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Protection of river basins in 20th century Norwegian energy- and industrial politics

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Synopsis

With around 4000 watercourses Norway is a water nation. Norwegian watercourses are characterised by great variety. As Norway is located far to the north geographically, we have a particular responsibility to take care of artic watercourse nature. Through the Protection Plan for River Systems in the period 1973-2005, 387 watercourses have become protected. Norway is also a hydropower nation. 20th century concession legislation secured government control over the hydropower development, which became mainly state directed. No other impact on nature is as regulated by laws as hydropower development.

In the 20th century the country's energy- and industrial politics was strongly associated with hydropower. In Norway hydropower development commenced towards the end of the 1800s. The foundation was laid for a speedy electrification and a power intensive industry which became internationally significant. Especially the years 1950-1990 are known for massive hydropower development. It was not until the year 2000 that the authorities announced that the time of the great hydropower developments had passed.

In the 1960s the development of Norwegian watercourses was progressing at such speed that had it continued, all watercourses would have been developed by the end of the 1980s. If a representative selection of Norwegian watercourse nature was to be preserved swift action was required. The result was the 1973 Protection Plan Resolution and in the 1980s The Master Plan for Water Recourses. The Master Plan is a survey of which hydropower projects will be considered for concession first.

In this paper we highlight the process towards the first Protection Plan resolution in 1973. The work on the Protection Plan must be seen in context with the primary goals of 20th century energy- and industrial politics. The work on The Protection Plan for River Systems has been a more or less continuous process since the 1960s until today; consequently a focus on the first part of this process is important in order to understand the development also after 1973. Central questions are why the work on the Protection Plan began, how it was carried out and how the work related to energy- and industrial politics.

Introduction

With around 4000 watercourses Norway is a "water country". Norway has highly varied nature and landscape, where mountains, valleys, fjords and water are the main elements. Some of the waterfalls are among the highest in the world, and today 0.8 percent of continental Norway is covered by glaciers. Norway is also a country of hydropower based electricity. The strong links between water and energy are unique for Norway. The electricity production is almost exclusively hydropower. The hydropower development started late in the 19th century and is the basis of the power intensive industry. Especially the years 1950-1990 are known for massive hydropower development. In the 1960s the development of the river basins was progressing at such speed, that had it continued, all river basins would have been put to use by the end of the 1980s. If a representative selection of Norwegian watercourse nature was to be preserved, swift action was required. The result was the 1973 Protection Plan resolution. It was followed by four more resolutions, the last in 2005. Today 387 river basins are protected. The reason for including watercourses in the Protection Plans has been to prevent any reduction of their conservation value through hydropower developments. The idea that virgin wilderness should be conserved was linked to a wave of national romanticism from the mid-1800s. In 1970, the decision to harness the potential of the Mardal Falls, one of Europe's largest, most beautiful waterfalls, resulted in one of the largest environment protests of the time.

In this paper we highlight the process towards the first Protection Plan Resolution in 1973. The Protection Plan must be seen in context with 20th century energy- and industrial politics. The work on The Protection Plan for River Systems has been a more or less continuous process since the 1960s until today. Central questions are why the work on the Protection Plan began, how it was carried out, and how the work related to energy- and industrial politics.

In the first part of the paper we present the industrialisation process in Norway, with focus on the hydropower development from 1900 to 1973. The second part deals with the Protection Plan for River Systems. In the last part we use the industrial community Odda as an example of sustainable administration of watercourses from 1900 until today.

Hydropower development 1900-1973

Industrialisation with water 1840 to 1920

The industrialisation process in Norway started in the 1840s. The first wave of industrialisation came with textile and mechanical industry. There were no major deposits of coal on the mainland, and the energy sources were water-driven wheels along the watercourses. The need for transport and energy fostered the development of industry along the rivers. Norway was favourable situated, in terms of resources and transportation, to be a major exporter of among else pulp and paper. Towards the end of the century the pulp and paper industry went through a period of major technological changes. Borregaard, owned by the Kellner Partington group of the United Kingdom, acquired the rights to the west side of the Sarpsfossen waterfall on the Glomma River (in the southeast), and started building two power plants in 1898. Electricity as a source of power for industry had already been introduced in 1885, when the first power plant was built near Skien.

The turn of the 19th century was a period of great transition for Norwegian industrial development with the breakthrough of power intensive industry. Hydropower became an incentive for introducing new types of production, processes and methods. Access to cheap and available hydropower in Norway tempted English, French and Swedish capitalists to make huge investments.

The world was in need of atmospheric nitrogen for fertilisers. The natural sources in Chile were emptying. In the period 1900-1940 three processes for fixating atmospheric nitrogen dominated internationally: the arc process, better known as the Eyde-Birkeland method, the Cyanamid process (the Frank-Caro-method) and the Direct Synthetic Ammonia Process (Haber-Bosch-process). Nitrogen fixed in these forms can readily be converted for other materials, like explosives. The arc-process installations, except Norsk Hydro's at Notodden and Rjukan, were relatively small because of the huge power requirement. The Cyanamid process was used in fourteen countries before the outbreak of the First World War. The largest factory was in Odda, in Western Norway. Table 1.0 presents the number of factories in the World producing nitrogen in 1913-1928 (Ernst, Frank A, *Fixation of atmospheric Nitrogen*, Chapman & Hall, London 1928).

Table 1.0 Number of works in the world producing nitrogen 1913-1928

Year	Arc process, number of works	Cyanamid process, number of works	Haber-Bosch process, number of works
1913	7	15	1
1918	12	35	3
1928	5	28	51

Source: Ernst, Frank A, *Fixation of atmospheric nitrogen*, Chapman & Hall, London 1928, s. 16.

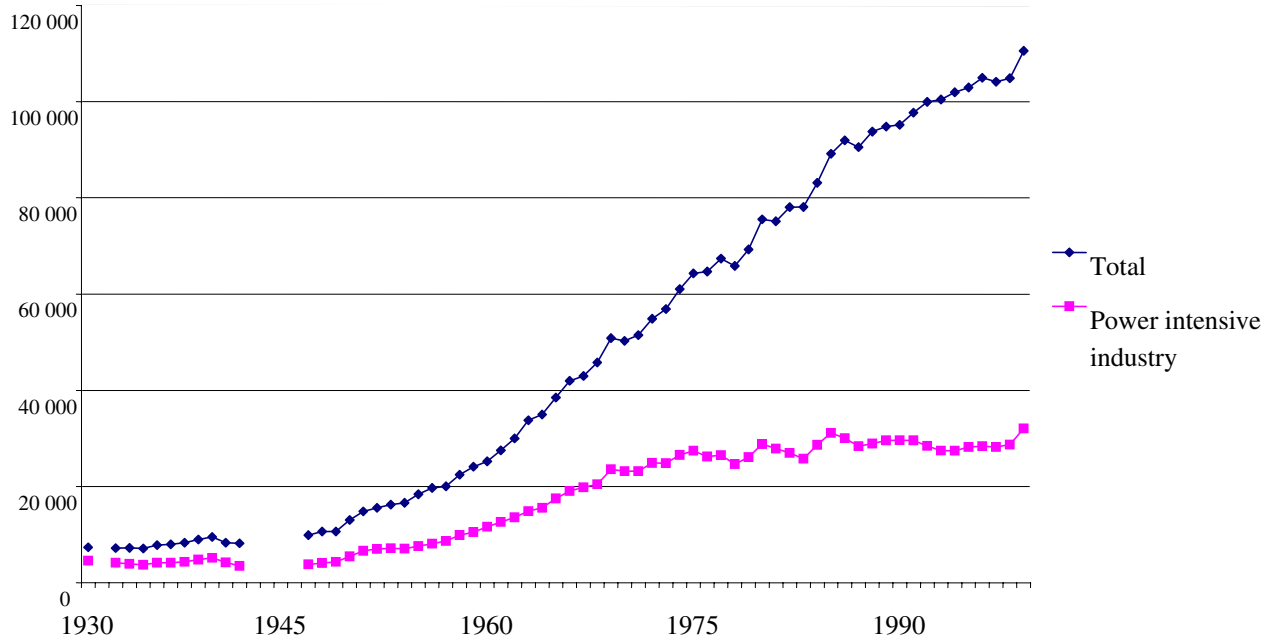
Norway was in a very favourable situation when it came to water resources. One reason why the development of hydropower was economically favourable in Norway was that there were many high and medium high waterfalls and that the ground was usually solid rock. Another reason was that the development of watercourses took place in unpopulated areas. In the first decades of the 20th century the transmission technology was lagging behind the production technology and this explains why industrial centres were established near the power source, between high mountains and fjords. In the 1950s the technology made it possible to establish power intensive industry disregarding distance to the power source.

The country became among the world leading in producing power intensive products like fertilisers, aluminium and carbide. The power intensive industry became an important part of Norwegian economy and economic growth in the 20th century. Other significant consequences of hydropower development were modernisation of the households. In 1920 64 percent of the population lived in households with electricity.

Hydropower development 1950-1973

The hydropower development after 1950 can be characterized as the age of large-scale installations. Several of the largest projects were directly related to industrial development. In 1946 the decision was made to build Norsk Jernverk (Norwegian Ironworks) at Mo i Rana and aluminium factories at Årdal and in Sunndalsøra. As a result, the production of electricity increased and also the consumption of electricity by power intensive industry. Figure 1.0 illustrates the total consumption of electric energy in GWh annually 1930-1998, and the consumption of the power intensive industry in the same period.

Fig. 1.0 Net consumption of electric energy 1930-1998, in GWh



Source: Bureau of National Statistics, ssb.no/histstat/aarbok/tab-2000-10-25-03.html

As shown in figure 1.0, the power intensive industry constituted around 45 percent of the total consumption in the period 1950-1970. In 1980 it was 37 percent. A larger part of the electric energy was now consumed by other branches, and households. In the period 1960-1990 hydropower production quadrupled to 108 TWh annually. The industrial development in Norway 1900-1970, and examination of hydropower resources shows that industrialisation through power intensive industry was a desired and planned development. During the years 1919 to 1922 a review of Norway's potential hydropower was issued by Norway's Watercourses- and Electricity Board. In 1961 The Electricity Board published a review based on reliable topographical maps of the country, in combination with other methods of measuring potential hydropower. Up to the 1970s Norwegian energy policies equalled hydropower policies (Ministry of Industry 1973-1974).

The breakthrough of the power intensive industry around 1900 was to a great extent initiated by foreign technology and capital. This is explained by several factors: There were probably few capitalists rich enough to take on the burden of hydropower development to the extent the new industry required. There were no electrical engineering training courses in Norway before 1900. Huge investments were made in shipping. The banking structure, with many and small saving banks, did not encourage industrial investments. The main challenge for the authorities after 1900 was to control the hydropower development. The result was the

concession laws, established in the years 1906-1920. One element in this legislation was the return policy, which was based on concessions. Hydropower stations with equipment and water rights in the hands of private investors were to be returned to the state 60 to 80 years after concession was given. As part of this, the hydropower development after 1920 was to a great extent initiated by the public sector. Concessions were now required for development of water resources, in accordance with the 1917 Watercourse Regulation Act. The general Watercourse Act was revised in 1940, and replaced in 2001 by the modern Water Resources Act. The Watercourse Regulation Act has been amended several times, and is now coordinated with the Planning and Building Act. Water management is based on well developed legislation, and involves several Ministries with subordinated Directorates. Major cases, cases of national interest and consequence, are decided by the Government or Parliament.

Protecting rivers and environmental awareness

Increased commitment to and understanding of the environment

The protest against developing the river in scenic Aurland Valley (which was decided in 1969), was among the first national confrontations between environmental and national interests (Faugli & Klemsdal 1994). In 1970, the decision to harness the potential of the Mardal Falls (in the northwest), one of Europe's largest, most beautiful waterfalls, resulted in one of the largest environmental protests of the time. The police had to intervene and carry demonstrators away. This was the first environmental protest of its kind in Norway (Næss 1973). This form of environmental activism has since characterised opposition to hydropower development in Norway. The conflict regarding the construction of a dam on the Alta-Kautokeino watercourse (in the north), became politicised from the mid-1970s in an entirely different manner than the Mardøla conflict when the rights of an ethnic minority, the Sami, were brought into the struggle. The activists sowed doubt as to whether Norway needed the electricity from the Alta River.

The idea that virgin wilderness should be conserved was linked to a wave of national romanticism from the mid-1800s. The 1920s marked the advent of the most heated environmental debate that had ever occurred in Norway. It was sparked by plans to develop vast areas in the Jotunheimen mountain range. In 1921, the National Organisation for Conservation lodged such a well-founded protest to the authorities that the Norwegian Water

Resources and Energy Administration (NVE), which was established the same year, decided to shelve the plans. Sjoavassdraget with among else the lake Gjende became protected in 1973, while the lakes Bygdin and Tesse were developed as early as 1936.

Toward the end of the 1960s considerable focus was put on environmental protection. Especially ecological and biological issues were discussed. An overview of the ecosystem's function in varying types of landscapes was needed. Ecological insight and competence had to be the foundation for the development of rational administrative strategies. This was partly the reason why 1970 was declared European Year of Environmental Protection. In the political arena the increase in environmental awareness led to the establishment of the Ministry of the Environment in 1972.

The Norwegian Protection Plan for River Systems

The strong increase in development of hydropower in the 1950s and 1960s made it necessary to take the environmental impacts into closer consideration. In 1960, parliament proposed a national plan for the conservation of watercourses from hydropower development. The discussion was motivated by the desire for comprehensive evaluation of watercourses that were partially or wholly untouched by hydropower projects. Until 2006 the national plan was adopted by parliament in five successive stages between 1973 and 2005. Until 1996 the government's criteria for the Protection Plan were (Ministry of Industry 1972):

- The selected river systems with adjacent areas should provide a variety of uses and also have scenic qualities. Some of the areas should be extensive in size.
- The conservation plan should ensure fair distribution throughout the country, i.e. give priority to centrally located river areas of recreational value.
- The plan must not be so comprehensive that it puts too heavy a burden on Norway's electricity supply
- Other inroads into protected areas that may impair their value in regard to nature conservation, sports recreation and science should be avoided.

The watercourses that under the Master Plan were categorised as "great disadvantages" or "negative consequences" to develop, and watercourses that were important to conserve because of the wild-salmon consideration (national salmon watercourses), were up for consideration in 2005. It was also possible to bring up watercourses on the basis of previously established guidelines.

Through parliamentary consideration of The Protection Plan for River Systems in the period 1973-2005 387 watercourses have been protected from hydropower development. As shown

in figure 2.0 (page 11), the power potential in these watercourses is around 44, 2 TWh, while 119, 7 TWh is developed.

The demand for more scientific knowledge about the river systems gradually increased. There were significant field studies carried out in the period 1977-1982, before the 1986 resolution (Halvorsen et al. 1998). Unfortunately, financial reasons reduced the requirements for scientific documentation during the next two stages (1993 and 2005).

In total, the natural values and conditions of the whole catchment were assessed. From stage 3, in addition to natural value, the agricultural and forestry potentials were considered, along with value for fish and game activities. Recreational value and occurrence of cultural relics were also assessed.

It is important to emphasize that what is central when evaluating a river system is the catchment and not only the river. Rivers flowing undisturbed from source to sea were judged to be of special value. In parts of Norway it is still possible to find relatively undisturbed catchments, but in most of the country the river systems are more or less affected by human activities. It therefore became necessary to include also second order and even third order rivers.

At that point, the work on the conservation plans had uncovered a need to view future hydropower development in a larger context than that of weighing up the demand for power against environmental interests. This method of planning was a useful new tool for working on the conservation plan.

The Master Plan for Water Resources

The Master Plan is a recommendation from the government to parliament. The process of The Master Plan for Water Resources started in 1981 under the leadership of The Ministry of the Environment, as a consequence of the conflicts between environmental interests, hydropower developers and the authorities. It sets priorities for considering individual hydropower projects and divides these into two categories. Those in category I can be considered for concession now, as can certain projects exempted from the Master Plan. Projects in category II and projects not covered by the Master Plan cannot be considered for licensing at present, but may be used for hydropower development or other purposes at a later date. The order of priority for considering individual hydropower projects is based on economic considerations and the degree of conflict with other interests. In other words, the aim is to ensure that the rivers that can provide the cheapest power with the smallest environmental impact are to be

developed first. However, approval of a project in the Master Plan does not mean that the authorities have made an advance commitment to grant concession.

Since parliament considered the Master Plan in 1993, the framework for hydropower development has altered in a number of ways. Environmental policy principles have changed, and most projects that are planned today are different in technological, environmental and economic terms than those described in the Master Plan. In connection with the 2005 National Plan for Protected Rivers, Parliamentary resolution determined that hydropower plants with effect up to 10 MW, or with annual yield up to 50 GWh, is exempted the procedure of the Master Plan. This reduces the scope of the plan. However, administration connected with small plants is simplified, which parliament has determined is a priority. Since 2003 the government has encouraged the construction of small power plants. It has also been conceded that power plants with an effect below 1 MW can be constructed in protected water courses.

Special provisions relating to works in protected river basins

The purpose of including watercourses in The Protection Plans for River Systems has been to prevent any reduction of their conservation value through hydropower developments. However, even if a watercourse is protected against hydropower development, other kinds of developments may also reduce its conservation value.

To prevent this from happening, the Water Resources Act includes several special provisions relating to the management of protected watercourses. The most important of these is the statutory principle that whenever a decision is made pursuant to the Water Resources Act that is of importance to protected watercourses; the conservation value of the watercourse is to be given considerable weight. This will, for example, result in stricter treatment of applications for licences in protected watercourses than in other watercourses. Permit for development is only given if it can be demonstrated that the conservational value remains unchanged. This must indicate that watercourses with type or reference qualities are unsuited for small power plants.

The situation in 2006

Through a strong focus on hydropower and the development of a national transmission grid, hydropower has for a long time been the corner stone of Norway's energy supply. It laid the foundation for a large power intensive industry, and the abundance of hydropower in earlier times has led to electricity being extensively used for heating. Today consumption has increased to such an extent that we are dependent on import. In order to get more stable energy access Norwegian power supply must be made less dependent on hydropower as power source, and on electricity as energy carrier. This is made clear when we consider that hydropower production for an average year is 119.7 TWh (figure 2.0), while the consumption is around 126 TWh. Consequently the government has for the past few years been developing a long term plan for rerouting energy production and energy consumption. However, hydropower will be the dominant energy source for many years to come. The uncertainty about how much hydropower can be produced each year, and the fact that for several years the growth in production and transmission capacity has been stagnant in comparison with increase in consumption, is cause for worry. Today's hydropower systems have an annual production capacity of between 84-145 TWh depending on the precipitation conditions. The power supply has become more vulnerable. The market's price mechanism has had a stabilising effect, while high prices in periods of scarcity has caused both private and business consumers to limit their electricity consumption. To meet this challenge, Norway has embarked on new development strategies:

- Harnessing wind power potential, with a target of at least 3 TWh wind power by 2010
- Focus on research and development projects to enhance gas thermal generation plants with no emissions of CO_2 and NO_x
- Support district heating system to reduce dependence on oil and electricity for heating
- Continued support for energy conservation technologies and schemes
- Map resources for small hydropower plants without reservoirs, and develop financing systems to enhance the implementation of these plants
- Upgrade existing hydropower stations.

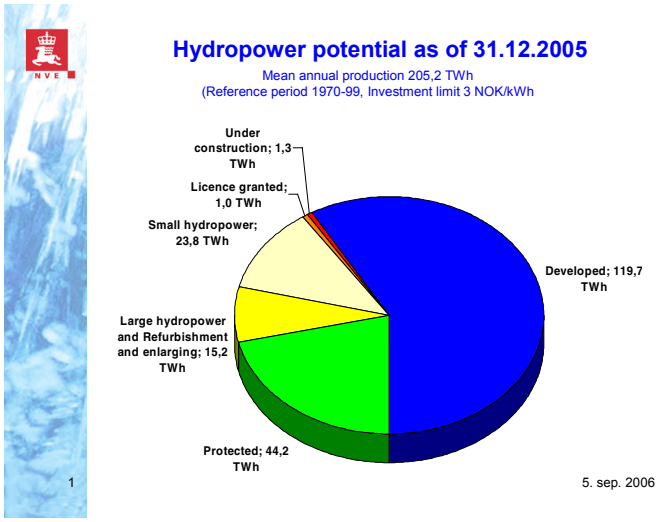


Fig. 2.0 Hypropower potensial as of 31.12.2005. From NVE.

Fig. 2.0 Hydropower potential of 31.12.2005. From NVE.

The case Odda/Tyssedal

Before power intensive industry, Odda, in Western Norway, was one of the world's main tourist destinations because of natural attractions such as glacier, waterfall, and fjord (Fig. 3)

Fig. 3.0 Odda before 1906. Photo: From NVIM -archive

The power company Tyssefaldene Ltd was established on April 20th 1906. Three weeks later parliament gave permission to commence construction of the power plant. The first section of the hydropower plant was completed in 1908, and had the largest high pressure hydropower station in Europe. After continuous building and development Tyssedal power plant (Tysso I) was completed in 1918.

The industrial communities Tyssedal and Odda developed around the Tysso watercourse and the power plant Tysso I. In the pioneering period it was not possible to transport electricity over great distances. Consequently the factories had to be built close to the power station. The

reason for the hydropower development in Tyssedal was the construction of carbide and cyanamide factories in Odda in the period 1906-1908.

Fig. 4.0. Odda and Sørfjorden 2005 Photo: Harald Hognerud, NVIM

Odda is today an industrial community with two large factories, figure 4.0. The area is seen as an example of sustainable water administration.

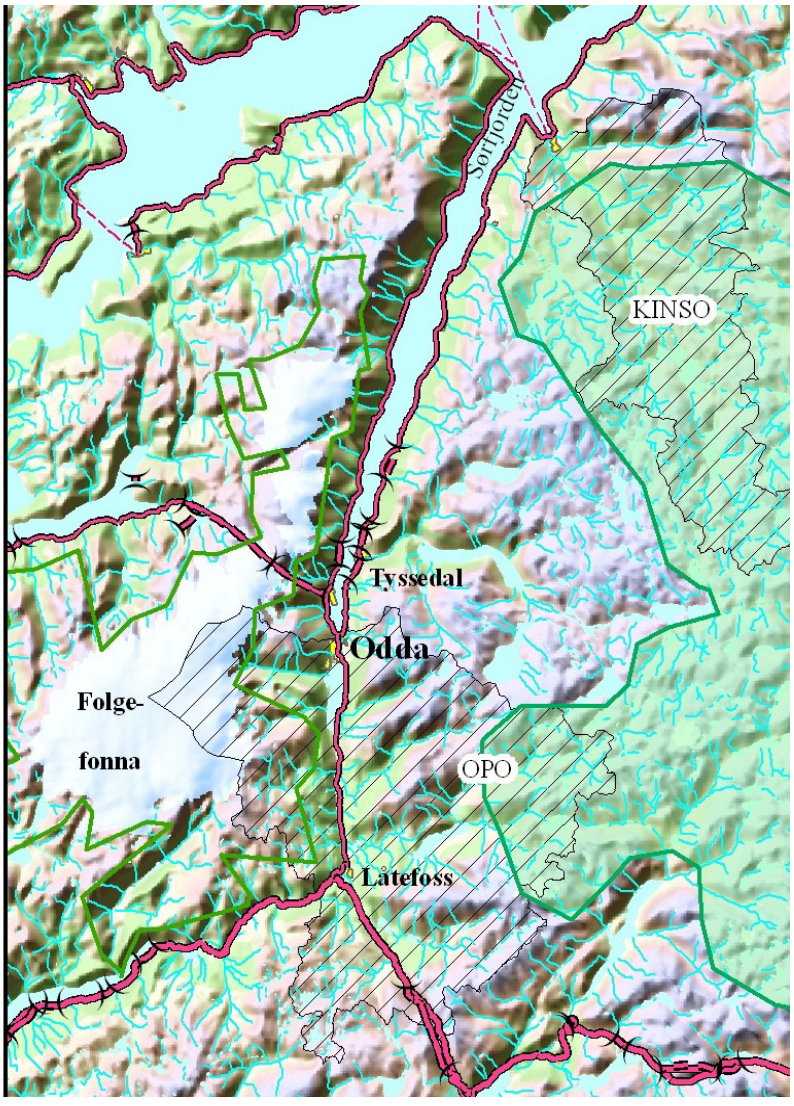


Fig. 5.0. Map of the area with the national parks (Hardangervidda in the east and Folgefonna in the west) and the protected rivers (Kinso and Opo).
Green line = border national park
Red line = road , ( ) = tunnel
Shaded area = catchment area of protected river
The length of the fjord Sørfjorden is 38 km.
From NVE.

The landscape along the fjord *Sørfjorden* is unique with two national parks (Hardangervidda National Park (established in 1981, area 3422 km^2) and the Folgefonna National Park (established in 2005, area 545 km^2). Water is found in all variations: glacier, fjord, waterfalls and pure water. In addition waterfalls have been put into penstocks, so that their water can become electricity. Two river systems (Kinso (catchment area 280 km^2), in the northeast, and Opo (catchment area 483 km^2), with the famous fall Låtefossen, in the south) are protected, figure 5.0. The fjord is a document and reminder of industrial and natural history.

Hydropower for the industry and protection of watercourses and nature, are central issues in the industrial community today. In 2005 a producer was denied concession for a hydropower project, because it involved an important watercourse that had its source in the newly founded Folgefonna National Park. We also note that hydropower projects in already developed watercourses on the west-side of the National Park were permitted.

Conclusion

In the first part of the 20th century economic growth were regarded as more important than environmental concerns. From the early 1970s environmental awareness was increasingly in focus, both as a political issue and within the government. After mandatory prior notification was introduced, the scientific studies accompanying licensing application were given much stricter guidelines from the administration. To improve scientific assessments, conscious effort was made to expertise within natural science. This led to the universities becoming involved in field studies, national environmental institutes were established, and administration was strengthened.

The authorities began to set more stringent requirements for licensing applications, to some extent in response to pressure from active "counter-expertise" in environmental protection organisations. This made the power sector recognise the logic of allocating resources for comprehensive consequence analyses of environmental impact, and potential environmental improvement measures, in advance of development. Taking action rather than passively accepting orders from the authorities. The power producers' organisation and the major power enterprises saw the significance of taking environmental questions into account, and actively contribute to research in this field, so they began hiring personnel with environmental expertise. At the beginning of the 21st Century balanced use and protection of our watercourses are more in focus than ever. Accordingly The Water Framework Directive is

now being implemented. The Directive is not considered to confer any need for new or changed status in Norway.

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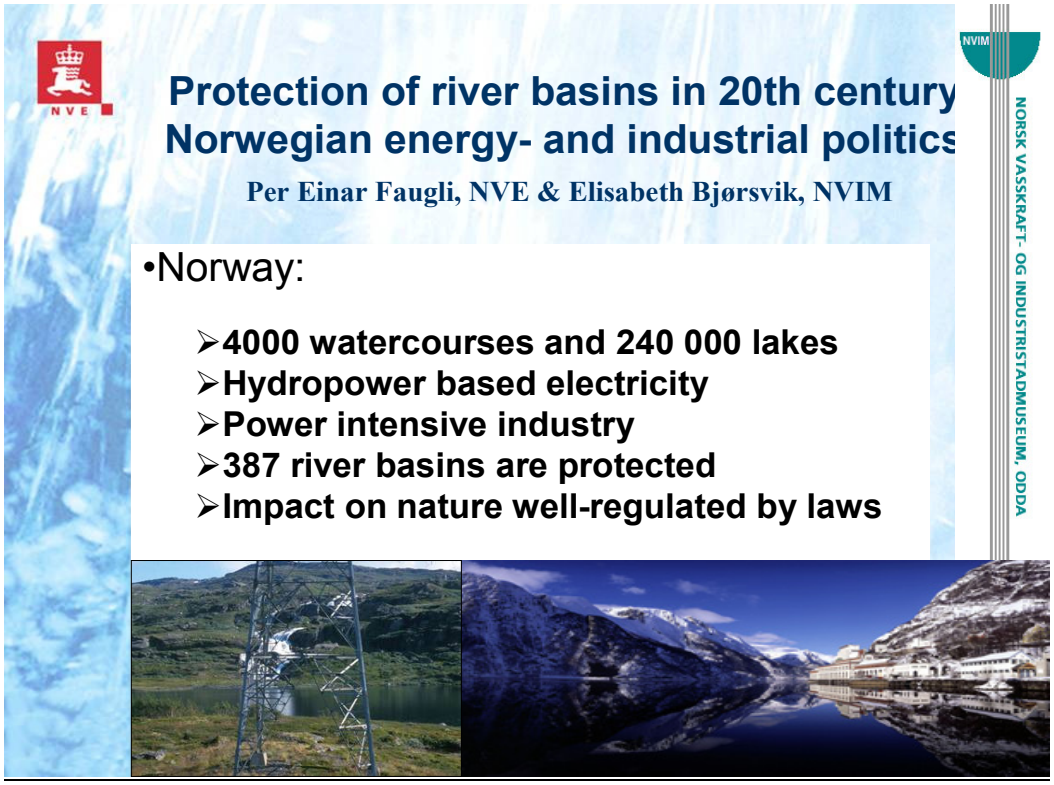
Appendix - The poster as slides:



Left: The Aurland mountain. Photo: Per Einar Faugli, NVE
Right: The hydropower plant Tysso I and Sørfjorden. Photo: Harald Hognerud, NVIM

- 1900-1940:
  - 1900-1920 - Breakthrough for the power intensive industry
  - Established in the fjord landscape
  - In 1920 64 % lived in houses supplied with electricity
  - 1940 production 9,5 TWh

- 1950-2000:
  - 1960-1990 - hydropower production quadrupled to 108 TWh annually
  - Net consumption of electric energy for the power-intensive industry (percent of total): *1958/68 ca 45 %,* 1988/98 ca 30 %
  - the period of extensive hydropower development is over

NORSK VASSKRAFT- OG INDUSTRISTADMUSEUM, ODDA

Left: From Aurland. Right: The regulated river Ekso. Photo: Per Einar Faugli, NVE

Protection Plan for River Systems

- 1950s/60s: Extensive development of water resources made it necessary to preserve a representative selection of river basins
- 1973-2005: Protection Plan is adopted by Parliament in five stages
- An equivalent of 44,2 TWh is protected

Today – discussions

- energy sources
- the power intensive industry in Norwegian economy
- Small power stations in protected river basins?

NORSK VASSKRAFT- OG INDUSTRISTA

Låtefossen. Photo: Arne Hamarsland,, NNVE

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