ALPINE CONVENTION
PLATFORM WATER MANAGEMENT IN THE ALPS

SITUATION REPORT ON HYDROPOWER GENERATION IN THE ALPINE REGION FOCUSING ON SMALL HYDROPOWER

IMPRINT

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EXECUTIVE SUMMARY

The Second Report on the State of the Alps has revealed a high number of hydropower stations already in place as well as their considerable impacts on ecology of waters. Nevertheless the Alps as a whole still possesses the technical potential for further hydropower generation. This holds true for small as well as for large hydropower.

The goal of this report is thus to provide substantial background information on hydropower (with a focus on small hydropower) in order to provide the basis for the elaboration of "Common Guidelines for the Use of Small Hydropower in the Alpine Region" mandated by the Xth Ministerial Conference of the Alpine Conference in Evian, March 2009.

The basis of this report is information received from Austria, Germany, Italy, Liechtenstein and Switzerland (for details please see annex 1) based on templates circulated to all countries within the Alpine area (Monaco has no hydropower sites and has thus been excluded).

This report covers a broad range of issues; however – acknowledging the complexity of the issue – it refrains from going into very detail by focusing strictly on the goals of the report to provide a brief orientation and a frame for drafting the common guidelines.

Key findings and conclusions are:

- **No need for new guidance with regard to residual flows and fish passes at present:** all countries – answering the templates – have appropriate national provisions for environmental residual (minimum) flows as well as provisions for fish passes to be applied to new projects. However, it may be necessary in the future to revise those provisions in-place to take into account changes in river flows due to climate change. Therefore no further work was undertaken with regard to residual flows and fish passes in order not to duplicate national efforts already in place. No major added value was seen in drafting general guidances covering the whole Alpine area. Work thus focused on providing the basis for the guidelines covering the use of small hydropower including common principles and recommendations, on an outline for an assessment procedure as well as on evaluation criteria.

- **High number of requests for licenses / authorisations:** Several hundred applications for new small hydropower stations have been reported across the whole Alpine area (with considerable differences of number between countries), which if realised will add to the high number of facilities already in place. This boom is understood to have been triggered, in particular by the financial incentives and support schemes in place in all the Alpine countries. The most widespread support is via feed-in-tariffs; however the form as well as the amount of subsidies differ considerably between countries.

  This boom presents a challenge to competent authorities in handling the huge amount of applications and deciding on authorisations for new facilities due to variety of aspects that have to be taken into account (energy generation, CO2 emission reduction, ecological impact).

- **Need for common guidelines:** A factor adding to the difficulties presented by the high number of applications for new facilities is that there are no criteria for a general approval in place. Decisions on new facilities are mostly determined for sites individually (with the exception that in some countries, projects within National Parks, Nature2000-Sites, etc. are generally rejected). So far authorisations seem to be based mainly on the assessment of impacts of the individual facility on the actual site. In line with provisions of the EU Water Framework Directive together with ecological needs and cumulative effects, a more holistic assessment needs to be carried out for new modifications affecting water status. This includes the impact on the ecological status of the river stretch in which the project is situated, the impacts on other river stretches, and, in case of several projects in the same river catchment, the cumulative effects of the various projects.

  Master Plans, action plans or strategies for the development of hydropower (in EU countries driven by the "20-20-20 targets") are mostly not yet in place. The same holds true for pre-planning mechanisms with regard to the identification of both the remaining potential and ecological compatibility. However, feedback provided indicates that efforts in this direction are under way. The forthcoming common guidelines will certainly support these ongoing efforts.

- **Try to acitivate the hydroelectric potential of facilities in place via refurbishment and modernisation:** One of the main results of the report on "Water and Water Management Issues – Report on the State of the Alps" was that quite a number of facilities in place (having got authorisations in the past without approriate environmental provisions) do not meet up-to-date ecological criteria with regard to fish passes, minimum residual flows, etc., as now imposed on new projects. Legal provisions in place to enhance ecological status go hand-in-hand with the provision of economic incentives to make such enhancements. These incentives include direct grants and increased feed-in-tariffs as well as "green labels" to get higher prices on the market. Good practise examples reported include initiatives to refurbish and modernise facilities in place leading to both improvement in ecological status and enhanced output of hydropower generation.
- **Contribution of small hydropower to overall hydropower generation:** The term "small hydropower" is frequently used in discussions on the generation of renewable energy and usually defined according to the characteristic figure for the bottleneck capacity. However the threshold for small hydropower is tailored to national needs and thus differs from less than 10 MW to less than 1 MW.

  From the collected data on hydropower plants it is evident that the larger plants contribute by far the major share of total electricity production from HP , i.e. over 95% of the total production comes from facilities with > 1MW power output. Plants with a capacity of less than 1 MW constitute around 75% of all HP plants within the Alpine area but contribute less than 5% to the total electricity production. The smaller the capacity class, the greater is the ratio between number of plants and contribution to the total hydroelectric production.

Based on the facts and findings presented in the report, the key conclusion is that due care and planning on a regional basis is considered necessary when deciding about new SHP facilities in order to ensure that further development of hydropower is compatible with environmental protection requirements as well as with the ambitious targets set for renewable energy. This explains the need for decision aid and common guidelines.

1 INTRODUCTION

1.1 Initial Situation and motivation of the report

The Second Report on the State of the Alps has revealed a high number of hydropower stations already in place as well as their considerable impacts on ecology of waters. Nevertheless the Alps as a whole still provide technical potential for further hydropower generation. This holds true for small as well as for large hydropower thus providing the prerequisites for further development; this is in spite high level of exploitation already achieved and the impacts on riverine ecology.

The development of the hydropower sector is strongly driven by the need to achieve the objectives of climate and energy policies by promoting renewable energy. The Renewable Energy Source Directive (RES) (Directive 2001/77/EC) aims at a significant increase in the contribution of renewable energy to electricity production. The most recent development in this respect at EU level was the adoption of Directive 2009/28/EC which sets ambitious targets for all EU Member States, in order to reach a 20% share of energy from renewable sources by 2020. Analogous, the Swiss Federal Energy Act stipulates growth targets for production from renewables. In order to achieve these objectives, most of the Alpine countries have established comprehensive support schemes for renewable electricity production.

In this context, Alpine countries have recently experienced increasing demands for the development of hydropower, leading to increasing applications for new hydropower facilities, in particular for small and micro hydropower stations. The support schemes provided seem to be sufficiently attractive financially to have triggered the present boom of small hydropower facilities (including micro hydropower plants).

While the development of renewable energy, including hydropower, should be strongly supported, it is equally important that such development takes place in a manner compatible with environmental protection requirements as well as encouraging a more efficient, and therefore more sustainable, use of energy.

At the Xth Alpine Conference in March 2009, the Ministers and High Representatives of the Alpine countries decided to set up the platform "Water Management in the Alps". Due to the importance of the above developments, one of the topics listed in the platform's mandate is the elaboration of recommendations for the sustainable use of hydropower generation with a focus on small hydropower. Additionally, the Climate Action Plan of the Alpine Convention, which was also adopted at the Xth Alpine Conference, requests the development of guidelines for the construction, optimisation and refurbishment of small hydropower facilities in order to lessen the impact on the aquatic biocenosis and biodiversity.

Hand in hand with decisions at the Alpine Conference, the "ArgeAlp" (Arbeitsgemeinschaft Alpenländer / Comunità di Lavoro delle Regioni Alpine) proposed at the 40th Intergovernmental Conference in June 2009 to "differentiate, concretise and optimise environmental regulations in order to enable customised solutions for individual hydropower stations" together with "promotion of small hydropower through information on the possibilities and by identification of suitable sites, taking into account the particular ecological sensitivity of the Alpine area."

Hence, while developing guidelines for the use of small hydropower, the work of the "Platform Water Management in the Alps" can

- Help to develop a common understanding on the topic hydropower in the Alps;
- Contribute to increase the efficiency of facilities and lessen their impact on the aquatic environment and the landscape via the exchange of good-practice examples;
- Support the competent authorities in deciding on appropriate ways for granting permission for new hydropower stations;
- Increase transparency, accelerate approval procedures and consequently facilitate the achievement of objectives of energy policies;
- Help to preserve river stretches in pristine condition and therefore
- Contribute towards policy integration by striking a balance between economic requirements and ecological and landscape needs while taking into account social concerns.

These aims also correspond with one of the main conclusions drawn in the frame of the European-funded SHERPA project - Small Hydro Energy Efficient Promotion Campaign Action: "Other essential elements are an increase of transparency in decision making, not only in data and procedures, but also in economic considerations, and an enhancement of the dialogue and the co-operation between the different competent authorities, stakeholders and NGOs, to achieve a good balance between water uses and protection".[1]

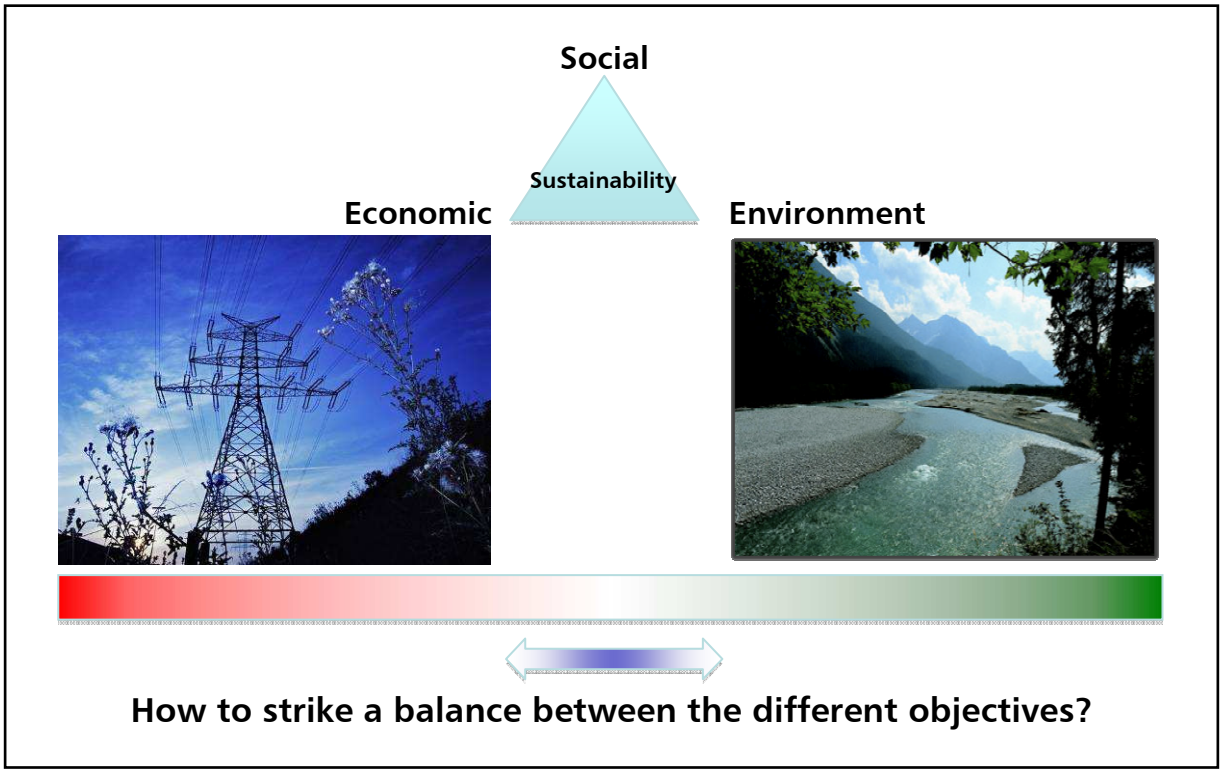


Figure 1: Striking the balance represents a challenge

1.2 Goal of the report

Achieving the objective of raising the share of renewable energy requires not only measures increase the generation from renewable sources but simultaneously an increase in energy efficiency and further efforts on the demand side. However, since this report is directed at the development of guidelines for small hydropower generation in the Alps, its focus is mainly on hydropower generation and therefore on the production side.

[1] SHERPA, 2008a. HYDRorPOWER? Assessment, at river basin level, of possible hydropower productivity with reference to objectives and targets set by WFD and RES-e directives. SHERPA project – Small Hydro Energy Efficient Promotion Campaign Action.

The report endeavours to provide substantial background information mainly on small hydropower in order to

1) Highlight the motivation and rationale behind the task of developing guidelines on small hydropower;
2) Facilitate the development of the guidelines by providing data on the situation of the hydropower sector and the policy framework in the individual Alpine countries;
3) Act as a supporting tool with additional information to enable a better understanding of the overall situation and the guidelines themselves.

Figure 2: The Situation Report as the fundament of the Common Guidelines on Small Hydropower

Finally, different policies need not necessarily conflict; there is room for significant progress in policy integration by enhancing the recognition of the different interests, fostering co-operation between the different competent authorities and stakeholders and promoting more integrated development strategies. This will require effort and understanding from all parties involved. The Platform "Water Management in the Alps" aims at contributing towards the achievement of those objectives by providing the following deliverables (cf. fig. 2):

- the present situation report
- common guidelines for the use of small hydropower in the Alpine region[2] and last but certainly not least

[2] Alpine Convention - Platform water management in the Alps (2011): Common guidelines for the use of small hydropower in the Alpine region.

- a set of Good Practice Examples covering a broad range of issues including planning mechanisms, strategies, innovative concepts and refurbishment of hydropower plants.

1.3 Definition 'Small Hydropower'

The term 'small hydropower' is frequently used in discussions on the generation of renewable energy although there does not exist a common international definition. The same is also the case for the countries of the Alps.

As a general rule, small hydropower is defined according to the installed bottleneck capacity. Such a technical definition of small hydropower is also used as threshold value for legal and economic aspects (legal frame for environmental impact assessments (EIA), entitlements for subsidies, etc.). The term small hydropower is used here with respect to the thresholds of installed capacity as defined in the legal frame of the individual countries.

The table below provides an overview of the different threshold values in the Alpine countries.

COUNTRY	THRESHOLD VALUE FOR DEFINITION SHP [MW]
Austria	< 10 MW
Germany	< 1 MW
France[3]	Multiple definition: < 4,5 or < 10 or < 12
Italy	Double definition: < 1 or < 3 MW
Slovenia	< 10 MW
Switzerland	< 10 MW
Liechtenstein	< 10 MW
Monaco	No hydropower

Table 1: Overview on the threshold values for the definition of "Small Hydropower" in the Alpine countries

As represented in Table 1, 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 Alpine countries is the bottleneck capacity of 10 MW. This value is also used by statistical agencies at European level (i.e. Eurostat).

[3] SHERPA, 2008b. Strategic Study for the Development of Small Hydro Power (SHP) in the European Union. SHERPA – Small Hydro Energy Efficient Promotion Campaign Action.

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 EU Water Framework Directive does not differentiate between small and large hydropower stations. The same environmental obligations (e.g. sufficient residual water or fish migration aids etc. in order to achieve the 'good ecological status' or the 'good ecological potential') have to be fulfilled in the same way for river stretches utilised for small or large facilities.

For the sake of this report and the development of guidelines, a unique definition of SHP within the Alps is not considered to be of major relevance since small and large hydropower in principle cause similar environmental impacts and can therefore be addressed by similar criteria. Exceptions from the rule are environmental impacts caused by hydro-peaking, which mostly result from storage power plants fed by alpine reservoirs.

1.4 Data base

1.4.1 Data request from Alpine countries

The collection of data from Alpine countries served as the main information basis for the development of the report. For this purpose, a data template (Annex 1) on statistical information, the regulatory as well as the policy framework has been developed and sent out to the country representatives. Figure 3 provides an overview on the received feedback, split up for the different countries regarding the individual shares of the Alpine area respectively the individual shares of the total Alpine population. Most of the analyses in the following chapters build on this received information.

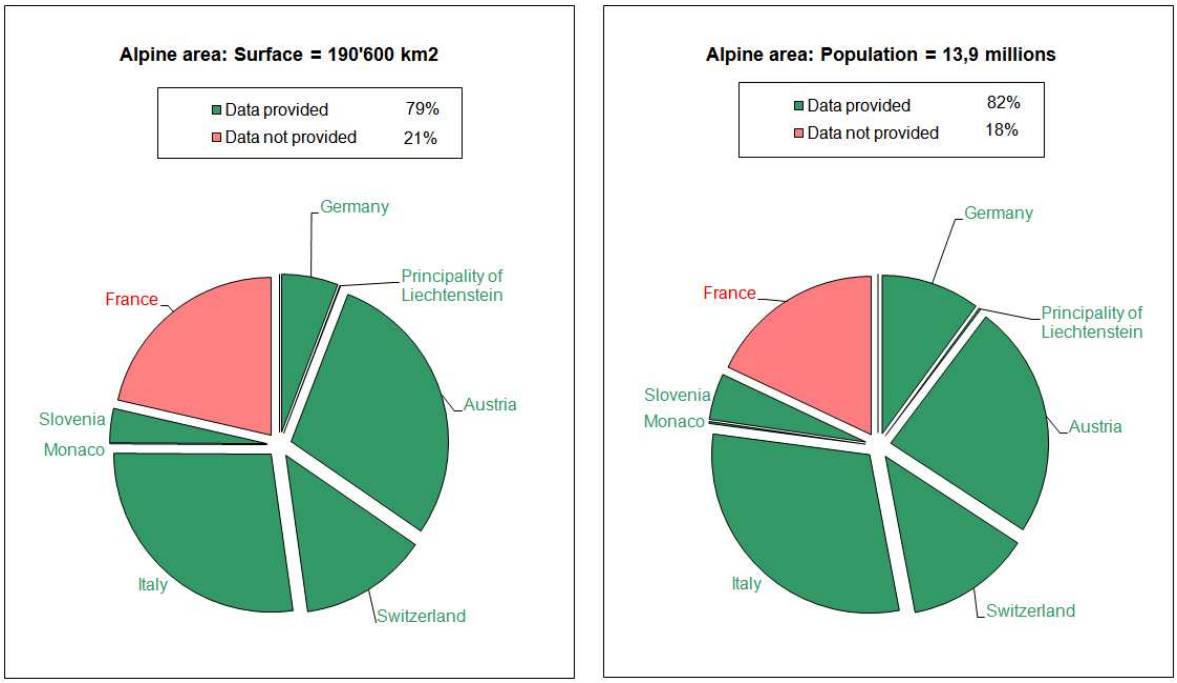


Figure 3: Overview on data delivery from Alpine countries (Status: April 2010) - left: surface pro rata; right: population pro rata

1.4.2 Data from other sources

Along with the data request from the Alpine countries, additional sources for information have been consulted. The main sources in this respect are the results of the European-funded SHERPA project - Small Hydro Energy Efficient Promotion Campaign Action, running from 2006 to 2008 as well as publications of the European Small Hydropower Association (ESHA), which was also the coordinator of the SHERPA project.[4]

[4] 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/).

2 BACKGROUND INFORMATION

2.1 Key data for the use of Small Hydropower in Europe

In the year 2010 more than 21.000 Small Hydropower plants were in place in the 27 EU countries, according to information contributed by ESHA, with a total installed capacity of over 13.000 MW bottleneck capacity. They produce 41.000 GWh electricity per year.

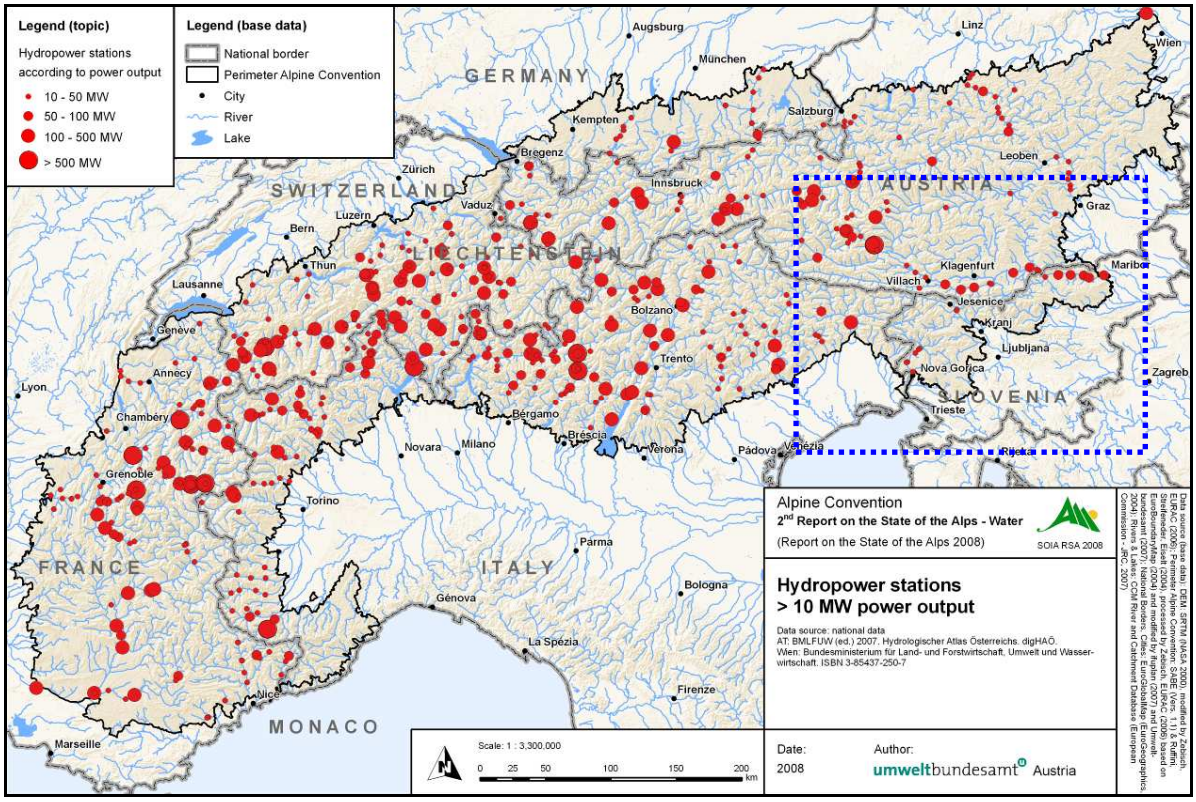
According to the ESHA data, in the EU-27 countries more than 90 % of the installed capacity is concentrated in six member states. The leading countries with respect to installed capacity in the EU-27 are Italy (21 %), France (17,5 %), Spain (15,5 %), Germany (14 %), Austria (9,4 %) and Sweden (7,7 %). Small hydropower has also great importance in the Non-EU countries Switzerland and Norway.

2.2 Hydropower generation in the Alps

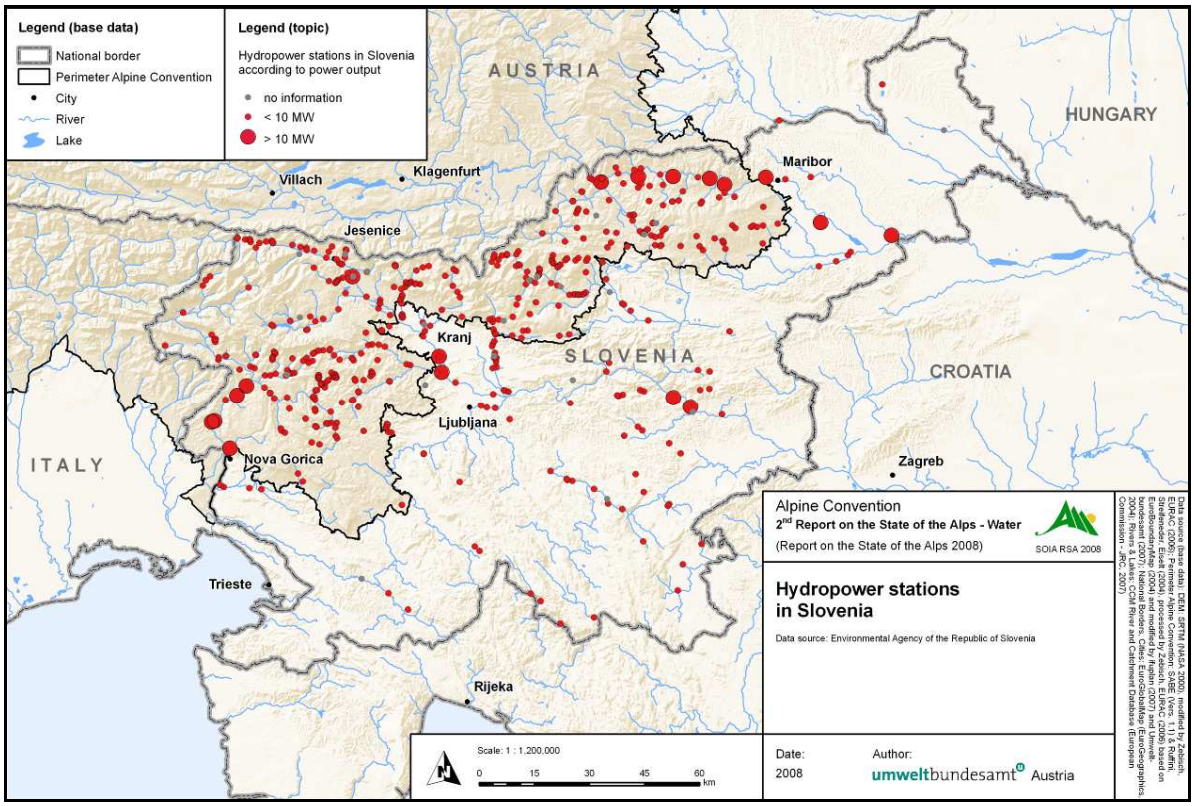
The Alps are poor in terms of natural resources like fossil oil or coal compared to other regions of Europe. Therefore, the use of the "mechanical power" of water has always been of vital interest for the Alpine population in order to meet energy needs.

Using the energy potential of water is not new to people living in the Alps. For centuries water was used to power flour, saw or hammer mills – technologies, which were introduced in order to substitute human manual labour. Later on, during the 20th century, this early form of use of hydropower was replaced by modern hydropower plants for electricity production as we know it today. Potentials for hydropower generation were further developed in the Alps, resulting in the present situation which is illustrated in Map 1, showing approximately 550 large hydropower stations with a power output greater than 10 MW in the Alps.

In addition to large hydropower stations, there are thousands of smaller hydropower stations with capacities of less than 10 Megawatt in place. Map 2 gives an example for the Slovenian situation which is fairly representative of the entire Alpine arc.



Map 1: Large hydropower stations with capacities of more than 10MW in the Alps. The blue frame indicates the section of the map which is displayed in Map 2. (Source: 2nd Report on the State of the Alps)



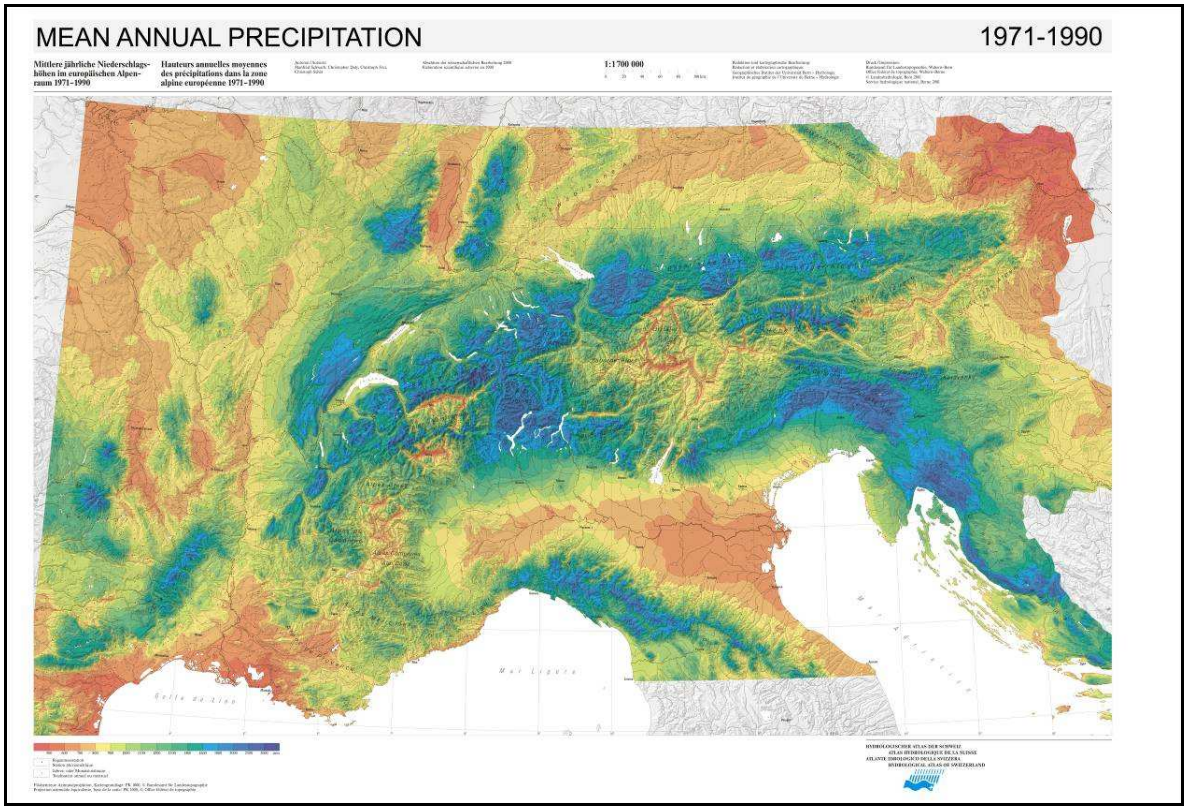
Map 2: Large and small hydropower stations in Slovenia. (Source: 2nd Report on the State of the Alps[5])

The reason for the attractiveness of hydropower generation in the Alps can be found in the perfect pre-conditions.

Steep slopes in combination with high precipitation (Map 3), which can exceed 3.500 mm per year in some areas, result in perfect site conditions for electricity production and make hydropower generation an important economic factor for Alpine countries. For additional information on hydropower generation in the Alps, see chapter B 3.4 of the 2nd Report of the State of the Alps[6].

[5] http://www.alpconv.org/documents/Permanent_Secretariat/web/RSAII/20090625_RSA_II_long.pdf

[6] http://www.alpconv.org/documents/Permanent_Secretariat/web/RSAII/20090625_RSA_II_long.pdf



Map 3: Precipitation (Source: 2nd Report on the State of the Alps)

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. However these developments in turn put pressure on the ecological status of river systems and the preservation of characteristic landscapes and natural scenery. In this context, new projects for hydropower generation can arouse controversy; difficulties also arise in trying to balance the objectives and targets of different policies like, for instance, the Directive on Electricity Production from Renewable Energy Sources (RES-e Directive) and the Water Framework Directive of the European Union and comparable legislation in Switzerland.

2.3 Potential Benefits and potential impacts

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 (cf. 2nd Report of the State of the Alps[7]). More information and qualitative data on benefits and negative impacts (e.g. on river hydromorphology) of hydropower generation can be obtained from later chapters and from national sources[8] e.g. the River Basin Management Plans[9].

2.3.1 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.

Economic benefits

An assured supply of energy is a key prerequisite for a modern economy and civilisation. 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 renewables 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

[7] http://www.alpconv.org/documents/Permanent_Secretariat/web/RSAII/20090625_RSA_II_long.pdf

[8] see Annex 2 of the Common Guidelines for the use of Small Hydropower in the Alpine Region

[9] Overview of River Basin Management Plans: http://ec.europa.eu/environment/water/participation/map_mc/map.htm

can be compensated at very short notice, much faster than thermal power stations may be able to do. In this respect, (pump) storage schemes in combination with the high volumes of the Alpine reservoirs as well as the high head in the Alps will play an ever increasing role; they are able to feed in times of peak demand as well as to store energy by pumping up water to reservoirs in periods of surplus electricity.

Last but not least hydropower plants, and in particular small hydropower plants are highly decentralised 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 net fiscal contribution to national budgets. The EU (mostly in Alpine Countries) and Switzerland are world leaders in the hydro industry. The export of technology and knowledge creates additional income for the national economies of Alpine states.

Social benefits

Hydropower plays a major role at the local and regional level because of its importance for the socio-economic development of peripheral alpine regions. Whenever hydropower facilities are built, this is done in combination with new infrastructure (e.g. to ensure accessibility…). If charges are levied for the use of water by regional administrations, considerable contributions to local or regional budgets may result.

Further benefits may 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.

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.

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 seems to be the least expensive form of renewable energy.

Hydropower can also lead to positive affects in river restoration, for example by raising the river bed and the associated groundwater level.

Figure 4: Employment creation for the green industry (© Camenzind + Co. AG[10])

Figure 5: Employment creation for the green industry: Here during the revision of the hydropower station of Luterbach in Switzerland (320kW) (© Hydroelectra AG[11])

Figure 6: St.Martin, a settlement in the alps without existing grid connection. Electricity production by a small hydropower installation. (© Programm Kleinwasserkraftwerke[12])

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. 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 paragraph.

2.3.2 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

[10] http://www.natural-yarns.com/default.asp?nav=energie

[11] http://www.hydroelectra.ch/joomla/index.php?option=com_ponygallery&Itemid=1011&func=detail&id=37#ponyimg

[12] http://www.smallhydro.ch/bdb/displayimage.php?pos=-182

perceived by the wider public. This is not only the case for large dams, reservoirs and related hydropower facilities but also for small and very small hydropower stations, indeed the high number of such facilities already in place in the Alps, have a cumulative effect which is already impacting on a considerable number of river stretches (quantitative information on the amount of hydropower stations in the Alps and related electricity generation can be obtained from chapter 3).

The main environmental concerns in connection with hydropower generation include the following:

- 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.

An effective way to reduce these negative effects of hydropower plants is the installation of fish migration aids.

Figure 7: Wires and dams can fragment habitats and be obstacles for fish migration by causing an interruption of the longitudinal river continuity (© H. Mühlmann, BMLFUW)

Figure 8: Near-natural fish pass at a smaller river in Austria. Fish migration aids reduce the negative effects of the fragmentation of rivers (© Verbund)

- 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 - A high number of hydropower plants in the Alpine region are diversion plants. Therefore the problem of no or non sufficient residual water in the affected reaches of Alpine rivers is an important issue causing a number of negative effects on the river ecology notably: homogenisation of the flow character and degradation of habitat, continuity disruptions for migrating fish and changes of the natural temperature conditions.

To mitigate such negative impacts it is necessary to ensure sufficient residual water in the downstream stretches of diversion plants.

Figure 9: No water – no life. Insufficient residual water beneath a Tyrolean weir for water abstraction for hydropower generation is causing an obstacle for fish migration and a loss of habitats (© H. Mühlmann, BMLFUW)

- Hydro-peaking: 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 soil 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.

Figure 10: River stretch influenced by hydro-peaking during the flushing event (© H. Mühlmann, BMLFUW)

Figure 11: The same river stretch influenced by hydro-peaking during the downsurge (© H. Mühlmann, BMLFUW)

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

Figure 12: Alpine reservoirs and impounded river stretches – reduced flow velocities lead to increased depositions of fine sediments while periodical flushings can cause severe negative impacts of downstream river stretches (© Verbund)

To sum up, the generation of electricity by hydropower can have severe impacts on the aquatic ecology and the natural landscape. Innovative technologies, improved methods of operation 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 has regard to these environmental concerns and is backed up by integrated planning processes.

3 HYDROPOWER SECTOR – STATISTICAL INFORMATION

3.1 Total electricity production

Hydropower contributes a significant share of total electricity generation in the Alps.

Figure 13 provides an overview of total electricity production (all sources – renewables including hydropower and non-renewables) and the electricity production solely from hydropower (small and large) in the reference year 2005 for individual Alpine countries (total area).

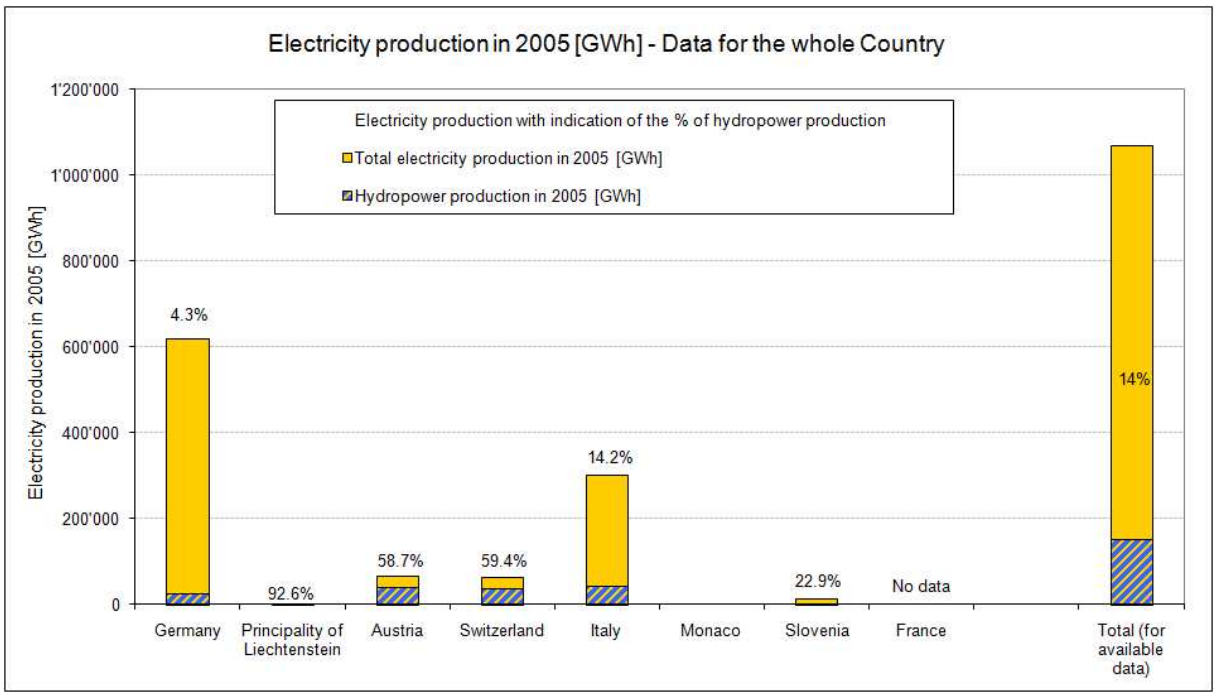


Figure 13: Overview of the electricity production by country in the year 2005 showing the percentage of hydropower production

Figure 13 shows that in countries where the topography is dominated by mountainous landscapes, hydropower provides the most significant contributions to electricity generation; nearly 60% in the case of Austria and Switzerland and more than 90% for Liechtenstein.

3.2 Electricity generated by hydropower and facilities in place

The following figures provide an overview of hydropower production and the number of facilities in place in Alpine countries, focusing on their share within the Alpine area. The data is split into five categories based on the bottleneck capacity of the individual hydropower stations.

The most significant contribution to the generation of electricity by hydropower comes from stations in the category larger than 10MW. The contribution of these large facilities range from 70% of total electricity generated by hydropower up to more than 90% in Switzerland and Slovenia (Figure 16).

Figure 15 and Figure 17 highlight the considerable number of smaller facilities, especially of those very small (micro) stations with a bottleneck capacity of less than 300 kW.

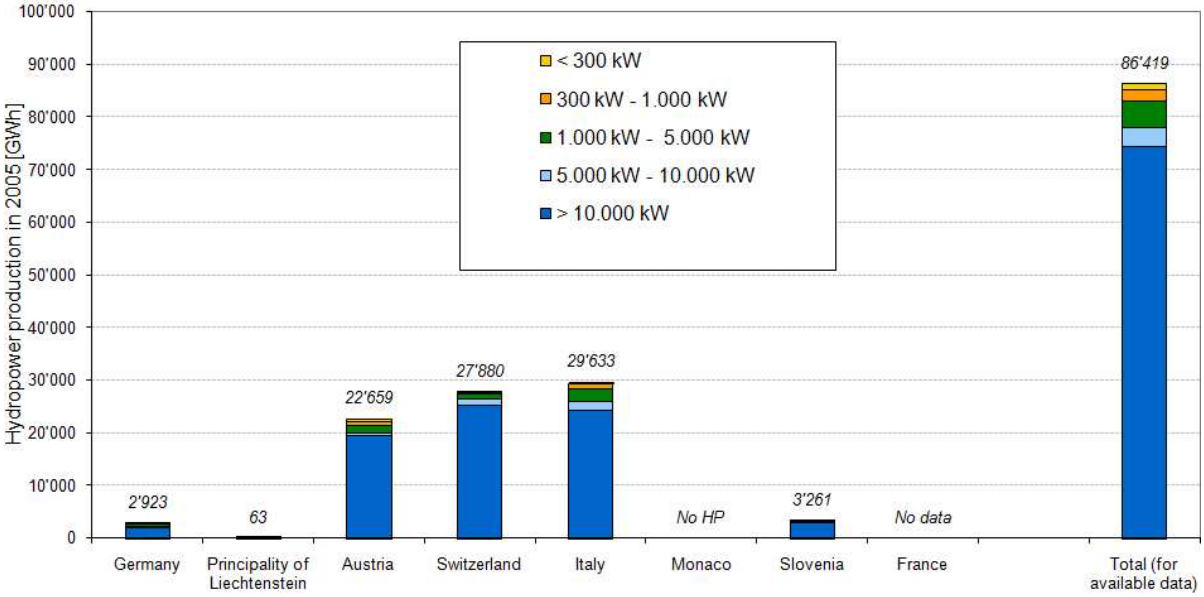


Figure 14: Absolute distribution of hydropower production (GWh) in Alpine countries, focusing on their share within the Alpine area[13] (reference year 2005) for different categories of hydropower stations[14]

[13] SL figures refer to the whole Country

[14] AT figures for installations smaller 10MW are based on certified SHP (data from E-Control). Not included are those plants without SHP certification, such as self-supply plants, which would increase the contribution of facilities smaller 10MW in Figure 14 but also considerably increase the number of facilities as indicated in Figure 15.

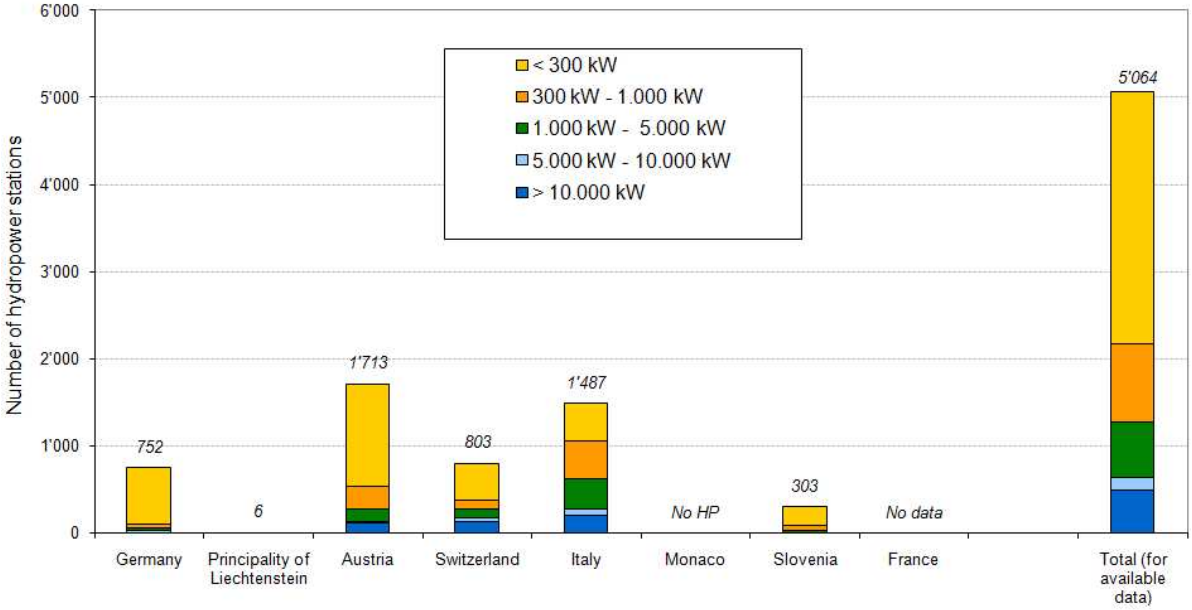


Figure 15: Absolute distribution of the number of hydropower stations in Alpine countries focusing on their share within the Alpine area[15] (reference year 2005) for different categories of hydropower stations[16]

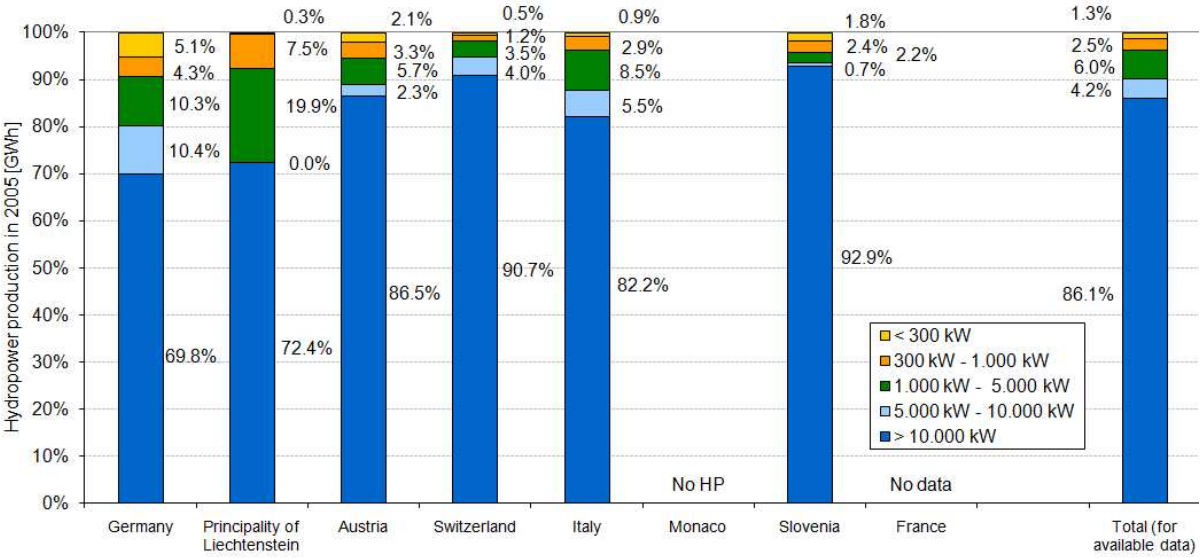


Figure 16: Relative distribution of hydropower production (GWh) in Alpine countries, focusing on their share within the Alpine area[15] for different categories of hydropower stations[16] (reference year 2005)

[15] SL figures refer to the whole Country

[16] AT figures for installations smaller 10MW are based on certified SHP (data from E-Control). Not included are those plants without SHP certification, such as self-supply plants, which would increase the contribution of facilities smaller 10MW in Figure 14 but also considerably increase the number of facilities as indicated in Figure 15.

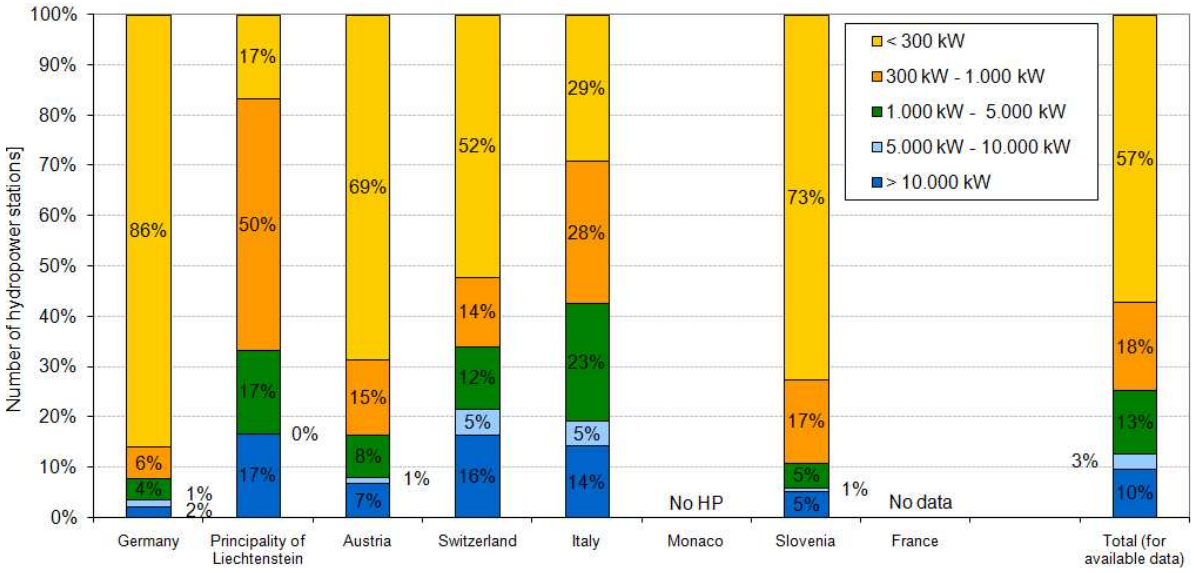


Figure 17: Relative distribution of the number of hydropower stations in Alpine countries, focusing on their share within the Alpine area[17] (reference year 2005) for different categories of hydropower stations

Figure 18 and Table 2 provide information on the number of facilities and the contribution to the total electricity generated by hydropower for different size categories of hydropower stations within the Alpine area.

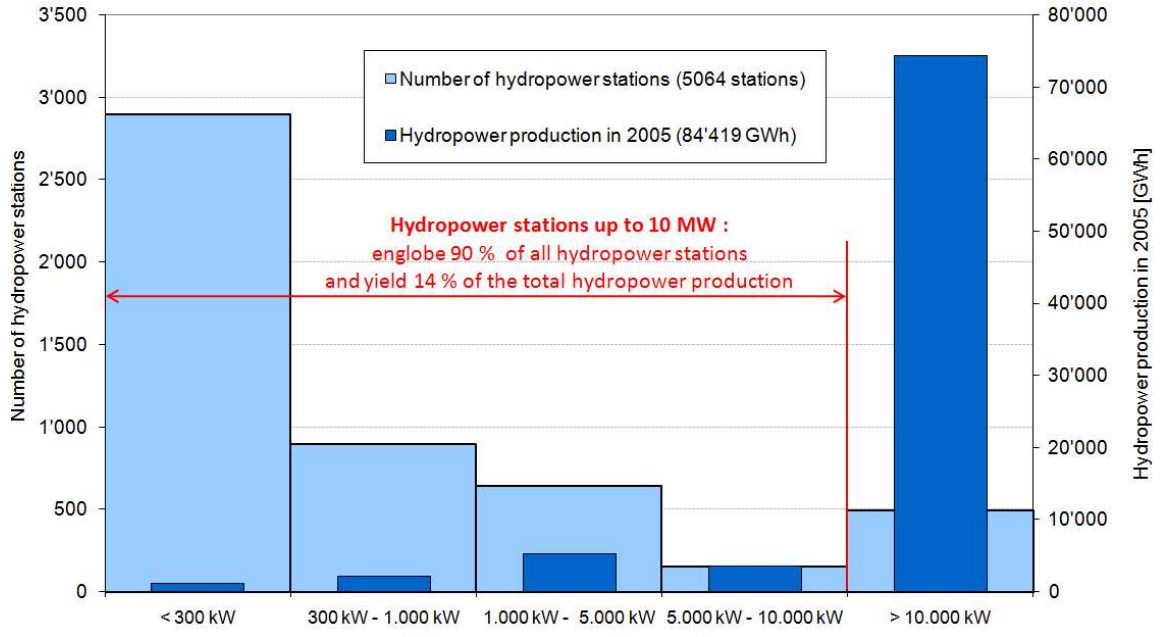


Figure 18: Relation between number of stations and hydropower production for the Alpine area[17] (available data)

[17] SL figures refer to the whole Country

	CATEGORY OF HYDROPOWER STATIONS (BOTTLENECK CAPACITY)				
	< 300 kW	300 - 1.000 kW	1.000 - 5.000 kW	5.000 - 10.000 kW	>10.000 kW
Production [%]	1,3%	2,5%	6,0%	4,2%	86,1%
Stations [%]	57,2%	17,6%	12,6%	2,9%	9,7%

Table 2: Relation between number of hydropower stations and hydropower production for the Alpine area[17] (available data)

By far the most significant share (86,1%) of electricity is generated by large facilities (representing 10% of the total number of hydropower stations) with bottleneck capacities of more than 10 MW (see Table 2).

Hydropower stations with bottleneck capacities of less than 10 MW (representing about 90% of all stations) produce about 14% of the total electricity generated by hydropower. Within this category, middle-size stations between 1 and 10 MW contribute about 10% of the total electricity generated by hydropower, while the most numerous type, that is the 57% of facilities with bottleneck capacities of less than 300 kW, contribute a share of about 1% to electricity production.

While figure 13 shows the share of hydropower (14%) of total electricity production in Alpine countries, figures 14 to 18 show the rather limited contribution of very small hydropower plants to overall electricity generated by hydropower. The data raises the question as to whether the financial incentives provided at national level for very small hydropower plants contribute significantly to increase the share of renewables. A potential need for optimisation of those economic incentives already in place may be derived from this data.

However, from a more local point of view, electricity production from SHP can represent a more significant contribution, e.g. for a small village a considerable share of the households may be supplied by a local SHP.

3.2.1 Green house gas emissions

Carbon dioxide is the most important anthropogenic greenhouse gas (GHG). The primary source of the increased atmospheric concentration of carbon dioxide since the pre-industrial period results from fossil fuel use.[18]

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.

Therefore, the substitution of hydropower for electricity generation within the European energy mix[19] with is often used in calculating the "savings" of GHG emissions. Expressed in CO_2 equivalents, every kilowatt hour from hydropower (emissions of 4g CO_2/kWh) would therefore replace one kilowatt hour from the UCTE mix (emissions of 500 g CO_2/kWh). Based on these figures hydropower would result in approximately 100 times less CO_2 being emitted compared to the current UCTE mix.

As indicated in Figure 19, 32% of the total GHG emissions in the Alpine countries (available data) occur due to the production of 1'070 TWh electricity[20]. Since hydropower causes approximately 100 times less GHG emissions, it can be assumed, approximately, that the 559 Mio.t of CO_2 equivalent (orange in the left pie chart) are principally caused by the 919 TWh of electricity produced from sources others than hydropower.

[18] 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.

[19] UCTE - Union for the Coordination of Transmission of Electricity; the UCTE mix includes all sources for electricity generation and is based on a statistical mean value

[20] Data from Germany given for total energy industry. Data from Switzerland include emissions from domestic fuel combustion activities for public electricity and heat production, being most of the emissions generated form waste incineration plants.

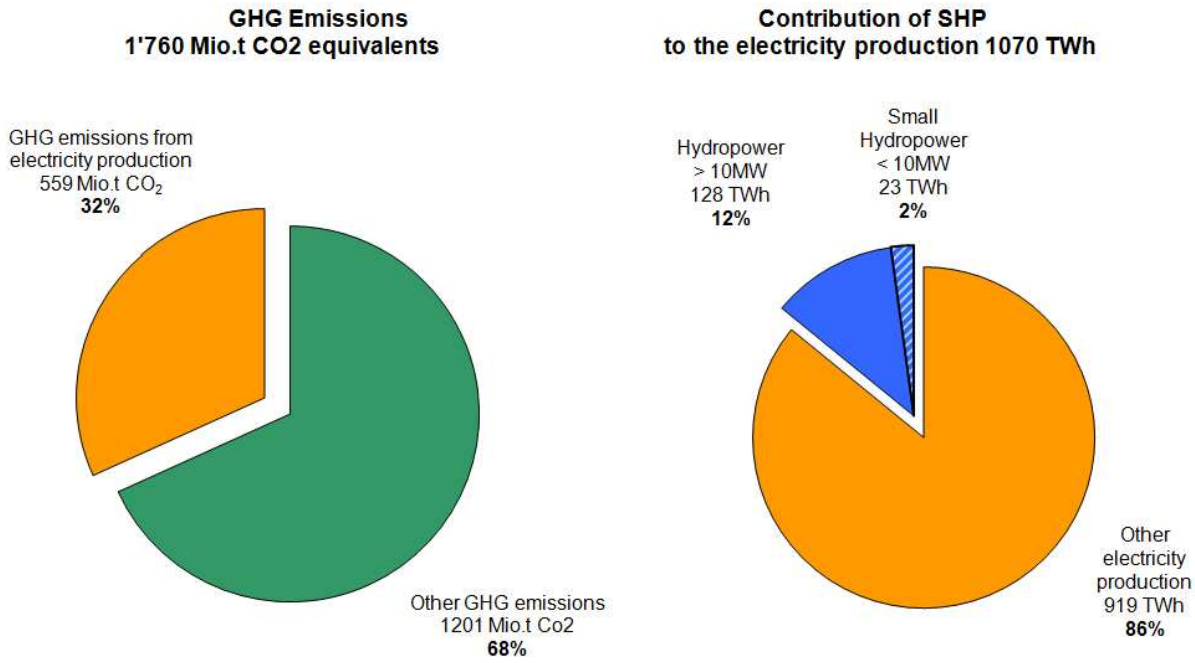


Figure 19: Left: Greenhouse Gases emissions from electricity production in Alpine countries (available data); Right: Electricity production in Alpine countries (available data) with indication of % of hydropower[21]

Assuming that the total electricity produced by hydropower (according to available data: 14% of the total electricity production – 151 TWh), would be generated by forms of power generation based on the UCTE mix, this would then cause additional 75,5 Mio. t CO_2 (151 TWh * 0,5) of the total CO_2 emissions caused by electricity generation.

Breaking down those figures for small hydropower facilities in place with capacities of less than 10 MW[18] (available data), the contribution of those facilities to "CO_2 emission reductions" from electricity generation would be about 11,5 Mio. t CO_2 (23 TWh * 0,5), equivalent to around 0,5 % of overall GHG emissions of Alpine countries (available data).

However, what has to be taken into account is that replacing electricity produced by sources from the UCTE mix with hydropower can only achieve a meaningful reduction in GHG emissions provided total electricity consumption remains at least stable. Hence,

[21] For Germany and Italy, the threshold value for SHP is not set at 10 MW. Thus, for those countries no specific data for installations < 10 MW were collected in the data template. Therefore for the present evaluation German and Italian data have been taken from the following source: SHERPA, 2008b. Strategic Study for the Development of Small Hydro Power (SHP) in the European Union. SHERPA – Small Hydro Energy Efficient Promotion Campaign Action.

with regard to the reduction of GHG emissions, it is in any case be essential to achieve a stabilisation or in fact reduction of the total energy consumption.

4 OVERVIEW ON POLICY FRAMEWORK

4.1 Protocols of the Alpine Convention

The Alpine Convention is a multilateral framework treaty signed in 1991 by the eight states of the Alpine arc as well as the European Community.[22] Water management is one of the topics in relation to which the Parties of the Alpine Convention committed to take adequate measures (Article 2.2 of the Convention, listing the fields in relation to which the Parties agreed to take measures), with the objective of preserving or re-establishing healthy water systems, in particular by keeping lakes and rivers free from pollution. Natural hydraulic engineering techniques should be applied and the use of water power should serve the interests of both the indigenous population and the environment alike.

Eight protocols have been adopted and are now in force in the countries of the Contracting Parties which have ratified them. Each of these has some bearing or influence on water management in the Alps.

The energy protocol[23] aims to establish sustainable development in the energy sector that is compatible with the Alpine region's specific tolerance limits. According to this protocol, remaining energy needs should be met by making a wider use of renewable energy sources, encouraging the use of decentralised plants. However, negative effects of new and existing hydroelectric plants on the environment and the landscape have to be limited by adopting appropriate measures to ensure that the ecology of watercourses and the integrity of the landscape are maintained.

4.2 Specific European Union legislation

Water policy and the hydropower sector in the area of the Alpine Convention are, to a considerable extent, influenced by the legislation of the European Union (EU). The most important parts of this legislation are the directives on the promotion of energy and

[22] The principality of Monaco signed the Alpine Convention in 1994.

[23] http://www.alpconv.org/NR/rdonlyres/77274D16-B20C-43F0-9E20-2C6DA92F68D4/0/EnergyProtocolEN.pdf

electricity from renewable sources along with the EU Water Framework Directive. The content of these directives is described as follows:

4.2.1 The RES-e Directive - Promotion of electricity from renewable sources

The promotion of electricity from renewable energy sources (RES) is a high EU priority for several reasons, including security and diversification of energy supply, environmental protection and social and economic cohesion. It also constitutes an essential part of the package of measures needed to comply with the commitments made by the EU under the Kyoto Protocol on the reduction of greenhouse gas emissions.

The RES-e directive (directive 2001/77/EC) aims at a significant increase in the contribution of renewable energy sources to electricity production, including hydropower together with all other renewable energy sources, and at creating a basis for a more comprehensive framework for the development of electricity from renewable energy sources.

The RES-e Directive identifies general principles and outlines strategies to direct Member States towards the achievement of their own national targets. Its provisions will be repealed by Directive 2009/28/EC from 1 January 2012.

4.2.2 The new EU directive on renewable energy 2009/28/EC

Directive 2009/28/EC 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.[24]

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.

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

Member States are to establish national action plans. These 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). These plans will also establish procedures for the reform of planning and pricing schemes and access to electricity networks, promoting energy from renewable sources.

4.2.3 The EU Water Framework Directive

Directive 2000/60/EC[25] was adopted in 2000 with the intention of creating a legal framework for water management within the EU and beyond. Its objectives are:

- to achieve/maintain good status for all waters, as a rule by 2015, to prevent the further deterioration of water, and protect and enhance the aquatic and terrestrial ecosystems;
- to ensure coordination and cooperation in shared river basins across administrative and political borders;
- to promote the sustainable use of water, based on long-term protection of the available water resources;
- to enhance the protection and improvement of the aquatic environment through the progressive reduction of discharges and the phasing-out of discharges, emissions and losses of particularly hazardous substances;
- to progressively reduce groundwater pollution, and
- to contribute to the mitigation of the effects of floods and droughts and
- to ensure widespread information and consultation of the public when developing and reviewing river basin management plans.

The Directive applies to surface and groundwater, as well as to coastal waters. By the end of 2004, EU Member States had to provide, an analysis of the characteristics of the district, 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.

[25] Directive 2000/60 establishing a framework for the Community measures in the fi eld of water policy, OJ EU 2000, L 327 p.1

By the end of 2006, EU Member States 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 Member States 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 are summarised in a River Basin Management Plan that contains all measures in place or foreseen, in order to reach the objectives of Directive 2000/60[26]. 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 Directive 2000/60/EC is fully taken into consideration and, furthermore, to ensure that the different plans, programmes and measures are subsequently effectively put into operation.

Article 4.7[27]

For new modifications to the physical characteristics of water bodies, WFD Article 4(7) exceptionally allows the deterioration of water status or failure to achieve good water status provided certain strict conditions are satisfied. This provision lies at the heart of new sustainable developments in river basins.

- Assessment: For new modifications affecting water status, an assessment according to the WFD definition of water status should be carried out. This includes:

  a) impacts on the quality elements for the classification of ecological status

[26] Overview of River Basin Management Plans: http://ec.europa.eu/environment/water/participation/map_mc/map.htm
[27] Information Note for Water Directors, European Commission, November 2009

b) impacts on other water bodies than the one in which the project is situated,

c) in case of several projects in the same river basin, cumulative effects of the various projects.

- 4(7)b – 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.
- 4(7)(c) – weighing benefits: 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. 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.
- 4(7)(d) – better environmental options: 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 common implementation strategy of the WFD recognises the need to address the issue of the better environmental options at a strategic – regional level[28]. 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.

Article 4(7) is of especial relevance for EU Member States in the context of hydropower generation and has to be taken into account with regard to planning procedures for potential further developments. This has been reconfirmed by the Note of Water Direc-

[28] See e.g. the conclusions from the 2007 Berlin Workshop on Water Framework Directive and Hydropower: http://www.ecologic-events.de/hydropower/

tors "Hydropower Development and the Water Framework Directive", May 2010[29]. Detailed information can be obtained from the CIS Guidance Document No. 20[30] on exemptions to the environmental objectives.

[29] Note of the Water Directors "Hydropower Development and the Water Framweork Directive", May 2010 http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/thematic_documents/hydromorphology/development_directivepdf/_EN_1.0_&a=d

[30]http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/documentn20_mars09pdf/_EN_1.0_&a=d

4.2.4 Policy framework in Switzerland and Liechtenstein

According to the European Economic Area Agreement[31], Liechtenstein implements the EU Water Framework Directive whereas the RES-e Directive shall not apply to Liechtenstein. The Swiss Federal Energy Act and Water Protection Act are the equivalents to RES-e and EU-WFD.

4.2.5 The Swiss energy policy and the Federal Energy Act

Based on the energy article in the Swiss Constitution (Article 89) the Federal Energy Act (EnG, dated 26 June 1998; SR 730.0), the Nuclear Energy Act, the Electricity Supply Act and the CO2 Act - along with their confirming ordinances - form the legal basis for a sustainable and modern energy policy. In particular the Federal Energy Act lays down the regulatory framework for renewable energy.

The revised Energy Act (in force since 1.1.2008) stipulates that the production of electricity from renewable energy sources must be increased by at least 5'400 GWh by 2030 in order to stabilise or reduce CO2 emissions as quickly as possible. For hydroelectricity the goal is to increase Swiss hydroelectricity production by at least 2'000 GWh by 2030. It also contains a package of measures for promoting renewable energy and efficient electricity use.

The most important measure for the promotion of electricity from renewable sources concerns the cost-covering remuneration for feed-in to the electricity grid[32] (CRF). For small hydropower plants, the subsidy period for compensatory feed-in remuneration is stipulated as 25 years. To finance the CRF scheme, the Energy Act introduced a surcharge on the electricity supply lines, which is levied per kWh on the final electricity consumption[33]. Further details on the CRF-scheme plus information on the antecedent financial incentive system are described in Annex 1 in the data template for Switzerland.

[31] http://www.efta.int/legal-texts/eea.aspx - Annex 4 (Energy) and annex 20 (Environment)

[32] http://www.bfe.admin.ch/themen/00612/02073/index.html?lang=en

[33] Currently the EnG stipulates a maximum surcharge of 0.6 CHF per kWh, for the year 2009 it was fixed at 0.45 CHF per kWh. There are ongoing political initiatives to increase the max. surcharge. This financing mechanism provides several hundreds of millions CHF per year for promoting renewable energy facilities.

4.2.6 The Swiss water policy34 and the Federal Water Protection Act

Based on the water article in the Swiss Constitution (Article 76), the Federal Water Protection Act (GSchG, dated 24 January 1991; SR 814.20), the Hydropower Act and the Federal Act on Hydraulic Engineering - along with their confirming ordinances - form the legal basis for a sustainable and modern water policy. With respect to hydropower exploitation, the Federal Water Protection Act and the Hydropower Act in particular lay down the regulatory framework. Further relevant regulations are provided in the Federal Fishery Act and the Nature and Cultural Heritage Act.

A study comparing the Federal Water Protection Act (GSchG) as Swiss equivalent to the EU-WFD, came to the conclusion that in essence these two pieces of legislation are pursuing the same main goals[35], following a holistic approach. The GSchG establishes a series of qualitative, quantitative and ecological targets for the protection of water bodies and water resources. More specific to hydropower, the GSchG specifies the requirements for authorisation of water abstractions, including minimum flow regulations. Recently a major GSchG amendment[36] has been approved by the Swiss Parliament specifying river restoration goals, regulations for hydro-peaking and activation of the bed load transport plus flexibility in regard to water abstractions. GSchG also lays down planning obligations and fixes deadlines for achieving specific goals. The procedure for granting concessions is laid down in the Federal Hydropower Act.

4.3 Others

Depending on specific circumstances, other directives or regulations not primarily addressing water issues may become relevant for water management. The 2nd report on the State of the Alps[37] contains a compilation of the existing legal framework concerning water management, both, EU legislation relevant for EU menberstates as well as similar national legislation in Switzerland. The compilation comprises references on directives or regulations for issues like flood protection, environmental impact assessment, specific uses of water, release of substances and bi- or multilateral agreements for transboundary and basin-wide water management in the Alps.

[34] www.giweh.ch/files/watermanagement.pdf

[35] http://www.bafu.admin.ch/wasser/01444/01995/index.html?lang=de

[36] http://www.parlament.ch/d/dokumentation/dossiers/wasser/Seiten/default.aspx

[37] http://www.alpconv.org/soia/soia03_b_en.htm

Furthermore, the following international agreements may be of relevance for hydro-electricity related programmes and activities:

- United Nations Framework Convention on Climate Change (UNFCCC)
  Link: http://unfccc.int/2860.php
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)
  Link: http://www.ramsar.org
- The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention)
  Link: http://www.unece.org/env/water/welcome.html)
- Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)
  Link: http://www.unece.org/env/eia/)
- Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention)
  Link: http://www.unece.org/env/pp/)

Finally, at national or provincial level, there are specific nature protection laws in place that have to be taken into account as well. These laws can be of considerable relevance for further hydropower development.

5 SUPPORTING POLICIES AND SHP PROMOTION

5.1 Renewable Energy targets

There are well recognised reasons for increasing the share of electricity from renewable energy sources. It can improve energy security, mitigate greenhouse gas emissions along with other regional and local pollutants from the power sector and it has the potential to increase competitiveness in renewable energy technologies.

For these reasons, each state has set targets for renewable energy sources. With regard to EU Member States, those national overall targets are specified in Annex I of the new directive on renewable energy 2009/28/EC and have to be met by 2020. In order to achieve these ambitious targets, each Member State had to establish national action plans by 30 June 2010 which address inter alia the production of electricity from renewables.

Furthermore, the Swiss Parliament has decided to increase the production of renewable energies by at least 5'400 GWh by 2030 in order to stabilise or reduce CO_2 emissions as quickly as possible. For hydroelectricity the goal is to increase Swiss hydroelectricity production by at least 2'000 GWh by 2030.

Targets for renewable energies[38]		
Country	**Share of energy from renewable sources in gross final consumption of energy, 2005 [%]**	**Target for share of energy from renewable sources in gross final consumption of energy, 2020 [%]**
Austria	23,3	34
France	10,3	23
Germany	6,7	20
Italy	5,2	17
Slovenia	16,0	25
Switzerland	The goal of Switzerland's energy policy is to increase the proportion of electricity produced from renewable energy by at least 5'400 GWh by 2030, which corresponds more or less to an increase of 10% of the country's present-day electricity consumption. To this target, the contribution from hydroelectricity production shall be at least 2'000 GWh.	
Liechtenstein	17	For 2020 no precise goals are set at the moment.

Table 3: Targets for renewable energies in the Alpine countries

[38] Targets for renewable energies as set for EU Member States in Annex I of directive 2009/28/EC and in Swiss Federal Energy Act (EnG, dated 26 June 1998; SR 730.0)

The main challenge resulting from these targets is to increase hydro-electric production in a manner which is compatible with environmental protection requirements.

5.2 Financial Support Schemes

In order to achieve the above objectives, most of the Alpine countries have set up support schemes for renewable electricity production. Different policy tools are in use, including guaranteed feed-in tariffs, investment grants, green certificates, tax exemptions, public procurement policies or research and development. These policy tools provide important incentives and seem to have been financially sufficiently attractive enough to trigger the present boom of small hydropower facilities (including micro hydropower plants).

Type of economic development schemes[39]							
Country	AT	FR	DE	IT	FL	SL	CH
Investment grants	x	?	-	x	-	-	-
Tariff subventions	(x)	?	x	x	-	x	x
Others	-	?	-	x	-	-	-

Table 4: Type of Financial Support Schemes

The support schemes (Table 4) differ partly because support has traditionally been linked to other national priorities and also because national electricity markets still can have very different characteristics and remain nationally segmented.[40] Therefore, further information on support schemes for renewable electricity production in the individual Alpine countries can be obtained from the individual national data templates annexed to this report. In most cases guaranteed feed-in tariffs are in place.

Summarising, support schemes are intended to act as a driving force for further developments in the hydropower sector. The magnitude of this driving factor is strongly

[39] More detailed information can be obtained from the individual national data templates annexed to this report

[40] Commission Report in accordance with Article 3 of Directive 2001/77/EC, Article 4(2) of Directive 2003/30/EC and on the implementation of the EU Biomass Action Plan COM(2005) 628 {COM(2009) 192 final}

linked to the level of support provided but can in some cases also depend on the level of market prices for electricity from renewable sources (i.e. in case the level of market prices is higher compared to the guaranteed feed-in tariffs).

5.3 Incentives for environmental adaptation and refurbishment of existing facilities

Environmental legislation has developed significantly in recent decades. Residual water (or environmental minimum flows) as well as fish passes are now seen as basic provisions of new hydropower plants. However, many old facilities do not meet modern environmental standards. For instance, older hydropower facilities may not provide sufficient residual water or be equipped with fish-passes, hence causing a fragmentation of river stretches and habitats. In such cases, adaptations to the facilities may be required in order to meet environmental objectives.

However in some countries, once a water licence or authorisation has been granted, this legal right can only be varied during the set period of the licence or authorisation (according to chapter 6.1 between 30 to 90 years) if it is economically bearable for the owner or for reasons of higher public interests and against compensation. Furthermore, some water rights from the past do not have a license or authorisation period at all, i.e. the right is for an unlimited time period.

When licences or authorisations have to be renewed, or when a new one is granted, the conditions for the water use are based on the current environmental legislation. Thus, if existing hydropower facilities request and need a renewal, extension or a new licence or authorisation then they have to comply and adjust to the new requirements of the actual environmental legislation, such as the residual water flow conditions.

Due to the length of time for which a licence or authorisation is granted, the effectiveness of new regulations on upgrading existing facilities in order to enhance the ecological situation can be limited. In order to allow for progress, some countries have set up promotion schemes and incentives to support operators or licensees in upgrading existing facilities with the aim of fulfilling environmental objectives [41].

[41] More information can be obtained from the individual national information annexed to this report

This is the case in Austria for instance, where through the "Umweltförderungsgesetz" (Environmental Promotion Act) EUR 140 Mio. the federal state is providing investment grants until 2015 for environmental measures like restructuring morphologically modified river beds, enhancement of river continuity and habitat connectivity or mitigation measures in case of hydro-peaking.[42]

There also exist examples of an effective "double-strategy", whereby the refurbishment of existing facilities (e.g. renewal of turbines and technical equipment) is combined with the implementation of environmental measures (e.g. sufficient residual water and fish-passes). In such a way upgraded hydropower facilities can generate more electricity while at the same time fulfilling modern environmental standards.

In the Austrian province of Upper Austria, for instance, 258 small hydropower facilities were modernised in the last five years, resulting in a 40% increase of electricity production (76 GWh per year) while at the same time respecting environmental needs.

In Germany, if existing facilities are modernised and thereby the ecological status is going to be improved significantly, tariff subvention schemes can be increased up to 12,67 ct/kWh for hydropower plants < 500 kW and up to 8,65 ct/kWh for power plants < 5 MW. Similar (degressive) regulations also exist for power plants up to 150 MW: increased tariff schemes are applied to the amount of electricity which is additionally generated due to the modernisation of the power plant.

[42] http://wasser.lebensministerium.at/article/articleview/71821/1/26045/

Another example comes from Switzerland. Certification of electricity with labels that get a higher price on the electricity market can serve as an economic incentive for enhancing the ecological impact of hydropower plants, with the granting of the label tied to ecological criteria. The "Naturemade" labelling scheme[43] was developed and organised by a private organization. The certificate system has two levels:

- The first level, "Naturemade Basic", needs a declaration of the source and origin of electricity (requiring that plants use renewable energy). Large hydropower plants (>10 MW) have to establish an environmental management system within five years of receiving the "Naturemade Basic" certificate.
- The second level, "Naturemade Star", was defined for environmentally preferable electricity. Power plants can be granted the "Naturemade Star" label if they fulfil "Naturemade Basic" criteria plus additional criteria. To achieve this level, hydropower plants must have a lower environmental impact than traditional hydropower plants. For example, they have to leave sufficient water in the rivers (i.e. respect residual flow limits) and allow fish to pass through weirs.

However, since framework conditions for licensing or authorisation can differ considerably between the Alpine countries, respective approaches for achieving environmental adaptation and refurbishment of existing facilities can also vary significantly and therefore a range of different solutions can lead towards achieving the environmental objectives.

5.4 SHP development and obstacles

A factor for evaluation of the effectiveness of support schemes for further hydropower development is the assessment of figures on intended new projects. Table 5 provides an overview of the situation in the Alpine countries, based on the received feedback. Since exact quantitative information is not always available, the table contains largely qualitative descriptions on the situation.

[43] http://www.naturemade.ch/Englisch/Label/label_e.htm

Country	Intended/Planned/Projected new small hydropower stations[44]
Austria	A considerable number of small hydropower projects are trying to get an approval. No precise number is available as authorisations are provided at district level.
Germany	The Renewable Energy Sources Act shows positive effects especially on the modernisation of existing small hydropower facilities in combination with ecological improvements Further Information given by Renewable Energy Sources Act (EEG) Progress Report 2007 by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).
France	No indication
Italy	The amount of new small hydropower stations which are intended / planned / projected to be realised within the Italian area of the Alps is high. No precise number is available as authorisations are provided at provincial level.
Slovenia	A substantial number (200) of hydropower plants below 10 MW are expected to be realised.
Switzerland	More than 600 applications were received for tariff subventions for the whole country (more than 400 than of them within the Alpine area). The available data refers to received applications at 22.4.2009. These applications have to be submitted to various evaluation processes, so the number of new small hydropower stations that will be finally realised could still undergo important changes.
Liechtenstein	There are no new installations planned but the hydropower station "Samina" is planned to be modified to a pump-storage power station in 2010/2011.
Monaco	No hydropower

Table 5: Information on intended, planned or projected new small hydropower stations in the Alpine area

Competent authorities in the Alpine countries are currently confronted with a considerable high number of applications for new small hydropower projects, what is inter alia a result of support policies for the sector in order to realise targets for renewable energy developments. This situation has implications for decision-makers since fast progress in the development of the renewables can only be achieved if procedures do not constitute an obstacle to balanced and sound decisions in due time. Table 6 presents a picture of the situation and how it is perceived in the individual Alpine countries.

[44] More detailed information can be obtained from the individual national data templates annexed to this report

Country	Difficulties in the decision procedure[45]
Austria	The main challenge is to cope with the non-deterioration provision of the EU-Water Framework Directive, respectively to comply with article 4.7 WFD (exemptions). So far only limited practical experience with these approaches is in place.
Germany	Approval procedures for new hydropower plants are mostly difficult due to variety of aspects and interests.
France	No indication
Italy	Approval procedures for new hydropower plants are mostly difficult due to variety of aspects: a) Lack of a territorial planning for hydropower. b) Lack of a diffused monitoring system: Often there is no comprehensive data base with information about all diversions; c) There is no substantial difference between the concession for small hydro and large hydro diversions, so even for very small power plants the procedure is very complex. d) Two procedures: To build a hydropower plant it is first necessary to obtain a concession for the use of water and secondly an authorisation to set up and run the plant. e) Competition procedure can be indefinitely long.
Slovenia	Problems are caused by lengthy proceedings.
Switzerland	The evaluation processes for tariff subventions and for authorisation are made independently and by different competent institutions/authorities. Subsidies are often granted to projects that are not yet sufficiently developed, that are located on natural river stretches and that do not consider cantonal planning. Increasing volume of submissions and an overload of work for the competent authorities. Guidelines, recommendations and instruments are needed.
Liechtenstein	No remarks
Monaco	No hydropower

Table 6: Overview on perceptions in Alpine countries with regard to authorisation procedures on new projects

As can be derived from the above information, many competent authorities in the Alpine countries are confronted with a range of difficulties in performing decision procedures for new projects. Frequently mentioned is the variety of aspects which have to be taken into account or difficulties over how to balance different interests. The need for decision procedures on new projects to take into account differing interests is, of course, not a new phenomenon.

However, due to progress in the frameworks on renewable energy generation already described and in environmental legislation, the pressure on the competent authorities has certainly increased in recent years. Hence, it seems vital to provide support to the

[45] More detailed information can be obtained from the individual national data templates annexed to this report

authorising bodies by backing up decision procedures with strategic planning instruments, since different aspects of the "(overriding) public interests" basically have to be defined on a higher level and cannot generally be decided on a case-by-case basis.

Last but not least, strategic planning is imperative for a sound implementation of the EU Water Framework Directive. As described in chapter 4.2.3, Article 4(7), which exceptionally allows the deterioration of water status under strict conditions, lies at the heart of new sustainable developments in river basins. According to Article 4(7)(d), alternatives for projects or better environmental options should be assessed at an early stage when better alternatives are available (e.g. alternative locations for hydropower stations). In instances of several developments in the same river basin, which is often case with regard to hydropower projects, best environmental options need to be addressed at strategic level as in such circumstances no adequate decision can be made at project level without strategic guidance.

6 FRAMEWORK AND GENERAL CONDITIONS FOR AUTHORISATION

The following chapters provide an overview of the varying general conditions with regard to the authorisation of new hydropower facilities in the Alps.

6.1 Competent authorities and legal status

Different competent authorities are responsible for granting authorisations, licences or concessions for new installations in the individual Alpine countries. Table 7 provides an overview of the responsible public bodies next to the legal status of the water use permissions.

Country	Competent authorities	System (legal status)
Austria	Facilities < 500 kW: Regional District Authority (= Bezirkshauptmannschaft) Facilities > 500 kW: Austrian Federal States (= Bundesländer) An environmental impact assessment (EIA) becomes obligatory above a 15 MW bottleneck capacity.	Authorisation system
Germany	District council; for some projects with supposed larger spatial effects there exist additional procedures	Authorisation system
France	No indication	No indication
Italy	Big concessions, with a nominal capacity >3MW, are generally granted by regional authorities, while small concessions, with a nominal capacity <3MW, are granted by provincial authorities. There is no substantial difference between the concession for small hydro and large hydro diversions. Producers have to make an EIA if there is a dam and they have to go through a screening procedure if the capacity is > 100kW or if the discharge is > 200 l/sec. However several Regions may ask for EIA even for smaller plants.	Authorisation system Licensing system
Slovenia	The competent authority is the government. 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 10000 m3, or for run-of-river schemes larger than 500 kW[46].	Authorisation system
Switzerland	International rivers: Confederation. Inland rivers: Cantons or Municipalities Installations > 3 MW have to be submitted to an EIA According to the Environmental Conservation Act, installations having a significant impact on the environment have to be submitted to an EIA. For hydropower, installations with a capacity of more than 3 MW are amenable to the EIA obligation in case of new construction, of significant changes of the installation, of significant changes of the existing concession and in case of renewal of the concession.	Authorisation system Water concession

[46] Source: SHERPA, 2008b. Strategic Study for the Development of Small Hydro Power (SHP) in the European Union. SHERPA – Small Hydro Energy Efficient Promotion Campaign Action.

Country	Competent authorities	System (legal status)
Liechten-stein	Concession from the government, independently of size	Authorisation system
Monaco	No hydropower	

Table 7: Competent authorities and legal status in the Alpine countries[47]

Since the legal systems developed largely independently from each other in the Alpine countries, it is not surprising that the general conditions vary considerably. What can often be observed is that the competences are shifted to a higher level in case of larger hydropower facilities, since larger projects can bring along more complex and demanding procedures. In such cases an environmental impact assessment is necessary.

6.2 Granting periods and charges for water-use

The following table gives information on granting periods for new but also existing hydropower installations and the charges which may be levied for the water use in order to generate electricity.

Country	Granted period	Charges for water use small or lager hydropower
Austria	New facilities: Usually 90 years Existing facilities: Usually 90 years but there still a number of facilities in place with authorisations without any limitation in time.	No charges
Germany	New facilities: 30 years Existing facilities: Variable, up to unlimited period	< 1 MW: No charges > 1 MW: special charge for hydropower generation
France[48]	Length of licence normally 30-40 years	Yes. The system is very complicated
Italy	New facilities: max. 30 years Existing facilities: max. 30 years The concession for hydropower use lasts a maximum of 30 years, but recently authorities tend to allow shorter concessions as well. In Italy all the concession are temporary.	Concessionaries have to pay an annual charge calculated on the basis of the concession capacity (kW) and the unitary value (€/kW) is fixed by each Region and updated every year. For 2008 the medium value was around 12-14 €/kW. Concessionaries also have to pay two additional annual charges (only if the capacity of the plant is more than 220 kW).
Slovenia[49]	Water abstractions are authorised for a period of time up to 30 years. Construction permit of the scheme is not time specified.	There are two types of fees to be paid by SHP producer: 1) Water concession charges – 3% of T (where T is buy-back rate for 1 kWh) and 2) extra charges - 0.3% of T)

[47] More detailed information can be obtained from the individual national data templates annexed to this report

[48] Source: SHERPA, 2008b. Strategic Study for the Development of Small Hydro Power (SHP) in the European Union. SHERPA – Small Hydro Energy Efficient Promotion Campaign Action.

Country	Granted period	Charges for water use small or lager hydropower
Switzerland	New facilities: Fixed by canton/municipality but never exceeding 80 years Existing facilities: Fixed by canton/municipality usually not exceeding 80 years. For some old installations unlimited periods are possible	< 1 MW: No charges 1 - 2 MW: linear increase to 80 CHF/kW (max.) > 2 MW: max. 80 CHF/kW (80 CHF ≈ ca. 50,- €/kW)
Liechtenstein	All plants constructed before 1976; no limitation for granted period	According to Water Act the yearly charges amount for 6,- CHF (ca. 4,- €) per gross horse-power
Monaco	No hydropower	

Table 8: Granted period and charges for the use of water for the hydropower generation in the Alpine countries[49]

The granting periods for new installations can vary between the countries from 30 years (e.g. Germany and Italy) up to 90 years (Austria). For existing facilities, water licences or authorisations already granted can range up to be time unlimited.

A certain period of licence or authorisation is essential for the operator of hydropower facilities in order to be able to reach the timeframe necessary for amortisation of the facility (which can vary depending on the type of station, interest rate, etc.) and therefore security of investment. However, too long granting periods can be problematic since management of water resources has to have the ability to adapt to changing conditions (e.g. natural, technical, political). Long granting periods for authorisations can make the system inflexible, especially in combination with strong user rights that do not allow any adaptations.

In all Alpine countries, with the exception of Austria, charges for water use have to be paid by the operator of the facility. The amount of charges often differs based on the size of the facility. Operators of smaller hydropower stations are often exempted from charges to a public body for the use of water for hydropower generation. Further information can be obtained from Table 8 or the national data templates annexed to the report. Nevertheless, the allocation of revenues from hydropower production and in particular an increase on the share of revenues that is return to the local level, seems to be an ongoing discussion.

[49] More detailed information can be obtained from the individual national data templates annexed to this report

6.3 Ecological licensing requirements and general criteria

In Alpine countries, the policy framework for the ecological licensing requirement generally does not make a distinction between small and large hydropower stations. The same environmental obligations (e.g. sufficient residual water or fish migration aids etc.) have to be fulfilled in the same way for river stretches utilised for small or large facilities. In Italy, the ecological requirements imposed are basically the same, but the compensation measures required by the environmental impact assessment are stronger for large hydropower.

In all Alpine countries the specific ecological conditions imposed for construction of new facilities include regulations on residual water and a guarantee of fish migration. With respect to fish migration generally no distinction between upstream- and downstream migration is made. In Alpine countries generally no specific ecological requirements for the maintenance of the bed-load balance are imposed for the authorisation procedure.

Imposed ecological conditions for fish migration[50]		
Country	Upstream migration	Downstream migration
Austria	Yes, but only in water bodies where naturally fish are living (natürlicher Fischlebensraum). This requirement is usually requested since the Wasserrechtsgesetz-Novelle 1990; but according to the Austrian River Basin Management Plan (March 2010) it s planned to strengthen this requirement by implementing a specific Ordinance (upstream migration has to be guaranteed for fish as being State of the Art concerning river continuity)	No, at present there are no specific legal provisions for downstream migration in place.
Germany	Substantial modification or operation of a power plant is only admissible if the continuity of the water body is maintained or restored where this is necessary to achieve the management goals.	
France	No indication	
Italy	Under certain circumstances, depending on the type of catchments and on the size of the water body and on the presence of fish. A fish pass is generally required	
Slovenia	Yes, fish migration has to be ensured for all new constructions that could cause continuity interruptions of rivers. This is regulated within the Freshwater Fishery Act. However, the Act does not define exactly the requirements for downstream migration.	
Switzerland	Yes, fish migration has to be enabled but no distinction between upstream and downstream migration. So far only facilities for upstream migration are generally provided (but efforts are made for downstream migration as well).	
Liechtenstein	Yes, fish migration must be guaranteed	
Monaco	No hydropower	

Table 9: Imposed ecological conditions for fish migration in the Alpine states

[50] More detailed information can be obtained from the individual national data templates annexed to this report

Country	Imposed ecological conditions on residual water[51]
Austria	Yes, good ecological status has to be guaranteed with specific regard to the biological elements. As for new installations the reaction of biology has to be predicted the "Qualitätszielverordnung Ökologie - BGBl. II Nr. 99/2010" (Ordinance on ecological quality standards) includes a guiding value for ecological minimum flow. This abiotic value means that with this minimum flow the good status of the biological elements can be guaranteed with high confidence.
Germany	Yes, Bavarian guideline for existing small hydropower facilities < 500 kW with ecologic and economic threshold value. According to the Bavarian guideline residual water in general limited by 5/12 MNQ for existing plants - idea of inventory protection. For new hydropower facilities special residual water studies are carried out including all concerned biotic and abiotic aspects. Often in situ discharge investigations. Individual survey considering single case circumstances rather than fixed threshold values. Often dynamic components such as percentage of actual supply are added (e.g. good practice example EV Oberstdorf). General approach for residual water studies is summarized in already conveyed sheets from Bavarian environment agency.
France[51]	Yes, normally 10% of inter-annual mean flow. For sites with inter-annual mean flow of more than 80 m^3/s it is reduced to 5% and also for some other cases. This rule is applicable to new projects, for existing plants at renewal or 1 January 2014 at the latest.
Italy	Yes, in order to make hydropower production more compatible with the natural life of rivers, a minimum flow must be released so as to assure the preservation of the hydrological continuity of the river and the consequent conservation of natural habitat and ecological life. For each river district the general criteria to evaluate residual flow are fixed by the basin authority within a wide range of possible methods. The effective value for each river stretch is regulated by the regions. A very common approach is to use parametric formulae, where the reserved flow is imposed as a fraction of the mean river flow. This fraction considered hydrological, morphological and environmental aspects.
Slovenia	Yes, conditions are defined in the decree on criteria for determination and on the mode of monitoring and reporting of ecologically acceptable flow (2009). An abiotic threshold value is applied.
Switzerland	Yes, minimum flow requirement in principal derived from Q347 flow rate with further specifications.
Liechtenstein	Yes (sufficient residual water after water abstraction required)
Monaco	No hydropower

Table 10: Imposed ecological conditions on residual water in the Alpine states

In Alpine countries the decision on approval of new facilities is mostly determined individually for the specific site, there are no "general criteria for approval". Nevertheless, as described in the following table, in some countries projects within National Parks, Nature 2000-Sites, etc. are generally rejected.

[51] Source: SHERPA, 2008b. Strategic Study for the Development of Small Hydro Power (SHP) in the European Union. SHERPA – Small Hydro Energy Efficient Promotion Campaign Action.

Country	Criteria for sites where construction of new facilities is generally rejected[52]
Austria	Work on specific criteria is in progress. However no final list is in place. Up to now it has to be proved during the approval process that no public interests are infringed upon for every individual plant.
Germany	Always decision in each single case by weighting all pros and cons.
France[52]	Several areas, decided by "Conseil Superieur de la Peche"
Italy	Yes, as a rule, constructions of new facilities are forbidden in areas like Nature2000 sites, Sites of Community Importance (SCI) and Special Protection Areas (SPA). There are also areas classified as exposed to high natural hazards, where the construction of new hydro-power plants is not allowed.
Slovenia[52]	The rivers are classed in 4 categories. 1st and 1-2nd are regarded as preserved (non-regulated or used for any economic activity) and are not intended for power production. In addition there are preserved territories under Natura2000.
Switzerland	If sites are located in inventoried national or cantonal sites with strong relation to water/groundwater/fish (alluvial zones, mires, spawning areas, …), this is normally taken as a strong argument by the competent authority for rejecting applications.
Liechtenstein	No remarks
Monaco	No hydropower

Table 11: Existence of criteria for sites where construction of new facilities is generally rejected

6.4 Further Hydropower development – pre planning mechanisms and strategic planning

In the Alpine countries, there is in general no strategic planning for further hydropower development in place. However, in most countries a discussion on planning instruments is ongoing and surveys of hydroelectric power potential are under preparation or in some cases already in existence.

Development Plans - Existence of concrete plans for future development		
Country	Plans	Description[53]
Austria	Not yet. Work in progress:	In the Austrian River Basin Management Plan (March 2010) the Austrian Federal States (Bundesländer) are supposed to proceed with regional planning which i.e. may lead to an assignment of water bodies where the high status will be protected in any case for the future
Germany	No concrete intentions	New Federal Water Act contains provisions for surface waters aiming at an examination of existing transversal structures being suitable for hydropower use; Criteria have to be defined under which hydropower use is conceivable at existing transversal structures Survey of hydroelectric power potential for promoting large hydropower (> 1 MW) has been done by large hydropower companies. Reflections on spatial prioritisation for hydropower use have been made.
France	No indication	

[52] More detailed information can be obtained from the individual national data templates annexed to this report

[53] More detailed information can be obtained from the individual national data templates annexed to this report

Development Plans - Existence of concrete plans for future development		
Country	Plans	Description[54]
Italy	Few plans at provincial level	At the moment there is a general lack of a territorial planning for hydropower. Only a few public authorities, generally at the province level, made a territorial plan for hydropower development. Based on WFD criteria, the Province of Sondrio identified suitable and less suitable areas for the construction of hydropower plants. Outside the Alps, the Province of Florencedeveloped a territorial planning indication that new hydroelectric plants must utilise the existing weirs.
Slovenia[55]	Under preparation	Local spatial plans are being produced in which SHP have to be included to apply for the concession. However, there is no intention to develop local spatial plans to guide the development of SHP project by highlighting suitable areas.
Switzerland	In some Cantons under preparation, a national recommendation foreseen for the beginning of 2011	In the "strategy for hydropower utilisation in Switzerland" the contribution of new small hydropower to the evolution of Swiss hydropower until 2050, is estimated at 1100 GWh/year. The strategy remarks that appropriate potential sites should be determined, but does not include specific geographical information. Competent authorities are demanding instruments and strategies for global evaluation of incoming applications. Some Cantons are about to prepare strategies. At national level a recommendation on the use of small hydropower is under preparation and is to be published by beginning of 2011[56].
Liechtenstein	No	No plans
Monaco	No hydropower	

Table 12: Development Plans - Existence of concrete plans for future development (e.g. Strategic Planning or Surveys of hydroelectric power potential) based on geographical information

[54] More detailed information can be obtained from the individual national data templates annexed to this report

[55] Source: SHERPA, 2008b. Strategic Study for the Development of Small Hydro Power (SHP) in the European Union. SHERPA – Small Hydro Energy Efficient Promotion Campaign Action.

[56] www.umwelt-schweiz.ch/UD-1037-D

7 MAIN FINDINGS AND CONCLUSIONS

One of the main findings drawn from feedback received from countries answering the template, was that appropriate national provisions for environmental residual (minimum) flows as well as provisions for fish passes are required for new projects; in general no distinction between small and large hydropower seems to be made with regard to imposing ecological conditions. Therefore no further work was undertaken with regard to residual flows and fish passes in order not to duplicate national efforts already in place, nor was any major added value seen in drafting general guidances to cover the whole Alpine area; this is in light of of the necessity to pay attention to regional differences and to varying national conditions. Work thus focused on providing the basis for the guidelines covering the use of small hydropower including common principles and recommendations, on an outline for an assessment procedure as well as on a pool of evaluation criteria.

Several hundred applications for new small hydropower stations have been reported across the whole Alpine area (with considerable difference of numbers between countries), thus potentially adding to the high number of facilities already in place. This boom has been triggered in particular by the financial incentives and support schemes in place in all countries of the Alps. The most widespread form of support are feed-in-tariffs; however the form as well as the amounts of subsidy differ considerably between countries. The allocation of revenues from hydropower production, and in particular the increase of the share of revenues returned to local level, is an ongoing discussion.

Nearly all countries levy charges for water use in hydropower generation (except AUT), for some Alpine regions this constitutes a major source of income. Some countries make a differentiation between small and large hydropower, exempting SHP from charges.

This boom in applications presents a particular challenge for competent authorities in handling the huge amount of applications and deciding on authorisations for new facilities, due to variety of aspects to be taken into account (energy generation, CO2 emission reduction, ecological impact etc).

Adding to the difficulties of the high number of applications for new facilities is the fact that there are no criteria for a general approval in place. The decision on new facilities is mostly determined for sites individually (with exception that in some countries projects within National Parks, Nature2000-Sites, etc. are generally rejected). So far authorisation seems to have been based mainly on the assessment of impacts of the individual facility on the actual site. In line with the provisions of the EU Water Framework Directive as well with ecological needs and cumulative effects, a more holistic assessment needs to be carried for new modifications affecting 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.

Master plans, action plans or strategies for the development of hydropower (in EU countries driven by the "20-20-20 targets") are mostly not yet in place. The same holds true for pre planning mechanisms with regard to the identification of the remaining potential and with regard to ecological compatibility. However, the feedback provided indicates that efforts in this direction are under way. The forthcoming common guide-lines will certainly support these ongoing efforts.

One of the main findings of the report on "Water and Water Management Issues – Report on the State of the Alps" was that quite a number of facilities in place (having got authorisations in the past without approriate environmental provisions) do not meet up to date ecological requirements with regard to fish passes, minimum residual flows, etc. While legal provisions are now in place to enhance ecological status so too are economic incentives to provide for such enhancement. These incentives include direct grants and increased feed-in-tariffs as well as "green labels" to get higher prices on the market. Good practise examples reported back include initiatives to refurbish and modernise facilities in place leading both to improvement in ecological status and an enhanced output of hydropower generation.

Last but not least two further findings shouldf be highlighted: the definition of small hydropower plants and their contribution to overall hydropower generation. Feedback provided revealed that the term "small hydropower" is frequently used in the discussions on the generation of renewable energy and defined usually according to the

characteristic figure for the bottleneck capacity. However the threshold for small hydropower is tailored to national needs and thus differs from less than 10 MW to less than 1 MW.

From the collected data it is evident that of the total electricity production from hydropower the larger plants contribute by far the major share, i.e. more than 95% of the total production comes from facilities with > 1MW power output. Meanwhile stations with a capacity of less than 1 MW constitute around 75% of all HP plants within the Alpine area yet contribute less than 5% to total electricity production. The smaller the capacity class the more contrasting is the ratio between number of plants and their contribution to the total hydroelectric production. This raises a question as to whether financial incentives provided at national level for very small hydropower plants contribute significantly to increase the share of renewables; a potential need for optimising current economic incentives may be derived from this data. However small hydropower plants play a crucial role in meeting electricity demand in more remote regions and provide important economic stimulation at local level in less favoured areas. Furthermore, when taken together, they go some way towards meeting ambitious goals on increasing the share of renewable energies.

Based on the facts and findings presented in the report, the key conclusion is that due care and planning on a regional basis is necessary when deciding about new SHP facilities in order to ensure that further development of hydropower is compatible with environmental protection requirements as well as with the ambitious targets set for renewable energy. This explains the need for support for decision-making and common guidelines.