EUROPEAN SMALL HYDROPOWER ASSOCIATION

HYDRO Contribution to the SET hearings

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Issued discussed

Hydropower now accounts for around 80% of electricity generated from renewable sources in Europe, and 19% of total electricity production in Europe. Electricity generation from SHP contributed about 3% to the total electricity generation in Europe. Hydropower despite being a mature technology (in comparison with other RES) with a vast potential already exploited, has still a significant untapped potential, not only in the development of new plants (of special interest for Europe, very low head Small hydro plants and pumped storage plants), but also in the upgrading (increase of efficiency and electricity production as well as environmental performance) of old ones.

Hydroelectricity meets the conditions of the European Strategic Technology Plan (SET-Plan). It is an affordable, competitive, clean, and efficient, without greenhouse gas emission technology and creates stable and predictable conditions for industry.

The electricity network can't be stocked, the balance of an electric system can be realized only by fitting permanently the production to the consumption, by being capable of modulating almost immediately the power produced and injected on the network. The possibility of being able to modulate quickly the electricity production thus dresses a particular importance.

The hydroelectricity, when associated with a reservoir (lake, dam, etc.), is the only flexible renewable energy, with besides the possibility of rise very quickly the produced electric power; it is thus not only about a source of energy, but also about a source of flexible electric power which plays a crucial role in the safety and the balance of our electric system.

So, of special interest for Europe, from both the economic and environmental point of view, is the exploitation of the high potential for upgrading and refurbishing (great potential for refurbishing and new plants also in Eastern Europe -also a way of conserving industrial heritage) and developing multipurpos**e** plants (electricity production combined with drinking water supply systems, waste water treatment plants, irrigation channels) where the infrastructure is already existing., At the same time a large proportion of the potential in Europe involves low-head and very low head plants. The benefits of concentrating development efforts in this area are obvious.

According to the RES EU Export Masterplan 2002 the European gap between exploited and economic potential is approx. 250 TWh/year, corresponding to 55 GW installed capacity. A further amount of 450 TWh/y (100 GW inst. cap.) seems to be technically exploitable, but not yet in economic terms.

This huge untapped potential is still available and it can be exploited only by R&D activities. These activities should address not only technological solutions (e.g. Very Low Head SHPs) connected to electromechanical equipment, **but also the whole plant.** It must be pointed out that hydro turbine units are just a part of the plant and that many other R&D activities are worth of attention.

1. **New turbines concept** (e.g. Very Low Head SHPs and modular Matrixturbines) for exploiting part of the untapped potential. It is estimated that 1 to 1.5 GW can be installed in Europe using existing dams, weirs, irrigation infrastructures etc, with a very low environmental impact as the infrastructure already exits. This will generate 6-7 TWh/year. There is a need to develop specific products for this untapped market of very low heads. These products (i.e. turbines) should not be just a reduced version of a large one. As a large proportion of the potential in Europe concerns **low-head** plants, the benefits of concentrating development efforts in this area, and particularly for low head power developments, are obvious. Moreover the environmental impact of such low-head power plants can be very limited, as numerous sites already exist (old mills weirs, abandoned power plants, etc.).

2. R&D activities related to efficiency improvement of hydro units in case of **refurbishment**, regardless of the size. This task is important also in view of the expected reduction in energy production due to implementation of the European Water Framework Directive (WFD): higher efficiency machines can reduce the impact of higher reserved flow on energy production. In France alone, it is estimated that with the existing 25 GW of installed capacity (most machines are 40-50 years old), a 5% increase efficiency of these machines will lead to a production increase of 4 TWh that represents 1 000 wind turbines. "Upgrading" may represents a 5% potential of the European hydroelectric production: this represents approximately 30 TWh for Europe (on a total production of 580 TWh). With a big capacity of development on this strongly competitive market, the technological advance is a major factor to maintain the European companies place on the world Hydroelectric market. These ambitious targets can be achieved by optimising the design of both generators and turbines only. Improved mechanical design which allows a higher energy density without risking machine failure requires better understanding of the mechanics and better calculation methods. Funding of R&D projects will help the industry to progress more rapidly

3. In parallel with 2: **R&D activities aimed at implementing the WFD** and avoiding as much as possible production losses (e.g. river restoration activities, fish passes, river bed and bank protection works, creation of stable low water river bed, etc.), optimization of materials and design (eco**-** technologies, eco design, water intake optimization, minimization of sediment deposits, optimal design of supply by canals

and forebay etc.). The major goal is thus to increase the efficiency of the power plant so as to generate the maximum electricity with the available discharges and head. This infers that R&D has to be conducted in a way to find a compromise between the cost of the equipments and their efficiency and that this efficiency has to be accurate and guaranteed on the long term, i.e. has to be environmentally sustainable.

4. **Promote multipurpose schemes** regardless of their size (electricity production combined with drinking water supply systems, waste water treatment plants, irrigation channels, the infrastructure is already there), to increase the energy value, currently lost, of most existing water networks (irrigation channels, canals, desalination systems, waste water and drinking water networks,) by generating hydropower electricity. There is a need for technological development to identify and further develop technological solutions for these purposes (new cost-effective solutions, efficient and reliable equipment, that can be easily integrated into the existing infrastructures). Thus, adaptation to the local infrastructure is a key word for such implementation, which infers a good knowledge of the infrastructure, but also a reliable technique. Development of such criteria has to be carried out for the whole hydropower area from a very low head of 1.5 metres to a high head of about 600 metres. This should be done in accordance with environmental regulations. Moreover, each type of site has its own specifications. For example, the use of wastewater before treatment means that special material and specific design must be considered in order to avoid any operational problems. As irrigation networks are generally dealing with low and very low heads, an efficient and economic energy recovery means that simple and reliable solutions have to be found and proposed. Finally, the small hydro power plants in drinking water networks need to correspond to a high quality level in order to avoid any pollution and to insure a safe and reliable water supply. For all these reasons, there is still place for development and innovation in these fields.

5. **Large pumped storage plants** are of high importance to grid stability (due to the increase in intermittent sources) and they achieve circuit efficiencies up to 80%. Pumped storage hydroelectricity is a method of storing and producing electricity to supply high peak demands by moving water between reservoirs at different elevations. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir. When there is higher demand, water is released back into the lower reservoir through a turbine, generating electricity. Reversible turbine/generator assemblies act as pump and turbine (usually a Francis turbine design). Pump-turbine offers hydro plant owners the flexibility to meet peak demands and to regulate power (grid stability).

   Store energy massively: In conjunction with the development of renewable energy (wind, solar,...), which produces electricity when conditions are favourable but cannot store it, Pumped storage plants are the most efficient way of storing large amounts of electrical energy at acceptable costs. Used to accumulate nuclear power at the beginning, pump turbines are also associated to other sources of renewable energy as wind power or photovoltaic, as efficient and reliable storage capabilities become more and more important in modern power networks.

   Moreover, in order to suit high and sudden variations in power demand, a large amount of power must be quickly available to be released at the required time. The excess current, generated during off peak hours, is used to store potential power by pumping water uphill back into reservoirs. Water is then available for delivery through turbines and produce energy at peak hours.

In Europe there is still significant potential for this type of plants, mainly by extension of existing storage schemes. Further research on power electronics for this type of plants (for innovation in terms of variability, stability and control) is need. Also, as these plants are exploited in a very dynamic manner to respond to new and challenging market constraints, new research on their compatibility with existing environmental regulations and with actual civil engineering design rules (for example impact on sediments transferred from one reservoir to the other, impact on design of galleries and pressure shafts, etc.) is necessary. Such research is estimated fairly expensive. This kind of research is fairly expensive.

6. **Small-scale pumped storage plants**: this issue also addresses the need for grid stability but even more the need for unloading transmission lines during peak hours. Pumped Storage plants are the first in the entire quest for energy storage, almost impossible for other renewables. It would allow building energy storage capacity close to the production location of wind farms. The R&D activities should aim at both electromechanical equipment (actually there are no or only a few small scale pumped storage plants) and environmental impacts, which were never specifically investigated before (only few results from large scale pumped storage are available). Also, specific challenges for civil engineering design optimisation as a function of increasing market constraints seems necessary. So far, the market of pumped storage plants is not open to private investors.

7. **Laboratory Development and Demonstration**. The majority of SME's supplying equipments and services in the field of small hydro do not have easy access to R&D laboratories and to demonstration, essentially for financial reasons (it is too expensive). There is a need for demonstration sites, to get closer to the customers, and to open the range of applications. The fact that a large number of plant operators are not systematically informed of the benefits they can make using efficient technology, prevents equipment suppliers from profiting from any investments they might have. Hydropower is very site specific, so demonstration despite being very useful in validating a given technique, nevertheless has the disadvantage of not being generally applicable to all sites or conditions. As such, many demonstration sites, in different countries and conditions should be a priority of RD&D programmes.

8. **Monitoring**. Proposed research efforts for new and site adapted design rules will need to increase monitoring of existing or newly constructed plants. Especially the impact of dynamic market constraints (continuously changing demand in energy during the day) on an existing plant should be monitored to better assess any new design guidelines.

9. **New markets worldwide and Islands.** Small hydropower meets the electrification needs of remote or peripheral areas, in countries or regions having a low-density grid, as it is the case in developing and emerging countries. Very low head turbines are also of special interest for African countries, with long rivers but no mountains, and also for the USA and Canada markets. All these conditions will give very interesting export opportunities for European industry, which is competing worldwide mainly with the Chinese one.

   For Islands, strongly dependent on fuel import, the security of supply of initiatives like 100% RES Islands can only be ensured with the backup of Hydro in the islands.

10. We usually forget **social issue**s: SET-plan addresses them too as "*it'll be to match the most appropriate set of policy instruments to the needs of different technologies at different stages of the development and deployment cycle*" and something should be done. In this context the harmonisation between different EU Directives could make

sense and further investigation on "*demand pull instruments*" specific to hydro, too.

11. **Administrative and legislative barriers**: numerous institutional barriers exist, the main one being, in many countries, the difficulty in getting the concession to use and divert water from the river (and the renewal of the concession after the concession period). Difficulties in gaining affordable connections to the grid are also common, and very long procedures in order to get all permits because hydro operators have to deal with many administrations (in Portugal or Spain it can go up to 12 years). Moreover in some countries there are even forbidden rivers, where no hydropower development can be carried out or even investigated). Hydropower is very site specific because rivers are individuals and, as such any generalisation lacks scientific rationality behind it. Any general and simple regulation is necessarily a wrong one.

    There is a need for investigating the possibilities for simplification and harmonisation of administrative procedures: Set up a single reception point for authorisation applications, ensure a co-ordination between the different administrative bodies involved and the establishment of reasonable deadlines. Establish a "*fast-track*" planning procedure for Small hydropower and for refurbishment- nowadays the same procedures are applied for a 50 MW plant than for a 60 kW one. Sometimes it is even more difficult to refurbish an old mill than to build up a new 30 MW gas power plant[1]. Where applicable, create the possibility of establishing mechanisms under which the absence of a decision by the competent bodies on an application for authorisation within a certain period of time automatically results in an authorisation. At the end of the concession period and the liberalization of the market, many big utilities, owners of hydropower plants will not invest in refurbishment, since they don't know if the concession will be renew for them in the future.

12. **Financing.** EIB focused on large projects does not favour the untapped potential of very low head projects. Any ideological support is highly welcome to modify that strategy.

It is essential to overcome the general impression that the technology is already mature and fully developed, and it is, consequently, wrongly assumed that the technology cannot be further developed and improved in any way or will be developed or improved without any need for significant institutional support. This general impression leads to a situation where hydropower is generally excluded from programmes designed to assist renewable energy development (from political support to R&D investments). It is essential to have well-structured and coordinated RD&D programmes, in order to continue and increase the development of new machines and construction techniques, with the objective that equipment and new and old plants are environment-friendly, simple, reliable, and efficient, i.e. to be environmentally sustainable.

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[1] APPA info (22 July 2006)