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Copenhagen Economics

Energy market reform options in Iceland

Promoting security of supply and natural resource value

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Preface

Iceland is a relatively small and isolated region with abundant access to cheap natural energy resources. While historically this resource has not been in high demand, this has now changed. Numerous power intensive consumers are to an increasing degree seeing Iceland as an attractive location for their facilities. While this is a positive situation for Iceland, it also raises some questions, such as:

- What will it imply for Icelandic households in terms of security of supply and implications for the energy bill?
- Does Iceland have the best framework in place for obtaining value from its natural resources?
- How can the value be increased without causing irreversible damage to the environment?

Against this background, Copenhagen Economics has been asked by Landsvirkjun to take stock of the Icelandic energy market regulation and how this matches the new developments for Iceland. In this study, we find that there are in fact a number of key challenges which should be addressed, and suggest potential options for reform.

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Executive summary

Iceland has access to abundant resources of cheap, carbon free energy based mainly on geothermal and hydro sources. However, as Iceland is isolated from the international electricity market, demand for these resources has been low. Consequently, it has historically been challenging to turn these resources into value for the Icelandic community, other than by offering energy at low costs to households and businesses. The first step taken in this direction was to attract international power intensive consumers to Iceland by offering power at low prices, in combination with very stable conditions and risk hedging contracts.

From the late 2000s onward, Iceland has seen a large increase in power demand and a broader base of industrial consumers such as data centres and new metal industries. Following the introduction of the new Energy Law in 2003 and combined with recent renewals of previous long-term power contracts, this has brought to the fore questions about whether Iceland is getting a fair value out of its natural resources, and if the regulatory framework in place is the best for addressing Iceland's particular energy market characteristics.

In this study, we argue that Iceland has already taken appropriate steps towards achieving fair value, but that there is potential for further improvement particularly in two areas. Based on our assessment of the situation in Iceland, we have also identified five areas for potential policy reform, which can combine into a policy package improving the overall energy market in Iceland to the benefit of the entire community.

Challenge 1: Security of supply for households and SMEs needs addressing
There are several indications suggesting that security of supply for the Icelandic households and small- and medium-sized enterprises (SMEs) is deteriorating. The existing capacity buffer is decreasing and is already almost exhausted. Moreover, due to increased demand from industrial consumers, the historical price premium obtained from supplying to households/SMEs, rather than to the power-intensive industry, is shrinking. This makes it relatively more attractive to supply to the power intensive segment instead of to households/SMEs. Indeed, several energy companies have publicly announced the possibility of withdrawal of capacity from the household/SME sector to cater for the power intensive segment.

In addition, the institutional responsibilities for monitoring and ensuring security of supply are not clearly defined, and there are limited signals to investors to build new capacity via the price. This development is of concern to households and businesses in Iceland, who might need to look towards local back-up capacity such as expensive and polluting diesel generators. Action is needed to address the situation.

Challenge 2: Potential to derive higher value from energy resources while preserving other important objectives

Recent negotiations with power intensive industry has aimed for a better balance between obtaining revenue to the Icelandic community while not jeopardising its position as an attractive location for international power-intensive consumers. Indeed, our analysis suggests that the historical revenue has been too low, with average return on capital on Icelandic power plants being significantly below international benchmarks, even with very little revenue collected from 'rent like' taxes.

Obtaining more value through higher electricity prices is likely to benefit the Icelandic community strongly, even if it also implies increased prices for households. We find that increasing the current average price of existing power contracts to an international benchmark such as the Nordpool price could bring additional value of USD 127–555 million per year to the Icelandic community, depending on the future developments in the Nordpool price.

Price increases must be seen in the context of maintaining Iceland as an attractive location for international power intensive consumers. This applies both to deals with new consumers, and to deals with existing consumers where relatively stable framework conditions over time are important for investment attractiveness. As long as the conditions offered in Iceland are at least as good as in alternative locations, e.g. by offering power prices against an international benchmark price and with contracts that are formed and honoured in a credible manner, prices can increase without undermining Iceland's position as an attractive location.

If it proves economical to expand power generation, it is important that this is done with an integrated view of the value to Iceland both from power generation and from environmental appreciation.

Based on our analysis, we have identified five areas for policy reform which could constitute a strong reform package for the future energy policy of Iceland.

Policy area 1: Options for improving security of supply to households/SMEs

A number of options should be considered in order to address the risk of insufficient security of supply for households and SMEs:

Firstly, the market signal of scarcity to investors could be improved. If the price of electricity does not increase as a reaction to a lack of supply, investors will not face incentives to invest in new capacity.

Secondly, the institutional responsibility for ensuring security of supply should be further defined. The current lack of clarity leaves the potential problem unmonitored. In addition, market participants have highlighted that in the absence of a clear institutional responsibility, Landsvirkjun is implicitly expected to have sufficient capacity at its disposal. This is not an appropriate role for an energy company in a competitive environment.

Thirdly, in the absence of a price increase in the household sector, subsidies for supplying to this sector could be considered, thereby giving energy companies an economic incentive to continue to do so. There are several potential models for achieving this, for example an explicit subsidy (capacity payment) or an implicit subsidy by requiring energy producers to supply to this segment. Such models should be assessed with respect to EU State Aid rules.

Policy area 2: Options for ensuring fair value to Iceland from power generation

The current setup for extracting value to the Icelandic community is to a large extent left to the discretion of Landsvirkjun, in the absence of clear instructions from its owner, the Icelandic state. As Landsvirkjun is also a player in a competitive market, this leaves the role and objectives of Landsvirkjun unclear. It may also run the risk of inhibiting the degree of competition between energy producers if Landsvirkjun's required return on equity is lower than the return on equity of commercially owned producers.

Instead, the Icelandic community should consider defining its expected return from power generation. The return should be as high as possible while still rendering Iceland an attractive location for electricity intensive consumers; consequently moving from cost-based pricing to opportunity cost pricing. An anchor for this could be to aim at prices close to international benchmark prices for power.

Two options to achieve this could be 1) setting up a transparent rent tax system to ensure that the Icelandic community would reap a fair value from its natural resources, and 2) defining a required return on equity for state owned companies in excess of the rent tax, thereby ensuring competition on equal terms with commercial entities.

Several different designs of the rent tax could be considered, e.g. a tax element linked to an international benchmark,[1] thereby mimicking the attractiveness of locating power intensive consumers in Iceland vis-à-vis other international locations. A national rent tax would also have the benefit of potentially replacing different and non-transparent local rent-like taxes levied by municipalities such as, e.g. licensing/concession fees. Such intervention should consider the impact on local municipalities and e.g. be accompanied by State compensation to municipalities.

Policy area 3: Integrated assessment of energy and environmental objectives

Harnessing power from natural resources can often be in opposition to enjoying the environmental value of the same natural resources. In Iceland, this trade-off is currently actively assessed in the Master Plan act, where specific energy projects are deemed to be in accordance or not with environmental objectives. This type of framework is commendable, as it has the potential to make an integrated assessment taking into account multiple objectives.

However, concerns have been raised that the practical assessment has not sufficiently taken into account the value from energy generation, thereby risking suboptimal outcomes for

[1] For example the Nordpool spot price

the Icelandic community. Specifically, when restricting particular zones or power expansion projects, the economic cost of doing so in terms of increased cost of energy generation, or even the resulting 'too little energy production', should be included. This becomes increasingly important if the demand for power increases, as power generation will then potentially generate a higher value to the Icelandic community. The cost to Iceland from restricting this will then also increase.

Policy area 4: Market organisation seem broadly appropriate but options could be considered especially in the household market

In the recent Icelandic policy debate, concerns have been raised that the degree of market concentration in power generation could potentially give rise to abuse of monopoly power. The particular concern seems to be about the risk of prices being 'too high'. We argue that the concern seems misplaced. We base this on a number of arguments, also suggesting that prices in Iceland are more likely to be 'too low' than 'too high':

Firstly, while Landsvirkjun holds an important position among energy producers in Iceland (about 70 per cent overall, and about 55 per cent of power sold to the retail market), this is not uncommon when compared internationally. Indeed in 14 out of 24 EU countries the incumbent electricity generator holds a market share of more than 50 per cent, and in six countries the market share is above 80 per cent. Moreover, the size of the larger energy companies in Europe is significantly higher than Landsvirkjun,[2] suggesting that while Landsvirkjun is a large player in Iceland, economies of scale suggest that it could be even bigger.

Secondly, the market for selling power to international, energy-intensive consumers has a very competitive nature. This implies that – no matter the market concentration in Iceland – power prices cannot exceed international benchmarks as the power-intensive consumers can choose to establish production somewhere else. Instead, it is likely to be an advantage for Iceland to have a strong counterpart to the large international power consumers in contract negotiations.

Thirdly, selling power at low prices will not improve market efficiency.[3] As long as a dominant player in the market does not restrict capacity utilisation, there is no rationale for low prices as such, as it will not distort market decisions.

Fourthly, it is important that there are proper incentives to invest in new capacity, and that a dominant player cannot restrict the expansion of potentially profitable new capacity. This is a case for ensuring that prices are not being kept artificially low to prevent new market entry, but instead being flexible enough to rise in order to make new investments viable.

Fifthly, there is currently ample room for other energy companies to invest in new capacity, both in small-scale assets such as wind turbines and small hydro facilities, and in larger

[2] Vattenfall for example, generates about 15 times more energy than Landsvirkjun, and the largest companies such as E.ON and EDF more than 50 times more.

[3] Which was otherwise suggested in a recent report, Christensen (2016)

assets. This is indeed taking place currently, and potential restrictions are more likely to be found in environmental concerns than in abuse of market position.

An area where attention could be paid, however, is the risk of operational inefficiency of the dominant player Landsvirkjun. In the absence of strong competitive pressure, a dominant player may develop inefficiencies in terms of, e.g., too high salaries and benefits, and lack of innovation. While we have not encountered reasons to believe that such inefficiencies currently exist, a rethink of the governance structure could be considered. Clarity could be introduced by defining the expected contribution to the state through a rent tax model and a required return on equity, as also suggested above.

Previously, suggestions have been made about making the wholesale market more 'market based', e.g., by establishing a power exchange. While exchange based trading has a number of desirable properties, such as lowering transaction costs for market participants, and giving rise to a price reflecting the true valuation of power, it requires a significant organisational setup to function, and the establishment of a well-functioning financial market. The Icelandic retail market is quite small, and a fully-fledged exchange solution might struggle to provide benefits in excess of the costs of administration. In addition, a market based almost purely on energy sources with zero (or very low) marginal costs may prove difficult to run without high price fluctuations and uncertainty.

Another option could be inspired by the so called *'Energy pool'* in the UK in 1990. The main idea behind such a pool is to introduce an independent buying agent on behalf of retail consumers (not power intensive industry). This agent would thus be responsible for purchasing sufficient energy from generators at the best possible price. Such a model would likely achieve both security of supply in the segment, and a market-based pricing of energy. Such a model would require economic regulation of the buying agent in order to determine a cost-reflective retail price. The model would also imply unbundling between the generation and retail arm for the local energy companies.

The Icelandic TSO Landsnet is currently owned by the Icelandic energy companies, in particular Landsvirkjun. This may create improper incentives in the choices made by Landsnet, e.g. related to investments in new transmission capacity, including connections to new power plants. This is not ideal and a plan for divestment could be considered.

Policy area 5: Maintain an interconnector as an option

There are numerous reasons why an interconnector to, e.g., the UK could be an attractive investment for Iceland, both in terms of security of supply and value creation for Iceland. This is a long-term option, as lead times on decisions and subsequent construction are substantial. In the meantime, it is important that potential policy reform is designed with a view to this as a possible long-term solution, e.g., by not locking Iceland into structures that will prove uneconomic in the case that an interconnector is built. One example could be to refrain from engaging in very long-term power contracts, unless they are linked to the price that would occur after building an interconnector.

Chapter 1

Taking stock of the Icelandic energy market and challenges going forward

Iceland has access to abundant natural resources of cheap, carbon-free geothermal, hydro and wind energy. These resources have historically been turned into value to the Icelandic community by providing energy at low prices to households and businesses, as well as by attracting international power intensive consumers to Iceland by offering low energy prices, in combination with very stable conditions and risk hedging features.

In recent years, Iceland has seen a large increase in electricity consumption and a broader base of industrial consumers such as data centres and new metal industries. Together with recent renewals of existing long-term contracts, this has brought to the fore questions of whether Iceland is obtaining a fair value out of its natural resources, and if the regulatory framework in place is the best for addressing Iceland's particular energy market characteristics.

We have identified two broad areas with potential challenges for the Icelandic community: 1) security of supply to households and SMEs is deteriorating and 2) the power sector has not delivered enough value to the Icelandic community. In this chapter, we describe these challenges, and set the scene for the policy reform discussion in Chapter 2.

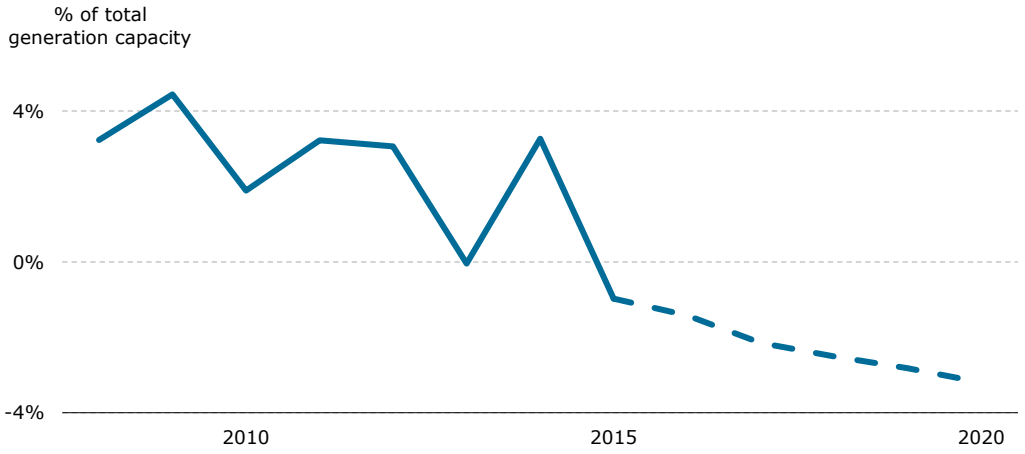
1.1 Threats to security of supply for households and SMEs

Iceland's power generation capacity has historically been higher than demand by some margin, but this buffer has been shrinking, due to increasing demand for power. Landsvirkjun's energy margin, i.e., the difference between yearly contractible firm power[4] and sold power, has experienced a reduction from around 4 per cent of capacity (corresponding to around 500 GWh/year) in 2008 to around zero in 2015, see Figure 1. The negative capacity margin already in 2015 is the result of relatively high precipitation, which meant that Landsvirkjun could sell more than just its 'contractible firm power'.

Importantly, given the expected demand growth just from households and SMEs (not taking into account power intensive industry), the energy margin will be significantly reduced in the coming years in the absence of new capacity coming online. Without new capacity, it is estimated that the capacity deficit could be approaching 4 per cent of capacity by 2020, see Figure 1. If local energy companies increasingly channel their energy from households to power intensive industry, the overall Icelandic capacity deficit will be even worse.

[4] Contractible firm power refers to the guaranteed power that Landsvirkjun can produce in a year. This is based on a low-precipitation year, with a corresponding low production of hydropower. The amount of power that Landsvirkjun can sell in a year fluctuates naturally with the inflow of water into the hydropower system.

Figure 1 The buffer of spare capacity is shrinking



Note: The figure shows Landsvirkjun's energy margin, i.e., unutilised capacity that could be activated, in the period 2008–2015. The dashed line gives the projected energy margin until 2020, given the expected demand increase in the retail segment (not including power intensive consumers).

Source: Copenhagen Economics based on Landsvirkjun and Orkustofnun (2015)

Three concerns for the security of supply for households and SMEs are forming on the horizon

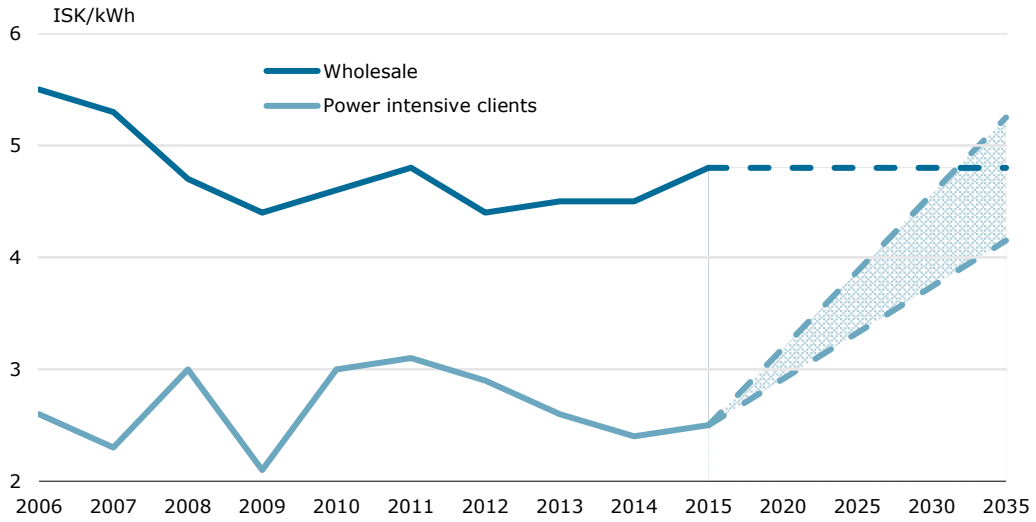
This shrinking capacity margin is cause for concern for the security of supply for households and SMEs[5], due to a combination of three factors: the lack of a price signal in the wholesale segment, the lack of a clear responsibility to ensure security of supply, and the long lead times to expand generation capacity.

Firstly, there is limited market signal in the price formation in this segment – potential investors cannot form an expectation of likely scarcity. Until now, the security of supply in the wholesale segment has been 'protected' by relatively high prices compared to power intensive consumers, giving an incentive for producers to cater for this segment.[6] However, in light of recent increases in demand, and considering that recently closed power contracts with power-intensive consumers have involved relatively high prices, this price difference is likely to be reduced, see Figure 2.

[5] It is not a cause of concern for the power intensive companies, as generators are contractually obliged to supply power through PPAs

[6] It is important to note that the two segments differ with respect to the cost of supplying power. A generator can supply to an industrial consumer at a lower cost than the wholesale market, due to the very stable and predictable loads in the PPAs

Figure 2 Industrial power prices are approaching household/SME prices



Note: Constant (2016) prices.

Source: Copenhagen Economics based on Landsvirkjun

As industrial prices approach the prices charged to households and SMEs, there is less incentive for generators to supply to the latter segment. Indeed, some producers have already announced that they are considering to sell more to the industrial segment at the expense of the household segment.

In a competitive market, this situation would put an upwards pressure on the prices in the wholesale segment, and lead to higher investments. However, the wholesale price is to a large extent determined by Landsvirkjun, rather than in a competitive manner. As a large state owned energy company, the pricing decision may to some extent be implicitly influenced by political resistance to increasing the energy bill of households and SMEs. This may hold back the natural upward adjustment of the price, and as such there is a risk that the household/SME segment will increasingly be at risk of power shortages.

Secondly, the role and responsibility of ensuring security of supply is not clearly defined. The lack of a price signal described above would be less of a problem if there were a clear responsibility for ensuring that there is power available to households and SMEs, but this does not seem to be the case. The Electricity Act (2003) mentions security of supply, mainly in the context that the TSO shall maintain and develop the transmission system in a way that takes into account security of supply. Article 9 of the Act further stipulates that the TSO shall ensure the security and quality of the electricity delivery. However, this relates to balancing of supply and demand, e.g. by ensuring an adequate supply of spinning reserves, rather than the kind of long-term security of supply concern under discussion here.

Thirdly, expansions of generation capacity are subject to long lead times. The issues laid out above would be less severe if new capacity could be brought in quickly. However, once a problem of scarce capacity has been identified, the lead time to the new generation being in place is significant. For projects already approved in the Master Plan, the lead time is likely to be around four years for geothermal and hydro projects, and around two years in the case of smaller wind projects. The time required to develop a completely new project is substantially longer, perhaps around ten years. In this period, supply will be seriously limited, or only possible using expensive, inefficient and polluting technologies such as local diesel generators.

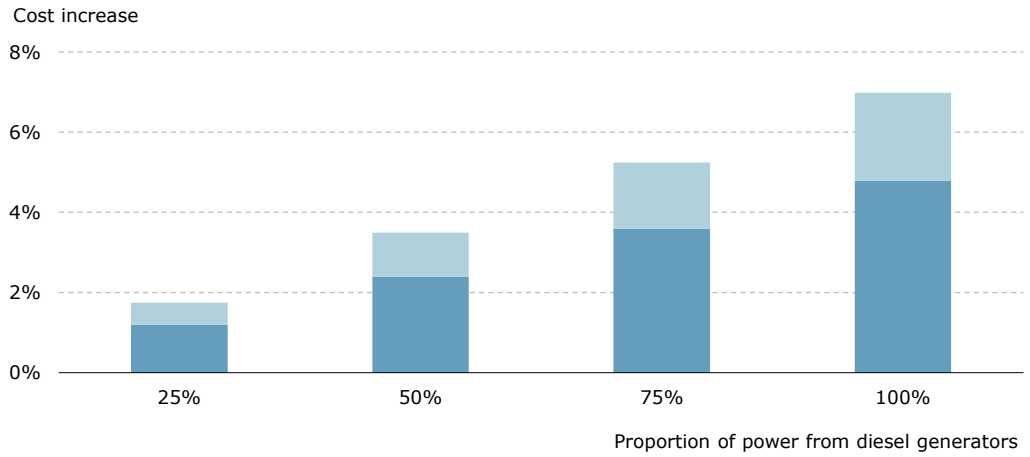
A high security of supply is crucial for smaller power consumers

SMEs in Iceland are very dependent on a stable supply of electricity. Power shortages would imply severe problems, and in the event that shortages start to become a serious issue, businesses are likely to secure their own supply of power with, e.g., local diesel generators. As an example, consider a fish processing plant. Having to invest in local generation capacity through, e.g., diesel generators would give rise to electricity cost increases of a magnitude of around 200 USD/MWh or more (a 400% increase), and will in addition lead to emissions of CO_2 and other pollutants.[7]

If a fish processing plant had to cover 25% of its electricity consumption with a local diesel generator, this would imply a rise in electricity costs of 60–90%, and a rise in total costs of 1.2–1.8%. In an extreme case where all power must be generated locally with a diesel generator, the total cost increase is on the order of 5–7%, thereby reducing the international competitiveness of the sector, see Figure 3.

[7] Based on levelised cost of energy of investing in a new diesel generator, based on Lazard Levelised cost of storage analysis (2015)

Figure 3 Costs increase with power supplied by diesel generators



Note: Based on the cost structure of an average fish processing plant in Iceland, and on the levelized cost of energy for diesel generators. The low end of the range represents continuous operation of the generator; high end represents intermittent operation of the generator.

Source: Statistics Iceland (Operating accounts of fish processing 1997-2014); Landsvirkjun; Lazard Levelized cost of storage analysis (2015)

1.2 The power sector can deliver more value to Iceland

Iceland has an abundance of natural resources, which can provide value to the Icelandic community in several ways. One way is for Icelanders to enjoy the natural environment, and another is to use the natural resources to create jobs and economic activity by providing power to industry or by promoting tourism in the Icelandic nature. In this section, we argue that current regulatory framework in place can be improved to derive more value from power generation without jeopardising environmental value.

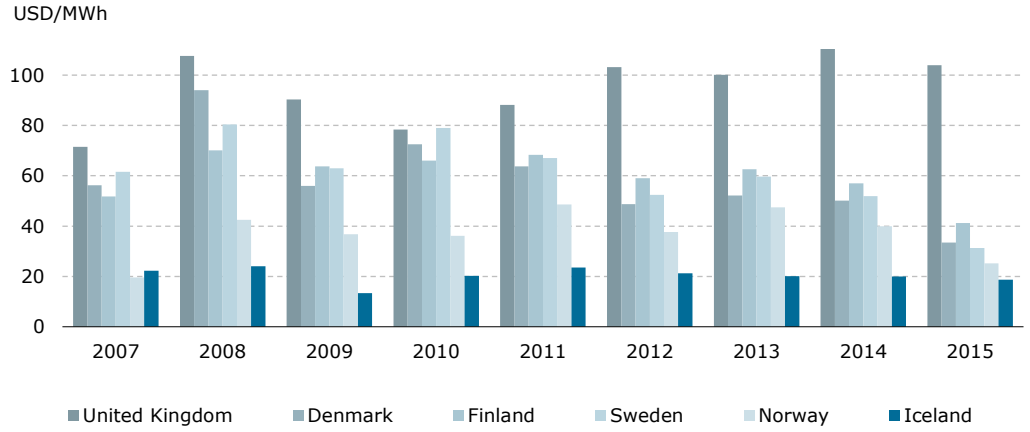
When discussing if Iceland is deriving a fair value from its natural resources, it is important to define 'value'. Traditionally, revenue from the power sector has been seen as less important since value has been generated through down-stream production of goods, most predominantly aluminium. However, basic indicators of value created in power-intensive industry, such as the share of GDP (6–7 per cent) and exports (40 per cent), do not necessarily reflect value to the Icelandic people. What is important is the added value generated and kept in Iceland.

The power sector has historically not generated the value that could be expected given its potential

Power prices to power-intensive industrial consumers in Iceland have historically been low in international comparison. The price of power in Iceland has generally been substantially lower than in the other Nordic countries, which in turn have relatively low power prices by

European standards – indeed, the UK has significantly higher prices, especially in the most recent years, see Figure 4.[8]

Figure 4 The price of power to power-intensive industry has historically been low in Iceland



Note: The figure shows the cost of power only, excluding transmission/distribution costs and taxes. For Iceland, the prices are average prices on PPA contracts sold by Landsvirkjun also in the past, and therefore this does not reflect the price of a new power contract in a given year.

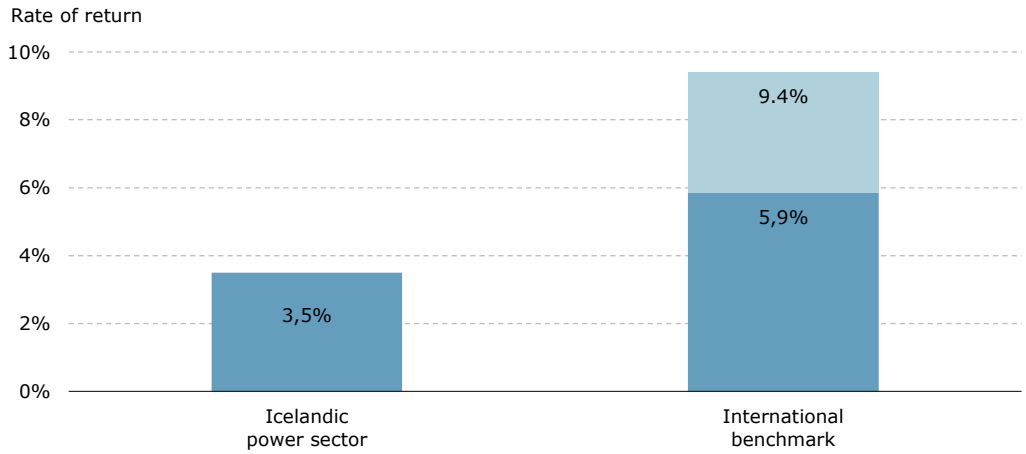
Source: Eurostat (nrg_pc_205_c); Statistics Norway; Landsvirkjun; Central Bank of Iceland

Another way to illustrate the value delivered to the Icelandic community from its power production is to look at the return on capital in the power sector. Compared to an international benchmark, the return on capital in the Icelandic power sector has been low. In the period 1966–2010, Landsvirkjun's average return on capital has consistently been around 3.5 per cent, see Figure 5. This is significantly lower than international benchmarks on power generation,[9] where the return on capital has been around 7.5 per cent on average.

[8] It should be noted that the power prices in Figure 4 are not fully comparable, as the Icelandic prices are weighted averages of prices on long-term contracts, some of which were signed a long time ago, while data for the other countries is rather based on spot prices. In other words, the figure does not show what power price potential investors considering locating in Iceland would have faced in each year, but rather the prices already existing power intensive consumers were facing.

[9] Data from Australia, Ireland and the UK

Figure 5 Low return on capital in Icelandic power sector



Note: Returns on capital in Iceland over the period 1966–2010. The international benchmark is based on data from Australia, Ireland and the UK, with rates of return reported as ranges for each country. The figure shows the range obtained from combining the individual country ranges.

Source: Copenhagen Economics based on Jónsson and Jóhannesson (2012)

Importantly, the 3.5 per cent return on capital for the average power plant contains both the return on capital needed for an investor to find it attractive to invest, and the resource rent which the Icelandic state should collect from allowing companies to harness Icelandic natural resources. An average return of 3.5 per cent implies that even with a low resource rent,[10] the return on capital is significantly lower than similar international investment opportunities.[11]

An in-depth economic analysis has been conducted on the Káranhjúkar hydropower plant in eastern Iceland, which was built to supply power to the aluminium smelter at Reyðarfjörður. Assuming that the power contract was linked to the international aluminium price, specified in USD, and including a right to purchase less power than the maximum stipulated in the contract, the economic risks associated with the aluminium smelter and the power plant are likely to be quite similar.[12] This would imply that the required return on capital should be similar for investors in the two facilities. Instead, the return on capital for the smelter (9.7 per cent) was nearly double the rate for the power plant (5.3 per cent).

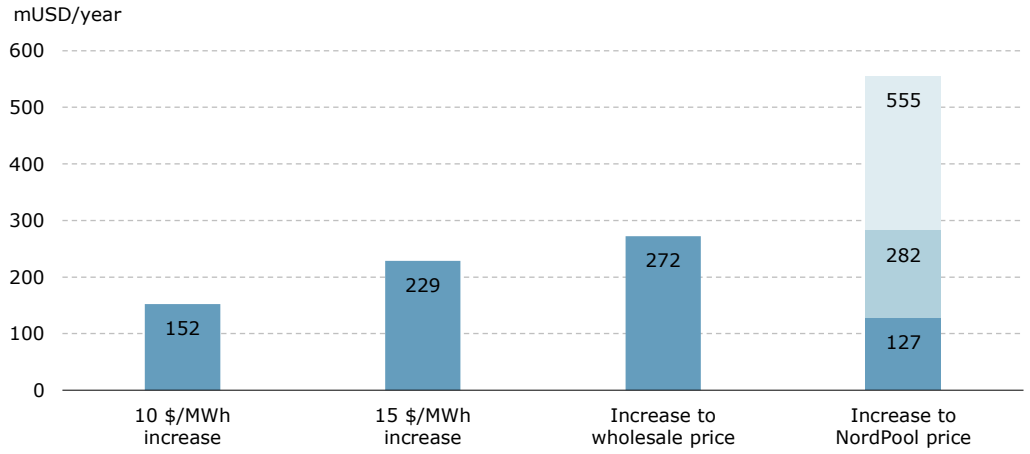
The fact that Iceland has had low power prices is not surprising given its abundance of energy that can be turned into power at low cost and the lack of a connection to international markets. However, low production cost does not necessarily mean that a producer should sell its product at a low price. A comparison with the oil market is instructive here: some oil fields in for example Norway produce oil at costs that are very low compared to

10 Iceland is currently levying some rent-like instruments such as licensing fees and local municipality taxes
11 Hydro plants in Norway for example pay a sizeable rent tax
12 Jóhannesson (2001). Both facilities are exposed to both price and demand fluctuations and the power plant is, in addition, exposed to currency risk

the world market oil price. Yet it is not suggested that the owners of those fields should sell at a low price, but instead at the world market price thereby capturing a substantial resource rent to the Norwegian community.

Higher power prices would allow Iceland to capture more resource rent from power generation. A crude illustration suggests that if the average power price for the power intensive industry increases between USD 10/MWh and USD 18/MWh (the latter corresponding to an increase to the current wholesale price) it would lead to a corresponding revenue gain in the range USD 150–270 million per year, which could be channelled to the Icelandic community. An increase to the NordPool system price would generate additional income of around USD 130–550 million per year, depending on the development in the Nordic power prices in 2020; see Figure 6.

Figure 6 Potential resource rent increases with higher power prices



Note: Based on power sold to power intensive consumers only. All values are in constant (2015) USD.
'Increase to wholesale price' is based on the average price difference between the Icelandic wholesale price and PPAs, over the period 2006-2015.
'Increase to NordPool price' is based on three scenarios for Nordic power prices in 2020, from Dansk Energi (2016). The low-price scenario is referred to as the Forwards scenario in Dansk Energi (2016), and has a NordPool price of around 25 €/MWh. The mid- and high-price scenarios are referred to as the Climate and the WEO2015 scenarios, and have NordPool prices of around 34 €/MWh and 50 €/MWh, respectively. The Swedish Energy Agency (Energimyndigheten, 2014) provides a scenario for power prices in the NordPool area, where the 2020 power price is around 42 €/MWh, i.e. halfway between Dansk Energi's mid and high scenarios.

Source: Copenhagen Economics based on Landsvirkjun, NordPool, Dansk Energi (Danish Energy Association), Energimyndigheten (Swedish Energy Agency) and Central Bank of Iceland

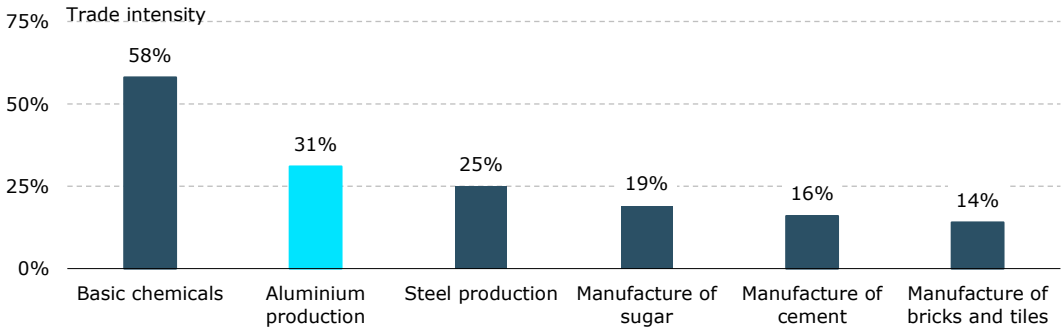
Power prices can be raised without detriment to Iceland's attractiveness as an investment object

Iceland competes with a range of other countries for attracting power-intensive industrial facilities. In order to remain attractive in the eyes of international power intensive consumers, Iceland needs to fulfil at least two criteria:

1. Offer commercial conditions including power prices similar to other alternative locations
2. Maintain its reputation as a stable country in which to invest and do business

Power intensive consumers such as aluminium producers are operating on an international market, where local conditions such as electricity costs are more important than the distance to the market and the associated transport costs. Both bauxite (the main ingredient for aluminium production) and aluminium are highly tradable commodities, which do not need to be produced close to where they are consumed. Indeed, aluminium is highly traded, as evidenced by the high trade intensity of aluminium compared to other products, see Figure 7.

Figure 7 Trade intensity of aluminium is comparably high



Note: Trade intensity of aluminium calculated for the EU, based on trade data for 2009–2011. The trade intensity is a measure of the extent to which a certain product is traded, as opposed to domestically consumed. It indicates the tradability of a particular product type, where e.g. fresh milk has a low trade intensity as it is very expensive to transport at lengthy distances. For a given country or region, trade intensity is defined as (X+M)/(M+Y), where X represents exports, M imports, and Y domestic production. See Copenhagen Economics (2011) for further details.

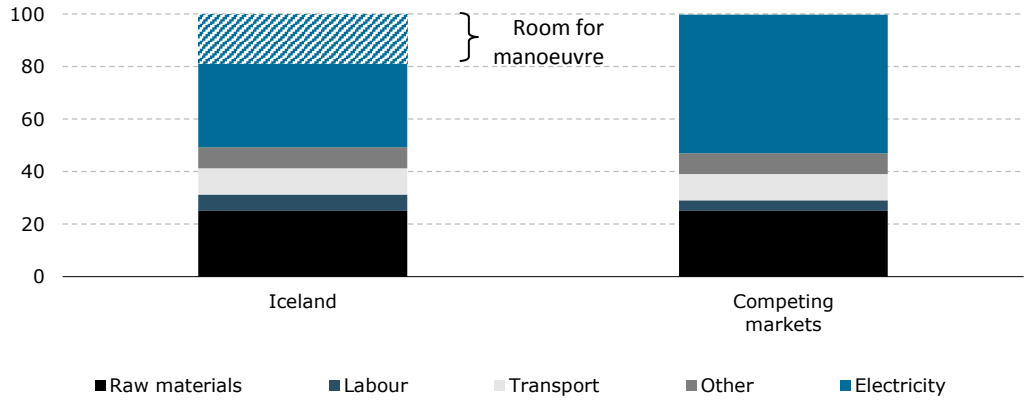
Source: Copenhagen Economics based on European Commission (2015), p. 172

As a result, a majority of aluminium smelters globally are located near sources of hydropower, to ensure cheap and reliable energy, and to waterways, to facilitate transport of input materials and final output. Iceland's location is therefore not a particular disadvantage for aluminium smelters, and does not in itself necessitate a discount relative to power prices in competing locations.

If power prices in Iceland become too high, however, the power intensive consumers will relocate somewhere else, or choose not to expand production. In the current environment of low commodity prices in general, including an aluminium price nearly 50% lower than

before the financial crisis, investment appetite is low. In order to remain attractive for such consumers, price setting should pay close attention to the alternative international opportunities, and align power prices thereafter. Figure 8 hypothetically illustrates the room for manoeuvre that Iceland is facing: power prices can be increased up to the point where an alternative location becomes more attractive.[13] This does not mean that Iceland has to offer lower power prices than competing markets, but that the entire package of locating in Iceland should be equally good as alternatives.

Figure 8 Illustration of room for manoeuvre in price setting



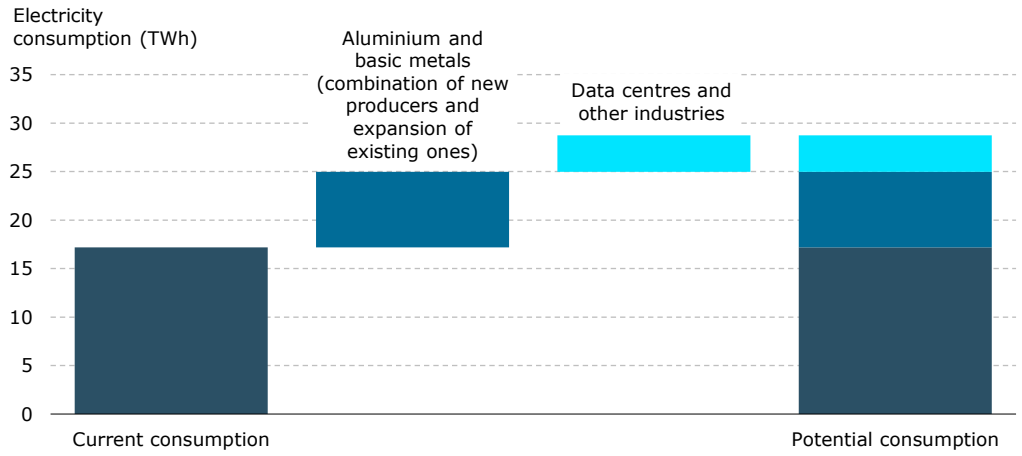
Note: Hypothetical illustration of Iceland's room for manoeuvre in price setting; not based on actual data.

Source: Copenhagen Economics

Historically, aluminium production has been the main channel through which Iceland's natural energy resources are turned into value. However, today the number of power consumers finding Iceland attractive is higher and still increasing. Expansion of existing facilities and new facilities such as data centres and silicon metal production have increased the demand for power. There are potential sources of additional demand, which would allow for expanding power production even further and at the same time potentially contribute to raising the power price in Iceland, see Figure 9. This increase in demand provides a natural point for raising power prices, and indeed newer power contracts are of higher levels than historically.

[13] Note that the figure is a conceptual illustration, and not based on actual data

Figure 9 Potential new consumers who could consider Iceland



Note: Current consumption refers to 2014 figures.

Source: Copenhagen Economics based on McKinsey (2012); Statistics Iceland (Gross consumption of electricity 1990–2014)

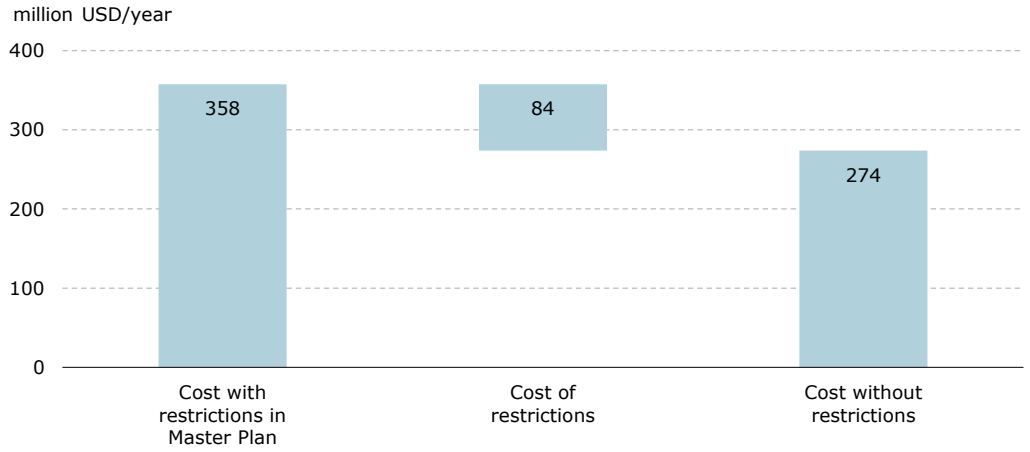
Energy policy and environmental objectives are not sufficiently coordinated

In many circumstances, there is a trade-off between power generation and environmental concerns. Building power plants and transmission lines changes the Icelandic landscape and may detract both from the value Icelanders derive directly from their natural environment and from the potential for tourism. Some of this damage to the natural environment may be irreversible in a similar manner to too much tourism. On the other hand, expanding power generation may also develop infrastructure which can make otherwise inaccessible land accessible.

No-build zones designed to protect the environment from the unrestricted expansion of power generation will likely reduce the potential value generated for the Icelandic community. There are concerns that this trade-off is not sufficiently integrated in decision-making. While it is commendable that the Master Plan Act stipulates that assessments of power plant expansion plans should take into account economic as well as environmental and sociological considerations, in practice the assessments does not always consider all these aspects. In particular, in the latest round of the Master Plan, economic assessments were completely set aside. A lack of economic analysis may have been less important historically, but it becomes more damaging as power prices increase and therefore generate more value for the Icelandic community.

The restrictions made in the recent round of the Master Plan will increase the cost of power from new capacity. This is because several of the most-cost efficient options have been restricted, which drives the cost of new generation up. Specifically we estimate that the cost of expanding power generation similar to the past 10 years will increase by about 84 million USD/year from around 270 to almost 360 million USD/year, see Figure 10. This cost should be evaluated against the potential benefit from an improved environment.

Figure 10 Master Plan restrictions increases power generation costs



Note: The figure shows the cost, per year, of expanding generation by 9,400 GWh per year. This is similar to the expansion in generation over the past 10 years, and also corresponding to the amount (and expected utilisation) of capacity currently on the list of approved projects in the Master Plan.

Source: Copenhagen Economics based on Olafsson (2016), p. 13

Chapter 2

Five options for policy reform

In order to address the potential challenges facing the Icelandic energy system, a number of policy options could be considered. We have identified five areas, where policy reform could be considered.

2.1 Enhancing security of supply for households and SMEs

As described in Chapter 1, security of supply for households and SMEs is pressured by the increased demand from industrial consumers as well as households and SMEs combined with increased environmental concerns and an inflexible and relatively low price resulting in too low incentives to invest in new capacity. In order to address this issue, the following three options could be considered.

Improve market signals of scarcity to investors

In traditional markets, a lack of supply will increase the price providing an incentive to expand supply. Similarly in electricity markets, new investments in capacity expansions will be driven by increased prices. However, there is a risk that the price formation in the market for households and SMEs does not reflect a potential underlying scarcity among other things due to the market organisation of the retail market. Going forward, it should be considered that prices should be allowed to rise in response to a lack of capacity, e.g. by considering retail market reform as also suggested below in section 2.4.

Improved institutional responsibilities to safeguard security of supply

In the case of an absence of a functioning energy-only market for electricity providing a scarcity price signal to investors, it becomes very important to ensure that a clear institutional responsibility is in place to monitor and safeguard sufficient available capacity. Having a clearly defined responsibility and mandate for ensuring security of supply, in addition to necessary resources and competences to fulfil the role, will reduce the risk of supply challenges.

Consider paying for a capacity reserve

Another option could be to shield the household and SME segment against price increases, by maintaining a relatively low price and instead provide the incentives to build capacity through other mechanisms. This could be done, e.g., by paying a capacity subsidy to any market participant willing to supply back-up capacity, ensuring that incentives to supply this capacity to households are at least equally attractive as supplying to the power-intensive segment. It is important to recognise that continuing to serve the household market at conditions less attractive than in the power intensive market constitutes an economic loss to the power producers, which should be made transparent, e.g., through a subsidy payment or an accepted lower dividend payment from state owned companies back to the Icelandic community.

The viability of an option shielding the household and SME segment from price increases should be assessed in respect of EU State Aid rules. EU State Aid rules are in place primarily to secure an efficient internal market with equal competitive terms for all companies across national borders. It is therefore a priori less of a concern that Icelandic households potentially are getting preferential treatment than if Icelandic companies are getting preferential treatment. Models where all companies are facing a cost-reflective power price are less likely to be in violation of the State Aid rules. Ultimately, any model will need to be assessed based on their concrete design.

2.2 Options to ensure fair value to the Icelandic community from its energy resources

As highlighted in Chapter 1, the value going back to the Icelandic community from power generation in the past has been relatively low. Recent developments suggest that Iceland has developed a quite strong position for attracting new sources of electricity demand with a willingness-to-pay exceeding historical power contracts. This is borne out by the observation that recent renegotiations with existing power-intensive customers have resulted in increased power prices. This puts the Icelandic community in a better position to achieve a more favourable share of the total value generated from the power sector.

The current setup for extracting value for the Icelandic society is to a large extent left to the discretion of Landsvirkjun, which is the largest generator in Iceland, in the absence of clear instructions from its owner, the Icelandic state. This lack of instructions from its owners leaves the role and objectives of Landsvirkjun unclear as it is also a commercial operator in a competitive market. It may even inhibit the degree of competition between energy producers if Landsvirkjun's return on equity is lower than the required return on equity of commercially owned producers.

Instead, the Icelandic community should consider defining its expected returns from power generation. The returns should be as high as possible while still rendering Iceland an attractive location for electricity-intensive consumers. An anchor for this could be to aim at setting power prices close to relevant international benchmark prices in order to mimic the alternative opportunities for electricity intensive consumers.

Two options to consider would be 1) setting up a transparent rent tax system to ensure that the Icelandic community would reap a fair value from its natural resources, and 2) defining a required return on equity for state owned companies in excess of the rent tax, thereby ensuring competition on equal terms with commercial entities.

Setting up a transparent rent tax system

A transparent rent tax system would help identify the value the Icelandic community is expecting to get in return for allocating the right to harness power from Icelandic natural resources. Ideally, this would replace some existing rent-like taxes, such as property taxes on power installations and water and geothermal rights payments, which are currently administered at the local level, with a transparent compensation to local municipalities e.g. from the State. This would, in turn, ensure equal conditions for all companies, whether

state owned or private, and all locations, and provide clarity about the take needed to achieve an acceptable return on equity (for private and public owners) and the take related to the company's access to valuable natural resources.

The specific design of the rent tax is important and several different variations of a rent tax can be found in different countries and between different sectors such as hydrocarbon extraction, mineral mining, fisheries and electricity generation. It is important that it is designed to provide the best incentives in the specific Icelandic context. A few examples of elements in the rent tax which are known from other countries could be:

- A one-off concession/license payment: makes government-take very secure and moves a high degree of risk to the licensing party in terms of future revenue streams.
- A royalty payment based on revenue: commonly used in the mineral mining industry, simple to administer and splits risk to future revenue streams between the government and the licensing party. It places all risk concerning cost developments in the hands of the licensing party.
- A tax element linked to a benchmark such as, e.g., the Nordpool price, i.e. the tax increases when the Nordpool price increases and vice versa. This would automatically link government-take to the degree of attractiveness Iceland has vis-à-vis other locations for power-intensive consumers.
- A tax element linked to actual profits, taking into account the fact that the costs of the underlying natural resources is different in different locations in Iceland.

Defining a required return on equity from state-owned companies

By defining a required rate of return in the form of dividend payments from state-owned companies, this provides a clear signal about the level of profitability expected when state-owned companies build and operate power facilities. This will contribute to Iceland's state-owned companies operating under equal conditions with privately owned companies and reduce the risk that some contracts are concluded at power prices that would constitute implicit state aid.

Making value to the Icelandic community from power generation more transparent

Options to increase transparency of the flow of value from power generation to the Icelandic community should be considered. While 'earmarking' government revenue for particular purposes does not generally make good economic sense, it would help mitigate the lack of public support for raising power prices to power-intensive consumers even if it might mean also raising power prices to households and SMEs. Options to consider could be to channel the revenue from a rent tax or the dividend payments from state-owned power companies into a sovereign fund, or simply reducing the general tax level in the country through reduced labour taxes, or paying out a yearly 'resource rent cheque'.

2.3 Integrating value from environment and energy

Harnessing power from natural resources can often be in opposition to enjoying the environmental value of the same resource. In Iceland, this trade-off is supposed to be assessed in the Master Plan act, where specific energy projects are deemed to be in accordance or not with environmental objectives. This type of framework is commendable, as it has the potential to make an integrated assessment taking into account multiple objectives.

However, concerns have been raised that the practical assessment has not sufficiently taken into account the direct and indirect value from energy generation, thereby risking suboptimal outcomes for the Icelandic community. Specifically, when restricting particular zones or power expansion projects, the economic cost of doing so in terms of increased cost of energy generation or even the leading to 'too little energy production' should be taken into account. This becomes increasingly important if power prices are increased, as power generation will then generate a higher value to the Icelandic community. The cost to Iceland from these restrictions will then also increase.

2.4 Market organisation in the Icelandic energy markets

Energy generation in Iceland is concentrated among few companies. Three companies generate 97 per cent of all electricity. Out of this, Landsvirkjun is the largest player, constituting about 73 per cent.[14] This is not a unique situation compared to other countries where in 14 out of 24 EU countries, the incumbent electricity generator holds a market share of more than 50 per cent, and in seven countries the market share is above 70 per cent, see Table 1.

Table 1 Market share of the largest power generator across European countries

	Below 30%	30-50%	50-70%	Above 70%
Number of countries	6	4	7	7
Countries	ES, IT, LT, PL, RO, FI	DE, DK, PT, SE	BE, CZ, HU, IE, LV, LU, SV	CY, EE, FR, GR, HR, MT, SK

Note: 2014 data. Austria, Bulgaria, the Netherlands and the UK are not included due to lack of data.

Source: Copenhagen Economics based on Eurostat (ten00119)

In most industries, 'economies of scale' is important. This is especially so, if there are important back-bone tasks that can be leveraged in bigger companies, and would inefficiently be duplicated by having too many companies. There are reasons to believe that such scale effect are significant in power generation. In fact, in all Nordic countries, Germany, France and the UK (among many others) the largest energy company is significantly larger in terms of energy generated than Landsvirkjun. Except for Danish DONG, which is similar in size, the Nordic companies Statkraft, Fortum and Vattenfall produce 5-15 times more energy than Landsvirkjun, see Table 2. Indeed, larger players such as EDF and E.ON produce more than 50 times more energy than Landsvirkjun.

[14] If sales to power-intensive industry is excluded, Landsvirkjun's market share is approximately 55%.

Table 2 Landsvirkjun's generation is low in international comparison

Country	Largest generator	Total domestic generation (TWh)	Market share of largest generator	Estimated domestic generation of largest generator (TWh)	Total generation of largest generator (TWh)
Iceland	Landsvirkjun	18	73%	13	13
Denmark	DONG Energy	31	37%	11	14
Norway	Statkraft	142	31%	43	56
Sweden	Vattenfall	151	43%	65	173
Finland	Fortum	65	25%	16	73
France	EDF	541	87%	470	624
Germany	E.ON	562	32%	180	215
Great Britain	EDF	318	29%	93	624

Note: Data for 2013 (Great Britain) and 2014 (all other countries)

Source: ENTSO-E, Eurostat (ten00119), Annual reports of Landsvirkjun, Dong, Statkraft, Vattenfall, Fortum, EDF and E.ON

Even so, there is cause to reflect on whether this kind of market organisation is appropriate. When market concentration is high, it is natural to be concerned about inefficient markets, e.g., in terms of setting prices too high. This is traditionally assessed in terms of *market efficiency* and *operational efficiency* respectively.

Market efficiency is reduced if a monopoly can restrict production in order to gain a higher price. This is inefficient as some transactions which would have been valuable to society are not taking place (a deadweight loss).

Operational efficiency is reduced if a monopoly is not facing sufficient competitive pressure allowing it to make inefficient decisions. This may lead to suboptimal investments, so called goldplating of, e.g., investments, overly high wages and bonuses, and a lack of innovation.

Based on our analysis, we argue that the case for reorganising the market for energy generation is not particularly strong. However, a potential for a lack of operational efficiency should warrant attention. We base this on particularly two arguments: 1) substantial parts of the electricity generation is supplied to a market subject to strong international competition and 2) potential challenges in Iceland stem from power prices being too low, not too high due to monopoly pricing.

Instead, there may be merit in considering a reorganisation of the market for supplying to households and SMEs, which is very different in nature than the market for supplying to power intensive consumers:

Market for power-intensive consumers

In this market there are currently three main companies: Landsvirkjun supplying about 77 per cent, Orka Náttúrunnar supplying 17 per cent, and HS Orka supplying 5 per cent. Even though this market is very concentrated in terms of suppliers, it is highly competitive in

nature. Large global corporations producing commodity products are deciding to locate production facilities based on a global menu of location options. If power prices in Iceland were to increase substantially above other locations, Iceland would reduce/lose its attractiveness as an investment object. This sets a natural ceiling for the degree of price increases possible by the generators.

It is also important to recognise that high prices do not necessarily imply inefficient markets. If Landsvirkjun continues to supply the same amount of power but for a higher price, this does not give rise to any inefficiencies. Instead it will lead to a transfer from power consumers to power producers (primarily the Icelandic state). There is reason to believe that prices indeed could be raised without reducing the electricity demand. As discussed in Chapter 1, new power-intensive consumers seem available at prices significantly higher than the historically low levels.

In addition, while Landsvirkjun is the dominant player in the market, there is de facto competition between the energy companies. HS Orka, Orka Náttúrunnar and potentially other companies can also offer contracts to power-intensive consumers, which has indeed also taken place. The main challenge with respect to market entry is likely to be environmental regulations restricting the building of new power plants.

A potential concern is whether Landsvirkjun's dominant position restricts new potential generation capacity from being built thereby restricting available capacity in the market going forward. This would be monopoly behaviour, which would contribute to 'too high' prices and a 'too high' return on capital from its assets. However, the situation in Iceland is in fact the opposite. Power prices have been so low that returns on capital on power plants historically have been way below international benchmarks (as shown in Chapter 1). The problem is therefore more about prices being too low to make new capacity commercially viable than a deliberate restriction in capacity to keep prices artificially high.

The main drawback from the high market concentration in Iceland is the lack of commercial pressure on Landsvirkjun's decisions with the potential for inefficient operation in future, overly high salaries etc. We do not have any indications of this taking place, but it is a risk. To address such a risk, the natural option to consider would be to use governance structures, e.g., commercially determined required rates of return, and performance-based contracts, as also touched upon in policy area 1.

Market for households and small- medium sized businesses

Landsvirkjun generates about 55 per cent of this market's total supply, while six other companies generate the remaining 45 per cent. These six companies are also active in the retail market of supplying energy to consumers. The current business model is that the six integrated companies generate energy to their retailers' consumers, and buy the residual energy from Landsvirkjun. This implies that Landsvirkjun is the only seller on the wholesale market, and its prices thereby sets the market prices.

Due to this, there have previously been suggestions about making the wholesale market more 'market-based'. A key ingredient in obtaining a more market-based system would be

to disrupt the close relationship between the local energy companies' generation portfolio and its retail consumers. This could be achieved by establishing a market design where the companies would find it commercially beneficial to offer its generation to a market instead of directly to its retail arm, or through direct regulation e.g. by requiring that a certain share of generation needs to be available for a general market or alternatively full ownership unbundling of the generation, and distribution and retail parts of the energy companies. Several options could be envisaged for obtaining a more market-based system. Here we touch upon two, namely 1) a full-fledged exchange-trade solution, and 2) an 'energy pool' solution:

A *fully-fledged exchange-trade solution*, e.g., by establishing a power exchange, would have a number of interesting properties. These include high transparency in the market thereby lowering search and transaction costs for market participants, and giving rise to a price reflecting the true valuation of power. Conversely, it requires a significant organisational setup to function properly and the establishment of a well-functioning financial market as well. The Icelandic retail market is quite small, and a full-fledged exchange solution might struggle to provide benefits in excess of the costs of administration. For similar reasons, in fact very few small, isolated regions have adopted power exchanges. Besides from Tasmania which joined the Australian power exchange after connecting to the mainland, and New Zealand which is significantly larger than Iceland both in terms of population and energy consumption, most other small, isolated regions trade electricity without an exchange, including Alaska, Canary Islands, Cyprus, Hawaii and Malta, see Table 3.

Table 3 Very few small isolated power markets with exchange-based trade

	Population (million)	Electricity consumption (TWh)	Electricity consumption (MWh/capita)	Isolated system	Power exchange
Iceland	0.33	17.7	53.8	Yes	No
Alaska	0.74	6.3	8.5	Yes	No
Canary Islands	2.13	8.6	4.0	Yes	No
Cyprus	1.17	4.1	3.5	Yes	No
Hawaii	1.43	9.5	6.6	Yes	No
Malta	0.43	2.0	4.7	Until March 2015; since then connected to Sicily	No
New Zealand	4.6	40.4	8.8	Yes	Yes (New Zealand Electricity Market)
Tasmania	0.52	9.8	18.8	Until December 2005, since then connected to mainland Australia	Yes (Australian National Electricity Market)

Note: Population figures from 2015; electricity consumption from 2013.

Source: World Bank, IEA, Orkustofnun, EIA, US Census Bureau, Executive Agency for Competitiveness and Innovation (2010), New Zealand Electricity Authority, Australian Bureau of Statistics, Office of the Tasmanian Economic Regulator (2016)

If consumption from power intensive industry were also to become exchange traded, the business case for an exchange would improve. However, the large industrial consumers are very interested in stability of price and delivery conditions, for which individual power purchasing agreements (PPAs) are well suited.[15] This makes it unlikely that the large industrial consumers will want to move their business to an exchange unless the same certainty can be established there. In addition, a market based almost purely on energy sources with zero (or very low) marginal costs may prove difficult to run without massive price fluctuations and unpredictability.

Another option could be a model inspired by the so called *'Energy pool'* adopted by the UK in 1990, see Box 1. The main idea behind such a pool is to introduce an independent buying agent on behalf of all retail consumers in the household and SME segment. This agent would thus be responsible to purchase sufficient amount of energy from generators e.g. through auctions and/or tender processes. Such a model would likely achieve important objectives of 1) securing energy at the lowest possible price for consumers by buying from

[15] Historically PPAs have been issued in USD and linked to global commodity prices alleviating both currency market and commodity market risks from the power intensive consumers such as aluminium smelters. OECD estimated in 2015 that 50 per cent of power contracts were linked to global aluminium prices (OECD (2015), page 26.)

the most efficient generators, and 2) improving security of supply for this segment by placing a responsibility for this on the buying agent thereby also giving an incentive to include scarcity concerns in the power price, if supply of capacity is deemed to be too low. Such a model would require economic regulation of the buying agent in order to determine a price then charged to retail consumers in line with a proper measure of costs of running the energy pool. While the UK version established a daily day-ahead spot market, the market in an Icelandic context could probably function well with fewer auctions.

Box 1 The Electricity Pool of England and Wales

The Electricity Pool of England and Wales was a market mechanism in place between 1990 and 2001. It was an unincorporated association of its members, wholesale buyers and sellers of electricity. The pool was operated and its settlement system was administered by the National Grid Company (NGC), the TSO. The House of Commons Trade and Industry Committee noted that the purpose of the Pool had not been set out, but they understood its three main functions to be determining the merit order, determining the prices for services traded, and ensuring sufficient capacity to maintain the system security.

The pool was a compulsory, day-ahead, last-price auction. The NGC provided an estimate of day-ahead system demand, and required generators to submit bids to the day-ahead auction. Based on these bids, the NGC calculated a generation schedule, and determined the System Marginal Price (SMP) based on the highest-price bid required to meet demand. Generators were paid the SMP, plus a capacity payment.

Retail price increases were subject to price caps linked to the retail price index, and to cost increases such as administration payments to the pool.

The Electricity Pool suffered from a number of problems, most importantly that it created an effective duopoly, where the two main generators set the price over 90 per cent of the time. Other criticisms were that it was only half a market with inadequate representation of the demand side, that was opaque, unpredictable, and therefore hard to hedge using standard contracts, and that was compulsory which prevented trading outside the Pool and hence discouraged contracting. To some extent, a number of these issues would likely be less severe in an Icelandic context.

Source: Copenhagen Economics based on Simmonds (2002); Newbery (1998)

A more market-based pricing is a prerequisite for flexible pricing, which can reflect variations in demand and supply, e.g., over the day or across seasons. This would be important in order to activate potentially flexible demand both in the retail and SME segment but also in the power intensive segment, if there is a business case for this. Another requirement is installation of smart metering devices. The value to the Icelandic community of pursuing such price flexibility is very dependent on variations in demand and supply, which, e.g., will increase if the share of electric vehicles increases.

Consider separating energy companies' ownership of Landsnet

The Icelandic TSO Landsnet is currently owned by the previous owners of the transmission grid, i.e. the energy companies, in particular Landsvirkjun. This may create improper in-

centives in the choices of Landsnet, e.g. related to investments in new transmission capacity, including connections to new power plants. This is not ideal, and a plan for divestment could be considered.

2.5 Interconnector project to be considered as an option

While Iceland's power system is currently isolated, the possibility to build a connection to, e.g., the UK has been discussed. This could be an attractive investment for Iceland for a number of reasons. It would raise the value of Icelandic electricity production as the UK is an area with high power prices. In addition, Iceland's large hydropower capacity provides plenty of balancing possibilities, which would be valuable to the UK market, which has a lot of intermittent power sources. An interconnector will also improve security of supply in Iceland, both through the physical connection, which allows for electricity imports when needed, and as a result of creating a new market place where power is sold at the UK price, thereby sending a price signal to new potential investors in new generation in Iceland.

An interconnector is a long-term option, however, as lead times on decisions and subsequent construction are substantial. In the meantime, it is important that any policy reform be designed with this option in mind, i.e. by not locking Iceland into structures that will prove sub-optimal in the case that an interconnector is built. One example of this would be for Iceland to avoid entering into very long-term power contracts - unless they are written in a way that is flexible with respect to the option of building an interconnector, e.g., by allowing the price to be linked to the market in the event that an interconnector is built.

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