The Master Plan for Water Resources

Ministry of Environment
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The Master Plan for Water Resources  
- a national coordinated plan for not developed hydropower sources in Norway  

A total of 16 user interests/topics provide a professional basis for evaluation  

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The basis for evaluation of watercourses  

Thorough weighing of the different interests  

Careful hydro-power development  

The implementation and follow-up of the Plan
The Master Plan for Water Resources - a national coordinated plan for not-developed hydropower sources in Norway

For many years, the development of the watercourses in Norway has created a basis for steadily increasing production and use of energy. This development has taken place, however, without a coordinated plan for the whole country. Moreover, in the last decades, conflicts with other users have become progressively greater. The so-called «hydro-power epoch» seems to be drawing to a close. It is therefore essential to consider the exploitation of the remaining watercourses in a larger perspective, which also takes into account user interests other than those concerned solely with energy. The above considerations led to the preparation of a «Master Plan for Water Resources».

The work was headed by the Ministry of Environment, in collaboration with the Ministry of Petroleum and Energy, the Norwegian Water Resources and Energy Board, and other relevant authorities.


The «Master Plan» (as it is usually called) covers 40 TWh. The projects are grouped into three categories.

The first category comprises watercourses which can be considered for a licence immediately and consecutively, in order to cover the energy demand in the years to come.

The second category includes projects which may be exploited for power production or for other purposes.

The third category includes watercourses which, on the basis of the technical solutions for development considered to date, are not regarded as relevant for development, either because of serious conflicts with other user interests, and/or because of the high costs involved.

Other user interests

Earlier on, watercourses were regarded as an almost unlimited source of power. Their development led to economic growth and prosperity. But as time went on, other user interests were brought more into the foreground, not the least, the need for protection.

The earliest arguments against development of watercourses was that the longest and most impressive waterfalls should not be led into pipes. The scenery around the watercourses is a characteristic feature of our landscape. Thus if the flow of water is reduced, or removed entirely, this also changes the landscape.

Gradually, the increasing need for recreation has also become an important factor to be considered when evaluating how a watercourse should be exploited.

Moreover, more stringent requirements concerning the quality of potable water, a greater need to irrigate large areas of cultivated land, increased use of watercourses as a recipient for waste water, and other conditions, may result in serious clashes of interests in connection with exploitation of watercourses.

A comprehensive overview, and planning, are essential if the needs of the different user interests are to be met.

The main purpose of the Master Plan

In the Report to the Storting No. 54 (1979-80) on the Future Use and Production of Energy, the Government’s suggestion was that in the further planning of hydro-power projects, and in the administrative procedures connected with the granting of licences, emphasis should be placed on developing first the watercourses which are the most favourable both economically and from an environmental standpoint.

In the Proposition to the Storting No. 130 (1981-82) on «Power Coverage in the 1980s and the Relation to the Master Plan for Water Resources», the government approved the main goal of the Master Plan, which was to present to the Storting a proposal for a priority grouping of hydro-power projects for subsequent consideration for a licence.

Further, the plan was to provide the basis for taking a standpoint on which watercourses could be used for other purposes.
About 500 watercourses have been developed
Since 1966, the Norwegian authorities, after considering each case individually, have granted a licence permitting regulation or development of about 500 large or small watercourses. During the same period, about 10 proposed projects were refused a licence. In several cases, the authorities’ evaluations in connection with the licences have resulted in a reduction in the scope of the project, due to the negative impact on other user interests.

In three Protection Plans, a large number of water courses were evaluated with a view to protecting them against hydro-power development. This resulted in the permanent protection of a total hydro-power resource of 21 TWh (thousand million kilo-watt hours). A total of 105.6 TWh has been developped.

A Contact Committee has been appointed to work on a fourth Protection Plan. This work will involve evaluating about 200 watercourses.

The Master Plan is neither a Protection Plan nor a Development Plan
The Master Plan can be described as a national coordinated plan for the management of watercourses. The intention is to present concrete proposals for the further administrative procedures. The basis of the Plan, the watercourses which seem to be economically profitable as a source of power, and involve relatively minor problems in relation to other user interests, will be considered for a licence first. At the same time, in the case of projects involving more serious conflicts of interests, consideration of applications for a licence can be postponed until a later date, without this affecting the energy coverage.

The Master Plan is neither a Protection Plan nor a Development Plan. It states which projects should be considered first for a licence when development is necessary. It also specifies which watercourses should preferably be reserved for uses other than hydro-power development.

Consideration of applications for a licence will be made more effective
One result of the Master Plan is that the evaluation of applications to develop new watercourses are made more effective. The reason is that, during the preliminary work on the Master Plan, the individual user interests were given the opportunity to make their interests clear for a large number of watercourses as a whole, thus making it possible to arrange the projects in order of priority. It is very likely that the basic material collected on the individual watercourses in connection with the Master Plan reduces the necessity for preliminary investigations when considering these watercourses for a licence. The Master Plan therefore paves the way for a sequence of development where the evaluation procedures are carried out with the fewest possible practical obstacles.

Some watercourses are excluded
Ideally, the Master Plan should cover all economically exploitable available hydro-power which has not yet been developed, granted a licence for development, or become permanently protected. However, the extent of the Master Plan has been reduced somewhat in relation to these criteria, partly due to the need to meet the demand for power.

When, on 23 March, 1983, the Storting discussed the Proposition to the Storting on Power Coverage in the 1980s and the Relation to the Master Plan for Water Resources, it was decided that some watercourses had to be excluded from the work in order to ensure adequate power coverage. Otherwise, the Storting would not be able to reach a final decision on new projects until the Master Plan had been finally discussed. However, since the Storting wanted as many watercourses as possible to be dealt with in the Master Plan, several projects under evaluation for a licence were included in the Plan, and the evaluation procedures postponed for the time being.
Watercourses being evaluated for a licence, and excluded from the work on the Master Plan for reasons of power coverage, represents an annual power production of 10.9 TWh.

Follow-up of the Master Plan.
Report No. 53 (1986-87) follows up the guidelines and principles laid down in Report No. 63 (1984-86), which received the general support of the Standing Committee on local Government and the Environment. Some of the hydro-power projects included in the previous Report have been re-evaluated. This has been done in the light of proposals for new solutions for development, or at the request of the developer. Projects where the municipalities did not agree to the categorization stated in the previous Report to the Storting have been re-evaluated. In addition, an evaluation and categorization has been undertaken of new projects, i.e. watercourse areas which were not included in the previous Report. The new Report also reviews the methods used to weigh up the different interests and to calculate the economic profitability of each project. This has led to an updating of the data providing the professional basis for the future work.

The Report also discusses other matters which the Standing Committee on Local Government and the Environment expected to be considered in the future implementation of the Master Plan, inter alia, planning watercourses for uses other than hydro-power production.

The results of this follow-up of the Master Plan and further updating must also be considered in the light of the conclusions concerning future energy coverage.

Report No. 53 (1986-87) to the Storting was adopted in the Storting in the autumn of 1988. The third updating is now in progress since it has been decided that the Master Plan is to be updated regularly.

Parallel with this work on the Master Plan, the Contact Committee is working on a fourth plan for protection of watercourses. To date, three such plans have been approved by the Storting.

The Contact Committee for Protection Plan IV The Ministry of Petroleum and Energy is responsible for coordinating the work, for preparing and submitting plans to the Government and the Storting, and for ensuring that the work is carried out in collaboration with the environmental authorities. The work has been delegated to the Norwegian Water Resources and Energy Board. Other organizations represented on the Committee are the Ministry of Environment, the Central Office of Historic Monuments, the State Councils for Open Air Recreation and Conservation of Nature, the Ministry of Agriculture and the Directorate of Nature Management.
A total of 16 user interests/topics provide a professional basis for evaluation

The consequences decide the priority
The most important effects on nature as a result of hydro-power development are related to changes in the natural course of the watercourse itself, changes in the flow of water and intervention connected with building and construction. This last type of intervention includes dams, quarrying, rock tips, roads and power transmission lines. These interventions may affect all the interests evaluated in the Master Plan.

Before the priority groupings in the Master Plan were decided, the interests were evaluated in several phases. For some interests, the area was described prior to development, that is, to say, the value of the area was charted. This was followed by a preliminary assessment of the impacts of the hydro-power project. These impacts were then corrected in the light of adjustments to the plans, regional and national evaluations, and the requested comments from interested parties. At this stage, a total impact analysis was carried out. The priority groupings were fixed after aspects of the regional economy, size of the project etc. had also been evaluated.

Nine responsible expert groups
The investigations and studies necessary to chart the different interests were carried out by nine expert groups for hydro-power, nature conservation and outdoor recreation, fish and wildlife, water supply and protection against pollution, preservation of ancient monuments, agriculture and forestry, reindeer husbandry and climate, regional economy, mapping and data, and an expert group for prevention of flooding and erosion and for transport, ice and water temperature, respectively. In several cases the secretariat function was carried out by specially engaged professional personnel.

In the course of the work, emphasis was placed on avoiding overlapping, which could lead to some interests being counted twice in the impact analyses. This applies particularly to interests connected with nature conservation, outdoor recreation, wildlife and fish, which many people consider to be closely related.
HYDRO-POWER
The expert group for hydro-power, placed under the Norwegian Water Resources and Energy Board, was responsible for presenting a technical and economic evaluation of the projects included in the Master Plan. The intention was to prepare plans at a level approaching those required for an application for licence.

An important requirement was that the different hydro-projects in the Master Plan were directly comparable. This required uniform presentation, cost estimates based on the same data, and the same method for carrying out calculations of production.

Classification by economy
The hydro-power projects are classified according to the economy connected with development. The most recent Report to the Storting on energy includes a definition of what constitutes economically exploitable projects which will produce power that costs more than power from a solid fuel or nuclear power plant.

In the Master Plan this cost is fixed at 300 øre (1962 kroner) per kilowatt-hour (development costs/mean annual production). The projects are grouped into six economy categories where the five lowest categories are projects where the costs are lower than the limit for economically exploitable hydro-power, while the sixth category comprises projects included in the Master Plan, even if they are not economically exploitable at the present. The reason is a somewhat diffuse limit between what is economically exploitable hydro-power and what is not, an uncertainty concerning the price of alternative sources of energy.

NATURE CONSERVATION
The Storting discussed the goals for the public work connected with nature conservation in 1981, in the light of the Report to the Storting on Nature Conservation in Norway. The fundamental principle of the report is that the purpose of the nature conservation efforts is two-fold:

1] An ecologically responsible management of natural resources which will ensure preservation of nature as a permanent basis for human activity, health and well-being.

2] Preservation of the diversity of nature, both in regard to plants and animals and their habitats, natural landscapes and geological formations and deposits.

In the light of the above objectives, the nature conservation evaluations in the Master Plan are based on the following specialized fields: geological disciplines, botany, landscapes and zoology.

Diversity and abundance
Out of consideration for the goal of preserving the diversity of nature, the protection plans for watercourses have made it an important objective to find watercourses which represent the country's different natural areas. But these goals have not been fully realized through the protection plans. Therefore the nature conservation evaluations have also given due consideration to the type of watercourse, and the value it represents as such.

Another important factor has been to evaluate the reference value of the watercourse. In this connection it is important that the watercourse as a whole remain as undisturbed as possible.

Apart from this, the studies have given particular attention to watercourses with special qualities. This may imply, for example, to wetland areas containing interesting plants, areas of importance to animal life, or if certain parts of the watercourse are the habitat of threatened plants or rare animal species.
Conflicting interests between hydro-power development and nature conservation

It is unlikely that any hydro-power project can be presented which has a positive impact on nature conservation. Therefore the classification in the Master Plan uses a scale ranging from 0 (no impact) to +4 (serious negative impact).

Watercourses fulfilling the criteria for designation as watercourses of a special type include the Bjerkreim watercourse, Vosso, the Flåm watercourse, Gaula (in Søg og Fjordane), Gaula (in Sør-Trøndelag) and Sandøya Lur.

So far, the county of Nordland has achieved very little in the way of nature conservation in regard to watercourses, a fact which has been duly emphasized in the evaluations in this county.

As far as reference watercourses are concerned, in Eastern Norway it has been impossible to find any reference watercourses which are completely undisturbed from source to outlet into the sea. Etna/Dokka, running out into the Randsfjord, could have complied with this criterion. The Tøredal and Lomdal watercourses are examples of valuable reference watercourses.

OUTDOOR RECREATION

The general purpose of the authorities’ efforts concerning outdoor recreation is to create good opportunities for all groups of the population to enjoy outdoor life. It has been found an advantage to distinguish between activities occurring in natural surroundings but where the actual experience of nature as such is not of first importance, and activities where the essential element is the aesthetic experience of the scenery and the nature itself.

Activities in the first group will often depend on various preparations in the environment and/or use of motorized transport, while the second group of activities includes those which are generally associated with outdoor life as Norwegians know it.

If the goal of diversity is to be achieved, it is important to preserve the few opportunities left to experience certain special kinds of nature. This applies, for example, to undisturbed watercourse areas and the few remaining waterfalls and long stretches of water in the main watercourses of Eastern Norway. There should also be nature areas accessible to people within easy distance of their homes.

Outdoor life is closely integrated with the watercourse and the surrounding nature

The nature surrounding the watercourses is a central element of outdoor life. The lakes and rivers provide opportunities for many different activities. Moreover, the watercourses in themselves often provide visual and other experiences of great value. When evaluating the value of the watercourse for outdoor recreation, emphasis has been placed both on the character of the area from the point of view of aesthetic experience, and the possibility of exploiting it now and in the future.

Further hydro-power development cannot be considered positive from the point of view of outdoor recreation. Nor can this be said of the associated road-building, since a lot of nature areas are already easily accessible by road. For this reason the impacts on outdoor recreation are evaluated according to a scale ranging from 0 to +4.
Negative impacts on fishing
Fishing is the outdoor activity which often suffers most as a result of hydro-power development, because the fish population is diminished or destroyed. Further, there will often be fewer possibilities for walking tours, partly because the marked trails or tourist cabins become flooded as a result of the regulation. And generally, the opportunities to experience the wonders of nature are often greatly reduced.

Few undisturbed areas
Areas practically unaffected by technical installations are becoming more and more scarce in Norway. For this reason, it has been especially important to avoid intervention in areas which at present stand out as being almost undisturbed by outside influence. Such areas exist in Northern Norway in Hellemo, Lomdalen and Innre Vesten, while Naustdal-Gjeingedal, is an example from Western Norway.

Based on present knowledge, it looks as though the goals for outdoor recreation as expressed in the protection plans have not been achieved in all parts of the country. The Master Plan has therefore tried to determine which watercourse areas can meet the needs of the different forms of outdoor recreation.

WILDLIFE AND FISH
Most hydro-power development projects have negative effects on fishing activities and on wildlife. Therefore a central element of the work on the Master Plan has been to clarify possible conflicts with wildlife and fishing interests.

Wildlife is affected, for example, because the places where the animals reproduce and raise their young are lost to them when areas of land are fenced in, immersed, or split up by roads or power transmission lines, or the animals are disturbed during the construction phase. A dam built in a valley destroys the most productive areas of land, and moose, deer and wild reindeer are often prevented from following their usual trails.

Negative effects on birds
The wetlands too, with their rich and vulnerable bird populations, often including species of high protection value, may be exposed to flooding or draining in connection with the power development. Transmission lines can injure bird life: large birds like swans, birds of prey and owls may collide with the high tension cables and die.

Fish migration is prevented
Our most important freshwater fish are salmon, trout and char. Regulation of watercourses may cause serious damage to these species. Species which migrate can be prevented from doing so because certain stretches of a river are laid dry. Spawning areas and places where the young fish develop may also be destroyed.

Although special measures can be introduced in the watercourse to reduce some of the damaging effects of the regulation, hydro-power development will seldom or never have positive impacts on fishing or wildlife interests. A scale of 0 to +4 has therefore been used to classify the impacts.

As far as fishing is concerned, compensatory measures, such as stipulating a minimum flow of water are often introduced. Another common measure is to build weirs and to stock the river with fish to compensate for diminished recruitment.

If the planned development of the watercourse affects an important salmon river locally or regionally, this has resulted in high negative classification. The same applies to important fishing lakes which are accessible to the general public. As far as wildlife is concerned, emphasis has been placed on the relation to nationally and internationally threatened species and their habitats.
WATER SUPPLY AND POLLUTION
It is an important public responsibility to ensure an adequate and hygienically acceptable supply of potable water for everyone. Similarly, water must be made available to industry and for agricultural purposes. It must be possible to maintain the water supply even in extremely dry periods.

Intervention for purposes of regulation may affect both the quality and quantity of the water in many ways. A side-effect of the regulation may be increased traffic in the area, for example by opening it up for the building of holiday homes, with consequent increased pollution.

Pollution control
Watercourses and fjords are being increasingly used as recipients for waste water from households, industry and agricultural run-off. Often the watercourses are the only places where the polluted water can be released and diluted. In areas with large sandy deposits, these may serve to clean the waste water, but large discharges may pollute the groundwater.

Several kinds of pollution may be released into the water. From sewage, the water receives nutrients, mainly phosphor and nitrogen, which have a polluting effect because they encourage excessive growth of algae. Sewage also contains organic material, from industrial waste and from agriculture. Toxic substances such as heavy metals, organic micro-pollutants and other products may also end up in the watercourses through discharges from industry, mining, etc. Microbiological pollutants usually originate in sewage, and affect the quality of the water for drinking purposes or for bathing.

The use of watercourses as recipients leads in itself to conflicts with other user interests such as water supply, fishing and outdoor recreation. Normally, regulation of the watercourse will intensify these conflicts because it will reduce the water’s self-purifying or diluting ability.

Countermeasures
Simple methods can be used to reduce the effects of hydro-power development on the water supply and on pollution control measures. A particularly relevant measure is to build treatment plants for potable water and for waste water. Only in very few cases can a situation be foreseen where the regulation will have a positive effect on the quality of the water or the water’s ability to receive polluted waste water. Therefore a scale ranging from 1 to +4 has been used to classify the impacts.

PRESERVATION OF ANCIENT MONUMENTS
Ancient monuments are traces of past human activity. They may be visible in the terrain, like burial mounds and buildings, but may also be hidden to a lesser or greater degree under the soil and vegetation, as in the case of Stone Age settlement sites. Sami (Lapp) tent sites and remains of charcoal kilns. Ancient monuments from before the Reformation (1537) are automatically protected as relics of our cultural heritage, and the same applies to Sami ancient monuments more than 100 years old. Other ancient monuments may be protected by a special decision in each case.

Steadiy greater emphasis is being placed on evaluating the environment of ancient monuments as a whole, and considering the ancient monuments in relation to the surroundings where they are to be found with evidence of human activity: the cultural landscape. In the Master Plan is particularly important to emphasize the interrelationship between ancient monuments, rivers and water. A water-driven saw may be seen in relation to the stream where the waterwheel was placed. A fishing settlement has an equally natural connection with water. Throughout time, rivers and water have had
a decisive influence on people's choice of places to settle and carry out their industrial activity. For this very reason, numerous ancient monuments are to be found in connection with water.

Ancient monuments are among the most important sources of knowledge about human life in earlier times. As far as prehistoric times are concerned, these sources are of all intents and purposes unique. To some extent, the value ancient monuments represent can be preserved by investigating them thoroughly before they are destroyed. Methods of investigation and the ways of approaching problems connected with the history of our culture are constantly changing, but an investigation of this type will destroy the ancient monument, and its value as a source, forever.

Close connection between ancient monuments and water.
Because of the close connection between ancient monuments and water, hydro-power development projects will often conflict with the preservation of ancient monuments, both directly and indirectly. Ancient monuments may be destroyed by becoming covered by water when the height of the water in the river is changed, thereby also changing the character of the cultural landscape. They can be destroyed by construction activities, for example mass excavation and the use of machines which destroy the landscape.

Hydro-power development has thus had particularly serious consequences for ancient monuments which are normally closely connected with water. These include Stone Age settlement sites and Sami ancient monuments. It is almost impossible to imagine any compensatory measures which would help to preserve ancient monuments. The law requires archaeological excavations to be carried out before the intervention occurs. This cannot be considered a compensatory measure, however, since the ancient monument will thus be destroyed. For this reason, a scale ranging from 0 to +4 is used to describe the impacts of the hydro-power projects on the preservation of the cultural heritage.

AGRICULTURE AND FORESTRY
Norway's scattered settlement is largely connected with the primary industries, agriculture and forestry, fishing and reindeer husbandry. If the goal is to maintain the scattered settlement, it is also important to preserve the necessary natural conditions. Agriculture and forestry are connected in particular with the areas of productive land, and also have a close connection with water resources.

Agriculture and forestry's economic interests in water resources are connected primarily with the need for a supply of water for humans, animals and plants, but also for transport, as natural boundaries for grazing, as recipients, as a source of power, and for purposes of outdoor recreation. A watercourse which is allowed to run unregulated is not always ideal from the point of view of agriculture and forestry. So the water level is sometimes lowered or otherwise regulated in order to satisfy agricultural interests. The purpose may be to prevent erosion or flooding, or to ensure sufficient water for agricultural purposes.

For a water course, Stjordal
Photo: Helge Sundt
Positive as well as negative
On the other hand, the development of hydro-power may also have negative consequences for agriculture and forestry. Productive areas may become immersed by water, there may be increased erosion, the groundwater level may sink and the land thus dry out, and the natural fences afforded by the watercourses may disappear.

Compared with many other interests affected by the hydro-power development, however, it is often quite an easy task to initiate compensatory measures. These include irrigation systems, measures to prevent erosion, etc. As a condition for a licence, the power developer is often required to implement such measures. Therefore, for agricultural and forestry interests, the impacts of hydro-power development may vary from very negative to very positive. Thus, in the Master Plan, these impacts have been classified according to a scale ranging from +4 to +4.

An important point when evaluating agricultural and forestry interests in relation to hydro-power development is that the consequences may vary from landowner to landowner. While some may experience serious disamenity, to others the development may be a considerable advantage. For many of the projects considered in the Master Plan, the impacts on agriculture and forestry have been found to be moderate.

REINDEER HUSBANDRY
Reindeer husbandry exploits scanty resources in the mountains and in upland forest areas to provide valuable food. There are about 200,000 domesticated reindeer in this country, and reindeer husbandry is the main source of income for more than 2000 persons. More than 1600 tons of reindeer meat is produced annually.

Moreover, reindeer husbandry is an essential part of the Sami culture and way of life. About one third of the projects considered in the Master Plan are located in the area used by the Sami people for reindeer husbandry, concentrated in the northernmost counties.

In the last decades several hydro-electric projects have been constructed in reindeer grazing areas. Some of them have caused minor disadvantages to reindeer husbandry, while others have totally destroyed the affected husbandry system.

Hydro-power development often leads directly or indirectly to loss of grazing. It may also result in barriers, making migration and reindeer herding more difficult. It may destroy or reduce the quality of calving and breeding sites, dwelling places and reindeer husbandry facilities. The disturbance caused by the construction may also lead to confusion and intermingling of the reindeer herds, and complicate the work of the reindeer herders.

In the Master Plan the impacts on reindeer husbandry are classified according to a scale ranging from 0 to +4. It is difficult to imagine any situation where hydro-power development would have a positive effect on reindeer husbandry.

For right: Floating timber in the River Glomma
Photo: Bjarke Arklett
Right: Beaver
Photo: Ragnar Frislid
Left: Sirdoná River, Voss
watercourse
Photo: Helge Sundet
PROTECTION AGAINST FLOODING AND EROSION

Several million kroner are spent in Norway annually on measures to protect against damage from flooding and erosion. All hydro-power projects with sizeable reservoirs help to reduce flooding. This applies especially to the spring floods which are collected in partly empty reservoirs. Autumn floods while reservoirs are full, may cause serious flooding and erosion damage below the reservoirs, however, if this has not been given special attention.

An increased flow of water in winter, when not adjusted to the natural conditions, may cause increased erosion. It may also cause drifting ice. Hydro-power development may have positive as well as negative effects on flooding and erosion. The most usual is reduction of flooding, where the positive effects may be considerable. When evaluating the consequences, the impacts are classified according to a scale ranging from +4 to -4.

TRANSPORT

The forms of transport which may be affected by hydro-power development include boat transport, floating of timber and tractor transport on ice, etc. The watercourses are used far less for transport today than in earlier decades.

In most watercourses timber floating has ceased, but it may still be of interest locally to float timber from forest areas where there are no roads. If the hydro-power development makes timber floating impossible, this can be compensated in many cases by building forest roads.

Transport on frozen rivers and lakes often occurs in connection with forestry. Hydro-power development may make such transport less safe, since difficulties may occur due to breaking up of the ice as water is tapped from the reservoirs. These disadvantages can be reduced by building roads. The impacts on transport are evaluated according to a scale ranging from +4 to -4.
REGIONAL ECONOMY
The effects on the local private and public economy are often a major issue in discussions on hydro-power development. This development often takes place in outlying areas where means of subsistence are very limited. Hence the hydro-power development will often have a positive effect on employment and on the economy. In places with serious unemployment, great importance should be attached to the effect on employment.

When considering the aspects of regional economy in the Master Plan, the aim has been to present the main features of the economic effects for the district and the municipalities affected by each individual project.

The basis for the evaluations
Each hydro-power project is located in a municipality, a few of them affect several municipalities. When evaluating the effects on the regional economy, a region comprising several municipalities was defined for each project – a broad daily commuting area. Employment at the plant has been calculated on the basis of the fixed proportions of wages for the different kinds of work done at the plant. The effects on employment have been estimated on the basis of the size of the region and the size of the plant. The evaluations have also taken into account how much of the labour force can be suitably recruited locally. Moreover, the analyses also take into account the positive effect on local trade and industry.

The licence fee, and the fund which the licence is required to make available for promotion of industry in the district, are the first sums to be clarified in the evaluation of an application for a concession, and these amounts will vary from project to project. The effects on the regional economy have been evaluated for all projects. In 35 per cent of the municipalities, the income from taxes from the power plant will be larger or about the same as the municipality's share of the funds distributed by the state to improve the

ICE AND WATER TEMPERATURE
Except in the case of small river power plants, hydro-power development will nearly always affect the condition of the ice and the temperature of the water. The most usual and visible effects are found in the stretches of river below the power plants. Here the river runs in the open. The result is often a higher temperature in summer and a lower temperature in winter.

Another visible effect is the breaking up of the ice on the reservoirs.

Hydro-power development has also been shown to cause changes in the fjords. The result is sometimes more ice, sometimes less ice. The impacts on ice and the temperature of the water have therefore been evaluated according to a scale ranging from +4 to -4.

CLIMATE
Hydro-power development may cause local changes in the climate. The most important changes are connected with the day and night temperatures, the amount of ice on rivers and lakes, the frequency and extent of frost mist, and the strength of the wind.

Normally the development only affects the climate over a limited area, for example, a specific rural community. Therefore, in the Master Plan, a scale ranging from +1 to -2 is used to evaluate the impact on climate.

The drawing of the River Nid in Trondheim shows how a watercourse can help to shape the landscape, and become a feature of it.
economy of municipalities with a low tax income. In the case of 65 per cent of the municipalities, however, these «tax-income equalizing» funds amount to more than the increase in income resulting from a future hydro-power project.

In general, the calculations show that the hydro-power projects have only a moderate effect on income and employment. The effects on taxes are the most significant, and of most permanent character. In addition, there are the licence fees and the Fund for Promotion of Industry, which are specifically stipulated in each individual case of licensing.

**Division into groups by regional economic considerations**

An evaluation of the municipalities’ situation on the one hand and the assumed effect of hydro development on the other has provided a basis for dividing the hydro-development projects into four groups on the basis of regional economic considerations. The first group is characterized by the following conditions:

- The state of the municipality is relatively good, with a level of income from taxes above the average for the country, and little unemployment. The plant will have little effect on employment and income from taxes. The municipality is given low priority from the point of view of regional policy.

At the other end of the scale, group 4, the conditions are characterized as follows:

- The state of the municipality is especially poor, with an income from taxes generally below 70 per cent of the average for the country. Unemployment is high, and the power production is expected to have a fairly substantial effect on employment and income from taxes. The municipality is given high priority from the point of view of regional policy. In the subdivision based on the regional economy, the two remaining groups lie between these extremities.

**MAPS AND DATA**

Special topic maps have been prepared for the watercourses. Up to 10 topic maps are enclosed with each report. These maps indicate:

1) Settlement and municipal boundaries
2) Nature conservation
3) Open-air life and recreation
4) Wildlife
5) Fish
6) Water supply
7) Pollution control measures
8) Preservation of ancient monuments
9) Agriculture, reindeer husbandry, preventative measures against flooding and erosion
10) The effects on climate, ice and water temperature

Another map enclosure has been prepared (scale 1:1 million) showing the present use made of watercourses in Norway by county. It describes the watercourses already developed and those which it has been decided to develop, which watercourses are evaluated in the Master Plan, which are protected and which are left out of the Master Plan.

In connection with the preparation of the reports on the individual watercourses, all key data have been registered by computer. These data were supplemented and adjusted when the requested comments were received from interested parties. The intention is to use these data references to compile a central watercourses register, to make information on the watercourses more easily available in the future.

In the course of the project period, the work of the expert group for maps and data was extended to include the preparation of a watercourses register. This was to ensure continuity from the most comprehensive collection of data on water ever carried out in Norway for use in water-use planning, to future use of these and other data.
The impact analyses in the reports on the watercourses are preliminary, since they are made on the basis of the watercourse and the hydro-power project seen in isolation. The value of the area from the point of view of the different user interests is shown on a topic map.

The work on the Master Plan involved full-time and part-time work by a large number of persons, both centrally and in the counties. Widely representative steering groups, expert groups and contact groups were organized at the different levels to ensure that all interests were taken properly into account.

The Ministry of Environment was responsible for the Report on the Master Plan. The work was carried out in cooperation with the Ministry of Petroleum and Energy, the Norwegian Water Resources and Energy Board, and other affected parties. The steering group for the project included representatives from the Ministry of Petroleum and Energy, the Ministry of Agriculture, the Ministry of Local Government and Labour, the Ministry of Health and Social Affairs and the Ministry of Environment.

The project management and administration was responsible for the progress of the project. While the project management consisted of representatives from the Ministry of Petroleum and Energy and the Ministry of Environment, with the Norwegian Water Resources and Energy Board as observer, the actual administration was located in the Department of Natural Resources in the Ministry of Environment.

Export groups were established to administer the study of the individual user interests. The evaluations included not only the hydro-power projects, but also nature conservation, open-air recreation, wildlife, fish, water supply, pollution control, preservation of ancient monuments, agriculture and forestry, reindeer husbandry, prevention of flooding and erosion, transport, ice, water temperature, climate, regional economy and maps and data. Large parts of the work on the Master Plan were done in the counties. The main link was a Master Plan coordinator in each county, who was responsible for coordinating the work in the county, collection of data, and contact with the municipalities, various expert authorities and organizations.

The coordinator for the Master Plan was responsible for preparing the reports on the watercourses in his county, and for distributing the reports for comments. Each county has also had an advisory contact group, in most cases headed by the County Governor.

In the work on the Master Plan, the main efforts were directed at the preparation of the reports on the watercourses. This work had been going on since 1981. The main
The evaluations and analyses performed by the agencies involved in the Master Plan for Water Resources were also undertaken by the governance and central and local officials. The affected municipalities were informed in the work at an early stage, through special meetings and other arrangements. Local interest organizations were also kept informed.

It was considered particularly important to ensure that all affected parties were given the opportunity to read the reports and submit their comments. This process involved a great deal of work, and was especially comprehensive for the reports on the watercourses. The main report on the Master Plan for Water Resources was distributed for comment in September 1984. The majority of the comments expressed agreement with the intentions of the plan. There were some critical comments from interest organizations representing the power companies and industry. Most municipalities, counties and County Councils proposed that certain projects were placed in another category than proposed in the main report. But there was general agreement that the work on the Master Plan should be followed up. The persons/organizations asked to comment on the plan were informed at an early stage about the organization and content of the plan, and were asked to comment in particular on the conditions which they considered relevant. At the same time, the "boiling process" was made as uniform as possible, partly to allow systematization of the material.

The directly affected municipalities, local interest organizations and the relevant developers received the reports on the individual watercourses for comment in early summer 1984. The comments from the municipalities were forwarded to the counties. The municipalities were asked, inter alia, for their views on the professional evaluations of the individual user interests as expressed in the reports, and further, for an evaluation of the importance of the individual user interests weighed one against the other. The municipalities were also asked to state their attitude towards the hydro-power project in question.

Ninety-five per cent of the municipalities and almost 100 per cent of the power companies submitted their comments within the fixed deadline. The feedback from other interest organizations was somewhat uneven.

The main conclusion is that the evaluations made by the agencies asked for comment agree well with the impact analyses presented in the reports on the individual watercourses. Some projects stand out clearly, in that the interested parties have a definite attitude towards the development. This applies, for example, to projects where the evaluation of the application for a licence is taking a long time.

The Siren dam
Hardangervidda
Photo: Helge Sunde
Thorough weighing of the different interests

One of the reasons why such a weighing of different interests is necessary is because the negative consequences for other interests are expected to increase as the remaining watercourses are developed and fewer areas of undisturbed nature are left. The order of the projects has therefore been adjusted in the light of the comments received, and giving due consideration to the regional economy. A total evaluation of the effects of a number of hydro-power projects implies the weighing against each other of a number of dimensions which are difficult to compare. Each of the interests has its own view of what is important. Some of the impacts can be compared by expressing loss or profit in terms of money or other measurable units. Some impacts, however, can only be expressed by using qualitative terms such as small, great, very great etc. Nevertheless, when weighing against each other the different user interests affected by the hydropower development, a comparison has
to be made between just these not easily comparable dimensions.

When hydro-power development projects are being considered for a licence, the final weighing up of the different interests is undertaken by the Government and the Storting. In the Master Plan, all the interests are evaluated collectively for a large number of projects, and the results compared for the purposes of setting up an order of priority for the different projects in relation to each other.

Sorting into groups
This process has involved a great deal of work. For one thing, the process has been systematically corrected at each stage of development to ensure that the final ranking is as fair as possible.

After evaluating and weighing the different user interests affected by a project according to a fixed scale (+3 to +4) it was possible to undertake a total evaluation. In the Master Plan, the first stage in this process was to sort the projects "technically", where all the user interests had the same weight. In this connection the projects were sorted into eight groups. When a project had been placed in an impact group, each project was evaluated individually. In this connection, emphasis was given to the comments received from the different interested parties. At this stage as well, the different interests were weighed against each other.

All the projects were also ranged according to the economy of the power plant. The next stage in the process was to weigh the economy of the plant against the impact class. With six economy classes and eight impact classes, there were 48 possible combinations. These 48 possibilities were reduced to 16 priority groups.

The impacts increase with fewer remaining undisturbed watercourses
In order to achieve this sorting into priority groups, economic considerations counted more for the first projects and less for the last projects in the list of priority groupings. The impact classes counted relatively more towards the end of the sorting into priority groups. Other individual adjustments were also made out of consideration to the local power supply.

Because larger projects may easily have a major impact on other user interests, they will be placed far down in the priority grouping. This may have an unfortunate effect, because several smaller projects, taken together, may result in equally serious negative effects as one large project. This was also taken into account by moving some larger watercourses further up in the order of priority.

Moreover, some projects have been given a different place on the list in the light of the comments received on the main report. In the case of projects where the affected interests are mainly local ones, emphasis is placed on the comments from the municipalities and counties. Where national interests are affected, however, these have very largely been decisive.

Buck-bean
Photo: Pål Hermansen
Careful hydro-power development

Thus, the Storting wanted the Master Plan to present the watercourses sorted into priority groups. As mentioned above, they were divided into 16 such groups, and then further grouped into three categories. When the previous Report on Energy was presented, the Government in power at the time considered that a rate of development of 125 TWh was a reasonable illustration of careful and considerate hydro-power development. The work on the Master Plan has shown that important conflicts may arise in connection with further power development. Therefore, it would seem that 125 TWh still applies as an expression of careful hydro-power development.

An impact class and an economy class
In order to achieve a division into groups and categories, all projects are placed in an impact class and an economy class. The impact classes are ranged according to a scale of 1 to 6, where class 1 is the one with the least impact, and class 6 with the greatest. Similarly, projects with the lowest development costs in relation to power production are placed in class 1 and projects with the highest development costs and economy in class 6. Projects with the best power plant economy and the least negative effects on other user interests are placed in the first of the priority groups. The projects are placed into 16 priority groups, and when sorting the projects into these groups, emphasis was placed on giving relatively more weight to the economy of the power plant for projects at the top of the priority list and less weight in the case of projects at the bottom of the list. This system of priority groupings means...
that more weight is given to undisturbed nature, open-air recreation, for example, as more of the remaining water resources are developed.

Other conditions are also taken into account before a project is finally placed in a certain priority group. Due consideration is given to regional conditions, for example, whether the hydro-power project is particularly important to ensure an adequate and reliable supply of power. Emphasis has also been placed on the comments received from the different interested parties.

Further consideration of the projects is based on a sorting into three categories:

**Category I.** Projects, all of which can be considered for a licence immediately and consecutively, in order to ensure an adequate supply of energy in the years to come.

This category comprises the first five priority groups in the Master Plan (I-5), representing a total of about 11 TWh mean power.

The further division into groups within Category I will be guiding and not binding for the granting of a licence.

Initially, only Category I projects will be evaluated for a licence.
Category II. Projects which can be used for hydro-power development or other purposes. Category II comprises groups 6-8 in the Master Plan, representing about 7 TWh mean power.

Whether or not it will be necessary to open up all or part of Category II for consideration for a licence will be decided on the basis of a broad evaluation of developments in regard to all the elements affecting the relation between the demand and the supply of energy, and of significance for how much firm power is needed from projects discussed in the Master Plan. At the same time, an assessment is made of the adequacy of the instruments used to ensure that the applications for a licence are considered, and the actual developments are carried out as far as possible in accordance with the intentions of the Master Plan.

Category III. Projects which, in the light of the technical solutions evaluated so far, are not considered relevant for hydro-power development, due to the large degree of conflict with other user interests and/or high costs of development.

Category III comprises groups 9-16 in the Master Plan, representing about 19 TWh mean energy production.

Continued work will clarify whether alternative developments can be found in these watercourses where the conflicts of interests are less serious, or which are cheaper to develop, and which watercourses should be protected or made available for other user interests.

Several user planning for watercourses

The boundary between projects in Category II and Category III is determined on the basis of several criteria. There are so many conflicts connected with all projects having a major impact on other user interests, that is to say, projects placed in impact classes 7 and 8, that the goal should be to use these for other purposes than hydro-power. Due consideration has also been given to the fact that the undisturbed watercourses will increase in importance, the fewer that remain.

When serious clashes arise between hydropower development and other user interests, it is not always possible to combine the other interests. User interests may be mutually incompatible. In such cases the Master Plan should be followed up by planning the use of watercourses [several user planning for watercourses].

From the Folgefonna glacier installations
Photo: Zenith-Film A/S
The implementation and follow-up of the Plan

For many of the projects dealt with in the Master Plan, alternative solutions for development have already been suggested. This is partly due to new technical/economic calculations, and partly as a result of the impact analyses obtained. This applies especially to several large projects, some of which have therefore been re-evaluated. The first supplementary consideration of certain individual projects was completed in the course of 1985-86, but the work, by its very nature, must continue in the long term. The Plan is thus being followed up. Otherwise, the evaluation would become out of date and unsuitable as a basis for deciding how the watercourses are to be used in the long term.

Instruments by which to implement the Plan

If the intention of the Master Plan is to be fulfilled, it is important that the order in which the watercourses are considered for a licence according to the Plan is maintained. Various instruments must be employed to ensure that the watercourses are managed in accordance with the Plan.

The first and most important instrument is information on the Plan itself. All user groups must be supplied with comprehensive and easily understandable information.

Economic instruments can be used to push forward projects which, for economic or other reasons, the owner of the waterfall does not wish to plan for power production. If the owner of the falls is unable to finance the development himself, it may be relevant to enter into a purchase or development agreement with power companies in areas with a scarcity of power. For some companies, the purchase of state-owned power has been a reasonable way to ensure their own power deliveries. So another instrument might be not to allow deliveries of state-owned power to purchasers unless they first exploit those of their own projects given priority under the plan.

Expropriation of the rights to the falls is another possible instrument which could be used if others fail.

The necessary authority has been provided to delay consideration of applications for a licence, in order to comply with the order of priority stipulated in the Master Plan.

Follow-up and adjustment of the Master Plan

When all exploitable hydro-power has been evaluated in the Master Plan, there will be a solid collection of data on which to base the future control of the development of hydropower. There will also be a good foundation for further planning entailing the use of watercourses for other purposes than power production.

After a time, technical solutions, the design of the projects and economic calculations will change. Simultaneously, further information will become available affecting other user interests.

If the Master Plan is to provide a good basis for considering applications for a licence and for decisions to use the watercourses for other purposes, it is very important to update it frequently. The basic data are therefore being updated continuously. The Ministry of Environment updates the Master Plan, for example by updating the order of priority of the projects. This takes place in cooperation with the affected parties and local interests. The first updating took place in 1987. The second will take place in 1991/92.

Water use planning

One form of follow-up is to evaluate some of the projects placed far down in the priority grouping in the Master Plan. They are regarded as not being very suitable for hydro-power production, and should be planned for other user interests in the watercourse. It is relevant to select several watercourses dealt with in the Master Plan for this type of water use planning.

The continued work will establish which watercourses should be considered from the point of view of protection. These will be evaluated in Protection Plan IV.

ROUTINES FOR COOPERATION WILL BE MAINTAINED

It is the Government’s intention that the continued work on the Master Plan shall take place within the normal public administration. This is necessary if the material is to be used directly by the administration in its work. The total resources have been reduced, however, relative to the completed project phase. The Ministry considers it important in the further work to maintain the routines for cooperation between the different sector services and between the different levels of administration, established when the Plan was being prepared.