Leopold-Franzens-Universität

Icelandic Energy Regimes

Fossil Fuels, Renewables, and the Making of a Low-carbon Energy Balance, 1940–1980

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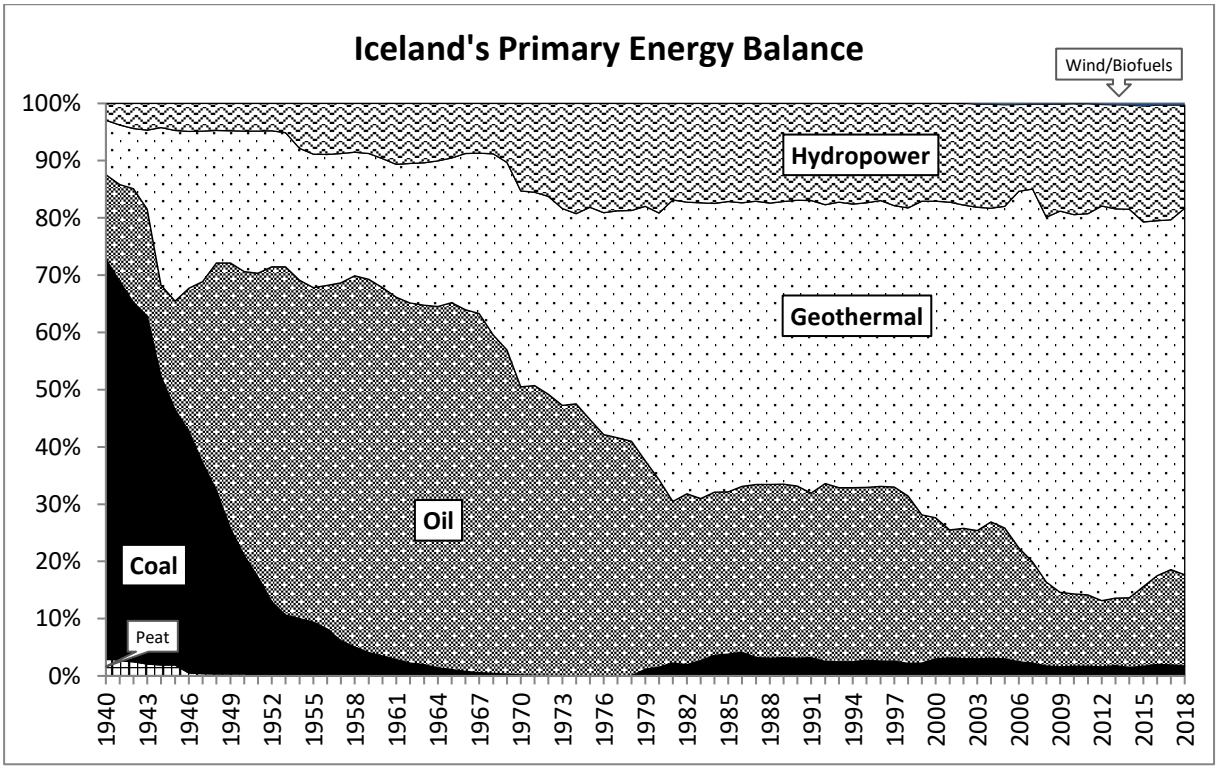
Snapshots of Iceland's Energy History: The Reykjavík Coal Crane, 1927–1968, the Búrfell Hydro-electric Power Station from 1969, and the Svartsengi Geothermal Power Plant with the Blue Lagoon Spa from 1976.

In the past few years and decades, widespread recognition of the challenges presented by the human use of fossil fuels – above all anthropogenic climate change – has resulted in governments from around the world to draft strategies for the implementation of a low-carbon energy balance until the mid-21st century. The primary aim is to increase the share of low-carbon energies in the national energy mix and thereby reduce greenhouse gas emissions. While the energy balance of most industrialized countries is still dominated by high-carbon fossil fuels, those of a few countries like Iceland are primarily based on low-carbon alternatives. Already in 1980, renewables accounted for 65,7% of primary energy in Iceland, increasing to 72,4% by 2000 and reaching the highest share yet with 86,9% in 2012. Like many other countries, Iceland used to rely heavily on imported fossil fuels, which accounted for 87,6% of primary energy in 1940. In the decades that followed, Iceland implemented a low-carbon energy transition that resembles many of the plans that other countries aim to implement in the coming decades. During 1940–1980, the space heating sector was entirely decarbonized, as coal and oil were replaced by geothermal and electric heating. At the same time, hydro-electric capacities were expanded, catering to power-intensive industries – aluminium smelters and ferro-silicon plants – and enabling the continuous growth in electric consumption as well as the replacing of oil-fired power stations. In addition, the energy potential of high heat areas linked to active volcanic systems was explored and harnessed for the combined production of hot water and electricity at geothermal power plants. At the same time, however, oil remained essential in the transportation sector, which despite the oil price shocks of the 1970s and the many ideas for low-carbon alternatives remained dependent on imported oil.

Picture 1: The Reykjavík Coal Crane. Source: Alþýðublaðið 4 May 1933, 1. Available at: http://timarit.is/view_page_init.jsp?pageId=17910
Picture 2: The Búrfell Hydroelectric Power Plant. Source: Wikimedia Commons, https://commons.wikimedia.org/wiki/File:B%C3%BArfellsvirkjun_Auslass.jpg
Picture 3: The Svartsengi Geothermal Power Plant and the Blue Lagoon Spa. Source: Wikimedia Commons, https://en.wikipedia.org/wiki/Blue_Lagoon_(geothermal_spa)#/media/File:BlueLagoon_Noface.jpg



Iceland's Primary Energy Balance, 1940–2015. Source: Adapted from Orkustofnun (2019). OS-2019-T003-02: Primary Energy Use in Iceland 1940-2018 [data file].

In this dissertation, I examine the causes for Iceland's historical reversal of the energy balance from high- to low-carbon between 1940 and 1980. Building on previous research and conceptual tools from energy history, history of technology, environmental history as well as sustainability transition research, I approach energy transitions as changes in incumbent energy *regimes*. Those regimes are defined as dynamically stable configurations of socio-technical systems of energy production, distribution and consumption, which allow them to remain incumbent for decades. My analysis of energy regimes is guided by four main principles: (1) I consider multiple socio-technical systems/regimes as co-evolutionary, since the emergence and stabilization of a new regime cannot be explained without examining the alteration and destabilization of the previously incumbent regime(s). (2) Transitions between energy regimes are analysed as processes that occur at multiple levels (at the level of socio-technical regimes, but also in niches for new technologies and exogenous changes outside the socio-technical system that affect it), and (3) in multiple phases of gradual reconfiguration (e.g. the destabilization of existing regimes, breakthrough of niche innovations or the stabilization of new regimes). In doing so, (4) I approach Iceland as a transnational case study, since it is essential to look beyond Iceland's political borders to analyse technology transfers, the entanglements with transnational developments in energy politics and technology, and to view the special case of Iceland in transnational perspective.

The study builds on extensive research in the archives of the relevant institutions and companies. The most important archival collections concerning Icelandic energy policy are those of the ministries of industry and commerce as well as their adhering agencies, which are preserved in the Icelandic National Archives in Reykjavík. The key sources on the development of geothermal district heating in Reykjavík are the utility's records in the Reykjavík Municipal Archives. In addition, the records of Swiss aluminium multinational *Alusuisse*, which was instrumental to power-intensive industrialization in Iceland in the 1960s, have been

consulted at the Swiss Economic Archives in Basel. Other central primary sources are contemporary reports by energy experts at public and private institutions, preserved in institutional libraries and archival collections, and Icelandic newspapers and magazines, which have been digitalized in their entirety by the Icelandic National Library. Complementary, the analysis builds on the Icelandic secondary literature, both concerning energy but also general studies of the histories of politics, economics and technology, and the international literature on the histories of energy, technology and environment, which enables an analysis of the case of Iceland in its transnational context.

The central argument of this dissertation is that Iceland's turn to a low-carbon energy balance was the result of gradual transitions between incumbent configurations of energy regimes. By transitioning from coal to oil, from fossil fuels to renewable heating, and from low- to high-level renewable energy production, Iceland ended up with a unique set of incumbent energy regimes, which have all grown in scale, but in principle remained unchanged since the 1980s. Contrary to later representations, Iceland's historical shift to low-carbon energies was not driven by considerations about "greening" or "decarbonizing" the energy economy, but rather seen as a means to reduce the dependency on imported fuels and to diversify the export economy. In the end, it was in no way predetermined that Iceland would shift to renewable alternatives, despite the existence of vast renewable resources for relatively few people. Path dependencies on fossil fuel technologies as well as the societal, technological and above all financial barriers towards investing in renewable energy development were just as present in Iceland as elsewhere and needed to be overcome. The examination of Iceland's relative shift to low-carbon energies also reveals an inherent paradox, as it remained purely relative. While the shares of coal and oil in the energy balance decreased owing to the vast growth of renewable energy production, the absolute consumption of fossil fuels increased continuously, from 4,7 PJ in 1940 to 19,7 in 1980 and 48,8 in 2018. In that, the case of Iceland offers several important lessons from the past that can inform future plans to implement low-carbon energy transitions.

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