

Brief History and Analysis of the Geothermal Energy Resources in Iceland

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Introduction

1.1 Mapping of Iceland and Geothermal Energy in the World

Iceland is near the North Atlantic sea, and they are known for their isolated land also characterized by extensive volcanic activity and frequent tectonic movements. The island is quite far from the mainland of Europe so people living in Iceland must find alternative methods to survive. The economy is strongly dependent on fishing and mining aluminum, yet there is one resource that boosts the economy of Iceland. That resource is geothermal energy helps Iceland to stay warm in the cold and they export their excess energy to other countries which makes a lot of money.

The figure 1 shown below is a great way to visualize the geothermal energy potential of the World and Iceland. Additionally, scientific research states that Iceland is the world's largest electricity producer per capita (kWh / Person). The presence of abundant electrical power due to Iceland's geothermal and hydroelectric energy sources has led to the growth of the manufacturing sector (Wikipedia, 2025)

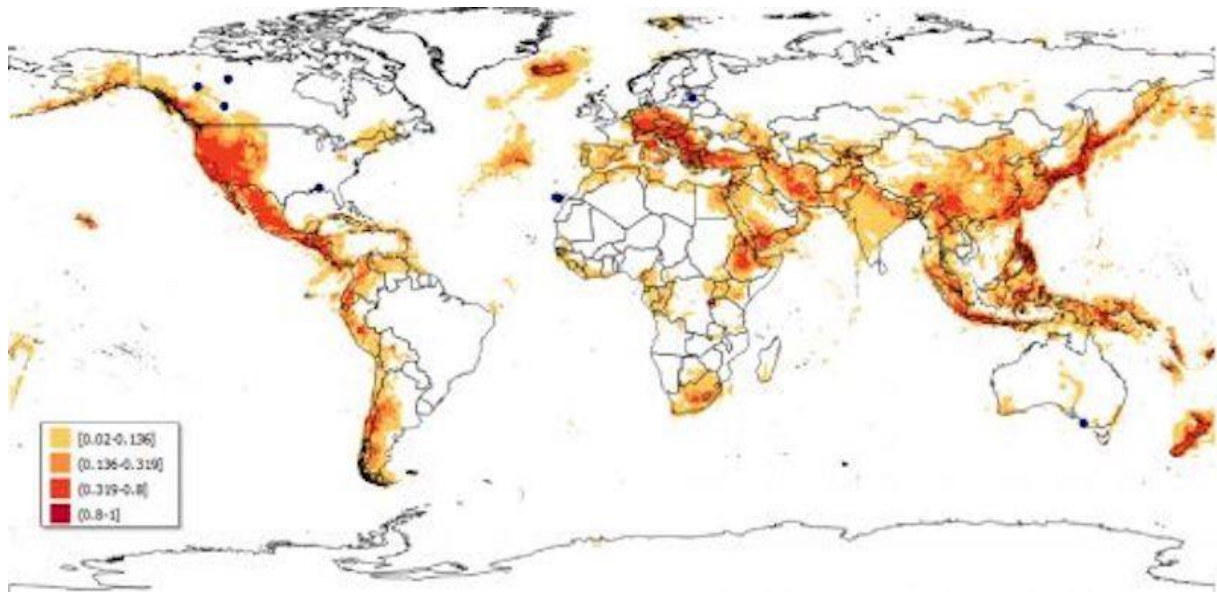


Figure 1 – Geothermal Power Plants Map of the World

1.2 Importance of Geothermal Energy to Iceland's Economy

There are many significant political and economic benefits associated with geothermal energy production. The economic impact can be described by analyzing Table 1 – Sector

Contributions to GVA in Iceland, which highlights the contribution of energy production to GDP. According to The Engineer (2022) “Iceland's volcanoes could power the UK: but at what cost?”, the authors of the article argue the trade-off between UK and Iceland. (The Engineer, 2022)

The comprehensive development of the energy sector in Iceland is due to the following directions: Sustainable development and energy production based on a balance of interests person, society, and state. Also, excluding the possibility of a negative impact on the environment. These facts connect the Iceland electricity network to the European Union and the United Kingdom with under-sea tunnels.

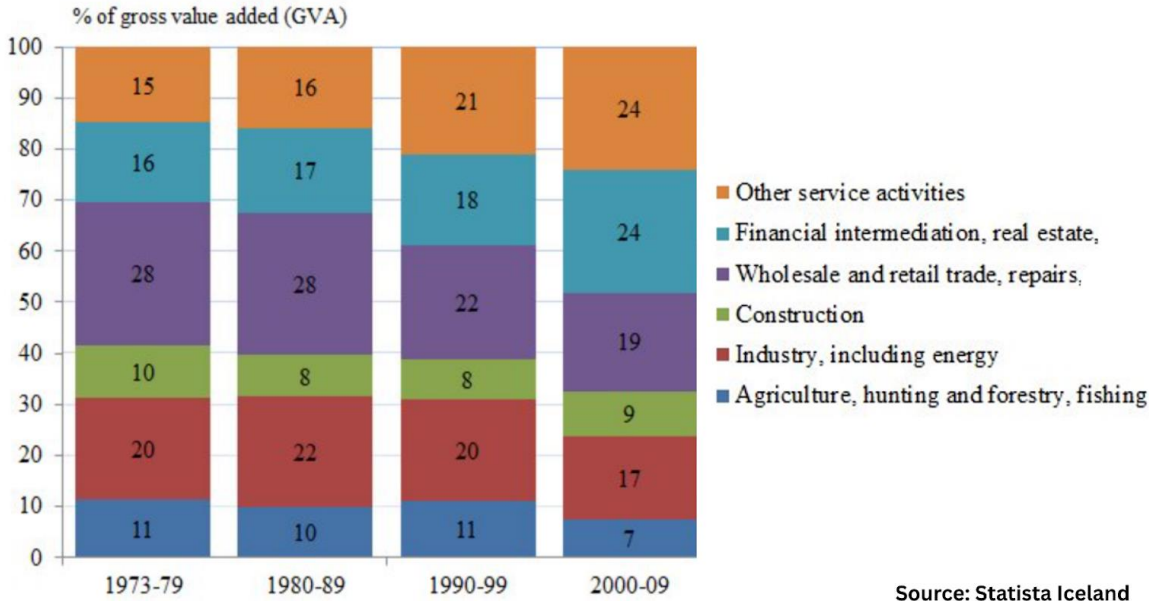


Table 1 - Sector contributions to GVA in Iceland

1.3 How do Icelanders Use Their Geothermal Energy?

As mentioned in sections 1.1 and 1.2, Geothermal Energy has significant importance for the people of Icelanders. Here is a more detailed list of purposes of how they use the manufactured energy.

- For heating closed spaces and houses
- To generate electricity
- To heat up Iceland’s many geothermal spas and pool
- To warm up streets so they don’t get slippery in winter
- For greenhouses, so they can grow organic fruits and vegetables
- To produce refined aluminum from the raw version

Utilisation of geothermal energy 2013

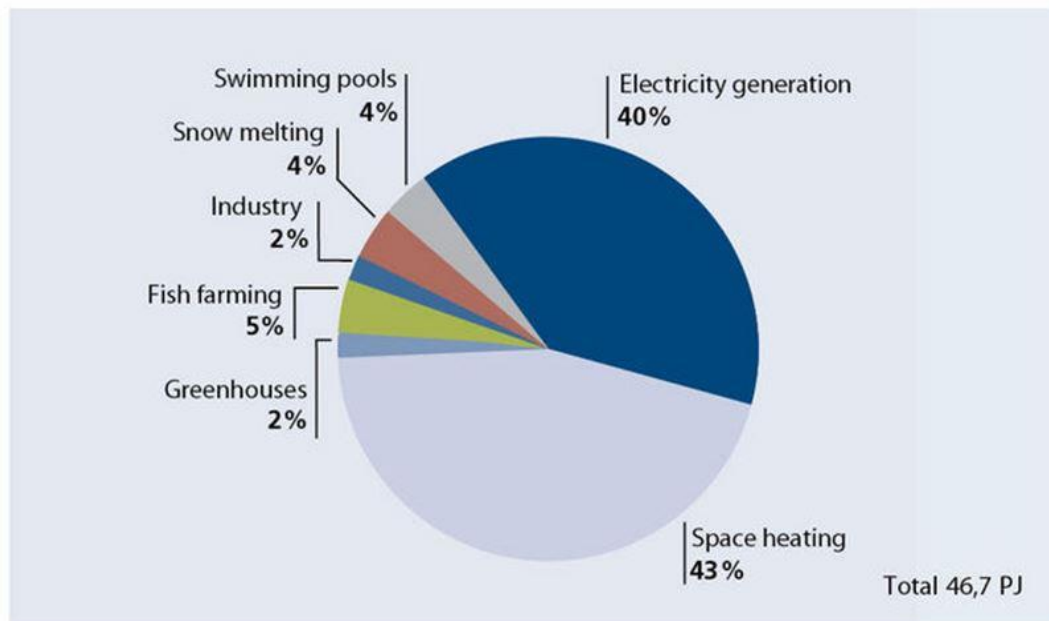


Table 2 – Distribution of the Utilisation of Geothermal Energy (2013)

History of Geothermal Energy in Iceland

2.1 Early and Mid Era of Geothermal Energy in Iceland

Icelanders have, almost since settlement, used geothermal sources to use it to make their life easier on a frozen island. The first recorded use of geothermal energy in Iceland is from the year 1907. (Arctic Adventures, 2013).

After some time in the island, the potential was quickly noticed, and a report was commissioned in 1970 by the country's National Energy Authority, **Orkustofnun**, which recommended increased domestic production of geothermal power and hydroelectricity to stabilize energy prices and reduce the nation's reliance on external energy resources. (Wikipedia, 2025)

2.2 Current Era of Geothermal Energy in Iceland

Arctic Adventures (2014) states that between the years 1990 and 2014, Iceland's geothermal electricity production grew by 1700% which is an outstanding number given that the population only grew 25%. The answer is found in the growth in aluminum production in the country but it is believed to take up 70% of the electricity.

The map of energy plants shows us only the geothermal energy and hydro energy, and in total there are 18 power stations in Iceland which are operated by the **Landsvirkjun**. (National Power Company of Iceland)



Figure 2 – Map of Energy Plants in Iceland (blue – geothermal, red – hydro)

Station	Location	Capacity, MW
Hellisheiði power station	Hveragerði	303
Reykjanes power station	Grindavík	150
Nesjavellir geothermal power station	Þingvellir	120
Svartsengi power station	Grindavík	76,5
Krafla power station	Reykjahlíð	60
Bjarnarflag power station	Reykjahlíð	3
Þeistareykir power station	Húsavík	90
Total		802,5

Source: Thomson Reuters

Table 3 – Geothermal Energy Plants in Iceland

Geothermal Energy Applications in Iceland

3.1 Case Study: Hellisheidi Geothermal Power Plant

The Hellisheidi Geothermal Power Plant, located at Hengill in Iceland, is one of the world's largest geothermal plants, with a total installed capacity of 303MW of electricity and around 400MW of thermal energy. Commissioned in stages from 2006 to 2011, it is operated by Orkuveita Reykjavíkur. The plant utilizes steam from over 300 boreholes and features advanced carbon capture and storage (CCS) capabilities through the Orca project, the world's largest direct-air CCS facility. This plant significantly contributes to Iceland's energy sustainability and serves industrial demands, particularly from Reykjavík's aluminum refineries.



Figure 4 - Hellisheiði Power Station

3.2 Case Study: Reykjanes Geothermal Power Plant

The Reykjanes Geothermal Power Plant, located on the Reykjanes Peninsula in southwest Iceland, generates 100 MW of electricity using two 50 MW turbines. Commissioned between May and December 2006, it harnesses geothermal steam from deep wells with temperatures ranging from 290°C to 320°C, making it one of the first large-scale facilities to use such high-temperature geothermal steam. Owned by Sudurnes Regional Heating Corp. and designed by ENEX extracts steam and geothermal brine from twelve wells located at approximately 2,700 meters deep. The extracted brine is directed into a steam separator, and the purified steam drives the turbines under high pressure. Cooling is efficiently achieved using seawater pumped through condensers due to the plant's coastal proximity.



Figure 5 - Reykjanes Power Station

3.3 Case Study: Nesjavellir Geothermal Power Plant

The Nesjavellir Geothermal Power Plant, located in southwest Iceland near the Hengill volcanic area, is the second-largest geothermal facility in the country by capacity. It produces over 120 MW of electrical energy and approximately 1,110 liters per second of hot water, supplying heating to the Greater Reykjavik area. Initial plans for harnessing geothermal energy in Nesjavellir date back to 1947, with construction officially commencing in 1987 and final expansions completed by 2005. Although the plant itself isn't open to visitors, the surrounding area offers beautiful views and hiking opportunities, with nearby attractions including Pingvellir National Park, Kerid Crater, and Reykjadalur Hot Spring Thermal River.



Figure 6 – Nesjavellir Geothermal Power Plant

Global effects of Geothermal Energy in Iceland

4.1 Benefits of Geothermal Energy in terms of Sustainability of Iceland

Iceland's extensive utilization of geothermal resources showcases a successful model of sustainable energy development. The geothermal plants support electricity generation, direct heating, industrial processes, and tourism, providing a general solution approach to the increasing need for electricity. The mentioned geothermal energy plants help to satisfy some of the GDP 17 (UNDP, 2015) such as Affordable and Clean Energy (7), Decent Work and Economic Growth (8), Industry Innovation, and Infrastructure (9), and Climate Action (13).



Source - United Nations Sustainable Development Programme (UNDP, 2015)

Figure 7 – SDGs 7, 8, 9, and 13 from The Paris Agreement

4.2 Comparison with Other Countries in terms of Geothermal Energy Potential

Iceland stands out globally for its exceptional geothermal energy utilization due to its unique geological positioning along the Mid-Atlantic Ridge, resulting in substantial volcanic activity and geothermal gradients often exceeding 100°C per kilometer (Coro & Trumpy, 2020). With an installed geothermal capacity of approximately 750 MW, geothermal power fulfills around 30% of Iceland's electricity demands and nearly 90% of the nation's residential heating needs (National Energy Authority of Iceland, 2025).

In comparison, the **United States**, particularly California, is currently ranked one in total installed geothermal capacity, generating about 3,700 MW; however, geothermal energy remains a relatively small portion of the overall U.S. energy landscape, contributing less than 1% of the national electricity supply (University of Michigan, 2025). **Indonesia**, situated within the volcanically active Pacific Ring of Fire, holds over 2,000 MW of geothermal capacity and ranks second globally, yet geothermal represents just a fraction of its diverse energy mix (ThinkGeoEnergy, 2023). Similarly, the **Philippines**, another key geothermal country, generates around 1,900 MW, supplying approximately 17% of its national electricity, demonstrating significant reliance on geothermal power within its renewable energy portfolio (Statista, 2025). **New Zealand** and **Italy** have substantial installed capacities of about 1,000

MW and 900 MW respectively, employing geothermal power extensively for both electricity generation and direct applications like district heat and agricultural processes (IRENA, 2023). **Turkey** has lately increased its geothermal production capacity to around 1,700 MW, significantly favoring geothermal heat for greenhouse agriculture and district heating (IEA, 2023). In North Africa, **Kenya** leads the continent's geothermal energy sector with approximately 950 MW installed capacity (ThinkGeoEnergy, 2023). Despite these numbers and advancements worldwide, Iceland's per capita geothermal energy usage in the daily life and industry remains unmatched, highlighting a sustainable solution with geothermal energy development.

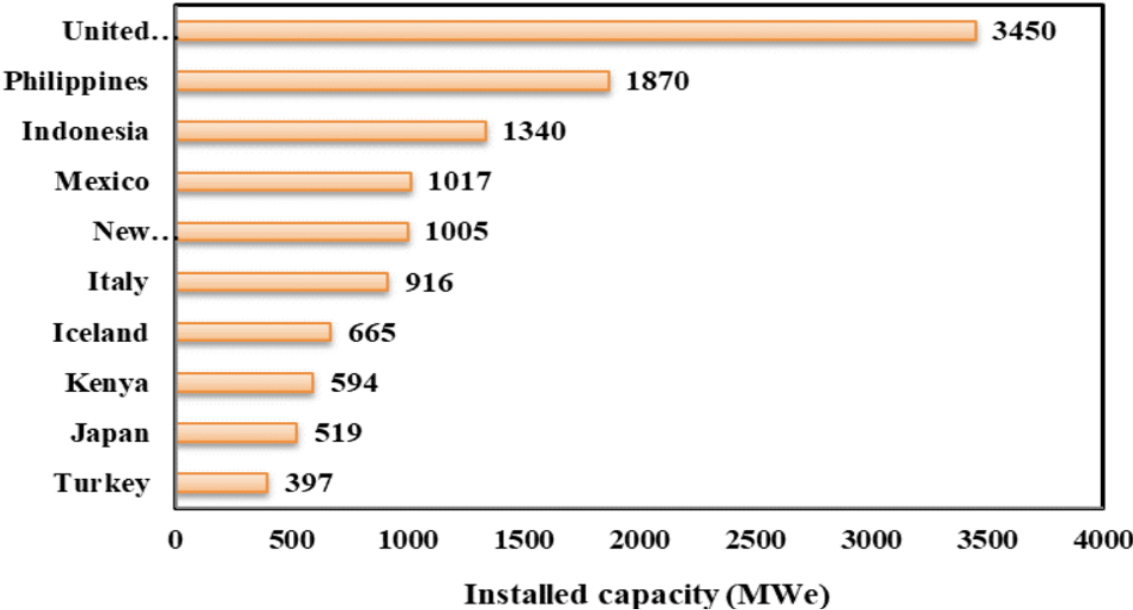


Figure 8 – Geothermal Energy Capacity in Ten Countries

In order to compare these countries, a smart approach would be compared with two variables the Installed Capacity of Geothermal Energy and by person (permanent citizens). Figure 9 Shows the population which helps us to make a deep dive analysis in our comparison.

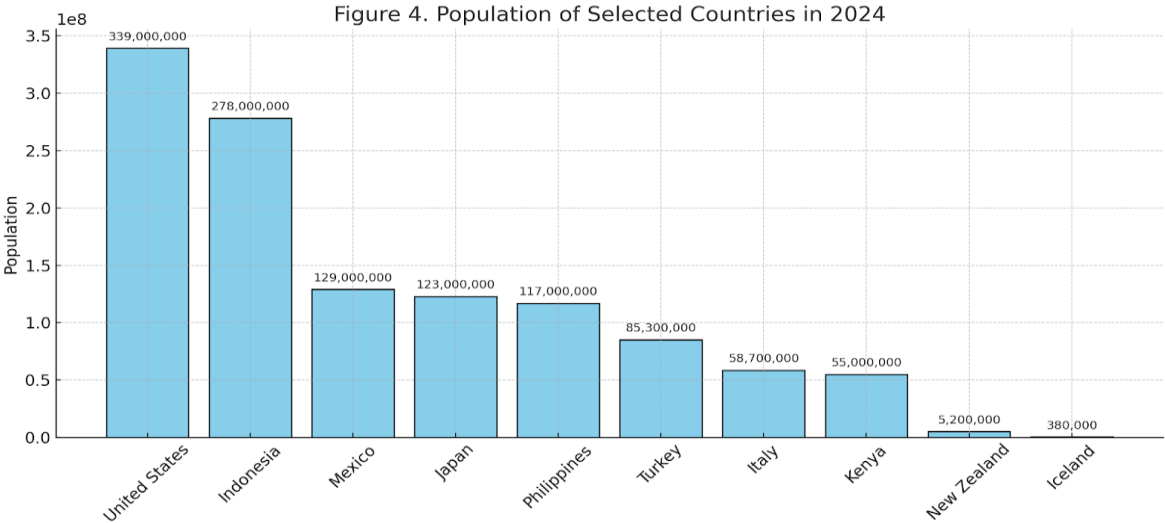


Figure 9 – Population of the 10 Countries which have the highest Installed Capacity (2024)

Conclusion

Iceland is a global leader in the effective use of geothermal energy for direct-use purposes as well as for the production of electricity. The nation has been able to effectively and sustainably utilize this renewable resource because of its exceptional geological location along the Mid-Atlantic Ridge. From early heating systems to cutting-edge power plants like Hellisheidi, Reykjanes, and Nesjavellir, Iceland's purposeful development of geothermal infrastructure reflects the country's dedication to environmental responsibility and self-sufficiency. Nearly 90% of Iceland's heating and roughly 30% of its electrical demands are met by geothermal energy, which has allowed the country to achieve energy independence while simultaneously drastically lowering greenhouse gas emissions.

In addition, Iceland has the highest per capita use rate among geothermal-rich nations, demonstrating a remarkable degree of integration with industry, tourism, and daily life. As mentioned in the article we conclude this information with the installed capacity divided by the population (MWh / Person).

Article mentioned the achievements that makes Iceland as a benchmark for sustainable energy development and highlight the true potential of geothermal energy for nations who are seeking clean, reliable, and long-term energy solutions to implement.

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