# Assessment Report on Hydropower Generation in the Danube Basin

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International Commission for the Protection of the Danube River

Internationale Kommission zum Schutz der Donau

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Contact
ICPDR Secretariat
Vienna International Centre / D0412
P.O. Box 500 / 1400 Vienna / Austria
T: +43 (1) 26060-5738 / F: +43 (1) 26060-5895

icpdr@unvienna.org / www.icpdr.org

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| | |
|---|---|
| Austria: | Mr. Jakob Schrittwieser, Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management |
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| Czech Republic: | Ms. Doubravka Nedvedova, Ministry of the Environment |
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| Ukraine: | Mr. Eduard Osiysky |

| | |
|---|---|
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| Energy Community Secretariat: | Ms. Gabriela Cretu |
| European Small Hydropower Association: | Ms. Martina Prechtl |
| European Anglers Association: | Mr. Helmut Belanyecz |
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## Disclaimer

The data used in this Report are based on replies to the "Questionnaire for data collection on hydropower generation and water management issues in the Danube countries", which was sent out to Danube countries in August 2011. Danube countries reported either data for their national share of the Danube River Basin District (DRBD) or, in case this data was not available, provided data for the whole territory of their country or for concerned administrative territories.

Comprehensive notes under each graph and a section on the quality, reliability and comparability of data sources (reference to section 1.4.3) provide detailed explanations of the source and reference of data in a transparent way. It should be pointed out that although not for all Danube countries data sets were available for the exact national shares within the DRBD and therefore the overall assessment does not sharply refer to the DRBD, this circumstance does not cause substantial deviations in the main outcomes and results of the overall assessment.

Hence, although certain lacks in the homogeneity of the data set exist, this does not impede gaining a concrete and clear overall picture on the situation of hydropower generation and water management issues in the Danube basin. Respectively, the required efforts for gaining a homogenised data set for the whole DRBD would be disproportionate. Further information for this Report were additionally gathered through the "1st ICPDR Workshop on Hydropower and Water Management", which took place from 21 to 22 February 2012 in Timişoara (Romania) and which was used to compare collected data as well as to clarify possible shortcomings and different interpretations which may arise in such a data collection.

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# List of terms and abbreviations

| | |
|---|---|
| AT | Austria |
| BA | Bosnia and Herzegovina |
| BG | Bulgaria |
| CZ | Czech Republic |
| DE | Germany |
| HR | Croatia |
| HU | Hungary |
| MD | Moldova |
| ME | Montenegro |
| RO | Romania |
| RS | Republic of Serbia |
| SI | Slovenia |
| SK | Slovak Republic |
| UA | Ukraine |

| | |
|---|---|
| AWB | Artificial Water Body |
| BAT | Best Available Techniques |
| CCS | Carbon Capture and Storage |
| CEE | Central and Eastern Europe |
| CIS | Common Implementation Strategy of the European Commission |
| DBA | Danube Basin Analysis 2004 |
| DRB | Danube River Basin |
| DRBD | Danube River Basin District |
| DRBMP | Danube River Basin District Management Plan |
| DRPC | Danube River Protection Convention |
| EC | European Commission |
| ECCP | European Climate Change Programme |
| EFTA | European Free Trade Association |
| EG | Expert Group |
| EIA | Environmental Impact Assessment |
| ESHA | European Small Hydropower Association |
| EU | European Union |
| EU MS | European Union Member State |
| EU WFD | European Union Water Framework Directive |
| EU WISE | European Union Information System on Water |
| EUROSTAT | Statistical Office of the European Communities |
| EUSDR | European Strategy for the Danube Region |
| FIP | Future Infrastructure Project |
| FP | Framework Programme of the European Union |
| GDP | Gross Domestic Product |
| GEP | Good Ecological Potential |
| GES | Good Ecological Status |
| GHG | Greenhouse Gas |
| GIS | Geographic Information System |

| | |
|---|---|
| Gton | Gigaton (1,000,000,000 tons) |
| GW | Gigawatt, 1 GW = 1,000,000 kW |
| GWB | Groundwater Body |
| GWh | Gigawatt hour (amount of energy produced in 1 hour by a plant with a capacity of 1 GW) |
| HMWB | Heavily Modified Water Body |
| HP | Hydropower |
| HPP | Hydropower plant |
| ICPDR | International Commission for the Protection of the Danube River |
| IHA | International Hydropower Association |
| IPPC | Integrated Pollution Prevention and Control |
| ISRBC | International Sava River Basin Commission |
| K | Kilo (thousand) |
| LDM | Long Distance Migrants |
| LHP | Large hydropower |
| LHPP | Large hydropower plants |
| LULUCF | Land Use, Land-Use Change and Forestry |
| MDM | Medium Distance Migrants |
| MNQ | Annual Mean Low Flow |
| MQ | Annual Mean Flow |
| MS | Member State(s) |
| Mtoe | Megaton of oil equivalent (amount of energy in 1000000 tons of oil) |
| MW | Megawatt, 1 MW = 1,000 kW |
| MWh | Megawatt hour (amount of energy produced in 1 hour by a plant with a capacity of 1 MW) |
| MWh/a | Megawatt hour a year |
| n.a. | Not available |
| n.r. | Not reported |
| Non EU-MS | Non European Union Member State |
| NREAP | National Renewable Energy Action Plan |
| PSP | Pumped storage power |
| PSPP | Pumped storage power plant |
| RBM | River Basin Management |
| RBMP | River Basin Management Plan |
| SEA | Strategic Environmental Assessment |
| SHERPA | Small Hydropower Energy Efficiency Campaign Action, EU funded project in the framework of Intelligent Energy for Europe (IEE), term 9/2006 to 9/2008 |
| SWMI | Significant Water Management Issue |
| TW | Terrawatt, 1 TW = 1,000,000,000 kW |
| TWh | Terrawatt hour (amount of energy produced in 1 hour by a plant with a capacity of 1 TW) |
| TWh/a | Terrawatt hour a year |
| WB | Water Body |
| WFD | Water Framework Directive |

# Executive Summary

The aim of the "Assessment Report on Hydropower Generation in the Danube Basin in the context of the Water Framework Directive and the Renewable Energy Directive" (short title: "Assessment Report on Hydropower Generation in the Danube Basin") is to summarize key information on hydropower generation in the context of water management, flood protection, biodiversity and nature protection at Danube basin-wide level. The outcome of the Report forms the fundament and a sound basis for the "Common Guiding Principles on Hydropower Development in the Danube Basin" including case studies and good practice examples.

The Danube River Basin District Management Plan (DRBDMP), which was elaborated according to Article 13 of the Water Framework Directive (WFD) and published by the International Commission for the Protection of the Danube River (ICPDR) in 2009, identified hydromorphological alterations as one of the main significant water management issues for the Danube basin.

As hydropower generation is one of the key water uses that cause hydromorphological alterations and due to the fact that planning is ongoing to further increase hydropower generation to contribute towards meeting the goals of renewable energy and climate policies, the ICPDR was asked in the Danube Declaration 2010, adopted at the Ministerial Meeting on 16 February 2010, "to organize 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".

The basis for this Report forms information received from Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Germany, Czech Republic, Hungary, Moldova, Romania, Republic of Serbia, Slovenia, Slovak Republic and Ukraine through a "Questionnaire for data collection on hydropower generation and water management issues in the Danube countries", circulated to the ICPDR member countries in August 2011. In addition to information gathered through the Questionnaire, several reports, documents and European databases from the ICPDR, the European Commission, EUROSTAT and currently ongoing research projects were used to compile the relevant data for the elaboration of the Report. The discussions and presentations, which were held during the "1st ICPDR Workshop on Hydropower and Water Management", organized from 21 to 22 February 2012 in Timişoara (Romania), provided further valuable background information as regards the main outstanding issues in terms of commonly agreed standards as well as clear criteria in relation to hydropower generation and provisions for environmental improvement in the Danube basin.

Hydropower generation in the Danube basin needs to be seen in the context of EU policies and legislation in the field of water protection (Water Framework Directive) and flood protection (Floods Directive), electricity production from renewable energy sources (Renewable Energy Directive) as well as nature and biodiversity (Birds and Habitats Directive) and environmental assessment processes (Strategic Environmental Assessment Directive and Environmental Impact Assessment Directive). These Directives present an opportunity but also a challenge in reaching multiple environmental objectives. Balancing the requirements of achieving "good status" for all surface waters and groundwater as a rule by 2015 (WFD) and reaching a 20% share of energy from renewable sources by 2020 (Renewable Energy Directive) is a major challenge and needs to be taken into account with regard to planning procedures for new hydropower developments.

Those six Danube countries not being member of the European Union (BA, HR, MD, ME, RS and UA) have committed themselves to implement the relevant “acquis communautaire” in the area of electricity, gas, environment and renewable energy through the Energy Community. Furthermore, non-EU Member States committed themselves to work towards a coordinated implementation of the WFD within the frame of the Danube River Protection Convention.

The key figures for electricity production in the Danube basin, from renewable energy sources in general and hydropower in particular, show that – also due to the national overall targets for the share of energy from renewable energy sources set in the Renewable Energy Directive – many Danube countries plan a considerable increase in electricity production from renewable energy sources until the year 2020. In most Danube countries surveyed, hydropower currently represents the most important component of total renewable energy production by contributing more than 45%. 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. However, when assessing the total amount of electricity production from hydropower expected for the year 2020, an increase in electricity production from hydropower can be seen for AT, BA, DE, HU, RS, SK and SI.

When looking at the different sizes of hydropower plants in the Danube basin and their share to the total electricity production from hydropower, it can be clearly seen that by far the most significant share (88.4%) of electricity in Danube countries is generated by large facilities (representing 3.4% of the total number of hydropower stations) with bottleneck capacities of more than 10 MW.

In line with the requirements of the WFD, a holistic assessment based on a strategic planning approach needs to be carried out for the development of new hydropower plants. The Report provides detailed information on requirements related to the following key domains of environmentally sound hydropower facilities: minimum ecological flow, upstream and downstream continuity, hydropeaking and sediment/bedload transport. While many Danube countries reported to have environmental requirements in relation to ensuring river continuity and ecological flow requirements included in their existing national legislation, technical guidelines as well as clear criteria, standards and definitions are not always in place yet causing difficulties in the practical implementation. As one of the main outcomes of the “1st ICPDR Workshop on Hydropower and Water Management” it was indicated that support in defining standards in terms of requirements for environmental improvement of negative impacts of hydropower is needed and a prerequisite for the efficient implementation of the provisions of the WFD on national level.

In case of new hydropower schemes or modifications to existing projects, Article 4.7 of the Water Framework Directive allows, under certain circumstances, exemptions from “achieving good ecological status”, “good ecological potential” and the general deterioration clause. The requirements of Article 4.7 for new hydropower include amongst others that there are no significantly better environmental options, that the benefits of the new infrastructure outweigh the benefits of achieving the WFD environmental objectives and that all practicable mitigation measures are taken to address the adverse impact of the status of the water body. An assessment of the application of Article 4.7 of the WFD in Danube countries shows that only in a few cases practical experience with the application of Article 4.7 for new hydropower projects was gained.

During the “1st ICPDR Workshop on Hydropower and Water Management”, many Danube countries emphasized that mechanisms to define or apply the criterion of “overriding public interest” currently do not always exist and that decisions are often made on a case by case basis. Political decision-making concerning hydropower follows the need for economic development by taking into account the requirements of environmental legislation. Therefore, a clear need for supporting administrations in decisions on the authorisation process for new facilities was identified.

In most Danube countries strategic planning instruments such as the River Basin Management Plans, National Renewable Energy Action Plan and the Hydropower Sector planning are in place; in some countries initial considerations of pre-planning instruments with regard to hydropower development have been undertaken. However, the link between further development of hydropower and the provisions set in River Basin Management Plans provides considerable room for improvement. The outcome of the discussions during the “1st ICPDR Workshop on Hydropower and Water Management” reiterated the importance of strategic planning processes being transparent in particular also for applicants of new hydropower facilities gaining a better overview of river stretches suitable for further hydropower development before licensing procedures start.

Based on the output of the replies to the Questionnaire as well as the presentations, discussions and feedback received during the “1st ICPDR Workshop on Hydropower and Water Management, a clear need for further action can be seen as regards hydropower development and specifications of requirements for environmental improvement in the Danube basin, taking into account relevant EU legislation and policies. As the situation in the Danube basin including EU and Non-EU Member States is rather diverse and complex, it is of utmost importance to set common guiding principles to support Danube countries with hydropower development in general as well as the application of new hydropower schemes in particular.

# 1 Introduction and background

This section summarizes the objective and scope of the ICPDR activity “Guiding Principles on Hydropower Development” (section 1.2), the aim and structure of this Report (section 1.3) as well as the data sources used for the assessment of hydropower generation in the Danube basin (section 1.4). Section 1.1 provides key figures on the Danube River Basin District and information about the Contracting Parties to the Danube River Protection Convention.

## 1.1 Danube River Basin District

The Danube and its tributaries, transitional waters, lakes, coastal waters and groundwater form the Danube River Basin District (DRBD). For the purpose of the Danube River Basin District Management Plan (DRBM Plan)[1], the DRBD has been defined as covering the Danube River Basin (DRB), the Black Sea coastal catchments in Romanian territory and the Black Sea coastal waters along the Romanian and partly Ukrainian coasts (Map 1).

All Danube countries with territories >2,000 km² in the DRB are Contracting Parties to the Danube River Protection Convention[2] (DRPC): Austria - AT, Bosnia and Herzegovina - BA, Bulgaria - BG, Croatia - HR, the Czech Republic - CZ, Germany - DE, Hungary - HU, Moldova - MD, Montenegro - ME, Romania - RO, the Republic of Serbia - RS, the Slovak Republic - SK, Slovenia - SI and Ukraine - UA. In addition, the European Community - EC is a Contracting Party. Six countries (BA, HR, MD, ME, RS and UA) are Non EU Member States (Non EU-MS).

The DRB is the “most international” river basin in the world covering territories of 19 countries. Those 14 countries with territories greater than 2,000 km² in the DRB cooperate in the framework of the ICPDR. The basis for the ICPDR database are rivers with catchment areas >4000 km² and the Danube River. With an area of 807,827 km², the DRBD is the second largest in Europe. Some of its basic characteristics are given in table 1.

The DRBD is not only characterised by its size and large number of countries but also by its diverse landscapes and the major socio-economic differences that exist between the upstream and downstream countries.

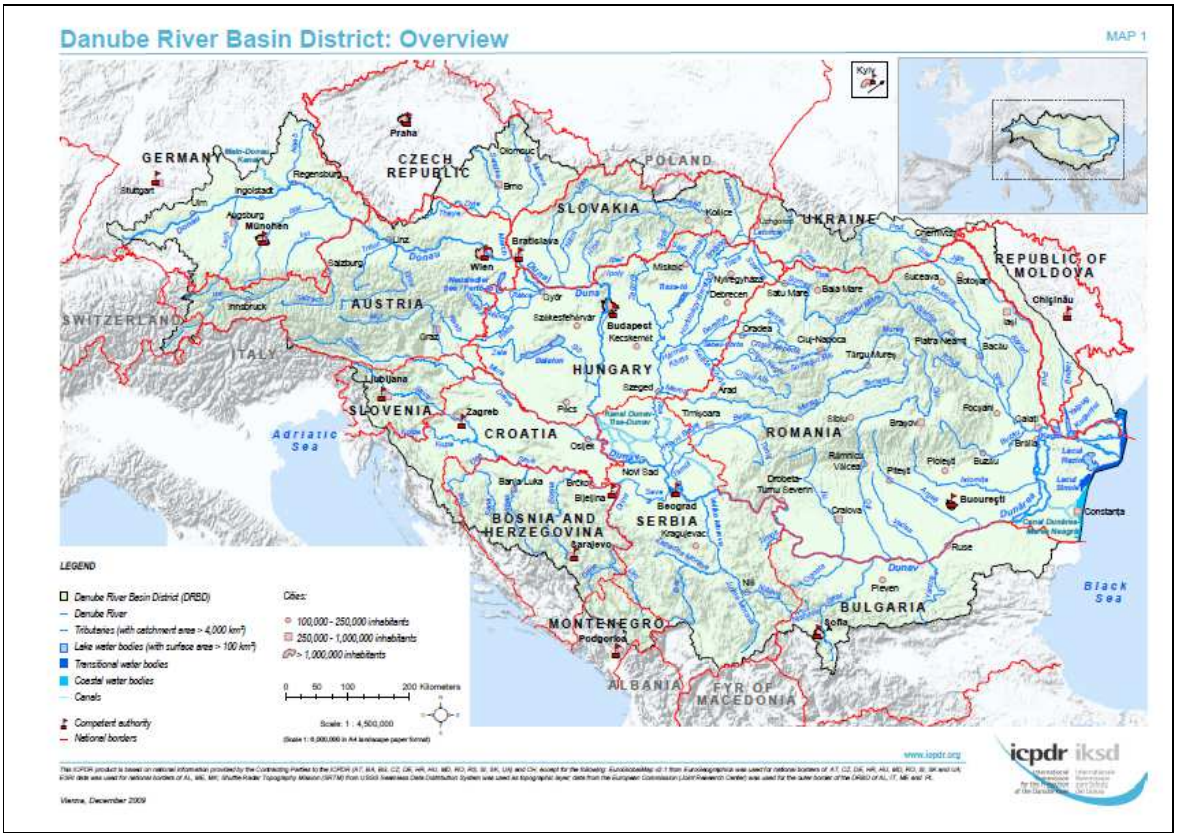
[1] ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview. Available online: http://www.icpdr.org/icpdr-pages/reports.htm.

[2] Convention on Cooperation for the Protection and Sustainable use of the Danube River (Danube River Protection Convention). Available online: http://www.icpdr.org/icpdr-pages/legal.htm.

| | |
|---|---|
| DRBD area | 807,827 km² |
| DRB area | 801,463 km² |
| Danube countries with catchment areas >2,000 km² | **EU Member States** (8): Austria, Bulgaria, Czech Republic, Germany, Hungary, Slovak Republic, Slovenia, Romania.<br>**EU Accession Country** (1): Croatia<br>**Non EU Member States** (5): Bosnia & Herzegovina, Moldova, Montenegro, Serbia and Ukraine. |
| Danube countries with catchment areas <2,000 km² | **EU Member States** (2): Italy, Poland.<br>**Non EU Member States** (3): Albania, FYR Macedonia, Switzerland. |
| Inhabitants | approx. 80,5 million |
| Length of Danube River | 2,857 km |
| Average discharge | approx. 6,500 m³/s (at the Danube mouth) |
| Key tributaries with catchment areas >4,000 km² | Lech, Naab, Isar, Inn, Traun, Enns, March/Morava, Svratka, Thaya/Dyje, Raab/Rába, Vah, Hron, Ipel/Ipoly, Sió, Drau/Drava, Tysa/Tisza/Tisa, Sava, Timis/Tamiš, Velika Morava, Timok, Jiu, Iskar, Olt, Yantra, Arges, Ialomita, Siret, Prut. |
| Important lakes >100 km² | Neusiedler See/Fertö-tó, Lake Balaton, Yalpug-Kugurlui Lake System, Razim-Sinoe Lake System (Lacul Razim and Lacul Sinoe, which is also a transitional water body) |
| Important groundwater bodies | 11 transboundary groundwater bodies of basin-wide importance are identified in the DRBD. |
| Important water uses and services | Water abstraction (industry, irrigation, household supply), drinking water supply, wastewater discharge (municipalities, industry), hydropower generation, navigation, dredging and gravel exploitation, recreation, various ecosystem services. |

Source: DRBMP, 2009

## Table 1: Basic characteristics of the Danube River Basin District




Source: DRBMP, 2009

## Map 1: Danube River Basin District Overview

### 1.2 Objective and scope of ICPDR activity "Guiding Principles on Hydropower Development"

The Danube River Basin District Management Plan, which was elaborated according to Article 13 of the WFD based on the contributions of Danube countries and published by the ICPDR on 14 December 2009, includes a basin wide assessment of the significant pressures, the protected areas, monitoring networks and ecological/chemical status, environmental objectives and exemptions, economic analysis of water uses, information on flood risk management and climate change as well as on public information and consultation. The Plan includes a Joint Programme of Measures for achieving the objectives of the WFD.

Four significant water management issues were identified for the Danube basin: Organic Pollution, Nutrient Pollution, Hazardous Substances Pollution and Hydromorphological alterations.[3]

Hydromorphological alterations[4] and their effects on water status have gained vital significance in Europe's water management activities due to the requirements of the WFD (in addition to traditional issues related to chemical pollution pressures on water quality). Anthropogenic pressures resulting from various hydro-engineering measures can significantly alter the natural structure of surface waters. This structure is essential to provide adequate habitats and conditions for self-sustaining aquatic populations. The alteration of natural hydromorphological structures can have negative effects on aquatic populations and therefore result in the deterioration of the water status of surface waters.

Hydropower generation, navigation and flood protection are the key water uses that cause hydromorphological alterations. Hydromorphological alterations can also result from anthropogenic pressures related to urban settlements, agriculture and other sources. These drivers can influence pressures on the natural hydromorphological structures of surface waters in an individual or cumulative way.

Three key hydromorphological pressure components of basin-wide importance have been identified for the Danube Basin: Interruption of river and habitat continuity; Disconnection of adjacent wetlands/floodplains; and Hydrological alterations. Potential pressures may also result from Future Infrastructure Projects (FIPs) which can impact and deteriorate water status, including potential negative transboundary effects. The ICPDR River Basin Management Expert Group (RBM EG) follows the overall process on the technical level, together with the ICPDR Task Group on Hydromorphology, which was established under the RBM EG in 2007.

In order to address the issue of hydropower generation as one of the key water uses that cause hydromorphological alterations in an effective and transparent way, the ICPDR was asked in the Danube Declaration 2010, adopted at the Ministerial Meeting on 16 February 2010, "to organize 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

[3] See also ICPDR document IC 132 (2007): Significant Water Management Issues in the Danube River Basin District.

[4] Source: ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview, Chapter 2.1.4. Available online: http://www.icpdr.org/icpdr-pages/reports.htm.

possible increase of their efficiency, as well as in the planning and construction of new hydropower plants".[5]

In the 13th Ordinary Meeting of the ICPDR, which took place from 9 to 10 December 2010, Austria and Romania expressed its willingness to take over the responsibility to steer the respective process of the ICPDR activity "Guiding Principles on Hydropower Development". The related resolution stated that "with regard to the aim of developing guiding principles for hydropower development, the ICPDR supports the proposal of the River Basin Management Expert Group (RBM EG) on first working principles and asks the Secretariat and interested countries to accomplish the establishment of a team of voluntary experts led by Romania and Austria until end of January 2011." Slovenia joined the team of leading countries in January 2011 to steer the hydropower activity in close cooperation with experts from the ICPDR Secretariat.[6]

The detailed working process of the ICPDR activity "Guiding Principles on Hydropower Development" was agreed in a first meeting of the "Team of Experts on Hydropower", which was organized on 7th July 2011 in Vienna (Austria). The main function of the "Team of Experts on Hydropower" is to serve as national focal point to the different sectors concerned and to provide the specific knowledge and input, as well as to comment on the different working steps of this activity. Participants from the leading countries Austria, Romania and Slovenia as well as from other Danube Countries (Germany, Serbia, and Slovakia), NGOs and stakeholders discussed the aim and focus of this work and agreed on the main deliverables and the general understanding of the respective working process.

The prerequisites for a successful elaboration of this process, for achieving a common understanding of the challenges and risks in place as well as for finding a joint agreement on the necessary actions, were agreed among all participants as follows:

- Broad participation and involvement of key players from both sectors (water and energy) including the hydropower sector, state organizations for energy and environment, NGOs, and representatives from the research sector in an utmost transparency,
- Collection of necessary data including energy and environmental strategies and measures,
- Support from all relevant stakeholders for the practical implementation.

The underlying principle of this activity was to build on work already performed as well as experiences gained through other processes on national, regional or European level and to look for synergies with ongoing processes in order to avoid duplication of efforts.

Particular emphasis was put on experiences from recently completed or ongoing activities in the Danube basin ("Joint Statement on Guiding Principles on the Development of Inland Navigation and Environmental Protection in the Danube River Basin", published in 2007/2008[7]), the Alpine region ("Situation Report on Hydropower Generation in the Alpine

[5] ICPDR document IC 089 (2004): The Danube Basin – Rivers in the Heart of Europe (Danube Declaration). Available online: http://www.icpdr.org/icpdr-files/15216. More information can be obtained from http://www.icpdr.org/icpdr-pages/mm2010.htm.

[6] A first "Draft Concept Paper Guiding Principles Hydropower Development" was developed in April 2011 highlighting the general background, the results expected out of this activity as well as the way forward and the relevant steps to be taken.

[7] ICPDR, Danube Commission, International Sava River Basin Commission: Development of Inland Navigation and Environmental Protection in the Danube River Basin. Joint Statement on Guiding Principles. The statement, all annexes as well as additional information are available online: http://www.icpdr.org/icpdr-pages/navigation_and_ecology_process.htm.

Region focusing on Small Hydropower", published in 2011[8]) and activities on EU level (Common Implementation Strategy, ad hoc activity "Hydromorphology", continued phase for 2010 to 2012[9] as well as the recently issued DG ENV study on "Hydropower Generation in the context of the EU WFD" [10]).

The ICPDR activity "Guiding Principles on Hydropower Development" is streamlined and linked with the ongoing activities under the European Strategy for the Danube Region (EUSDR), proposed by the European Commission on 8 December 2010 (Commission Communication – EU Strategy for the Danube Region) and endorsed by Member States at the General Affairs Council on 13 April 2011 (Council Conclusions), which aims at a better coordination and cooperation between the countries and regions to address the challenges identified in the Danube region. The EUSDR is accompanied by an Action Plan, including actions and examples for projects to be implemented in the course of the implementation of the Strategy. The Danube Region Strategy focuses on eleven priority areas; priority area coordinators were identified to coordinate the respective activities. [11]

Priority Area 2 "To Encourage More Sustainable Energy" coordinated by HU and CZ, includes the following two actions directly addressing hydropower generation:

- "To develop and set up pre-planning mechanism for the allocation of suitable areas for new hydro power projects".[12]
- "To develop a comprehensive action plan for the sustainable development of the hydropower generation potential of the Danube River and its tributaries (e.g. Sava, Tisza and Mura Rivers)".[13]

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[8] Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower. Available online: http://www.alpconv.org/documents/Permanent_Secretariat/web/ACXI/AC11_B8_1_Situation_Report_FIN_annex.pdf.

[9] The continued activity for the phase 2010 to 2012 focuses on the exchange of information, experiences and examples via workshops. In this context, a workshop on "Water Management, WFD and Hydropower" was organised by DE, UK and the European Commission from 13 to 14 September 2011 in Brussels (Belgium). The final Issue Paper "Water management, Water Framework Directive & Hydropower", Authors: Eleftheria Kampa, Johanna von der Weppen (Ecologic Institute) and Thomas Dworak (Fresh-Thoughts), is available online: http://www.ecologic-events.eu/hydropower2/documents/IssuePaper_final.pdf.

[10] European Commission, DG Environment, Hydropower Generation in the context of the EU WFD, Contract N° 070307/2010/574390, Project number 11418 (2011). Available online: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/hydropower_september/11418_110516pdf/_EN_1.0_&a=d. The study gives qualitative and quantitative information on the current and potential future contribution of the hydropower sector to the achievement of the renewable energy targets as well as to the reduction of greenhouse gas emissions, the influence of meeting the objectives of the WFD on the achievement of those objectives as well as an overview of strategic planning approaches, as proposed in jointly developed CIS guidance documents, applied by Member States for achieving the objective of better policy integration (between WFD and hydropower development).

[11] European Commission, COM(2010) 715 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Union Strategy for the Danube Region,{SEC(2010) 1489 final}, {SEC(2010) 1490 final}, {SEC(2010) 1491 final}.The text of the Commission Communication - EU Strategy for the Danube Region, the Council Conclusions as well as more background information can be obtained from the following webpage: http://ec.europa.eu/regional_policy/cooperate/danube/index_en.cfm. The countries and regions that will act as coordinators for each priority area were announced in February 2011.

[12] The Action Plan to the EUSDR (European Commission, SEC(2010) 1489 final, Commission Staff Working Document, Action Plan, Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Union Strategy for the Danube Region, {COM(2010) 715 final}, {SEC(2010) 1490 final}, {SEC(2010) 1491 final}) further specifies this project as follows: *This pre planning mechanism and its criteria would pave the way for new hydropower plants by identifying the best sites balancing economic benefits and water protection. It should also take into account climate change impacts (e.g. lower or higher water levels). This should be based on a dialogue between the different competent authorities, stakeholders and NGOs. In the suitable areas, the permits process could be streamlined.*

Furthermore, close coordination with activities ongoing under priority area 4 ("to restore and maintain the quality of waters") coordinated by HU and SK, as well as priority area 5 ("to manage environmental risks") coordinated by HU and RO, are ensured to avoid any duplication or overlapping of work ongoing as regards hydropower generation in the Danube Basin. For these actions reference is made to the ICPDR and the DRBDMP as well as to the Danube Declaration 2010. The leading countries as well as the ICPDR Secretariat are in close contact with the relevant Priority Area Coordinators to link the ongoing work on hydropower generation in the Danube Basin with the respective activities under the EUSDR.

The final deliverables of the ICPDR activity "Guiding Principles on Hydropower Development" will include

- The "Assessment Report on Hydropower Generation in the Danube Basin in the context of the Water Framework Directive and the Renewable Energy Directive" summarizing key information and data on hydropower generation in the Danube Basin,
- the elaboration of "Common Guiding Principles on Hydropower Development in the Danube basin" including case studies and good practice examples and
- the organization of two workshops in which the results of this activity will be disseminated, broadly discussed and finally concluded among all relevant stakeholders.

While the Assessment Report is setting the scene and compiling background information as regards hydropower generation in the Danube basin, the "Common Guiding Principles on Hydropower Development in the Danube basin" provide principles and criteria for the elaboration of hydropower projects, including case studies and good practice examples how the different issues were addressed in the context of the provisions of protection of waters (WFD) and production of renewable energy (Renewable Energy Directive).[14] Both, the Report and the common guiding principles are envisaged to facilitate the discussion for future projects, but will not replace any legal requirements or technical discussions on national level.

The first workshop with the aim to present the activity, to raise awareness as regards the challenges in place and to provide insight into the policy and legal framework as well as the expectations of all concerned parties and stakeholders was held in Timisoara, Romania from 21 to 22 February 2012. The second workshop, which will be organized in the first half of 2013, will present the results and outcomes of the work achieved and will pave the way forward for broad acceptance and practical implementation of the main outcomes and findings of this activity.

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[13] The Action Plan to the EUSDR further specifies this project as follows: *The plan would pave the way for the coordinated and sustainable development of new power stations in the future and retrofitting the existing ones in the way that would minimise the environmental impact and the impact on the transportation function of the rivers (navigation). The options for using hydropower to respond to fluctuations in the electricity demand should be explored – using dams to maintain high water level in preparation for the demand peak.*

[14] The guiding principles will include comprehensive information as regards different planning options, including modernization and upgrading of existing infrastructures, new facilities with fish passages and minimum ecological flow, analysis of costs and benefits of the project necessary to enable judgment on whether benefits to society outweigh the losses to the environment as well as mitigation measures including disruption of flow dynamics, the attenuation of hydropeaking and sediment and debris management to avoid flooding and degradation due to downstream erosion.

## 1.3 Aim and structure of the Report

The aim of this Report is to provide comprehensive background information on the situation of hydropower generation in the Danube Basin and constitutes the fundament of the "Common Guiding Principles on Hydropower Development in the Danube Basin" including case studies and good practice examples of hydropower generation in the context of the Water Framework Directive and Renewable Energy Directive.

The Report provides background information on the objectives of the ICPDR activity "Guiding Principles on Hydropower Development" as well as on the data sources and collection used for this Report (section 1). Section 2 focuses on the policy and legislative framework in the field of renewable energy and water management, flood protection as well as biodiversity and nature protection. Hydropower generation in the Danube basin including key figures on energy and hydropower as well as types and plants of hydropower plants is addressed in section 3. In addition, potential benefits and impacts of hydropower generation in the Danube basin are described in this section. Section 4 summarizes information on hydromorphological pressures on the status of waters due to hydropower, explains the environmental objectives of the Water Framework Directive and highlights the linkages between hydropower and heavily modified water bodies. Section 5 focuses on general conditions for hydropower authorization including legal and technical requirements for environmental improvements. Incentives for hydropower generation are listed in section 6, information as regards the implementation of Article 4.7 of the WFD or similar approaches can be found in section 7. Strategic planning tools for hydropower generation are highlighted in section 8. The main findings and conclusions are addressed in section 9.

The Report aims at

- Highlighting the motivation and the rationale behind the task of developing guiding principles on hydropower development in the Danube Basin,
- Stimulating discussions and identifying issues for further discussion by providing up-to-date information on hydropower generation in the context of the implementation of the WFD and the Renewable Energy Directive in Danube Countries,
- Facilitating the development of the guidelines by providing comprehensive data on the situation of the hydropower generation sector and the policy and legislative framework in the individual Danube countries and
- Acting as a supporting tool to enable a better understanding of the overall situation and the guidelines themselves.

## 1.4 Data sources and collection

The collection of data from Danube countries served as the main information basis for the development of this Report. For this purpose, a Danube Questionnaire – drafted on the basis of the EU Questionnaire on "Hydropower and WFD" and slightly adjusted to key issue of particular importance for the Danube basin – was sent out to Danube countries in August 2011. The replies to the Questionnaire were used as basis for the elaboration of this Report.

Most of the analyses in section 3 ("Hydropower Generation in the Danube Basin"), section 5 ("General conditions for hydropower authorization including requirements for environmental improvement"), section 6 ("Incentives"), section 7 ("Implementing Article 4.7 WFD or similar national approaches") and section 8 ("Strategic planning tools") build on this received information.

Further information for this Report were additionally gathered through the “1st ICPDR Workshop on Hydropower and Water Management”, which took place from 21 to 22 February 2012 in Timişoara (Romania) and which was used to compare collected data as well as to clarify possible shortcomings and different interpretations which may arise in such a data collection.[15]

In addition to information gathered through the Danube Questionnaire and the “1st Workshop on Hydropower and Water Management”, several reports, documents including the DRBMP and European databases from the ICPDR, the European Commission (DG ENV, DG REGIO), EUROSTAT and currently ongoing research projects were used to compile the relevant data for the elaboration of the Report, in particular for section 1 (“Introduction and background”), section 2 (“Overview of Policy and Legislative Framework”) and section 4 (“Hydropower and environmental objectives of the Water Framework Directive”).

### 1.4.1 Data request from Danube countries

Based on the EU Questionnaire on “Hydropower and WFD”, a slightly revised “Questionnaire for data collection on hydropower generation and water management issues in the Danube countries” was elaborated by the lead countries Austria, Slovenia and Romania, in close cooperation with the ICPDR Secretariat (see template in Annex I). The questions were adjusted to the particular situation of the Danube basin[16], in particular due to the reason, that also non-EU-MS are located in the Danube basin.

The Questionnaire included six main sections:

[15] Final summary of the “1st ICPDR Workshop on Hydropower and Water Management” available online: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=94017.

[16] Relevant issues for the Danube basin were added to the Questionnaire: Question for information on availability of GIS data sets on nature protected areas and existing hydropower plants (information about the exact site), designation of areas for new hydropower use and existence of exclusion criteria, for non EU-Member States the question whether no deterioration principle similar to the provision required by the WFD is in place, responsibility for control of permits and the existence of an obligation / recommendation to monitor effectiveness of measures.

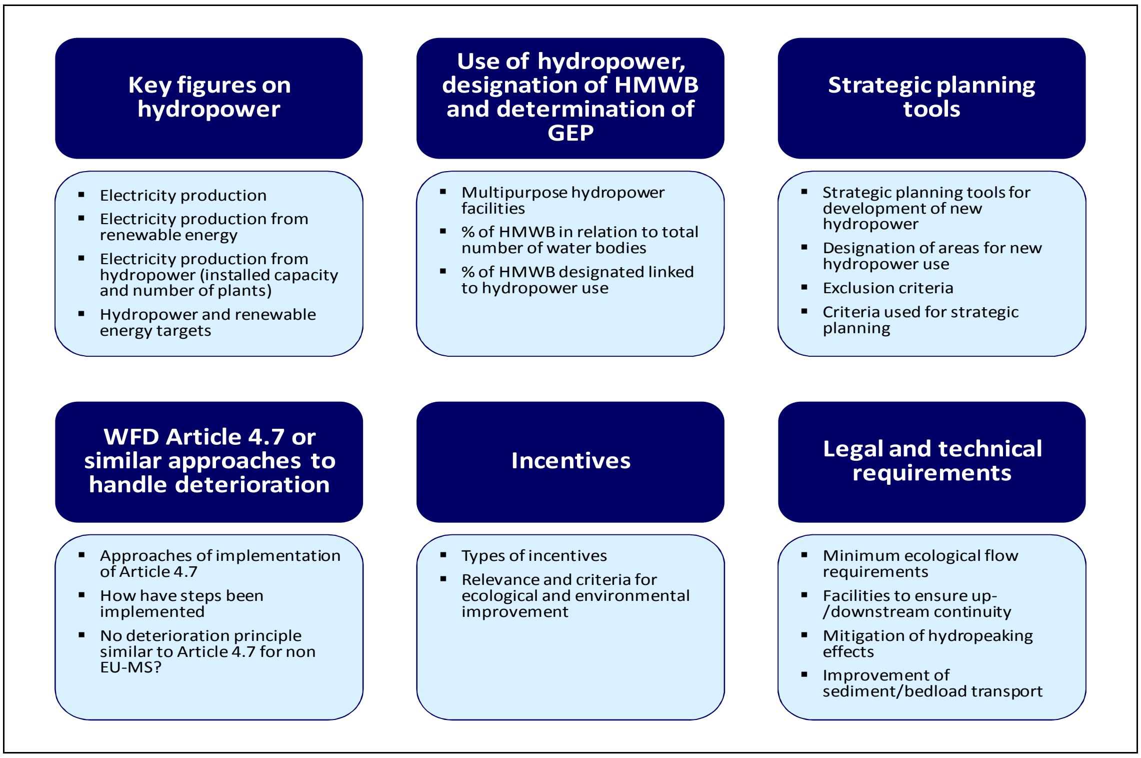


**Figure 1: Outline of the Danube Questionnaire "Hydropower Development and Water Management Issues"**

The Questionnaire was sent out to Danube countries on 4 August 2011, using the RBM EG contacts as well as those of the "Team of Experts on Hydropower", with a deadline to reply to the questions until 18 September 2011. Until 12 December 2011 ten Danube countries, seven EU-Member States (Austria, Bulgaria, Czech Republic, Germany, Romania, Slovak Republic and Slovenia) and Moldova, the Republic of Serbia and Ukraine, returned the Questionnaire. Bosnia-Herzegovina (consolidated version for Republic Srpska and Federation of Bosnia and Herzegovina), Croatia and Hungary provided a reply to the Questionnaire in January, respectively February 2012.[17] From those 14 Danube countries being contracting parties to the DRPC, Montenegro did not provide any feedback and data to the Danube Questionnaire.

Figure 2 provides an overview on the received feedback, split up for the different countries regarding the individual share of territory in the Danube Basin, respectively the individual share of the total population compared to the total population in the Danube basin.

[17] In total, 13 Danube countries returned the Danube "Hydropower & WFD" Questionnaire: AT, BA, BG, CZ, DE, HR, HU, MD RO, RS, SK, SI and UA. All Questionnaires are available online at: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=92399.

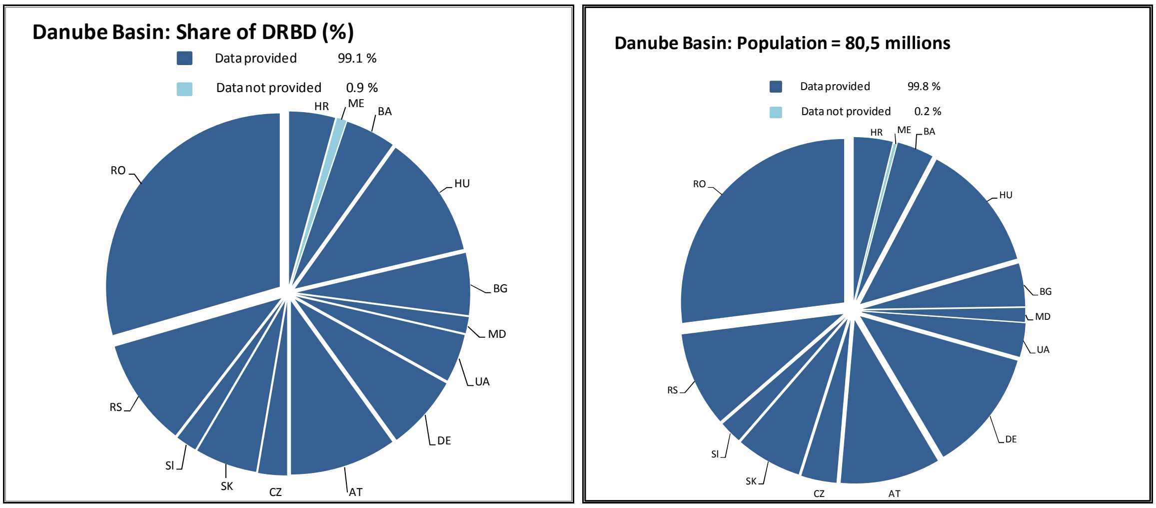


**Figure 2: Overview on data delivery from Danube countries, left: share of DRBD pro rata; right: population pro rata**

Furthermore, the results of the discussions and feedback received during the "1st ICPDR Workshop on Hydropower and Water Management", which was organised from 21 to 22 February 2012 in Timisoara, Romania, were integrated in the Report.[18]

### 1.4.2 Data from other sources

Along with the data request from the Danube countries, additional sources for information have been consulted. The main sources in this respect are reports, policy and legal documents as well as European databases from the ICPDR, the European Commission (DG ENV, DG REGIO), and the Alpine Convention, EUROSTAT as well as currently ongoing research projects as the SHERPA project[19] and the South East Europe Project "SEE HydroPower"[20].

Particular importance has been put on the following strategic sources from the ICPDR and the European Commission:

- Danube River Basin District Management Plan (December 2009) and Danube Declaration (December 2010).
- Joint Statement on Guiding Principles on the Development of Inland Navigation and Environmental Protection in the Danube River Basin (2007/2008).
- Common Implementation Strategy Guidance Documents[21] and EU Water Directors documents[22], in particular those specifying hydromorphological and hydropower aspects of the Water Framework Directive implementation.

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[18] Final summary of the "1st ICPDR Workshop on Hydropower and Water Management" available online: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=94017.

[19] ESHA, 2006. State of the Art of Small Hydropower in EU -25. European Small Hydropower Association. Brussels. Other related material can be obtained from the ESHA website: http://www.esha.be/.

[20] Further information about the South East Europe Project "SEE HydroPower" can be found under the following link: www.seehydropower.eu. The project will be finalized in August 2012; results are regularly updated on the webpage (flood control and sediment management, environmental flow, pilot case studies reports).

[21] More information can be obtained from the following webpage: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents&vm=detailed&sb=Title.

- Main outcome and findings of the “CIS Workshop Water management, Water Framework Directive & Hydropower” (13 to 14 September 2011, Brussels, Belgium) highlighted in the Issue Paper.
- DG ENV Study Hydropower Generation in the context of the EU WFD (May 2011).
- “Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower” and “Common Guidelines for the Use of Small Hydropower in the Alpine Region” (March 2009).
- EU Energy Strategy 2020[23] as well as National Energy Action Plans/Strategies.

### 1.4.3 Quality, reliability and comparability of data sources

Information and data collected for this Report include textual information as well as information on the availability of GIS data. If applicable, Danube countries provided readily available information and data sets already prepared for different national and international purposes.

Danube countries were asked to report the most recent and reliable data, to the extent possible. AT, BG, HU, MD, RO (data reported for the whole country are also relevant for the Romanian part of the Danube River Basin), RS, SI and SK reported data for the whole country. CZ, DE and UA reported data partly for the whole country, partly only for the Czech, German, respectively Ukrainian part of the Danube basin. Figures as regards electricity production expected for the year 2020 were reported by BA for the whole country;

all other data for BA was reported for the national part of the Danube basin. HR reported data for the Croatian part of the Danube River Basin.

As regards the figures on hydropower generation (figures in chapter 3), data reported for RO are relevant both for the Romanian part of the Danube River Basin as well as for the whole country. As regards the number of hydropower plants in the different plant size categories, it can be highlighted that for CZ individual data for P > 100 MW were not available, but the data are included in the class category "10 MW < P < 100MW".

The data of RS includes Kosovo, a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.

Consolidated data reported for BA are the result of the sum of data provided from the Republic of Srpska and the Federation of Bosnia and Herzegovina.

Key figures on the current situation as regards hydropower (electricity production, renewable energy production, hydropower generation, installed hydropower capacity) were reported for the year 2008 (AT), 2009 (DE, RS), 2010 (BG, CZ, HU, MD, RO, SK, UA) and 2011 (BA, SI). It has to be stated that in RO, the year 2010 was an exceptional year as regards hydro-energy production, being the second highest year in the hydro-

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[22] Please find more information on the following webpage: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/thematic_documents/hydromorphology/development_directivepdf/_EN_1.0_&a=d.

[23] More information can be found on the webpage: http://ec.europa.eu/energy/index_en.htm. For the Renewable Energy Directive as well as the national overall share and targets for the share of energy from renewable sources in gross final consumption of energy in 2020, the following webpage provides detailed information and figures: http://ec.europa.eu/energy/renewables/targets_en.htm.

energy production history of RO. Average values (data from 2009 and 2011) were reported for BA (data from the Federation of Bosnia and Herzegovina refer to 2009, while data from the Republic Srpska refer to 2011); data from the year 2010 were not taken into account for BA due to the fact that data from 2010 significantly deviates from the average values. Average values were also provided by HR.

While the Danube Questionnaire mainly asked for data for all DRBD rivers and the Danube River and/or the whole country (depending on the data availability of Danube countries), the data assessment done by the ICPDR and presented in the DRBMP refers to DRBD rivers with catchment areas >4000 km² and the Danube River only. Thus, differences in some figures included in section 4.2 may differ from data reported through the Danube Questionnaires due to the different scaling used in the Danube Questionnaires and the DRBMP. As most of the hydropower plants are situated in rivers with catchment areas smaller than 4,000 km², Danube countries were asked to provide data on hydropower plants in smaller rivers.

Table 2 summarises the availability of GIS data for nature protected areas, the exact site of hydropower plants on rivers with more than 4,000 km² and less than 4,000 km² as well as on the different capacities of the hydropower plants. All Danube countries, with the exception of UA, can provide GIS data sets on the location of hydropower plants at rivers with catchment areas larger 4000 km². GIS data sets for hydropower plants at rivers with catchment areas smaller 4000km² can be delivered by AT, BA, BG, CZ, DE, HR, HU, SI, RS and UA. As regards the different sizes of capacity of hydropower plants, AT, BG, RO, SK and SI are able to provide GIS data for all four size classes (< 1 MW, 1 MW – 10 MW, 10 MW – 100 MW and > 100 MW). GIS data for Natura 2000 sites are available from nine Danube countries.

| Is it possible to provide GIS data sets on nature protected areas?*<br>** SI did not provide any information as regards "Areas covered by the landscape protection convention under the Council of Europe" and "River stretches of scenic / cultural / archeological importance". MD did not report information if GIS data sets on "Natura 2000/ Emerald network areas" and "Areas covered by the landscape protection convention under the Council of Europe" are available. HR did not provide any information if GIS data sets on "IUCN category I-IV protected areas", "Areas covered by the landscape protection convention under the Council of Europe" and "River stretches of scenic / cultural / archeological importance" are available.* | Yes | No |
|---|---|---|
| Natura 2000[24] / Emerald network areas | AT, BG, CZ, DE, HR, HU, RO, SK, SI | BA, RS, UA |
| IUCN category I-IV protected areas | AT, CZ, HU, MD, RO, SK, SI | BA, BG, DE, RS, UA |
| Areas covered by the landscape protection convention under the Council of Europe | CZ, DE | AT, BA, BG, HU, RO, RS, SK, UA |
| River stretches of scenic / cultural / archeological importance | MD | AT, BA, BG, CZ, DE, HU, RO, RS, SK, UA |
| Is it possible or would you be willing to provide GIS data sets for existing hydropower plants (information about the exact site) for the purpose of generating overview maps to be included in the assessment report?*<br>** MD did not report any information if GIS data sets for hydropower plants with catchment areas smaller 4000km² are available. BA reported that GIS data for hydropower plants at rivers > 4.000 km² were already delivered to the ICPDR and hydropower plants at rivers > 1.000 km² to the ISRBC.* | Yes | No |
| Hydropower plants at rivers with catchment areas larger 4000 km² | AT, (BA), BG, CZ, DE, HR, HU, MD, RO, RS, SK, SI | UA |
| Hydropower plants at rivers with catchment areas smaller 4000km² | AT, (BA), BG, CZ, DE, HR, HU, SI, RS, UA | SK |
| Data on hydropower plants with the following capacities*<br>** HU and RS did not provide any information on this question. MD only reported for the capacities of 10 MW to 100 MW. BA reported that GIS data-coordinates are available for two existing power plants ( HPP Visegrad on the River Drina, and HPP Bocac on the River Vrbas). HR reported data only for the Danube River Basin in Croatia, in which no hydropower plant with a capacity exceeding 100 MW is present.* | Yes | No |
| < 1 MW | AT, BG, RO, SK, SI, UA | BA, CZ, DE |
| 1 MW – 10 MW | AT, BG, DE, HR, RO, SK, SI, UA | BA, CZ |
| 10 MW – 100 MW | AT, BG, DE, HR, MD, RO, SK, SI, UA | BA, CZ |
| > 100 MW | AT, BG, DE, RO, SK, SI | BA, CZ, UA |

Source: Replies to the Danube Questionnaire, Question QA.3 and QA.4

**Table 2: GIS data availability**

[24] GIS data on Natura 2000 sites is available for EU-MS through the Danube River Basin Management Plan.

# 2 Overview of Policy and Legislative Framework

This section provides an overview of the policy and legislative framework in the field of electricity production from renewable energy sources (section 2.1), water management and biodiversity as well as flood protection (section 2.2). National legislation, policies and strategies in the field of energy and environment are addressed in sections 2.1.2 and 2.2.2 (weblinks and references to national legislation, policies and strategies can be found in Annex V).

Hydropower generation in the Danube basin needs to be seen in the context of EU policies and legislation in the field of water protection (Water Framework Directive), flood protection (Floods Directive) and electricity production from renewable energy sources (Renewable Energy Directive). Furthermore, linkages with the provisions of the Birds and Habitats Directive as well as the Strategic Environmental Assessment (SEA) Directive and the Environmental Impact Assessment (EIA) Directive are relevant to be taken into account.[25]

Balancing the requirements of achieving "good status" for all surface waters and groundwater as a rule by 2015 (WFD) and reaching a 20% share of energy from renewable sources by 2020 (Renewable Energy Directive) is a major challenge and needs to be taken into account with regard to planning procedures for new hydropower developments.

Win-win measures to improve the status of water bodies with acceptable loss of energy production would be eligible as well as measures to increase hydropower generation without negative effects on water ecology, such as raising efficiency at existing sites and defining suitable sites for new hydropower plants by strategic planning tools and the application of Article 4.7 of the WFD.[26]

The use of water to gain energy is not ruled out by the WFD but it is also not a necessity to reach renewable targets in some Member States. In order to achieve a proper and well-balanced approach to meet climate protection, water protection and nature protection objectives, the benefits of hydropower as a highly reliable CO2-free and renewable source of electricity production but also the need to maintain the ecological functions of hydropower-affected water stretches have to be taken both into account.[27]

To limit the impact of possible new hydropower sites, it is necessary to implement strategic planning tools including river ecology aspects. The strategic planning of the development of hydropower should be accompanied by an improvement of water ecology, through clear ecological requirements for new and existing facilities. The Water and Energy discussions should also be linked to the debate on adaptation to climate change,

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[25] In addition to legislation and policies on EU-level, it has to be stated that there are several international Conventions and Treaties in place covering specific aspects of electricity production from renewable energy sources, water management and biodiversity as well as flood protection. Furthermore, the European Green Infrastructure Initiative, aiming at strengthening ecosystems by developing an integrated land management, can also be highlighted in this regard.

[26] Source: Common Implementation Strategy "Water Framework Directive and hydromorphological pressures", ad hoc activity „Hydromorphology" (2011): Issue Paper "Water management, Water Framework Directive & Hydropower", section 2.

[27] Key Conclusions, Common Implementation Strategy Workshop on WFD & Hydropower, Berlin, 4-5 June 2007.

including other water and energy issues like energy efficiency (WD meeting, Brno 2009).[28]

Six Danube countries (BA, HR, MD, ME, RS and UA) are Non EU Member States (Non EU-MS). Out of these Non EU-MS, one country (HR) carries the status of an EU Accession Country. All six countries committed themselves to implement the relevant "acquis communautaire" in the area of electricity, gas, environment and renewable energy through the Energy Community. When the WFD was adopted in the year 2000, all countries cooperating under the DRPC decided to make all efforts to implement the WFD throughout the whole basin. The Non EU-MS committed themselves to implement the WFD within the frame of the DRPC.

## 2.1 Policy and Legislation in the field of renewable energy

### 2.1.1 Policies and legislation on European level

The "Renewable Energy Directive 2009/28/EC"[29] amends and subsequently repeals "Directive 2001/77/EC of the European Parliament and the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market ("RES-e Directive - Promotion of electricity from renewable sources")" and "Directive 2003/30/EC of the European Parliament and the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport" from 1 January 2012.

The new Renewable Energy Directive is part of a package of energy and climate change legislation that provides a legislative framework for Community targets for greenhouse gas emission savings. It encourages energy efficiency, energy consumption from renewable sources, the improvement of energy supply and the economic stimulation of a dynamic sector. This Directive establishes a common framework for the use of energy from renewable sources in order to limit greenhouse gas emissions and to promote cleaner transport.

Each Member State has a target calculated according to the share of energy from renewable sources in its gross final consumption for 2020. This target is in line with the overall "20-20-20" goal for the Community, which means a saving of 20% of the Union's primary energy consumption and greenhouse gases, as well as the inclusion of 20% of renewable energies in energy consumption by 2020.

Member States are to establish national action plans which set the share of energy from renewable sources consumed in transport, as well as in the production of electricity and heating, for 2020. These action plans must take into account the effects of other energy efficiency measures on final energy consumption (the higher the reduction in energy consumption, the less energy from renewable sources will be required to meet the target).

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[28] Final Synthesis. Informal meeting of Water and Marine Directors of the European Union, Candidate and EFTA Countries. Brno, 28-29 May 2009. Reference is also made to the Common Implementation Strategy "Water Framework Directive and hydromorphological pressures", ad hoc activity „Hydromorphology" (2011): Issue Paper "Water management, Water Framework Directive & Hydropower", section 2.

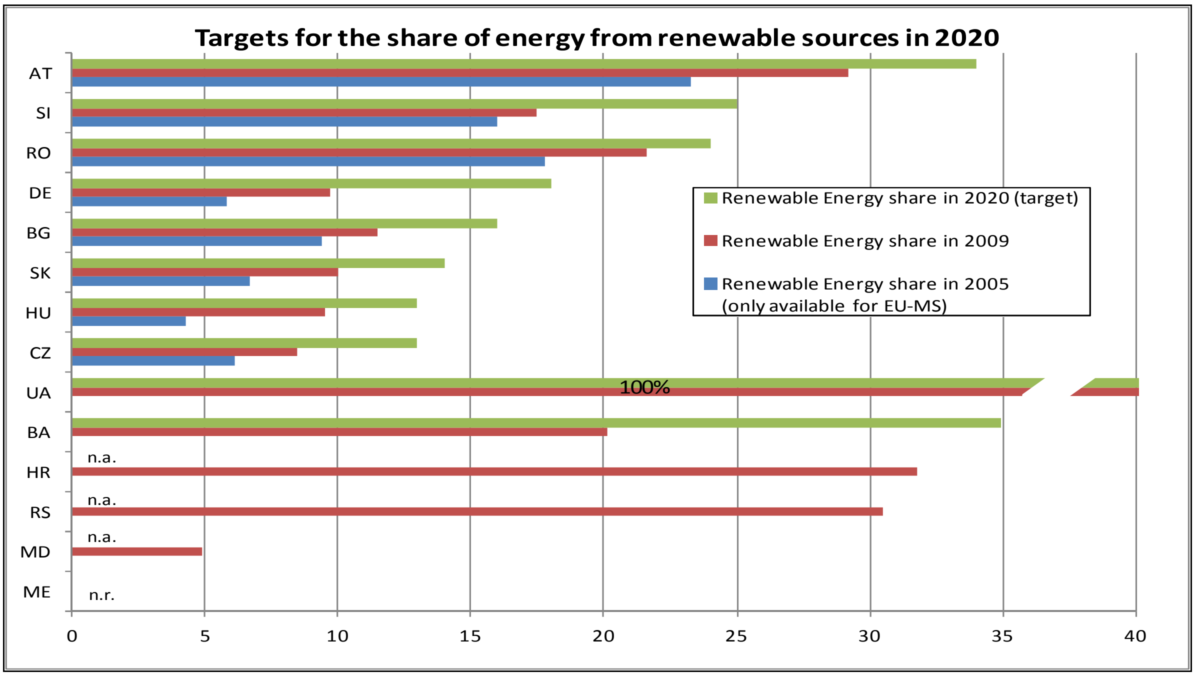
[29] DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. To be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:en:PDF.

These plans will also establish procedures for the reform of planning and pricing schemes and access to electricity networks, promoting energy from renewable sources.[30]

### 2.1.2 Policies and legislation on National level

Those Danube Countries, which are part of the European Union, are obliged to transpose EU legislation into their national legislation. Article 4 of the Renewable Energy Directive required Member States to submit national Renewable Energy Action plans by 30 June 2010. These plans, to be prepared in accordance with the template published by the Commission, provide detailed roadmaps of how each Member State expects to reach its legally binding 2020 target for the share of renewable energy in their final energy consumption.

Annex I of the Directive sets the national overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020. The renewable energy action plans set out the sectoral targets, the technology mix they expect to use, the trajectory they will follow and the measures and reforms they will undertake to overcome the barriers to developing renewable energy.[31] Figure 3 provides data on the renewable energy share in gross final consumption of energy for the years 2005 (only available for EU-MS), 2009 and the targets for 2020 based on figures provided in the national Renewable Energy Action Plans (for EU-MS) and data provided through the Danube Questionnaire (non EU-MS).




Source: DG ENERGY, http://ec.europa.eu/energy/renewables/targets_en.htm for EU-MS and Danube Questionnaire Questions Q3.2 and Q3.8 for non EU-MS

**Figure 3: National overall share and targets for the share of energy from renewable sources in gross final consumption of energy in 2020**

[30] Sources: http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm.

[31] All renewable energy action plans can be downloaded from this webpage: http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm.

The Energy Community[32] extends the EU internal energy market to South East Europe and beyond on the ground of legally binding framework. The Treaty establishing Energy Community was signed in October 2005 in Athens (Greece). It entered into force on 1 July 2006. The Parties to the Treaty are the European Union, on the one hand, and the Contracting Parties, namely, Albania, Bosnia & Herzegovina, Croatia, former Yugoslav Republic of Macedonia, Montenegro, Serbia and the United Nations Interim Administration Mission in Kosovo. Whilst Moldova became a full-fledged member as of 1 May 2010, Ukraine officially acceded the Energy Community on 1 February 2011. The Contracting Parties have committed themselves to implement the relevant "acquis communautaire", to develop an adequate regulatory framework and to liberalise their energy markets in line with the "acquis communautaire" under the Treaty. The latter includes key EU legal acts in the area of electricity, gas, environment and renewable energy.

The status of implementation of the relevant energy legislation in BA, HR, MD, RS and UA can be summarized as follows:

- Bosnia and Herzegovina: A target for electricity production from hydropower for 2020 has been set and defined in the Book for Rules about Renewable Energy (Official papers for RS, No. 28/11 and 39/11).

- Croatia: Targets are generally set in the Energy Sector Development Strategy of the Republic of Croatia (Official Gazette No. 130/2009).

- Moldova: No targets for electricity production from hydropower for 2020 have been set yet.

- Republic of Serbia: The targets for electricity production from hydropower for 2020 have not been set yet. Those targets will be set through the 2020 RES Targets document which will be developed by the Energy Community Secretariat in cooperation with the Contracting Parties. In addition, in the year 2012, the new Energy Sector Development Strategy of the Republic of Serbia by 2025 with the projections by 2030 will be developed including targets for electricity production from hydropower for 2020.

- Ukraine: The targets for electricity production from hydropower for 2020 have been set and correspond to the national energy programs. After amendments of the national "Law of Ukraine on Energy" (from 16.10.1997 № 575/97-BP) in the year 2008 a new stage of development of renewable energy resources has started (including "green tariffs"). According to the current national energy programs, renewable energy resources should produce up to 5 bln. KWt annually until the year 2016. This corresponds to 12 to 15% of the total production of energy in the Ukraine. In Ukraine at present, such types of renewable energy production cover around 3% of the total energy production.

[32] More information can be obtained from the following webpage: http://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY.

## 2.2 Policy and Legislation in the field of water management and biodiversity

### 2.2.1 Policies and legislation on European level

#### 2.2.1.1 Water Framework Directive

Since the adoption of the Water Framework Directive[33] in the year 2000, protection of Europe's waters is regulated in one single piece of framework legislation including the expanded scope of the water protection to all waters (surface water, groundwater, transitional and coastal water), the achievement of a "good status" for all waters (including the preservation of the hydromorphological characteristics) as a rule by 2015 as well as water management based on river basins. In addition, a strong linkage of the implementation of the Water Framework Directive is given with the provisions of the Birds and Habitats Directives aiming at the protection of Europe's most valuable species and habitats. Both the nature Directives and the WFD aim at ensuring healthy aquatic ecosystems while at the same time ensuring a balance between water/nature protection and the sustainable use of nature's natural resources.[34]

The main elements of the Water Framework Directive can be summarised as follows:

- The protection of all waters, surface and ground waters, transitional and coastal waters as well as covering all impacts.
- The achievement of a "good status" for all surface waters and groundwater, as a rule, by 2015.
- Prevention of further deterioration of water bodies, including the protection of aquatic and terrestrial ecosystems.
- Definition of water quality defined in terms of biology, chemistry and morphology (surface waters) and of chemistry and quantity (groundwater).
- To ensure coordination and cooperation in shared river basins across administrative and political borders.
- Establishment of monitoring programmes for surface and groundwater.
- Water management based on river basins.
- Integration of economic instruments: economic analysis, and pricing reflecting cost recovery - to promote prudent use of water.
- Mandatory public participation by citizens, municipalities, NGOs in developing river basin management plans.

Not all surface water bodies, however, can be brought to a "good ecological status" (GES) which refers to a nearly natural undisturbed condition. Many water bodies have been heavily modified in their physical structure to serve various uses including navigation, flood protection, hydropower, and agriculture. In many cases, it is not viable or desirable from a socio-economic perspective to abandon such uses and to remove the physical modifications which affect the water bodies. Where there are existing

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[33] 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. To be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF.

[34] A first workshop was organised in June 2010 under the auspices of the Water Framework Directive (WFD) Common Implementation Strategy (CIS) and supported by the Biodiversity Strategic Coordination Group as the first event of a new activity on Biodiversity and Water that seeks to explore and understand the practical issues involved in the implementation of the Birds and Habitats Directives (BHD) and the WFD and to foster improved understanding between the water and nature communities. More information can be obtained from the following webpage: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/biodiversity_legislation&vm=detailed&sb=Titl.

hydropower facilities it is possible to designate a water body as heavily modified if the good ecological status cannot be achieved, if changes to the hydromorphological characteristics of a water body would have significant adverse effects on the use and if the objectives cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option. For those water bodies designated as HMWB, the "good ecological potential" must be reached and measures need to be taken to improve the quality of the water body as much as possible (e.g. by building fish passes, setting ecological flows).[35]

The milestones in the implementation of the Directive since the year 2000 can be summarized as follows:

- By the end of 2004, EU-MS had to provide, an analysis of the characteristics of the river basin district(s), an analysis of the impact of human activities on the state of surface water and of groundwater, an economic analysis of the use of water, a register of the areas which require special protection and all those water bodies which were used for the abstraction of drinking water.
- By the end of 2006, EU-MS had to establish programmes for monitoring the status of the surface waters and groundwater of each river basin district, in particular the ecological and chemical status of surface waters and the chemical and quantitative status of groundwater.
- On the basis of the analyses and the findings of the monitoring measures, EU-MS had to develop, by the end of 2009, a programme of measures for each river basin district. These programmes of measures shall be reviewed and, if necessary, updated in 2015 and every six years thereafter.
- Furthermore, all the previous elements were summarised in a River Basin Management Plan that contains all measures in place or foreseen, in order to reach the objectives of the WFD. These management plans had also to be established by 2009; they will be reviewed and updated in 2015 and every six years thereafter.

All plans and programmes have to be the subject of intensive public participation, in order to ensure that the balancing of diverging interests in the different stages of implementing the WFD is fully taken into consideration and, furthermore, to ensure that the different plans, programmes and measures are subsequently effectively put into operation.

For new modifications to the physical characteristics of water bodies, 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 provisions which have to be taken into account with regard to planning procedures for potential further hydropower developments are not only of particular relevance for EU-MS, but may also serve as general recommendations to be used in non EU-MS. Figure 38 in section 7 highlights the application and the relevant questions of Article 4.7 WFD in a stepwise approach.[36]

[35] Kampa, E. & C. Laaser (2009): Updated Discussion Paper. Common Implementation Strategy Workshop Heavily Modified Water Bodies. Brussels, 12-13 March 2009. Available online: http://www.ecologic-events.de/hmwb/documents/Discussion_Paper_Updated.pdf.

[36] See more information under section 7.

#### 2.2.1.2 Floods Directive

The purpose of "Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks"[37] is "to establish a framework for the assessment and management of flood risks – aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community". The Directive covers all types of floods, from rivers, mountain torrents, Mediterranean ephemeral water courses, but also floods from the sea in coastal areas. There are also other risks, such as urban floods and sewer floods, which should be taken into account. The Floods Directive requires Member States to take a long term planning approach to reducing flood risks in a three-step approach:

- EU-MS will by 2011 undertake a preliminary flood risk assessment to identify the river basins and associated coastal areas at potential risk of flooding. The assessment shall include information on the boundaries of river basins in the district concerned, floods that have occurred in the past, the likelihood of future floods and the estimated adverse consequences for human health, the environment, cultural heritage and economic activity. On the basis of the assessment, Member States must then categorise river basins for which they conclude that potential significant flood risks exist or might be considered likely to occur in the future. This assessment and the resulting categories assigned to river basins must be published and reviewed by 22 December 2018 and every six years thereafter.

- Where real risks of flood damage exist or might be considered likely to occur, EU-MS must set up flood hazard and flood risk maps identifying all areas posing a risk of flooding and indicating the probability (high, medium or low) of flooding for each of those areas as well as the potential damage for inhabitants, economic activity and the environment. The maps must be drawn up and published by 22 December 2013 at the latest and reviewed every six years.

- Finally, EU-MS shall develop and implement Flood Risk Management Plans for each river basin district, by 2015. In the FRMPs, Member States shall include measures for achieving objectives focusing on reducing the probability and the potential consequences of flooding. Those measures will address all phases of the flood risk management cycle but focus particularly on prevention (e.g. by avoiding construction of houses and installations in present and future flood plain areas or by adapting future enlargement to the risk of flooding), protection (e.g. by taking measures to reduce the probability of floods and/or the impact of floods in a specific area such as restoring flood plains and wetlands) and preparedness (e.g. making available instructions to the public on what to do and how to react in the event of flooding). In addition, FRMPs shall take into account relevant costs and benefits, flood extent and flood conveyance routes, the environmental objectives of Article 4 of the WFD, soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure.

These three steps are to be repeated in a six-year cycle to ensure that long-term developments are taken into account. The Floods Directive shall be closely coordinated and synchronised with the implementation of the WFD, particularly through coordinated

[37] DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks. To be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT.

Flood Risk Management Plans and River Basin Management Plans. All preliminary flood risk assessments, flood hazard and flood risk maps as well as Flood Risk Management Plans prepared shall be made available to the public. Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans.

#### 2.2.1.3 Birds and Habitat Directives

The "Birds"[38] and the "Habitats"[39] Directives (BHD) together form the backbone of the EU's biodiversity policy as they protect Europe's most valuable species and habitats. The ultimate objective of the Habitats Directive is to protect, maintain or restore at favourable conservation status selected species and habitats of Community importance and to ensure a coherent network of special areas of conservation (Natura 2000 sites). In addition, also species (e.g. priority fish and other river species) outside protected areas are covered by the BHD; a particular focus of a coherent network of protected areas should also be led on the habitat connectivity outside of protected areas. Both the WFD and the Birds and Habitats Directives aim at ensuring healthy aquatic ecosystems while at the same time ensuring a balance between water/nature protection and the sustainable use of nature's natural resources.

The implementation of measures under the WFD will generally benefit the objectives of the nature Directives. Relevant linkages of the WFD and the Birds and Habitat Directives can be summarised as follows: Any Natura 2000 site with Annex I aquatic habitat types or Annex II aquatic species under the Habitats Directive or with water-dependent bird species of Annex I of the Birds Directive, and, where the presence of these species or habitats has been the reason for the designation of that protected area, has to be considered for the register of protected areas under Article 6 of the WFD. These areas are summarised as "water-dependent Natura 2000 sites". For these Natura 2000 sites, the objectives of BHD and WFD apply. The objectives of the Directives are closely related and special attention and coordination is needed where these Directives are implemented in the same areas. The measures serving the BHD and WFD objectives need to be included in the River Basin Management Plans required under Article 13 WFD and could also be included in the management plans of the Natura 2000 sites.[40]

#### 2.2.1.4 Environmental Assessment Directives

Environmental assessment is a procedure that ensures that the environmental implications of decisions are taken into account before the decisions are made. Environmental assessment can be undertaken for individual projects, such as a dam, motorway, airport or factory, on the basis of the "Environmental Impact Assessment"[41]

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[38] DIRECTIVE 2009/147/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 November 2009 on the conservation of wild birds. To be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:020:0007:0025:EN:PDF.

[39] COUNCIL DIRECTIVE 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. To be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1992:206:0007:0050:EN:PDF.

[40] More information can be found in the FAQ paper on links of WFD and BHD implementation; available online: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/biodiversity_legislation&vm=detailed&sb=Title.

[41] COUNCIL DIRECTIVE of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment. The consolidated version can be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1985L0337:20090625:EN:PDF.

(EIA Directive), as amended, or for public plans or programmes on the basis of the "Strategic Environmental Assessment"[42] (SEA Directive). The common principle of both Directives is to ensure that plans, programmes and projects likely to have significant effects on the environment are made subject to an environmental assessment, prior to a decision on their approval, authorisation or rejection. Consultation with the public is a key feature of environmental assessment procedures.

The Directives on Environmental Assessment aim to provide a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation of projects, plans and programmes with a view to reduce their environmental impact. They ensure public participation in decision-making and thereby strengthen the quality of decisions. The projects and programmes co-financed by the EU (Cohesion, Agricultural and Fisheries Policies) have to comply with the EIA and SEA Directives to receive approval for financial assistance. Hence the Directives on Environmental Assessment are crucial tools for sustainable development.[43]

### 2.2.2 Policies and legislation on National level

Those Danube Countries, which are part of the European Union, are obliged to transpose EU legislation into their national legislation. When the WFD was adopted in the year 2000, all countries cooperating under the DRPC decided to make all efforts to implement the WFD throughout the whole basin. The Non EU-MS committed themselves to implement the WFD within the frame of the DRPC.

In addition to the Danube wide River Basin Management Plan, Danube countries elaborated national River Basin Management Plans[44], which are setting the national framework for protecting and enhancing the water environment from 2009 to 2015. The first cycle of River Basin Management Plans (period until 2015), will be followed-up by two more RBM cycles that will be finalized by 2021 and 2027, respectively.

The plans include detailed information of how the objectives set for the river basin (ecological status, quantitative status, chemical status and protected area objectives) are to be reached within the timescale required. The plans include all the results of the river basin's characteristics, a review of the impact of human activity on the status of waters in the basin, an estimation of the effect of existing legislation and the remaining "gap" to meeting these objectives. A programme of measures including national, regional and local measures are included in the Report setting out the actions to be taken during the plan period to secure Directive objectives.

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[42] 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. To be downloaded from the following weblink: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:197:0030:0037:EN:PDF.

[43] Sources: http://ec.europa.eu/environment/eia/home.htm (EIA Directive) and http://ec.europa.eu/environment/eia/sea-legalcontext.htm (SEA Directive).

[44] National RBMPs can be downloaded for EU-MS from http://ec.europa.eu/environment/water/participation/map_mc/map.htm and http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/submitted_rbmps&vm=detailed&sb=Title.

# 3 Hydropower generation in the Danube basin

This section lists types and sizes of hydropower plants (section 3.1), provides information on key figures on energy and hydropower generation in the Danube basin (section 3.2), examines potential benefits and impacts of hydropower generation (section 3.3) and looks at the possibility of reducing greenhouse gas emissions through hydropower generation (section 3.4). The original figures on hydropower generation submitted by Danube Countries in the Danube Questionnaires are listed in Annex II.

Since the 16th century man has been changing the natural course of the rivers in the Danube River Basin, mainly for flood defense, hydropower generation and navigation. Hydrological engineering works include dams, dykes, reservoirs, navigation channels and irrigation networks. Dams and reservoirs have been built in nearly all mountainous areas of the Danube Basin and in some lowland regions; over 700 dams and weirs have been built along the main tributaries of the Danube. About half of the Danube rivers are used to generate hydropower. Stretches of rivers used for flood protection and hydropower generation also co-exist.[45]

The largest hydropower dam and reservoir system along the entire Danube is located at the 117-km-long Djerdap (Iron Gate Dam I and II) Gorge.


**Figure 4: Pictures from Iron Gate Dams I and II**

[45] Source: http://www.icpdr.org/icpdr-pages/dams_structures.htm.

The second largest dam system is operated at Gabcikovo, downstream of Bratislava, since 1992.


**Figure 5: Pictures from Gabcikovo-Cunovo**

## 3.1 Types and sizes of hydropower plants

Hydropower (or hydroelectric power) schemes harness the energy from flowing water to generate electricity, using a turbine or other device. This can be from rivers or man-made installations. The amount of hydropower generated depends on the water flow and the vertical distance (known as 'head') the water falls through. Turbines placed within the flow of water extract its kinetic energy and convert it to mechanical energy; a generator then converts this to electrical energy.[46]

There are three main types of hydropower schemes, which have to be distinguished[47]:

- Run-of river hydropower schemes ("Run-of-the-river stations"): This type of installation uses the natural flow of a water course in order to generate electricity. There is no intention to store water and to use it later on. This type is most common for small hydropower stations but can also be found with large stations.


[46] Source: http://www.environment-agency.gov.uk/business/topics/water/32022.aspx.

[47] Source: European Commission, DG Environment, Hydropower Generation in the context of the EU WFD, Contract N° 070307/2010/574390, Project number 11418 (2011). Available online: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/hydropower_september/11418_110516pdf/_EN_1.0_&a=d.

Sources: Freudenau, http://www.verbund.com/tm/en/, [up left]; Jochenstein, Bayerisches Landesamt für Umwelt [up right]; Vohburg and Ingolstadt, Bildrechte E.ON Wasserkraft GmbH, Bildautor Rolf Sturm [down]

**Figure 6: Pictures from Run-of river hydropower plants (Freudenau, Jochenstein, Vohburg and Ingolstadt) in the Danube basin**

- Storage hydropower schemes ("Hydropower stations with storage reservoir"): A storage reservoir offers the opportunity to store energy and to meet e.g. the peak electricity demands. Such reservoirs can comprise daily, seasonal or yearly storage. Many of the large hydropower stations operate with a reservoir.

Sources: http://www.verbund.com/tm/en/, Kaprun Power Plant, Mooserboden reservoir in Kaprun

**Figure 7: Pictures from Storage hydropower plants in the Danube basin**

- Pumping storage hydropower schemes ("Pumped storage hydropower plants"): Pumped hydropower stations utilize two reservoirs located at different altitudes. Water can be pumped from the lower into the upper reservoir and can be released, if needed, to the lower reservoir producing energy on its way through the turbines. In times of high demand e.g. during peak hours electricity is produced to satisfy the demand. When there is a surplus of electricity in the system, water can be pumped to the upper reservoir. This may happen during peak production hours from wind and solar energy or at times of low demand. Pumped storage stations are well suited to serve a reliable electricity supply with fluctuating sources because they can provide balancing power (Deutsche Energie Agentur, dena Studie "NNE Pumpspeicher", Abschlussbericht 2008-11-24). The energy balance of pumping storage plants is negative as it takes more energy to pump up the water than it can recover from hydropower generation. Nevertheless, pumping storage schemes are at the moment one of the most effective storage options for electricity. For pumping, surplus electricity was and is partially used from thermal or nuclear power plants. However, with the increase of electricity production from wind and solar energy they will play an important role in the electricity management.

Source: Pumping Storage hydropower plant Ranna in Upper Austria, www.panoramio.com/photo/35978005 [left]; Pumping Storage hydropower plant Cierny Vah in Slovakia [right]

**Figure 8: Pictures from Pumping Storage hydropower plants in the Danube basin**

For the purposes of this report, electricity production from pumped storage hydropower schemes should be excluded due to the fact that the Renewable Energy Directive states that “electricity produced in pumped storage units from water that has previously been pumped uphill should not be considered to be electricity produced from renewable energy sources”.[48] Although pumped storage is not considered as renewable energy source under the Renewable Energy Directive, it has to be noted that in the view of contributing to climate change mitigation, pumped storage will play an important role in the future by firming the variability of renewable power sources, such as wind and solar. Pumped storage hydropower plants are not generating electricity, but function as transmission facilities for energy storage, grid balancing, and providing ancillary services in a very cost-effective way. Pumped storage can absorb excess generation (or negative load) at times of high output and low demand and release that stored energy during peak demand periods. As pumped storage facilities may have negative environmental impacts on river and river valley ecosystems, it is necessary to include the assessment of the benefits and impacts of pumped storage plants in the national River Basin Management Plans.

Hydropower plant facilities range in size from large hydropower plants that supply many consumers with electricity to small plants that individuals operate for their own energy needs or to sell power to utilities. As the sizes are defined differently in most of the Danube countries, the following categories of hydropower plants were chosen to be displayed in this Report:

- Hydropower plants having a capacity less than 1 MW
- Hydropower plants having a capacity between 1 and 10 MW
- Hydropower plants having a capacity between 10 and 100 MW
- Hydropower plants having a capacity more than 100 MW

Currently there is no international consensus on a technical threshold value defining the boundary between small and large hydropower. The most common threshold value in use in the Danube countries is the bottleneck capacity of 10 MW.[49] This value is also used by statistical agencies at European level (i.e. Eurostat). However, although a defined threshold value can be of relevance e.g. for gaining investment support or guaranteed feed-in tariffs, environmental legislation such as the WFD does not differentiate between small and large hydropower stations.

[48] See recital 30 of Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

[49] See footnote 3 of the Danube Questionnaire on „WFD and Hydropower“: “The bottom line for “P < 1 MW” is defined as hydropower plants still linked to the network”.

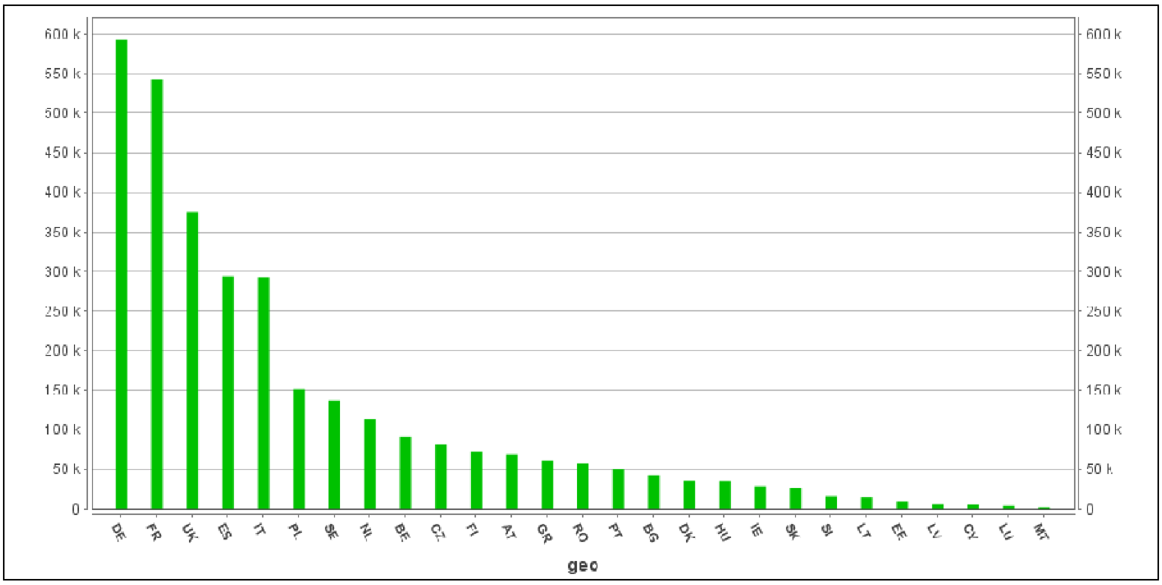
The same environmental obligations have to be fulfilled in the same way for river stretches utilised for small or large facilities.[50]

Compared to the EU-Questionnaire the size of hydropower plants generating more than 100 MW was included in the Danube Questionnaire.

## 3.2 Key figures on energy and hydropower

### 3.2.1 Electricity generation and renewable energy in Europe

In 2008 a total gross electricity of 3,374 TWh was generated in the EU-27 MS. Total gross electricity generation covers gross electricity generation in all types of power plants. The gross electricity generation at the plant level is defined as the electricity measured at the outlet of the main transformers, i.e. the consumption of electricity in the plant auxiliaries and in transformers are included. DE, FR, UK, IT and ES showed the largest generation values (Figure 9).[51]




Source: EUROSTAT, reference year 2009,
http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables ten00087

**Figure 9: Total gross electricity generation in the EU, GWh**

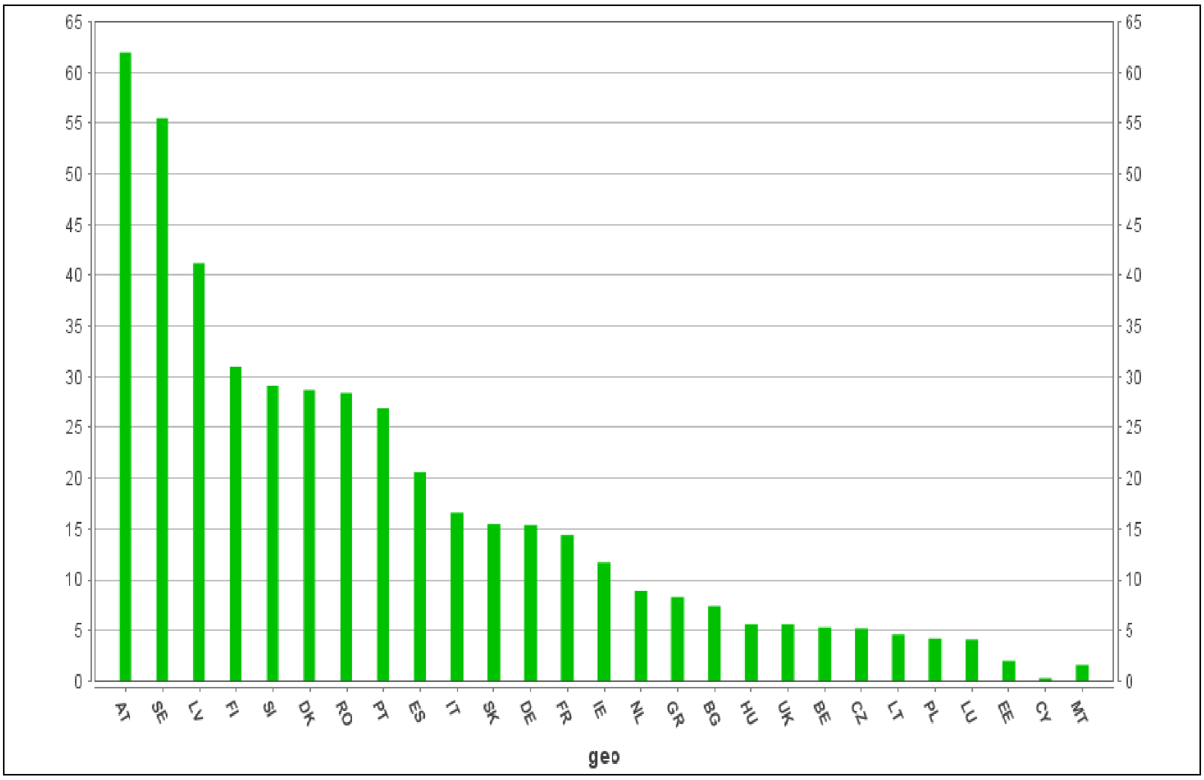
Despite policy support at EU level after 2000, the development of renewables just begins to appear as a major GHG-reducing factor compared to these drivers and represents therefore an important future challenge for further reducing EU emissions from energy supply. However in some EU-MS renewable energy already considerably contribute to national GHG emissions reductions.[52]

[50] See also Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower, page 8. Available online: http://www.alpconv.org/documents/Permanent_Secretariat/web/ACXI/AC11_B8_1_Situation_Report_FIN_annex.pdf.

[51] Source: European Commission, DG Environment, Hydropower Generation in the context of the EU WFD, Contract N° 070307/2010/574390, Project number 11418 (2011), section 2.2.2.

[52] Source: EEA (2011): Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008 . Available online: http://www.eea.europa.eu/publications/ghg-retrospective-trend-analysis-1990-2008.

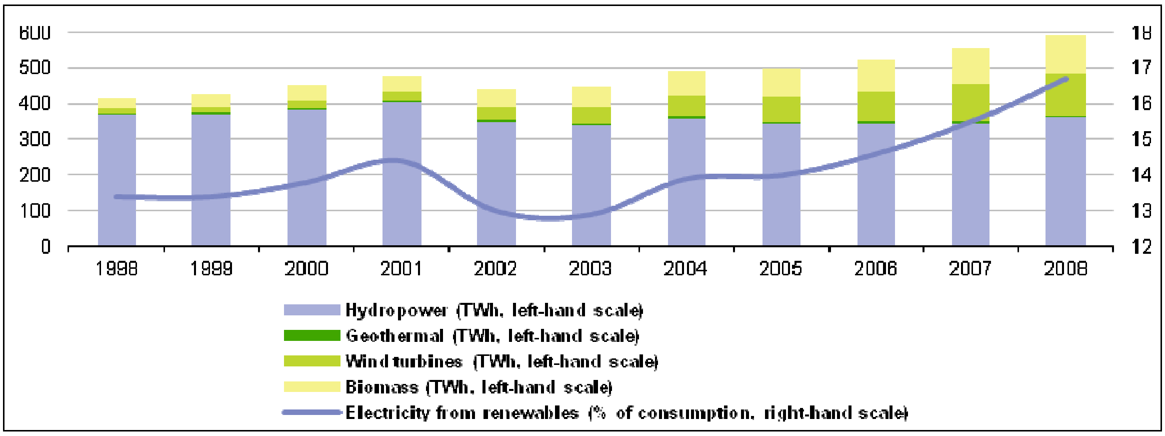
The countries with the largest share of renewable energy sources on the electricity consumption were AT (62%), SE (55%), LV (41%) and FI (31%). In 2008 electricity generation from renewable sources covered 16.6% of gross electricity consumption (Figure 10). While figure 3 in section 2.1.2 refers to the national overall share and targets for the share of energy from renewable sources in gross final consumption of energy in 2020, figure 10 covers the ratio between the electricity produced from renewable energy sources (i.e. from hydro plants (excluding pumping), wind, solar, geothermal and electricity from biomass/wastes) and the gross national electricity consumption (i.e. the total gross national electricity generation from all fuels (including autoproduction), plus electricity imports, minus exports).




Source: EUROSTAT, 2008, Electricity generated from renewable sources, http://epp.eurostat.ec.europa.eu/tgm/graph.do?tab=graph&plugin=1&pcode=tsien050&language=en&toolbox=sort

**Figure 10: Electricity generated from renewable sources in % of gross electricity consumption Share in the EU**

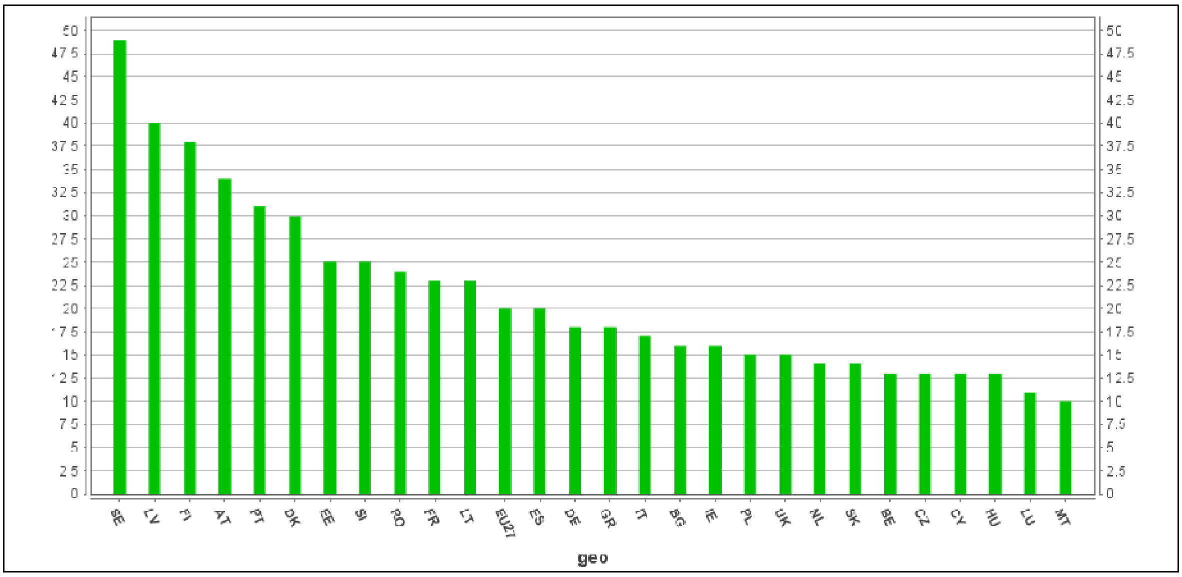
As it can be seen from figure 11, the share of hydropower among renewable energy did not substantially change or increase from the years 1998 to 2008 compared to other renewable energy sources such as wind turbines and biomass.




Source: EUROSTAT, nrg_105a and tsdcc330, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Renewable_energy_statistics

**Figure 11: Electricity generated from renewable energy sources, EU-27, 1998 to 2008, EUROSTAT 2008**

The national overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020 are specified in Annex I of the new Directive on Renewable Energy (see figure 12). The targets for share of energy from renewable sources in gross final consumption of energy in the year 2020 range between 49% for SE, 40% for LV, 38% for FI and 34% for AT to 14% for NL and SK, 13% for BE, CY, CZ and HU, 11% for LU and 10% for MT.

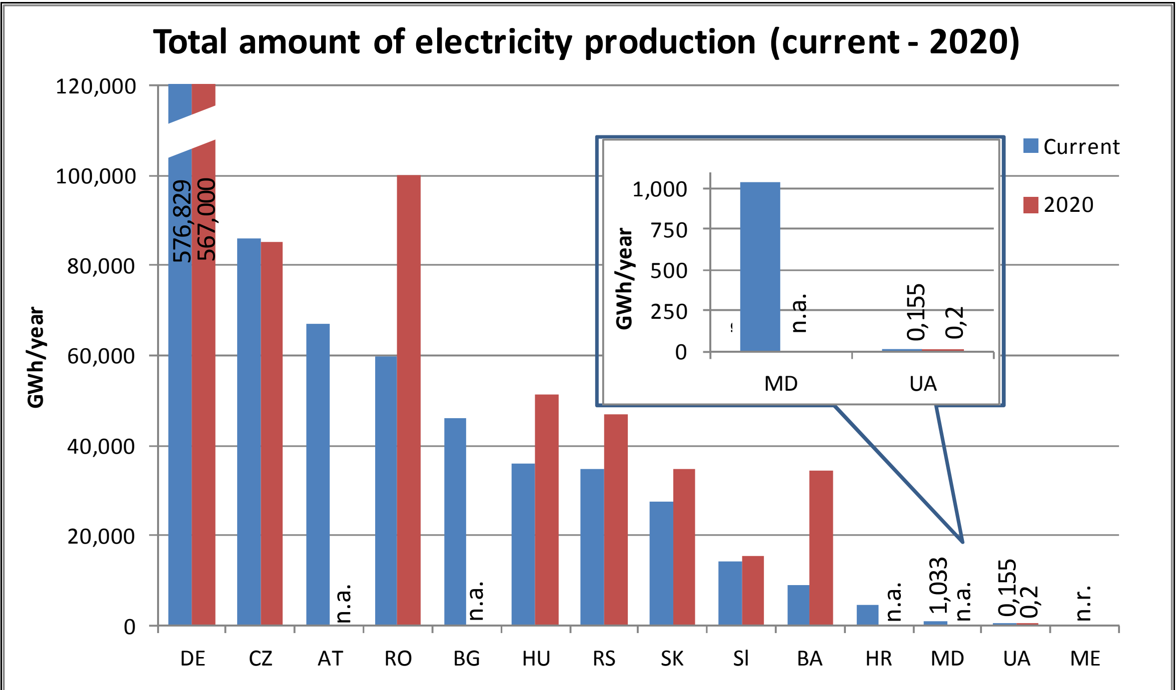



Source: EUROSTAT, targets for 2020, http://epp.eurostat.ec.europa.eu/tgm/graph.do?tab=graph&plugin=1&pcode=tsdcc110&language=en&toolbox=data

**Figure 12: Share of renewable energy in gross final energy consumption, targets for 2020**

### 3.2.2 Electricity generation and renewable energy in the Danube basin

Figure 13 provides information on the total current electricity production as well as those expected for the year 2020. No considerable increase in the electricity production can be seen for DE, CZ, SI and UA. RO (+ 40,234 GWh/year), HU (+ 15,473 GWh/year), RS (+ 11,869 GWh/year), BA (+ 25,189 GWh/year) and SK (+ 6,930 GWh/year) expect an increased electricity production for the year 2020. For AT, BG, HR and MD no values for the total amount of electricity production expected in 2020 were reported.

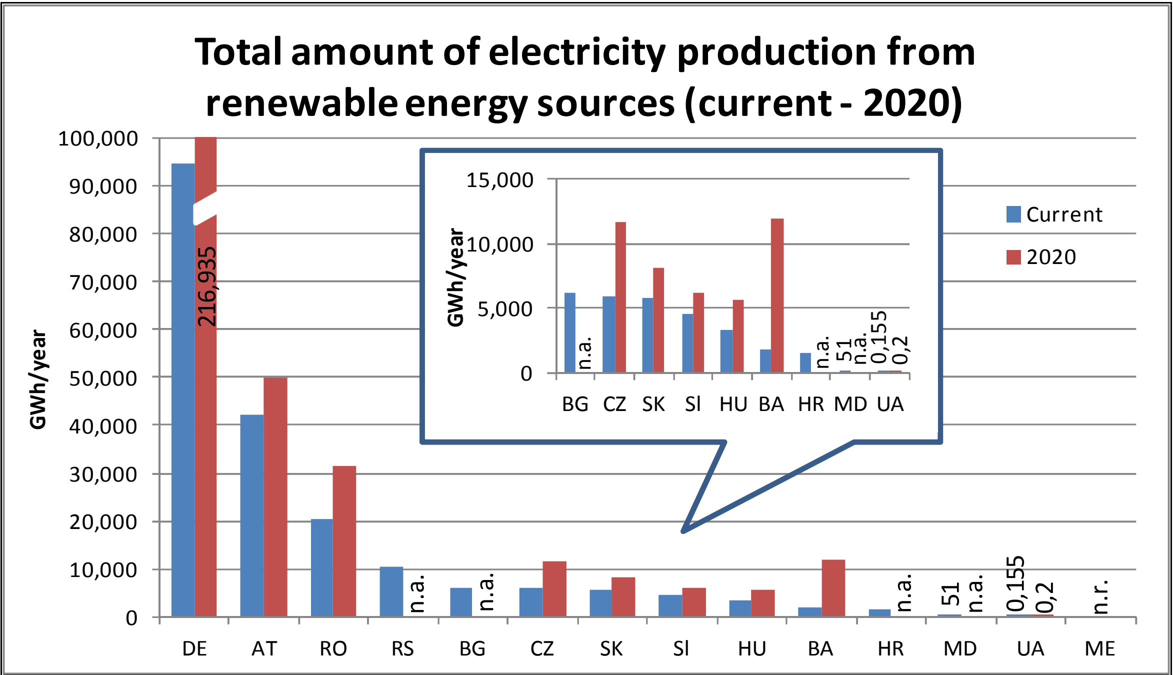



***Notes:***
*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA reported data for the current amount of electricity production for the national part of the Danube 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.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Questions 3.1 and 3.7

**Figure 13: Total electricity production currently and in 2020, in GWh/year**

In terms of the development of electricity production from renewable energy sources by 2020, many countries (DE, AT, RO, CZ, SK, SI, HU and BA) plan a considerable increase in electricity production from renewable energy sources (see figure 14).




***Notes:***
*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as 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.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Questions 3.2 and 3.8

**Figure 14: Electricity production from renewable energy sources currently and in 2020, in GWh/year**

### 3.2.3 Electricity generation from hydropower in Europe

The latest data published on hydropower production by the Statistical Office of the European Communities EUROSTAT represent the year 2008. With a hydropower installed capacity of 102 GW hydropower (PSP excluded) the electricity generation was 327 TWh for the EU-27 MS (Table 3). According to these data there was no hydropower production in Cyprus and Malta in 2008. Including pumped storage plants with an installed capacity of 40,3 GW the total gross generation of hydropower was 359.2 TWh in 2008. The consumption of pumped storage plants was 11.3 TWh.[53]

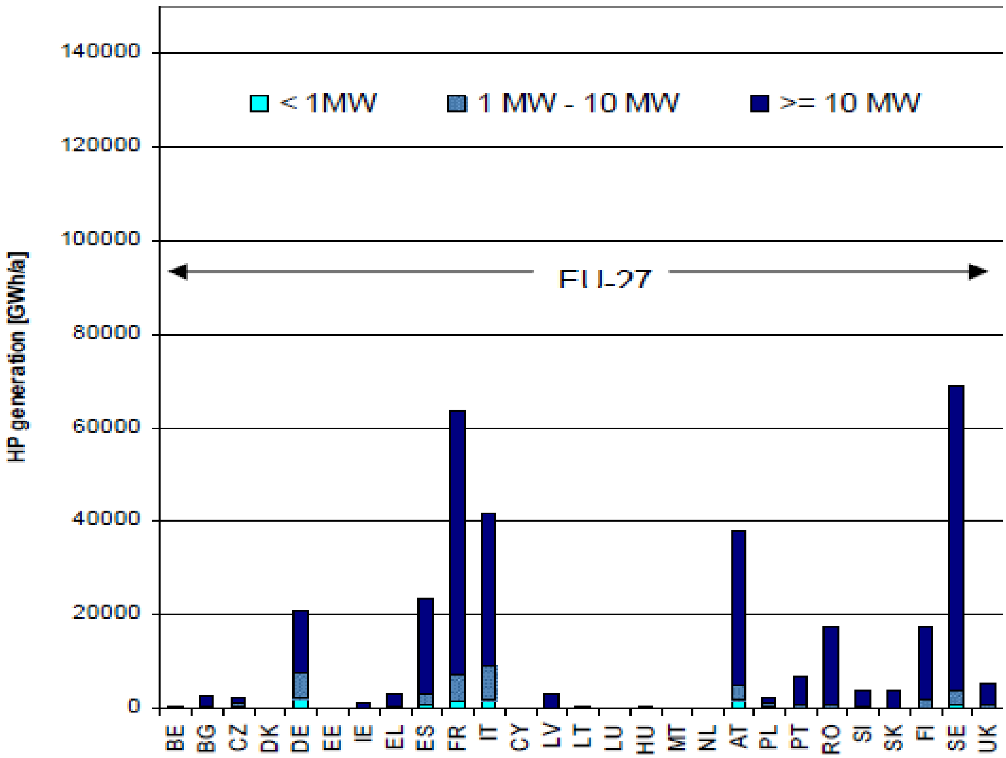
| *2008* | *Generation Ea [GWh/a]* | | | | *Installed capacity P [MW]* | | | |
|---|---|---|---|---|---|---|---|---|
| *class* | *P < 1 MW* | *1 MW ≤ P < 10 MW* | *10 MW ≤ P* | *all* | *P < 1 MW* | *1 MW ≤ P < 10 MW* | *10 MW ≤ P* | *all* |
| BE | 26 | 207 | 176 | 409 | 9 | 50 | 52 | 111 |
| BG | 108 | 417 | 2299 | 2824 | 39 | 191 | 1890 | 2120 |
| CZ | 492 | 475 | 1057 | 2024 | 151 | 141 | 753 | 1045 |
| DK | 12 | 14 | n.a. | 26 | 3 | 5 | n.a. | 8 |
| DE | 2060 | 5286 | 13596 | 20942 | 561 | 842 | 2104 | 3507 |
| EE | 28 | n.a. | n.a. | 28 | 5 | n.a. | n.a. | 5 |
| IE | 47 | 85 | 836 | 968 | 23 | 20 | 196 | 239 |
| EL | 117 | 207 | 2987 | 3311 | 44 | 114 | 2319 | 2477 |
| ES | 674 | 2357 | 20469 | 23500 | 267 | 1605 | 11232 | 13104 |
| FR | 1582 | 5342 | 56802 | 63726 | 445 | 1604 | 18823 | 20872 |
| IT | 1770 | 7390 | 32464 | 41624 | 437 | 2105 | 11190 | 13732 |
| CY | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| LV | 64 | 6 | 3038 | 3108 | 24 | 1 | 1511 | 1536 |
| LT | 51 | 22 | 329 | 402 | 17 | 8 | 90 | 115 |
| LU | 7 | 126 | n.a. | 133 | 2 | 38 | n.a. | 40 |
| HU | 16 | 34 | 163 | 213 | 4 | 10 | 37 | 51 |
| MT | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| NL | n.a. | n.a. | 102 | 102 | n.a. | n.a. | 37 | 37 |
| AT | 1637 | 3179 | 33129 | 37945 | 454 | 725 | 7040 | 8219 |
| PL | 290 | 605 | 1257 | 2152 | 74 | 183 | 672 | 929 |
| PT | 67 | 670 | 6060 | 6797 | 31 | 361 | 3634 | 4026 |
| RO | 99 | 549 | 16547 | 17195 | 61 | 292 | 6009 | 6362 |
| SI | 264 | 193 | 3561 | 4018 | 117 | 37 | 873 | 1027 |
| SK | 58 | 108 | 3874 | 4040 | 25 | 65 | 1542 | 1632 |
| FI | 167 | 1449 | 15496 | 17112 | 31 | 285 | 2786 | 3102 |
| SE | 601 | 3188 | 65280 | 69069 | 101 | 815 | 15436 | 16352 |
| UK | 57 | 511 | 4600 | 5168 | 65 | 108 | 1456 | 1629 |
| EU-27 | 10294 | 32420 | 284122 | 326836 | 2990 | 9605 | 89682 | 102277 |

Source: EUROSTAT yearly statistics 2008; for Iceland the only available data from 2006 were taken

**Table 3: Electricity generation and installed capacity of hydropower plants in 2008**

[53] Source: European Commission, DG Environment, Hydropower Generation in the context of the EU WFD, Contract N° 070307/2010/574390, Project number 11418 (2011), Section 2.2.3.2.

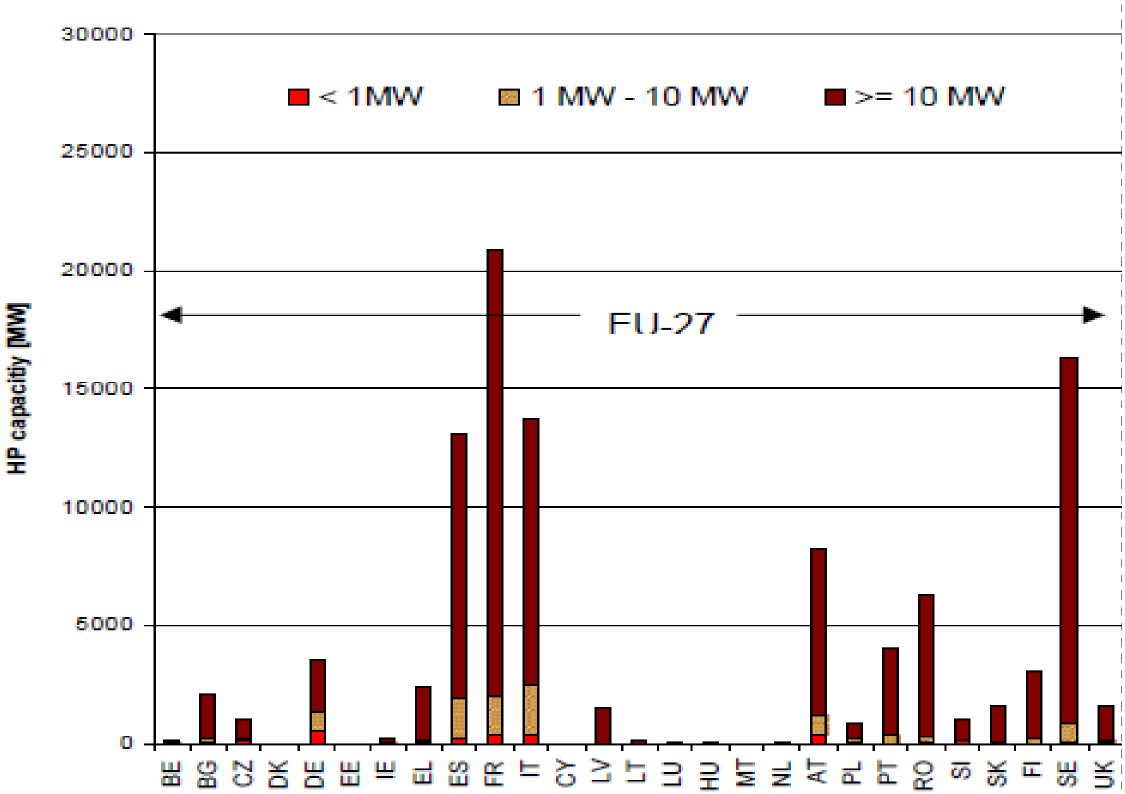
The individual values for the European countries on hydropower electricity generation and on electrical capacity are shown in Figure 15 and 16. In all countries large hydropower stations (LHPP) with a capacity >= 10 MW are the major contributors. They produced 87% of the total generation and comprise 88% of the total capacity with regards to EU-27 MS.[54]




Source: EUROSTAT yearly statistics 2008; for Iceland the only available data from 2006 were taken

**Figure 15: Hydropower electricity generation for different hydropower plant sizes in 27 EU-MS, Norway and Switzerland in 2008, excluding pumped storage**

[54] Source: European Commission, DG Environment, Hydropower Generation in the context of the EU WFD, Contract N° 070307/2010/574390, Project number 11418 (2011), Section 2.2.3.2.

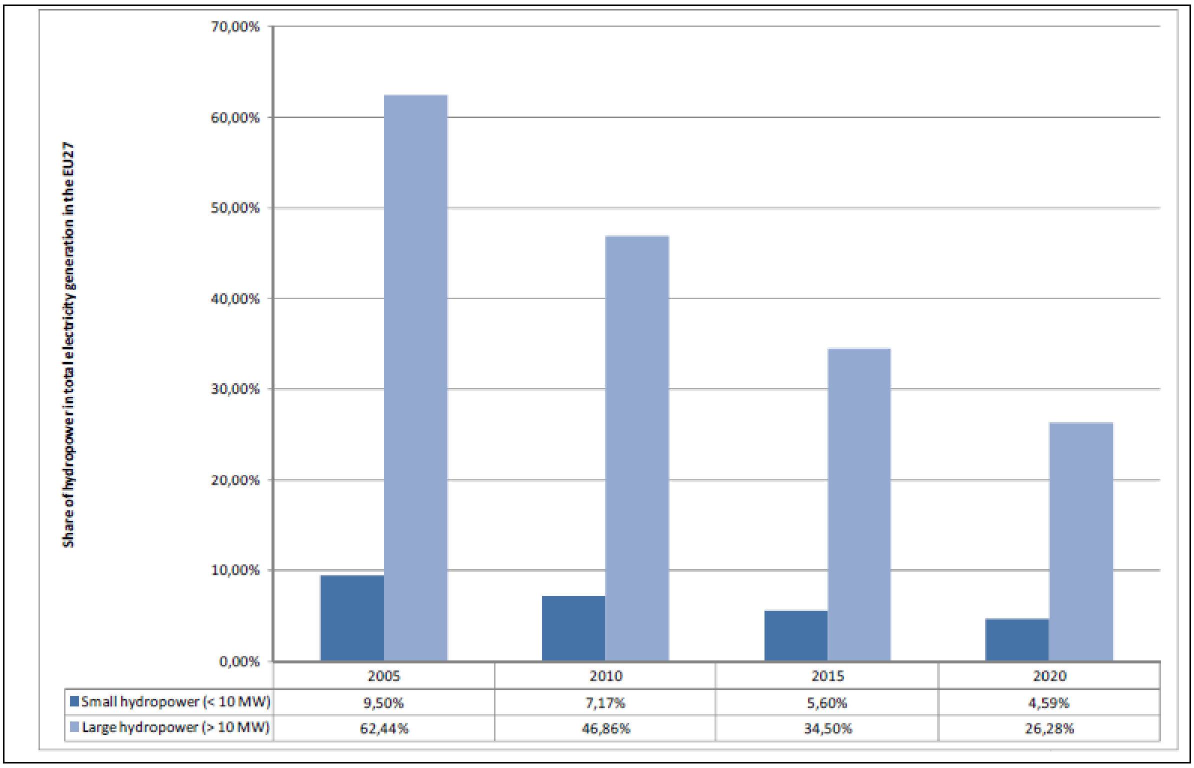



Source: EUROSTAT yearly statistics 2008; for Iceland the only available data from 2006 were taken

**Figure 16: Installed electrical capacity of hydropower for different hydropower plant sizes in 27 EU-MS, in Norway and Switzerland in 2008, excluding pumped storage**

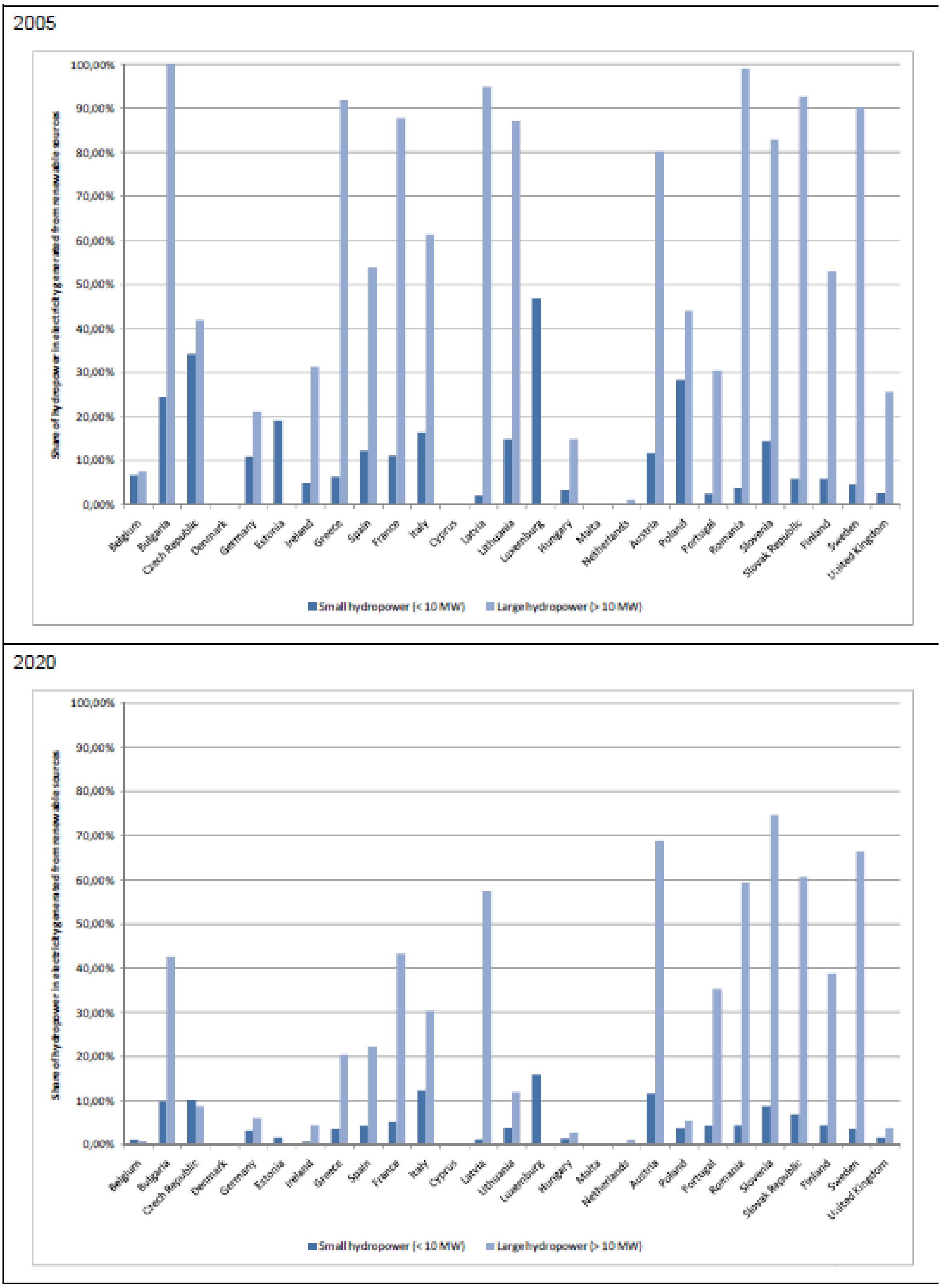
The share of hydropower in the total electricity generated from renewable sources decreases significantly over the period 2005 – 2020 as it can be seen from the data for the EU-27 MS (Figure 17) and the individual Member States (Figure 18).

While in 2005, hydropower (small & large) still accounted for over 70% of all electricity generated from renewable sources in the EU-27, its share will drop to somewhat over 30% by 2020 according to the NREAPs. This indicates a stronger growth rate for electricity generation from other renewable sources (wind, biomass, PV and geothermal) than the expected growth rate from hydropower.




Source: DG ENV Study, Hydropower Generation in the context of the EU WFD

**Figure 17: Contribution of small (< 10 MW) and large (>10 MW) hydropower to electricity generation from renewable sources in the EU-27**



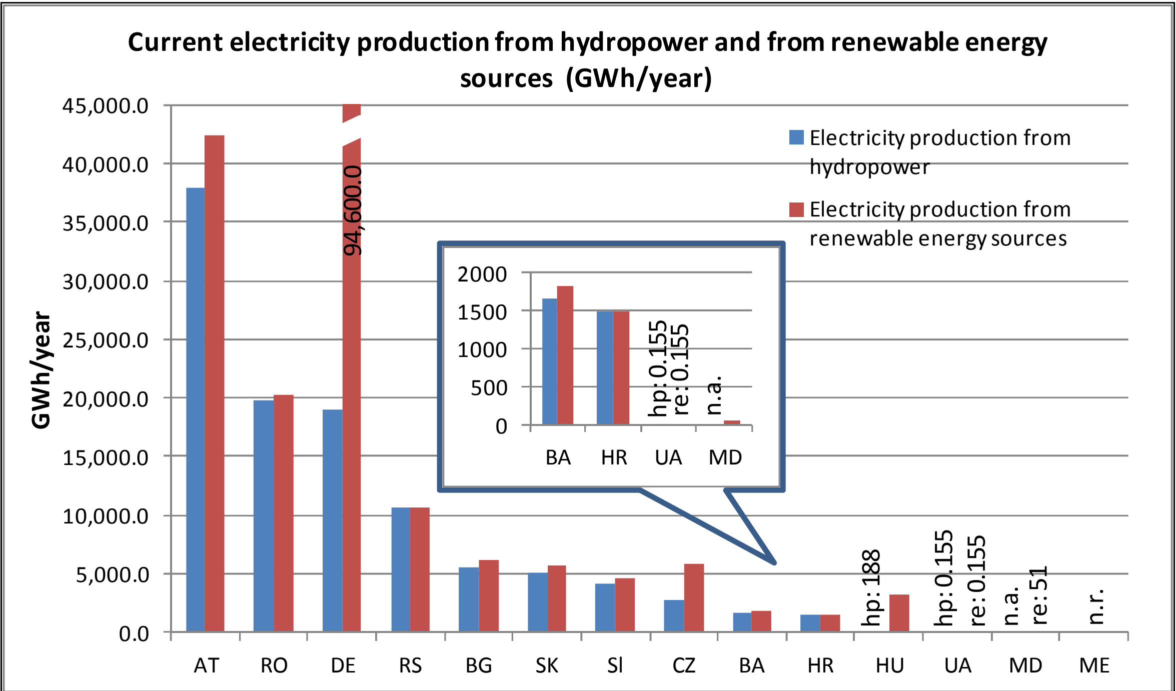

Source: DG ENV Study, Hydropower Generation in the context of the EU WFD

**Figure 18: Contribution of small (< 10 MW) and large (>10 MW) hydropower to electricity generation from renewable sources per MS in 2005 and 2020**

### 3.2.4 Electricity generation from hydropower in the Danube basin

Figure 19 shows the current electricity production from hydropower and renewable energy sources in absolute figures, while figure 20 provides the figures as a percentage of the total national electricity production.

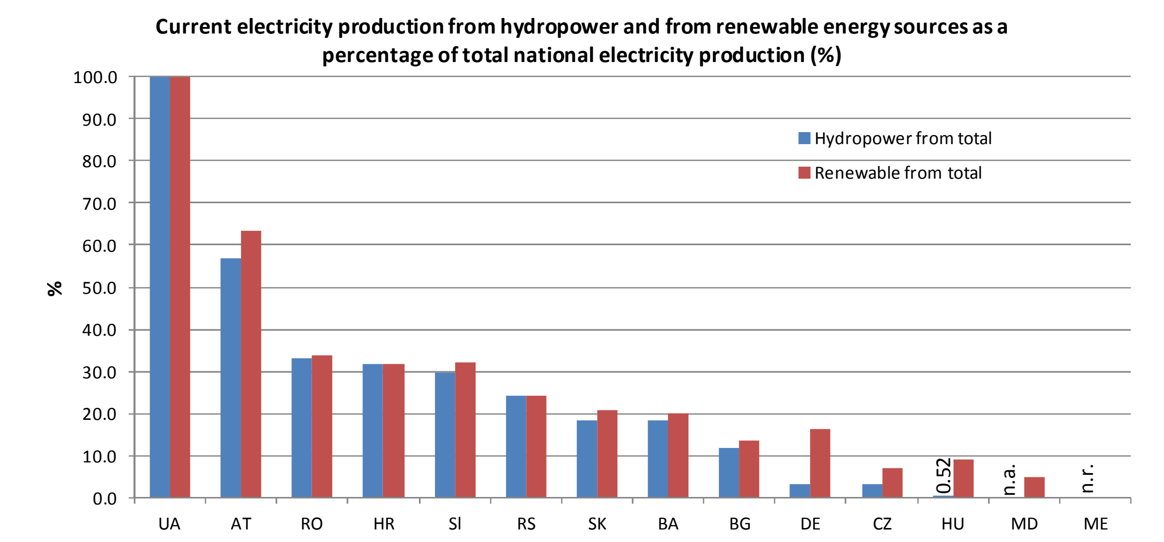
In AT, 57% of total electricity generation is produced by hydropower and around 7% by other renewable energy sources. DE shows a share of electricity production from hydropower by 5% in relation to the total electricity production, while 16% of electricity is produced by renewable energy sources in relation to the total electricity production. In CZ electricity production from hydropower is currently below 5% and from renewable energy sources is currently 6.9% of the total electricity production.




***Notes:***
*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA, HR and UA reported data for the national part of the Danube River Basin only.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Questions 3.2 and 3.3

**Figure 19: Current electricity production from hydropower and from renewable energy sources, in GWh/year**




***Notes:***
*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA, HR and UA reported data for the national part of the Danube River Basin only.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Questions 3.1, 3.2 and 3.3

**Figure 20: Current electricity production from hydropower and from renewable energy sources as a percentage of total national electricity production, in %**

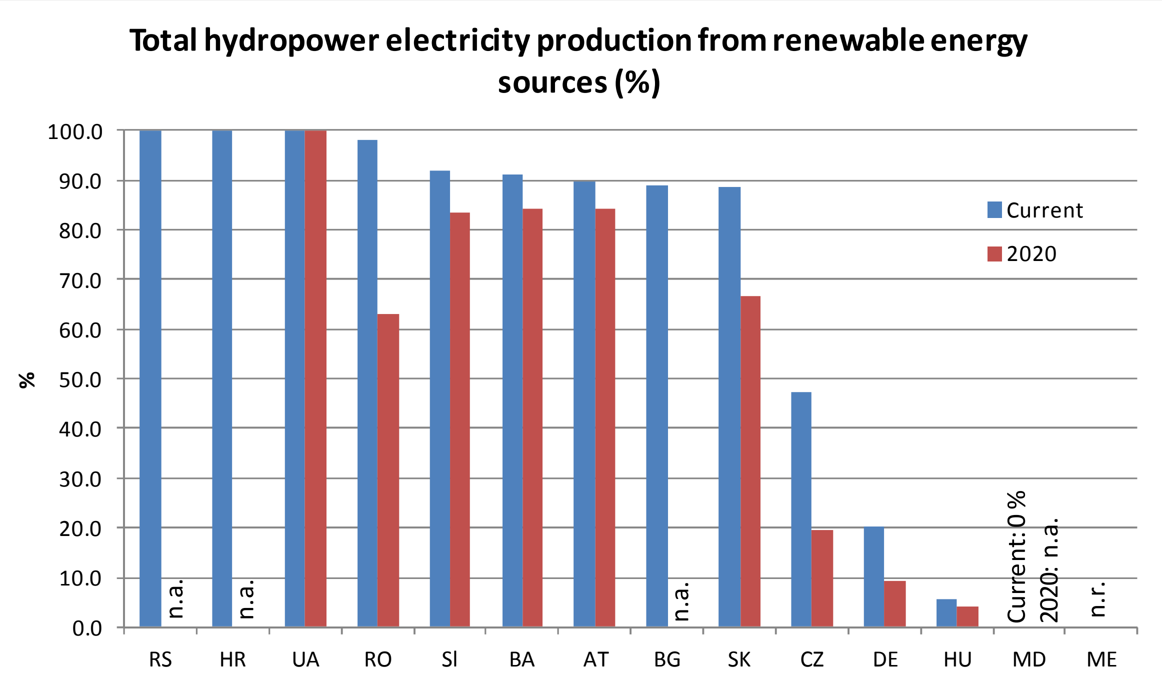
In all Danube countries surveyed, with the exception of CZ, DE, HU, MD and UA, hydropower represents an important component of current total renewable energy production, contributing by more than 50% (see figure 21).

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, and SI). For DE the current share of electricity production from hydropower to total electricity from renewable energy sources is considerably low (20%).

The share of hydropower to total renewable electricity production will not increase in the surveyed Danube countries. On the contrary, the share of hydropower will decline by 35% for RO, 28% for CZ, 22% for SK and 11% for DE (see figure 1).

This is an indication that by 2020 other renewable energy sources are expected to develop more dynamically than hydropower. However, in most countries, hydropower will remain a relatively significant contributor of renewable energy.[55]

[55] Common Implementation Strategy "Water Framework Directive and hydromorphological pressures", ad hoc activity „Hydromorphology“ (2011): Issue Paper "Water management, Water Framework Directive & Hydropower", section 3.1.

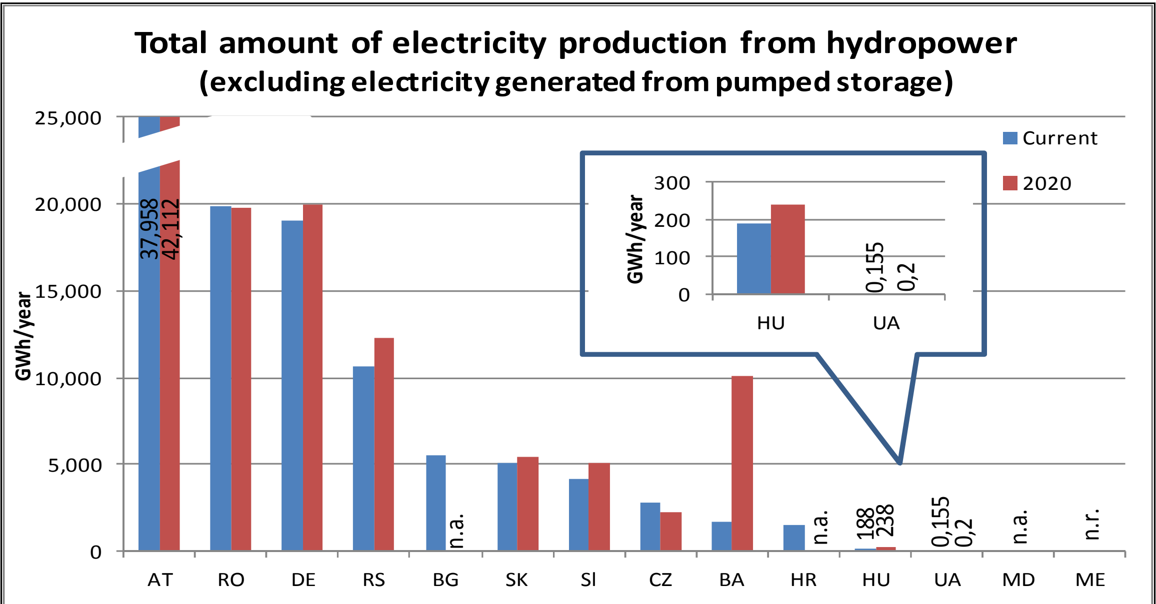



***Notes:***
*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA reported data for the current amount of electricity production for the national part of the Danube 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.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Questions 3.2, 3.3, 3.8 and 3.9

**Figure 21: Total national electricity production from hydropower as a percentage of total electricity production from renewable energy sources currently and in 2020, in %**

Figure 22 shows the total electricity production from hydropower (excluding electricity generated from pumped storage) expected for 2020. An increase in electricity production from hydropower can be seen for AT, BA, DE, HU, RS, SK and SI; while a slight decrease of electricity production from hydropower is expected for CZ and UA. The situation for RO can be explained as follows: The year 2010 was an exceptional year for hydro-energy production in RO, being the second highest year in the hydro-energy production history of RO. The value reported for the year 2020 is based on an average hydrological year in RO.




***Notes:***

*- AT, BG, CZ, DE, HU, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*

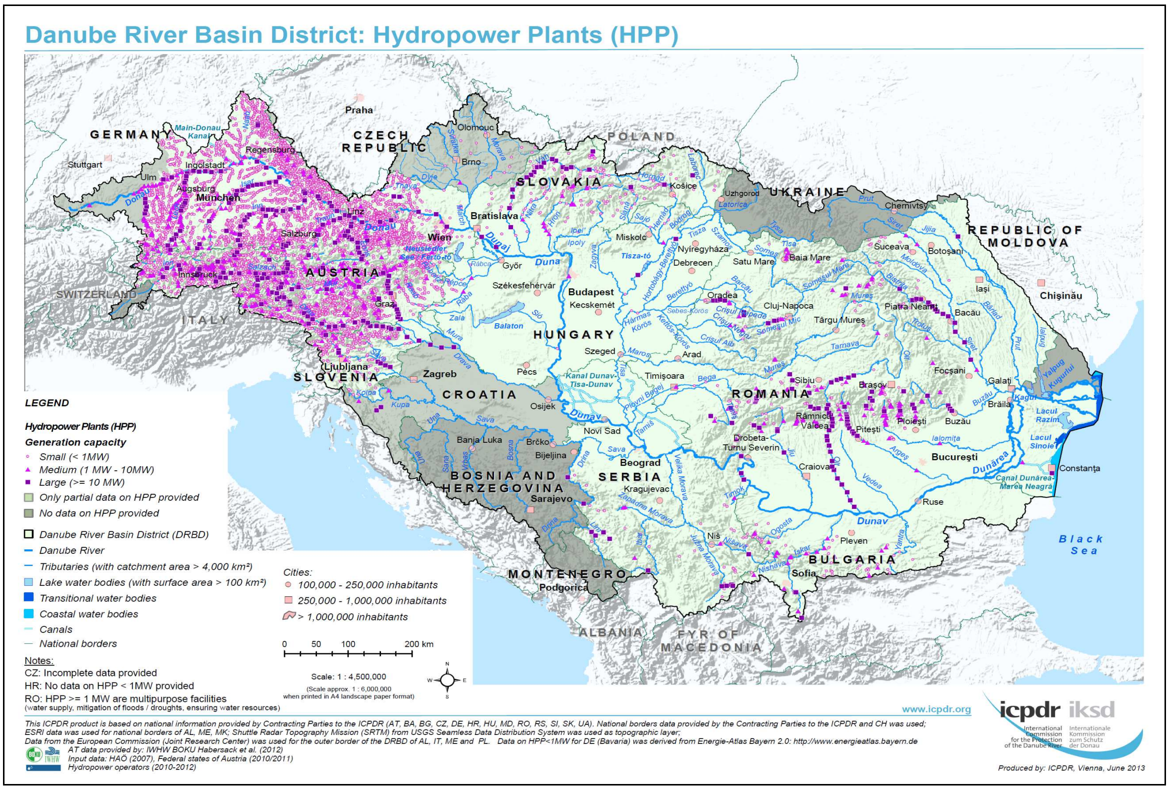
*- BA reported data for the current amount of electricity production for the national part of the Danube River Basin, while the figures for the expected amount of electricity production in the year 2020 refer to the whole country.*

*- HR and UA reported data for the national part of the Danube River Basin only.*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Questions 3.3 and 3.9

**Figure 22: Electricity production from hydropower currently and in 2020, in GWh/year**




**Map 2: Existing hydropower plants in the Danube basin**

Table 4 indicates how Danube countries intend to achieve the objectives set for the contribution of hydropower to the 2020 renewable energy targets via construction of new hydropower plants, and/or refurbishment, modernization and maintenance of existing plants. The table is based on qualitative statements of Danube countries on the level of importance of the contribution of each option to the targets.

BG did not provide any information on the main source of contribution to the 2020 renewable energy targets by construction, refurbishment, and/or modernization of hydropower plants. MD informed that the main contribution is the maintenance of the hydropower plant, together with Romanian authorities with the produced energy to be shared equally between the countries. UA reported that new mini hydropower plants are planned to be constructed, the reconstruction of existing hydropower plants from the state budget is an obligation of the Ukrainian government. HU provided information that only the construction of new minor hydropower plants or the installation of turbines in existing dams will be possible.

| | Main source of contribution | Minor source of contribution | Negligible source of contribution |
|---|---|---|---|
| Construction of new hydropower plants | AT, BA, HR, RO, RS, SK, SI* (*HPP> 10MW), UA | CZ, DE, SI** (**HPP<10MW) | |
| Refurbishment of plants[56] | CZ, DE, HU | AT, BA, HR, RO, RS, SI | SI, UA |
| Modernisation and maintenance of plants[57] | CZ, DE, HU, RO | AT, BA, HR, RS, SI | BA, SI, BA |

Source: Replies to the Danube Questionnaire Question Q3.11

**Table 4: Main source of contribution by hydropower to the 2020 renewable energy targets: construction, refurbishment and modernization of hydropower plants**

When estimating the ratio between the contribution of new large hydropower plants to the contribution of new hydropower plants smaller than 10 MW to the 2020 objectives set for the overall hydropower production, it can be seen from table 5 that the contribution by large hydropower is considerably higher in AT, BA, DE, RO and SI, while CZ, HU and SK will contribute to the 2020 objectives by 100% through new small hydropower plants.

The information is based on quantitative or qualitative statements of Danube countries. BG, HR and MD did not provide information on the main source of contribution to the 2020 renewable energy targets by new large/small hydropower plants.

[56] "Refurbishment" refers to measures which increase installed capacity in existing hydropower plants (Source: Danube Questionnaire).

[57] "Modernisation" refers to measures which increase electricity production and in the same time contribute to ecological improvement, e.g. new turbines according to best available techniques/good environmental practice (Source: Danube Questionnaire).

| | AT | BA | CZ | DE | HU | RO | RS | SK | SI | UA |
|---|---|---|---|---|---|---|---|---|---|---|
| % large hydropower | 66 | 89 | 0 | 80 | 0 | 93 | Ratio will be defined by the new Energy Sector Development Strategy of the Republic of Serbia by 2025 with the projections by 2030. | 0 | 100 | 0 |
| % small hydropower | 33 | 11 | 100 | 20 | 100 | 7 | | 100 | 0 | 100 (only small hydropower stations are planned to be built in the Tisza and Prut basin) |

Source: Replies to the Danube Questionnaire, Question QA.2

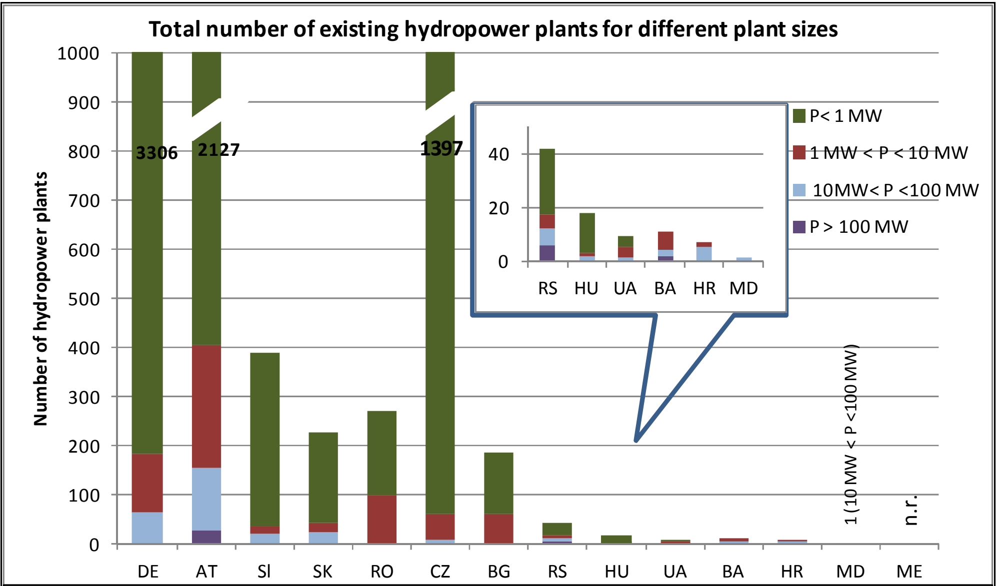
**Table 5: Main source of contribution to the 2020 renewable energy targets by new large/small hydropower plants**

### 3.2.5 Number and capacity of different hydropower plant sizes in the Danube basin

Figure 23 and 24 present the number of hydropower plants by plant size category (respectively, in absolute numbers and percentage).

The highest number of hydropower plants in all surveyed Danube countries can be found in the category of hydropower plants smaller than 1 MW (see figure 23). Figure 24 shows that in 7 Danube countries (AT, BG, DE, HU, RS, SI, SK), plants smaller than 1 MW make up for more than 50% of total hydropower plants. In 5 Danube countries (AT, DE, HU, SI, SK), these small hydropower plants even make up for more than 80%.

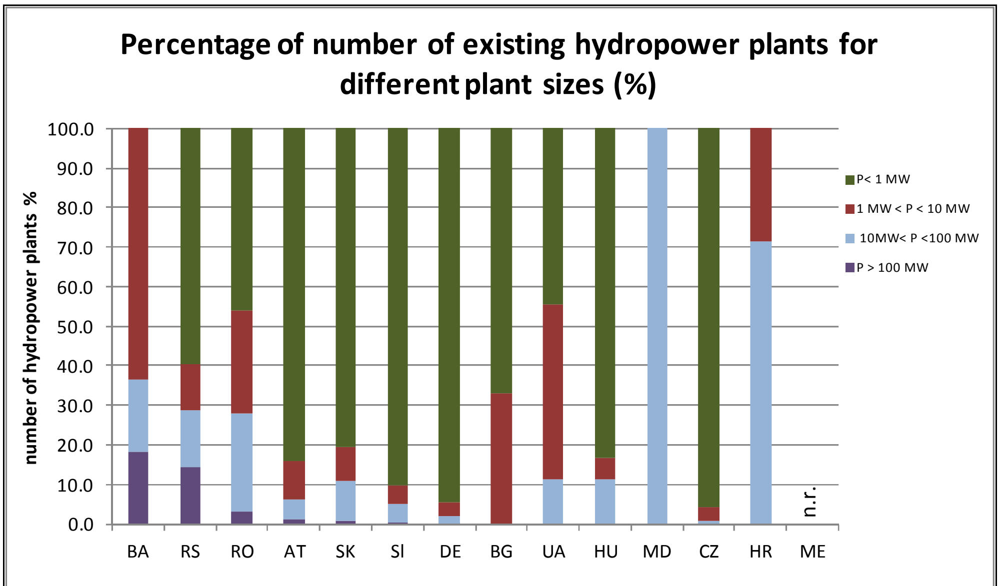
The absolute number of hydropower plants with more than 100 MW varies from 28 in AT, 12 in RO, 6 in RS, 2 in BA, 2 in SK and SI and 1 in the German part of the Danube River Basin. Hydropower plants with more than 100 MW are currently not present in BG, HU, and MD, as well as in the Croatian and Ukrainian part of the Danube River Basin.




***Notes:***
*- AT, BG, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*
*- BA, DE, HR and UA reported data for the national part of the Danube River Basin only.*
*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question 3.5

## Figure 23: Total number of existing hydropower plants for different plant sizes




***Notes:***
*- AT, BG, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*
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*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

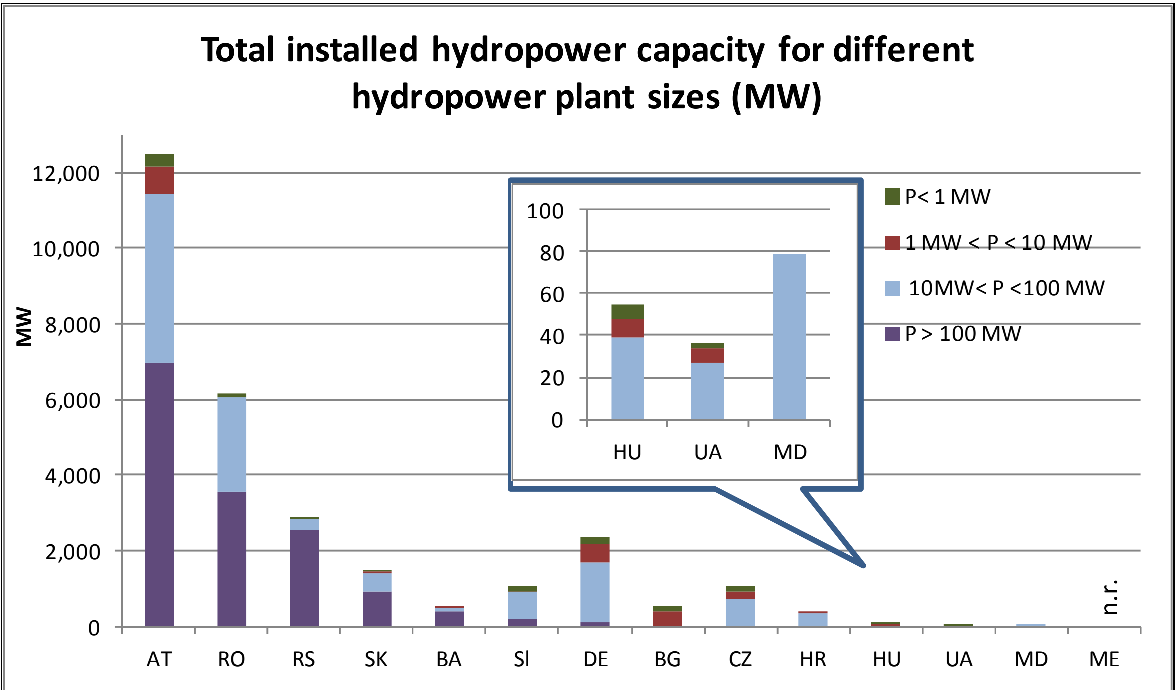
Source: Replies to the Danube Questionnaire, Question 3.5

## Figure 24: Percentage of number of existing hydropower plants for different plant sizes, in %

Figures 25 to 28 present the installed capacity of hydropower by plant size category (respectively in absolute numbers (MW, GWh/year) and percentage).

Hydropower plants with more than 100 MW take up for 50 to over 80% of total installed capacity in AT, BA, RS, SK and RO. Plants smaller than 1 MW installed capacity (in MW) only account for a small share of installed hydropower capacity (below 10% for AT, BA, DE, HR, MD, RO, RS, SK and UA).

In most surveyed Danube countries, a relatively small number of hydropower plants > 1 MW, respectively > 10 MW account for the largest share of installed capacity.

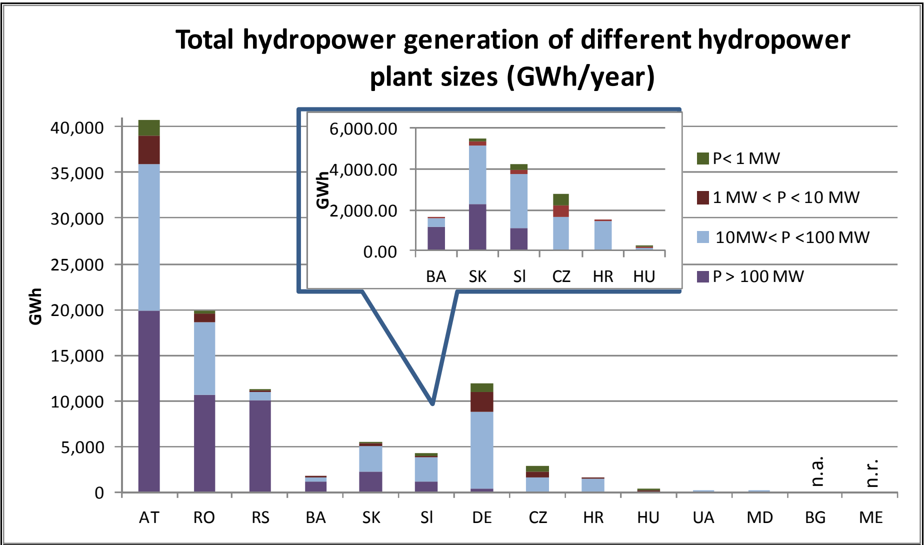



***Notes:***

*- AT, BG, HU, MD, RS, SI, SK and UA reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*
*- BA, HR and DE reported data for the national part of the Danube River Basin only.*
*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question 3.5

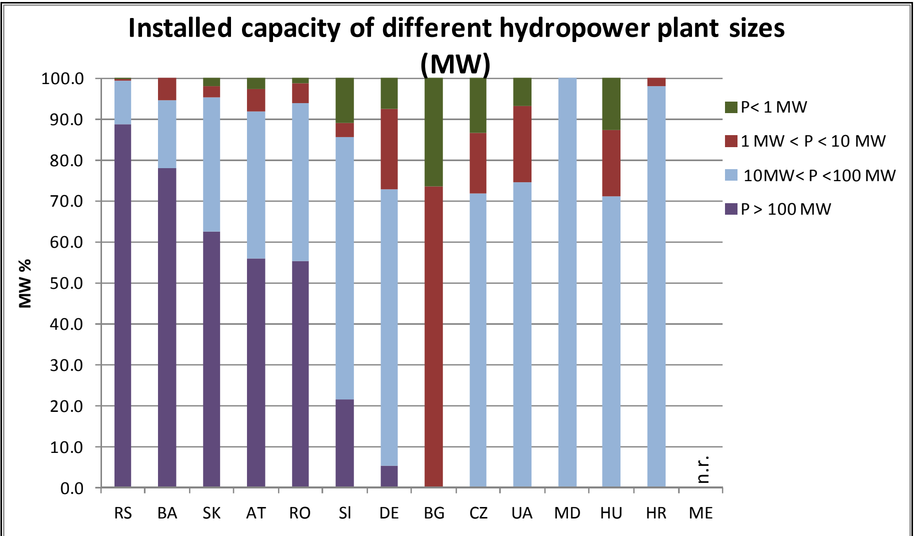
**Figure 25: Total installed hydropower capacity for different hydropower plant sizes, in MW**




*Notes:*
*- AT, HU, MD, RS, SI, SK and UA reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*
*- BA, HR and DE reported data for the national part of the Danube River Basin only. For the category P < 1 MW, DE reported the data for the Bavarian part of the Danube River Basin only.*
*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question 3.5

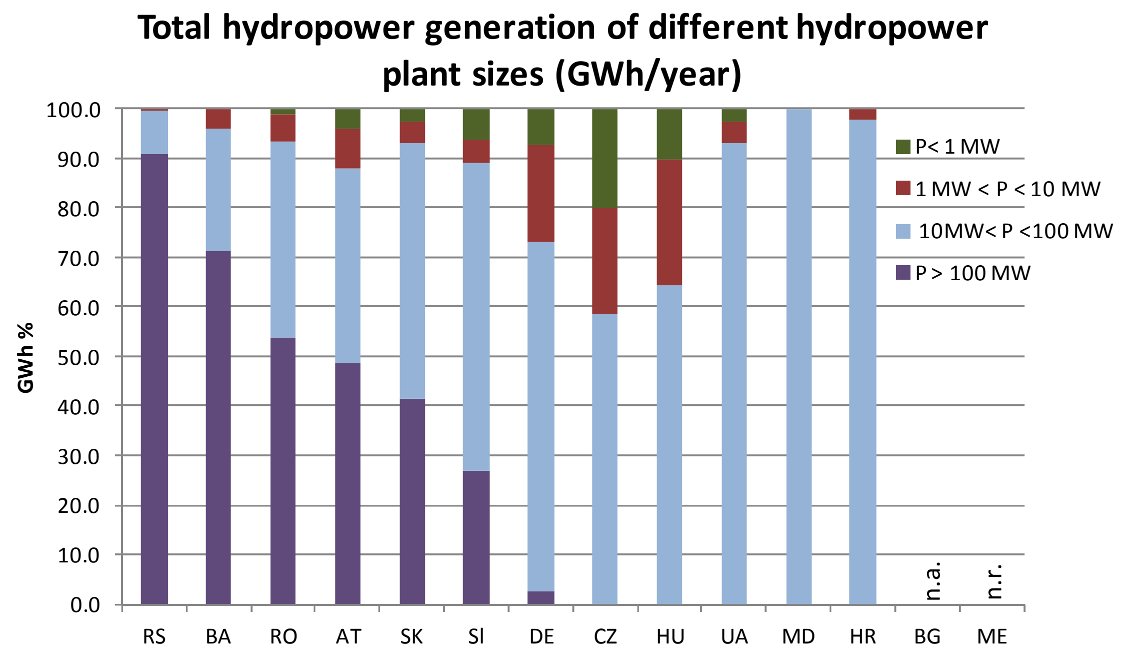
**Figure 26: Total hydropower generation of different hydropower plant sizes, in GWh/year**




*Notes:*
*- AT, BG, HU, MD, RS, SI, SK and UA reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*
*- BA, HR and DE reported data for the national part of the Danube River Basin only.*
*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question 3.5

**Figure 27: Percentage of total installed hydropower capacity for different hydropower plant sizes (MW)**




***Notes:***
*- AT, HU, MD, RS, SI, SK and UA reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*
*- BA, HR and DE reported data for the national part of the Danube River Basin only. For the category P < 1 MW, DE reported the data for the Bavarian part of the Danube River Basin only.*
*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

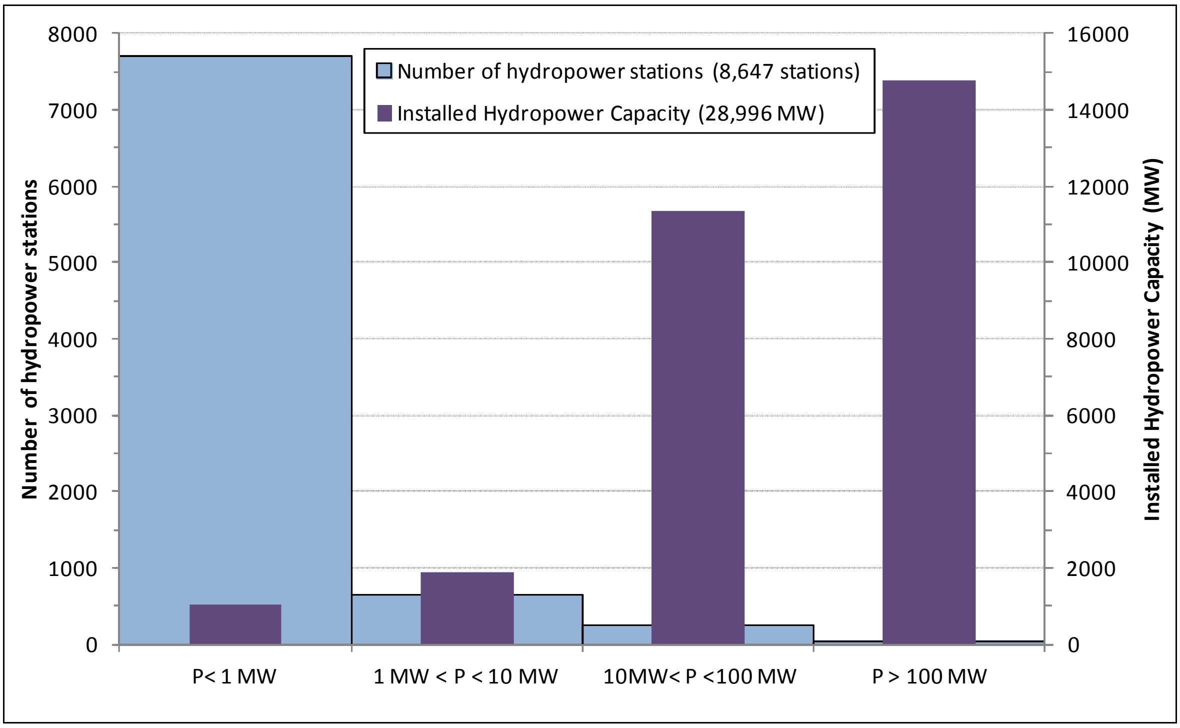
Source: Replies to the Danube Questionnaire, Question 3.5

**Figure 28: Percentage of total hydropower generation of different hydropower plant sizes (GWh/year)**

Figure 29 and 30 as well as table 6 provide comprehensive information on the number of hydropower facilities and the contribution to the total electricity generated by hydropower for different size categories of hydropower stations.

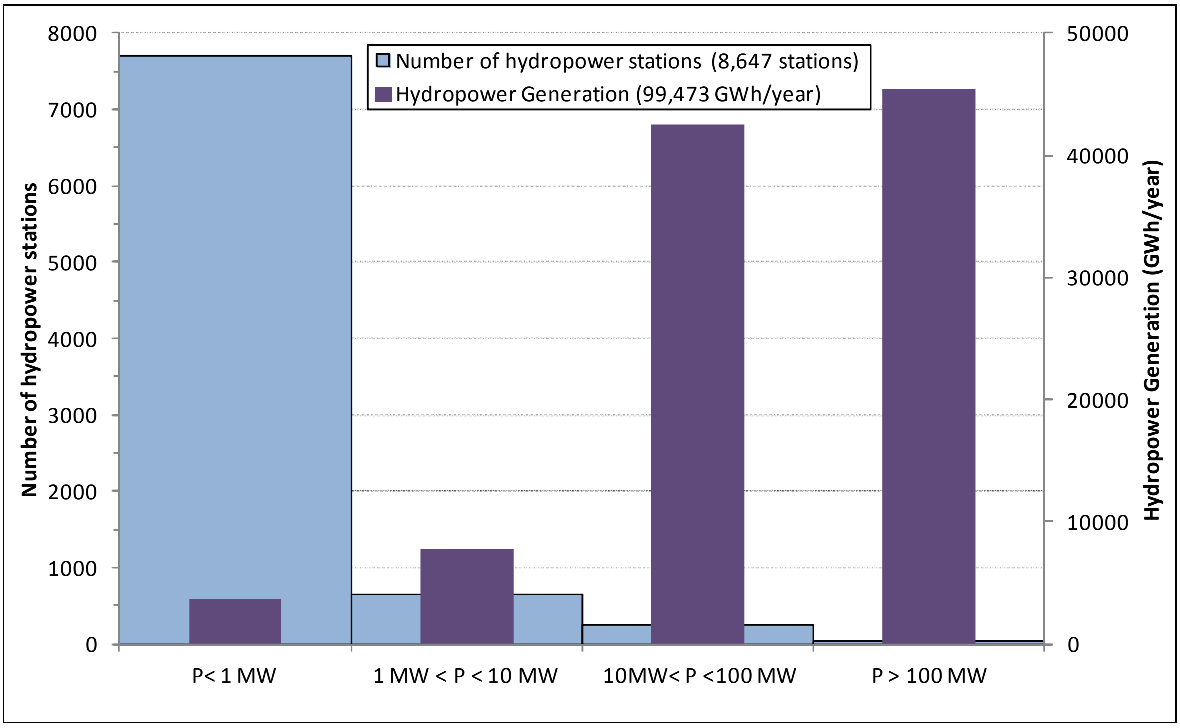
By far the most significant share (88.4%) of electricity is generated by large facilities (representing 3.4% of the total number of hydropower stations) with bottleneck capacities of more than 10 MW.

Looking at the installed capacity of different hydropower plant sizes, it can be seen that 3.4% of the total number of stations with more than 10 MW provide an installed capacity (in MW) of 90.0% in Danube countries.




Source: Replies to the Danube Questionnaire, Question 3.5

**Figure 29: Relation between number of stations and installed hydropower capacity, in MW**




Source: Replies to the Danube Questionnaire, Question 3.5

**Figure 30: Relation between number of hydropower stations and hydropower generation, in GWh/year**

| | P< 1 MW | 1 MW < P < 10 MW | 10MW < P < 100 MW | P > 100 MW |
|---|---|---|---|---|
| Number of Hydropower Stations [%] | 89.15 | 7.41 | 2.96 | 0.47 |
| Installed Hydropower Capacity, in MW [%] | 3.56 | 6.45 | 39.07 | 50.92 |
| Hydropower Generation, in GWh/year [%] | 3.76 | 7.83 | 42.69 | 45.73 |

Source: Replies to the Questionnaire, Question 3.5

**Table 6: Relation between number of hydropower stations and installed hydropower capacity in MW and hydropower generation in GWh/year Potential benefits and impacts of hydropower**

Development activities are motivated by the potential benefits for human well-being. However, modification of natural conditions can also have negative impacts which have to be taken into account when deciding on the way projects are implemented or whether to carry out such projects at all. This is clearly the case in respect of hydropower generation. In the following paragraphs a qualitative description of the benefits and impacts is provided.[58]

### 3.2.6 Benefits of hydropower generation

Most of the benefits of hydropower generation are self-evident since the consumption of electricity in one form or another is central to our daily life. Since hydropower has the benefit to be an almost emission-free form of electricity generation, the requirement to reduce greenhouse gas emissions acts as an additional driver for its further development. Below, the main benefits for both, small and large hydropower generation, are grouped according to three categories, economic benefits, social benefits and environmental benefits.

#### 3.2.6.1 Economic benefits

An assured supply of energy is a key prerequisite for a modern economy and civilization. However, considerable shares of energy demand are at present met by imports of oil, natural gas, coal or uranium from regions of the world with sometimes rather fragile political stability. Hydropower – being a domestic and renewable source of energy – can contribute to reduce energy dependency from external sources. Furthermore, investments in this sector are characterised by a long lifespan, relatively low operational and maintenance costs, attractive long term payback ratios, and a low need for support schemes (compared with other renewable energy sources) thus contributing further to security of energy supply.

Hydropower can cover parts of the base load but 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 all the more important as an increasing share of supply comes from other, less reliable but highly

[58] Source: Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower, section 2.3.

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 has here 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. Last but not least hydropower plants, and in particular small hydropower plants are highly decentralized and close to the consumer, thus contributing further to security of supply; furthermore, losses due to the transmission grid are low due to the short distances involved. These ‘local’ benefits stand in contrast to, for example, nuclear power plants. 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 and safe (green) jobs and to the growth of domestic economies as well as bringing a positive netfiscal contribution to national budgets.

#### 3.2.6.2 Social benefits

Hydropower plays a major role at the local and regional level because of its importance for the socio-economic development. Whenever hydropower facilities are built, this is done in combination with new infrastructure. For large hydropower plants the main benefits come from the multi-functionality of reservoirs used for hydropower generation (e.g. in periods of low flows (or drought), water stored in reservoirs can contribute to enhance flows for downstream regions, in periods of flood, reservoirs may contribute to water retention and mitigation of floods). Reservoirs may be further used for tourism and recreational purposes, as well as for drinking water, irrigation or other needs. If charges are levied for the use of water by regional administrations, considerable contributions to local or regional budgets may result. Hydropower plants also become part of the historical cultural landscape (like old mills or historical monuments of industry) and therefore a specific feature for the community.

#### 3.2.6.3 Environmental benefits

The key environmental benefit of hydropower generation is the positive contribution to climate change mitigation through the avoidance of burning fossil fuels. Hydropower allows the generation of electricity from a renewable source virtually without emitting carbon dioxide. This acts as driver for further exploitation of the remaining limited potential of hydropower, in particular as so far this presently seems to be the least expensive form of renewable energy. A further benefit of hydropower as a form of energy generation is that there are hardly any emissions of pollutants, neither to the atmosphere nor to the water bodies. Reservoirs of hydropower plants can become precious and valuable secondary habitats, which are of international importance (e.g. bird protection areas in the reservoirs of the Lower Inn).However, despite the fact that hydropower can be considered a clean form of energy generation with regard to emissions of pollutants, it is clear that there also exist negative impacts which will be highlighted in the following section.

### 3.2.7 Impacts of hydropower generation

Despite its clear benefits, hydropower generation can also have substantial negative impacts on the aquatic ecology, natural scenery and ecosystems which are not always perceived by the wider public. This is the case for large dams, reservoirs and related hydropower facilities and also for small and very small hydropower stations.

The main environmental concerns in connection with hydropower generation can be summarized as follows:

- Interruption of river continuity

Dams and weirs used for hydropower generation cause an interruption of the longitudinal river continuity, which can have significant adverse effects on the river's biocoenosis. Migrating species like fish are heavily affected by the fragmentation of their habitat.

- Changes in river morphology, loss of habitats

Hydropower plants can cause changes to a river's morphology. The morphological degradation affects not only the composition of natural structural elements and the loss of dynamic processes in the riverbed but can also cause fundamental changes to the river type.

- No residual water or lack of sufficient residual water

The problem of no or non-sufficient residual water in the affected reaches is an important issue causing a number of negative effects 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.

- Hydro-peaking

Hydro-peaking is mainly caused by large hydropower plants in combination with reservoirs. The demand for electricity varies strongly during the day as well as over the year. Reservoirs with their huge storage volume and their high head provide the perfect means to adjust production to variations in demand. 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.

- Impoundment – Impounded river stretches

Impounded river stretches, which can occur over a longer distance especially at large hydropower stations, show a significant reduction of flow velocity which can cause an increase of water temperature and decrease of oxygen content, 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 underneath the impounded section. A series of impoundments (chain of hydropower plants) have strong cumulative effects on the aquatic ecosystem.

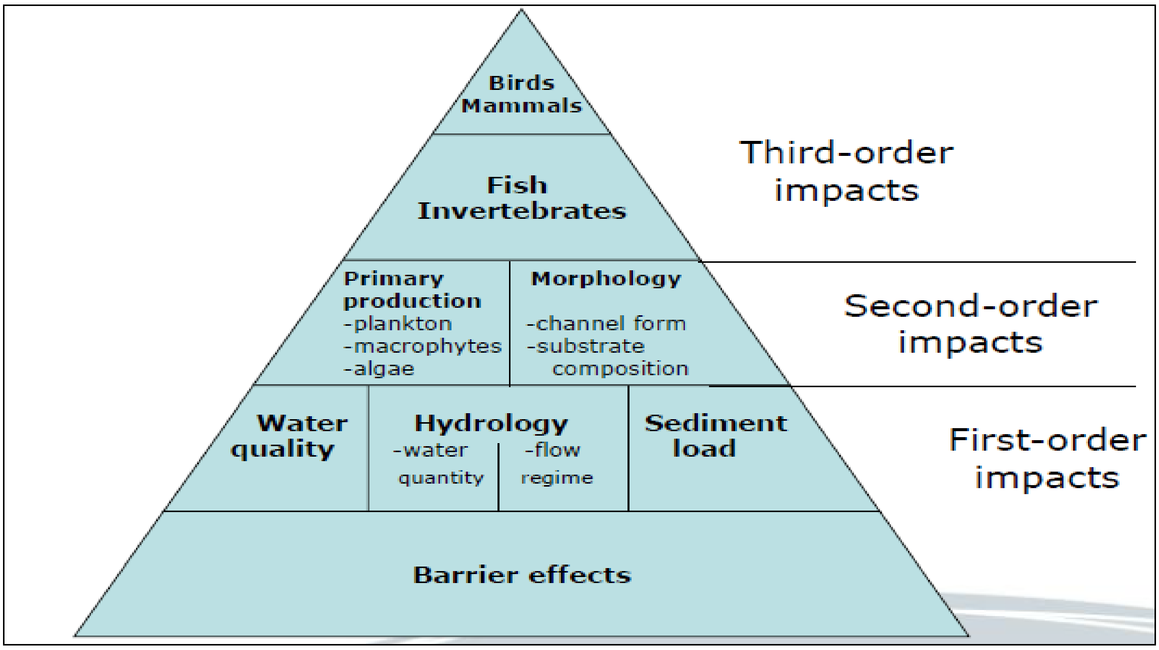
- Flushing of reservoirs and impounded river stretches

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

Nowadays the environmental consequences of impoundments are not considered in isolation but in view of the whole river ecosystem. To this end, impacts can be considered within a hierarchical framework of interconnected effects (Petts, 1994, Figure 31). Within this framework, first, second and third order impacts are identified (McCartney et al., 2000).

In general terms the complexity of interacting processes increases from first to third order impacts[59]:

- First order impacts: These are the immediate abiotic effects that occur simultaneously with dam closure and influence the transfer of energy, and material, into and within the downstream river and connected ecosystems (e.g. changes in flow, water quality and sediment load).
- Second order impacts: These are the changes of channel and downstream ecosystem structure and primary production, which result from the modification of first order impacts by local conditions and depend upon the characteristics of the river prior to dam closure (e.g. changes in channel and floodplain morphology, changes in plankton, macrophytes and periphyton). These changes may take place over many years.
- Third order impacts: These are the long-term, biotic, changes resulting from the integrated effect of all the first and second order changes, including the impact on species close to the top of the food chain (e.g. changes in invertebrate communities and fish, birds and mammals). Complex interactions may take place over many years before a new "ecological equilibrium" is achieved.




Source: European Commission, DG Environment, Hydropower Generation in the context of the EU WFD

**Figure 31: A framework for assessing the impact of dams on river ecosystems, modified from Petts, 1994**

[59] Source: European Commission, DG Environment, Hydropower Generation in the context of the EU WFD, Contract N° 070307/2010/574390, Project number 11418 (2011), section 3.2.2ff.

## 3.3 Greenhouse gas emissions

### 3.3.1 Greenhouse gas emissions in Europe

Carbon dioxide is the most important anthropogenic greenhouse gas (GHG). The primary source of the increased atmospheric concentration of carbon dioxide since the preindustrial period results from fossil fuel use.

Carbon dioxide emissions from fossil fuel use also occur in the course of the generation of electricity, mainly due to combustion processes in thermal electric power plants and gas power plants, whereas the generation of electricity from hydropower can be considered as a form of electricity generation that is nearly free from GHG emissions, particularly in Alpine reservoirs.[60]

Combating climate change is a top priority for the EU. The European Union has long been a driving force in international negotiations that led to agreement on the two United Nations climate treaties, the UN Framework Convention on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 1997. The Kyoto Protocol requires the 15 countries that were EU-MS at the time (EU-15) to reduce their collective emissions in the 2008-2012 period to 8% below 1990 levels. In 2007 EU leaders endorsed an integrated approach to climate and energy policy and committed to transforming Europe into a highly energy-efficient, low carbon economy. They made a unilateral commitment that Europe would cut its emissions by at least 20% of 1990 levels by 2020. This commitment is being implemented through a package of binding legislation. [61]

Europe is working hard to cut its greenhouse gas emissions substantially while encouraging other nations and regions to do likewise. Initiatives it has taken to cut its climate emissions include:

- Continually improving the energy efficiency of a wide array of equipment and household appliances;
- Mandating increased use of renewable energy sources, such as wind, solar, hydro and biomass, and of renewable transport fuels, such as biofuels;
- Supporting the development of carbon capture and storage (CCS) technologies to trap and store CO2 emitted by power stations and other large installations;
- Launching the European Climate Change Programme (ECCP) in 2000, which has led to the adoption of a wide range of new policies and measures, including the Emissions Trading System, the EU's key tool for reducing greenhouse gas emissions from industry cost-effectively.
- Developing a comprehensive EU adaptation strategy that strengthens Europe's resilience to climate change.

In 2008, the EU-27 emitted 4 940 Mt CO2-equivalent, excluding net CO2 removals from LULUCF and emissions from international bunkers (international aviation and international maritime transport), 627 Mt CO2-equivalent less compared to 1990 (-11 %). Total GHG emissions in 2008 present the lowest emission level achieved in the EU-27 between 1990 and 2008.

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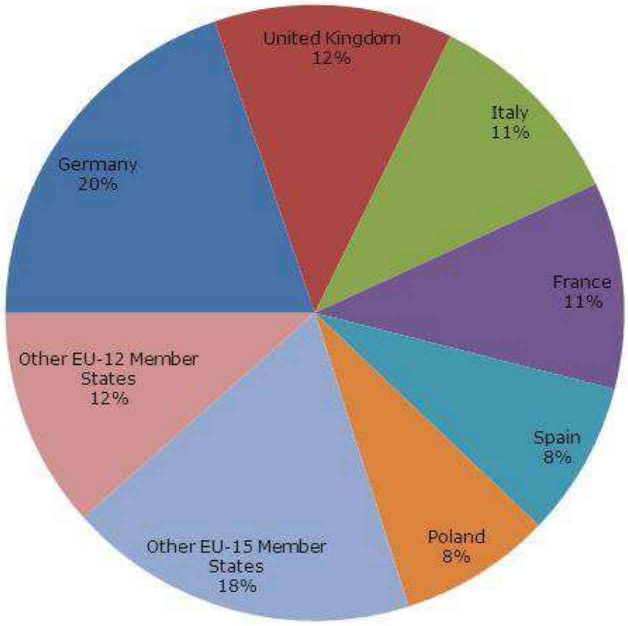
[60] Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower, section 3.2.1. Reference is made to IPCC, 2007. Contribution of Working Group I to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom.

[61] Source: http://ec.europa.eu/clima/policies/brief/eu/index_en.htm.

Eighty per cent of total EU-27 GHG emissions are generated in the EU-15 also representing the EU-15 share on the whole EU-27 population. The five largest GHG emitters in the EU-27 were, in decreasing order of emissions: DE, UK, IT, FR and ES. Together they accounted for more than 60 % of EU-27 GHG emissions. Poland was the largest GHG emitter in the EU-12 (Figure 32).[62]




Source: EEA, 2011, Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008

**Figure 32: Greenhouse gas emissions in the EU-27 by main emitting countries, 2008**

A selection of the drivers that had the largest effects on sectoral emission trends shows the large dominance of energy-related drivers on GHG emissions. Rising energy demand – particularly electricity – from industrial users and households, due to economic growth and overall wealthier population had by far the largest negative impacts on GHG emissions, necessitating energy industries to raise their output through increased thermal power production, with direct consequences on GHG emissions. Energy-related emissions account for about 79 % of total GHG emissions in the EU-27 (80 % in the EU-15).

As a consequence of the role played by fossil fuel combustion, CO2 is the predominant GHG emitted, accounting for 82 % of total GHG emissions (excluding LULUCF and international bunkers). About 93 % of this CO2 originates from the combustion of fossil fuels, and the remaining 7 % from specific industrial processes (e.g. production of cement, chemicals, iron and steel) as it can be seen from Figure 33.[63]

[62] Source: EEA (2011): Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008 . Available online: http://www.eea.europa.eu/publications/ghg-retrospective-trend-analysis-1990-2008, section 3.1.

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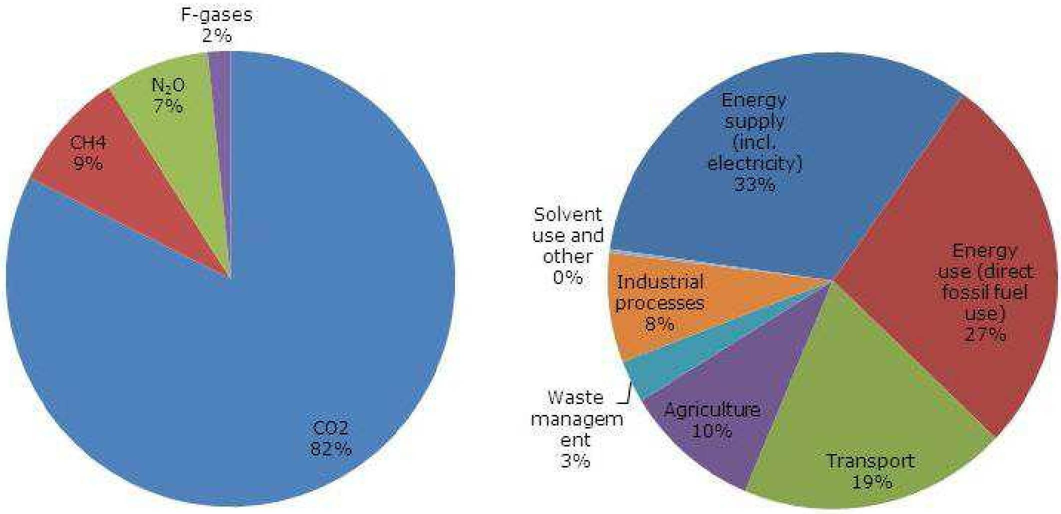
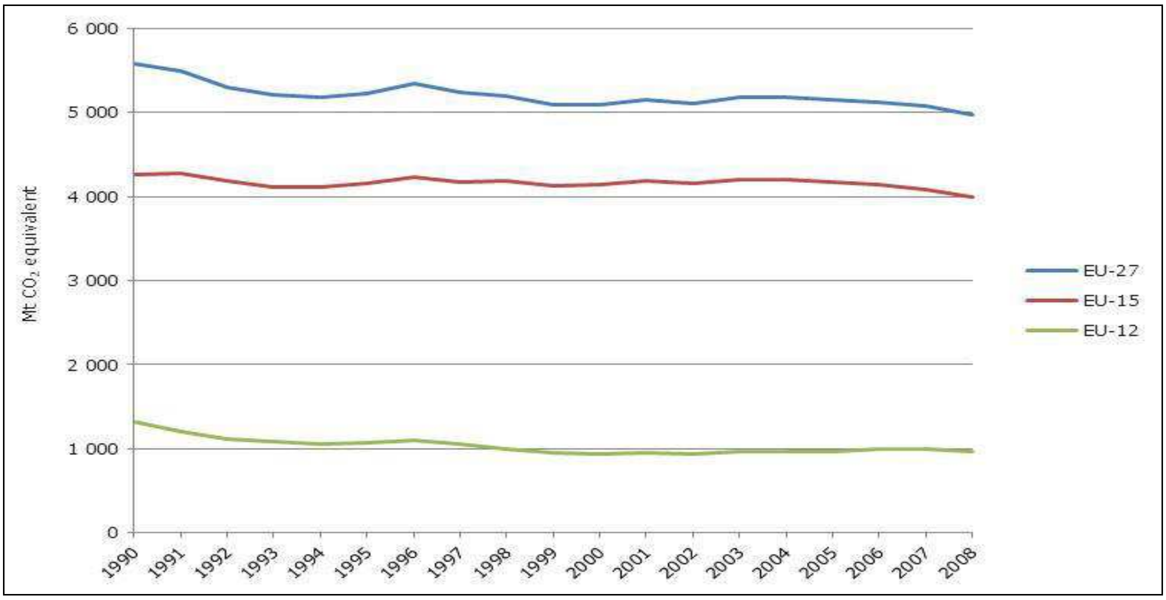
[63] Source: EEA (2011): Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008 . Available online: http://www.eea.europa.eu/publications/ghg-retrospective-trend-analysis-1990-2008, section 3.1.




Source:EEA, 2011, Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008

**Figure 33: GHG emissions in the EU-27 by gas and by sector, 2008**

Between 1990 and 2008, total EU-27 GHG emissions (without LULUCF) decreased by 11.1 %. This overall change is the result of GHG emission reductions of 6.3 % in the EU-15 and emission reductions of 26.7 % in the EU-12. A large part of these reductions took place during the 1990s (Figure 34).[64]



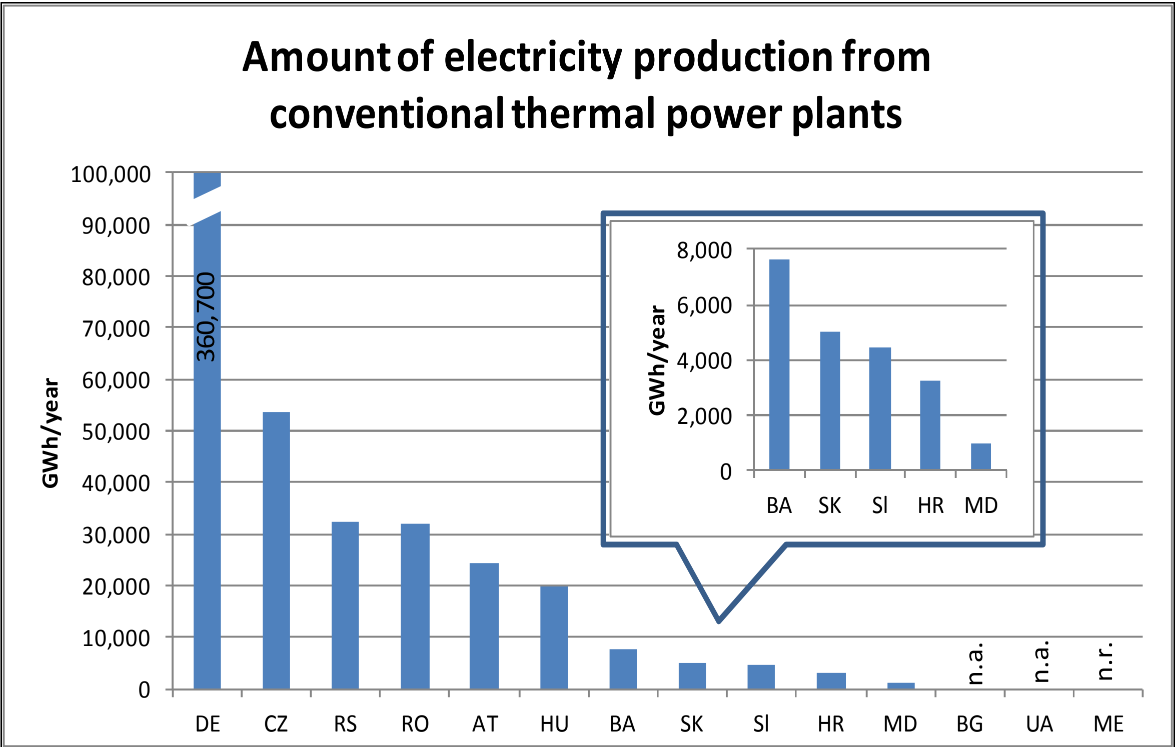

Source: EEA, 2011, Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008

**Figure 34: Greenhouse gas emission trends in the EU-27, the EU-15 and the EU-12, 1990–2008**

[64] Source: EEA (2011): Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008 . Available online: http://www.eea.europa.eu/publications/ghg-retrospective-trend-analysis-1990-2008, section 3.2.

### 3.3.2 Greenhouse gas emissions in the Danube basin

A large part of human CO2 emissions comes from fossil fueled thermal power plants. In DE, a considerable part of electricity is generated by thermal power plants. Based on the provided data it can be seen that between 30,000 and 56,000 GWh/year electricity from thermal power plants is generated in CZ, RS and RO, while the share of electricity generated by thermal power plants in SK, SI, HR and MD is very low. For BG and UA no data for the electricity production from conventional thermal power plants were available.




***Notes:***
*- AT, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA and HR reported data for the national part of the Danube River Basin only.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question A.1

**Figure 35: Electricity production from conventional thermal power plants in the Danube countries**

### 3.3.3 Reduction of greenhouse gas emissions through Hydropower in the Danube basin

The use of hydropower as renewable energy is a way to limit the emission of greenhouse gases that are harming the climate. In the Danube Declaration adopted at the Ministerial Meeting on 16 February 2010, Danube countries highlighted that "hydropower plants offer an additional reduction potential for greenhouse gases but recognizing as well their negative impacts on the riverine ecology"[65]. Recognizing that hydropower schemes can help meet renewable energy and greenhouse gas reduction targets, the main challenge is

[65] ICPDR document IC 089 (2004): The Danube Basin – Rivers in the Heart of Europe (Danube Declaration). Available online: http://www.icpdr.org/icpdr-files/15216.

to increase hydro-electric production in a manner which is compatible with environmental protection requirements.

However, what has to be taken into account is that replacing electricity produced with hydropower can only achieve a meaningful reduction in greenhouse gas emissions provided total electricity consumption remains at least stable. Hence, with regard to the reduction of greenhouse gas emissions, it is in any case essential to achieve a stabilization or in fact a reduction of the total energy consumption.[66]

[66] Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower, section 3.2.1.

# 4 Hydropower and environmental objectives of the Water Framework Directive

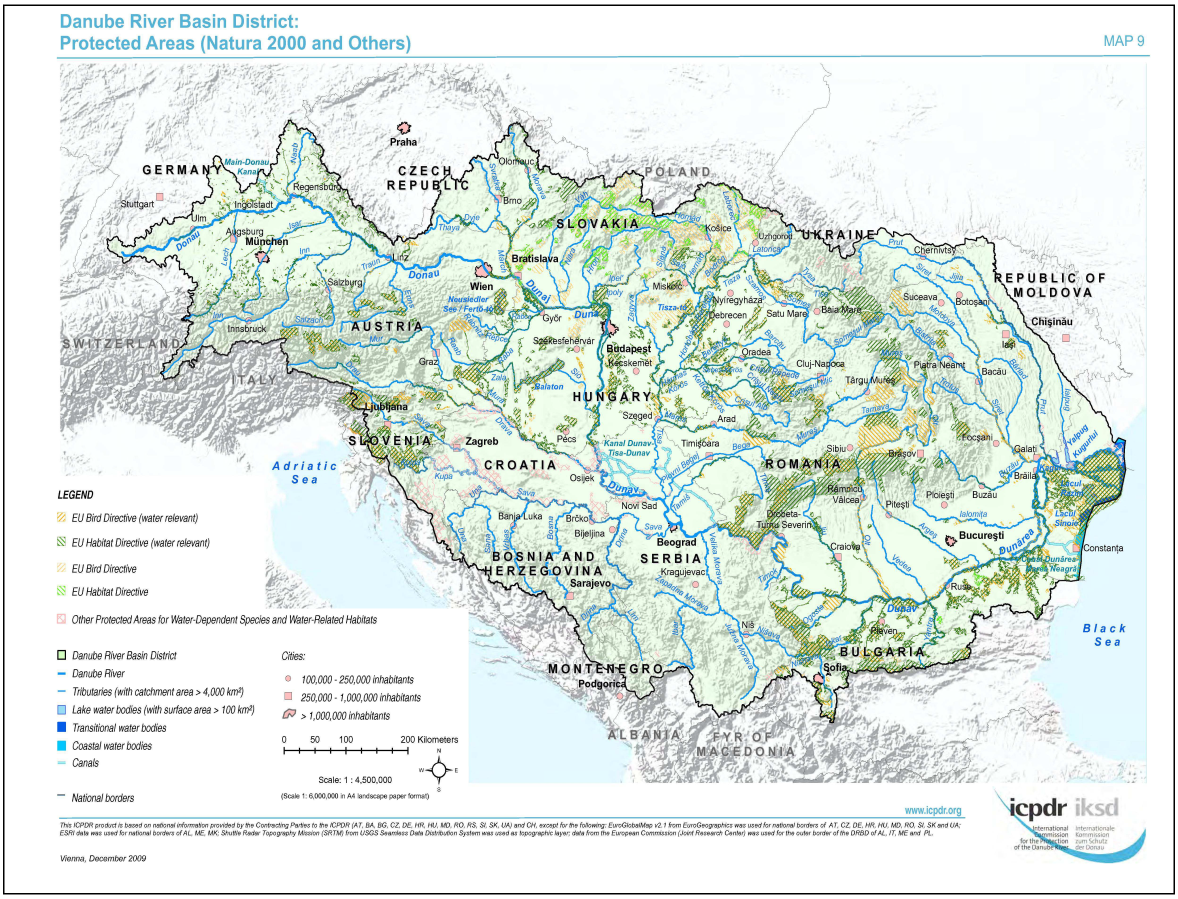
Section 4 addresses the linkage of hydropower generation and environmental protection of waters in the Danube basin. The environmental objectives of the WFD are summarised in section 4.1. Section 4.2 provides key figures on hydromorphological pressures resulting from the assessment carried out in the frame of the DRBMP. The issue of hydropower and Heavily Modified Water Bodies is addressed in section 4.3.

The Danube River Basin hosts a variety of fascinating, diverse and dynamic ecological territories with many unique plants and animals. The habitats created by the Danube and its tributaries include fast flowing mountain streams, wide and slowly flowing lowland rivers, large sand and gravel banks, wetlands and floodplains, wet meadows, oxbows, small and large lakes and the dynamic Danube Delta.[67]

Anthropogenic pressures resulting from various hydro-engineering measures can significantly alter the natural structure of surface waters. This structure is essential to provide adequate habitats and conditions for self-sustaining aquatic populations.

Map 3 illustrates the protected areas >500 ha designated for the protection of habitats or species where maintenance or improvement of the water status is an important factor in their protection (including Natura 2000 sites). Furthermore, the map visualises protected areas in the Non EU-MS and indicates the respective types.

[67] Source: http://www.icpdr.org/icpdr-pages/ecosystems.htm.




Source: DRBMP, 2009, Map 9

**Map 3: Danube River Basin District: Protected areas (Natura 2000 and others)**

The alteration of natural hydromorphological structures can have negative effects on aquatic populations and therefore result in the deterioration of the water status of surface waters. Hydropower generation, navigation and flood protection are the key water uses that cause hydromorphological alterations. These drivers can influence pressures on the natural hydromorphological structures of surface waters in an individual or cumulative way.[68] Three key hydromorphological pressure components of basin-wide importance have been identified in the DRBMP as follows: Interruption of river and habitat continuity, Disconnection of adjacent wetlands/floodplains and Hydrological alterations.

## 4.1 Environmental objectives of the Water Framework Directive

The environmental objectives of the Water Framework Directive for surface waters, groundwater, heavily modified water bodies (HMWBs) and artificial water bodies (AWBs) are set in Article 4 and Annex V.[69] The overall environmental objective is to achieve "good

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[68] Source: ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview., section 2.1.4.

[69] The WFD defines "Surface water" as inland waters, except groundwater as well as transitional waters and coastal waters and "Groundwater" as "all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil". HMWBs are bodies of water which as a result of physical alterations by human activity are substantially changed in character and cannot, therefore, meet "good ecological status" (GES). In this context physical alterations mean changes to e.g. the size, slope, discharge, form and shape of river bed of a water body. AWBs are surface water bodies which have been created by human activity in a location where no water body existed before and which have not been created by the direct physical alteration, movement or realignment of an existing water body.

status" for all surface waters and groundwater as a rule by 2015; for those water bodies which have been heavily modified in their physical structure or newly created by human activity, the Water Framework Directive distinguishes between two types of altered water bodies: "Heavily Modified Water Body" (HMWB) and "Artificial Water Body" (AWB) for which the environmental objective of the "Good ecological potential" is required.

For surface waters, the environmental objective of the "good status" consists of the "good ecological status" as well as the "good chemical status". [70]

### 4.1.1 Good ecological and chemical status of surface waters

"Good ecological status" is defined in terms of the quality of the biological community (e.g. phytoplankton, macrophytes and phytobenthos, benthic invertebrate fauna and fish fauna), the hydromorphological characteristics (supporting the biological community e.g. hydrological regime, river continuity, morphological conditions, river width and depth variations, structure and substrate of the river bed and the riparian zones), and the chemical and physico-chemical characteristics (e.g. thermal conditions, oxygenation conditions, salinity, acidification status, nutrient conditions). The reference conditions are specified as allowing only a slight variance from the biological community that would be expected in conditions of minimal anthropogenic impact, thus accounting for ecological variability between different waters.

"Good chemical status" is defined in terms of compliance with all the quality standards established for chemical substances at European level. The Directive also provides a mechanism for renewing these standards and establishing new ones by means of a prioritisation mechanism for hazardous chemicals. This will ensure at least a minimum chemical quality, particularly in relation to very toxic substances, everywhere in the Community.

### 4.1.2 Good chemical and quantitative status of groundwater

For groundwater, "good status" consists of the "good chemical status" as well as the "good quantitative status". The "good chemical status" comprises a prohibition on direct discharges to groundwater, and (to cover indirect discharges) a requirement to monitor groundwater bodies so as to detect changes in chemical composition, and to reverse any antropogenically induced upward pollution trend. Taken together, these should ensure the protection of groundwater from all contamination, according to the principle of minimum anthropogenic impact.

### 4.1.3 Good ecological potential for Heavily Modified and Artificial Water Bodies

The environmental objective of the "Good ecological potential" for HMWB and AWB recognises that changes to morphology may make good ecological status very difficult to meet, but requires Member States to adopt measures to improve the quality of the water body as much as possible (e.g. by building fish passes, setting ecological flows, etc.). A water body shows a GEP when there are slight changes in the values of the relevant biological quality elements as compared to the values found at Maximum Ecological Potential (MEP). The MEP is considered as the reference conditions for HMWB, and is intended to describe the best approximation to a natural aquatic ecosystem that could be

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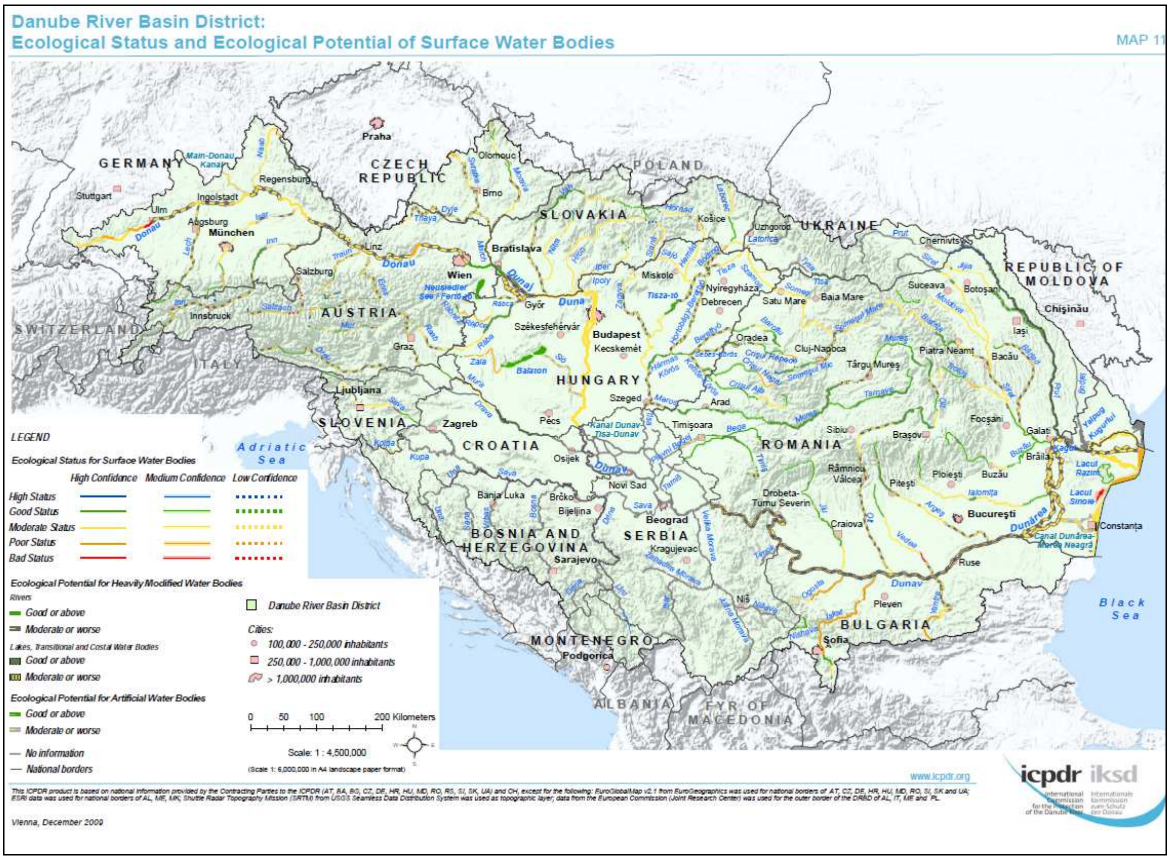
[70] The source for the following sub-chapters can be found in the following webpage: http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm.

achieved given the hydromorphological characteristics that cannot be changed without significant adverse effects on the specified use or the wider environment.[71]

Information on the ecological status and the ecological potential of surface water bodies in the Danube basin is provided in map 4.




Source: DRBMP, 2009, Map 11

**Map 4: Danube River Basin District: Ecological status and ecological potential of surface water bodies**

## 4.2 Key figures on hydromorphological pressures

Hydropower plays an important role as regards the three key hydromorphological pressure components of basin-wide importance. The key figures on hydromorphological pressures described in this section were identified in the assessment carried out in the frame of the DRBMP[72]. It has to be noted, that while the Danube Questionnaire mainly asked for data for all DRBD rivers and the Danube River and/or the whole country (depending on the data availability of Danube countries), the data assessment done by the ICPDR and presented in the DRBMP refers to DRBD rivers with catchment areas >4000 km² and the Danube River only. Thus, differences in some figures included in this section may differ from data reported through the Danube Questionnaires due to the different scaling used in the Danube Questionnaires and the DRBMP.

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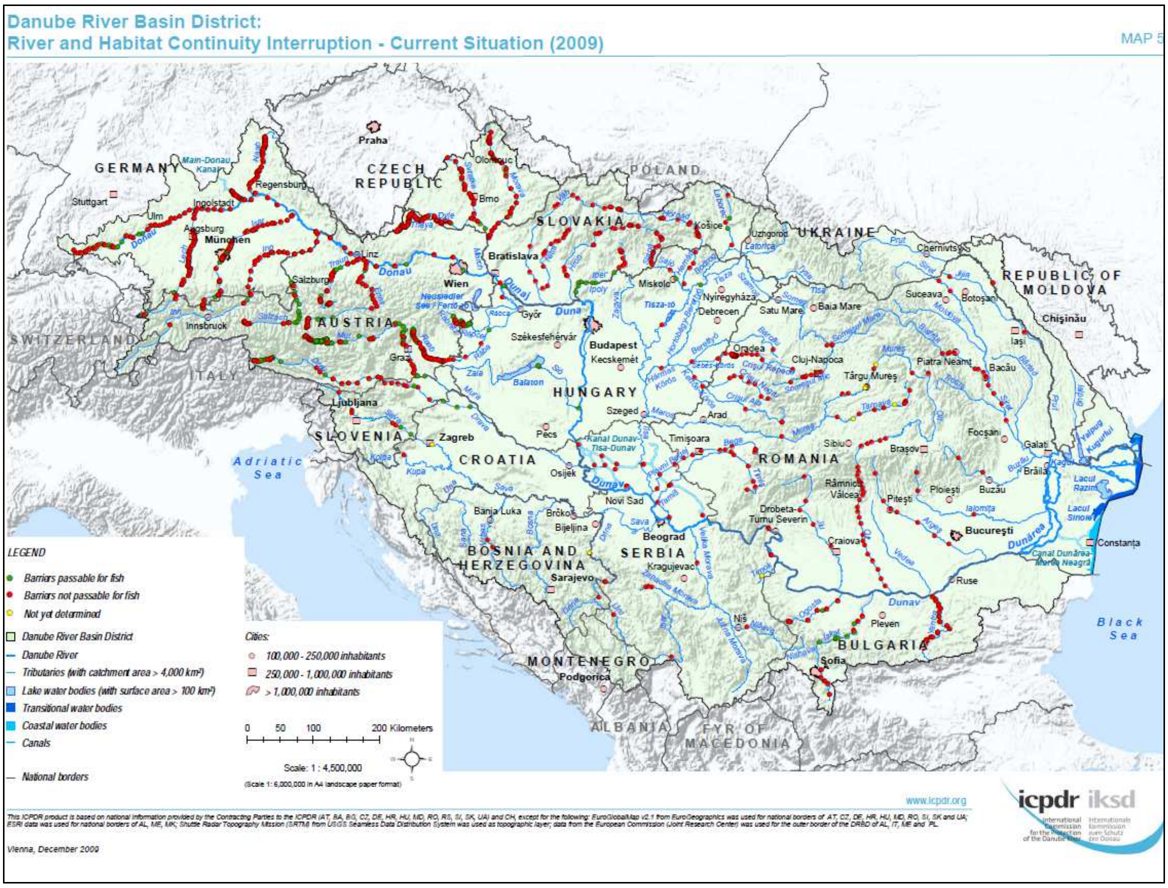
[71] Kampa, E. & C. Laaser (2009): Updated Discussion Paper. Common Implementation Strategy Workshop Heavily Modified Water Bodies. Brussels, 12-13 March 2009. Available: http://www.ecologic-events.de/hmwb/documents/Discussion_Paper_Updated.pdf.

[72] Source of this section is ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview, section 2.1.4.

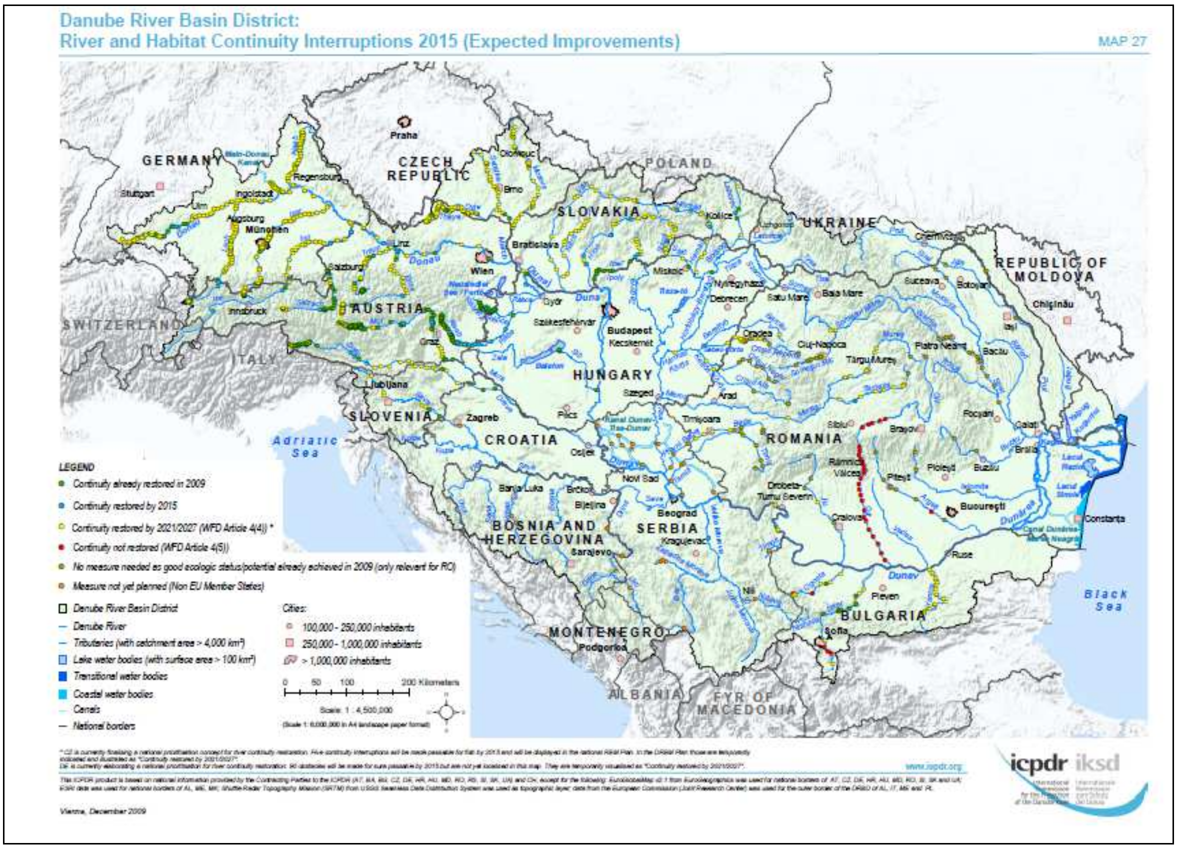
- Interruption of river and habitat continuity

The key driving forces causing eventual river and habitat continuity interruptions in the DRBD are mainly flood protection (45%), hydropower generation (45%) and water supply (10%). In many cases barriers are not linked to a single purpose due to their multifunctional characteristics (e.g. hydropower use and navigation; hydropower use and flood protection). 1,688 barriers are located in DRBD rivers with catchment areas >4,000 $km^2$ (Map 5). 600 of the 1,688 continuity interruptions are dams/weirs, 729 are ramps/sills and 359 are classed as other types of interruptions. 756 are currently indicated to be equipped with functional fish migration aids. Therefore, 932 continuity interruptions (55%) remain a hindrance for fish migration as of 2009 and are currently classified as significant pressures. 296 water bodies in the DRBD are significantly altered by continuity interruptions un-passable for fish species. This is 44% of the total number of DRBD water bodies (681). The Danube countries plan to significantly reduce the continuity interruption by dams (Map 6).




Source: DRBMP, 2009, Map 5

**Map 5: Danube River Basin District: River and habitat continuity interruption – current situation (2009)**




Source: DRBMP, 2009, Map 27

**Map 6: River and Habitat Continuity Interruptions 2015 (expected improvements), extracted zoomed map version**

- Disconnection of adjacent wetlands/floodplains

Among many ecosystem services, wetlands/floodplains and their connection to adjacent river water bodies play an important role in the functioning of aquatic ecosystems by providing important habitats for fish as well as other fauna and have a positive effect on their water status. According to the WFD, pressures on wetlands are to be considered as significant and need to be addressed by measures where they are impacting negatively on the water status of adjacent water bodies. Connected wetlands/floodplains play a significant role when it comes to retention areas during flood events and may also have positive effects on the reduction of nutrients. The DBA concluded that the main causes of wetland destruction have been the expansion of agricultural uses and river engineering works concerning mainly flood control, navigation and power generation. Drainage and irrigation are also responsible for alterations in water levels and the loss of wetlands and floodplains. Compared with the 19th Century, less than 19% of the former floodplain area (7,845 km² out of a once 41,605 km²) remains in the entire DRB. Since the 1950s, engineering works have accounted for a total of 15-20,000 km² of Danube floodplains being cut off from the rivers. The basis of the pressure analysis for this DRBM Plan was the consideration that disconnected wetlands/floodplains are potential pressures to aquatic ecosystems on the basin-wide level and that the highest possible area should be re-connected to the adjacent rivers in the DRBD in order to support the achievement the environmental objectives by 2015 and beyond. The pressure analysis therefore focused on analyzing the location and area of disconnected wetlands/floodplains (>500 ha or which have been identified by the Danube countries of basin-wide importance) with a definite potential for reconnection by 2015 and beyond. To date, 95 wetlands/floodplains (covering 612,745 ha) with potential to be re-connected to the Danube River and its tributaries have been identified. The 31,932 ha of wetlands/floodplains reported by RS are already partly connected to the adjacent river and this will be further improved in the future.[73]

- Hydrological alterations

The main pressure types in the DRBD causing hydrological alterations are in numbers: 449 impoundments, 140 cases of water abstractions and 89 cases of hydropeaking.[74]

Impoundments are caused by barriers that – in addition to interrupting river/habitat continuity – alter the upstream flow conditions of rivers. The character of the river is changed to lake-like types due to decrease of flow velocities and eventual alteration of flow discharge. The pressure analysis concludes that 449 impoundments are located in the DRBD affecting 201 water bodies. It can be concluded that out of 25,117 km of all rivers in the DRBD with catchment areas > 4,000 km², 4,258 km are affected by impoundments (17%). For the Danube River, impoundments are the key hydrological pressure type causing significant alterations. 1,111 km of its entire length (of 2,857 km) are impounded (representing 39% of the length) by 78 barriers including hydropower plants. In fact, impoundments are the major hydrological pressure type for the Danube River. The impoundment upstream of the Iron Gate Dams affects the flow of the Danube River over a length of 310 km up to Novi Sad (11% of the entire length of the Danube River) and represents a significant pressure. In the middle Danube Basin, the Gabcikovo Dam impounds for more than 17 km (less than 1% of the entire length) and the AT/DE chains of hydropower plants impound a significant length of the upper Danube River (approx. 269 km; representing 77% of the Austrian Danube River length share). However, significant free-flowing stretches are located upstream of Novi Sad to the Gabcikovo Dam and downstream of the Iron Gate Dams to the Black Sea.

In the DRBD, the key water uses causing significant alterations through water abstractions are mainly hydropower generation (76%), public water supply (5%), agriculture and forestry (3%) and irrigation (9%). The pressure analysis concludes that 140 water abstractions are causing alterations in water flow in DRBD rivers >4,000 km$^2$. 77 water bodies are affected by these pressures. Out of the 140 water abstractions, 105 are significant going below the ICPDR criterion. The Danube River itself is only impacted by alterations through water abstraction at Gabcikovo hydropower dam (bypass channel) and three water abstractions in Germany as well as Hungary.

Hydropeaking is a pressure type that occurs in the DRBD and is undertaken by the hydropower sector to generate peak energy supply. Altered flow regimes below hydropower plants occur 89 times in the rivers of the DRBD. Out of those and according to the ICPDR criterion, 32 are causing significant water level fluctuations larger than 1 m/day below a hydropower plant (or less in the case of known negative effects on biology). Overall, 44 water bodies are affected by an altered flow regime.

[73] The location and size of the evaluated wetlands/floodplains (more than 500ha) with reconnection potential (2009) and expected improvement by 2015 can be found in ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview, Map 6.

[74] The current situation (2009) of hydrological alterations can be found in ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview, Map 7a (impoundments), Map 7b (water abstractions) and Map 7c (hydropeaking and altered flow regime). Map 29 displays the expected improvements for the year 2015.

## 4.3 Hydropower and Heavily Modified Water Bodies

Recent data from all EU-MS on the designation of heavily modified water bodies (HMWB) showed that water storage for hydropower generation is the third most common water use for designating HMWB (following water regulation and flood protection).[75]

In all Danube countries surveyed multipurpose facilities with hydropower use exist. The multipurpose uses of those facilities (electricity generation, improvement of navigation, flood protection, tourism/recreation, others as drinking water, irrigation) and their main, secondary and tertiary use are described in table 7. It can be seen that flood protection is often indicated as secondary use of those facilities, while the improvement of navigation is reported as secondary or tertiary use by a small number of Danube countries. In HR, SK and SI flood protection is reported as one of the main uses of the respective multipurpose facilities. Further uses are drinking water, water supply in general and irrigation (BA for water supply, BG, HR, SI, partly UA) and nature conservation (DE).

| | Main use | Secondary use | Tertiary use |
|---|---|---|---|
| Electricity generation | AT, BA, CZ, DE, HR, HU, RO, partly in RS, SK, SI, UA | BG | BG |
| Improvement of navigation | SK | DE, partly in RS, SI | AT |
| Flood protection | HR, SK, SI | AT, BG, partly CZ, HU, DE, RO, partly RS, UA | BA, BG |
| Tourism/Recreation | | SI | BA, partly in CZ and HU, HR, DE, partly in RS and UA |
| Others | • Drinking water, water supply and irrigation (BA, BG, HR, SI, partly in UA)<br>• Nature conservation (DE) | | |

Source: Replies to the Danube Questionnaire, Question A.7

**Table 7: Multipurpose uses of facilities and their main, secondary and tertiary use**

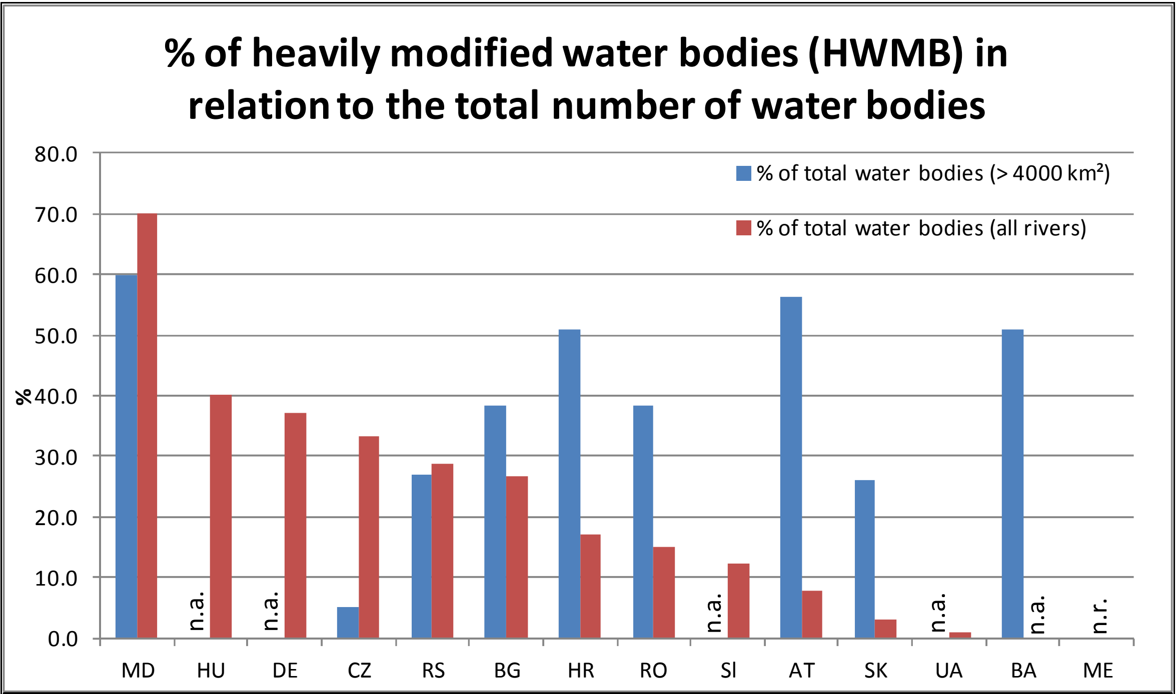
Figure 36 gives an overview of designated heavily modified water bodies (HMWB) in relation to the number of total surface water bodies as well as all water bodies > 4,000 km².

From this overview, the following may be noted in relation to all water bodies: BG, CZ, DE, HU, MD and RS have the highest percentage of HMWB (26% to 70%). RO and SI have 15%, respectively 12% HMWB, AT has 8% and SK and UA has the lowest

[75] Kampa, E. & C. Laaser (2009). Updated Discussion Paper. Common Implementation Strategy Workshop Heavily Modified Water Bodies. Brussels, 12-13 March 2009. Available: http://www.ecologic-events.de/hmwb/documents/Discussion_Paper_Updated.pdf.

percentage of HMWB (3%, respectively 1%) in relation to all water bodies. UA performed the assessment of HMWBs in the Tisza river basin only.

As regards the relation of HMWB to all water bodies larger than 4000 km², it ranges from 60% in MD, 56% in AT, 51% in BA and HR, 38% in BG and RO, 27% in RS and 26% in SK. In CZ, the relation of HMWBs to all water bodies larger than 4000km² lies at 5%.




***Notes:***
*- AT, DE, HU, MD, RS, SI and SK reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA, CZ and HR reported data for the national part of the Danube River Basin only.*
*- For BG the value for % of total water bodies include data for the whole country, while the value for % of total water bodies (> 4000 km²) include data for rivers Iskar, Yantra Ogosta and the Danube.*
*- UA reported data for the Tisza River Basin only.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question Q4.1

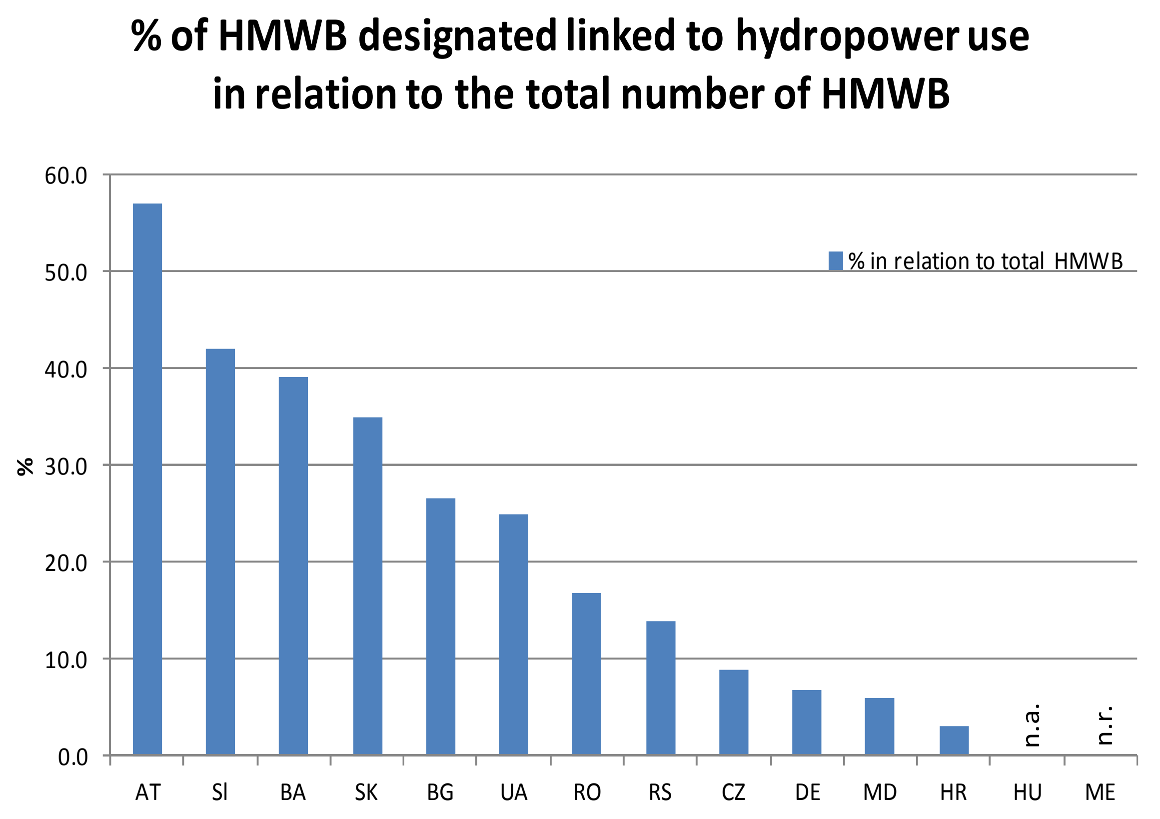
**Figure 36: Percentage of HMWB in relation to total number of surface water bodies (%)**

Figure 37 shows the percentage of HMWB designated as such due/linked to hydropower use in relation to total HMWB.

AT shows the highest percentage of HMWB due/linked to hydropower (57% in AT), followed by SI (42%), BA (39%) and SK (35%).

UA reported data for the Tizsa River Basin only, in which 4 water bodies were designated as HMWB and one of those due to hydropower use. As regards the Prut River Basin, UA reported that the designation of HMWB was not yet conducted, no information was available for the Danube Delta in UA.

RO, RS, CZ, DE, MD and HR have the lowest percentage of HMWB due to hydropower (below 20% of total HMWB). HU did not provide data.

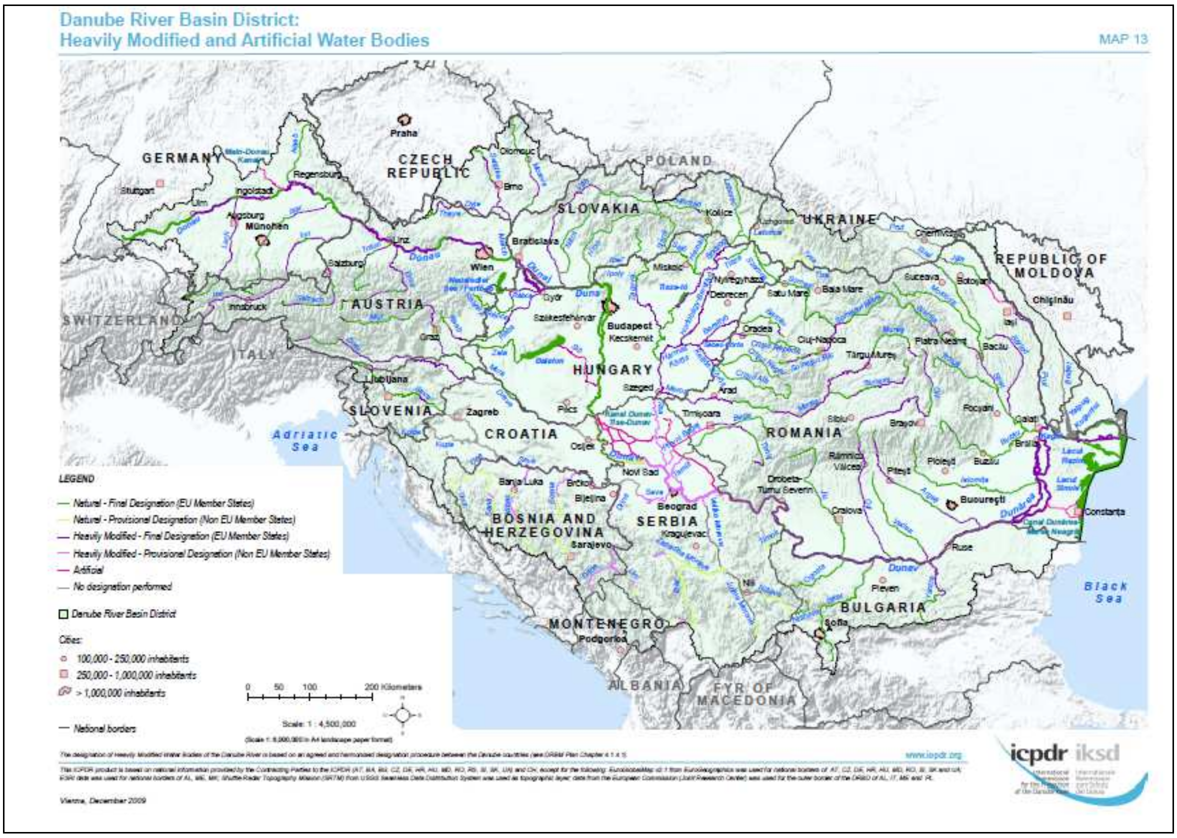



***Notes:***
*- AT, BG, DE, MD, RS, SI and SK reported data for the whole country.*
*- RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*
*- BA, CZ and HR reported data for the national part of the Danube River Basin only.*
*- UA reported data for the Tisza River Basin only.*
*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

Source: Replies to the Danube Questionnaire, Question Q4.2

**Figure 37: Percentage of HMWB designated due to hydropower in relation to total HMWB (%)**

Map 7 indicates the heavily modified and artificial water bodies designated in the Danube basin.




Source: DRBMP, 2009, Map 13

**Map 7: Danube River Basin District: Heavily modified and artificial water bodies.**

The majority of Danube countries plan to make improvements to water bodies affected by hydropower by 2015.

In the context of making improvements to water bodies via specific measures, two Danube States (AT, RO) have agreed national or local criteria for determining what impact on hydropower generation is acceptable (i.e. not a significant adverse effect):

- AT: A study was conducted by the hydropower sector and the Ministry responsible for water management to assess the possible effects of restoring good status of water bodies (losses of hydropower generation, investment costs, effects on peak load production and ancillary services). Based on the outcome of a study on the possible effects of the WFD on hydropower, by using different scenarios and the ecological requirements set out in the Ordinance on ecological quality objectives, it was calculated that restoring upstream continuity for fish migration and restoring an ecological minimum in all Austrian hydropower plants flow would not lead to a loss in hydropower generation of more than 3% of the total generation (that is about 1,2 TWh). This led to the following commitments: 1) Losses of hydropower generation due to the building of fish migration aids (to restore continuity which is crucial to achieve and maintain good ecological status/good ecological potential) cannot be stated as significant adverse effect as a rule, 2) losses of hydropower generation due to restoration of ecological minimum flow by a hydropower plant (by which the diverted water is reverted into the same river after a certain distance from the abstraction point) cannot be stated to be a significant adverse effect as a rule, 3) losses of hydropower generation due to the restoration of ecological minimum flow in rivers, where the water is abstracted and transferred to a storage reservoir will lead to a decrease of peak load production and of ancilliary services and are therefore excluded from this rule and might be stated as significant adverse effect, 4) changes in the operational mode of hydropeaking power plants to reduce high flow variations resulting in significant losses of peak load production and ancillary services can be stated as significant adverse effects, 5) investments costs for restructuring the head sections of impoundments, improving habitat structures in impoundments and water stretches affected by hydropeaking like building a compensation reservoir, constructing spawning grounds cannot be stated as significant adverse effect as a rule.

- RO: For RO, a reduction/loss of energy production is considered acceptable (without having a significant adverse effect) for ensuring the ecological flow, the reduction/loss of energy production for <2%/year for a single hydropower plant and the reduction/loss of energy production for <5%/year for a whole hydropower development scheme.

For UA, general guidance principles are set for the environmental impact assessment, but the exact criteria are to be developed individually for each hydropower station.

| | Yes | No |
|---|---|---|
| Are improvements to any water bodies affected by hydropower schemes planned by 2015? | BG, CZ, DE, HU, MD, RO, SK, SI | AT, HR, RS, UA |
| Have national or local criteria for determining what impact on hydropower generation is acceptable (i.e. not a significant adverse effect) been agreed? | AT, RO, UA | BA, CZ, DE, HR, MD, RS, SK, SI |

Source: Replies to the Danube Questionnaire, Question Q4.3 and Q4.4

**Table 8: Improvements planned to any water bodies affected by hydropower schemes by 2015**

# 5 General conditions for hydropower authorisation including requirements for environmental improvement

Section 5 summarizes the general conditions for hydropower authorisation including requirements for environmental improvement with a special focus on three specific water management issues in the Danube basin: fish migration aids for mid and long distance migration, minimum ecological flow and sediment transport (section 5.3). Section 5.1 provides information as regards the competent authorities for issuing and controlling permits; section 5.2 focuses on the duration and content of the permits for hydropower generation. Sections 5.4 and 5.5 highlight how fish migration aids, minimum ecological flow and sediment transport has been taken into account in the Danube countries and address the legal and technical requirements related to the following key domains of environmental improvement at existing and/or new hydropower plants: minimum ecological flow, upstream continuity facilities (including fishpasses), downstream continuity facilities, hydropeaking mitigation and sediment/bedload transport. Section 5.6 lists other domains identified as relevant for environmental improvement. The issue of cumulative effects is explained in section 5.7. Annex III provides original information submitted by Danube countries on methods for defining minimum ecological flow; requirements for upstream continuity facilities are explained in Annex IV.

## 5.1 Competent authorities for issuing and controlling permits

Different competent authorities are responsible for regulating and permitting hydropower schemes, i.e. for granting authorisations, licences or concessions for new installations in the individual Danube countries. Table 9 provides an overview of the responsible public bodies as well as the legal status of the water use permissions.

| Danube Country | Competent Authority/ies | System (legal status) |
|---|---|---|
| AT | Facilities < 500 kW: Regional District Authority (= Bezirkshauptmannschaft).<br>Facilities > 500 kW: Austrian Federal States (= Bundesländer).<br>An environmental impact assessment (EIA) becomes obligatory above a 15 MW bottleneck capacity.<br><br>The authorization for the construction is granted by the competent authority. No charge for any hydropower plant for the use of water is foreseen according to the Austrian Water Act. | Authorisation system. |
| BA | No information provided. | |
| BG | According to the national Water Act, the Council of Minister shall adopt an Ordinance on the use of surface waters.<br><br>A permit for water body use shall be issued by:<br>1. the Minister of Environment and Water for use of a water site for the complexes and significant dams under Annex 1 of the Water Act; | Authorisation system. |

| | | |
|---|---|---|
| | 2. the municipality mayor after a resolution of the Municipal Council for use of water sites constituting public municipal property;<br>3. the competent Basin Directorate Director in all other cases of water body use.<br>Permits for use of water sites constituting parts of the Danube River, the internal marine waters or the territorial sea shall be issued by the competent Basin Directorate Director with the advance consent of the Minister of Defense and of the Minister of Transport, Information Technology and Communications. | |
| CZ | The competent authority from the energy point of view is the Czech Energy Regulation Office and from the water management point of view the relevant Water Authority. The water authority issues the permissions for water use. | Authorisation system. |
| DE | District council; for some projects with supposed larger spatial effects there exist additional procedures, e.g. legal procedures accomplished by the Regional government. | Authorisation system. |
| HU | The competent authority is the Hungarian Energy Office, who issues the contracted permits for the hydropower plants. From the water management point of view the relevant Water Authority issues the permit for water use. | Authorisation system. |
| HR | Based on a request from the Ministry in charge of water (Ministry of Agriculture), the agency in charge of water (Croatian Water) issues an expert opinion and concession conditions. Based on the above, Croatian Parliament awards concessions for plants with a capacity of 20 MW and above, whereas the Government of the Republic of Croatia awards concessions for plants with a capacity of up to 20 MW. An administrative system for issuing water rights documents is within the competence of Croatian Water. | Authorisation system. |
| MD | No information provided. | |
| SI | The competent authority for issuing permits and controlling permits in Slovenia is the government and partially the Ministry for Agriculture and the Environment. There is no differentiation between the concession for small and large hydro power with regard to the competent authorities. An EIA must be carried out for reservoir plants where the reservoir volume exceeds 10000m$^3$, or for run-of-river schemes larger than 500 kW. | Authorisation system. |
| SK | The State Water Authority is the competent authority for issuing and controlling permits in Slovakia. | Authorisation system. |
| RS | No information provided. | |
| RO | Romanian Water Authority issues the water management permits. | Authorisation system. |

| | | |
|---|---|---|
| UA | The following compentent authorities were reported for Ukraine:<br>• Zakarpatska Oblast Administration<br>• Ministry of Fuel and Energy<br>• Ministry of Ecology and Natural Resources of Ukraine<br>• National Commission of Regulation of Electroenergy of Ukraine<br>• National Agency of Effective Use of Energy Resources<br><br>The Ministry of Regional Construction of Ukraine established a special state enterprise "Special State Expert Organization", which has branches in all Oblasts, including Zakarpatska. This organization conducts state integrated expertise of project and issues permit for commencement of works. State Integrated Expertise includes state ecological expertise, conducted by Regional Departments of Environmental Protection. State expertise involves into the assessment all relevant departments, including Tisza basin Authority and fishery.<br><br>Since 01/01/2012 the Law of Ukraine "On list of Documents for Permits in the field of Economic Activities" entered into the force, which also regulates permits for construction or restoration of hydropower plants at small rivers. | Authorisation system. |

Sources: Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower and additional information provided by Danube countries

**Table 9: Competent authority/ies for issuing permits**

The control of the permits and the compliance with the provisions of the permits for hydropower plants is done by local, regional and/or provincial water authorities (AT, CZ, DE), including self-monitoring records (AT), and by federal and/or river basin authorities (BA, BG, HU, HR, MD, RO, SK, SI and UA): Ministry for Agriculture, Forestry and Water Sector and Water Agency (BA), Ministry of Environment and Water Basin Directorates (BG), Hungarian Energy Office (HU), Croatian Water Authority (HR), Ministry of Environment and Department for Energy (MD), Apele Romane (RO), State Water Management Authority (SK), the Ministry of Environment (SI), Cabinet of Ministers of Ukraine (their representatives at Oblast level), the Ministry of Fuel and Energy, the Ministry of Environmental Protection, National Commission of Regulation of electro-energy of Ukraine, National Agency of Effective Use of Energy Resources and the State Inspection of Operation of Electric Stations and Networks (UA). In RS, the authority issuing the construction permit is authorized to control permits and compliance with permits.

## 5.2 Permits for hydropower plants

The duration of permits for hydropower plants varies significantly between countries, being based on different criteria. In some countries, there is a mix of permits in perpetuity and time-limited permits (AT, DE, UA) and in the remaining countries (BA, BG, CZ, HU, HR, MD, RO, RS, SK, SI) only time-limited permits exist. Table 10 summarises the differences in the duration of permits for hydropower plants in Danube countries.

| Danube Country | Duration of permits for hydropower plants |
|---|---|
| AT | Permits for existing and very old small hydropower plants are issued without limitation, but need to be renewed in case of severe changes of water use. For new hydropower plants permits are limited to 90 years as a maximum taking into account economic and water management aspects as well as technical development. Due to this, new permits for small hydropower plants usually have a duration of 30 to 60 years. |
| BA | Permits for hydropower plants are issued for a maximum of 10 years according to the national Water Law. |
| BG | Permits for hydropower plants are issued for 6 to 10 years. According to the national Water Act a permit shall be issued for a maximum period of 1) thirty-five years for water abstraction for water-power from complexes and significant dams under Annex 1 of the Water Act and 2) twenty years, in all other cases. |
| CZ | Licenses for doing operational business in energy sector are issued in perpetuity. Water use permission is issued for limited time, but minimum 30 years. |
| DE | Permits for new hydropower plants are issued for 20 to 30 years, longer to unlimited for pre-existing plants (pre-existing rights). |
| HU | Permits for hydropower plants are issued mainly for 25 years. |
| HR | A concession for the exploitation of water power for the production of electric power can be granted for the following periods: for hydropower plants of and above 20 MW up to 60 years and for hydropower plants up to 20 MW up to 30 years. |
| MD | Permits for hydropower plants are issued for 10 years. |
| RO | The duration of the water management license is represented by the duration of the operational period of time for the hydropower project, defined by the owner, and being renewed every 5 years. |
| RS | Construction permit for hydropower plants in Serbia expires if the construction is not started within 2 years from permit validity date. According to the Serbian Laws there is the distinction between energy and construction permits for the development of hydropower plants. The energy permit for hydropower plants with capacities above 1 MW is issued by the Ministry for Infrastructure and Energy. Energy permit is a standalone document independent of the hydropower plant capacities. Energy permit is valid for three years from the date of its issuance with possibility for prolonging it for additional one year. |

| | |
|---|---|
| SK | Duration of licence for construction-technical part is unlimited. Duration of licence for utilization of water (operation) could be limited. |
| SI | Permits for hydropower plants are issued for periods up to 50 years. |
| UA | The permit for the operation of hydropower stations is given once during the lifetime of the hydropower plant; for special water use (which is essential for hydropower stations) is issued once each 3 years. |

Source: Replies to the Danube Questionnaire, Question 8.1

**Table 10: Duration of permits for hydropower plants in Danube countries**

The duration of permits for hydropower plants in the Danube countries has not been changed at any point in BA, HR, MD, RO, SI and UA. No information was provided by HU. Changes to the duration of permits were processed in AT, BG, CZ, DE, RS and SK:

- AT: Unlimited permits were changed to a limitation of up to 90 years (large hydropower plants) or up to 60 years (small hydropower plants) in case of renewal of the permit.
- CZ: From the water management point of view changes are possible in line with conditions defined in the Water Act to achieve water protection targets defined in the water management plans, to implement programs of measures for improvement quality of waters and to ensure public drinking water supply.
- DE: The legal principles for fixing the duration of permits have changed. These changes did not affect existing permits. As a general rule, prevailing law does not stipulate any specific duration. It is recommended that the maximum limit for a permit does not exceed 30 years.
- RS: The duration of hydropower permits has not been changed since 2003. The new Energy Law, which is in force since August 9$^{th}$, 2011, defines that the energy permit is valid for three years from the date of its issuance.
- SK: In case of changed conditions, permits could be changed as well.

In most Danube countries, it is possible to make changes to permits of hydropower plants with regard to contents. Changes can be made and additional measures requested (either in the context of permit revision or at any time), or when this is considered necessary to achieve environmental objectives or when a degradation of environmental conditions has been identified. However, it seems that changes in permits due to necessary environmental improvements including fish migration aids, are not generally possible in Danube countries and should be taken into account in future licensing procedures.

| Danube Country | Types of changes possible to existing permits for hydropower plants |
|---|---|
| AT | A change of permits can be done by the authorization body in case that the National River Basin Management Plan contains relevant requirements for restoration. Taking into account efficiency and the most appropriate means, the regional authority has the possibility to issue a regional restoration programme. This programme may contain specifications for restoration measures (e.g. restoration of river continuity by building fish passes, guarantee of ecological minimum) as well as a deadline by which the owner of a permit has to deliver a restoration project to the authorization body. |
| BA | Changes are possible with regard to technology, size, and the water level in the reservoir. |
| BG | Existing permits for hydropower plants can be changed as regards the parameters of abstraction (quantity used, structural part, time of completion of construction). |
| CZ | The decisions on changes are individual and must be achieved on the basis of administrative procedure in line with the Czech regulations. Changes are possible in line with the conditions defined in the Water Act to achieve water protection targets defined in the water management plans, to implement programs of measures for improvement quality of waters and to ensure public drinking water supply. |
| DE | Permits can be withdrawn under certain conditions and certain measures can be requested retrospectively. The legal principles for fixing the duration of permits have changed. These changes did not affect existing permits. As a general rule, prevailing law does not stipulate any specific duration. It is recommended that the maximum limit for a permit does not exceed 30 years. |
| HU | No information provided by HU. |
| HR | The beneficiary can request a change in the permission in case of modernization / refurbishment or a change in the water legislation. |
| MD | No information provided by MD. |
| RO | Change is only possible if the beneficiary requires a change/changes in the license (in the case of modernization/refurbishment or in case of Water Law updating according to European requirements, a compliance period being applied), a new water management license needs to be issued. |
| RS | Existing permit may be amended due to: change of investor, technical changes during construction (installed power, location, dimensions etc.) or a required design change. |
| SK | Only minimum changes, which are described in the issued permit, are possible. Changes going beyond the provisions in the existing permits (e.g. legislative change, change of operation, construction changes, fish pass etc ) require a revision of the permit. |
| SI | Any type, also rescission is possible. |
| UA | The changes to the existing permits include fixed tariffs of payment and duration of the permit for special water use, full compensation for inclusion into general network and the identification of green tariffs based on the capacity of mini hydropower stations. The following conditions should be preserved: Solving of the issues of privatization and renting of small hydropower plants and relevant hydroconstructions; simplified procedure of |

| | |
|---|---|
| | land provision for construction and reconstruction of small hydropower stations; priority design of hydropower stations which can be used also for flood protection in the Carpathian region; simplified procedure of obtaining of permit for special water use and simplified procedure of hydropower stations commencement. |

Source: Replies to the Danube Questionnaire, Question 8.3

**Table 11: Types of changes possible to existing permits for hydropower plants**

## 5.3 Specific water management issues – fish migration aids, minimum ecological flow and sediment transport

The Danube Basin Analysis 2004 (DBA) identified the following Significant Water Management Issues (SWMI) which directly or indirectly affect the status of surface water and transboundary groundwater: Pollution by organic substances, Pollution by nutrients, Pollution by hazardous substances and Hydromorphological alterations. The main specific water management issues in the Danube basin, which are of particular relevance for hydromorphological alterations and directly linked to hydropower generation are fish migration aids, minimum ecological flow and sediment transport.

### 5.3.1 Fish migration aids – mid and long distance migration

The Danube rivers with catchment areas >4,000 km² are large to medium sized and include crucial living and spawning habitats, vital to the life cycles of fish species. These rivers can be classified as ecologically very sensitive as they are the key routes and starting points of fish migration for long and medium distance migratory fish species. The Danube River, for example, is not only a key migration route itself, it is also of special importance for those species migrating from the Black Sea and connects all tributaries in the basin for migration. The overall goal of river and habitat continuum restoration is free migration routes for the DRBD rivers with catchment areas >4,000 km², as this will be crucial for achieving and maintaining good ecological status/potential for the future.

In general, all fish species of the DRB are migratory, however, the importance of migration for the viability of fish populations varies considerably among them. Differences exist in terms of migration distances, direction (upstream, downstream, lateral), spawning habitats, seasons and the life stage for which migration takes place. DRB migration requirements are more relevant in lowland rivers than in headwater fish communities.

A key challenge is to ensure the upstream as well as downstream migration of migratory fish in first place of major rivers in order to ensure the sustainability of existing stocks. Anadromous fish like salmon and sturgeon need freshwater in order to spawn and to reproduce, and catadromous migrating species need freshwater habitats for growing. Thus, free migration of those species in rivers and their protection in the open seas as well as in the coastal waters is crucial.

Long distance migrants (LDM), such as the Beluga sturgeon (Huso huso), formerly migrated from the Black Sea up to (what is termed) the Barbel region of the DRB. Medium distance migrants (MDM, so called potamodromous fish species) such as Nase (Chondrostoma nasus) and Barbel (Barbus barbus) migrate within the river over distances between 30 to 200 km within the Barbel and Grayling regions of the Danube River Basin. In contrast, headwater fish species migrate over comparable short distances because their living and spawning habitats are closer to each other. Nevertheless, under a long term perspective all fish species need open river continuity.

Table 12 lists examples for both the long distance migrants of the DRB as well as nine DRB medium distance migrants that are represented with the highest numbers in the Danube River and adjacent lowland rivers, and which are therefore of key importance regarding continuity restoration. The key MDMs have been selected out of overall 58 fish species that have been classified in the European FP7 Project EFI+.[76]

| | Nr. | Scientific name | English name |
|---|---|---|---|
| **DRB Long Distance Migrants (LDM)** | | | |
| | 1 | Huso huso | Great sturgeon, Beluga |
| | 2 | Acipenser guldenstaedti | Russian sturgeon |
| | 3 | Acipenser nudiventris | Ship sturgeon |
| | 4 | Acipenser stellatus | Stellate sturgeon |
| | 5 | Alosa caspia | Caspian shad |
| | 6 | Alosa immaculate (pontica) | Pontic shad |
| **DRB Medium Distance Migrants (MDM)** | | | |
| | 1 | Abramis brama | Common bream |
| | 2 | Abramis sapa | Danubian bream |
| | 3 | Acipenser ruthenus | Sterlet |
| | 4 | Aspius aspius | Asp |
| | 5 | Barbus barbus | Barbel |
| | 6 | Chondrostoma nasus | Nase |
| | 7 | Hucho hucho | Danube salmon |
| | 8 | Lota lota | Burbot |
| | 9 | Vimba vimba | Vimba |

Source: DRBMP, 2009

**Table 12: Examples for long and medium distance migrants in the DRB (based on EFI+ guild classification**

A study of the International Association for Danube Research (IAD) resulting in an Action Plan for the Conservation of Sturgeons in the Danube Basin[77] under the Bern Convention signed by all Danube countries was finalised in the year 2005. Further research is needed as regards the questions of what are the population structure and exploitation status, the stocks, the key habitats and migration patterns in the Danube and the Black Sea; which potential key habitats are still available; and what are the best and most realistic measures in conserving and restoring Danube sturgeons.

### 5.3.2 Minimum ecological flow

As described in section 4.2, the key water uses in the Danube basin causing significant alterations through water abstractions are mainly hydropower generation (76%), public water supply (5%), agriculture and forestry (3%) and irrigation (9%).

These abstractions can significantly reduce the flow and quantity of water and impact the water status in case where the minimum ecological flow of rivers is not guaranteed. A minimum ecological flow is needed to conserve the hydrological and ecological functions of the river network.

[76] Source: ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview, chapter 7.1.4.1.2.

[77] The study can be downloaded from the following webpage: http://www.iad.gs/docs/reports/SAP.pdf.

The methods for defining minimum ecological flow are described in section 5.5 and Annex III. There is a great variety in the definitions, and AT, DE, RS and SI have a dynamic definition that is adjusted to the seasonal discharge.

### 5.3.3 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, torrent control, hydropower development and dredging, as well as the reduction of adjacent floodplains by nearly 90%, are the most significant causes of impacts.

Hydropower plants in the upper Danube catchments trap almost 80 to 90% of the sediment bed load. The middle Danube, due to a decreasing slope, is characterised by a transition from a gravel river into a sand river. In the lower Danube, the suspended load dominates the overall sediment transport. At present the torrent control works and impoundments on the upper catchments in the Danube River Basin retain about one third of the suspended load. During floods, large quantities of sediments can be remobilised and deposited e.g. in the inundated floodplains. In the lower Danube the transport of suspended load currently reaches only 30% of the original amount recorded, due to abundant anti-erosion and hydro-technical works throughout the entire DRB and significant sediment settling in the Iron Gate 1 reservoir.

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 has often to be extracted 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. Sediment flushing of reservoirs is a major problem, if sediments are contaminated. By all means, sediment flushing needs to be controlled and monitored. 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. Dredging is very common throughout the DRB. The extraction of sediment is mostly related to navigation (minimum water depth); flood protection purposes; reservoir management and torrent control. The major dredging user groups include: Waterway transport maintenance dredging; commercial extraction, construction sector; Channel maintenance for flood protection; Impoundment clearing for hydropower plants; and Fish farming.

## 5.4 Legal requirements for environmental improvement

Most Danube countries reported to have relevant legislation on national level in place to ensure minimum ecological flow and upstream and downstream continuity via fish passes at hydropower plants (see table 13). No legislative means for downstream continuity facilities are present in BG, no legislative means for upstream continuity facilities are in place for BA. However, discussions and feedback received during the “1st ICPDR Workshop on Hydropower and Water Management” showed that technical guidelines as well as clear criteria, standards and definitions are not always in place yet causing difficulties in the practical implementation of downstream and upstream continuity facilities. The term “minimum ecological flow” is not applied in all Danube countries and – although similar expressions are used, studies are being conducted and a minimum flow is recognized as a general necessity to ensure ecological requirements – discussions in the “1st Workshop on Hydropower and Water Management” showed that different definitions and criteria are used in the DRBD. Some Danube countries use the terms “ecologically acceptable flow”, “ecological/biological flow” or “environmental flow” including criteria of dynamics, duration and frequency of the flow to maintain the river and riparian ecosystem.[78]

Provisions for hydropeaking mitigation are legally established in AT and RO, a relevant recommendation on national and regional level exists in MD. No information was provided from HU as regards hydropeaking mitigation and sediment/bedload transport.

For mitigating the disruption of sediment/bedload transport, several countries have no relevant legislative means. In BG relevant legislation on national level exists as regards sediment/bedload transport; for MD a relevant recommendation on national level is in place. Only for a few countries mitigation measures are defined in individual cases. Generally no legislative means to address sediment/bedload transport are in place in BA, RO, RS and SK. In Romanian legislation there is no distinction between upstream and downstream continuity facilities for fish migration.

| | There is relevant legislation | | There is no legal requirement but there is a relevant recommendation | | No legal requirement or recommendation but defined in individual cases | Generally no legislative means |
|---|---|---|---|---|---|---|
| | National | Regional | National | Regional | | |
| Minimum ecological flow | AT, BA, BG, CZ, DE, HU, MD, RO, RS, SI, UA | DE | CZ, SK | | HR | |
| Upstream continuity facilities | AT, BG, DE, HU, RO, RS, SK, SI, UA | DE | | MD | CZ, HR | BA |
| Downstream continuity facilities | DE, HU, RO, RS, SK, SI, UA | DE | | | AT, BA, CZ, HR, MD, RS | BG |
| Hydropeaking mitigation | AT, RO | | MD | MD | BA, CZ, DE, HR, RS, SK, SI | BG |
| Sediment/ bedload transport | BG | | MD | | (AT), CZ, DE, HR, SI, UA | BA, RO, RS, SK |

Source: Replies to the Danube Questionnaire, Question Q8.5, Q8.12, Q8.18, Q8.25 and Q8.29

**Table 13: Legal requirements for environmental improvement**

[78] Final summary of the "1st ICPDR Workshop on Hydropower and Water Management" available online: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=94017.

Table 14 summarises if requirements for minimum ecological flow and upstream as well as downstream requirements exist for new and existing hydropower plants.

For new hydropower plants, in most Danube countries, requirements exist for every plant to ensure minimum ecological flow and upstream as well as downstream continuity facilities. Although a general requirement exist for every new hydropower plant to build upstream continuity facilities (fish passes) in DE, it has to be noted that under some regional circumstances (in particular in the case of natural, not to overcome obstacles in the Alpine region) those facilities are not automatically to be built. HR reported that fish passes are not technically/economically justified in some cases, e.g. in case of high dams.

For existing hydropower plants, BA, BG, HR, HU, SK, SI, MD and UA have requirements for minimum ecological flow in place; HR, HU, SK and SI reported to have a requirement for upstream continuity which is being applied to every single installation. For ensuring downstream continuity, most Danube countries have relevant requirements to do so for every new hydropower plant (with the exception of AT), while for existing hydropower plants requirements do exist in BG, HR and HU.

| | New hydropower plants | | Existing hydropower plants | |
|---|---|---|---|---|
| Does a requirement exist for every hydropower plant on: | Yes | No | Yes | No |
| Minimum ecological flow | AT, BA, BG, CZ, DE, HU, HR, RO, RS, SK, SI, UA | | (AT), BA, BG, HU, HR, MD, SK, SI, UA | CZ, DE |
| Upstream continuity facilities (fishpass) | AT, BA, BG, CZ, DE, HU, HR, RO, RS, SK, SI, UA | | HU, HR, SK, SI | BA, CZ, DE, MD, UA |
| Downstream continuity facilities | BA, BG, CZ, DE, HU, HR, RO, RS, SK, SI, UA | AT | BG, HU, HR | AT, BA, CZ, DE, MD, RS |

Source: Replies to the Danube Questionnaire, Questions Q8.6, Q8.13 and Q8.19

**Table 14: Requirements existing for every new and existing hydropower plant as regards minimum ecological flow as well as up-/downstream continuity facilities**

However, most Danube countries reported possibilities and/or needs for further improvement of enforcing and implementing requirements for environmental improvements at hydropower plants. For minimum ecological flow requirements, this include e.g. the introduction of these provisions in hydropower plants with unlimited pre-existing rights (DE) and the better linkage of the requirements with the criteria of good ecological status/potential (SI).

In RO, the ecological flow requirement for existing hydropower plants is established on a case-by-case basis after conducting a technical analysis.

Most Danube countries reported possibilities and/or needs for further improvement as regards upstream continuity facilities (fishpasses), e.g. economic pressure on operators to foster environmental behaviour (CZ), the introduction of these provisions in hydropower plants with unlimited pre-existing rights (DE), by setting a legal definition and technical standardisation (SK), as well as by the reinforcement of the controls over the operation of hydropower stations (UA). As regards downstream continuity facilities, further improvement could be achieved by research and pilot projects as regards short and medium migrators (AT) as well as by legislative and financial measures (CZ) and more stringent fish protection requirements for diadromous species (DE).

As one of the main outcomes of the "1st ICPDR Workshop on Hydropower and Water Management" it was indicated by Danube countries that support in defining standards in terms of requirements for environmental improvement of negative impacts of hydropower is needed and a prerequisite for the efficient implementation of the provisions of the WFD on national level.[79]

## 5.5 Technical requirements for environmental improvement

For most technical requirements relevant to environmental improvement at hydropower plant facilities, standards are often compiled in recommendations or more frequently set on a case-by-case basis, e.g. within permit requirements (see table 15).

In AT, BA, BG, HU, RO, SI and UA technical standards for requirements related to minimum ecological flow are set by law. For HR, the term "biological minimum" is more frequent than the term "ecological flow requirement". The "minimum biological flow" is regulated by operating regulations of each hydropower plant. The criteria for setting the flow are not always due to environmental reasons, i.e. serving not only for the preservation of aquatic plant and animal species, but also for meeting the demands of other users of water resources.

In RO and UA technical standards for upstream and downstream continuity facilities are legally set on a national level for new hydropower plants. In the case of new and existing hydropower plants in RO, for which technical standards are set by national law and on a case-by-case basis, respectively, there is no distinction between standards for upstream and downstream continuity facilities. In AT, a technical standard (guideline) is under preparation and will contain specific requirements for upstream continuity facilities in the future.

During the "1st ICPDR Workshop on Hydropower and Water Management" the technical feasibility of fish passes for high dams (10 to 50 meters) was discussed and the need for

[79] Final summary of the "1st ICPDR Workshop on Hydropower and Water Management" available online: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=94017.

good practice examples, which were mentioned to also exist for larger dams, was raised.[80]

HU did not provide data as regards hydropeaking mitigation and sediment/bedload transport.

| | There is a technical standard set by law | | There is a recommendation | | Set on case-by-case basis | No relevant method defined |
|---|---|---|---|---|---|---|
| | National | Regional | National | Regional | | |
| Minimum ecological flow | AT, BA, BG, HU, RO, SI, UA | | CZ, DE, RS | DE | HR, MD, RS | HR |
| Upstream continuity facilities | RO, UA | DE | AT, BA, DE | AT, DE | CZ, HR, SI | BA, BG, HU, MD, RS, SK |
| Downstream continuity facilities | RO, UA | DE | DE | | BA, HR, MD, SI, CZ | AT, BG, HU, RS, SK |
| Hydropeaking mitigation | | | | | AT, BA, CZ, HR, MD, RO, RS, SK, SI | BG, UA |
| Sediment/ bedload transport | | | DE, MD | | AT, CZ, HR, RS, SI, UA | BA, BG, SK, RO |

Source: Replies to the Danube Questionnaire, Questions Q8.10, Q8.16, Q8.23, Q8.27 and Q8.31

Table 15: Technical requirements for environmental improvement

### Methods for the definition of minimum ecological flow

The definition of minimum ecological flow used by Danube countries is 5% or 10% of natural annual mean flow (AT, BA, BG, CZ, DE, HU, MD, RO, RS, SK and UA) and/or a dynamic definition (AT, DE, RS, SI) and/or modelling determination (AT, DE). HU reported that 2/3 of the “standard low flow” must be left in the river bed; BA provided information that according to the current Water Law 95% of the minimum average flow need to be ensured. For BA, a by-law for minimum ecological flow is currently being developed. For HR, the approach to define minimum ecological flow is case specific.

### Requirements for upstream continuity facilities

The methods and approaches used to ensure upstream continuity include the following requirements. UA reported that requirements for upstream continuity facilities are not an issue in the mountainous rivers in the Tisza and Prut river basins. HU did not provide any information.

[80] Final summary of the “1st ICPDR Workshop on Hydropower and Water Management” available online: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=94017.

- Type of fish pass (technical or bypass channel): There are indications on the existing approaches for the type of fish passes in RO used in the frame of RBMPs, while in AT there is no preference for a technical fish pass or a bypass channel (more or less natural) as long as it is the best ecological and technically feasible solution at the specific site location. No requirements exist in DE and RS. Methods include type of fish passes in BA.
- Special type of fish pass (e.g. denil, vertical slot fish pass): In AT, a denil is not assumed as acceptable. No requirements exist in DE and RS.
- Hydraulic design (e.g. discharge, flow velocity): AT (discharge, flow velocity, energy dissipation, attraction flow), DE (based on main types of fish, the size of the fish pass and the size of the water body), MD, RS has requirements for hydraulic designs in place.
- Recommendations/requirements on duration of time for passability of the fish pass (e.g. 300 days/year): In AT, passability is required the whole year except in extreme flow conditions. RS has no recommendations on the duration of time for passability in place.
- Recommendations/requirements for fish to locate a fish pass in the river are in place in AT, DE and MD. In RS no recommendations for fish to find a fish pass exist.
- Recommendations/requirements to monitor effectiveness: In AT (whether the construction requirements are met including, for larger facilities, normally also a biological monitoring) and DE (Technical-hydraulic, site characterisation, preliminary function test, biological function check by way of fish-trap controls, electric-shock fishing, fish marking) technical checks are performed. In RO recommendations to monitor effectiveness are generally not foreseen, but the water authority can decide, if necessary, to include the monitoring of effectiveness in the water licenses as an obligation for the owner of the hydropower facility. In RS no recommendations/requirements to monitor effectiveness exist.
- Recommendations/requirements to apply best available technique (BAT) are available in AT, DE and RO. RS does not have any recommendations/requirements to apply BAT in place.
- For HR, the approach to ensure upstream continuity is case specific.

**Tools for downstream continuity facilities**

Several tools are reported to be used in Danube countries in the context of measures to ensure downstream continuity at hydropower plants. While some of the different measures described below technically ensure downstream continuity and fish migration, others only minimise the negative impact of impounded rivers through compensation measures for land owners, fishermen and environmental/fishery authorities. HU did not provide any data.

- Physical barriers to protect fish from turbine intake channels (screens) are used in AT (in some pilot cases), CZ, DE, HR, MD, RO, RS and UA (fish protection nets, grids of water intakes). DE requires a width of 15–20mm at small hydro power plants.
- Bypasses and sluiceways exist in AT (in few pilot cases), BA, CZ, DE, RO and UA (wooden fish pass of steplike type). MD and RS are not using bypasses and sluiceways.
- Plant operation management and spill flow (water releases independent of power generation) are used in CZ, DE (in individual cases in plants > 1 MW) and MD (in case of flooding), while this tool does not exist in AT, BA, and UA.

- Fish-friendly turbines (i.e. Kaplan turbines) are used in AT; some pilot projects are foreseen for the Bavarian part of the German Danube River Basin. These turbines are not used in BA, CZ, MD, SK and UA.
- Catch and carry / Trap and truck are used in individual cases in DE (Mosel cascade) and RS (in cases of bad conditions of waters which are not able to support fish populations). This tool is not used in AT, BA, CZ, SK and UA.
- Monetary compensation for restoration measures for land owners, fishermen, environment / fishery authorities (single or annual payment) are used in AT, MD, RS and UA. In AT, in case of negative effects on fish due to a hydropower plant, which cannot be mitigated by technical measures the owner of the fish area can receive monetary compensation in some cases.

In RS, some hydropower plants are paying for mitigation of negative effects on river fauna which is used for restocking of fish populations. In MD, the owners of damaged lands and/or fishermen can receive monetary compensation in case of floods. UA reported that monetary compensation are already applied (e.g. during construction phase of Krasna hydropower station). This tool does not exist in BA and SK.

- Compensation according to fish stocking (e.g. smolts and fingerlings) is used in DE (for individual cases, as the cascade in the Mosel), RS and UA (according to fish species and feeding area). AT, BA and SK do not use compensation tools according to fish stocking.
- Compensation for measures taken to reproduce habitats (construction of spawning and rearing channels, restoration of habitats) exist in AT, BA and DE. In DE, such tools are widely applied for hydromorphological improvement measures, but less as compensatory measures for hydropower plants. This tool is not used in RS, SK and UA.
- Obligation / recommendation to monitor effectiveness of measures are used in CZ, DE, MD and UA. In DE, recommendations for monitoring downstream eel migration pursuant to EU Eel Protection Regulations are in place. An obligation/recommendation to monitor effectiveness of measures does not exist in AT and RS.

**Specific requirements for hydropeaking mitigation**

The country-specific recommendations and/or standards on hydropeaking mitigation include several specific requirements:

- Amplitude of flow fluctuation
- Frequency of hydropeaking
- Duration of rising and falling of hydropeaking
- Compensation basins
- Improvement of hydromorphological structures
- Coordination of different plants' operation

While in RO all requirements are used, several Danube countries reported that the inclusion of different requirements for hydropeaking mitigation is defined on a case-by-case basis (AT, BA, DE and SI). HR reported that some of the recommendations and/or standards on hydropeaking mitigation are used to the extent in which they are possible and economically justified. No information on specific requirements for hydropeaking mitigation was provided by BG, HU, MD and UA.

**Specific requirements for sediment/bedload transport**

Specific requirements for sediment/bedload transport include

- Technical solutions for the transfer of sediment/bedload
- Considering sediment contamination and
- Addition of sediment/bedload.

On a case-by-case basis technical solutions for the transfer of sediment/bedload are used in AT and DE. In DE, addition of sediment is common in the federal water ways used for transport. RO reported that detailed studies on the evolution of the sediment/bedload transport are needed, including the determination of their evolution in time at the scale of the DRBD. In UA, a hydromorphological research of the water body is obligatory by qualified scientific institutions. For BA, a By-Law about mitigation of sediment transport from the river bed is in place, but mostly as regards the regulation of the rivers.

## 5.6 Other domains for environmental improvement

Other domains, which Danube countries consider important for the improvement of ecological status/potential in hydropower-affected water bodies, were reported:

- Habitat improvement in impounded sections: at the head of the impoundment, in particular, creating new "flowing" river habitats parallel to the impounded sections (AT).
- Creation of continuity (upstream and downstream) and the minimum water discharge is considered to be an important criterion in the context of specific loads from use of hydropower (DE).
- Floating debris (RS).
- Importance of considering issues of the construction of hydropower stations and flood protection activities separately, especially in the mountainous river basins (UA).

## 5.7 Cumulative effects

Cumulative effects are taken into account in the definition of measures set for individual hydropower plants in AT, BG, DE, HR, MD, RO, RS and UA. Cumulative effects are not taken into account in BA and SI.

In AT, all effects including cumulative ones are taken into account when assessing the impact of a new hydropower plant to the water body in which the plant is planned as well as to other water bodies which might be affected. Cumulative effects are also one criterion when weighing public interest in applying Article 4.7. In BG cumulative effects are investigated in the environmental impact assessment procedure. In DE, recommendations on considering cumulative effects can be derived from the continuity strategies of the river basin authorities, which are instruments for strategic water management on river basin and sub-basin level (e.g. continuity strategies for potamodromous and diadromous fish).

Cumulative effects are also taken into account in the pre-planning of hydropower plants as a strategic instrument of management of the catchment area in AT, DE, RO and RS (not in SI). In DE, the continuity strategies of the river basin authorities for potamodromous and diadromous fish can be used to identify suitable areas for the use of hydropower. HR reported that cumulative effects will be analysed within RBMPs.

# 6 Incentives

This section summarizes the different types of incentives as well as their presence in Danube countries. In addition, the relevance and criteria of the different types of incentives for ecological and environmental improvement (e.g. river continuity measures as prerequisite for receiving feed-in tariff or support for modernization, reduction of green house gas emissions) are highlighted.

National and European instruments (such as tradable certificates, feed-in tariffs, support schemes for renewables or ecolabelling) to support and promote hydropower development should be linked to ecological criteria for the protection of water status.[81]

Incentives which combine the support to (existing and new) hydropower and targets to improve water status/potential are in place in AT, DE, HR, RS, SI and UA. In BG, incentives combining support to hydropower and targets to improve water status are absent, while these are under development in BA, CZ and MD. SK reported that the relevance of the incentives for ecological and environmental improvement can be seen in an indirect way, by obligatory requirements for a fish pass and secured minimum ecological flow set in the Water Act for issuing a permit for the construction and operation of a new hydropower plant.

Table 16 indicates the types of incentives in Danube countries and whether these are used, not used or under development. Information for RO was provided for hydropower plants with an installed capacity <10 MW.

| Types of incentives | Presence of incentives in Danube countries | | |
|---|---|---|---|
| | Yes | No | Under development |
| Feed-in tariffs | HR (for hydropower plants < 10 MW), CZ, DE, MD, RS, SI, SK, UA | (AT), HU | BA |
| Support schemes for new plants | HR (for hydropower plants < 10 MW), CZ, DE, RS, SK, RO | AT, BA, HU, MD, SI | RS, UA |
| Support schemes for modernisation | AT, CZ, DE, HR, MD, RO, SK | BA, HU, SI | RS, UA |
| Ecolabelling | AT, DE, UA | BA, SI | MD, RS |
| Tradable certificates | DE, HR, RO, RS, SI, UA | AT, BA, HU, MD | |

[81] Key Conclusions, Common Implementation Strategy Workshop on WFD & Hydropower, Berlin, 4-5 June 2007. Available online: http://www.ecologic-events.de/hydropower/documents/key_conclusions.pdf.

| | | | |
|---|---|---|---|
| Simplified authorisation and licensing procedure | HU, MD | AT, BA, CZ, DE, SI, UA | RS |
| Compensation for energy production loss (monetary or other) | | AT, BA, CZ, DE, RS, SI, UA | MD |

Source: Replies to the Danube Questionnaire, Question Q7.1

**Table 16: Types of incentives**

When highlighting the relevance and criteria of the different types of incentives for ecological and environmental improvement (e.g. river continuity measures as prerequisite for receiving feed-in tariff or support for modernization, reduction of green house gas emissions) the following can be summarized:

- Feed-in tariffs: In AT, feed-in tariffs (only existing for new small hydropower) only have an indirect relevance for ecological improvement as there is no difference made between those plants which improve the water status and those which do not. The criteria for ecological improvement reported by DE include minimum water flow, upstream and downstream continuity, and hydromorphological improvement. In UA green (feed-in) tariffs were introduced including a legal obligation to buy all produced electro-energy from renewable sources, the establishment of the state fund of energy saving, tax and customs bonuses, bonus crediting, state subsidies and obligations of energy suppliers to join producers of electric energy from renewable sources into the network. In BA, feed-in tariffs as incentive for the production of energy from renewable sources are regulated, and application will start from 1 January 2012.

- Support schemes for new plants exist, in most cases, for small and medium size hydropower. In AT, the support scheme for new plants is not directly linked to ecological improvements/criteria, but only indirectly as any new plant needs a permit by the water authority, which is only given for those plants which fulfil ecological requirements (e.g. fish pass and/or ecological minimum flow). In addition, there are support schemes for investments in AT to improve the ecological status at existing plants (building fish passes, improving habitat diversity, reconnection of side arms, etc) earlier than by 2015. 20 to 30% of investment costs are promoted by the government with an obligatory concurrent promotion by the regional government (up to additional 25%).

- Support schemes for modernization exist mainly for small and medium size hydropower.

- Ecolabelling exists in AT and DE, but is not playing an important role among the incentives for ecological and environmental improvement. In UA ecolabelling is voluntary, the logo of ecolabelling belongs to an ecological certification system.

- Tradable certificates are in place in DE, RO, RS and SI. DE reported that tradable certificates are of no significance in the context of national hydropower use. HR provided information that all hydropower plants have certificates on the production of electric energy from renewable sources.

- Simplified authorization and licensing procedures are not in place for Danube countries. Only RS reported this potential incentive to be under development.

- Compensation for energy production loss (monetary or other) is not an issue in Danube countries. However, in 2006, DE (Bavaria) undertook the attempt in the "Framework Agreement for Sustainable Hydropower Use" (Bayerische Eckpunktevereinbarung für eine nachhaltige Wasserkraftnutzung) to compensate energy production losses.

# 7 Implementation Article 4.7 WFD or similar national approaches

Section 7 summarises background information as regards the implementation of Article 4.7 WFD or similar national approaches in those Danube countries not being part of the European Union.

Member States should avoid taking action that could further jeopardize the achievement of the objectives of the WFD, notably the general objective of good ecological status of water bodies. The further use and development of hydropower should consider the environmental objectives of the WFD in line with the requirements of Article 4. Under Article 4.7 WFD, exemptions from "achieving good ecological status" or "good ecological potential" and the "non deterioration clause" (failure to prevent deterioration from high status to good status of a surface water body) can be applied for new modifications and new sustainable human development activities. This can relate to new projects (e.g. new specific hydropower dams) or to modifications to existing projects.

The requirements of Article 4.7 for new hydropower include amongst others that there are no significantly better environmental options, that the benefits of the new infrastructure outweigh the benefits of achieving the WFD environmental objectives and that all practicable mitigation measures are taken to address the adverse impact of the status of the water body.

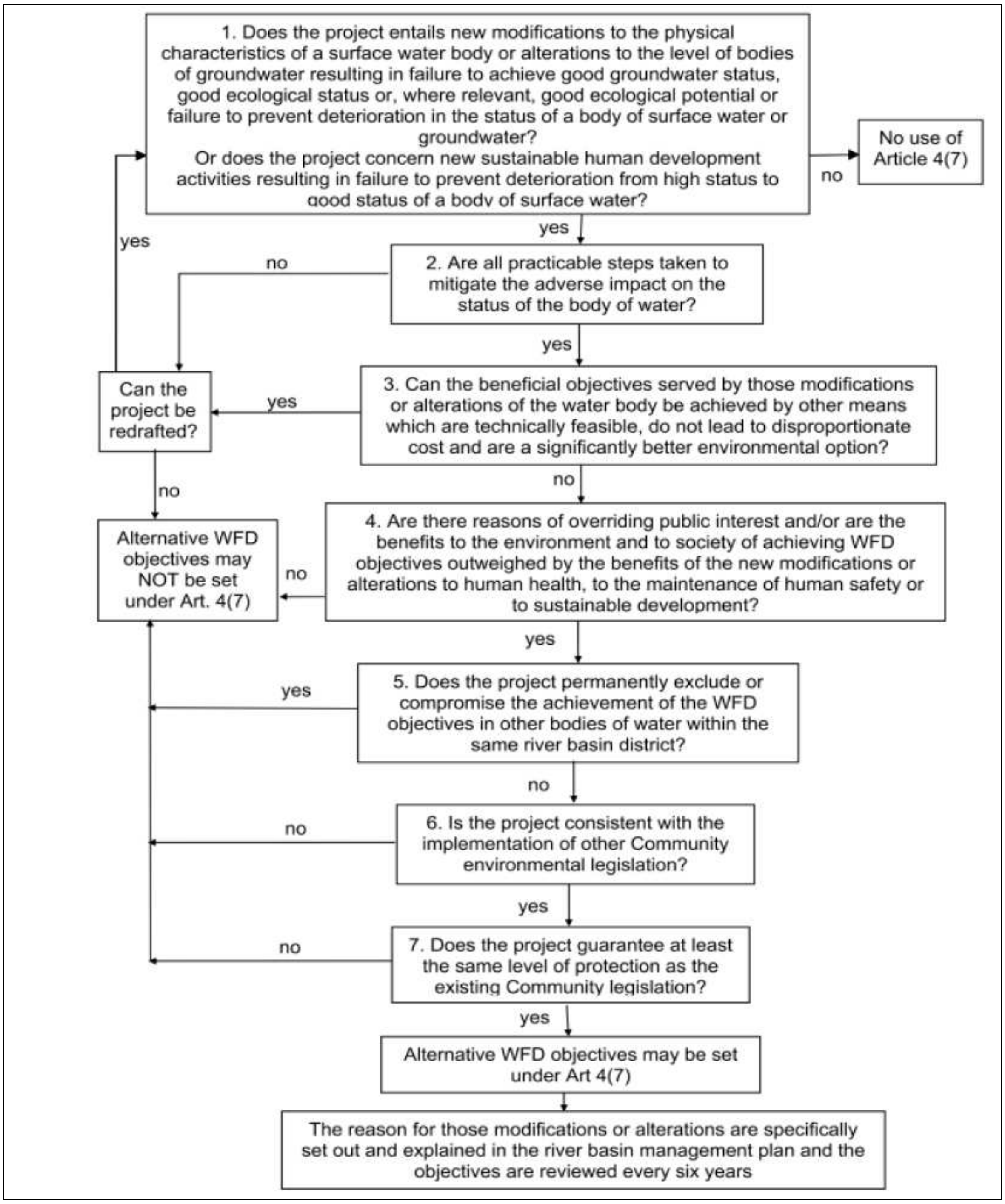
For new modifications affecting water status in relation to hydropower projects, an assessment according to the WFD definition of water status should be carried out[82] in a stepwise approach:

- All practicable steps are taken to mitigate the adverse impact on the status of the body of water. This includes impacts on the quality elements for the classification of ecological status, impacts on other water bodies than the one in which the project is situated, and in case of several projects in the same river basin, cumulative effects of the various projects (Article 4.7 (a)).
- Article 4.7 (b) requires a justification in RBMPs: The risk of deterioration of status occurring should be assessed at the time a new modification or alteration is being considered. This means that a modification should be included in the river basin management plan when it is still in the planning stage, and not only when a final consent is reached.
- Balancing the benefits of the new modifications to the foregone benefits of water protection or to the public interest should be done in the very early stages of the project's development according to Article 4.7 (c). Foreseen benefits of the project in the early stage may not be fully achieved when the project is planned in more detail. For example, a certain potential of hydropower may not be feasible to develop because of water / nature legislation.

[82] Key Conclusions, Common Implementation Strategy Workshop on WFD & Hydropower, Berlin, 4-5 June 2007. Available online: http://www.ecologic-events.de/hydropower/documents/key_conclusions.pdf.

- Article 4.7 (d) regulates that any available alternatives, or better environmental options, should be assessed at an early stage of developing the project. Those alternative options could involve alternative locations, different scales or designs of development, or alternative operational processes. In case of several developments in the same river basin, best environmental options need to be addressed at a strategic - regional level. The CIS recognizes the need to address the issue of the better environmental options at a strategic – regional level. When arguing the case of “no better environmental option” not only the single project and locality but a whole region or catchment should be considered.

Figure 38 highlights the step-wise application of Article 4.7 WFD and the different provisions which have to be taken into account with regard to planning procedures for potential further hydropower developments. The approach described is not only of particular relevance for EU-MS, but may also serve as general recommendations to be used in non EU-MS.




Source:CIS Guidance document on exemptions to the environmental objectives[83]

**Figure 38: Application of Article 4.7 WFD in a stepwise approach**

In 2010, the Water Directors endorsed a Statement on “Hydropower Development under the Water Framework Directive” summarising key principles and recommendations, which

[83] The CIS Guidance document on exemptions to the environmental objectives can be downloaded from http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents&vm=detailed&sb=Title.

have been previously agreed in the CIS process (WD meeting, Segovia, 27-28 May 2010).[84] This Statement was mainly based on elements of the CIS Policy Paper on WFD and Hydro-morphological pressures[85], the CIS Guidance Document No. 20 on Exemptions to the Environmental Objectives[86] and the Conclusions of the first CIS Workshop on WFD and Hydropower[87]. An earlier screening of the draft RBMPs indicated absence of clear and explicit references to the use of WFD Article 4.7, whose requirements have to be taken into account in the case of new hydropower projects.[88]

As it can be seen from table 17, in five Danube countries (BG, MD, SI and UA), it is generally considered that a new hydropower plant will lead to a deterioration of water bodies. For MD it was reported that new hydropower plants are not foreseen in the Moldavian part of the Danube river basin, but that there is an understanding that the functioning of actual hydropower plants leads to the deterioration of a water body (Costesti-Stinca). The procedure of Article 4.7 is generally followed in DE, SI and RO. On the contrary, in AT, CZ, DE, RO and SK it is not generally assumed that new hydropower plants will lead to a deterioration of GES. However, when interpreting this question it is necessary to take into account whether new hydropower plants are always seen in conjunction with mitigation measures or without any measures ensuring requirements for environmental improvement.

| | Yes | No | Unknown | Not answered |
|---|---|---|---|---|
| Is it generally considered that new hydropower plants will lead to a deterioration of water bodies? | BG, MD, SI, UA | AT, CZ, DE, RO, SK | BA, HR | HU, RS |
| If it is assumed that new hydropower plants will deteriorate GES, is the procedure of Article 4.7 for new plants generally followed? | DE, SI, RO | BG, | HR, UA | AT, BA, CZ, RS, SK |

Source: Replies to the Danube Questionnaire, Q6.2

**Table 17: General consideration that new hydropower plants will lead to a deterioration of water bodies**

[84] Final Synthesis of Informal meeting of Water and Marine Directors of the European Union, Candidate and EFTA Countries, Segovia, 27-28 May 2010.

[85] Common Implementation Strategy for the Water Framework Directive 2006: WFD and Hydro-morphological pressures - Policy Paper. Version 8.0. 3 November 2006.

[86] Common Implementation Strategy for the Water Framework Directive 2009: Guidance Document No. 20 on exemptions to the environmental objectives. Technical Report - 2009 – 027

[87] Key Conclusions, Common Implementation Strategy Workshop on WFD & Hydropower, Berlin, 4-5 June 2007. Available online: http://www.ecologic-events.de/hydropower/documents/key_conclusions.pdf.

[88] Kampa, E.; Dworak, T.; Grandmougin, B.; Cheung-Ah-Seung, E.; Mattheiß, V.; Strosser P.; Campling P. (2009): Active Involvement in River Basin Management – Plunge into the debate. Conference document to the 2nd EU Water Conference 2-3 April 2009, Brussels

Certain Danube countries that do not generally consider that new hydropower plants will lead to a deterioration of GES, highlight the site-specific nature of hydropower plants and mention different variables to take into account in this context:

- Current status of water body, type of hydropower plant/design, obligatory and feasible mitigation measures (AT).
- Outcome of environmental impact assessments (RO).

The application of Article 4.7 as regards new hydropower plants and the number of plants approved, although a deterioration of GES is expected, is summarized in table 18. RO reported that the construction of two hydropower plants was approved before the year 2000 and having in view that their construction is currently under way, the exemptions have been identified and requested in the RBMPs.

| | Yes | No | Unknown | Not answered |
|---|---|---|---|---|
| Has Article 4.7 been already applied for new hydropower plants? | AT (2), CZ, RO (2), SI (4) | BA, HR, SK, BG | DE, MD, UA | HU, RS |
| Number of plants approved although a deterioration of GES is expected | AT (1), RO (2), SI (4) | SK, BG | DE, MD, UA | RS |

Source: Replies to the Danube Questionnaire, Question Q6.1

**Table 18: Application of Article 4.7 for new hydropower plants**

When assessing how the different steps of Article 4.7 (a), (c) and (d) have been implemented in the Danube countries, the following can be summarized:

Referring to the provisions of Article 4.7 (a), the following practicable steps (national examples) have been taken to mitigate the adverse impacts on the status of the affected water body(s):

- AT: In Austria, mitigation measures to reduce negative impacts on water status are a precondition to get a permit/license for a new hydropower plant. Ecological continuity as well as an ecological minimum flow are obligatory mitigation measures for new plants in natural water bodies as well as in heavily modified water bodies (when defining the ecological minimum flow in HMWBs the altered flow and/or bed structures have to be taken into account). Other mitigation measures which are technically feasible depend on the actual situation. Austria has published a catalogue of mitigation measures. It included measures stated to be State of the Art and Technology/best available techniques for all kinds of hydrological alterations and also information on the relevance for ecological improvement. In the frame of the HMWB designation process mitigation measures to achieve GES were identified out of the measure-catalogue mentioned above which mean a significant adverse effect on specific uses/wider environment and for hydropower as a use in particular. These measures are excluded. The rest of measures – if technically feasible at the specific water body – will be used as a basis for the definition of GEP (alternative measure approach). From the Austrian point of view, it makes sense to link measures needed for the GEP definition with mitigation measures for new hydropower plants which would mean a deterioration of water status and require an application of Article 4.7.

Those measures relevant for GEP (and not disproportionate costly) are at least also relevant for the definition of practical measures to mitigate the adverse impact as mentioned in Article 4.7 (a). In many cases, the following mitigation measures are used: constructing high variability (fish) habitats in the impoundments (at the head of the impounded section in particular), improving habitat structures, constructing spawning habitats, reconnection of flood plains/side arms, building new (connected) side arms. Fish passes to maintain continuity and ecological minimum flow are state of art and technology in Austria.

- CZ: The Czech Republic has used methodological direction for establishing minimum residual flow and control of the use of water. Presently a new government order and new methodological direction based on an acceptable degree of natural flow modification for individual catchments are prepared. Water authority will be responsible for assessing what is considered as acceptable modification of natural flow and the use of water.

- MD: The main instrument for mitigating the adverse impacts on the status of the affected water body(ies) is forestation of the banks of the water body and construction of facilities to combat bank erosion.

- RO: Exemptions in relation to Article 4.7 were required for 2 hydropower plants and the analysis of the implementation of Article 4.7 for these cases will follow. The Ministerial Order 1.163/2007 of the Minister of Environment and Sustainable Development provided principles for mitigation of the adverse impacts on the ecosystems and for ensuring, as much as possible, the equilibrium of the natural water course and of its adjacent area.

- UA: The practical steps included cleaning of some stretches of the tributaries, construction of additional steep drops for the water course, conduction of the actions to reduce the speed of flow, improvement of hydrological regime and provisions for sanitary discharges during low water period (for e.g. Bilun hydropower station at Chorna Tisza).

As regards the provisions of Article 4.7 (c), the overriding public interest of a new hydropower plant or the fact that the benefits of a new plant outweigh the benefits of achieving the WFD environmental objectives were judged in the following way (national examples):

- AT: In the national RBMP it was stated that when weighing public interest, it is a clear principle that the higher the ecological value of a water stretch (water body) is, the higher the energy output has to be. In order to support water management authorities when weighing the different public interests in the Article 4.7 test, to ensure an Austrian wide common understanding and application as well as to make the decision transparent, it was included in the national RBMP that a "catalogue of criteria for hydropower" has to be developed. This catalogue was published in January 2012 and summarises ecological aspects, energy management and other water management aspects (like effects on flood protection, tourism, groundwater quality and quantity, and others). The "catalogue of criteria" also provides the information, which water bodies are of high or very high value and can be downloaded from the following webpage: http://www.lebensministerium.at/wasser/wasser-oesterreich/wasserrecht_national/planung/Kriterienkatalog.html).

- CZ: The Czech nature potential for construction of large hydropower plants is almost depleted; hence no new large hydropower plant is planned in the CZ. Only reconstruction and modernization of existing small hydropower plants comes into question and, in these cases, the public involvement will be managed on local level.

- RO: The Law 220/2008 with subsequent amendments stipulates that the works for hydropower generation are considered as of overriding public interest. In the frame of the Governmental Decision 1069/2007 it is mentioned that one of the strategic objectives of the Romanian strategy in the field of energy for 2007 to 2020 is represented by sustainable development through the promotion of the energy production/generation from renewable resources. The benefits and the impact is analyzed at the level of each development project.

- UA: At present, energy production, stable salary for local population and improvement of infrastructure, override any ecological goals.

The methods used to assess if the beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option (reference to provisions of Article 4.7 (d)) can be described as follows (example):

- AT: During the approval/licensing process applying the Article 4.7 test, the question of better environmental option is decided by the authorities on a case-by-case basis. It would be helpful to answer the following questions (examples): Is it technically feasible a) to produce the same amount of electricity by another renewable source, b) to produce the same amount of electricity by modernisation or upgrading of existing plants, c) are there any additional mitigation measures which can reduce the negative effect significantly, even to such extent, so that there is no deterioration any more, d) will there be an alternative site where the project will not lead to a deterioration or at least to much less significant environmental damage and e) are the technically feasible options disproportionate costly. The “catalogue of criteria” will also be a supporting tool to answer the above listed questions (for example the “catalogue of criteria” includes the information about the sensitivity (ecological value) for all Austrian water bodies in order to support as regards the decision on alternative sites). In addition, hydropower plants > 15 MW have to apply an environmental impact assessment in which a discussion of other options/alternatives is included as an obligation. The “catalogue of criteria” in Austria does include questions concerning „other renewable energy sources“ and „modernisation/upgrading of existing plants“.

# 8 Strategic planning tools

In most Danube countries, there are planning instruments for the strategic development of new hydropower generation. This section provides an overview of the levels and types of strategic planning instruments (section 8.1), the criteria of strategic planning instruments (section 8.2) and strategic planning as a tool to foster the dialogue with water users (section 8.3).

## 8.1 Levels and types of strategic planning instruments

The strategic planning instruments are used on several different levels and, in the majority of Danube countries, different instruments are applied on different levels. Most common are strategic planning instruments on national and regional level.

| | Yes | | No |
|---|---|---|---|
| | National | Regional | |
| Are strategic planning instruments for the development of new hydropower generation used in your country? | AT, BA, DE, HR, RO, RS, SK, SI, UA | AT, DE, RS, UA | BG, CZ, HU, MD |

Source: Replies to the Danube Questionnaire, Question Q5.1

**Table 19: Strategic planning instruments on different levels**

Examples of strategic planning instruments can be summarised as follows:

- AT: Hydropower potential studies for the national and some regional levels; Alpine region: Common Guidelines for the use of small hydropower in the Alpine region.
- BA: Planning instruments for the development of new hydropower are the Strategy for Energy Sector for the Republic Srpska until 2030 as well as the Action Plan for the development of the Water Sector, which is currently under preparation. For the Federation of Bosnia and Herzegovina, planning instruments for the development of new hydropower generation are the Strategic Plan and Program of the Energy Sector Development until the year 2020.DE: There are planning instruments for the administrative level (national, state); e.g. a Study on potential of hydropower for the Danube and sub-catchments (e.g. also Neckar Potential Study), Hydropower Master Plan. On state level, the water authorities check whether hydropower can be used on non-down sizable transverse structures.
- HR: The Energy Sector Development Strategy of the Republic of Croatia is a national-level document for strategic planning (Official Gazette No. 130/2009).
- RO: Elements for pre-planning process can be found in the River Basin Management Plans, Management Plans for NATURA 2000 sites (those elaborated and the ones which are under approval procedure), legislation in the field of nature protection and biodiversity conservation in NATURA 2000 sites, natural protected areas and in the National Renewable Energy Action Plan.

- RS: The National Spatial Plan of the Republic of Serbia was adopted in 2010; relevant regional, local and other spatial plans are developed/under developing. Development of new hydropower plants are in line with these plans.

- SK: The Slovak government adopted the “Conception on hydropower potential utilization of Slovak water courses” by its resolution No.178/2011. It aims to secure an increase in hydro-energy utilization for energy production from renewable energy sources in compliance with EU and national strategic energy targets and other relevant EU and national strategic documents. The conception passed through the SEA process.

- SI: Pre-planning instruments are used on national level for hydropower plants > 10MW and are applied by the Ministry for the Economy (Directorate for Energy).

- UA: National and regional planning instruments are reflected in the legal documents. There are even rayon (district) programs of development for small hydroenergy (for e.g. Rajhiv rayon of Zakarpatska oblast, Verkhovunsky rayon of Ivano-Frankivsk Oblast). At regional level, energy programs are being developed (schemes of complex use of water resources following the river basin principle for Tisza, Prut and Cheremosh river basin).

The strategic planning instruments are part of the following overall planning processes:

| | Danube Countries |
|---|---|
| River Basin Management Planning<br>River Basin Development and Management Scheme | AT, BA, DE, RO<br>RO |
| National Renewable Energy Action Plan | AT, BA, DE, HR, RO, RS, SK, SI, UA |
| Hydropower Sector planning | AT, BA, DE, HR, RO, RS, UA |
| Designation of areas for new hydropower use: | |
| • Appropriate areas | AT, DE |
| • Less appropriate areas | AT, DE |
| • Not appropriate areas | AT |
| • Others | • SK: list of technically suitable localities for energy production – for plants of capacities up to 10 MW.<br>• SI: areas for new hydropower plants are designated in the frame of National Renewable Energy Action Plan).<br>• UA: reflected in Energy Programs and Schemes.<br>• BA: reference to Strategy for Energy Sector for the Republic Srpska until 2030 as well as the Action Plan for the development of the Water Sector. |

Source: Replies to the Danube Questionnaire, Question Q5.2 and QA.8

**Table 20: Strategic planning instruments are part of the following overall planning processes**

There are no general exclusion criteria (e.g. biodiversity data, priority rivers / river stretches for protection of migratory and/or endemic fish species) for hydropower generation in the Danube countries. However most of the Danube countries refer to the need of case-by-case decisions in the light of nature conservation areas and water-dependent Natura 2000 sites and related environmental legislation:

- BG: The criteria are specified in the Water Act and the Ordinance for the use of surface waters as well as highlighted in the River Basin Management Plan.

- DE: No general exclusion criteria; the examination of hydropower use is performed in each specific case with the overall consideration of all aspects. Management objectives for water bodies must be observed, exceptions being possible where appropriate. The following must be ensured on principle: minimum water flow in diversion plants, continuity and the protection of fish populations. In particular nature conservation areas and water-dependent Natura 2000 areas can have prejudicial impact in the sense of exclusion.

- RO: From the point of view of nature protection and biodiversity conservation, the regulation of the investment/development activities in natural protected areas is done through specific legislation, according to the type of protected areas and their conservation objectives and their management.

- RS: One of the conditions to obtain an operation permit for a new hydropower plant is the compliance of the Ministry in charge for environmental issues. To obtain the above compliance, the necessary conditions stipulated under the Environmental Protection Act, the Nature Preservation Act, the Fish Stock Preservation and the Sustainable Use Act have to be met, as well as other acts from this field.

- SI: Exclusion criteria are described in comprehensive environmental impact assessments of the National renewable energy action plan.

## 8.2 Criteria of strategic planning instruments

Due to the variety of planning instruments used in different countries, the criteria applied are very diverse. AT, DE and SK reported information on how the criteria were set for the strategic planning instruments:

- AT: Hydropower potential studies for national and some regional levels; Vorarlberg: water stretches in high status are not appropriate areas; 4 river stretches are more or less designated for hydropower use; Tirol: voluminous criteria catalogue taking into account ecology, nature protection, energy/economic aspects, water management aspects, regional/spatial planning (see http://www.tirol.gv.at/regierung/steixner-anton/kriterienkatalog); Alpine Convention: Common Guidelines for the use of small hydropower in the Alpine region; National criteria catalogue: criteria assessing the ecological value of river stretches, criteria for the assessment of specific hydropower projects taking into account ecological, energy management and water management aspects in case of an expected status deterioration.

- DE: Study on potential of hydropower in Germany: determination of hydropower potential using the line potential for Germany (ecological exclusion criteria e.g. no new works in freely flowing rivers, new works on existing transverse structures only on discharge of ecological flows.), determination of potential on existing transverse structures.

Criteria for allowing hydropower use can be: the downsizing of the weir is not possible for other reasons (e.g. regulation of groundwater level), discharge of ecologically necessary flows, no impact on flood control) Continuity strategies for fish fauna (LAWA Strategy Paper on Fish Continuity), fixing of routes with special significance for the preservation and reestablishment of diadromous and potamodromous species (structure: defining target species, development of transverse structure cadastres with assessment of fish continuity, hydromorphological condition and development potential of habitats); Neckar Potential Study: In an interdisciplinary study, the technological-economic-ecological development potential was assessed in the Neckar river basin at sites already in use and the potential of new works on transverse structures not yet in use.

- SK: Criteria of valid legislation and International Conventions.
- UA: The hydroenergy potential of the water course is the main criterion used during planning (in order to get maximum income). The second criterion is the flood protection for the Ukrainian population, reflected in the Flood Management Plans for the Tisza and Prut basins.

## 8.3 Strategic planning and dialogue with water users

AT, DE, SK and UA reported that their strategic planning instrument foster the dialogue with the water users.

- In AT, for instance, all pre-planning instruments have been the subject of extensive consultations with stakeholders.
- In DE, strategic concepts are communicated with the users in varying intensity. A large proportion of the general public and users participated in the preparation of the management plans and this involvement was continued when defining the concrete measures.
- In UA, strategic planning not only takes into account issues of hydro-energy, but also uses the integrated approach. The construction of hydropower stations in the mountainous area of the Tisza and Prut river basin considers issues related to flood protection, water supply for settlements, infrastructure construction (roads, schools, kindergardens) and the conservation of the recreation-tourism potential of the region.

# 9 Main findings and conclusions

The objective and scope of the ICPDR activity “Guiding Principles on Hydropower Development” was initiated through the Danube Declaration, which was adopted in February 2010 and in which the ICPDR was asked “to organize 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”.

The “Assessment Report on Hydropower Generation in the Danube Basin in the context of the Water Framework Directive and the Renewable Energy Directive” summarizes key information and data on hydropower generation in the context of water management, flood protection, biodiversity and nature protection at Danube basin level at Danube Basin level and serves as fundament and basis for the elaboration of “Common Guiding Principles on Hydropower Development in the Danube basin including case studies and good practice examples of hydropower generation in the context of the Water Framework Directive and Renewable Energy Directive”. Information and data for this report were gathered through data reported by Danube countries via a “Questionnaire for data collection on hydropower generation and water management issues in the Danube countries” as well as complemented by official sources such as EUROSTAT, the European Commission, and the ICPDR. In addition, discussions and feedback received during the “1st ICPDR Workshop on Hydropower and Water Management”, organized from 21 to 22 February 2012 in Timişoara (Romania), provided further valuable background information to this Report.

**Policy and legislative Framework**

Hydropower generation in the Danube basin needs to be seen in the context of EU policies and legislation in the field of water protection (Water Framework Directive) and flood protection (Floods Directive), electricity production from renewable energy sources (Renewable Energy Directive) as well as nature and biodiversity (Birds and Habitats Directive) and environmental assessment processes (Strategic Environmental Assessment Directive and Environmental Impact Assessment Directive). These Directives present an opportunity but also a challenge in reaching multiple environmental objectives.

Balancing the requirements of achieving “good status” for all surface waters and groundwater as a rule by 2015 (WFD) and reaching a 20% share of energy from renewable sources by 2020 (Renewable Energy Directive) is a major challenge and needs to be taken into account with regard to planning procedures for new hydropower developments. Win-win measures to improve the status of water bodies with acceptable loss of energy production would be eligible as well as measures to increase hydropower generation without negative effects on water ecology, such as raising efficiency at existing sites and defining suitable sites for new hydropower plants by strategic planning tools and the application of Article 4.7 of the WFD. The Water and Energy discussions should also be linked to the debate on adaptation to climate change, including other water and energy issues like energy efficiency.

**Commitment of non EU-MS Danube Countries to implement the relevant EU "acquis communautaire"**

Six Danube countries which are not part of the European Union (BA, HR, MD, ME, RS and UA) have committed themselves to implement the relevant “acquis communautaire” in the area of electricity, gas, environment and renewable energy through the Energy Community. Furthermore, non EU-MS committed themselves to implement the WFD within the frame of the Danube River Protection Convention.

**Key figures on hydropower generation**

When assessing the key figures for electricity production in the Danube basin, from renewable energy sources in general and hydropower in particular, it can be seen that – also due to the national overall targets for the share of energy from renewable energy sources set in the Renewable Energy Directive – many Danube countries plan a considerable increase in electricity production from renewable energy sources until the year 2020. In most Danube countries surveyed, 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). 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. However, when assessing the total amount of electricity production from hydropower expected for the year 2020, a moderate increase in electricity production from hydropower can be seen for AT, BA, DE, HU, RS, SK and SI, while a slight decrease of electricity production from hydropower is expected for CZ.

When looking at the different sizes of hydropower plants in the Danube basin and their share to the total electricity production from hydropower, it can be clearly seen that by far the most significant share (88.4%) of electricity in Danube countries is generated by large facilities (representing 3.4% of the total number of hydropower stations) with bottleneck capacities of more than 10 MW.

**Hydropower and environmental protection**

In line with the provisions of the Water Framework Directive as well with ecological needs and cumulative effects, a more holistic assessment needs to be carried out for new hydropower plant facilities affecting the water status. This includes the impact on the ecological status of the river stretch, the impacts on river stretches other than the one on which the project is situated and, in the case of several projects in the same river catchment, cumulative effects of the various projects.

The Report provides detailed information on legal and technical requirements related to the following key domains of environmental improvement at hydropower plants: minimum ecological flow, upstream continuity facilities, downstream continuity facilities, hydropeaking mitigation and sediment/bedload transport. Although many Danube countries reported to have environmental requirements in relation to ensuring river continuity and ecological flow requirements included in their existing national legislation, technical guidelines as well as clear criteria, standards and definitions are not always in place yet causing difficulties in the practical implementation.

**Legal requirements for environmental improvement**

In all surveyed Danube countries, upstream continuity facilities for fish migration and standards for minimum ecological flow are required for new hydropower plants. Requirements for downstream continuity facilities for fish migration are reported to be in place for new hydropower plants in all surveyed countries, with the exception of AT.

As regards existing plants, requirements for upstream continuity facilities only exist in HU, SK and SI, while only BG and HU reported requirements as regards downstream continuity facilities in place for existing plants. For minimum ecological flow, requirements for existing hydropower plants are in place partly in AT, BA, BG, HU, MD, SK, SI and UA. For sediment/bedload transport, requirements in individual cases partly exist in AT as well as in CZ, DE, HR, SI and UA. In other Danube countries, technical requirements are set on a case-by-case basis. Generally no legislative means for sediment/bedload transport are available in BA, RO, RS and SK.

**Technical requirements for environmental improvement**

Only in a few Danube countries technical standards for upstream continuity facilities exist, recommendations and standards set on a case-by-case basis can be found more often. For downstream continuity facilities no relevant technical method is defined in most of the surveyed Danube countries.

National technical standards for minimum ecological flow are set by law in AT, BA, BG, RO, HU, SI and UA, while a recommendation is in place in CZ, DE and RS. From a technical point of view, a recommendation for sediment/bedload transport exists in DE and MD, while technical requirements are set on a case-by-case basis in AT, CZ, HR, RS, SI and UA. No relevant technical method is defined in BA, BG, SK and RO.

**Implementation of Article 4.7 WFD or similar national approaches**

Under Article 4.7 WFD, exemptions from “achieving good ecological status”, “good ecological potential” and deterioration clause can be applied for new modifications and new sustainable human development activities. This can relate to new hydropower schemes or to modifications to existing projects. The requirements of Article 4.7 for new hydropower include amongst others that there are no significantly better environmental options, that the benefits of the new infrastructure outweigh the benefits of achieving the WFD environmental objectives and that all practicable mitigation measures are taken to address the adverse impact of the status of the water body.

An assessment of the application of Article 4.7 WFD in Danube countries show that only a very small number of new hydropower plants were checked against the provisions of Article 4.7 WFD (four hydropower plants in SI, two in AT and two in RO, rarely in CZ), whereas one hydropower plant was approved in AT, two in RO are currently under construction and four in SI, although a deterioration of the “good ecological status” is expected.

The step-wise application process of Article 4.7 WFD and the different provisions which have to be taken into account with regard to planning procedures for potential further hydropower developments are not only of particular relevance for EU-MS, but may also serve as general recommendations to be used in non EU-MS. Political decision-making concerning hydropower follows the need for economic development by taking into account the requirements of environmental legislation. Therefore, a clear need for supporting administrations in decisions on the authorisation process for new facilities was identified.

**Strategic planning tools**

In most Danube countries, there are planning instruments for the strategic development of new hydropower generation. The strategic planning instruments are used on several different levels and, in the majority of Danube countries, different instruments are applied on different levels. Most common are strategic planning instruments on national and regional level. The strategic planning instruments are mostly part of the River Basin Management Planning, the National Renewable Energy Action Plan and the Hydropower Sector planning. However, the link between further development of hydropower and the provisions set in River Basin Management Plans provides considerable room for improvement. The outcome of the discussions during the "1st ICPDR Workshop on Hydropower and Water Management" reiterated the importance of strategic planning processes being transparent in particular also for applicants of new hydropower facilities gaining a better overview of river stretches suitable for further hydropower development before licensing procedures start.

There are no general exclusion criteria (e.g. biodiversity data, priority rivers / river stretches for protection of migratory and/or endemic fish species) for hydropower generation in the Danube countries. Most of the Danube countries refer to the need of case-by-case decisions in the light of nature conservation areas and water-dependent Natura 2000 sites and related environmental legislation.

*Summarising the main findings and results of this report, the following conclusions can be highlighted:*

- Growing energy demand, increased electricity prices as well as targets for reducing greenhouse gas emissions act as drivers for further expansion of hydropower generation and additional facilities. On the other hand, generation of electricity by hydropower can have severe impacts on the aquatic ecology and the natural landscape. **Innovative technologies, methods of operation including environmental improvements and the willingness of all actors to integrate environmental concerns in the planning process, and also by the adaptation of already existing hydropower stations, can mitigate negative effects and make hydropower a more sustainable way for generating electricity**. This has to be assured through a legislative framework that takes into account these environmental concerns and is backed up by integrated strategic planning processes.

- **Targets for energy from renewable sources and the environmental objectives of the WFD are compatible**, but it is a prerequisite that provisions of Article 4.7 WFD and legislation according to water and biodiversity are taken into consideration at an early stage, that the planning and the consideration for alternatives is done on a river basin level and that stakeholders and the public are involved as early as possible. The recent study on "Hydropower Generation in the context of the EU WFD", commissioned by DG ENV (2011), estimated that hydropower could be reduced by only 8 to 9 TWh (2.3 to 2.6% of total hydropower generation on European level scale) because of ecological mitigation required by the WFD. Furthermore, case studies show that in particular the refurbishment and modernization of existing hydropower plants offer important opportunities to combine ecological mitigation and increased hydropower generation.

- When looking at the different sizes of hydropower plants in the Danube basin and their share to the total electricity production from hydropower, by far **the most significant share (88.4%) of electricity is generated by large facilities**

**(representing 3.4% of the total number of hydropower stations) with bottleneck capacities of more than 10 MW**. Referring to the installed capacity of different hydropower plant sizes, it can be seen that 3.4% of the total number of stations with more than 10 MW provide an installed capacity (in MW) of 90.0% in Danube countries. The smaller the capacity class, the more contrasting is the ratio between the number of plants and their contribution to the total hydroelectric production.

- A considerable number of **future infrastructure projects** are at different stages of planning and preparation throughout the entire DRBD. These projects **might provoke pressures and deterioration of the water status, leading to the application of Article 4.7 of the WFD in justified cases**. The Article 4.7 exemption tests are a legal requirement for new modifications and their proper application reflects good practice in environmental decision-making. In some Danube countries new large hydropower plants are considered as infrastructure development projects with multiple uses, the main objectives being human safety (water supply, flood defense), hydropower use being an additional purpose.

- As one of the main outcomes of the “1st ICPDR Workshop on Hydropower and Water Management” it was indicated that **support in defining clear criteria and standards in terms of requirements for environmental improvement of negative impacts of hydropower is needed and a prerequisite for the efficient implementation of the provisions of the WFD** on national level. As the situation in the Danube basin including EU and Non-EU Member States is rather diverse and complex, it is of utmost importance to set common guiding principles to support Danube countries with hydropower development in general as well as the application of new hydropower schemes in particular.
- The **elaboration of the “Common Guiding Principles on Hydropower Development in the Danube Basin”** will play a crucial role in **supporting the ongoing efforts of combining the different requirements in a balanced way,** focusing also on the identification of the remaining hydropower potential in the Danube countries by taking into account criteria for the ecological compatibility of new hydropower facilities**.** Both, the Report and the common guiding principles are envisaged to facilitate the discussion for future projects, but will not replace any legal requirements or technical discussions on national level.

# 10 References

This section summarises references used for this Report from the European Commission (EC), the International Commission for the Protection of the Danube River (ICPDR), the European Environment Agency (EEA), international organisations as the Alpine Convention as well as other sources. References and links to national legislation, policies and strategies in the field of energy and environment can be found in Annex V.

**European Commission (EC):**


- Common Implementation Strategy "Water Framework Directive and hydromorphological pressures", ad hoc activity „Hydromorphology" (2011): Issue Paper "Water management, Water Framework Directive & Hydropower", Authors: Eleftheria Kampa, Johanna von der Weppen (Ecologic Institute) and Thomas Dworak (Fresh-Thoughts). Available online: http://www.ecologic-events.eu/hydropower2/documents/IssuePaper_final.pdf.

- Common Implementation Strategy for the Water Framework Directive (2006): WFD and Hydro-morphological pressures - Policy Paper. Version 8.0. 3 November 2006.

- European Commission, COM(2007) 128 final: Commission Staff Working Document accompanying to the Communication from the EC to the European Parliament and the Council. 'Towards Sustainable Water Management in the European Union'. First stage in the implementation of the Water Framework Directive 2000/60/EC.

- European Commission, COM(2010) 715 final: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Union Strategy for the Danube Region,{SEC(2010) 1489 final}, {SEC(2010) 1490 final}, {SEC(2010) 1491 final}.

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- European Commission, SEC(2010) 1489 final: Commission Staff Working Document, Action Plan, Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Union Strategy for the Danube Region, {COM(2010) 715 final}, {SEC(2010) 1490 final}, {SEC(2010) 1491 final}.

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- Key Conclusions, Common Implementation Strategy Workshop on WFD & HMWB, Brussels, 12-13 March 2009. Available online: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/modified_brussels_12-13/conclusions_2009pdf/_EN_1.0_&a=d.

- Key Conclusions, Common Implementation Strategy Workshop on WFD & Hydropower, Berlin, 4-5 June 2007. Available online: http://www.ecologic-events.de/hydropower/documents/key_conclusions.pdf.


**International Commission for the Protection of the Danube River (ICPDR) and other regional River Basin Commissions in the Danube basin:**


- Convention on Cooperation for the Protection and Sustainable use of the Danube River (Danube River Protection Convention). Available online: http://www.icpdr.org/icpdr-pages/legal.htm.

- ICPDR & ISRBC (2007/2008): Development of Inland Navigation and Environmental Protection in the Danube River Basin. Joint Statement on Guiding Principles. The statement, all annexes as well as additional information are available online: http://www.icpdr.org/icpdr-pages/navigation_and_ecology_process.htm.

- ICPDR document IC 089 (2004): The Danube Basin – Rivers in the Heart of Europe (Danube Declaration). Available online: http://www.icpdr.org/icpdr-files/15216.

- ICPDR Document IC 084 (2005): The Danube River Basin District. River basin characteristics, impact of human activities and economic analysis required under Article 5, Annex II and Annex III, and inventory of protected areas required under Article 6, Annex IV of the EU Water Framework Directive (2000/60/EC), Part A. Basin-wide overview. Available online: http://www.icpdr.org/icpdr-pages/reports.htm.

- ICPDR document IC 132 (2007): Significant Water Management Issues in the Danube River Basin District.

- ICPDR document IC 151 (2009): Danube River Basin District Management Plan. Part A – Basin-wide overview. Available online: http://www.icpdr.org/icpdr-pages/reports.htm.

- ISRBC (2010): Sava River Basin Analysis Summary. Available online: http://www.savacommission.org/dms/docs/dokumenti/documents_publications/publications/sava_river_basin_analysis_-_summary/sava_booklet_eng.pdf.

- ISRBC (2011): Sava River Basin Management Plan (currently under development).


**European Environment Agency (EEA):**


- EEA (2011): Greenhouse gas emission trends and projections in Europe 2011 - Tracking progress towards Kyoto and 2020 targets. Available online: http://www.eea.europa.eu/publications/ghg-trends-and-projections-2011.

- EEA (2011): Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990-2008. Available online: http://www.eea.europa.eu/publications/ghg-retrospective-trend-analysis-1990-2008.


**International Organisations:**


- Alpine Convention, Platform Water Management in the Alps (2011): Situation Report on Hydropower Generation in the Alpine Region focusing on Small Hydropower. Available online: http://www.alpconv.org/documents/Permanent_Secretariat/web/ACXI/AC11_B8_1_Situation_Report_FIN_annex.pdf.


**National Documents:**


- All River Basin Management Plans of EU-MS, which have been adopted according to the provisions of the Water Framework Directive, can be downloaded from this webpage: http://ec.europa.eu/environment/water/participation/map_mc/map.htm.
- All Renewable Energy Action Plans of EU-MS, which have been adopted according to the provisions of the Renewable Energy Directive, can be downloaded from this webpage: http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm.


**Other Documents/References:**


- ESHA (2006): State of the Art of Small Hydropower in EU -25. European Small Hydropower Association. Brussels.
- IHA (2010): Hydropower Sustainability Assessment Protocol. Available online: http://hydrosustainability.org/.
- Petts, G.E. (1994): Rivers: dynamic components of catchment ecosystems. In Calow, P. and Petts, G.E. (eds) The River Handbook. Hydrological and Ecological Principles, Vol 2. Blackwell Scientific Publications, Oxford. 3 – 22.

# 11 Annexes

Annex I: Questionnaires "Hydropower Development and Water Management Issues in the Danube Basin" filled by Danube countries (will be added to the Final "Assessment Report on Hydropower Generation in the Danube Basin" in a separate document). All Danube Questionnaires can be downloaded from the following webpage: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=92399.

Annex II: Key figures on Hydropower

Annex III: Methods for defining minimum ecological flow

Annex IV: Requirements for upstream continuity facilities

Annex V: References and links to national legislation, policies and strategies in the field of energy and environment

**Annex I:** **Questionnaires "Hydropower Development and Water Management Issues in the Danube Basin" filled by Danube countries (will be added to the Final "Assessment Report on Hydropower Generation in the Danube Basin" in a separate document).** All Questionnaires can be downloaded from the following webpage: http://www.icpdr.org/pls/danubis/danubis.wwv_main.main?p_siteid=1&p_cornerid=92399.

**Annex II:** **Key figures on Hydropower**

| | National electricity production | Electricity production from RES | Electricity production from HP including pumped storage | Electricity production from HP excluding pumped storage | Currently installed HP capacity: Total | | Currently installed HP capacity: From run-off river HP-plants | | Currently installed HP capacity: From storage HP-plants | | Currently installed HP capacity: From pumping storage HP-plans | | Figure of installed capacity includes pumping storage | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Unit** | (GWh/y) | | | | MW | GWh/y | MW | GWh/y | MW | GWh/y | MW | GWh/y | | |
| **AT** | 66,841.0 | 42,369.0 | 40,690.0 | 37,958.0 | 12,469.0 | 40,690.0 | 5,192.0 | 28,413.0 | 7,069.0 | 12,276.0 | 4,285.0 | n.a. | yes | |
| **BA** | 9,215.0 | 1,831.0 | 0.0 | 1,667.0 | 90.0 | 1,667.0 | n.a. | 1,255.0 | 90.0 | 412.0 | 440.0 | 400.0 | | no |
| **BG** | 46,260.0 | 6,196.0 | 6,160.0 | 5,523.0 | 3,108.0 | n.a. | 143.0 | n.a. | 2,027.0 | n.a. | 938.0 | n.a. | yes | |
| **CZ** | 85,910.0 | 5,903.1 | 3,381.0 | 2,790.0 | 2,203.0 | 3,381.0 | n.a. | n.a. | n.a. | n.a. | 1,147.0 | 591.0 | yes | |
| **DE** | 576,829.0 | 360,700.0 | 24,834.0 | 19,059.0 | 4,050.0 | 20,095.0 | n.a. | n.a. | n.a. | n.a. | 6,213.0 | 6,413.0 | | no |
| **HR** | 4,700.0 | 1,495.0 | 0.0 | 1,495.0 | 339.0 | 1,495.0 | 291.0 | 1,301.0 | 48.0 | 194.0 | 0.0 | 0.0 | | no |
| **HU** | 35,908.0 | 3,283.0 | 188.0 | 188.0 | 55.0 | 188.0 | 0.0 | n.a. | 55.0 | 188.0 | 0.0 | n.a. | | no |
| **MD** | 1,033.0 | 51.0 | 79.1 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | |
| **ME** | *not reported* | | | | | | | | | | | | | |
| **RO** | 59,766.2 | 20,264.9 | 19,857.2 | 19,857.2 | 6,453.0 | 19,857.0 | 2,756.0 | 11,181.0 | 3,697.0 | 8,676.0 | 0.0 | 0.0 | yes | |
| **RS** | 43,931.0 | 32,343.0 | 11,243.0 | 10,636.0 | 2,859.0 | 11,144.0 | 1,876.0 | 9,743.0 | 369.0 | 794.0 | 614.0 | 607.0 | yes | |
| **SI** | 14,142.0 | 4,559.0 | 4,624.0 | 4,198.0 | 1,188.0 | 4,588.0 | 950.0 | 3,993.0 | 53.0 | 169.0 | 185.0 | 426.0 | yes | |
| **SK** | 27,720.0 | 5,750.0 | 5,493.0 | 5,099.0 | 2,584.0 | 5,493.0 | 1,361.0 | 4,597.0 | 308.0 | 502.0 | 915.0 | 394.0 | yes | |
| **UA** | 0.16 | 0.16 | 0.0 | 0.16 | 36.2 | 0.16 | 36.2 | 0.16 | 0.0 | 0.0 | 0.0 | 0.0 | | no |

***Notes:***

*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*

*- BA, HR and UA reported data for the national part of the Danube River Basin only.*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

| | Number and capacity of hydropower plants P< 1 MW | | | Number and capacity of hydropower plants 1 MW < P < 10 MW | | | Number and capacity of hydropower plants 10 MW < P < 100 MW | | | Number and capacity of hydropower plants P > 100 MW | | | Set targets for electricity production from HP (excludes pumping storage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Unit** | **Nr** | **MW** | **GWh/y** | **Nr** | **MW** | **GWh/y** | **Nr** | **MW** | **GWh/y** | **Nr** | **MW** | **GWh/y** | | |
| **AT** | 2,127 | 328.0 | 1,611.0 | 252 | 721.0 | 3,217.0 | 126 | 4,452.0 | 16,064.0 | 28 | 6,966.0 | 19,798.0 | yes | |
| **BA** | 0.0 | 0.0 | 0.0 | 7.0 | 29.1 | 67.4 | 2.0 | 90.0 | 412.0 | 2.0 | 425.0 | 1,183.0 | | no |
| **BG** | 125 | 140.3 | n.a. | 62 | 386.4 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | yes | |
| **CZ** | 1,397 | 140.9 | 554.8 | 53 | 155.9 | 603.8 | 9 | 752.8 | 1,630.9 | n.a. | n.a. | n.a. | yes | |
| **DE*** | 3,306 | 187.5 | 877.0 (EZG Bayern; unknown for Baden Württemberg) | 120 | 460.5 | ca. 2328 | 63 | 1,596.0 | ca. 8,393.0 | 1 | 124.0 | ca. 320.0 | yes | |
| **HR** | 0.0 | 0.0 | 0.0 | 2.0 | 7.2 | 31.0 | 5.0 | 331.8 | 1,464.0 | 0.0 | 0.0 | 0.0 | | no |
| **HU** | 15.0 | 7.0 | 19.0 | 1.0 | 9.0 | 48.0 | 2.0 | 39.0 | 121.0 | n.a. | n.a. | n.a. | yes | |
| **MD** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 79,068 | 79,068 | 0.0 | 0.0 | 0.0 | | no |
| **ME** | *not reported* | | | | | | | | | | | | | |
| **RO** | 174 | 80.0 | 247.7 | 98 | 315 | 1,025.4 | 93 | 2,493.0 | 7,893.0 | 12 | 3,565.0 | 10,691.0 | yes | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RS** | 25 | 8.0 | 15.0 | 5 | 16.0 | 33.0 | 6 | 298.0 | 954.0 | 6 | 2,537.0 | 10,091.0 | | no |
| **SI** | 352 | 118.0 | 262.0 | 18 | 37.0 | 192.0 | 18 | 686.0 | 2,619.0 | 2 | 230.0 | 1,125.0 | yes | |
| **SK** | 184 | 30.0 | 140.0 | 19 | 40.0 | 243.0 | 23 | 485.0 | 2,833.0 | 2 | 918.0 | 2,277.0 | yes | |
| **UA** | 4 | 2.43 | 0.004 | 4 | 6.75 | 0.0068 | 1 | 27.0 | 0.1444 | 0 | 0 | 0 | yes | |

***Notes:***

***Number of existing hydropower plants for different plant sizes:***

*- AT, BG, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*

*- BA, DE, HR and UA reported data for the national part of the Danube River Basin only.*

*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

***Installed hydropower capacity for different hydropower plant sizes (in MW):***

*- AT, BG, HU, MD, RS, SI, SK and UA reported data for the whole country.*

*- RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*

*- BA, HR and DE reported data for the national part of the Danube River Basin only.*

*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

***Hydropower generation of different hydropower plant sizes (in GWh/year):***

*- AT, HU, MD, RS, SI, SK and UA reported data for the whole country.*

*- RO data are relevant both for the Romanian part of the Danube River Basin as well as for the whole country.*

*- BA, HR and DE reported data for the national part of the Danube River Basin only. For the category P < 1 MW, DE reported the data for the Bavarian part of the Danube River Basin only.*

*- CZ reported data for the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

| Regarding the planned electricity production from hydropower in 2020 according to the 2020 objectives of the Renewable Energy Directive as set in your NREAP | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Expected electricity production 2020 | | | Expected installed HP capacity in 2020 from: | | | | | | | | Figure of installed capacity includes pumping storage |
| | Total | from RES | from HP | Total HP | | run-off river HP-plants | | storage HP-plants | | pumping storage HP-plants | | |
| Unit | GWh/y | GWh/y | GWh/y | MW | GWh/y | MW | GWh/y | MW | GWh/y | MW | GWh/y | |
| AT | n.a. | 49,900 | 42,112 | 8,997 | 42,112 | n.a. | n.a. | n.a. | n.a. | 4,285 | 2,732 | no |
| BA | 34,314 | 11,990 | 10,121 | 3,903 | 10,124 | 576 | 2,077 | 447 | 1,386 | 0 | 0 | no |
| BG | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| CZ | 85,000 | 11,660 | 2,275 | 1,125 | 2,275 | n.a. | n.a. | n.a. | n.a. | | | no |
| DE | 567,000 | 216,935 | 20,000 | 4,309 | 20,000 | n.a. | n.a. | n.a. | n.a. | 7,900 | 8,395 | no |
| HR | n.a. | n.a. | n.a. | 559.0 | n.a. | 511.0 | n.a. | 48.0 | n.a. | 0.0 | 0.0 | no |
| HU | 51,381 | 5,597 | 238 | 66 | 238 | n.a. | n.a. | n.a. | n.a. | 0 | 0 | no |
| MD | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| ME | *not reported* | | | | | | | | | | | |
| RO | 100,000 | 31,388 | 19,768 | 7,729 | 19,768 | 3,536 | 10,046 | 4,193 | 9,722 | 0 | 0 | yes |
| RS | 46,800 | | 12,260 | 3,845 | 12,260 | 2,180 | 10,524 | 1,665 | 1,736 | 1,325 | 940 | yes |
| SI | 15,607 | 6,129 | 5,121 | 1,820 | n.a. | 1,182 | n.a. | 53 | n.a. | 585 | n.a. | yes |
| SK | 34,650 | 8,100 | 5,400 | 2,728 | 5,850 | 1,504 | 4,900 | 308 | 500 | 915 | 450 | yes |
| UA | 0.2 | 0.200 | 0.2 | 45 | 0.2 | 45 | 0.2 | 0 | 0 | 0 | 0 | no |

***Notes:***

*- AT, BG, CZ, DE, HU, MD, RS, SI and SK reported data for the whole country. RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country. Separate CZ data for P > 100 MW are not available; the data are included in category "10 MW < P < 100MW".*

*- 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.*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

| | % of HWMB to the total WBs | % of HMWB due to HP to total HMWB |
|---|---|---|
| **Unit** | **%** | **%** |
| **AT** | 7.7 | 57 |
| **BA** | n.a. | 39 |
| **BG** | 26.6 | 26.6 |
| **CZ** | 33.4 | 9 |
| **DE** | 37.1 | 6.8 |
| **HR** | 17 | 3 |
| **HU** | 40 | n.a. |
| **MD** | 70.0 | 5-7 |
| **ME** | *not reported* | |
| **RO** | 15.0 | 16.76 |
| **RS** | 28.8 | 14 |
| **SI** | 12.3 | 42 |
| **SK** | 3.0 | 35 |
| **UA** | 1.0 | 1.0 |

***Notes:***

*- AT, DE, HU, MD, RS, SI and SK reported data for the whole country.*

*- RO data are relevant both for the Romanian part of the Danube River Basin as well as the whole country.*

*- BA, CZ and HR reported data for the national part of the Danube River Basin only.*

*- For BG the value for % of total water bodies include data for the whole country, while the value for % of total water bodies (> 4000 km²) include data for rivers Iskar, Yantra Ogosta and the Danube.*

*- UA reported data for the Tisza River Basin only.*

*- RS: This value includes Kosovo - a territory defined by the United Nations resolution 1244 (1999) as an autonomous province of the Republic of Serbia administered by the UN.*

## Annex III: Methods for defining minimum ecological flow

| 8.11 What method/approach is (are) applied to defined minimum ecological flow in your country? | | | | | | |
|---|---|---|---|---|---|---|
| | Static definition | Dynamic definition | Modelling | Other methods | Explanation of methods | Comments |
| **AT** | x | x | x | | | Guide values for a "basic" minimum flow and additional "dynamic flow" (Ordinance on Ecological Status Assessment ) or determination by modelling which proofs that good status for all biological elements is achieved. |
| **BA** | | | | | Water Law Article 65 – minimum average monthly flow with 95% covering. | By- Law for ecological flow is under preparation,until it is finished Water Law Article 65 will be applied. |
| **BG** | x | | | | | 10% of annual mean flow |
| **CZ** | x | | | | The category is chosen according to value of Q355 and after it minumum residual flow (MRF) is calculated which is based on values Q330, Q355 and Q364. If Q355 < 0,05 m3.s-1; MRF=Q330 If Q355 is 0,05 - 0,5 m3.s-1; MRF=(Q330 + Q355)*0,5 If Q355 is 0,51 - 5,0 m3.s-1; MRF=Q355 If Q355 > 5,0 m3.s-1; MRF= (Q355+ Q364)*0,5 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **DE** | x | x | x | The minimum water flow is defined by the LAWA method for determining the minimum water flow in outlet structures. | LAWA approach: Structure-related definition: a. Biotope-flow approach - via the factors flow speed and water depth, b. ecohydrological approach - mean low-water conditions in relation to water depth Other approaches: a. Static definition of uniform flow values for the whole year or on a monthly basis (e.g. 1/3 MNQ (mean low-water flow)) b. Modelling of habitat conditions for different flow conditions and definition of the minimum water flow. | The states decide which approach is applied. |
| **HR** | | | | | | The approach is case-specific. |
| **HU** | x | | | | 2/3 of the standard flow must be left in the river bed. | |
| **MD** | x | | | | | |
| **ME** | *not reported* | | | | | |
| **RO** | x | | | In the current RBMPlans the method for establishing the minimum ecological flow is represented by the minimum between the Q95% and 10% of the multiannual average flow. | | |
| **RS** | x | x | | | In past the criteria were set on case-by-case basis, according to national recommendations. | |
| **SI** | | x | | | Ecological acceptable flow consider hydrological baseline, type of water abstraction, hydrological, hydromorphological and biological characteristics and information on protection regimes. Hydrological baseline consider value of mean minimum flow and mean flow at the location of water abstraction. Qes=f*sQnp (Qes - ecological acceptable flow, f-factor depend on ecological type of watercourse, sQnp - mean minimum flow) It is also possible to choose interdisciplinary holistic approach. | |

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| **SK** | x | | | | Q355 - Average daily water discharge during the reference period, achieved or exceeded during 355 days in the year. | |
| **UA** | x | | | | | Only statistical calculation methods are used based on the data of hydrometeorological service. |

## Annex IV: Requirements for upstream continuity facilities

| 8.17 Do the methods/approaches mentioned above include requirements regarding: | | | | | |
|---|---|---|---|---|---|
| | **Type of fish pass** | **Special type of fish pass** | **Hydraulic design** | **Recommendations/ requirements on duration of time for passability** | **Other/comments** |
| **AT** | There is no preference for a technical fish pass or a bypass channel (more or less natural); decision depends on on what is the best ecological and technical feasible solution at the specific location. | Denil is not assumed to be acceptable. | Discharge, flow velocity, energy dissipation, attraction flow. | Whole year except extreme situations (i.e. floods > HQ1, icing). | Depth / length and width of basins, width of slots; For each river stretch (river type) the relevant fish species which have to pass the fish pass are defined including the length of the largest one which forms the basic element for designing a fish pass. |
| **BA** | yes | no | no | no | |
| **BG** | n.a. | n.a. | n.a. | n.a. | n.a. |
| **CZ** | n.a. | n.a. | n.a. | n.a. | All these approaches will be included in the new methodology. |
| **DE** | No. The functionality of the fish pass is the criterion. | No. The functionality of the fish pass is the criterion. | The hydraulic design is geared to the main types of fish, the size of the fish pass and the size of the water body. | A passability time of 300 days per year is desired (Q30-Q330). | |
| **HR** | n.a. | n.a. | n.a. | n.a. | The approach is case-specific. |
| **HU** | *not reported* | | | | |
| **MD** | n.a. | n.a. | x | n.a. | n.a. |
| **ME** | *not reported* | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RO** | x | x | x | | In the frame of RBMPs, there are indications about the height of the damming structures in relation to the measures for longitudinal connectivity restoration of the WBs which fail to reach good ecological status due to hydro morphological alterations. |
| **RS** | no | no | yes | no | n.a. |
| **SI** | n.a. | n.a. | n.a. | n.a. | Approaches are included in case by case decisions. |
| **SK** | n.a. | n.a. | n.a. | n.a. | n.a. |
| **UA** | n.a. | n.a. | n.a. | n.a. | This issue is not raised for mountaineer rivers of Tisza and Prut basins. |

## Annex V: References and links to national legislation, policies and strategies in the field of energy and environment

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
|---|---|---|---|
| AT | • The Austrian River Basin Management Plan (NGP 2009) can be found under http://wisa.lebensministerium.at/article/archive/29367. | The following websites provide useful references in the field of water management, biodiversity and flood protection:<br>• Federal Ministry of Agriculture, Forestry, Environment and Water Management: http://wasser.lebensministerium.at/<br>• Assessment of impacts of the WFD on Hydropower Generation (only in German): http://gpool.lfrz.at/gpoolexport/media/file/Auswirkungen_WRRL_auf_Wasserkraft-Studie.pdf | The following websites provide useful references in the field of in the field of electricity production from renewable energy sources:<br>• Hydropower in Austria: http://www.wassernet.at/article/archive/6402/<br>• Environment Agency Austria (Eco-Energy): http://www.umweltbundesamt.at/umweltschutz/energie/erneuerbare/oekostrom/<br>• Austrian Association of electric utility companies (VEÖ): http://www.veoe.at/start.html<br>• Austrian Association of Small Hydropower: http://www.kleinwasserkraft.at/ Austrian Energy Strategy (only in German): http://www.energiestrategie.at<br>• Austrian Energy Strategy Report (only in German): http://www.energiestrategie.at/images/stories/pdf/longversion/energiestrategie_oesterreich.pdf<br>• Austrian Hydropower Potential Study (only in German): http://www.energiestrategie.at/images/stories/pdf/36_veo_08_wasserkraftpotenzial.pdf<br>• Technical-Economic Assessment of Small |

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
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| | | | and Micro plants for Generation of Electricity (only in German): http://www.energiestrategie.at/images/stories/pdf/37_bmlfuw_endberichtmikrotech.pdf<br>• Energy-Control GmbH: http://www.e-control.at/de/publikationen<br>• Austrian Energy Agency: http://www.energyagency.at |
| BA | No information provided. | | |
| BG | River Basin Management Plans are published on the websites of the 4 River Basin Management Directorates:<br>• Danube River Basin Directorate: http://dunavbd.org/index.php?x=204<br>• Basin Directorate for Water Management in Black Sea Region: http://www.bsbd.org/v2/bg/BSPLAN2009.html<br>• East Aegean Sea River Basin Directorate: http://www.bd-ibr.org/details.php?p_id=0&id=69&cl_lang=BG<br>• West Aegean Sea River Basin Directorate: http://www.wabd.bg/bg/index.php?option=com_content&task=view&id=16&Itemid=32 | • Information as regards the implementation of the WFD and the Flood Directive as well as the Water act are available on the website of the Ministry of Environment and Water: http://212.122.183.24/newsite/files/file/PNOOP/Acts_in_English/Water_Act.pdf<br>• Information as regards the implementation of the Birds and Habitat Directives as well as the Biological diversity act are available under: http://natura2000bg.org/natura/bg/index1.php<br>• Information as regards EIA and SEA as well as the Environmental protection act are available under: http://www.moew.government.bg/recent_doc/legislation/ZOOS.pdf | • The Energy act can be downloaded from the website of the Ministry of Economy, Energy and Tourism: http://www.mi.government.bg/bg/library/zakon-za-energetikata-256-c25-m258-2.html.<br>• The Renewable Energy Sources Act: http://www.mi.government.bg/bg/library/zakon-za-energiyata-ot-vazobnovyaemi-iztochnici-167-c25-m258-2.html.<br>• The Energy Efficiency Act can be downloaded from: http://www.mi.government.bg/bg/library/zakon-za-energiinata-efektivnost-168-c25-m258-2.html. |

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
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| | • Renewable Energy Action Plans can be downloaded from the website of the Ministry of Economy, Energy and Tourism: http://www.mi.government.bg/bg/library/zakon-za-energiyata-ot-vazobnovyaemi-iztochnici-167-c25-m258-1.html | | |
| CZ | • The Czech River Basin Management Plans of the Elbe, Danube and Oder river basins - levels A, B and C are available on the web site of the Ministry of Environment of the Czech Republic www.mzp.cz/cz/planovani_oblasti_vod.<br>• The Czech National Renewable Energy Action Plan is available on the web site of the Czech Ministry of Industry and Trade www.mpo.cz/dokument79564.html. | • The relevant environmental Czech legislation is available only in Czech on the website of the Ministry of Environment www.mzp.cz/cz/platne_pravni_predpisy. | • The Act on Support for the Use of Renewable Energy Resources is available on the web site of the Czech Ministry of Industry and Trade www.dokument6697.html. |
| DE | • Information as regards renewable energies can be found on the following platform: http://www.erneuerbare-energien.de/inhalt/<br>• Information as regards the implementation of the WFD in Bavaria | • National Law: http://www.gesetze-im-internet.de/index.html<br>• Federal Law (Bavaria): http://www.verwaltung.bayern.de/portal/by/ServiceCenter/BayernRecht<br>• Further information can be obtained from the following webpages: www.bmu.de, http://www.stmug.bayern.de/ and | |

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
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| | can be found on the following weblink: www.wrrl.bayern.de | http://www.lfu.bayern.de/index.htm | |
| HU | • The River Basin Management Plan of Hungary is available only in Hungarian on the official website: http://www.vizeink.hu/files/ovgt_rovid_100505.pdf<br>• The Renewable Energy Action Plan of Hungary is available only in Hungarian on the official website: http://www.kormany.hu/download/2/88/20000/NCsT_20110106_v%C3%A9gleges_201103.pdf | • All relevant documents and information on the Hungarian water management are available: www.vizeink.hu. | • The relevant legislation as regards energy production is available on the website of the Hungarian Energy Office: www.eh.gov.hu. |
| HR | • The Draft River Basin Management Plan is available at the following web address: http://www.voda.hr/puvp/ | • Strategic documents:<br>Water Management Strategy (OG No. 91/08)<br>Energy Sector Development Strategy of the Republic of Croatia (OG No. 130/09)<br>Strategy and Action Plan for the Protection of Biological and Landscape diversity of the Republic of Croatia (OG No. 143/08)<br>National Environmental Strategy (OG No. 46/02)<br>• Acts:<br>Water Act (OG No. 153/09)<br>Concessions Act (OG No. 125/08)<br>Nature Protection Act (OG No. 70/05, 139/08 and 57/11)<br>Environmental Protection Act (OG No. 110/07)<br>• All relevant documents and information on the water management are available | • Strategic documents: Energy Sector Development Strategy of the Republic of Croatia (OG No. 130/09)<br>• All relevant documents and information in the field of electricity production: http://www.hep.hr/hep/novosti/default.aspx |

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
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| | | on the following webpages:<br>• Ministry of Agriculture: http://www.mps.hr/<br>• Croatian Water: http://www.voda.hr<br>• Ministry of Environmental and Nature Protection: http://www.mzoip.hr/ | |
| MD | No information provided. | | |
| SI | • Regulation on River Basin Management Plan for Danube and Adriatic River Basin. / Uredba o načrtu upravljanja voda za vodni območji Donave in Jadranskega morja. Official Gazette of the Republic of Slovenia / Ur.l. RS, št. 61/2011.<br>• National Renewable Energy Action Plan. / Akcijski načrt za obnovljive vire energije za obdobje 2010-2020 Slovenija: http://www.mg.gov.si/fileadmin/mg.gov.si/pageuploads/Energetika/Porocila/AN_OVE_2010-2020_final.pdf | • Water Act. / Zakon o vodah (ZV-1). Official Gazette of the Republic of Slovenia / Ur.l. RS, št. 67/2002.<br>• Environment Protection Act. / Zakon o varstvu okolja (ZVO-1). Official Gazette of the Republic of Slovenia / Ur.l. RS, št. 41/2004.<br>• Nature Conservation Act. / Zakon o ohranjanju narave (ZON). Official Gazette of the Republic of Slovenia / Ur.l. RS, št. 56/1999 (31/2000 popr.) | • Draft proposal on National Energy Programme of the Republic of Slovenia. / Osnutek predloga Nacionalnega energetskega programa Republike Slovenije za obdobje do leta 2030: »aktivno ravnanje z energijo«. http://www.mgrt.gov.si/fileadmin/mgrt.gov.si/pageuploads/Energetika/Zelena_knjiga_NEP_2009/NEP_2010_2030/NEP_2030_jun_2011.pdf<br>• Regulation on supports for the electricity generated from renewable energy sources. / Uredba o podporah električni energiji, proizvedeni iz obnovljivih virov energije. Official Gazette of the Republic of Slovenia / Ur.l. RS, št. 37/2009. |
| SK | • National Renewable Energy Action Plan, Ministry of Economy of the Slovak Republic, 2010 - http://www.economy.gov.sk/narodny-akcny-plan-pre-energiu-z- | • Water Act 364/2004 Coll. in its later wording (last amendment in year 2009); link: http://www.vyvlastnenie.sk/predpisy/vodny-zakon/<br>• Act No. 543/2002 Coll. on nature and landscape protection in its later | • Act No. 309/2009 Coll. on support for renewable energy resources - http://www.zbierka.sk/zz/predpisy/default.aspx?CiastkaID=26023<br>• Conception on hydropower potential |

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| | obnovitelnych-zdrojov/135436s<br>• Water Plan of Slovakia, Ministry of the Environment SR, 2010, link: http://www.vuvh.sk/rsv2/index.php?option=com_content&view=article&id=67&Itemid=87&lang=sk<br>• Decision of Slovak government No. 279/2011 Coll. on Programme of Measures for reaching of the environmental objectives | wording (last amendment in year 2010), link: http://www.sopsr.sk/natura/dokumenty/legislativa/eu/Zakon543.doc<br>• Act 24/2006 Coll. on environmental impact assessment in its later wording (last amendment in October 2011), link: http://www.sopsr.sk/natura/dokumenty/legislativa/eia.pdf<br>• Act Nr.7/2010 Coll. on Flood Protection - http://www.zbierka.sk/zz/predpisy/default.aspx?PredpisID=209451&FileName=zz2010-00007-0209451&Rocnik=2010 | utilization of Slovak water courses - http://www.minzp.sk/files/sekcia-vod/priloha-3-strategicky-vyznamny-technicky-vyuzitelny-hydroenergeticky-potencial-pre-mve-pdf-217-kb.pdf<br>• National limits for renewable energy resources - http://www.energie-portal.sk/Dokument/limity-pre-obnovitelne-zdroje-energie-100448.aspx |
| RS | No information provided. | | |
| RO | • RO River Basin Management Plan, http://www.rowater.ro/SCAR/Planul%20de%20management.aspx<br>• RO Renewable Energy Action Plan, http://www.minind.ro/pnaer/PNAER_29%20iunie_2010_final_Alx.pdf | • WFD and Flood Directive: Water Law 107/1996 with subsequent amendments, http://www.rowater.ro/Lists/Legislatie%20specifica/DispForm.aspx?ID=1&Source=http%3A%2F%2Fwww%2Erowater%2Ero%2FLists%2FLegislatie%2520specifica%2FAllitemsg%2Easpx<br>• Birds and Habitat Directives: Governmental Emergency Ordinance 57/2007 regarding the regime of natural protected areas, natural habitats, flora and fauna, with subsequent amendments, http://www.mmediu.ro/legislatie/biodiversitate.htm<br>• EIA – Governmental Decision 445/2009 & SEA - Governmental Decision 1076/2004, http://www.mmediu.ro/protectia_mediului/legislatie_orizontala.htm | • Law 220/2008 amended by the Law with subsequent amendments for the establishing the promotion system of electricity produced from renewable energy sources, http://leg-armonizata.minind.ro/ |

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
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| UA | • Tisza River Basin Management Plan (National part), which can be downloaded from the website of the Tisza Basin Authority: http://www.buvrtysa.gov.ua.<br>• Energy Program of Ukraine developed until 2030: http://www.esbs.kiev.ua/uk/energy-sector-cooperation-and-reforms/energetichna-strategiya-ukrayini-na-period-do-2030-roku. | • Integrated program of Complex use of Water Resources of Zakarpatska Oblast Rivers, adopted by Zakarpatska Oblast Administration and developed until 2015: http://document.ua/pro-programu-kompleksnogo-vikoristannja-vodnih-resursiv-zaka-doc56830.html<br>• Environmental Impact Assessment: According to Ukrainian legislation (Law of Ukraine “On Environmental Protection” (1991), “On Environmental Expertise” (1995), “On Waste” (1998), “Water Code of Ukraine” (1995), “Land Code of Ukraine” (2001); all of them can be found at http://www.rada.gov.ua), projects of new construction, reconstruction and technical amendments of industrial and civil objects should include an EIA, the main requirements towards it are reflected in State Construction Norms of Ukraine “Structure and Contains of Documents on EIA during design and construction of enterprises, houses and installations”: http://proxima.com.ua/dbn/normdocs/a2/dbn-A.2.2-1-03.DOC. | • Law of Ukraine “On Energy” 16.10.1997 № 575/97-ВР http://zakon3.rada.gov.ua/laws/show/575/97-%D0%B2%D1%80<br>• Law of Ukraine «On Amendments to some Laws of Ukraine regarding establishment of “green” tariffs http://www.uazakon.com/documents/date_ci/pg_gbncxe.htm<br>• Regulations on National Commission of Regulation of Electroenergy of Ukraine, adopted by the Decree of the President of Ukraine 14.03.95 № 213 http://zakon3.rada.gov.ua/laws/show/335/98<br>• Decree “On Approval of the Order of Establishment, Revision and Termination of “Green” Tariffs for Economic Units” 22/01/2009 # 32 http://search.ligazakon.ua/l_doc2.nsf/link1/GK17877.html<br>• Decree on “On Establishment of Value of “Green” Tariffs on Energy for January 2012 with amendments, introduced by Decrees on 29.12.2011 № 235, від 05.01.2012 № 8 www.nerc.gov.ua/control/uk/publish<br>• Law of Ukraine “On Alternative Sources of Energy” #555-15 |

| Danube Country | Reference to national River Basin Management Plans and Renewable Energy Action Plan | Other references in the field of water management, biodiversity and flood protection | Other references in the field of electricity production from renewable energy sources |
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| | | | http://zakon.rada.gov.ua/laws/show/555-15 |