrological and hydraulic rating, habitat simulation and holistic approaches. The development of methods is dynamic and new research provides a better understanding of the relationships between flow requirements and biological, physico-chemical and hydro-morphological elements of riverine ecosystems. In this regard the European commission strives to develop a guidance document in the framework of the WFD CIS to address the issue of ecological flow[2].

3.4.3 Other mitigation measures

3.4.3.1 Ensuring sediment transport

At present the sediment balance of most large rivers within the DRB can be characterized as disturbed or severely altered. Morphological changes during the last 150 years due to river engineering works, flood and torrent control, hydropower development and dredging, as well as the reduction of adjacent floodplains by nearly 90%, are the most significant causes of impacts.

Upstream of a dam, in a reservoir or impounded sections, the reduction of the sediment transport capacity of water results in sediment deposition. This retained sediment needs to be extracted in certain time periods in order to maintain the river depth for navigation and reservoir operation and in order to limit the height of the water level in the case of floods.

1) Conclusion of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011

2) COM (2012) 673: The blueprint to Safeguard Europe's Water resources – Communication from the Commission. Available online: http://ec.europa.eu/environment/water/blueprint/index_en.htm

Downstream of dams the loss of sediment load requires an artificial supply of material or other engineering measures to stabilise the riverbed and to prevent incision and impacts on the groundwater table. Otherwise this could lead in combination with river channelization to river bed degradation and a loss of morphodynamic structures with associated problems concerning ecological status[1].

Appropriate measures for improving the above mentioned situation on an international level should be addressed in the Danube River Basin District Management Plan. Availability of sufficient and reliable data on sediment transport is a prerequisite for any future decisions on sediment management in the Danube River Basin. Attention should be given to ensuring the sediment continuum (improving existing barriers and avoiding additional interruptions). Reservoir flushing must respect fish spawning periods and critical suspended sediment concentration downstream for not silting up the river bed and not harming fish gills and benthos, thus flushing should be done in a controlled and planned way. If the accumulated sediments are polluted they must not be flushed but should be dredged out and technically treated as special solid waste according to Best Available Techniques (BAT).

In summary, the effects of hydropower schemes on river continuity for sediment transport, and the potential to mitigate these effects, should receive greater attention by countries than they have so far received[2], requiring as well an approach at Danube basin-wide scale.

3.4.3.2 Mitigating effects of artificial flow / water level fluctuations (hydropeaking)

Hydropeaking (the artificial water level fluctuation, defined as the ratio of Qmax and Qmin in a certain time period) is a pressure type that occurs in the Danube River Basin District by the generation of peak energy supply by hydropower stations. The ratio has to be assessed in relation to natural flows as a basis.

The Danube country-specific recommendations and/or standards on hydropeaking mitigation include several specific requirements: reduction of amplitude of flow fluctuation, reduction of frequency of hydropeaking, change of ramping time, building of compensation basins, improvement of hydromorphological structures of the river and coordination of different plants' operation. However, results of ongoing research projects aiming at most cost-effective measures as well as also ensuring security of electricity supply should be taken into account.

Mitigating the effects of hydropeaking demands the definition of the variation range for relevant ecological parameters such as discharge, water temperature, fish habitats sediment/suspension load, etc. Special emphasis is needed to be given to sediment transport and river morphology since hydropeaking can foster colmation/siltation of the river bed sediments.

3.4.3.3 Further mitigation and compensatory measures

Depending on the assessment of the project-specific level and the individual project design, further mitigation measures and potential compensatory measures[3] may be needed to mitigate adverse effects of hydropower. Such measures can include for instance the restructuring or restoration of riparian zones (particularly in the head of a reservoir), the improvement of lateral connectivity or the restoration of habitats.

1) Danube River Basin Management Plan 2009
2) Conclusion of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011
3) The EU Habitat Directive Article 6.4 requires compensatory measures to offset negative effects of projects that cannot be mitigated in order to maintain the ecological coherence of the NATURA 2000 network

4. Administrative support and proposals for follow-up

The implementation of the Guiding Principles is recommended to take place on the national level accompanied by an exchange between the Danube countries, allowing to make best use of expertise in place on approaches, administrative processes and technical provisions for sustainable hydropower.

The following issues were identified where a further exchange is considered to be in particular beneficial:

- Implementation of the strategic planning approach, including practical data requirements, concrete methodologies for the national/regional assessment and approaches for the weighing process including stakeholder involvement;
- Experiences and approaches for the project-specific assessment, including the linkage with the national/regional assessment, applied criteria and mechanisms towards the final decision of a concrete project application;
- Technical exchange on the experiences regarding the application and effectiveness of mitigation measures at already existing and new hydropower facilities, including
  - Fish migration aids (technical solutions in place in the Danube countries for upstream migration and experiences and approaches for fish protection and downstream migration);
  - Ways towards the definition of ecological flow and issues to be considered;
  - Assessments for the restoration of the sediment transport in the Danube basin and approaches and measures for the establishment of the sediment continuum.

Also the river basin management planning process according to the WFD provides an opportunity to integrate strategic planning for hydropower development with water environment objectives[1].

Building on the experience gained during the elaboration of the Guiding Principles, the follow-up is recommended to be carried out in an integrative manner with involvement of representatives from administrations, the hydropower sector, NGOs and other interested parties, allowing to bring in expertise from various backgrounds. This exchange could also be supported by joint projects on specific issue, based collaboration on and/or co-funding of research and development (R&D) projects[1].

A similar process was already set up for inland navigation following the adoption of the "Joint Statement"[2]. Yearly meetings allow for an exchange on the experience with the implementation of the Joint Statement. In the frame of a specific project[3] the issue of integrated planning approaches was further elaborated and clarified in support for administrations and relevant stakeholders. This process can act as an inspiring example also for sustainable hydropower. Finally, it is recommended to strive for a close exchange with Priority Area 2 of the EU Danube Strategy on "Sustainable Energy" as well as with Priority Area 4 "Water Quality" and 6 "Biodiversity" in the execution of possible follow-up activities since specific actions on hydropower are also foreseen under the EU Danube Strategy.

1) Conclusion of the Water management, EU Water Framework Directive & Hydropower Common Implementation Strategy Workshop, Brussels, 2011

2) Joint Statement on Inland Navigation and Environmental Sustainability in the Danube River Basin.
Available Online: http://www.icpdr.org/main/activities-projects/joint-statement-navigation-environment

3) PLATINA Manual on Good Practices in Sustainable Waterway Planning.
Available Online: http://www.naiades.info/file_get.php?file=33990c74a5a3f6e836ccf543626c24171ab

5. List of background material and related documents

In addition to the references highlighted as footnotes in the individual chapters, the following list provides an overview on background material and related documents relevant for the issue of sustainable hydropower.

Alpine Signals Focus 1, Common Guidelines for the use of Small Hydropower in the Alpine Region.

AP, Action Plan (2005): Action Plan for the conservation of sturgeons (Acipenseridae) in the Danube River Basin. AP-Document, final version, 12. December 2005. Reference "Nature and Environment", No. 144. Recommendation 116 on the conservation of sturgeons (Acipenseridae) in the Danube River Basin, adopted by the Standing Committee of the Bern Convention in December 2005.

Assessment, at river basin level, of possible hydropower productivity with reference to objectives and targets set by WFD and RES-e directives (Aper, ESHA, Intelligent Energy Europe, Sherpa).

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Gebler, R.-J. (2005): Entwicklung naturnaher Bäche und Flüsse. Maßnahmen zur Strukturverbesserung. Grundlagen und Beispiele aus der Praxis. Verlag Wasser + Umwelt, Walzbachtal.

Gebler, R.-J. (2009): Fischwege und Sohlengleiten. Band I: Sohlengleiten, 205 S., Verlag Wasser + Umwelt ISBN 978-3-939137-02-3.

Hassinger, R. (2011): Neue Entwicklungen zur gewässerökologischen Optimierung von Wasserkraftstandorten. Wasserwirtschaft 101, 7/8: 61–65.

Hydropower and Environment, Technical and Operational Procedures to better integrate small hydropower plants in the Environment (Sherpa).

ICPDR (2007a): A vision for sturgeon and other migratory species in the Danube River Basin. Draft, 29 April 2007, 5 pp.

ICPDR (2007b): Re-opening migration routes for sturgeon and other migratory species to enable upstream and downstream passage at the Iron Gate dams 1 and 2 including habitat survey. 8 October 2007, 7 pp.

ICPDR (2008): Joint Danube Survey (JDS) 2. Report available under www.icpdr.org/jds.

ICPDR (2009): Danube River Basin District Management Plan Part A - Basin-wide overview. Vienna.

ICPDR (2012): Technical paper on measures for ensuring fish migration at transversal structures. Vienna.

Larinier, M. (2000): Dams and fish migration. World Commission on Dams, Environmental Issues, Final Draft, June 30-2000 (30 pp.).

Manual on Good Practices in Sustainable Waterway Planning (Platina).

Strategic Study for Development of Small Hydropower in the European Union (Sherpa).

Small Hydropower Local Planning & Participatory Approach (Sherpa).

The Application of the ISO 14001 Environmental Management System to Small Hydropower Plants.

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