Environmental report

Vattenfall Hydro Power 2011

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The cover illustration shows Akkats Power Station

The Environment in Focus

Gunnar Axheim

A historic year

2011 was a historic year for Vattenfall Hydro Power. We welcomed Vattenfall's German hydro power operations into our Nordic organisation. This has meant that our environmental work has been conducted in a wider perspective and based on each country's specific requirements regarding the environment and generation technology. In 2011, we spent a lot of time working with understanding and conducting dialogues with the authorities, politicians, municipalities and other interested parties regarding the EU's Water Framework Directive. The Directive is based on guaranteeing water quality in Europe. Vattenfall has therefore launched an operation to find measures to promote biological diversity in our developed rivers without affecting important renewable hydro power generation. For Vattenfall, the dialogue about the Water Directive is extremely important and it is our ambition to increase our commitment and our cooperation with the Directive's stakeholders in the next few years.

Vattenfall Hydro Power's important roll as a renewable energy provider means that in 2011 we continued our efforts to streamline our power plant. At Akkats Power Station on the Lule River, for example, we are investing a billion Swedish kronor on extending the power plant from one to two new units. When the reconstruction is finished in 2014, Akkats Power Station will generate about 590 GWh. This means that after reconstruction the power plant will increase electricity generation by 25 GWh.

I hope that this year's environmental report gives you, the reader, good insight into our environmental work. If you have any questions, please contact us.

Gunnar Axheim
Head of Vattenfall Hydro Power

About Vattenfall Hydro Power

Renewable energy source
About half of Sweden's electricity is generated from hydro power, which is a renewable energy source.

Vattenfall Hydro Power is responsible for the operation, maintenance and renovation of Vattenfall's hydro power plants. We own and operate 126 wholly or partly owned hydro power plants in Sweden, Finland and Germany. In Sweden, we have 54 large-scale hydro power plants (more than 10 MW) and 51 small-scale ones. In Finland, there are 1 large-scale and 9 small-scale hydro power plants, and in Germany there are 8 pumped storage power plants (PSPPs) and three river power plants. Today we have 600 employees operating in 3 countries and our head office is in Luleå.

Our operation also includes six fish farms. We are in an exciting development phase where we will invest about SEK 13 billion until 2023, at the same time as entering a generational change.

In 2011, our total electricity generation increased to just over 30 TWh, which was in line with expected generation and just below our normal annual generation. Annual generation of hydro power varies from year to year, mainly depending on the availability of water, and in the past ten years it has varied between 25.5 and 37.2 TWh. In principle, annual generation is based on the precipitation during that year and the previous year.

Management system – tools for structured environmental work and continuous improvement
Since 2000, Vattenfall Hydro Power uses a management system for the environment, work environment and quality.

We are certified in accordance with:
- Environmental management (ISO-14001:2004)
- Quality management (ISO-9001:2008)
- Work environment (AFS 2001:1)

What does the management system mean to us?
We work systematically with the environment, work environment and quality, which makes it possible for us to make continuous improvements. We can quickly see trends in development in the area of the environment since monitoring and measurement are an important part of environmental work. This creates the prerequisites for us to be able to take effective and important measures.

One of the advantages we have seen over the years is that the management system creates a decision-making basis based on facts. A functioning management system has advantages for the environment, staff and customers.

Generation of hydro power in Sweden and Finland 2000-2010 (GWh)

Graph 1. Vattenfall Hydro Power electricity generation in Sweden and Finland

Pumped storage power plant – Hydro Germany
The basic idea behind a pumped storage power plant is to pump water up to a higher reservoir during times of low electricity consumption. When the demand for electricity is high, the previously pumped water is then released through the pumped storage power plant and generates electricity. More electricity is always required to pump than to generate electricity in a pumped storage power plant because of the losses that occur in turbines, generators etc. This is done as a regulation power for other energy generation (coal, nuclear) in Germany.

Pumping	**Electricity generation**
Low electricity consumption	High electricity consumption
Plenty of electricity in the system	Demand for electricity in the system
Low electricity prices	High electricity prices
Often at night	Often during the day, weekdays

German pumped storage

Pumped storage, power output	2,482 GWh
Pumped storage, power consumption	- 3,280 GWh
River power plant, power output	109 GWh
TOTAL	- 689 GWh

(Power plants consume more electricity than they generate)

Stora Sjöfallet

The Environmental Year 2011 in Brief

We have targeted environmental problems for a number of years to reduce our environmental impact. This is done through renewal projects and make hydro power more efficient so that we generate more energy per water volume, at the same time as further improving the safety of our power plants and dams.

The Environmental Year 2011 in Brief

- The introduction of a new risk management tool and starting to update all of the plants' environmental risks.
- We have reduced the quantity of oil in a number of plants, at the same time as introducing an environmentally-friendly synthetic ester.
- Streamlining plants (renewal projects) to obtain more energy per water volume and minimising environmental risks.
- At all plants we continue to work on energy monitoring, heat, ventilation, lighting etc.
- Conducted emergency drills focusing on environmental accidents.
- No serious environmental deviations were reported in 2011.

You can read more on a number of the environmental measures we have implemented in 2011 under other headings in this environmental report.

Vattenfall Hydro Power – our environmental focus

Vattenfall Hydro Power is part of the Vattenfall Group. Its environmental focus is an interpretation of the group's environmental policy, which all employees of Vattenfall Hydro Power must actively adhere to in all activities.

Vattenfall Hydro Power operates and manages hydro power in the Nordic countries and Germany, and generates electricity for our customers with as little impact on the environment as possible. Vattenfall Hydro Power develops hydro power as an energy source, works together with other energy sources, and increases the generation of renewable electricity by stream-lining, review of the applicability of water conservation regulations and the reconstruction of hydro power.

Vattenfall's vision is to be one of the energy providers leading the transition to environmentally sustainable energy generation and to set an example on the markets where we operate.

Vattenfall Hydro Power's areas of focus are the use and protection of land and water, safe waste disposal, biological diversity, dam safety and energy efficiency.

We have a structured and systematic approach to taking environmental and other essential sustainability aspects into account, including setting requirements and targets as well as following up on our results.

We specify and assess environmental, social and ethical performance when selecting suppliers, contractors and business partners.

Our performance in environmental matters is a foundation for a sound business development and for improving our competitive position.

Vattenfall Hydro Power's ambition is to be one of the companies leading the transition to environmentally sustainable energy generation.

This means that Vattenfall Hydro Power:

- Will be one of the companies leading the way on environmentally sustainable hydro power generation.
- Is one of the companies actively participating in Swedish and international environmental work.
- Contributes to carbon-neutral energy generation in the Nordic countries and Germany.
- Will, as far as technically and economically possible, reduce the company's impact on the environment and prevent pollution.
- Seek measures to improve the environment, which are well-founded, cost-effective and provide a significant environmental improvement, locally and globally.
- Follow the applicable legislation, and continuously improve operations by working systematically.
- Actively seek regular dialogue with local representatives, customers, authorities and stakeholders.
- Openly present our environmental work and impact.
- Identify environmental and social values before specifications are made. This is in order to reduce the impact on the environment as much as possible, and to simplify the choice of alternatives, primarily for renewal projects and new investment projects.
- Adapt projects by seeking the best solution so that the impact on biological diversity is minimised.

Green certificates stimulate renewable energy generation

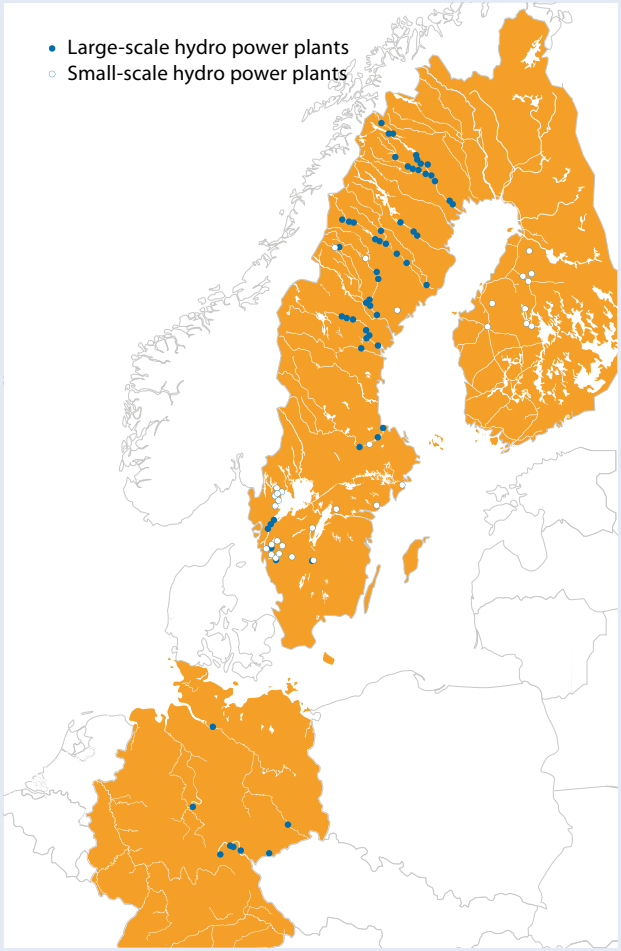
The power plants that were constructed during the 1940s and 50s are being renovated and parts are being replaced with new ones in an ongoing renewal and reinforcement programme. In many cases, new technology provides opportunities to streamline electricity generation, at the same time as improving safety and reducing environmental risks. The green certificate system makes it possible to increase renewable electricity generation in large-scale hydro power plants with the same water volume and therefore has no negative environmental effect. Increasing the efficiency of hydro power plants is positive for society in general because the use of fossil fuels is declining.

The Swedish Energy Agency has so far approved 26 of Vattenfall's large scale power plants for green certificate compensation. Overall, green certificate compensation was approved for large-scale hydro power plants with 249.5 GWh new electricity generation in 2011 (normal annual generation 190.9 GWh). Previously, almost all small-scale hydro power plants qualified for green certificate compensation. In 2011, small-scale hydro power plants were given green certificate compensation for 190 GWh.

Focus on improving fish migration routes

Vattenfall is working on a number of projects to free migration routes for salmon, salmon trout and eels, so they can pass hydro power plants upstream and downstream and return to their original spawning grounds and nursery environments. In consultation with the former Swedish Board of Fisheries and county councils, measures have been taken at Apelnäs and Bosgården power plants to allow upstream migration and migration of different types of fish such as eel and trout. At Bosgården, a fishway has been built in the scenic surroundings of the power plant. The fishway gives the Lygnern trout a greater chance of migrating upstream for spawning and reproduction. Work on the smolt guidance device (obstacle in the river that guides the fish towards the fishway) at Stornorrfors has now taken a step in the right direction after the teething problems in 2010.

The smolt guidance device has been in place for large parts of the smolt migration period and a significant number of smolts have been seen coming out of the fishway; even the occasional kelt (migrating brood fish) has been seen. There are plans to evaluate the guidance device in 2012.



Our hydro power plants in Europe

Pamilo power plant, Finland

"We have had continuous dialogue with the authorities, environmental organisations and the local population."


Marja Rankila

Water Control in Lake Koitere in Finland

Pamilo hydro power plant is located in the middle of the North Karelian wilderness. It is the largest and most beautiful of the 10 Vattenfall hydro power plants in Finland. It is also one of the largest hydro power plants in Finland with annual electricity generation of 256 GWh1). Pamilo gets its water from the wilderness Lake Koitere and the Koita River, which flows into Russia and into Lake Koitere.

The water level in Lake Koitere is regulated by Pamilo power plant. From 2004-2006, a development project was carried out for the regulation of Lake Koitere, which identified the ways in which the lake would be affected by regulation. It was particularly important for the project to let interest groups and the local people express themselves and consider their views in the subsequent investigatory work.

In 2006, the investigation resulted in 22 recommendations, which the production company Vattenfall Sähköntuotanto committed to following.
The recommendations deal with improved regulation practices, rehabilitation of beaches, care of fish stocks and fisheries, and opportunities for recreation and boating. The implementation of the recommendations has been monitored by a special monitoring group.

Vattenfall Sähköntuotanto is satisfied with the project.
"In the public debate, it's our wilderness bird, the diver, which has received the most attention. The diver breeds in Finland and builds its nest right next to the water's edge, which also means that small rises in water level can jeopardise the diver's nesting," says Vattenfall Sähköntuotanto Oy's environmental coordinator, Marja Rankala.
"For this reason, we do our best to keep a water level that doesn't jeopardise this bird's nesting."

Cooperation between the parties has been successful.
"We've had continuous dialogue with the authorities, environmental organisations and the local population. We've held regular meetings with them a couple of times per year where we've discussed current issues," states Marja Rankila.

The next step in the regulation project is an investigation by the regional centre for the environment, which will examine how successful the project has been and what effects it has had. The recommendations will also be re-evaluated. The investigation is expected to be finished in spring 2012.

[1] 1 GWh = 1 million kWh, which is equivalent to the electricity consumption of about 40 normal houses in a year.


Margit Lenser

"The aim was to avoid, minimise and offset adverse effects in the environment, for example through compensation measures within and outside of the project area."

Considering Environmental Aspects

In the middle of the "green heart of Germany" is one of the most modern pumped storage power plants in Europe: in the Thuringian Highlands, among forests, mountains and streams, Vattenfall's pumped storage power plant, Goldisthal, is found. The power plant has an installed capacity of 1060 MW and was inaugurated in 2003. In the scenic area, the plant encroaches on the environment: flora and fauna, soil, surface water and groundwater, forestry and agriculture and other protected areas are affected.

How can we prevent power plant construction like this from having a negative effect on the natural environment? What can we do to ensure that the adverse effects are as minimal as possible or that there are none? How can we make sure the ecological balance is not affected in the long term? Before the power plant was built, Margit Lenser, who was part of the project management team for the pumped storage power plant, occupied herself with exactly these questions. From 1995, she was responsible for implementing a large number of environmental monitoring measures. She thinks back to the initial phase in the construction of Goldisthal:

"The aim was to avoid, minimise and offset adverse effects on the environment, for example through compensation measures within and outside of the project area," she says.

Even before the project, they had realised that the environment for capercaillie, black storks and bats would be affected by the plant construction in Goldisthal. The habitat of all these species would be affected. In order to conserve the endangered capercaillie, Margit Lenser worked on a project which placed them out in their natural environment: in an area removed from the pumped storage power plant, an area of 350 hectares of forest was adapted so that capercaillies captured in Russia could be moved to Thuringia.

"The forests were very disturbed, just like in GDR times, and there was no undergrowth," says Margit Lenser.

Thanks to the dedicated work, it was possible to create a field layer. Newly planted bushes gave the capercaillie food, and it quickly accepted the new environment and even reproduced.

"We've exposed small streams, planted meadows, cleared away old dams and built natural fishways.

In addition to these measures, Vattenfall and the former company VEAG, have contributed EUR 3.6 million to a local conservation organisation to set up a foundation. The aim of the foundation is to improve conservation in the new federal states.

The majority of the local people, most politicians and companies welcomed the construction of the power plant, however, there was criticism from environmental organisations. The project management team focused on dialogue:

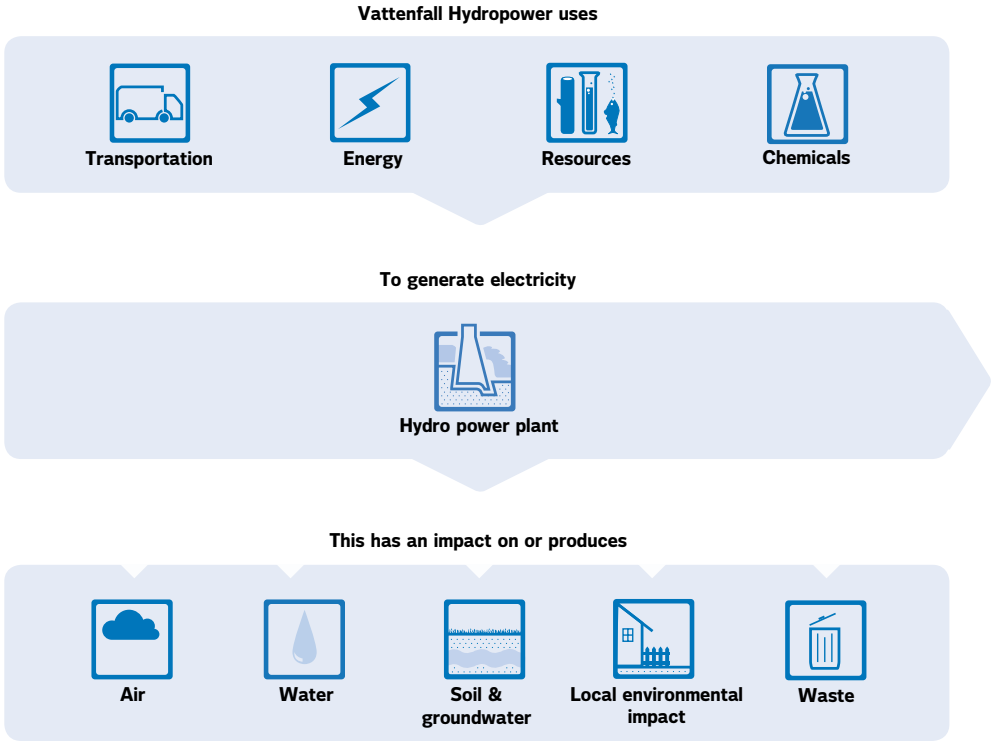
"Communicating and talking directly with people has proven successful," says Margit Lenser.

Today, Margit Lenser is the environment manager for all BU Hydro's German plants and is glad to be able to use all of her experience. Above all, she is glad that almost ten years after the power plant in Goldisthal was commissioned, she still has the chance to minimise environmental problems.

Goldisthal hydro power plant

Environmental Flow Chart of Environmental Impact


Stornorrfors



How Do Hydro Power Plants Affect the Environment?

Vattenfall Hydro Power – environmental impact
Hydro power is a renewable energy source and accounts for almost half of our electricity generated in Sweden. Once the power plants have been built and are in operation, their emissions into soil, water and air are fairly small and in the same range as for wind power. You can read more about the impact of hydro power on the environment in the environmental product declaration (EPD) and life cycle assessment (LCA) that are available at www.vattenfall.se.

Annual assessment
Every year, we assess the environmental risks at our plants and set objectives and action plans to minimise any significant environmental risks. Below there is a description of the significant environmental risks and their impact, as well as some examples of measures we took in 2011. During the year, environmental risk identification was carried out at all plants, and a new risk management system (Capello) was introduced in the organisation. (See interview with Sören Ek in this environmental report).

Environmental Product Declaration (EPD)
Almost 100 per cent of the electricity generated by Vattenfall in Sweden has a certified environmental product declaration. This means that we have clear, quality assured and comparable information on the environmental impact of our various electricity generation methods. We were the first company in the world to be awarded a certified Environmental Product Declaration (EPD).

EPD makes comparison possible
The Declaration describes resource consumption, emissions, waste, recycling and land use for every kilowatt hour of electricity generated. It does not evaluate the environmental impact or environmental friendliness, but makes it possible to compare the environmental characteristics of various products from a life-cycle perspective – "from the cradle to the grave". An accredited certification body ensures the quality of the information in the environmental product declaration.

The purpose of EPD
EPD is a systematic tool and guarantees:
- Quality-assured figures for emissions, resource consumption, the impact on biodiversity, etc.
- Information that can be summarised for companies that will certify their own EPD.
- Objectivity, based on ISO 14025.
- Comparability, that is a requirement for industry-wide rules.
- Quality assurance with requirements for inspection by an independent third party.

Read about Hydropower's EPD and make your own comparison between the energy acts at www.environdec.com/en/Detail/?Epd=7468

Resources

SF_6 (Sulphur hexafluoride) – is handled only by certified personnel

What impact do we have?
The insulating gas sulphur hexafluoride (SF_6) is used in high voltage equipment because of the gas's excellent insulating and electric discharge quenching properties. SF_6 is one of the fastest-acting greenhouse gases that the Kyoto Protocol mentions and emissions of SF_6 gas contribute to the greenhouse effect. In our plants there are relatively small quantities of SF_6 gas.

What do we do to minimise the impact?
To reduce the risk of SF_6 emissions, there are procedures for handling, monitoring and record keeping. We only employ certified personnel for servicing units with SF_6 gas. In certain cases, we can use the new vacuum technology to replace SF_6. This possibility is being investigated for all replacement of high voltage equipment.

Chemicals

Minimal quantities in our power plants

What impact do we have?
The most common chemicals in Vattenfall Hydro Power plants are grease, oils, lubricants and cleaning chemicals. These products have a negative impact on the environment when they are produced and if they leak into the natural environment. Fish farming uses chemicals (salt and formalin) to reduce the bacterial flora and promote fish development.

What do we do to minimise the impact?
There are procedures and instructions for handling and using chemicals, and training courses are continually being organised for staff who handle chemicals. Vattenfall Hydro Power has a computerised reporting system for chemicals for all plants, which includes the classification of chemicals, safety datasheets, risk assessments, annual consumption etc. The system pro-

vides a good overview of the chemicals we hold and their impact on humans and the environment. Our ambition is to replace the potentially dangerous chemicals, where technically possible, with less polluting alternatives.

Examples of measures in 2011

- Replacing chemicals with biodegradable alternatives (water-lubricated hubs, new turbine designs).
- Purchase of oil cuff for the floor drain.
- Clearing out old chemicals for transport to a recycling station for destruction.
- Purchase of bunded chemical cabinets (Dal River).
- Performed risk analysis and safety rounds with focus on handling chemicals.
- Trained staff in risk management (chemicals).
- Improved handling of chemicals by purchasing a catch tray for storing oil and lubricants.

Oil and grease – replacement with environmentally friendly products

What impact do we have?

Oil and grease are used in hydro power plants for various purposes, including regulating turbines (mineral oil) and as lubricants (bearing oil and grease). Any oil leakage can result in a limited environmental impact.

What do we do to minimise the impact?

To reduce the environmental impact of managing oily waste and minimise the consequences of any leakage, we are changing to biodegradable oils and water-lubricated systems, where technically possible. The ongoing renewal of the turbines in hydro power plants with new and more environmentally accepted technology means that the risk of oil leakage is reduced considerably, and that the quantity of oil in hydro power plants is reduced (see also under Discharge into water).

From oil to water – oil-free hydro power plants soon a reality

Within ten years, Vattenfall will be a world leader in environmentally sound, efficient hydro power generation. The long term objective is that none of our hydro power plants will use mineral oil as bearing or hydraulic fluid. Environmental improvement is taking place in the form of reduced liquid volumes with faster biodegradability, increased renewability (reduced use of resources) and reduced energy losses. A pilot project is taking place at Älvkarleby power plant to replace hydraulic oil with biodegradable glycol in the dam gates system.

Vattenfall currently sees three ways we can move on from today's mineral oil-based system:

- Environmentally sustainable oil (synthetic ester).
- Water-lubricated systems.
- Liquid-free techniques.

Examples of measures in 2011:

- Changeover to environmentally sustainable oil (synthetic ester) in Bergeforsen and Harsprånget, for example.
- Replacement of oil-insulated transformers with a dry-type transformer (Apelnäs power plant).
- Emergency drills focusing on environmental accidents (Långed, Messuare power plants).

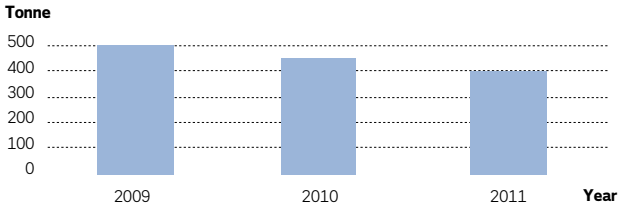
Transports

Emissions from business trips decrease during the year

What impact do we have?

Vattenfall Hydro Power is active throughout Sweden, Finland and Germany, which involves a lot or travelling. The geographical spread of power plants means that driving and flying are often the only practical transport methods. Transport creates air pollution through the emission of carbon dioxide and nitrogen compounds, among other things. In 2011, our emissions from travel reduced, which we see as a positive thing. Compared to 2010, we reduced our carbon dioxide emissions by about 10%.

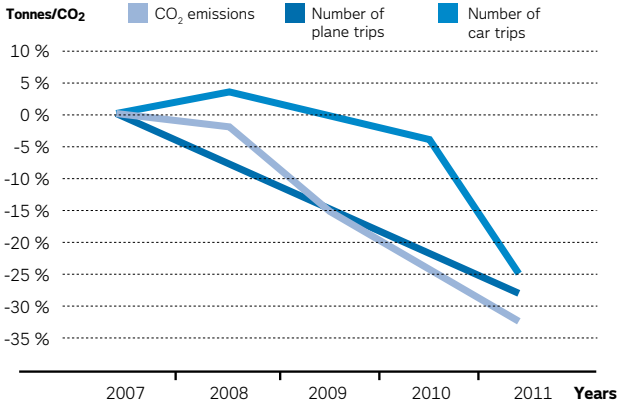
Total emissions of CO_2 (tonnes) (Business trips by plane, car and train) – Staff of Hydro Sweden



Graph 2. Carbon dioxide emissions from business travel by employees of Vattenfall Hydro Power (Sweden).

The proportion of flights and train travel has declined since last year. The graph below shows that this positive trend coincides with the development of our reduced carbon dioxide emissions.

Percentage change from 2007



Graph 3. Percentage change in trips undertaken by Vattenfall Hydro Power personnel in Sweden.

What do we do to minimise the impact?
Vattenfall Hydro Power continually works to minimise travel and reduce emissions. To reduce the environmental impact, trains will be used primarily for shorter distances; eco cars should also be requested when using hired cars. We are working constantly to try to reduce the number of trips and their environmental impact. One of our environmental targets for 2012 is to continue to reduce emissions from our travel. (See also under the heading Environmental Targets in this environmental report).

Other alternatives for reducing emissions from travel are:
- Telephone and video conferencing.
- Coordinating purchases.
- Switching to eco vehicles.
- Eco driving training.
- Better coordination and planning of meetings.

Energy

Improved energy monitoring, control of heating and ventilation reduces energy consumption

What impact do we have?
Energy is used to generate electricity (large-scale and small-scale hydro power) and for fish breeding, to a smaller or lesser extent. Above all, electricity is used as feedstock. Electricity consumption (local power) varies somewhat from year to year but has decreased in recent years, which is in line with Vattenfall's ambition to reduce the local energy consumption of all its generating units.

What do we do to minimise the impact?
Streamlining is performed continuously to reduce the consumption of energy in generation. We have conducted energy evaluations at a number of plants to find sources where energy consumption can be reduced.

Examples of measures in 2011:
- At Norrfors, we installed a geothermal energy pump for the staff building.
- Reconstruction of heat management systems and dehumidifiers.
- Improved energy monitoring and control of heating and ventilation in a number of plants.
- Installed frequency controlled pumps.
- Installation of air heat pumps at several plants
- Installation of better and more precise thermostats for heat control in a number of plants.

Discharge into water and soil

No emissions with significant environmental impact have occurred

What impact do we have?
For turbines and sluices, oil and grease are used in hydraulic systems, transformers and hubs. Small quantities of oil and grease can leak into the water and soil during operation. These small discharges do not have a great impact on the environment, however, leakage should still be minimised. Larger oil leakages can cause damage to plants and animals in the aquatic environment. There are continuous leakages of nutrients and certain chemicals from fish farms, but without significant environmental impact. There was no oil leakage with significant environmental impact in 2011. This is a result of systematic work to eliminate the risk of leakages.

What do we do to minimise the impact?
When the level in the power plant's oil system is too low, an automatic alarm is triggered because this indicates a possible breakdown and oil leakage. Most potential leakage points are connected to sumps with oil alarms and oil separators to minimise the risk of oil leakage into the water and soil. Identifying plant-specific environmental risks has resulted in an action programme which increases safety and preparedness for emergencies.

Examples of measures in 2011:
- In the event of major renovations, the oils are replaced with more environmentally suitable oils or other alternatives (synthetic esters).
- Improved emptying device for oil separators.
- Functional inspection of oil separators at a number of plants.
- Environmental risk inventory and conducting safety rounds.
- Reduced oil volume in renovation and renewal projects.
- Renovation of the pressurised oil system for a unit in Olidan. This has reduced the consequences if an oil leakage were to occur.
- Emergency drills with a focus on oil leakage in collaboration with the emergency services (Långed and Messaure power plants).
- Continued efforts to improve the food supply system and feeding controls on fish farms, which also means lower emissions of nitrogen and phosphorus.

Practice creates better understanding and preparedness
In our ongoing work to improve safety and preparedness for emergencies at the plants, in recent years we have organised joint emergency drills with the Emergency services, SOS Alarm and contractors to practise handling oil leakages from a hydro power

plant. For us, the drills are important to ensure that our organisation has the right knowledge and tools to handle an environmental accident, and to improve cooperation with external players.

In 2011, two emergency drills with a focus on oil leakages were conducted; at the power plants in Långed and Messaure.

Waste

Recycling increases

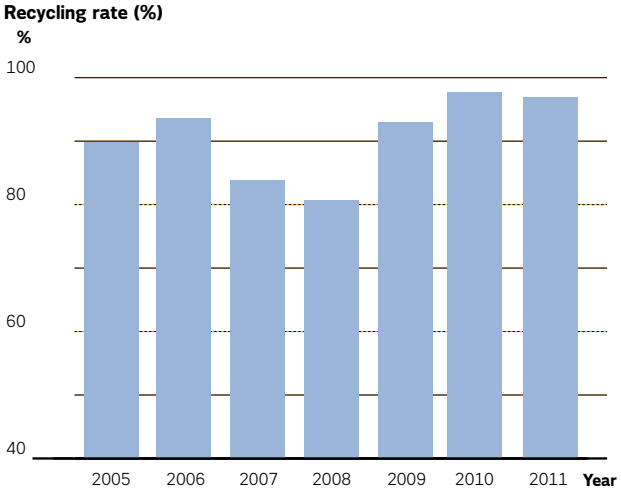
What impact do we have?

Vattenfall Hydro Power does not convert any raw materials, and the quantities of waste are therefore relatively small. However, in connection with the major modernisation projects at the plants, there is a lot of construction waste. Vattenfall Hydro Power has, for example, waste in the form of oil spills (recovered), grease, household waste and chemicals, as well as construction waste. From fish farms, the main types of waste are fish remains, feed sacks and chemical waste.

During the year we have increased our recycling rate, that is, the percentage of waste that is recycled from operational waste and residues, which we think is a positive step. This was one of our environmental targets for 2011.

What do we do to minimise the impact?

The plants report the amount of waste and the type of waste in the categories landfill, incineration, recycling and hazardous waste, and there are instructions for handling it. All plants have an environmental storehouse, where all waste is collected and handled in an environmentally friendly way. We only use waste transporters that are authorised to remove waste from our plants.



Graph 4. Recycling rate Vattenfall Hydro Power (Sweden).

Examples of measures in 2011:

- Inventoried unused devices and handed over for recycling.
- Waste, for example waste oil, has reduced because we have replaced old regulators over the years with counterweight units.
- Training and information for contractors in how to handle waste (waste records, sorting, etc.).

Emissions to the air

What impact do we have?

Airborne emissions from the generation of electricity from hydro power are relatively small; coal dust, SF_6, oil vapours and solvents. However, these emissions (except for SF_6) do not have a significant environmental impact since they are relatively small. Vattenfall is working continually to further minimise emissions.

What do we do to minimise the impact?

- Maintenance and adjustment of units minimises oil vapours.
- Supervision, safety rounds and periodic maintenance. (See also the example of cargo transport).

Local environmental impact

What impact do we have?

Building dams, storage reservoirs and power plants affect the landscape. In many cases, hydro power generation results in water being conducted through tunnels, and the flow in the original river channel decreases. In some cases, the river channel becomes completely dry. The variations in water level in the regulating and river storage reservoirs affect the plants and animals in the littoral zone (close to the shore); for example fish looking to feed or spawn in the littoral zone.

What do we do to minimise the impact?

The negative effects of Vattenfall Hydro Power's activities have, in some cases, been offset by drawing off water to the dry river channels, often in combination with building weirs. This helps to conserve plant and animal life. In developed rivers, unique species are often found, and in the river valley along the Lule River many protected biotopes have been identified and protected in nature conservation areas (see also under Positive environmental aspects). In 2010, work began on developing a tool to evaluate the biodiversity surrounding our plants. This project is also continuing in 2012.

Apelnäs power station

Environmental Risks Identified in all Large Power Plants

Sören Ek is environmental coordinator at Vattenfall Hydro Power and has worked with environmental safety since 1996. In 2011, this environmental enthusiast visited all of Vattenfall's large-scale hydro power stations and identified and risk-assessed deficiencies in environmental safety. In 2010, Sören Ek will take stock of all small-scale hydro power stations.

"By setting targets for reducing environmental risks, we avoid damaging soil and water and injuring third parties," he says.

Corporate decision starting point for systematic environmental work

The starting point for systematic environmental work was the corporate decision in 1996 that all activities should be certifiable according to ISO 14001 by 2000 at the latest. Back in 1996, Sören Ek developed a training package for environmental work.

"At first, some people were sceptical when I came out to visit and held training courses, but today I meet nothing but enthusiasm and keen interest in environmental safety wherever I go," says Sören.

Assesses probability and consequences of environmental risks

In his work, Sören Ek uses the tool Capella, which has a checklist with hundreds of questions covering all possible environmental risks. When making an inventory onsite, Sören Ek checks off all the conditions against the checklist and assigns a risk number to all identified environmental risks. The risk numbers are based on the probability that something will occur and what the consequences are. All risks and risk numbers are entered in Capella, as well as the measures that are then implemented to reduce the risk numbers. Data from Capella is then used as a basis for reporting to the Group's risk system ERM.

"I do all risk assessments and so far I've always reached a consensus with the regional and environmental managers that the identified risks really are risks. We often take action immediately," says Sören Ek.

"I set the risk numbers for all identified environmental risks. A four for "probability" means that something might happen often, and a four for "consequence" means that the damage to the surrounding environment will be great and third parties can be seriously injured," explains Sören.

Graphic presentation of risk numbers

It is possible to download presentations with graphs from Capella. Managers at all levels in the company can see the risk numbers for the various plant sites in the form of graphs, and see how the risk numbers decrease after the measures have been implemented.

"Our staff show great commitment and interest every time I meet them to present risk numbers and tell them about measures to reduce the risk numbers. Safety is a core value for Vattenfall and Capella is a good tool for systematically identifying, evaluating, handling and following up all environmental risks," concludes Sören Ek, who is very positive about the work to increase environmental safety at all Vattenfall's power plants.


"By setting targets for reducing environmental risks, we avoid damaging soil and water and injuring third parties."
Sören Ek

Positive Environmental Aspects

Protecting sensitive natural areas
Vattenfall Hydro Power has made an inventory of the natural environments where our plants are situated, and some of the most valuable land environments have been protected as Vattenfall's nature conservation areas for biodiversity. The purpose of nature conservation areas is to protect, conserve and, to some extent, recreate conditions for environments with unique plant and animal species. There are currently three nature conservation areas; Porsi nature conservation area, which is 30 hectares in size; Bombmurkle forest, which is 20 hectares of spruce forest by a river; and Messaure nature conservation area. Many unusual and demanding animal and plant species, including several previously unknown species, are found in nature conservation areas. Nature conservation areas have a large number of visitors and there is great interest, for example from universities, environmental organisations and the public.

Annual fish releases – from our six fish farms
Dams and power plants block the fishes' natural migration routes. In compensation, Vattenfall Hydro has six fish farms for salmon smolts, sea trout smolts and whitefish. We continue to release one year-old smolts, which has reduced environmental impact with lower emissions of nitrogen and phosphorus. Other measures to increase fish stocks are artificial spawning areas, and fishways and fish ladders for reproduction and for migrating fish to overcome obstacles. Today more smolts are released than required by water-rights court rulings.

Vattenfall is one of the largest fish farmers in Sweden, and each year releases around 1.3 million smolts into the rivers where we have our operations.

Bergeforsen Continues With High Pressure and Biodegradable Oil

Bergeforsen power plant supplies 147,000 households with electricity from the Indal River in Timrå municipality. It has an installed capacity of 168 MW. With a vertical drop of 23 metres and water discharge of 840 cubic metres per second, the power station produces around 735 GWh per year. The power station has four Kaplan turbines which were commissioned between 1955 and 1959. In 2011, one of the turbines was renewed and, at the same time, all mineral oil was replaced with biodegradable ester oils.

"Reducing the total oil volume at our plants is both an environmental benefit and ultimately an economic benefit for us," says Linn Forsberg, Maintenance Manager South.

High pressure reduces the oil volume from 20,000 to 1500 litres

In the renovation process, the turbine got a new runner with an oil-free hub, a new, high-pressure control system for the runner's blades and a guide vane ring and lubrication-free bushings on the guide vane ring. In addition, the turbine parts were refurbished and rotor poles and the generator's stator windings were replaced. Since the new high-pressure system increases the turbine's controlling pressure from 20 bar to 160 bar, the oil volume has been reduced from 20,000 litres to just 1500 litres. However, it is not just the oil volumes that have decreased dramatically in this renewal project. The oils that are now used are much better for the natural environment than previous mineral oils and are completely biodegradable.

"In the long term, smaller oil volumes in our plants means a reduced burden on the earth's finite resources. In those places where we're replacing the finite resource of mineral oil with a renewable synthetic ester, we're taking yet another step," says Linn.

All mineral oil replaced with biodegradable ester oils

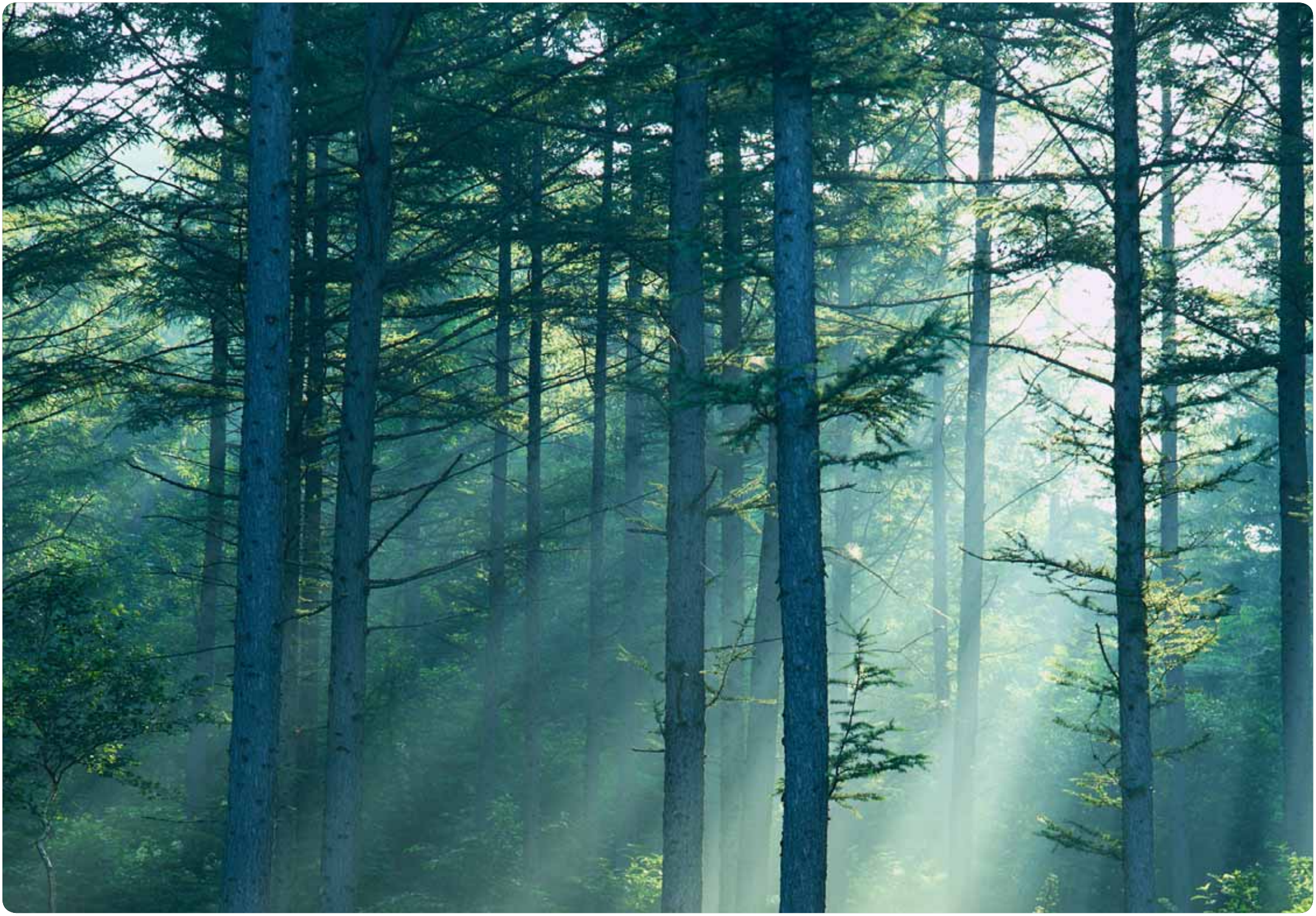
All mineral oil has been replaced with biodegradable ester oils in the turbine's control system and in all stocks. The ester oils used are entirely biodegradable in the natural environment. Within 28 days, all ester oil has been converted into carbon dioxide and water if it is discharged into the river. The decision to switch over to ester oils was made during the course of the renewal project. The turbine started to run with ester oils in autumn 2011. After some teething problems with oil leakage in joints in pressure pipes, the turbine has been running without any problem since Christmas 2011. To turn the runner blades, a control system is used where oil is brought down in pressure pipes in the axle system to the servo motor. Experience of leakage in the pressure pipe taught us to use tested sealing material for ester oils and the application used.

"In a heavy engineering organisation like this, it's been inspiring to experience the organisation's positive attitude to this development, even though it means we had some teething problems in the beginning," says Linn Forsberg.

Changing to ester oils for each turbine renewal

During operation with ester oils, there has been no noticeable difference in function compared to mineral oils. It is even the case that the viscosity of ester oils is less affected by temperature. The advantage of this is a more even oil film and reduced storage losses. Ester oils are more expensive than mineral oils, but they are essential for creating more environmentally sustainable power plants. It is therefore our ambition to replace all mineral oils with ester oils when renewing each turbine.

Linn Forsberg



Environmental Targets

Overall target – to continually reduce our environmental impact.

Continuously working towards environmental improvements and taking the initiative with environmental measures are two important parameters in our environmental ambitions. Every year, targets and a plan of action are formulated for each area. The overall targets are then broken down for each unit and plant. Below you will find the overall environmental targets we worked with in 2011 and new targets planned for 2012. On the right, you can see the status of each target.

Environmental targets 2011	When?	Results
Self-inspection • Set up a self-inspection programme for all plants and projects (P). • Ensure that our contractor, VS, supplies quality-assured environmental data correctly. • Guarantee the functioning of the purification plants and measuring equipment.	2011	Partly achieved
Waste • The recycling rate of operational waste and residues must be increased to at least 92%.	2011	Achieved
Environmental risks • Introduction of new risk management tool Capella. • Inventory and classification of environmental risks, finished Q2. • Conduct four emergency drills for oil leakage.	2011	Partly achieved
Travelling • Travel by plane and car must be reduced by 10% compared to 2010. • 50% of internal meetings must be conducted using distance technology. • The costs of business travel must be monitored annually to reduce business travel to and from the plants.	2011	Achieved
Chemicals • Leakage of oil into water (rivers) and soil must not exceed 500 litres (including diffuse emissions). • Reduce the amount of mineral oil in plants by introducing high-pressure systems and replace with environmentally friendly alternatives according to the oil strategy. • Conduct in-depth survey of oil-contaminated soil in Järkvissle.	2011	Achieved

Environmental targets 2012

Self-inspection
- Ensure that contractors provide quality-assured environmental data.

Waste
- The recycling rate of operational waste and residues must increase to 94%.

Climate
- Travel by plane and car must be reduced by 10% compared to 2011.

Biodiversity
- Create a new nature conservation area at Laxholmen by the Laxede power plant to protect endangered species.
- Investigate the conditions for further nature conservation areas in central and southern Sweden.
- Develop a model for environmental foundation Vattenel.
- Catch silver eels in Lake Vänern to release them downstream of Lilla Edet power plant, and together with other parties in the letter of intent, release eel fry in the Skagerrak and Kattegat straits.

Chemicals
- Leakage of oil into water and soil must not exceed 300 litres (excluding diffuse emissions).
- Reduce the volume of mineral oil by 0.5% compared to 2011.

Environmental risks
- Set up a four-year plan of action to reduce environmental risks by 25% annually (Capella) for risk levels 3 and 4.
- Make inventory of risks for small-scale hydro power.
- Make inventory of all cisterns for which inspection is mandatory and produce an action plan.

Worm-gear in Akkats

The Future

Hydro power is an important source of energy
Hydro power is a clean and renewable source of energy, which will become very important in the future to balance and facilitate the development of wind power. A major expansion of wind power is Sweden's most important measure for meeting its climate targets and achieving EU requirements. All energy generation of various forms has an environmental impact of some form, even hydro power. Therefore, Vattenfall is constantly working actively with environmental issues. Continuous improvements are implemented gradually in order to eliminate risks to the environment. Large investments are made to enhance the safety of our dams and measures are taken to renew and streamline our power plants.

Examples of these are:
- Vattenfall's efforts to remove mineral oils in power plants.
- Increased recycling of waste and improving energy efficiency in power plants.

By focusing on research and development, we create the prerequisites for improving our business. When we learn more about the environmental value that exists in our developed rivers, we can understand how best to protect it.

We look for biodegradable alternatives with the best possible environmental technology at existing power plants and in connection with new plants. We also take measures in our waterways to improve the ecology. However, in the long term we want to avoid measures which significantly reduce our production capacity since this undermines the climate policy that Sweden has chosen.

Vattenfall constantly strives for environmental improvements. There are many good examples of what has been done and what is being done to promote biodiversity and reduce the environmental impact of hydro power. Vattenfall is working actively with the EU Water Framework Directive and is in constant contact and dialogue with the authorities and local water councils that deal with the question of which targets are to be achieved for regulated waterways in Sweden.

Vattenfall intends to start an in-depth dialogue with the relevant authorities and local action groups, primarily to identify opportunities to promote biodiversity, so that it does not involve the loss of valuable renewable energy.

Examples of measures
- Continuity and biotope measures in smaller rivers.
- Food supply in storage reservoirs.

Safe dams
In early 2007, Vattenfall decided that investment in measures to improve safety will continue. This means investment in measures to further improve dam safety to the sum of SEK 1 billion by 2013. In subsequent years, flood gates will be modernised, for example,concrete structures will be repaired and surveillance with cameras and measuring instruments will be reinforced. A renewal means that the power plant turbines are restored to their original condition or better, enabling safe and renewable electricity generation for another 40 years. New technology and new knowledge means that the turbines can often be improved, not least from an environmental perspective. Where Vattenfall is concerned, there are around 30 units in Sweden, where measures or replacements of turbines,

generators, control and regulating equipment, auxiliary equipment and transformers are being implemented. Replacing turbines means, in addition to enhanced performance, that the quantity of oil in the plant is more than halved. Many improvements to power plants are made from a safety perspective. Evacuation routes, fire protection and fire cell division have been significantly improved.

Green certificate important for the environment

In 2012, Vattenfall Hydro Power will continue to focus on measures to improve efficiency at the plants and invest in environmental measures. In this way, we can increase generation of renewable electricity, which in turn means that use of fossil fuels can be reduced. The law on green certificates makes it possible to streamline in order to increase renewable electricity generation in large-scale hydro power plants with the same volume of water and therefore no negative environmental impact. Green certificates also allow replacement of plant components in advance and therefore increased safety and reduced environmental risks. We have an ongoing investment program totalling SEK 13 billion by 2023 to improve efficiency and minimise the environmental impact of our plants.

Research projects

In our R&D work, we have identified a number of focus areas:

- Environment; reduce the impact on the natural environment of our business and create trust in and acceptance of our company.
- Safety; safety of third parties, for example at dams, is central but staff and plant safety must also be continuously improved.
- Development; cross-industry research projects.

In 2011, a series of research projects was carried out and started to develop methods and procedures that minimise environmental impact; Vattenfall has conducted research in the following areas:

- "Environmentally acceptable small-scale hydro power" – future opportunities to build new hydro power plants.
- The 'oil-free plant' – pilot project with water hydraulics in Älvkarleby.
- "Environmental effects, measures and costs in regulated water" – industry-wide cooperation with Elforsk as principal. Now planning a fourth phase of this.
- "Functional methods for farming physiologically adapted salmon smolt" – study of smolt quality together with the former Swedish National Board of Fisheries, among others.

Glossary

AFS 2001:1
The Swedish Work Environment Authority's regulations on systematic work environment management.

Ecosystem
An area with plants, animals, microorganisms and their non-living environment that live in harmony with each other.

Green certificate
A state-issued electronic proof that one megawatt hour (MWh) of renewable electricity has been generated in accordance with the Swedish Act (2011:1200) on Electricity Certificates. (Source: The Swedish Energy Agency)

EPD
(Environmental Product Declaration). An environmental product declaration where all a product's environmental effects are identified "from the cradle to the grave".

Hazardous waste
Waste that the EU considers to have a particularly large environmental impact. Must be handled in a particular way.

Fish ladder
A device that allows fish to get past migration barriers (such as a hydro power dam) in a waterway. Can, for example, be designed as a water channel of wood or concrete with transverse walls.

Francis turbine
Francis turbines are used in large vertical drops (from 75 metres up to 450 metres). The water flows horizontally through the turbine, which can be placed under the outlet's level surface. This creates a suction effect in the suction tube, which increases the turbine's output.

GWh
Gigawatt hour. A unit of energy. 1 GWh = 1 million kWh, equivalent to the electricity consumption of about 40 normal houses in a year.

ISO-14001
Global standard for environmental management (that is, conducting structured environmental work, focusing on continuous improvement, monitored by an independent certification body).

ISO-9001
Global standard for quality management, (that is, a structured working approach with a focus on meeting customer requirements, monitored by an independent certification body).

Kaplan turbine
A turbine with a runner shaped like a propeller, often with rotating blades, which are controlled during operation to achieve optimum performance. Generally used at drops under 75 metres.

Life Cycle Analysis (LCA)
A tool for highlighting the environmental impact of a process, product or activity throughout its lifetime.

Sump
Low pit which catches leakage water from a power plant.

Runner
In the turbine runner, power is transmitted to the rotating shaft by means of a directional change of the water passing through the runner. (In many cases the runner is shaped like a propeller).

Runner blade
The runner comprises a number of blades by means of which the water drives the turbine.

Environmental aspect
Parts of an organisation's activities, products or services that have or may have an environmental impact.

The Swedish Environmental Code
Coordinated, widened and tightened environmental regulations for sustainable development which came into force on 1 January 1999.

Environmental management system
A system, which through procedures and division of responsibilities, describes how the company is to work with environmental issues in a systematic manner.

Environmental policy
Controls environmental work and indicates the company's overall intentions.

M74 syndrome
Reproductive disease M74. M stands for environmental and 74 because it was first identified in 1974 (in Bergeforsen's salmon farming in the Indal River). The phenomenon is caused by the female having a shortage of thiamine (vitamin B1) and the shortage being passed on to the eggs and fry. *Source: Swedish National Board of Fisheries*

Pumped storage power plant
Pumped hydro power, which is based on pumping water into a reservoir where energy is stored and then releasing it through turbines when energy needs to be produced.

Smolt
Young salmon that are ready to migrate (out to sea).

Small-scale hydro power
<10 MW output

Large-scale hydro power
>10 MW output

River power plant
River power plants do not have a dam reservoir for regulating the flow of water, but generate energy from natural running water. They can be compared to wind turbines, which are controlled by how much wind blows.

Transformer sump
Sump connected to transformers to trap any oil leakage.

TWh
Terawatt hour. A unit of energy. 1 TWh = 1,000 GWh, which is the average electricity Sweden uses in three days.

Spillway
Openings in the dam construction that makes it possible, if necessary, to draw off more water from the dam than the maximum that can be run through the turbines. This results in a rise in the level below the dam. Spillways have gates that can be adjusted so that the required quantity of water can pass by the power plant.

Water hydraulics
Hydraulic system containing water and glycol as a medium instead of oil.

Vattenfall nature conservation area
Vattenfall nature conservation area for biodiversity.

Water release at Älvkarleby power plant

Do you want to find out more?

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Links
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Swedish Society for Nature Conservation: www.snf.se
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