Article

Nature and Space

Environment and Planning E: Nature and Space
2018, Vol. 1(4) 579–601

DOI: 10.1177/2514848618796829
journals.sagepub.com/home/ene
SAGE

# Modernist dreams and green sagas: The neoliberal politics of Iceland's renewable energy economy

**Hrönn Guðmundsdóttir, Wim Carton, Henner Busch and Vasna Ramasar**
Lunds Universitet, Sweden

**Abstract**
Transitioning to renewable energy is an imperative to help mitigate climate change, but such transitions are inevitably embedded in broader socio-ecological and political dynamics. Recent scholarship has focused on these more-than-technological dimensions of energy transitions to help understand their promises and drawbacks. This article contributes to this research agenda by highlighting the importance of considering not only *who* benefits from renewable energy development, but also *what* renewable energy is *for*. We analyse two cases in Iceland, the Kárahnjúkar hydropower project and Hellisheiði geothermal energy plant, in which renewable energy was used to attract heavy industry investments in the form of aluminium smelters. Attractive regulatory conditions in the form of 'minimal red tape', low electricity prices and an industry-friendly tax regime led to significant profits for the aluminium industry but questionable benefits for the state and the people of Iceland. Renewable energy development in this way put Iceland's nature to use for private gain, while marginalizing alternative ideas of what that nature is for. Our analysis underlines the need to pursue perspectives that recognize the complex political and socio-ecological nature of energy systems, which includes attention to the political economy of industrial energy consumption.

**Keywords**
Renewable energy, Iceland, energy justice, neoliberalism, hydropower, geothermal energy

## Introduction

Renewable energy (RE) development is central to climate change mitigation and the transition to a more sustainable energy system. Together with investments in energy efficiency, it is the main strategy that countries are deploying in their attempts to achieve

**Corresponding author:**
Wim Carton, Biskopsgatan 5, Lund 22100, Sweden.
Email: wim.carton@lucsus.lu.se

the Paris Agreement's mitigation targets, which requires that 80% of current coal reserves, half of all oil reserves and one-third of natural gas reserves remain unused (McGlade and Ekins, 2015). While current efforts fall far short of what is needed to meet this challenge, the direction of change is clear. The RE industry has grown rapidly in recent years and installed capacity now stands at more than double what it was a mere decade ago (International Renewable Energy Agency (IRENA), 2017). The policy commitments that governments have made together with rapidly decreasing prices for renewables suggest that this trend is likely to continue. As of 2017, 176 countries have some form of RE target in place, while 126 countries have policies specifically aimed at incentivizing the development of renewables in the electricity sector (REN21, 2017).

In light of the detrimental consequences of fossil energy use and the urgency that climate change poses, this is an encouraging development. For all the necessity and doubtless potential of RE, however, there is increasing recognition that the benefits of fossil-free energy are by no means automatic, and that RE is not the panacea that it is often made out to be. A growing body of research shows that RE development often comes with significant negative social and environmental impacts (Avila, 2018; Lawrence, 2014; Navarro and Zhao, 2014; Rignall, 2016; Winemiller et al., 2016), and that it can in any case only serve as a solution to climate change to the extent that it replaces fossil fuels, something that so far has been far from evident (Tollefson, 2018; York, 2012). More generally, scholars have pointed out that energy transitions need to be understood as politically and socio-economically constituted, with due attention to the power relations that project design, production, distribution and consumption are infused with (Baker et al., 2014; Huber, 2015; McCarthy, 2015; Newell and Phillips, 2016). As a major component of the 'green economy' agenda, RE easily becomes implicated in neoliberal environmental governance and the consequent promotion of certain interests over others (Bailey, 2015; Carton, 2016; Wanner, 2014). Indeed, in spite of hopes for a 'just' transition (Newell and Mulvaney, 2013), the RE boom so far appears to be occurring on capital's own terms (cf. Harris, 2010; Sayer, 2009), with all its concomitant fall-outs and injustices.

As a counterweight to the dominant promotion of RE as a technofix-solution to climate change, then, critical scholarship usefully highlights the need to take seriously the global political economic and political ecological dimensions of the ongoing energy transition. In this article, we argue that this not only involves asking questions about who is (not) included in decision-making, whose concerns are recognized, and who ends up benefiting, but ultimately also *what* RE is actually *for*. We pursue this argument through an analysis of recent RE development in Iceland, focusing on the generation of hydropower and geothermal energy. Iceland is an interesting case because it is frequently held up as a best-practice example of RE development, serving as a blueprint for the future of sustainable energy production (Edenhofer et al., 2012; Lund et al., 2011; Orkustofnun, 2009). In the words of the National Energy Authority ('Orkustofnun'), Iceland 'has succeeded in doing what many consider impossible: transforming its energy system from fossil fuels to clean energy' (Orkustofnun, 2009). In recent years, virtually all of the country's electricity production (Orkustofnun, 2017a) and 82–87% of its primary energy (Orkustofnun, 2017b) came from renewable sources, with production continuing to increase. This expanding capacity primarily serves the energy-intensive industry, which is the outcome of a long-term and controversial energy strategy that was most pronounced in the 1990s and 2000s (Karlsdóttir, 2010). The contradictions of this approach were to some extent exposed by the financial crisis of 2008/2009, which hit Iceland exceptionally hard and put the country on the map as a 'neoliberal laboratory' (Benediktsson, 2014) in which social and environmental concerns had fallen victim to narrow economic interests (Guðmundsdóttir, 2014). Yet while the crisis provided a sense of urgency that in some ways deepened the country's reliance on resource extraction and industrial development, it also triggered a political debate on the sensibility of its longstanding energy strategy and prompted attempts to move away from the promotion of large-scale industrial investments. Iceland in this way constitutes a critical case of the intersection between RE development and broader political economic processes, discourses and power relations.

Concretely, this article develops an analysis of recent RE development in Iceland in the context of what we argue essentially became a neoliberal alignment between the country's long-term energy strategy and industrial interests. Our analysis is centred on two energy projects: the Hellisheiði geothermal power plant and the Kárahnjúkar hydropower project, which are respectively, and by a large margin, the largest geothermal and hydropower projects so far undertaken in Iceland. The two projects share a number of other commonalities, in that they are both recent developments, with Hellisheiði coming into full operation in 2011 and Kárahnjúkar in 2007. Considerable controversy surrounds both projects and the scale of their impacts – environmental, economic and social – is unprecedented in the country. In both cases also, the electricity generated was exclusively intended for use by heavy industry, i.e. aluminium smelting, exemplifying the main, longstanding focus in Icelandic energy policy. That being said, the two cases are also relevant because of their obvious differences. They enable us to explore processes across RE technologies and at two different levels of government, namely the state (represented by the National Power Company of Iceland (Landsvirkjun), which operates Kárahnjúkar) and the municipal (represented by Orkuveita Reykjavíkur (OR), the municipal energy provider that owns the Hellisheiði power plant via its subsidiary Orka náttúrunnar (ON)).

The article is structured as follows. We begin by briefly summarizing recent debates on energy geographies and the political economy of the RE transition, with particular attention to discussions on neoliberalism and RE policy. We then discuss the RE sector in Iceland in the context of broader neoliberal trends in Icelandic governance, focusing on the sector's structure, the regulations that pertain to it, and the main tenets of the country's energy policy. In the analysis, we explore how these general dynamics played out in the context of our two cases, and briefly highlight the environmental consequences of each of the projects. Our objective here is not to give an exhaustive overview of the cases, but to give a sense of the trade-offs involved, allowing us to then contextualize and problematize the scope and direction of energy policy in the country. The penultimate section takes this one step further by discussing who has benefited from the two projects, who has not, and how we can understand these dynamics as an unarticulated expression of what RE is for. The conclusion, finally, sums up our argument and suggests some lessons that can be drawn for transitions to RE more broadly.

Our analysis relies on publicly available information on the Icelandic energy sector and its impacts, e.g. reports and statistics issued by Icelandic authorities and institutions, notably Orkustofnun. This has been complemented with an analysis of grey literature, scientific articles and reports on the impacts of RE development in Iceland. In addition, we have relied on the data collected through semi-structured interviews with five actors from the Icelandic energy sector, five government members and representatives, actors from three NGOs and five academics and energy experts. All of these 18 interviews were conducted in 2014. Since most of the data (interviews, grey literature) were only available in Icelandic, translations for this article were made by the first author.

## Neoliberal politics and renewable futures

Recent social science scholarship has rekindled an interest in the more-than-technological or economic character of energy systems. As Calvert (2016) argues, energy production and consumption essentially constitute the 're-ordering of the non-human world in the context of some culturally significant imaginary or vision' (p. 110), highlighting the multifaceted social character of energy and therefore the need to understand its utilisation within the specific historical, political economic processes that enable it. Through its ability to do 'useful work', and as with all sorts of other resources, energy inevitably becomes mobilized to serve particular agendas and future visions. Huber (2015) for example notes how energy extraction is often enlisted in nationalist projects, underpinning discourses of national identity or development, as when large-scale hydropower or oil extraction is justified in the name of energy independence or the greater public good (see also Bridge, 2014; Calvert, 2016; Huber, 2013). As a vehicle through which social power can be exercised, energy in this way often helps to maintain and reproduce rather than challenge hegemonic socioeconomic and political relations (cf. Bridge, 2014; Huber, 2018).

Most directly perhaps, the political character of energy is manifested through contestations and outright conflicts over energy developments, from fracking and tar sands to large-scale solar and wind power installations. These not only illustrate that dominant imaginaries about energy are not universally shared, but also that there is nothing inherent about RE technologies that make them 'sustainable', just or democratic. Conflicts over wind power, e.g. show deep-rooted inequalities in where installations are built, what groups are consulted in the process, and how benefits and social and environmental impacts are distributed (Avila, 2018; Dunlap, 2018). Similarly, large-scale solar power developments easily reproduce the kind of unjust institutions and modes of governing that define fossil fuel investments, an inconvenient truth that is obscured by narratives preoccupied with solar energy's role in 'global environmental remediation' (Rignall, 2016; Yenneti et al., 2016). Beyond its capacity to produce low-carbon electricity, then, RE is just as likely to engender negative social and environmental consequences if it is mobilized through political agendas that enable these (McCarthy, 2015). Indeed, because renewables are less energy dense and therefore more spatially expansive than fossil fuels (Smil, 2010), one could in fact anticipate *more* conflicts over land use and socio-environmental impacts than with fossil fuels (Huber, 2015), though evidently fewer conflicts to do with the specific kinds of pollution that fossil fuel extraction is associated with. In various ways, therefore, the ongoing energy transition merely shines a new light on the familiar 'role of energy in fuelling the very stuff of social theory – modernity, democracy, capitalism' (Huber, 2015: 335). To the extent that such continuities are obscured by ecomodernist discourses casting RE as a distinctively benign and desirable form of energy production, it is incumbent on critical scholars to ask whom renewables' 'useful work' is useful for, and to what ends this work is being put.

One approach to this involves examining the relationship between capital and the state as a central actor in RE developments. A large literature has sprung up in the past decades, which scrutinizes capital–state relations through a focus on neoliberalism as a concerted effort to move private interests to the centre of governance. Amongst others, this literature shows how in the context of environmental concerns, policy making has moved towards an increased focus on markets and a narrow concern for economic efficiency and profitability, through processes that include privatization, de- and re-regulation, economic valuation and commodification (Bakker, 2010; Castree, 2008; Mirowski, 2014). Recent interventions, however, also show how these processes are by no means straightforward or homogenous, highlighting the sometimes persistent obstacles that economic valuation encounters (Dempsey, 2016) and the 'hybrid' forms that emerge when abstract economic ideas need to be reconciled with the pragmatic politics of everyday social reality (Bigger, 2018; McAfee and Shapiro, 2010; Mansfield, 2007). As Peck (2008) moreover reminds us, neoliberalism was never a single, coherent project. Despite popular conceptions of it as an ideology dominated by a preoccupation with *laissez-faire* economics, many of neoliberalism's proponents never aimed to take the state completely out of the equation, but rather sought to re-engineer it 'as the guarantor of a competitive order' (Peck, 2008: 7). It is most useful, then, to characterize neoliberalism on the basis of its political and socioeconomic objectives, rather than the specific tools (e.g. privatization) employed to achieve these. In this sense, neoliberalism can be understood as 'a utopian, ideational project of reorganizing international capitalism, often conjoined with a set of political projects that seek to enhance conditions for capital accumulation and restore the power of economic elites at multiple scales' (Yates and Bakker, 2014: 63–64). More succinctly put, it is 'the projection of economic principles on (the art of) government' (Turnhout et al., 2014: 582) through a range of measures and reforms, though not necessarily successfully. Understanding neoliberalism in this way helps explain the various ways in which the state itself often ends up playing a central role in 'the emergence of ''neoliberal landscapes''' and the transfer of resources 'from the poor to the powerful' (Bridge, 2014: 125).

Analysing RE through its entanglement with these political economic processes provides a useful window onto its political character. As Newell and Philips (2016) show for the case of Kenya, energy transitions in many ways 'are constrained and enabled by processes of neoliberalisation' (p. 39), and unpacking these contentious and often contradictory dynamics allows us to examine what social priorities transitions are propelled by, and what their likely outcomes are in socioeconomic and environmental terms. As we argue in this article, these questions not only call attention to the ways in which political institutions are beholden to the interests of transnational capital, and the specific modes of energy production that result, but also to the intended end-users of energy investments. In other words, by focusing on the nexus between RE policy and the spheres of production *and* consumption (cf. Huber, 2015), we here seek to emphasize how analyses of RE's 'winners and losers' ultimately need to grapple with the question of what that energy is used for. It is, we argue, in the sphere of consumption – in our case industrial energy consumption – that questions about the use value of RE are most easily broached, providing valuable perspectives on the kind of socio-ecological visions and imaginaries of the future that are made to count, and those that are not.

## RE in Iceland: Between national development and neoliberal bonanza?

The harnessing of RE in Iceland started at the onset of the 20th century in an effort to improve living standards and energy security (Pálmason, 2005). In its early days it was part of a developmental project buoyed by nationalist narratives of modernity, sovereignty and technological progress, which turned the taming of Iceland's rivers from an enabling possibility into a 'duty or even [...] national mission' (Hálfdanarson, 2005). The Icelandic nation benefited greatly from this, with electrification, district heating and the provisioning of warm water at low prices leading to clear improvements in living standards. With growing industrialisation after the 1970s, the energy sector expanded rapidly (Karlsdóttir, 2010). This process has continued to accelerate during the 21st century, with installed electrical capacity more than doubling from 1169 MW in 2000 (Orkustofnun, 2014a) to 2767 MW in 2017 (Orkustofnun, 2018). With nearly all its electricity and district heating provided by renewables, Iceland is currently one of the countries with the highest share of RE in its energy mix (Sawin, 2016). The country's two main RE sources, hydropower and geothermal energy, together account for virtually all of the country's electricity production (Figure 1).

In spite of this rapid increase in energy production, many rivers and geothermal fields with harnessing potential remain untapped, and large parts of Iceland are still relatively unaffected by energy development. To proponents of RE development, including the country's successive governments, Iceland has an abundance of RE sources waiting to be exploited. A number of new projects are in the pipeline or already under way, e.g. a 90 MW geothermal power station in Þeistareykir, northeast Iceland, which came into operation in November 2017. In March 2017, a comprehensive plan for future energy production (*Rammaáætlun*, here translated as 'the Master Plan') was proposed to the Icelandic Parliament, according to which 10 new geothermal areas and 7 hydropower projects are set for development, totalling an installed electrical capacity of 1400 MW. Orkustofnun meanwhile estimates that energy demand and production will increase by a further 42% between 2015 and 2035 (Orkuspárnefnd, 2014), a projection that is echoed by Iceland's energy companies. The national energy company, Landsvirkjun, has in recent years been assessing 20 potential power projects for development all over Iceland, and Landsvirkjun's current CEO has stated that the company could potentially double its production in the future (RÚV, 2011a).

The history of Icelandic energy development reflects the convoluted history of neoliberal state–capital relations described above. Much like the 'hybrid' neoliberalism identified by McAfee and Shapiro (2010), Newell and Philips (2016) and others, RE development in Iceland is characterized by an assemblage of state-driven, developmental pursuits and the courting of corporate interests through market-friendly policies. It is defined by an ongoing process of reregulation that attracts and benefits industrial capital while in important ways still being embedded within historically developed institutions. On the one hand, the energy sector today is still shaped by the ideals it was originally founded on, with the overwhelming majority of the country's energy companies remaining in public hands, i.e. owned by the state and the municipalities (Benediktsson, 2014). The largest of these is the abovementioned Landsvirkjun, a 100% state-owned company that has the task of developing and operating Iceland's energy infrastructure, including reservoirs, dams and heating utilities. Landsvirkjun currently produces 72% of all electricity in Iceland (Orkustofnun, 2017a).

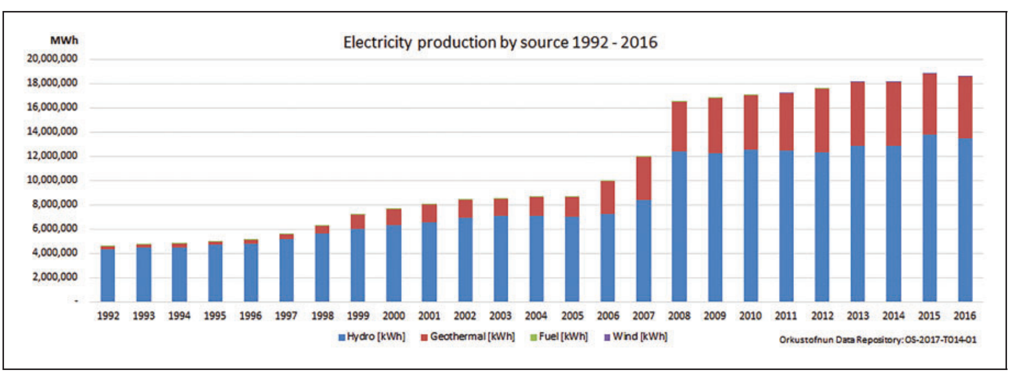


**Figure 1.** Electricity production in Iceland by source 1992–2016. The contribution of fuel and wind (harnessed since 2013 only) is negligible (Source: Orkustofnun, 2017a).

Its dominant market status has long granted it a *de facto* primacy on power plant licenses and until recently it was the only company selling electricity to heavy industry (Helgason, 2007). This implied a heavily centralised energy market with no possibility for individual consumers to choose their own providers. To comply with EU directives, laws aimed at liberalizing Iceland's electricity market were implemented in 2003. This was meant to increase competition amongst energy companies both in the generation, transmission and distribution of electricity, but has so far proved only partly successful. While privately owned energy companies have increased production somewhat in recent years, Landsvirkjun and the municipally-owned Reykjavík Energy/OR currently still produce 88% of Iceland's electricity (Orkustofnun, 2017a).

Yet while ownership structures in the Icelandic energy sector have so far remained largely unresponsive to the call of private capital, the same cannot be said for the mobilization of RE itself. From the 1990s onwards, the harnessing of RE resources was increasingly put to use for corporate profit. As the world's largest electricity producer per capita (Orkustofnun, 2014b), Iceland easily guarantees energy security for its population and demand for increased generation therefore arises almost exclusively in the context of industrial expansion. A full 80% of Iceland's electricity production is currently used to supply export-oriented heavy industry, of which the vast majority (70% of total) goes to the country's three aluminium smelters (Figure 2). Most of the added generation capacity in the last decades has been used to foster the expansion of this sector, which together with fishing and tourism is now one of Iceland's three largest economic sectors (Olafsson et al., 2014; Orkustofnun, 2017c).

This situation is the result of a comprehensive energy strategy promoted by national and local politicians in the name of economic development. In 1994, the Ministry of Industry issued a report titled *Domestic energy sources for the production of electricity* (The Ministry

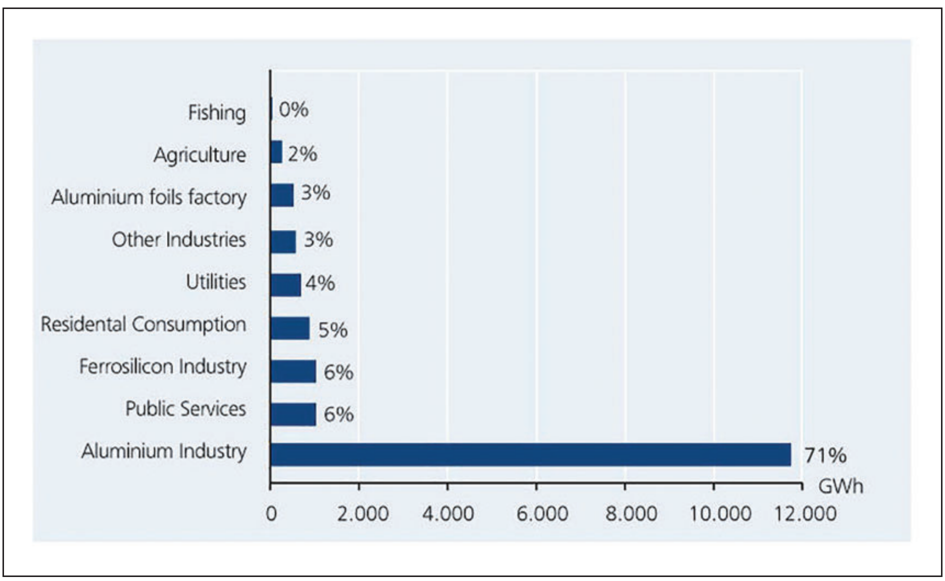


**Figure 2.** The share of different sectors in electricity consumption in Iceland in 2012 (Source: Orkustofnun, n.d.). For updated (2017) figures on the share of different economic sectors, see Orkustofnun (2017c).

of Industry, 1994), later referred to as the white book on energy. This document provides a comprehensive overview of Iceland's estimated RE sources and highlights the country's potential to drastically increase energy production in a way that would incur significantly less environmental impacts than in most other countries. Aluminium smelting is singled out (p. 32) as a viable industry for Icelandic development. A year later, a brochure by the Icelandic Energy Marketing Unit (MIL), titled *Lowest Energy Prices!!* (MIL, 1995), spelled out the government's energy policy in unambiguous terms. The brochure, addressing international industrial companies, framed Iceland as an 'ideal location for energy intensive industries' (p. 2) and promised 'minimum environmental red-tape' and 'relatively little environmental impact' of energy development. It presents essentially all of Iceland's glacial rivers and geothermal fields as harnessable with very little or no environmental impact. The document also noted that the Icelandic government had created a favourable climate for investment in heavy industry by adopting flexible tax policies and by offering energy prices that were lower than anywhere else in Europe and North America. The brochure goes on to offer low corporate tax rates, high tax-free dividend on share capital, tax-free imports on construction material and equipment, low harbour dues and a wide choice of industrial sites, as well as abundant environmentally-friendly energy sources. Finally, the brochure assured investors that the utilisation of Iceland's RE sources for economic development was high on the government's priority list.

It is apparent from this that the Icelandic government at the time considered it urgent to expand its electricity production and attract heavy industry. This can partly be explained by Landsvirkjun's weak financial situation at the time, and the fact that the global aluminium industry was gaining strength in the mid-1990s after a period of instability, creating favourable conditions for new investments (Pálsdóttir, 2005). As two of our interviewees argued, Iceland sought to make use of what it perceived as an opportune moment, before expansion in nuclear energy production abroad would make hydropower less attractive for heavy industry, and it would lose its chance to attract a major industry to its shores (interviews with Master Plan expert and geochemist familiar with the policy). This strategy was seen as an effective way to develop the more remote regions of the country, where smelters were believed to bring jobs and lead to a revitalisation of the countryside. The country has more or less stuck to this path ever since. Today, Orkustofnun still uses the 1994 white book on energy as a reference basis for Iceland's energy development.

Reconciling this courting of private industrial capital with wider public interests, however, proved anything but easy. Conflicts over environmental conservation versus further energy development illustrate some of the tensions that emerged. A number of policies and regulations were adopted in the 1990s to regulate energy development, e.g. mandatory environmental impact assessments (EIAs) and the country's Master Plan for Hydropower and Geothermal Energy Resources. The Master Plan was initiated in 1999 to 'provide a comprehensive national-level policy basis for the sustainable use of potential hydropower and geothermal resources' (Thórhallsdóttir, 2007) and is seen as a tool to reconcile the interests of nature conservation and energy utilisation. It is implemented through a number of special steering committees, which are supported by working groups of experts and professionals (Master Plan, n.d.). These working groups have the task of evaluating power projects based on (a) *impacts of the project* and (b) *the value of the area in question as protected land*. In recent years, the Master Plan has become a bone of contention in Iceland, with political parties accusing each other of manipulating the procedure (Jóhannsdóttir, 2015). Disagreements revolve around the legal interpretation of the Master Plan and the relevance of the protection category in particular. In 2015, Iceland's then Prime Minister, Sigmundur Davíð Gunnlaugsson, stated that continued improvements of living standards and capital creation in Iceland were 'stranded on energy production' and that he was therefore in favour of further energy sector expansion (Baldursdóttir, 2015; Jónsson, 2015). Gunnlaugsson's comments were given in the context of recent motions in the Icelandic parliament, after the majority of the Industrial Affairs Committee of the Icelandic parliament had proposed that five energy projects be 'up-scaled' to the utilisation category of the Master Plan without the standard involvement of the framework's steering committee. The parliamentary committee's chairman, Jón Gunnarsson, referred to demand by industries and the need for increased economic activity as the justifications for the committee's proposal (Guðmundsson, 2015; *Viðskiptablaðið*, 2015). The chairman of the Master Plan's steering committee claimed that Gunnarsson's proposal was 'against the purpose of the laws' on the Master Plan (Jóhannsdóttir, 2015). Gunnlaugsson and Gunnarsson's comments are indicative of a long-dominant discourse that frames further RE production in Iceland as necessary for prosperity and economic security, even though, as we discuss below, this is far from evident and the environmental impacts are significant.

## RE production as contested politics

We here elaborate two cases through which the political economic dynamics discussed above have manifested themselves: the Kárahnjúkar hydropower project and the Hellisheiði geothermal power plant. Our focus in the discussion is on the tensions between public and private interests, and as such highlights the socioeconomic and ecological relations in which RE development is embedded.

### *Kárahnjúkar hydropower project*

Discussions on a large hydropower project in Iceland's north-eastern highlands date back to the early 1980s. Initial plans were for a power plant with an installed capacity of 210 MW, slightly smaller than Iceland's largest power plant at the time, the 270 MW Búrfellsvirkjun (Pálsdóttir, 2005). In 1999, Landsvirkjun signed a letter of intent with the Norwegian company Norsk Hydro, which expressed interest in buying the electricity and building an aluminium smelter in the town of Reyðarfjörður. The project was put on hold when Norsk Hydro indicated that the company would require more energy for its smelter. In 2000, the concept that later became the Kárahnjúkar hydropower project was put on the table. The Kárahnjúkar project comprised of a 690 MW hydropower plant in the highlands northeast of Vatnajökull glacier, an aluminium smelter and harbour construction in Reyðarfjörður and a transmission system from the inland power station in Fljótsdalur to the aluminium smelter (Atvinnuvega-og nýsköpunarráðuneytið, 2000). EIAs of RE projects became mandatory as of 1994, but regulations allowed for an exemption for projects that were licenced before the law came into effect. The Kárahnjúkar project's precursor – with the smaller power station in the same place – had been granted a construction permit already in 1991, which led some to assume that the Kárahnjúkar project would not have to undergo an EIA (Hálfdanarson and Karlsdóttir, 2005; Karlsdóttir, 2010). This idea met with considerable opposition and in 2000, the National Planning Agency (Skipulagsstofnun) began preparations for an EIA of the Kárahnjúkar project. The same year, the Ministry for Industries and Business announced that the government would propose amendments to laws and regulations to ensure the Kárahnjúkar project became a reality (Atvinnuvega-og nýsköpunarráðuneytið, 2000). When Skipulagsstofnun's EIA rejected the Kárahnjúkar project on the grounds of its scale and the irreversibility of expected environmental impacts (Skipulagsstofnun, 2001), the Minister of the Environment, Siv Friðleifsdóttir, overrode the agency's verdict, claiming that the national economic and societal benefits of the project superseded environmental concerns (Karlsdóttir, 2010). She also revoked the protection of an area that would be partly submerged by the largest reservoir. This framing of the project as an economic necessity was common also to other members of the government, parliament and the local governments in the East, who argued that the dam and aluminium smelter would strengthen the rural countryside and bring substantial benefits for the local people, not least in terms of employment and population growth (Hrafnsson, 2000).

In spite of the government's dedication to the project, Norsk Hydro withdrew in March 2002, for reasons unrelated to developments in Iceland. Shortly afterwards, negotiations began with the American industrial corporation Alcoa, and a deal was struck between Alcoa and Landsvirkjun in July of that year. A mere three years after the Kárahnjúkar project was officially proposed, construction began in early 2003. The project was completed in 2007 and consists of several dams and storage reservoirs in the glacial rivers Jökulsá á Dal and Jökulsá í Fljótsdal. From the reservoirs, the water flows in underground tunnels at a distance of approximately 40 km (72 km altogether) to the Fljótsdalur power station. The water is then directed into a surface channel and back into the waterway of Jökulsá í Fljótsdal, finally flowing through lake Lagarfljót to the sea (Landsvirkjun, n.d.). The power station generates approx. 5000 GWh/yr, all of which is transmitted to the Alcoa-operated Fjarðaál aluminium smelter in the nearby town of Reyðarfjörður. This is Iceland's largest smelter and produces approximately 350 thousand tonnes of aluminium annually (Samál, 2015).

The project proved extremely controversial, not least after the Minister of Environment had rejected and overruled Skipulagsstofnun's verdict. Public opposition to the project grew in the years to come, although local communities generally supported its construction and welcomed the smelter and the dams (Benediktsson, 2009; Karlsdóttir, 2010). Only one political party opposed the project. Now, 10 years later, most predictions of negative environmental impacts have been realised while the smelter's socio-economic benefits are debatable. The construction of the hydropower dam and secondary developments such as the building of roads, surface channels, embankments and other infrastructure dramatically altered the previously undeveloped landscape in the area, affecting a wilderness area of approximately 735 $km^2$ (Sustainability.is, 2014). The biggest of the four reservoirs alone, Hálslón, submerged 57 $km^2$ of land and with it a part of Iceland's longest and deepest river canyon, Hafrahvammagljúfur. The area held evidence of glacial surges by Brúarjökull glacier and contained unique natural features such as lava formations, old river channels and hot springs (Einarsson, 2001). It was believed to be of high scientific, cultural and educational value and parts of the area had also been protected since 1975 due to its value as grazing and breeding grounds for Iceland's reindeer population (Umhverfisstofnun, n.d.-b). Stefánsson and Þórisson (2011) furthermore point out that the project greatly transformed hydrologic conditions in an area of over 2000 $km^2$, stretching from the glacier's edge in the highlands to the outwash planes of the two glacial rivers in Héraðsflói bay. This in turn has impacted freshwater ecosystems, leading to the collapse of local fish populations in Lagarfljót, the destruction of spawning grounds for salmon (Jónsson et al., 2013), and knock-on effects for bird populations (Úlfarsson, 2013). As Einarsson's (2001) and Skipulagsstofnun's (2001) assessments showed, the accumulated impacts of the project significantly disrupted the unity of landscapes in the wilderness areas east and west of Mt. Snæfell, now part of Vatnajökull National Park, and irreversibly degraded the environmental integrity of the north-eastern highlands as a consequence.

## *Hellisheiði geothermal power plant*

Our second case is the geothermal power plant, Hellisheiði, located in the Hengill volcanic system in southwest Iceland, approximately 20 km from the capital city of Reykjavík and 10 km from the nearest town of Hveragerði. The plant is operated by Orka náttúrunnar (ON), a subsidiary of Reykjavík Energy (OR). OR, which built the power plant and operated it until 2014, is a public utility company that is co-owned by three municipalities, with the city of Reykjavík holding a 94% share in the company. Hellisheiði is a combined heat and power plant, providing hot water for district heating as well as electricity (OR, n.d.).

While geothermal energy is generally considered a renewable resource, the nature and intensity of its utilisation decide whether the exploitation can be sustained in the long-run. Exploitation of low-temperature geothermal systems, e.g. for house heating, is less intensive and more efficient than electricity generation from high-temperature geothermal fields (Axelsson et al., 2004), where efficiency can be as low as 12% (Zarrouk and Moon, 2014). The latter can actually be described as the mining of heat from the earth's bedrock, since extraction rates generally exceed regeneration rates and therefore in the short-term gradually deplete the resource (Evans et al., 2009; Krater and Rose, 2009; O'Sullivan et al., 2010). In this sense, geothermal energy use for electricity generation is comparable to the extraction of non-renewable resources (Arnórsson, 2012; Pálmason, 2005), a fact that was recognised by Icelandic scientists prior to Hellisheiði's construction (Axelsson and Stefánsson, 2003). Accurate estimates regarding the capacity and nature of the geothermal resource are impossible to make with certainty prior to utilisation, and utilisation therefore usually starts gradually, with extraction rates increased in small steps when the field's activity is better understood. Sound scientific knowledge of geomorphological and hydrological conditions of an area is essential for sustainable harnessing of the energy (Pálmason, 2005).

The Hellisheiði power plant was not the first geothermal energy project in the Hengill volcano system. The Nesjavellir high-temperature geothermal field, northeast of Hellisheiði, has been utilised since 1990, first for thermal energy only and later also for electricity. The geothermal potential of the Nesjavellir high-temperature geothermal field had been studied extensively for over 40 years prior to electricity generation (Axelsson et al., 2004). In 1998, electricity generation began at 60 MWe, expanded by 30 MWe in 2001 and another 30 MWe in 2005 up to 120 MWe altogether, demonstrating a degree of caution in the development of the Nesjavellir power plant (Orkustofnun, 2014a). Although the Hellisheiði power plant was also built in phases, between 2006 and 2011, its development was faster and more intense than that of the Nesjavellir plant, and the field had been studied far less prior to its utilisation. Unlike Nesjavellir, the field also had no history of thermal energy (hot water) extraction (Logadóttir, 2017).

Experimental drilling in Hellisheiði began in 2001 and the project was approved after OR submitted an EIA in 2003 (Skipulagsstofnun, 2003). Both the experimental drilling and the project approval were based on a planned capacity of 120 MWe. However, in December 2005, OR announced plans to expand this significantly, from 120 MWe to 240 MWe, while simultaneously expanding the extraction area (OR, 2005). Skipulagsstofnun approved the expansion on certain conditions, claiming in its verdict that it would not have substantial environmental impacts (Skipulagsstofnun, 2005). Shortly after electricity generation finally began in 2006, the plant's capacity was expanded further, to 303 MWe and 130 MWth between 2006 and 2011.

In 2013, OR announced that Hellisheiði would not be able to support its full generation capacity of ca. 303 MWe for very long due to a decline in the field's output resulting from the energy extraction. To compensate for this, the company decided to expand its activities to a nearby geothermal area (OR, 2013). By 2013, the plant's capacity had dropped to 276 MWe and is expected to further decrease by a few per cent every year. OR now concedes that the initial extraction intensity at Hellisheiði was too high and that extraction was increased too quickly (Logadóttir, 2017). Geologists and geothermal experts agree that the resource is being used unsustainably (O'Sullivan et al., 2010) and have criticised the project for initiating extraction before sufficient scientific data were gathered on the nature and capacity of the area. Geochemist Stefán Arnórsson claimed in 2015 that the field's capacity had been estimated with the help of speculation and statistics rather than scientific data and that the rapid expansion of Hellisheiði power plant had been risky and in contradiction to standard practices on the development of geothermal energy fields (Indriðason, 2015).

OR (2005) and Skipulagsstofnun (2005) reports suggest that rapid increases in the production capacity at Hellisheiði were motivated by growing demand from industries, particularly Norðurál, which operates an aluminium smelter in Grundartangi and was preparing to build a new smelter in Helguvík, and Alcan, which runs the aluminium smelter in Straumsvík (both in southwestern Iceland). It is important to note that the construction of the smelter in Helguvík, for which OR had in 2009 signed a contract with Norðurál for the delivery of at least 175 MWe, had wide public and political support at the time. When it became clear that OR would struggle to provide the energy due to difficulties with the Hellisheiði plant, local politicians, MPs and members of the government mobilized in support of the project, calling for measures to guarantee the promised electricity (Árnadóttir, 2013; Friðriksson and Sigfússon, 2011; Sigurðsson, 2011). It was even suggested that OR could sell its Hellisheiði operations to Landsvirkjun, which would have more financial capacity to expand the plant's electricity production (Sigurðsson, 2011). Together, this suggests that OR felt compelled to take a number of decisions in which normal scientific deliberation and sound decision making were suspended in order to achieve rapid energy expansion and secure heavily politicised industrial investments.

To contextualize this further, it is worth highlighting some environmental implications associated with the energy production process itself. By far the most serious of these is geothermal gas emissions, which are an unavoidable part of high temperature geothermal utilisation and have both local and global environmental effects (Gunnarsson et al., 2013). Geothermal fluids from the Hellisheiði power plant contain dissolved $CO_2$, $H_2S$, $H_2$, $N_2$, $CH_4$ and Ar to a lesser extent (Gunnarsson et al., 2011), some of which ($CO_2$, $H_2$ and $CH_4$ (methane)) are greenhouse gases (GHGs). The geothermal field in Hellisheiði is characterized by high concentrations of $H_2$ and $H_2S$ (hydrogen sulphide), a colourless, flammable and toxic gas that is one of the main environmental concerns of geothermal utilisation. Although $H_2S$ is considered harmless in small quantities (Umhverfisstofnun, n.d.-a), extended exposure at higher concentrations can lead to health problems ranging from irritation of the eyes and inflammation to dizziness, headaches, nausea and in extreme cases even death. The Hellisheiði power plant emits 13,000 tonnes of $H_2S$ into the atmosphere annually, which inhabitants of the capital area and Hveragerði often notice as a foul smell reminiscent of rotten eggs. A recent study found a correlation between concentrations of $H_2S$ and the use of anti-asthma drugs in the capital area (Carlsen et al., 2012). Concentrations of $H_2S$ in air and waterways close to Hellisheiði have also increased since 2006, posing an additional health risk for a larger part of the Icelandic population (Gunnarsson et al., 2013). $H_2S$ has also been detected in groundwater after OR injected excess water from the electricity production process into shallow injection holes for two years (Morgunblaðið, 2011a). Little is known about the potential health implications of long-term low exposure to $H_2S$, but a recent Icelandic study suggests that ambient $H_2S$ air pollution may contribute to increased mortality in the capital region of Iceland (Finnbjörnsdóttir et al., 2015).

## Energy for *whom* and for *what*?

The exploitation of Iceland's abundant RE potential has over the past few decades commonly been framed as a national development project, in continuation of 20th century discourses that linked energy projects to increased living standards and the modernization of the Icelandic nation (interview with historian at the University of Iceland). In contrast to earlier RE developments, however, which clearly benefited the population through the provision of cheap and universal access to heat and electricity, recent invocations of this narrative hinge on the assumption that investments in heavy industry bring wider social and economic benefits and thereby outweigh the negative environmental consequences of continued energy development. While this conflation between national interests and large-scale industrial investments is seen as unproblematic by many Icelandic politicians, and indeed is shared by part of the public, our two cases show that reality is rather more complicated. The Kárahnjúkar development, for example was promoted as a project to increase social welfare and economic growth in the East fjords, where the population had been steadily decreasing for decades and job opportunities were limited. A 2001 report by researchers at the University of Akureyri (UNAK) claimed that the aluminium smelter would strengthen the rural community in the east, increase demand for a range of services and trade, strengthen economic growth and bring long-term benefits in the form of employment opportunities and population growth (EyÞórsson et al., 2001). While some of these predictions were later confirmed, it has also become clear that many of the purported benefits turned out to be short-lived (Jóhannesson et al., 2010). Population increases (hence economic growth) during the construction of the smelter were for the most part fuelled by an influx of foreign labourers, which was reversed again after the plant was completed. The literature also suggests a crowding-out of other economic activity in the region, with fewer jobs in agriculture, the fishing industry and other industries now than before the Kárahnjúkar project, demonstrating that the labour market in the East has to some extent become dependent on the smelter (Guðmundsson, 2011). Additionally, the reliability of electricity delivery to the east fjords has not improved along with the construction of Iceland's largest power plant in that area. Companies such as fishmeal factories, which are numerous in the east, are still partly dependent on oil, to some extent due to a lack of electricity. General users, meanwhile, have had to tolerate temporary electricity shortages and fluctuations in the system due to blowouts in Alcoa Fjarðaál's aluminium smelter, resulting in damage to electrical equipment (VSÓ Ráðgjöf, 2015).

For Landsvirkjun and the Icelandic state, the Kárahnjúkar project has brought less financial benefits than its proponents promised. The sale of electricity for power-intensive projects in Iceland is characterized by business-friendly long-term contracts, below-average electricity prices and special transmission tariffs (OECD, 2014). The Alcoa Fjarðaál smelter in Reyðarfjörður in particular appears to enjoy one of the lowest electricity tariffs in the world, in a contract that can officially only be revised in 2028 (Askja Energy, 2017). Because of this, experts have noted that Landsvirkjun in fact earns very little from its electricity sales to heavy industry after tax and inflation have been deducted (Sigurjónsson, 2015a, 2015b). Indeed, the company's current CEO, Hörður Arnarson, has publicly stated that returns on the Kárahnjúkar project are simply 'too low' compared to the investments that were made (Morgunblaðið, 2011b; RÚV, 2011b; see also Jónsson and Jóhannesson, 2012). A recent Copenhagen Economics report, commissioned by Landsvirkjun, confirms this, describing the Icelandic energy sector in general as characterized by average capital returns that are 'significantly below international benchmarks' (Næss-Schmidt et al., 2017: 5). After an in-depth analysis of the Kárahnjúkar hydropower project, the authors find that capital returns for the Fjarðaál smelter were nearly double that of the power plant, although returns for respective investors should have been similar. The authors attribute this to unnecessarily low energy prices, leading to little substantial resource rent being returned to the Icelandic state. Landsvirkjun *de facto* also ended up bearing a large part of the investment risk for Kárahnjúkar, because electricity prices to Alcoa, just like with the Norðurál smelter that OR provides electricity for, are tied to the world market price of aluminium (Jónsson and Jóhannesson, 2012).

The Alcoa conglomerate, on the other hand, depicts the Fjarðaál smelter as one of its most profitable operations worldwide. In its 2012 annual report, Alcoa declared the smelter a 'profit leader' amongst its global primary businesses, describing it as 'highly profitable' due to 'affordable energy and technical advancements' (Alcoa, 2012: 4). This is particularly interesting given that, according to the company's financial statements, the smelter has never turned any profits in Iceland. This caused considerable controversy in Iceland when media reported that by 2015, the Alcoa Fjarðaál operation had paid close to 60 billion ISK to its parent company in Luxemburg in the form of interest payments, which are not taxable in Iceland. The parent company, Alcoa Global Treasury, financed the smelter in Reyðarfjörður which now owes it 220 billion ISK, more than Alcoa Iceland's total assets (Seljan, 2015). While Alcoa Fjarðaál has been paying off the interests of these loans in recent years, its debt to Alcoa Global Treasury reportedly remains the same (Seljan, 2014). Indriði Þorláksson, Iceland's former Director of Internal Revenue, concluded that it is evident that the Alcoa conglomerate is deliberately turning a made-up loss in order to avoid tax payments and that '[o]f course this is a scandal' (Vilhjálmsson, 2015). This form of tax evasion is widely practiced in other parts of the world and is referred to as transfer pricing. Alcoa Fjarðaál's director was forced to clarify that the company's payments to its parent company are entirely justifiable and that nothing illegal is taking place (Reynisson and Seljan, 2015), though this was dismissed by tax fraud experts who noted that the deliberate use of loopholes in the tax regime to avoid paying taxes is, in fact, illegal (RÚV, 2015). Norðurál, the owner of the smelter in Grundartangi, uses a similar construction to avoid paying taxes in Iceland.

OR has not turned any profits on its Hellisheiði geothermal project either and has actually suffered significant losses as a consequence of industry-friendly energy policies (Pétursdóttir et al., 2012). Reykjavík city, the biggest stakeholder in OR, in 2011 commissioned an independent enquiry into OR's financial situation which concluded that ill-advised investments – the Hellisheiði plant in particular – brought the company to the brink of bankruptcy in a very short period of time (Morgunblaðið, 2012; Pétursdóttir et al., 2012). For decades, OR had been financially stable and yielded profits for the municipalities that owned it. When the company began producing electricity for heavy industries in the early 2000s, it took on large loans in foreign currency, loans that then multiplied when the economic crisis hit and the Icelandic currency plummeted (as pointed out in interviews with two experts involved in the writing of the Master plan). Meanwhile, the need for OR to establish new areas and new drill sites in order to compensate for the original field's insufficient (and dwindling) output, so that it could keep generating the electricity contracted to Norðurál, caused building costs at Hellisheiði to quickly quadruple compared to the initial budget (Pétursdóttir et al., 2012). Together with OR's reluctance to raise its tariffs, the dramatic costs of the Hellisheiði plant and the currency crunch nearly left OR in ruins. Bjarni Bjarnason, the company's director since 2011, has been clear as to why the development of the power plant became such a burden: 'It was built too fast and it was too big' (Logadóttir, 2017). As with Landsvirkjun's operations in the east, then, the Hellisheiði plant has so far been a financial burden for OR more than anything else. In both cases, public money has been poured into large-scale energy projects that enable industrial conglomerates to utilise Iceland's resources at minimum risk for themselves and with considerable state support in the form of infrastructure, low energy prices and a tax regime that allows them to channel profits out of the country. This has led some critics to conclude that the sector has resulted in overall financial losses for the nation, contrary to the claims of those who supported industrial development (Þorláksson, 2009).

Together then, the two cases suggest that it is unconvincing to argue for the continued expansion of the energy sector based on a discourse of national development. The recent benefits of harnessing Iceland's RE resources have mostly ended up with the aluminium companies (Þorláksson, 2009). If we consider the significant environmental, cultural and health-related implications of the Kárahnjúkar and Hellisheiði projects, it is therefore hard to avoid the conclusion that Iceland's resources are being put to work for narrow private gains, but at great costs to society. The Icelandic state has played a key facilitating role in this, removing environmental restrictions or sanctioning the bypassing of ordinary scientific and regulatory processes in the name of rapid industrial expansion. Political leaders have also invested significant public resources, through state-owned companies like Landsvirkjun, to construct and manage the extensive energy infrastructure that makes aluminium production in Iceland possible. Our interviewees in fact suggested that the Kárahnjúkar power plant is unlikely to have been built if it had not been for the state support that Landsvirkjun enjoys, seeing how returns on initial investments were not deemed to be commercially viable. The role that the Icelandic state has played in all of this – through the active promotion of an investment-friendly climate, the flaunting of environmental regulations, the creation of an attractive tax regime and low electricity costs, the mobilization of common economic and environmental resources for private gain – reflects common neoliberal themes, even if it has occurred through state-driven and state-owned energy developments. Indeed, it is in the sphere of energy consumption that the neoliberal character of Icelandic energy policy became most pronounced, while energy production maintained a much more interventionist – though no less industry-friendly – character. Combined, the Icelandic RE energy sector in this way exemplifies a necessarily 'varied, fractured, and even contradictory' (Mansfield, 2004), or as Castree (2010) puts it, 'impure' expression of familiar neoliberal ideas. Fundamentally, the expansion of RE development in Iceland took form through the reshaping of state/market relations instrumental to corporate agendas and capital accumulation, a development that matches parallel processes elsewhere (Castree, 2008; Peck and Tickell, 2002).

These processes have taken hold in Iceland in part through the appropriation and alteration of the country's natural environment, a powerful identifier in Icelandic society, under the guise of social and economic development, and in tack with an ecological modernisation discourse that flaunts the narrowly-defined environmental benefits of low-carbon hydropower and geothermal energy. As our cases however show, this narrative is easily unpicked when considering the political and socio-ecological complexity of energy developments. To promote large-scale hydropower projects such as Kárahnjúkar as environmentally-friendly energy development is at best a selective reading of reality, a green saga that conveniently marginalizes alternative perspectives on *what* Iceland's spectacular nature is for and obscures the project's far-reaching impacts on the region's landscape and ecosystem. Likewise, geothermal energy can only be described as a RE resource when it is managed sustainably, which does not appear to be the case at Hellisheiði, and its health-related and environmental consequences remain unclear.

Moreover, the aluminium industry that all this ‘green’ energy powers is hardly free from direct climate change impacts, a fact that is conveniently forgotten in the environmentalist discourse that Icelandic governments and energy authorities have been promoting. Apart from electricity-related emissions, which with RE technologies are indeed largely absent, aluminium smelters also produce GHGs as by-products in the production process. These processes, mainly from the country’s three aluminium smelters and one ferrosilicon factory, account for the largest source of GHG emissions in Iceland (35%). Industrial process-based emissions grew by 83% between 2000 and 2011 and are currently the main driver of the country’s emissions growth (Hellsing et al., 2017; OECD, 2014). They are the single most important reason why, despite the country’s almost perfect reliance on fossil fuel-free electricity production, Icelandic GHG emissions show a 40% increase since 1990, the second largest (after Cyprus) of all countries in the EEA (Eurostat, 2017). In addition, of course, if one takes a lifecycle approach, there are significant emissions associated with the mining and transport of materials to Iceland and the shipping of aluminium around the world (Cullen and Allwood, 2013).

## Conclusion

The history of Icelandic RE development underscores the importance of the political economic conditions under which energy transitions unfold, and the obstacles these pose to ambitions for a more socially and environmentally just energy future. As such, it highlights the limitations of the ongoing and accelerating deployment of RE technologies as a goal in itself. To be perfectly clear, we are not suggesting here that RE development as such is a bad idea. There are clearly tremendous gains to be had from developing renewables – when done properly – and the realities of climate change leave us no choice but to rapidly upscale their use if we want to stand a remote chance of limiting warming to 2°C, let alone 1.5°C. Rather, our analysis follows others in problematizing a dominant faith in technological fixes for solving what is essentially a social and political crisis. Indeed, the trajectory of RE development in Iceland suggests that it is naïve to think that the adoption of renewables in itself will put us on the path towards a more socio-ecologically desirable future. This is true in respect to mitigating climate change, as shown by the fact that Iceland’s GHG emissions are in fact growing and are doing so rapidly. It is also shown in the various environmental impacts that both the Kárahnjúkar and the Hellisheiði projects have, and in the highly uneven benefits that the two projects created for the different actors involved.

While our discussion is of course specific to the large-scale hydropower and geothermal energy generation that we analysed, we think this usefully illustrates the broader political dilemmas of energy in an age undergoing rapid transitions. For one, our case emphasizes how putting nature to productive economic use inevitably triggers tradeoffs between public and private interests, and between environmental, health, social and economic priorities. Negotiating these tensions requires careful attention to the distribution of socioeconomic benefits, and mandates that risks and drawbacks are taken seriously. This was often not the case in Iceland. Not only did political leaders bypass normal procedures to assess and evaluate the full impacts of the two energy projects, they blindly yielded to dominant economic narratives and formulated energy and economic policies with the near exclusive goal of attracting heavy industry. Essentially, this has enlisted Iceland’s natural resources in the expansion of an industry with a significant environmental footprint, while the long-term social and economic benefits to the wider Icelandic population are questionable at best.

Encouragingly, there are signs that recent governments and Iceland's energy companies are steering away from the expansion-oriented path that has guided the country's energy development for the last decades. Both OR and Landsvirkjun have replaced their former leadership with directors who have openly criticised previous developments at Hellisheiði and Kárahnjúkar and brought their respective companies to a more secure financial status. Two more aluminium plants that were planned for Helguvík, south Iceland, and Bakki, in the northeast, were recently cancelled when the necessary energy investments proved untenable (Ásgrímsson, 2015; Júlíusson, 2016). In the case of Helguvík, the plant had already been half-built and now stands as a testimony to the shortcomings of the country's industrial development strategy. It remains to be seen whether these recent developments are signs of a more permanent rethinking of the country's relationship to its energy resources.

Finally, our study shows the importance of analysing the political economic dimensions of (industrial) energy consumption as integral to critical energy studies. Neoliberal energy politics and its concomitant creation of winners and losers fundamentally operate through dominant notions of *what* energy is for, i.e. the kind of social needs that are worth fulfilling. A 100% RE-driven economy might seem like a wonderful achievement, but it is an achievement that is only given meaning in the context of discussions on the social and economic purposes that this energy serves. If RE is utilised predominantly to power heavy industry, boosting corporate profits while socializing the environmental and social consequences of resource use and landscape transformations, then the realities of Iceland's energy strategy are clearly far-removed from the green sagas that its politicians have been flaunting. Going beyond such fetishizations of RE development requires asking broader questions about the kind of economies we want, and where to draw the line on the amount of energy we need, an idea that evidently stands in sharp contrast to the pursuit of economic development as an end in and of itself. It is only by recognizing that energy systems are political and social constructions, and that therefore even RE technologies have their limits, that we are likely to come up with real solutions to the socio-ecological predicaments we face.

## Acknowledgements

We would like to thank the interviewees, who generously provided their time, as well as Karl Benediktsson and three anonymous reviewers for their valuable comments on earlier drafts of this article.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

## ORCID iD

Wim Carton http://orcid.org/0000-0003-3339-1514

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