



SOCIAL RESPONSIBILITY

Landsvirkjun supports social matters benefiting the areas where the company works. For this purpose, the company seeks to participate in projects which are of mutual interest to the company and its partners. Landsvirkjun places special emphasis on developing the infrastructure of tourism and outdoor recreation in the vicinity of its power plants and wishes to strengthen tourism there by cooperation in the field of culture, e.g. by staging exhibitions and other events at company power stations.

The photographs in this brochure, taken by Ágúst Elvar Vilhjálmsson and Birgir Freyr Birgisson, form part of their exhibition „Ecce homo!“ illustrating natural beauty in a man-made environment.

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The Environment in Our Hands



The Kaldakvísl channel – natural or man-made?

Iceland is the only western country that produces all its electricity from emission-free and sustainable natural resources in the form of geothermal and hydro power.

These energy resources can strengthen the Icelandic economy, eliminate dependence on imported fuels and make an important contribution towards environment conservation.

ENERGY AN IMPORTANT RESOURCE

As is the case in most parts of the world in recent years, the utilization of energy resources has been a major topic of debate in Iceland. More often than not, the focus has been on disputes about the development of individual projects, and as a result, the wider issue of efficient and environmentally sound energy policies has sometimes been lost. At the initiative of the Icelandic government, a framework plan has been designed in order to draw up a comprehensive picture of Iceland's energy resources and to lay the foundation for a methodology of utilising hydro power and geothermal energy. Presenting proposals for harnessing them with

reference to a wide variety of interests, including tourism and the environment. A consensus is needed on a comprehensive strategy and the prioritization of possible development of the central highlands of Iceland in order to avoid conflicts about individual energy development projects.

By means of this brochure, Landsvirkjun wishes to direct the reader's attention to the characteristics of electricity production in Iceland and to the success that may be achieved in environmental affairs through sensible utilisation of the country's energy resources.

FROM THE MINISTER OF INDUSTRY:

The objective of the Framework Plan is to assess and categorise development options, whether of hydropower or geothermal energy, for instance regarding energy potential, feasibility and other aspects of economic value. At the same time, the Plan aims to define, assess and categorise the impact of these different options on nature and natural and cultural features as well as on the well-being and interests of everyone who utilises these resources.

In this way a foundation is to be laid for prioritising power development options in respect to the needs of society regarding business, the preservation of natural resources, the strengthening of rural regions and the benefit of everyone who uses these same resources under the goal of sustainable development.



Groundwater springs forth in the Sigalda canyon below Krókslón reservoir. Unexpected man-made beauty!

We aim to provide our customers with the best energy solutions to create the bases for quality in modern life.

LANDSVIRKJUN

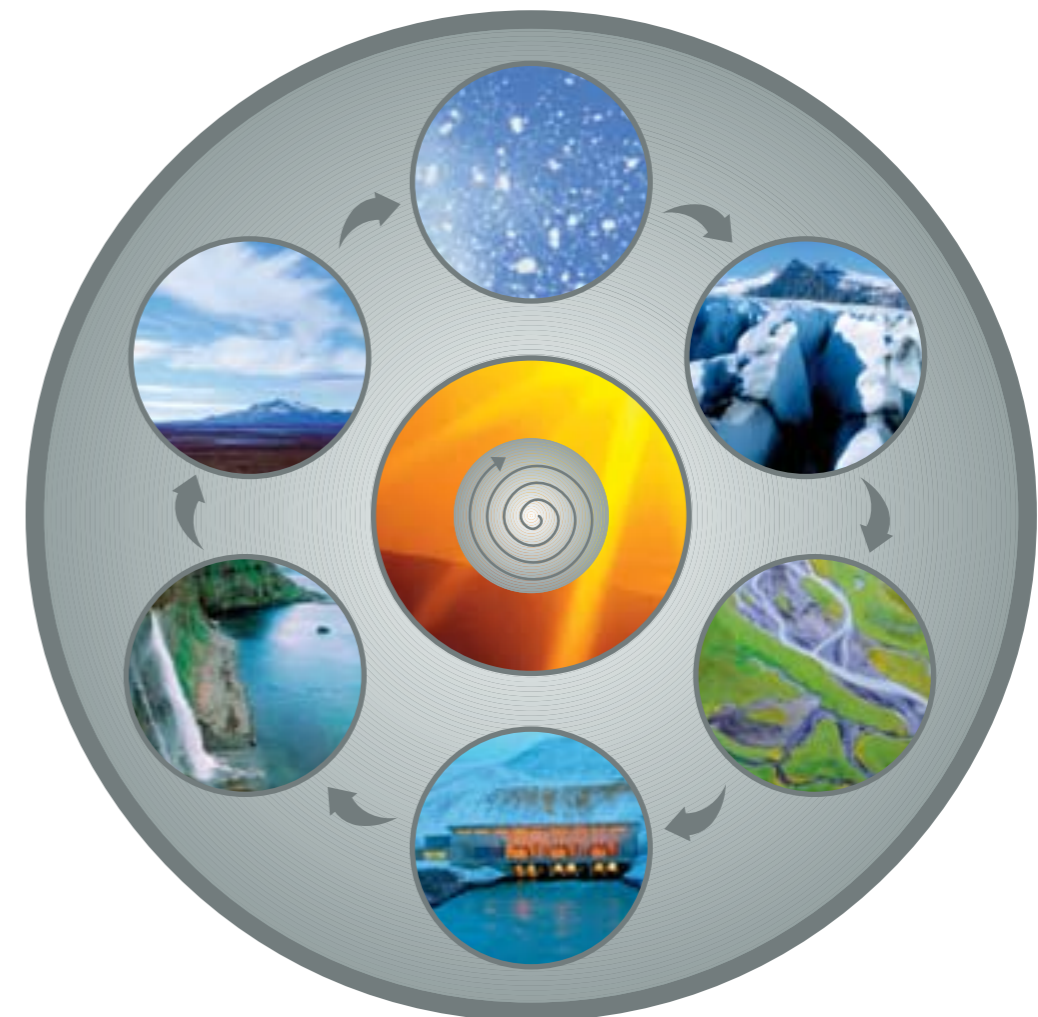
Since its establishment in 1965, Landsvirkjun has constructed six hydropower stations, the largest ones in Iceland. These power stations are at Búrfell, Sultartangi in Thjórsá river, at Sigalda and Hrauneyjafoss in the river Tungnaá, and on the river Blanda. Furthermore, in autumn 2001 a power plant was completed at Vatnsfell in a man-made diversion channel from lake Thórisvatn. The total installed capacity of the Landsvirkjun power stations is 1,212 MW. Since the founding of Landsvirkjun, Iceland's

electricity production has increased by fifteen times. The use of electricity for society's general needs has grown, while it has also proved possible to utilise energy resources for the benefit of power-intensive industry, which yields income in foreign currency. Selling electricity to power-intensive industry has enabled the development of glacial rivers on a larger, more economical scale than would have otherwise been the case. This results in lower energy prices to the public and leads to less disruption of the environment.

HYDROPOWER IS SOLAR POWER

Through the action of the sun, water is continuously vaporizing from the surface of the Earth. On reaching cooler air, the water condenses into clouds and falls as precipitation. Hydropower stations take advantage of the natural water cycle to produce electricity by

harnessing the energy inherent in the fall of the water on its way to the sea. This is a true perpetual motion machine, driven by the sun. Harnessing it delivers pollution-free energy by a sustainable process without depleting the energy source.



THE CYCLE OF WATER

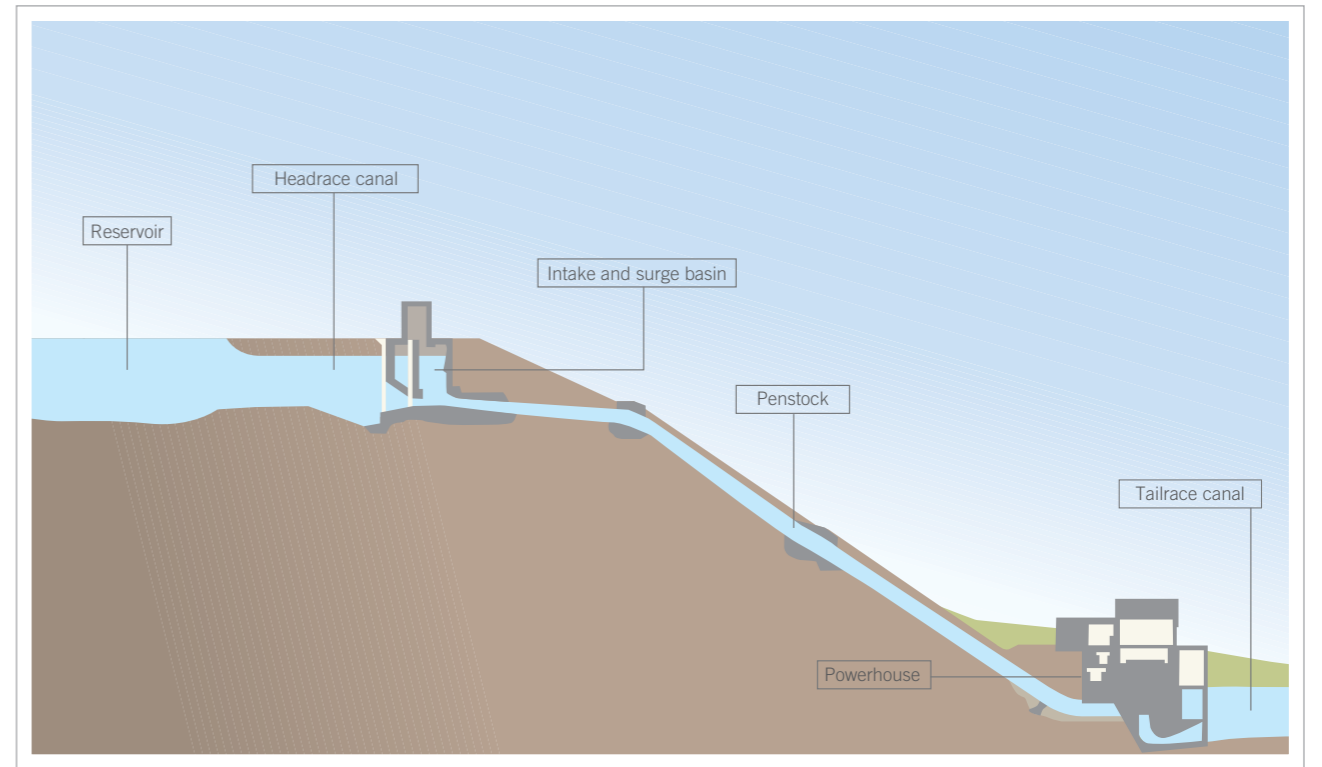
VISION

There is no question that Icelandic society has benefited from the harnessing of hydropower and geothermal resources in the past. All energy policy decisions have consequences for the future whether they involve utilization or conservation

of natural resources. Yet, it is impossible to say what is best for the future. What is needed when decisions are made is careful groundwork and a firm vision of the future, based on the assumptions of today.



When reservoirs are filled beyond capacity, the water runs off through a spillway. This results in a diversity of waterfalls, as demonstrated by the man-made scenario of these falls below Krókslón reservoir, belonging to the Sigalda station.



HARNESSING HYDROPOWER

We feel it is important to listen to and respect the opinions of those who work and live in communities where Landsvirkjun operates.

ENVIRONMENTAL IMPACT ASSESSMENT

The aim of Iceland's Environmental Impact Assessment Act is to ensure that prior to any decision relating to construction that may significantly affect the environment, natural resources and society, an assessment will have been conducted of these matters. Comments are sought on potential improvements, and a description is included of the countermeasures to be undertaken for minimising any disturbance. During the assessment process, the right of the general public to express itself is guaranteed, and the authorities gain a full perspective for their decision-making on whether the construction project should be permitted.

The environmental assessment of the impact of Kárahnjúkar Power Plant is a good illustration. In this instance, Landsvirkjun embarked on some of the most comprehensive research ever conducted in the Icelandic highlands.

All Icelanders are entitled to comment on the environmental impact assessment of any construction project. This contributes to democratic decision-making and open discussion within society.

WHAT IS A SUITABLE HYDRO SITE?

To harness the latent energy of water to the utmost, the ideal location in the river is where the drop, or head, is greatest in the shortest possible distance. Moreover, the quantity of water dictates how much energy can be generated.

The quantity of water flowing through a power plant may be increased by diverting water into the catchment area above it; also, through reservoirs, water may be accumulated during the summer and stored until winter when the river is running low.

There are various ways of maximising the head to be developed. A dam in the river bed above the power station will raise the water level. Headrace tunnels or canals can bring water at a high level to a location where the river course lies lower. A tailrace canal or tunnel from the station might also be dug below the river channel at the point of the station in an effort to obtain the maximum head.

A BROAD PERSPECTIVE

The total picture needs to be weighed up and assessed when a hydro project is launched, in order to win back as much as possible of what is lost. We live in a modern society and

require our creature comforts. It is a great advantage for Icelanders to be able to use clean renewable energy to fulfil them all.



A man-made reservoir above Hrauneyjafoss Hydro Station

Landsvirkjun wishes to contribute to improved quality of life diversification, growth of knowledge and know-how, while at the same time respecting the importance and diversity of culture.

RESEARCH YIELDS A BETTER ENVIROMENT

Reservoirs are a controversial aspect of hydropower station operations but are necessary for harnessing glacial rivers. Obviously, it is regrettable to have to submerge any area of land, and especially land with vegetation cover. Landsvirkjun's reservoirs cover a total surface area of 250 km , including the natural lakes used for this purpose. However, reservoirs produce certain benefits too. For example, they can improve the viability of fish stocks in glacial rivers, since bedload is deposited as sediment in the reservoirs. Thus, the river Blanda has become one of the finest salmon rivers in Iceland after it was harnessed.

Reservoirs also raise the groundwater level in the vicinity, thereby boosting natural vegetation growth.

The Blanda project involved submerging land with vegetation cover, and to compensate for this, Landsvirkjun launched a major seeding programme on the moors above the river. In the same area, Landsvirkjun has also funded the most diverse and detailed studies ever made on the results of land reclamation in the highlands and its impact on the ecosystem of Iceland's barren desert areas.

RESERVOIRS HAVE A PURPOSE

Electricity cannot be stored. It has to be used as soon as it is generated.

Because of the character of the Icelandic climate, the use of electricity is considerably heavier during the winter months. This, however, does not correspond to the flow of the glacial rivers, since this peaks in the summer when glacial melt occurs and decreases during the chill of the winter months, just when the requirement for water is at its highest.

To counteract this difference, rivers are dammed and reservoirs created where water is collected during summer, while it is plentiful, and stored until winter, when it is distributed to power plants as required.

WHAT IS SUSTAINABLE DEVELOPMENT?

Sustainable development involves fulfilling the requirements of the present without diminishing the possibilities for coming generations to do the same. The use of oil, gas, coal or nuclear energy for electricity production continuously depletes

the Earth's natural resources as well as creating pollution and waste. Hydro and geothermal energy are eco friendly resources which are continuously replenished by nature. This is why Iceland's electricity production is sustainable.



The flow in the river Kaldakvisl is controlled from a computer console in the capital city of Reykjavik.

ENVIRONMENTALLY FRIENDLY ELECTRICITY

Iceland's electricity production is an environment-friendly product from the country's natural resources. In most parts of the world, increased needs for electricity are met by burning greater quantities of polluting fossil fuels. In Iceland, this is done with geothermal steam and hydropower.

Climatic fluctuations cause Iceland's electricity production to vary and they determine how much can be generated at any time. Under favourable hydrological

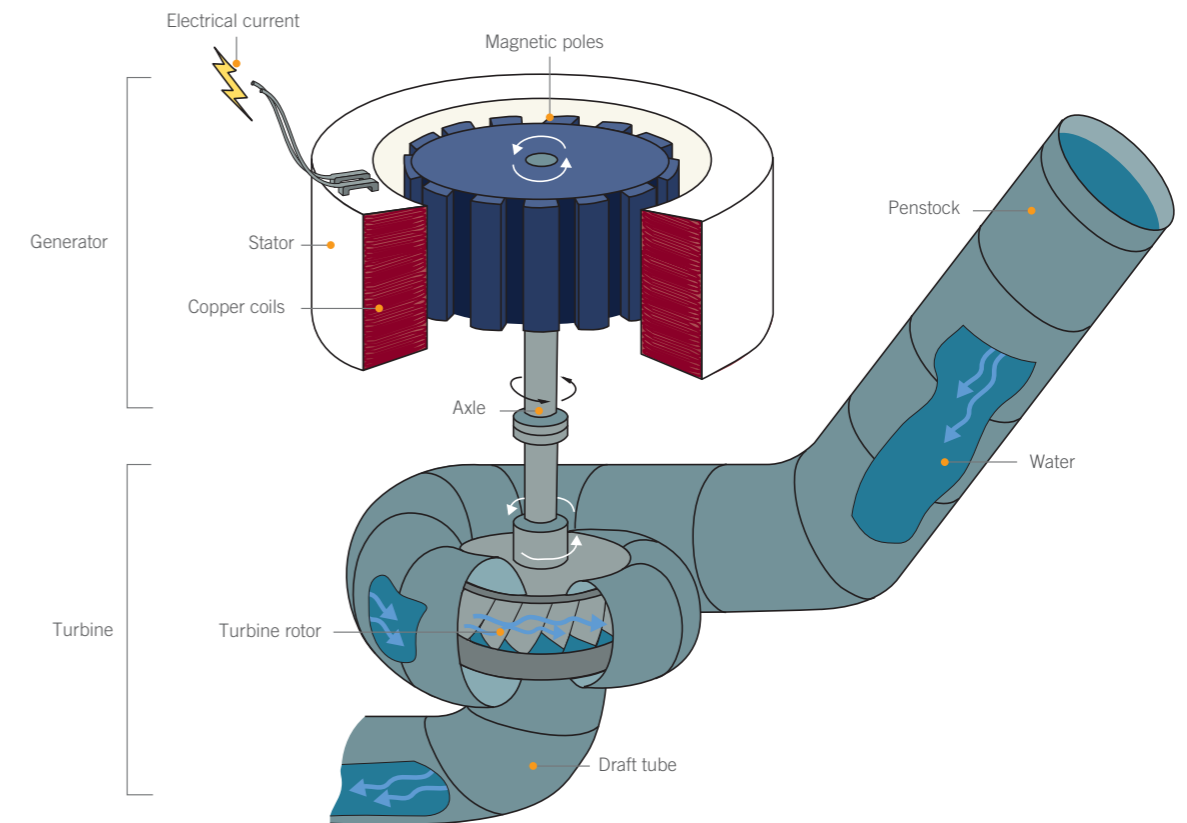
conditions, the present power system can produce electricity in excess of the stations' expected annual capacity. This electricity is sold to certain businesses at lower prices, on condition that they entitle Landsvirkjun to curtail delivery when hydrological conditions are adverse. Good years mean extra financial benefits for Landsvirkjun, its customers and the Icelandic nation as a whole. Harnessing of hydropower reflects the interaction between man and nature which has characterized living in Iceland from its settlement 1100 years ago.

"ELECTRICKERY"

Energy is required to lift an object, and if it is allowed to fall the energy is returned. Water in the mountains contains static energy, which is converted into kinetic energy upon the water flowing towards the sea.

In a hydropower plant, this kinetic energy is harnessed by letting the water rotate a turbine which propels a

magnetised wheel in the generator. This wheel is surrounded by copper coils, and as the magnet moves electric current begins to flow through the coils. The current is then conducted through high-voltage cables out into the electricity grid.



HARNESSING HYDROPOWER

IRREVERSIBLE CHANGE?

Many critics of proposed hydropower projects point out that the structures would cause irreversible changes to the natural environment. But nature itself is the most powerful agent of change. New mountains are created by a single volcanic eruption, water carves its way through the land and carries it out to sea. Many hydropower reservoirs in Iceland are

located in the bed of ancient natural lakes. For this reason, nature can never be traced back to a single starting point or preserved in unchanged form. Man is part of nature and he leaves his impression on it, just like any other natural force at work.



Blanda reservoir. On the moors around the reservoir, Landsvirkjun was involved in the largest revegetation project ever carried out in the Icelandic highlands.

MAXIMUM CONSUMPTION WITH MINIMUM EMISSIONS

Iceland has now reached the stage where 70% of its energy consumption is met by domestic, sustainable energy resources. The remaining one-third comprises imported fossil fuels, especially for motor vehicles and ships. Presently unharnessed hydro and geothermal energy could be utilized in the future to produce energy for transportation purposes, once new technology makes hydrogen or methanol viable options as fuel.

Landsvirkjun is the largest producer of electricity in Iceland. Its electricity production is equivalent to 18% of total national energy consumption. Iceland has the world's highest electricity consumption per capita, while the level of CO² emission from electricity production is the lowest in the Western world.

WHICH ENERGY SOURCE WOULD YOU CHOOSE?

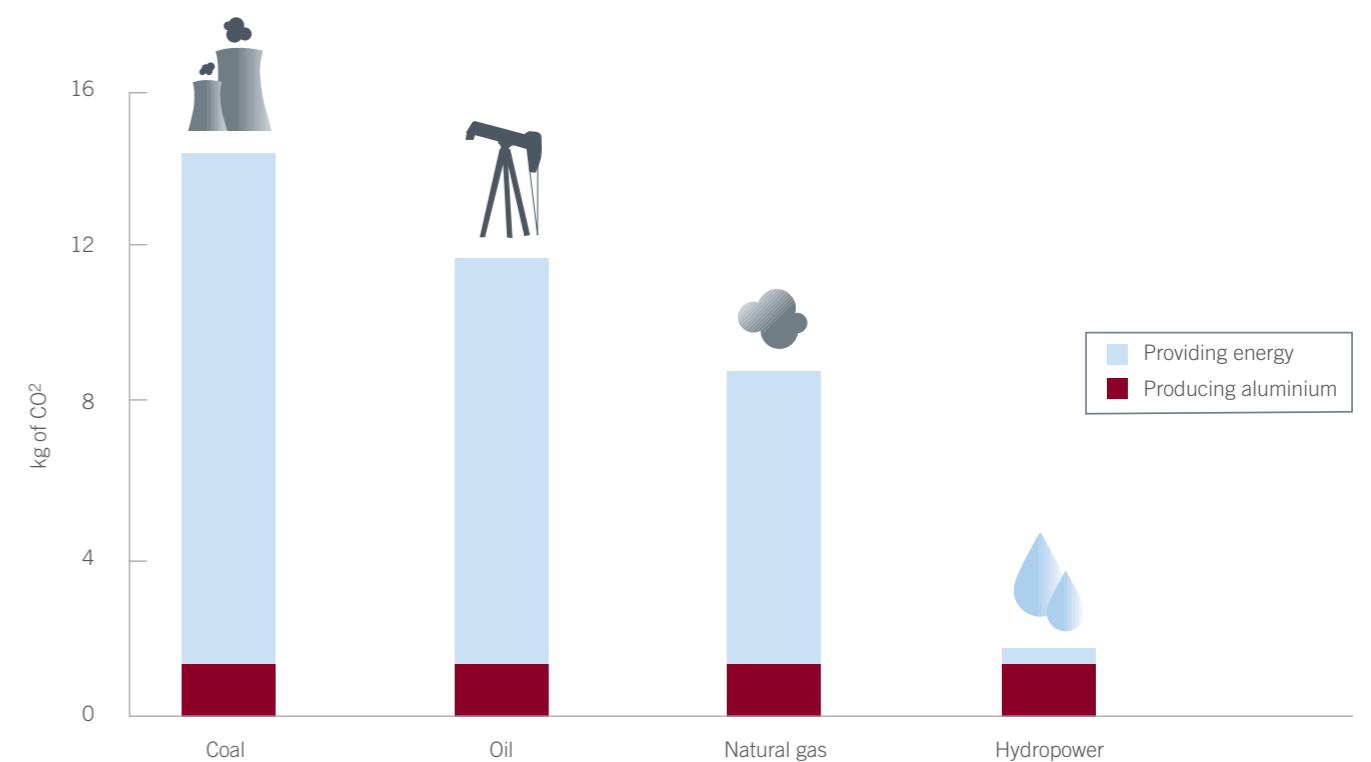
Hydropower stations are sustainable and take advantage of the natural water cycle. Geothermal fields renew themselves over a relatively short period of time, but can be expected to need to be rested after several decades of use.

In the Western world in general, electricity production results in the annual emission of 3-6 thousand kilos of CO per capita. The corresponding figure for Iceland is only a few kilos.

Oil, coal and natural gas are replenished with the formation of new strata beneath the Earth's crust at intervals of several million years. Nuclear waste does not become harmless until after tens of thousands of years.

Utilising Iceland's principal glacial rivers and high-temperature fields for electricity production would result in occupying less than 2% of the country's total area with energy facilities.

THE GREENHOUSE EFFECT OF PRODUCING 1 KG OF ALUMINIUM



Estimated discharge of CO₂ in kg through using varying energy sources for aluminium production, calculated per kg of processed aluminium

THE BRUNDTLAND REPORT

"The Brundtland Report, 'Our Common Future', urges the nations of the world to utilize renewable energy resources, including unharnessed hydro, on a global scale. This would

allow a reduction in the greenhouse effect on the Earth's atmosphere and should be a priority energy issue in the 21st century."

(See: "Our Common Future", pp. 192-196)



A winter day at Úlfliótsvatn lake. Developing this reservoir for generating electricity brought electric stoves to the capital city, Reykjavik in the 1930s. Housewives spoke of "boiling electricity" and received a brochure explaining that electrically cooked food was no danger.

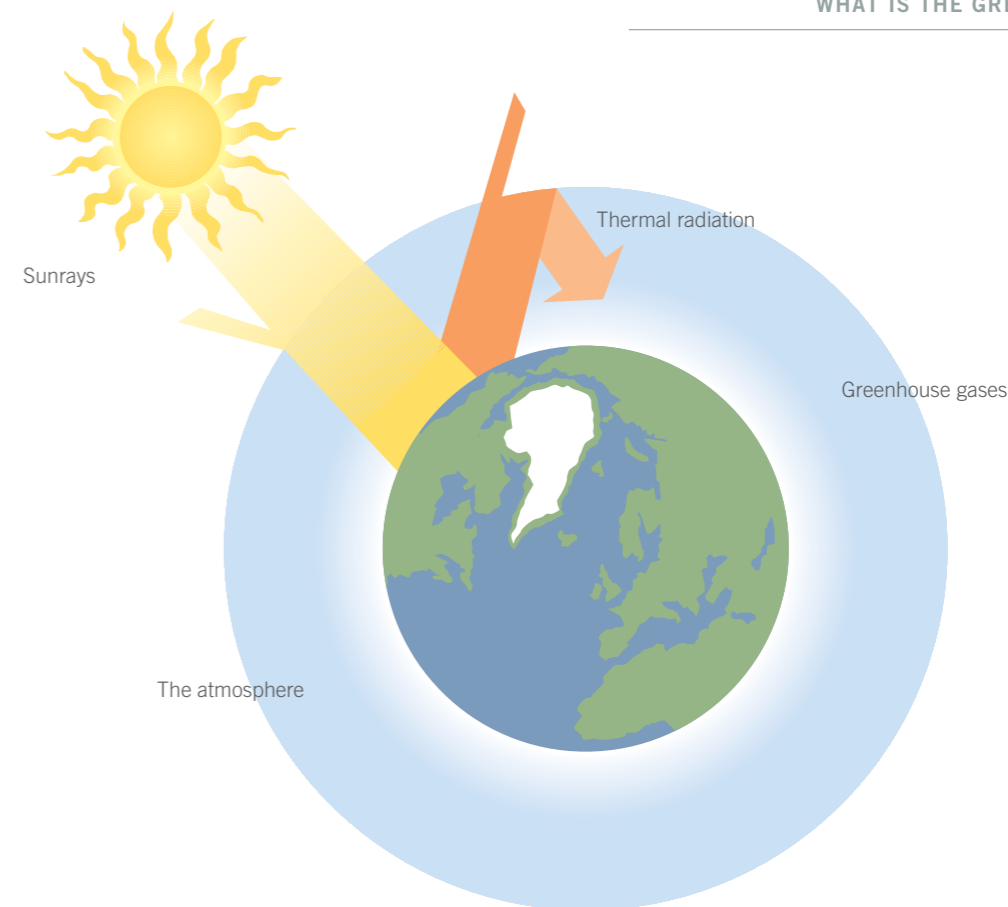
The nations of the world recognise Iceland's contribution to the struggle against global warming in such a way that they have made it possible for us to increase the production of environmentally friendly electricity more than any other Western country.

In the Kyoto Protocol a quota is placed on CO₂ emissions in industrial countries, based on their emission figures from 1990. Iceland received recognition in Kyoto for its success by being permitted to increase its emissions more than any other nation, i.e., by about 10% from the 1990 rate. In an annex agreed upon later, the provision regarding Iceland exempts small countries from counting emissions caused by new power-intensive industry when clean energy is used for such manufacturing and when it can be demonstrated that this reduces the emission of greenhouse in the global context. The benefit to Icelanders of this provision is 50% of their 1990 emissions being added to their quota.

The greenhouse effect is considered one of the most serious problems faced by humankind. All over the world, people are striving to counteract this development, and the Kyoto Protocol is one step in that direction. Even though the world faces this peril,

demand for energy continues to increase. Emission-free energy sources are therefore more important than ever as a way of fulfilling modern society's requirements.

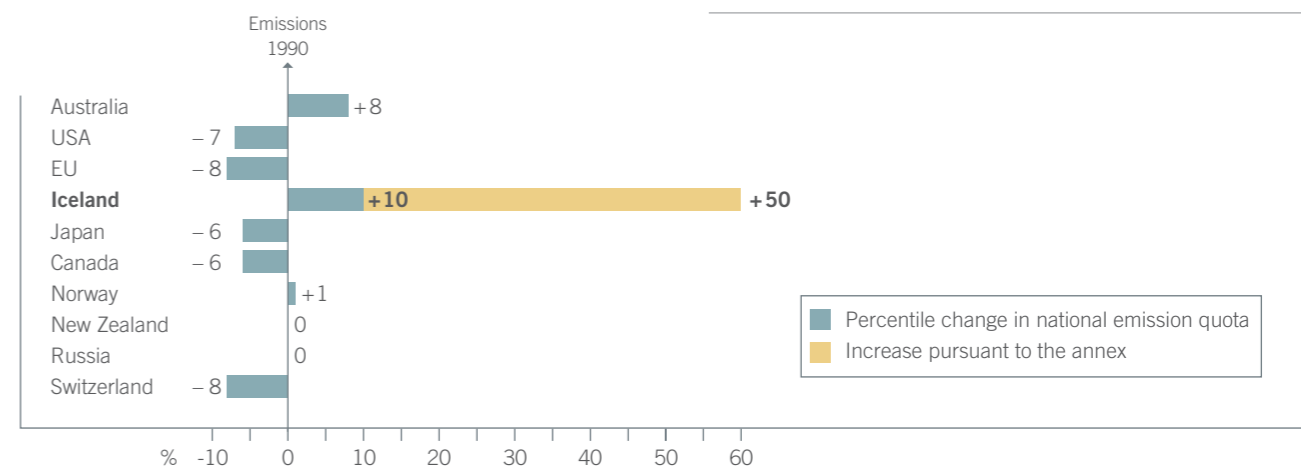
WHAT IS THE GREENHOUSE EFFECT?



WHAT IS THE GREENHOUSE EFFECT?

The Earth's atmosphere may be compared to the glass of a greenhouse. The sun's rays penetrate the atmosphere. Various atmospheric gases absorb some of the heat that would otherwise be radiated from the Earth's surface, thereby retaining part of the energy that it gives off. This property of the atmosphere has been called the greenhouse effect. Use of fossil fuels increases the proportion of greenhouse gases in the atmosphere and raises the temperature on Earth, with unforeseeable consequences.

NATIONAL EMISSION QUOTAS, AS PER KYOTO





Rock rising through Vatnsfellslón reservoir. The total surface area of Iceland's current reservoirs is 260 km², which corresponds to 0.25% of the country's total area.

In order to minimize disruption caused by power plants, Landsvirkjun undertakes extensive programmes in revegetation, afforestation and the nurturing of fish stocks. In this way, efforts are made to sustain and protect the quality of life for future generations.

GENERATING ELECTRICITY IS A KNOWLEDGE BASED ENTERPRISE

Harnessing rivers builds on years of preparatory research, for instance on hydrology, weather patterns, glaciers, geological formations, and flora and fauna. The knowledge thus obtained should ensure to the utmost that the country's energy resources are utilised in the most efficient way and in harmony with their

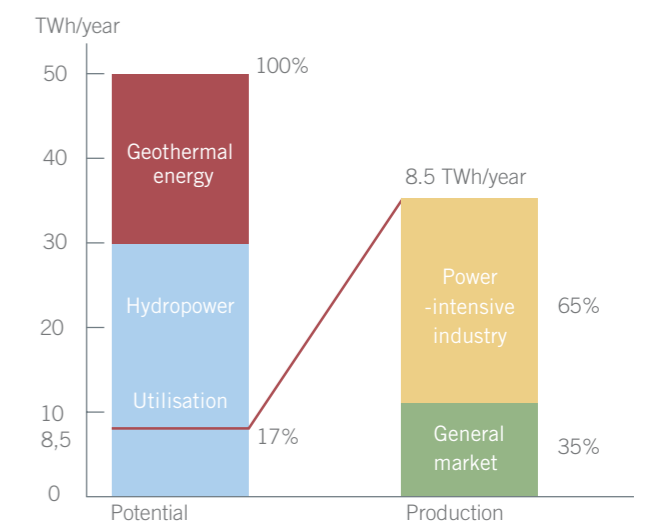
surroundings. Every year, Landsvirkjun invests great sums in research to this end. Comprehensive research programmes of this kind have also furthered specialised knowledge, practical skills and science in Iceland.

UNHARNESSED ENERGY?

Hydro and geothermal energy are underutilized resources in Iceland and can be used for efficient, environment-friendly and sustainable electricity production on many times the present scale.

Sensible utilization of all resources is necessary if all members of the community are to enjoy the optimum benefit from them. Utilization of one resource, however, must never impair utilization of others. Development of hydro projects in Iceland has strengthened the tourist industry, boosted research in the natural sciences and prompted the most ambitious land reclamation programs ever undertaken in the Icelandic highlands.

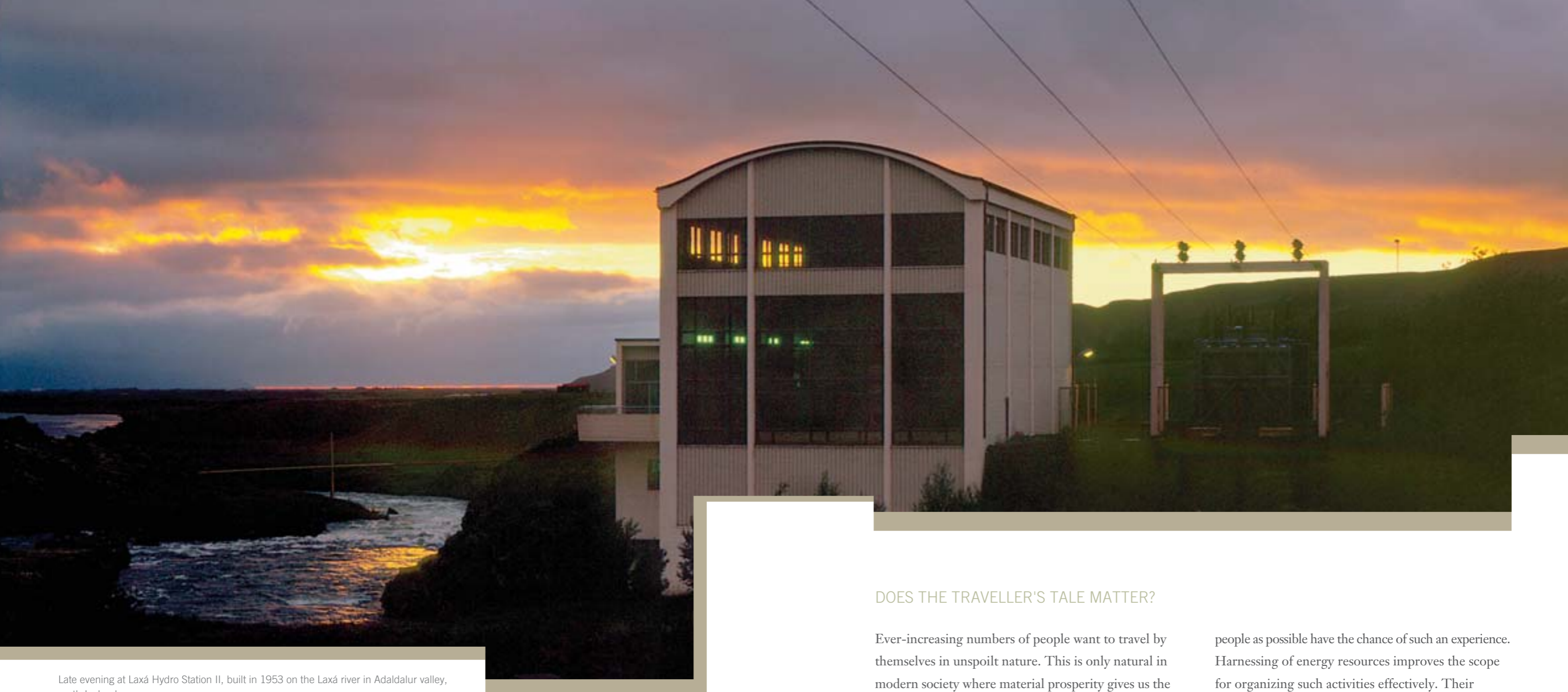
POWER POTENTIAL AND PRODUCTION, 2004



ENJOY EVERYTHING NATURE HAS TO OFFER!

Man has always had some effect on nature and enjoyed both its benefits and its beauty. The interaction between man and nature always needs to be in balance and we must avoid overexploiting it. At Thingvellir where the settlers of Iceland founded their parliament in the year 930, there is a manmade

waterfall they created by diverting a river in order to supply water to the site of their assembly - thus making life there more comfortable. Man has always sought to harness the forces of nature.



Late evening at Laxá Hydro Station II, built in 1953 on the Laxá river in Adaldalur valley, north Iceland.

POWER DEVELOPMENT AND TOURISM

Building power stations calls for extensive construction work, for example laying roads which become of use to the public and opened access to areas that had previously been isolated. A leading example of this is how the valley of Thjórsárdalur was opened by the building of Búrfell Power Station. Nowadays this valley has become a popular tourist stop. On the other hand, multiplying numbers of tourists bring added responsibilities. Care must be taken so that areas which become accessible are not damaged by the increased load of tourists and that power plant structures do not interfere with the experiences of those visiting the area. From the very first, Landsvirkjun has made efforts to improve

the surroundings of its power stations, in order to ensure an attractive appearance. In many parts of the country, cooperative projects are under way, aiming at improving access to tourist destinations near power plants, while opening the plants themselves to the public. Iceland's pollution-free electricity production may turn out to be an important contribution to the country's image of a clean environment. We at Landsvirkjun are aware of the responsibility placed on us. At the same time, we also emphasise that electricity production, environmental protection and tourism can prosper in happy unity.

DOES THE TRAVELLER'S TALE MATTER?

Ever-increasing numbers of people want to travel by themselves in unspoilt nature. This is only natural in modern society where material prosperity gives us the freedom to pursue such interests. But greater interest in the wilderness means more encroachment upon it. The interests of the whole call for nature conservation and leisure to be organized in such a way that as many

people as possible have the chance of such an experience. Harnessing of energy resources improves the scope for organizing such activities effectively. Their utilization also contributes to general economic well being and thereby the opportunity for more people to enjoy the delights of nature.

SUSTAINABLE DEVELOPMENT IN EAST ICELAND

Landsvirkjun and Alcoa have joined hands in a cooperative venture aiming to develop procedures with potential for assessing the contribution of Fjarðaál Aluminium Smelter and Kárahnjúkar Power Plant to sustainable development in East Iceland. The project is being carried out by a broadly-based cooperative team comprising the representatives of both these companies, government, the local population and others. The team plays an important role in this task, not in the least with regard to developing statistical indicators and

determining criteria for sustainable development. These indicators will be employed in monitoring sustainable development in East Iceland over the long term, accompanying the construction and operation of Kárahnjúkar Power Plant and Fjarðaál Aluminium Smelter. There will be a particular focus on studying the economic, social and environmental impact of those undertakings, with sustainability and other factors being assessed on the basis of the indicators.