

= Renewable energy in Iceland =

About 85 percent of total primary energy supply in Iceland is derived from domestically produced renewable energy sources .

In 2011 , geothermal energy provided about 65 percent of primary energy , the share of hydropower was 20 percent , and the share of fossil fuels (mainly oil products for the transport sector) was 15 percent . In 2013 , Iceland also became a producer of wind energy .

The main use of geothermal energy is for space heating with the heat being distributed to buildings through extensive district @-@ heating systems . About 85 % of all houses in Iceland are heated with geothermal energy .

Renewable energy provides almost 100 percent of electricity production , with about 75 percent coming from hydropower and 25 percent from geothermal power . Most of the hydropower plants are owned by Landsvirkjun (the National Power Company) which is the main supplier of electricity in Iceland . In 2011 , the total electricity consumption in Iceland was 17 @,@ 210 GWh .

Iceland is the world ? s largest green energy producer per capita and largest electricity producer per capita .

= = Geology = =

Iceland 's unique geology allows it to produce renewable energy relatively cheaply , from a variety of sources . Iceland is located on the Mid @-@ Atlantic Ridge , which makes it one of the most tectonically active places in the world . There are over 200 volcanoes located in Iceland and over 600 hot springs . There are over 20 high @-@ temperature steam fields that are at least 150 ° C [300 ° F] ; many of them reach temperatures of 250 ° C. This is what allows Iceland to harness geothermal energy and these steam fields are used for everything from heating houses to heating swimming pools . Hydropower is harnessed through glacial rivers and waterfalls , which are both plentiful in Iceland .

= = Hydropower = =

The first hydropower plant was built in 1904 by a local entrepreneur . It was located in a small town outside of Reykjavík and produced 9 kW of power . The first municipal hydroelectric plant was built in 1921 , and it could produce 1 MW of power . This plant single @-@ handedly quadrupled the amount of electricity in the country . The 1950s marked the next evolution in hydroelectric plants . Two plants were built on the Sog River , one in 1953 which produced 31 MW , and the other in 1959 which produced 26 @.@ 4 MW . These two plants were the first built for industrial purposes and they were co @-@ owned by the Icelandic government . This process continued in 1965 when the national power company , Landsvirkjun , was founded . It was owned by both the Icelandic government and the municipality of Reykjavík . In 1969 , they built a 210 MW plant on the Þjórsá River that would supply the southeastern area of Iceland with electricity and run an aluminum smelting plant that could produce 33 @,@ 000 tons of aluminum a year .

This trend continued and increases in the production of hydroelectric power are directly related to industrial development . In 2005 , Landsvirkjun produced 7 @,@ 143 GWh of electricity total of which 6 @,@ 676 GWh or 93 % was produced via hydroelectric power plants . Additionally 5 @,@ 193 GWh or 72 % was used for power @-@ intensive industries like aluminum smelting . In 2009 Iceland built its biggest hydroelectric project to date , a 690 MW hydroelectric plant to provide energy for another aluminum smelter ? the Kárahnjúkar Hydropower Plant . This project was opposed strongly by environmentalists .

Other hydroelectric power stations in Iceland include : Blöndustöð (150 MW) , Búfellsstöð (270 MW) , Hrauneyjafosstöð (210 MW) , Laxárstöðvar (28 MW) , Sigöldustöð (150 MW) , Sogsstöðvar (89 MW) , Sultartangastöð (120 MW) , and Vatnsfellsstöð (90 MW) .

Iceland is the first country in the world to create an economy generated through industries fueled by renewable energy , and there is still a large amount of untapped hydroelectric energy in Iceland . In

2002 it was estimated that Iceland only generated 17 % of the total harnessable hydroelectric energy in the country . Iceland ' s government believes another 30 TWh of hydropower every year could be produced , whilst taking into account the sources that must remain untapped for environmental reasons .

= = Geothermal power = =

For centuries , the people of Iceland have used their hot springs for bathing and washing clothes . The first use of geothermal energy for heating did not come until 1907 when a farmer ran a concrete pipe from a hot spring that led steam into his house . In 1930 , the first pipeline was constructed in Reykjavík , and was used to heat two schools , 60 homes , and the main hospital . It was a 3 km pipeline that ran from one of the hot springs outside the city . In 1943 , the first district heating company was started with the use of geothermal power . An 18 km pipeline ran through the city of Reykjavík and by 1945 it was connected to over 2 @, @ 850 homes .

Currently geothermal power heats 89 % of the houses in Iceland and over 54 % of the primary energy used in Iceland comes from geothermal sources . Geothermal power is used for many things in Iceland . 57 @. @ 4 % of the energy is used for space heat , 25 % is used for electricity , and the remaining amount is used in many miscellaneous areas : swimming pools , fish farms , and greenhouses , for example .

The government of Iceland has played a major role in the advancement of geothermal energy . In the 1940s , the State Electricity Authority was started by the government in order to increase the knowledge of geothermal resources and the utilization of geothermal power in Iceland . It was later changed to the National Energy Authority (Orkustofnun) in 1967 . This agency has been very successful and has made it economically viable to use geothermal energy as a source for heating in many different areas throughout the country . Geothermal power has been so successful that the government no longer has to lead the research in this field because it has been taken over by the geothermal industries .

Geothermal power plants in Iceland include Nesjavellir (120 MW) , Reykjanes (100 MW) , Hellisheiði (303 MW) , Krafla (60 MW) , and Svartsengi (46 @. @ 5 MW) power plants . The Svartsengi power plant and the Nesjavellir power plant produce both electricity and hot @- @ water for heating purposes . The move from oil @- @ based heating to geothermal heating saved Iceland an estimated total of US \$ 8 @. @ 2 billion from 1970 to 2000 and lowered the release of carbon dioxide emissions by 37 % . The equivalent amount of oil that would have been needed in 2003 to heat Iceland ' s homes was 646 @, @ 000 tons .

The Icelandic government also believes that there are many more untapped geothermal sources throughout the country , estimating that over 20 TWh per year of unharnessed geothermal energy is available . This is about 3 @. @ 3 % of the 600TWh per year of electricity used in Germany . Combined with the unharnessed feasible hydropower , tapping these sources to their full extent would provide Iceland another 50 TWh of energy per year , all from renewable sources .

Iceland 's abundant geothermal energy has also enabled renewable energy initiatives , such as Carbon Recycling International 's carbon dioxide to methanol fuel process , which could help reduce Iceland 's dependence on fossil fuels .

= = Solar power = =

Iceland has relatively low insolation , due to the latitude , about 20 % less than Paris , and half as much as Madrid , with very little in the winter . Unlike geothermal , solar power is a non @- @ dispatchable renewable energy source - the sun follows a predictable path but the weather is not controllable . This makes both wind power and solar power variable renewable energy (VRE) sources . Net metering credits electricity generated during the summer for use during the winter . If net metering nor local energy storage is not available , the largest array that is practical for a consumer to install is that which will generate less than or equal to the amount of electricity used during the sunniest month , a much smaller array .

= = Hydrogen = =

Currently , imported oil fulfils most of Iceland 's remaining energy needs . This cost has caused Iceland to focus on domestic , renewable energy . Bragi Arnason , a local professor , first proposed the idea of using hydrogen as a fuel source in Iceland during the 1970s , which is also when the oil crisis occurred . At that point in time this idea was considered untenable , but in 1999 Icelandic New Energy was established to govern the project of transitioning Iceland into the first hydrogen society by 2050 . This followed a decision in 1998 by the Icelandic Parliament to convert vehicle and fishing fleets to hydrogen produced from renewable energy .

Iceland provides an ideal location to test the viability of hydrogen as a fuel source for the future , since it is a small country of only 320 @,@ 000 people , with over 60 % living in the capital , Reykjavík . The relatively small scale of the infrastructure will make it easier to transition the country from oil to hydrogen . There is also a plentiful supply of natural energy that can be harnessed to produce hydrogen in a renewable way , making it perfect for hydrogen production . Iceland is a participant in international hydrogen fuel research and development programs , and many countries are following the nation 's progress with interest . However , these factors also make Iceland an advantageous market for electric vehicles . Because electric vehicles are four times more efficient , and less expensive than hydrogen vehicles , the country may switch to electric vehicles .

Iceland already converts its surplus electricity into exportable goods and hydrocarbon replacements . In 2002 it produced 2 @,@ 000 tons of hydrogen gas by electrolysis ? primarily for the production of ammonia for fertilizer .

ECTOS demonstration project

The first step towards becoming a hydrogen society was the ECTOS demonstration project , which ran from 2001 until August 2005 and was very successful . ECTOS (Ecological City TranspOrt System) involved three hydrogen fuel cell buses and one fuel station . Many international companies contributed to the project including Daimler Chrysler , who made the hydrogen fuel cell buses , and Shell which produced the hydrogen fuel station . The European Commission 5th framework programme sponsored the project .

The first hydrogen fuel station in Iceland opened in 2003 in Reykjavík . To avoid transportation difficulties hydrogen is produced on site using electrolysis to break down water into hydrogen and oxygen . All of the energy used to produce the hydrogen comes from Iceland 's renewable energies and the full cycle of energy , from the water to the hydrogen in the fuel cells , emits no CO₂ .

During the project the researchers studied the efficiency of using hydrogen as a fuel source . They examined the reliability of the fuel and effectiveness of hydrogen as a fuel in buses . They also studied the cost effectiveness of using hydrogen as a fuel source and how the process of introducing hydrogen into the country could be implemented . They examined specific areas like the ease of incorporating fuel stations and producing hydrogen , and the safety precautions involved with distributing and using hydrogen , a very explosive fuel .

HyFLEET : CUTE project

In January 2006 it was decided to continue testing the hydrogen buses as part of the HyFLEET : CUTE project , which spans 10 cities in Europe , China and Australia and which is sponsored by the European Commission 's 6th framework programme . This project studies the long @-@ term effects and most efficient ways of using hydrogen powered buses . The buses are run for longer periods of time and the durability of the fuel cell is compared to the combustion engine , which can theoretically last a lot longer . The project also compares the fuel efficiency of the original buses with new buses from different manufacturers that are supposed to be more fuel efficient .

The project ended in January 2007 , and as a result of the research an improved bus prototype is expected in 2008 . Details of further demonstrations involving private cars and a boat were expected in April 2007 .

Other projects

Iceland has also begun many other projects involving hydrogen .

The EURO @-@ HYPORT project is investigating the feasibility of exporting hydrogen fuel to Europe . Options include transporting the gas through an undersea pipeline or by boat , or exporting electricity generated in Iceland through a submarine cable .

Another project to build a hydrogen @-@ powered H @-@ ship started in February 2004 and is looking at the practicalities of using hydrogen as a fuel for Iceland 's fishing fleet , one of the country 's main industries . The project will identify and try to remove barriers that may prevent marine vehicles from using hydrogen as a fuel , such as problems caused by water and salt . It will also try to identify and remedy weakness within the fuel cell to ensure the protection of marine life . The H @-@ ship project is a major step in the plan for Iceland to become the first country to phase out the use of fossil fuels . Government funding as well as private organizations such as the World Renewable Energy Congress are the primary sponsors of research in this sector .

From hydrogen to electricity

Electric cars with strategically located charging stations make a lot of sense for Iceland , where 75 percent of the country 's residents live within 37 miles of the capital city . Hydrogen cars are not expected to be mass @-@ produced anywhere in the world until at least 2015 , and with the first electric cars rolling off production lines in 2010 , it will be faster to introduce electric vehicles . Iceland 's 840 @-@ mile @-@ long ring road could theoretically be covered with just 14 fast @-@ charging stations .

= = Education and research = =

There are several educational institutions that offering education in Renewable Energy in Iceland on university level .

The University of Iceland is a progressive educational and scientific institution , renowned in the global scientific community for its research . It is a state university , situated in Reykjavík , the capital of Iceland . A modern , diversified and rapidly developing institution , the University of Iceland offers opportunities for study and research in almost 300 programmes spanning most fields of science and scholarship : Social Sciences , Health Sciences , Humanities , Sciences and Engineering . Some 9700 students are registered at UI and 1000 full @-@ time employees .

Reykjavik University has the mission to create and communicate knowledge , in order to increase the competitiveness of individuals , firms and society as a whole , while at the same time enhancing the quality of life of their students and staff . The aim is to make Reykjavik University the centre for international research collaborations in Europe and across the Atlantic . The university consists of five academic schools : School of Law , School of Business , School of Health and Education , School of Computer Science and the School of Science and Engineering . Reykjavik University is a community of over 3000 students and over 500 full @-@ time and part @-@ time employees . About half of all instructors at RU are active in Icelandic industry , and about 10 % are guest instructors from overseas .

Keilir , Atlantic center of excellence in Ásbrú next to the Keflavik International Airport , offer a multidisciplinary BSc. programs in energy technology in co @-@ operation with the University of Iceland . The school also runs a state @-@ of @-@ the @-@ art research center in energy sciences .

RES - The School for Renewable Energy Science , located in Akureyri North Iceland is offering an intensive and unique interdisciplinary research oriented one @-@ year graduate (M.Sc.) programme in Renewable Energy Science . The program is offered in cooperation with University of Iceland and University of Akureyri , as well as in partnership with a number of leading technical universities around the world . In 2009 the school offers four specializations of study : 1 . Geothermal Energy ; 2 . Fuel Cell Systems and Hydrogen ; 3 . Biofuels and Bioenergy ; and 4 . Energy Systems & Policies . RES offers also summer programs and individual courses in the field .

Iceland School of Energy located in Reykjavik , offers MSc . Studies in the field of Renewable Energy Engineering , Policy and Science . The foundation for the ISE was laid in April 2007 when Reykjavik Energy , the University of Iceland and Reykjavik University signed an agreement on establishing an international graduate program on sustainable energy . ISE is an interdisciplinary

school in higher education for engineers and scientists , has a focus on global environmental protection and sustainable use of energy resources and creates leading experts in management , design and research in utilization of sustainable energy . The unique expertise of all its founding partners forms an excellent platform for the school to build on .

The largest research institution in renewable energy in the country is University of Iceland which is state university , founded in 1911 and situated in the heart of Reykjavík , the capital of Iceland . As a scientific institution is it renowned in the global scientific community for its research in renewable energy .

Another state university University of Akureyri , located in Akureyri in North Iceland , is also conducting various research in the field of renewable energy .

One of the main tasks of the National Energy Authority of Iceland is to carry out energy research and provide consulting services related to energy development and energy utilization .

Several companies , public and private are conducting extensive research in the field of renewable energy .

Landsvirkjun the national electricity company of the Republic of Iceland , is both in research of hydro and geothermal as well and funding a great deal of research work in the field in the country .

The Icelandic Energy Portal is an independent information source on the Icelandic energy sector .

Iceland Geosurvey (ÍSOR) is a public consulting and research institute providing specialist services to the Icelandic power industry , dedicated mainly to geothermal and hydro research .