OUR ENERGY 2030

Efficiency, competitiveness and transparency in the Icelandic energy sector

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Table of Contents

Introduction and background

The title of this report is **Our Energy 2030**. That is no coincidence as the purpose is to analyse and discuss the present state of Iceland's energy sector and its future outlook.

Energy is a vital resource for the Icelandic economy. The focus of this report is to discuss the industry's importance to the entire population, both in terms of the sector's impact on macroeconomic development as well as by looking at the influence of the regulatory framework.

Furthermore, the report examines the demand and price outlook for Icelandic energy, both from a domestic and a global perspective.

Finally, a SWOT analysis of the Icelandic energy sector is conducted to identify the main challenges it will face.

Based on the analysis in the report, policy recommendations are then presented.

In summary, Iceland has a very strong position in the global energy markets and its energy sector is vital to the economy. However, to maintain the country's relatively strong international position and to develop the sector to the benefit of all Icelanders – with due respect for Iceland's natural environment – regulatory reforms are needed.

It is our hope that this report will contribute to a more informed public discourse about the future of Iceland's energy sector and how it can best contribute to the welfare of all citizens.

The report has been commissioned by the Federation of Icelandic Industries (SI) and was written by Lars Christensen and his team at Markets & Money Advisory. Gunnar Tryggvason from KPMG Iceland has provided technical support.

The views expressed here do not necessarily reflect those of the Federation of Icelandic Industries or KPMG and are those of Lars Christensen and Markets & Money Advisory alone.

Overview of the Icelandic energy sector

Market Structure in the Icelandic electricity market

The Alþingi, or Icelandic legislature, adopted the European Union directive on competition and unbundling of the internal energy market in 2003 by passing a new law on the electricity market (Raforkulög no. 65/2003). The aim of the directive was to transform a vertically integrated market structure into a fully liberalised market. Power generation and retailing was opened up, although the transmission and distribution portions of the industry remained natural monopolies.

One company engaged in power generation, HS, has been privatised, but the industry's remaining incumbents are still all owned by the Icelandic state or municipalities.

Figure 2.1 maps out the current landscape of Iceland's electricity sector, from generation through transmission, distribution and retailing to end users.

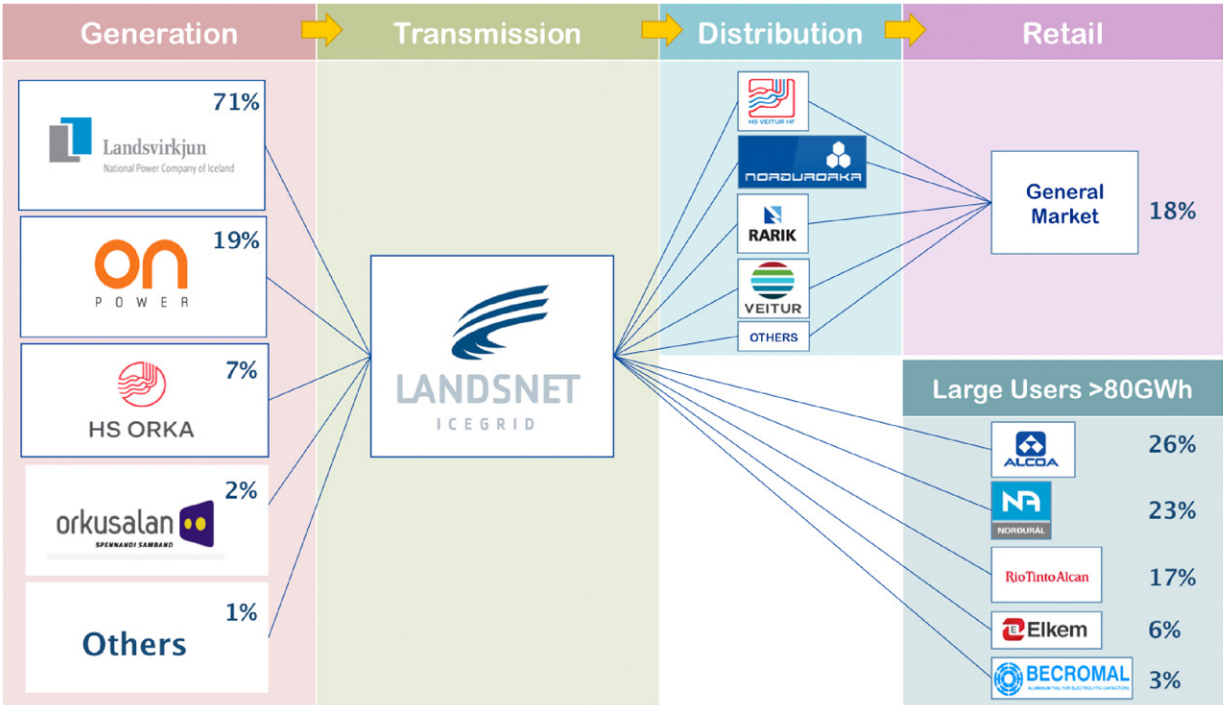

FIG 2.1: *Schematic diagram of the whole sector* *Source: KPMG Iceland*

Large users are entitled to opt out of distribution and service costs by making direct contracts with Landsnet, the transmission service operator (TSO), and a generator. The law defines large users as those with a minimum of 80 GWh in annual consumption. Prior to unbundling, large users negotiated long term power purchase agreements with the national power company, Landsvirkjun, which included transmission costs in the power price.

Ownership

As is evident from Table 2.1, Iceland's power generators are predominantly owned by the state and the municipality. The third-largest generation company, HS-Orka, was privatised in 2007 and is the only exception to this rule.

Genaration by company 2014 [GWh]						
Company	**GWh**		**State**	**Municipality**	**Private**	**Comment**
Landsvirkjun	12.811	70,7%	100%			
Orka Náttúrunar	3.443	19,0%		100%		
HS-Orka	1.337	7,4%			100%	Magma 66,6%, Jarðvarmi 33,4%
Orkusalan	276	1,5%	100%			
Other	255	1,4%	40%	40%	20%	Guess - OV, Norðurorka, RR, IPP's
	18.122	100,0%	73%	20%	8%	

TABLE 2.1: *Ownership of generation companies* *Source: Statistics Iceland*

In the recent OECD[1] report on Iceland, the organisation suggests that the government should consider selling off Landsvirkjun's assets to pave the way for a competitive market in electricity generation.

Exchange and PPA's

In recent decades, electricity exchanges have emerged in most markets of the developed world. On such exchanges, electricity is traded a day ahead of its physical delivery. In addition, a financial market with electricity futures and derivatives has evolved. Transparency has increased and long term power purchase agreements (PPAs) have almost disappeared.

However, this has not been the case in Iceland, where PPAs are still dominant. As shown in Figure 2.2, their weighted average duration is currently 15 years.

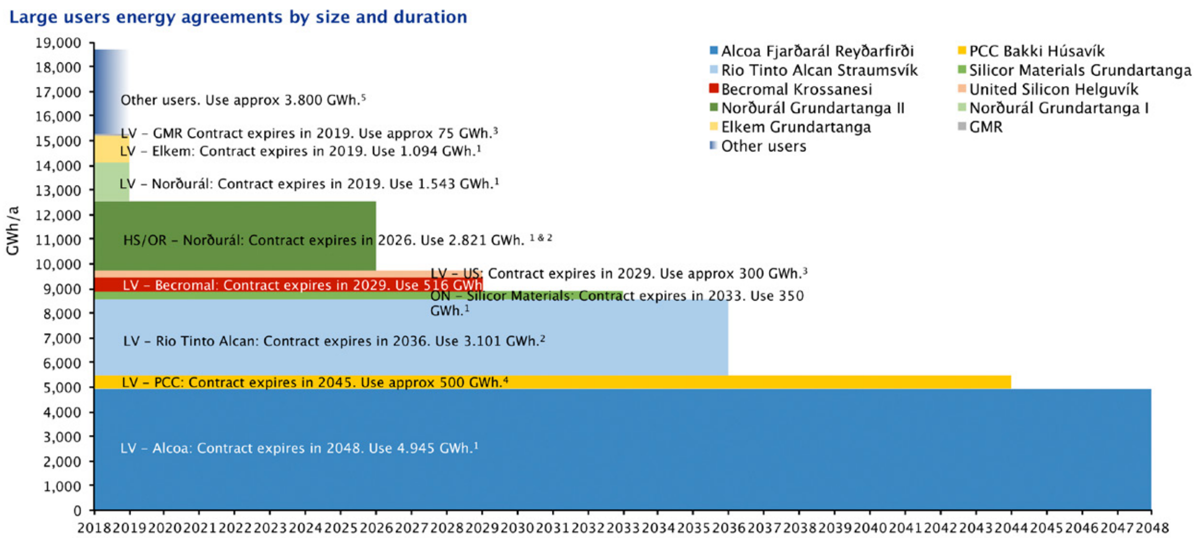

FIG 2.2: *Long term PPA's in Iceland* *Source: KPMG Iceland*

1. *OECD Economic Surveys: Iceland 2015*

Despite the fact that Landsnet, the national grid operator, is authorised by law to establish and run a power exchange, no such market has yet emerged. This may be because market participants are few and most available electricity is locked up in long term PPAs. The lack of supply would definitely spur high price volatility if an exchange market were to be established, and quite possibly lead to a market breach.

The dominance of long term PPAs in Iceland's electricity market has a logical explanation, because both buyers and sellers both seek long term security in a market with limited liquidity. For example, the largest and longest PPA in Iceland today is a 4.9 TWh/a contract between Landsvirkjun and Alcoa, with a duration of 40 years.

Similar situations were found in many European countries during the early phases of market restructuring, when unbundling was occuring and wholesale electricity exchanges were being set up. Much of the power was also locked up in long term PPAs. To break up this situation, countries such as Poland forced power companies to shift from long term contracts by setting a minimum percentage of energy each generator was required to trade through a transparent exchange market (PX).

The duty to trade on a power exchange

The imposition of a duty to trade on a PX was an appropriate response to serious problems that were affecting the Polish electricity market in 2008-2009, namely:

- Lack of transparency in power trading
- Negative effects of vertical integration
- Horizontal consolidation
- Termination of Long Term Agreements (LTAs)
- Deregulation of prices for industrial customers
- Lack of credible price indexes

BOX 2.1 *Source: "Liquidity and Transparency of the Wholesale Electricity Market: The Duty to Trade on a Power Exchange" Mariusz Swora et al.*

The role of the regulator

The National Energy Authority (NEA – i. Orkustofnun) is the regulator of Iceland's electricity market. Its main responsibilities are to regulate the operation of the electrical transmission and distribution system, advise the government on energy and related topics, promote research, and license and monitor the development and exploitation of energy and mineral resources.

Each year, the NEA issues a revenue cap for each distribution company and for the single transmission service operator, Landsnet. These companies, which are defined as natural monopolies, set their prices in accordance with the revenue cap. The NEA does not specify how the cost is to be distributed among customers.

Only transmission and distribution prices are regulated, since power generation has been liberalised.

In 2015, the Consumers Association of Iceland, on behalf of some of their members, requested bids from all power generators in order stimulate competition and lower prices. They received only one offer, at a discount of 0.65% from list prices. The association claims this as sign of inactive competition[2].

OECD report on Iceland

“A proposal to capture more of the resource rent by laying an electricity transmission cable to Scotland has not been fully fleshed out and how the resource rent would be shared is unresolved.”

“Additional progress should be made in reviewing the legal barriers to entry in the electricity, air transport and airport, and seaport sectors (OECD, 2013).”

“In particular, entry is severely constrained in fishing, electricity and to a lesser extent some parts of transportation, often through limitations on equity participation.”

“However, in some cases economic efficiency appears to have been sacrificed. For example, the return on equity, when taking into account state guarantees, has been negative for the main state-owned electricity company. In part, this outcome reflects past weaknesses in decision-making within the company.”

“Fisheries, energy and energy-intensive industries have traditionally been the pillars of the Icelandic economy. Iceland has abundant energy resources compared to the size of the local population, and most of the energy generated (hydroelectric or geothermal) is sold to energy-intensive industries such as aluminium smelters and ferro-silicon producers.”

“The increasing share of the energy sector in GDP is due to investment projects in energy generation from the abundant geothermal and hydroelectric resources as well as the accompanying build-up of energy-intensive industries (Table 1). There is still scope for further expansion, but environmental concerns play an important role in determining where and how much remaining energy sources will be harnessed.”

“The price of energy to energy-intensive industries is strongly linked to product prices and is often denoted in foreign currency. As a result, revenues of the power companies are strongly correlated to fluctuations in the foreign exchange rate, but since the debt of the power companies is also mostly denominated in foreign currency, the result is a natural hedge against currency fluctuations.”

“The government should consider privatising the National Power Company’s generation activities, which benefit from a cost-of-capital advantage conferred by government ownership, to pave the way for a competitive market in electricity generation.”

BOX 2.2 *Source: OECD Economic Surveys: Iceland 2015*

2. Óvirk samkeppni á raforkumarkaði, Neytendasamtökin Frjáls félagasamtök December 2nd 2015

Comparison with Norway

The Icelandic power system is in many ways unique. It is isolated, small and based on low-cost renewable energy; generation per capita is extremely high and no functional exchange market exists. Due to this peculiar combination of factors, benchmarking with other countries is difficult and not likely to produce any useful conclusions.

Norway compared to Iceland (2014)			
General information	**Iceland**	**Norway**	**Factor**
Population Persons '000	329	5214	15.8x
Area km^2 '000	102.8	385	3.7x
GDP bn. USD	14.5	363	25.0x
Electricity generation			
El.production GWh	18.122	141.968	7.8x
Hydro	76.0%	95.9%	
Geothermal	28.9%		
Thermal		2.5%	
Wind	0.04%	1.6%	
Electricity uses			
Share of EII	76.4%	25.8%	
Import % of production		5.3%	
Export % of production		15.4%	

Table 3.1 – *Comparison with Norway* *Source: KPMG Iceland*

Norway is perhaps the closest available comparison for Iceland in this regard. However, its installed generating capacity connected to the electrical grid is almost 8 times greater than Iceland's. In both countries, hydroelectric generation is dominant, as shown in Table 3.1.

Unlike other Nordic countries, which possess significant thermal electric and heat production and district heating systems, Norway has electrified its energy system to a much greater extent. Much Norwegian residential and commercial heating is electric, and in recent years a push has been made to introduce electric cars. Iceland's abundance of geothermal heat supplies most space heating in that country.

Hydro power

Thanks to the common Nordic grid, Norway's large hydro reservoir capacity can be used to store and regulate a fluctuating supply from renewable energy sources, such as wind and solar power in neighbouring countries. Norway has therefore increased interconnections with Sweden and Finland, and through undersea cables with Denmark, Germany and the Netherlands. Two more undersea cables to the United Kingdom are now in the planning stage.

Glaciers play a major role as batteries for the Icelandic hydropower system. Glacier melt during warm and dry summer days reduces fluctuations of generating capacity in Iceland's hydro power plants. This is not the case in Norway, which is very dependent on precipitation and snowmelt. Fluctuating production capacity has led to fluctuation in market prices.

Wind energy

In 2012, Norway joined the market for electricity certificates, established by Sweden in 2003. Norway and Sweden are each responsible for financing half of the new production capacity in the certificate system, regardless of where it is built[3]. The aim is to stimulate the further buildup of renewable energy through this type of subsidy. In February 2016, Statkraft and several partners announced a plan to build Europe's largest onshore wind farm in Norway with an installed capacity of 1,000 MW.

No incentive schemes of any kind are in place in Iceland to stimulate the growth of renewable energy.

Electricity market

Iceland's electricity market is dominated by long term bilateral power purchase agreements, as was the case in Norway several decades ago. Now Norway is part of an integrated Nordic market traded through Nordpool, which is Europe's largest power market measured by traded volume. More than 80% of the electricity consumed in the Nordic countries is traded through this exchange.

3. The Norwegian-Swedish Electricity Certificate Market ANNUAL REPORT 2013

The microeconomics of Iceland's energy sector

The economic significance of the Icelandic energy sector can be considered in two perspectives. Firstly, the industry has a macroeconomic impact on employment, exports and economic growth. Secondly, there is the microeconomic perspective, which studies the relationships and competition between different players – producers, distributors and consumers – in the Icelandic energy markets, together with the efficiency and pricing power of key players in the market.

While our examination of the macroeconomic impact of Iceland's energy market will be quantitative in nature, our discussion of its microeconomic structure will be qualitative.

Landsvirkjun as a "Stackelberg" price leader

It is clear from the description above that Landsvirkjun has a very dominant position among the Icelandic energy producers, with more than 70% of the market.

Furthermore, even though there are no formal legal barriers to market entry, it is clear that environment regulation, for example, to some extent constitutes an informal barrier to entering the power generating market. It is therefore also clear that we should not expect price setting in the market to follow the idealised norm of perfect competition, where all players in the market are price takers, there are no abnormal profits, and prices are equal to the marginal cost of production.

Rather, it seems more appropriate to describe the power generating market as what Industrial Organisation economists call a Stackelberg Industry[4]. In a Stackelberg Industry, a dominant player – in this case Landsvirkjun – will be the price leader in the market, while the smaller players will be price followers.

According to the Stackelberg Industry model, the leader will be able to set a price higher than the marginal cost of production – taking the reaction of the price followers into account – and thereby is able to gain an abnormal profit. In the textbook version of the Stackelberg Industry model, this leads to a welfare loss as output will be lower and prices higher than they would have been under perfect competition.

While we will not argue that Landsvirkjun is acting as Stackelberg leader, its dominant market position creates an environment in which there is a risk that Landsvirkjun could set prices too high in relation to what would be welfare optimal. This is particularly the case because the very close relationship – in terms of ownership and funding – between Landsvirkjun and Landsnet creates a risk of transfer pricing, or an indirect subsidy from the natural monopoly Landsnet to Landsvirkjun.

4. "The Theory of Industrial Organization", Jean Tirole, MIT Press, 1988.

Obviously, the fact that the energy sector is under the supervision of both the energy regulator (NEA - i. Orkustofnun) and the Icelandic competition authority (Samkeppniseftirlitið) should in theory reduce the risk that Landsvirkjun would potentially misuse its dominant market position.

However, regulatory oversight is never a perfect substitute for competition. Therefore, it seems that the best way of reducing the risk of Landsvirkjun misusing its market position would be to reduce its total market share and increase the number of players in the market – for example, by reducing potential barriers to entry. In this regard, it should be noted that there is no "optimal" size for energy producers in Iceland, as the industry's unique characteristics give no obvious reason to believe that increasing economies of scale are possible.

One should note that Iceland's energy market is not completely closed to outside competition. Landsvirkjun might the dominant player on Iceland's domestic market, but it is just one of many players on the international energy market. When it comes to attracting global aluminium producers or data centres, for example, Landsvirkjun and the other Icelandic energy producers engage in global competition. This undoubtedly helps reduce the risk of Landsvikjun misusing its dominant position when negotiating new projects. On the other hand, this applies primarily to the biggest consumers of energy such as the aluminium smelters, but not to smaller end users (households and the local manufacturing sector). And even for the large customers, such bargaining takes place only when the existing PPA's expire.

Landsnet – a natural monopoly

While it is clear that we can think of power generation as a more or less competitive market where all players in theory could be price followers, the case of the "transmission" market – the energy grid – is by definition harder to think of as a competitive market with more than one player. That player today is grid operator Landsnet, which is regulated by the national energy regulator NEA. Landsnet is what we in economic terms call a natural monopoly.

In theory, an unregulated natural monopoly will set prices above marginal costs; in consequence, production will be too low and prices too high, thereby causing a welfare loss. This is precisely the reason that Landsnet, like other natural monopolies, is regulated. To ensure that it does not fix prices too high, the NEA sets a cap on Landsnet's revenue each year.

This cap is based on a complicated calculation of Landsnet's costs, including labour and capital. Landsnet gets its primary funding from its main owner, Landsvirkjun. This appears problematic, as it reduces transparency about Landsnet's actual capital costs. It therefore seems obvious that Landsnet should be getting its funding from the international capital markets rather than from Landsvirkjun.

Furthermore, while setting a revenue cap is a durable way of regulating Landsnet's price behaviour, it will always be very hard to set the "right" or "optimal" revenue cap. This is particularly true if the cap is calculated on Landsnet's actual costs, rather than its hypothetical costs if the company were fully efficient.

This shows the informational asymmetry between management's knowledge of Landsnet's cost structure and the regulator's insight. An obvious problem could be that the "excess profit" or at least part of this profit is not reflected in Landsnet's actual results, but rather as so-called X-inefficiencies[5] within the company.

X-inefficiencies arise when a lack of competition creates slack in the organisation of the monopolist. Such inefficiencies are different from so-called allocative inefficiency, which applies to the pricing behaviour of the monopolist.

Given the asymmetrical information available to the regulator and Landsnet, and in view of the grid operator's ownership and funding structure, we believe that there is a real risk that such X-inefficiency could arise within Landsnet. That said, such analyses as ours suffer from the very same asymmetrical information problem, making it very hard for us to say anything concrete about the scale of such potential problems.

It has occasionally been suggested that Landsnet could be split up – for example, into two separate energy grids for northern Iceland and southern Iceland. According to some experts, this could be a good idea for technical reasons. However, it should be stressed that– contrary to the case of the energy producers – there is no microeconomic rationale for this, because the two separate grids would still be natural monopolies. They would not compete against each other because they would be supplying separate markets.

The distributors – local natural monopolies

The distribution of energy to the retail market, which accounts for about 18% of Iceland's total energy consumption, is performed by local distributors such as Rarik and Norðurorka. These companies are typically owned by municipalities and other local players. HS-Veitur is the only privately owned distributor.

In microeconomic terms, the distributors should be considered as local natural monopolies. They do not compete with each other because they serve different geographical areas.

Since these distributors operate in much the same way as Landsnet, it is natural that they should be regulated in exactly the same way, which is in fact the case.

The same concerns regarding asymmetrical information available to the regulator on cost structure apply to these companies as to Landsnet. That said, the regulator has one advantage: because there is more than one distributor, the regulator in principle can benchmark each company relative to others in the sector. To our knowledge, this is not done today, or least the information is not made public. Benchmarking should therefore be considered by the regulator was a way to improve the efficiency of the distributors.

The sale of HS-Veitur should certainly be welcomed as a step toward this goal. From an economic perspective, there are few arguments against privatising all of the distributors.

5. Leibenstein, Harvey (1966), "Allocative Efficiency vs. X-Efficiency", American Economic Review 56 (3): 392–415

Government-owned monopolies should not maximise profits

State ownership dominates the Icelandic energy sector. The majority owner of both Landsvirkjun and Landsnet is the Icelandic government, while the local energy distributors are primarily owned by the municipal authorities. This fact is often taken in Iceland's public debate to mean that these companies should maximise their profits – effectively acting as monopolists or oligopolists – in order to maximise government revenues and therefore, indirectly, Icelanders' income.

This, however, misses the very important point that Icelanders are not just taxpayers, but also consumers of energy – both as retail customers and as consumers of Icelandic goods using locally produced energy as an input. Furthermore, since Iceland's energy sector competes on the international markets, maximising "local profit" might undermine the industry's international competitiveness.

By following the Norwegian example of implementing a resource rent tax for the hydro and geothermal sector, Iceland could unlock the ownership issue. The private sector could own the generation assets, but the public would still receive most of the rent from the natural resource[6].

To ensure that Iceland's energy sector produces the highest level of welfare for the population, prices should be set to reflect marginal costs of production under the maximum possible level of competition and transparency. That might not necessarily maximise government revenues, but it would balance two concerns, supplying the cheapest possible energy to households and companies in Iceland, while at the same time ensuring the best deal for taxpayers.

6. Konsesjonskraftpris, December 17th 2014, Regjeringen.no

Macroeconomics share and economic contribution

Icelandic energy market

Relative to its small population, Iceland is a fairly big island (103,000 sq.km) with an area more than double the size of Denmark and quarter of Norway – its two main historical competitors. The country is geographically isolated, and the same applies to its power grid, which has no interconnections. The island's geographical characteristics – particularly high precipitation, mountainous highlands featuring Europe's largest snowcaps, and a high concentration of volcanoes – give it great potential for both hydro and geothermal power.

Only a small fraction of this potential is required by the local power market. Due to the isolated power grid, the remainder has been described as "stranded power", unable to be utilised due to its location. The situation is analogous to Norway some decades ago and to the Middle East, where natural gas is considered to be stranded. Some sites in Canada display similar characteristics.

In order to exploit the economic potential of the country's energy sector, Icelanders have actively sought to attract foreign investors in energy intensive industries. This led to the development of aluminium smelting, which remains the most electricity intensive large-scale manufacturing process. In recent years, Iceland's power industry has been looking for ways to reduce market risk by diversifying into other electricity intensive industries such as silicon metal and data centres.

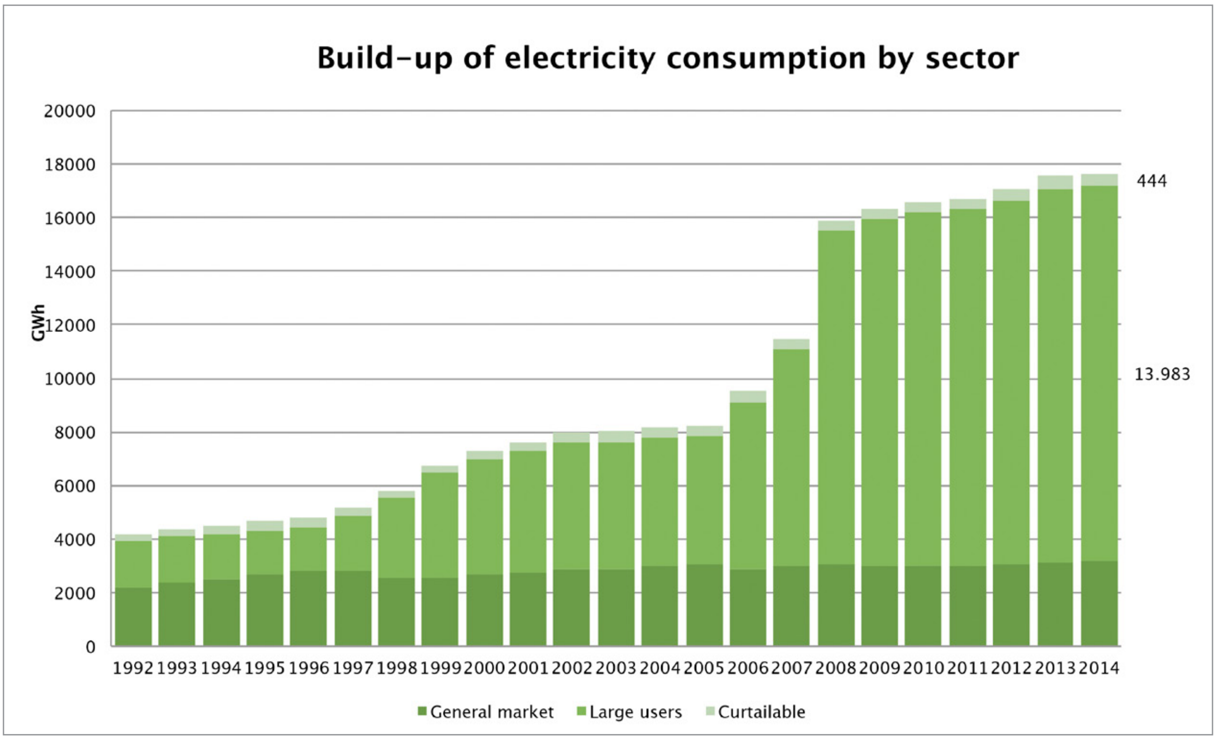

FIG 5.1: *Electricity intensive industries have outpaced general market consumption.* *Source: KPMG Iceland*

In 2014, large users were responsible for almost 80% of Icelands total electricity consumption. As illustrated in Figure 5.1 large users have been the driving force behind the surge in electricity consumption over past two decades, leading Iceland to become the world's largest electricity producer per capita.

Two silicon smelters now under construction will start production in 2018, adding further to the "large users" part of the column. Their annual consumption will be about 800 GWh, representing an approximately 4% increase in total usage. Two more silicon projects are in development, while growth in the data centre industry is expected to continue. Over the next five years, the Icelandic Energy Forecast Committee is predicting an 11% increase in total consumption and annual growth slightly below 0.5% after that.

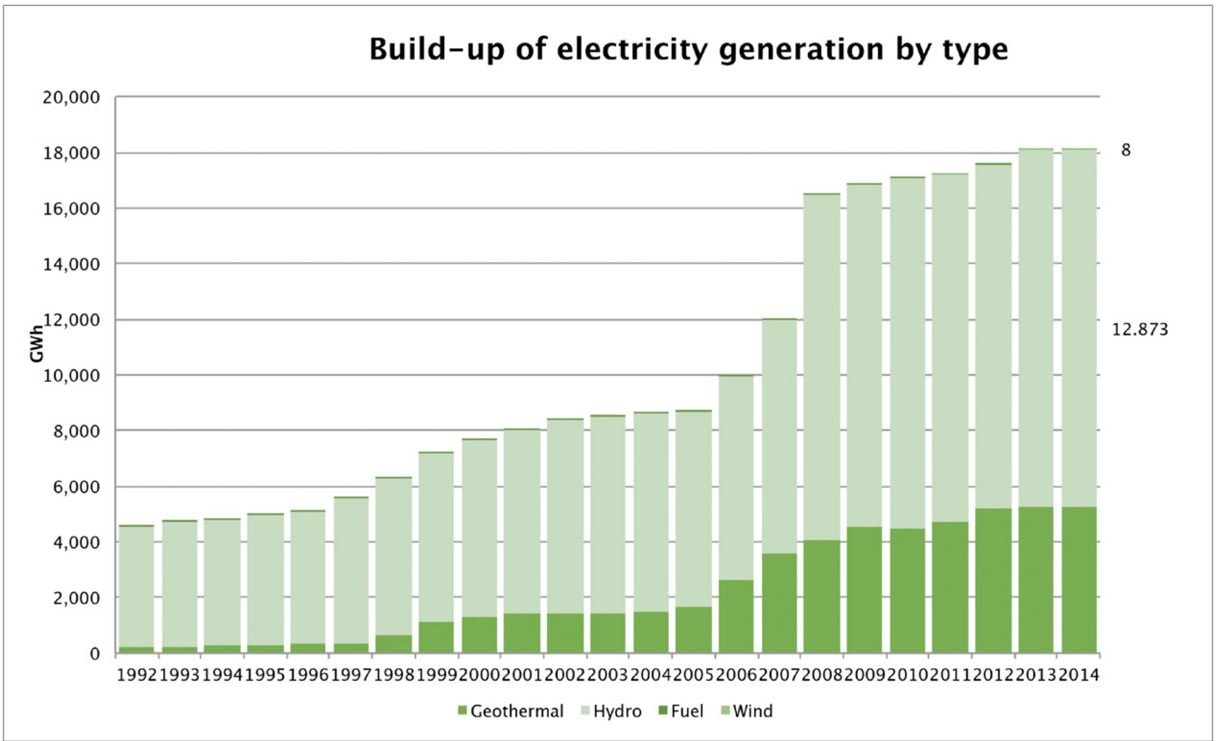

FIG 5.2: *Demand has been met by hydro and geothermal plants; space heating is a key driver* *Source: KPMG Iceland*

In order to all but eliminate the use of fuels in space heating, large geothermal plants with Combined Heat and Power (CHP) have been built. Heat and electricity give these units two revenue streams. As the heating market is nearly saturated, newer geothermal plants can only expect revenue growth from electricity.

Macroeconomic impact

Because the general market demand for electricity has remained relatively constant over the past decade, consumption growth has been driven by the energy intensive industries, which have also had the biggest impact on the economy. Further growth of Iceland's power sector is dependent on attracting more energy intensive industries. The two sectors should be regarded as completely co-dependent, and therefore should be treated as one in terms of their macroeconomic contribution.

Data on the macroeconomic share and economic contribution of the power industry and related sectors is not readily available. However, in 2012 the Institute of Economic Studies of the University of Iceland issued a report on the direct and indirect contribution of the aluminium industry to gross domestic product. As shown in Figure 5.2, the aluminium industry is by far the largest sector measured in electricity use. An executive summary of the University of Iceland study can be seen in Box 5.1.

BOX 5.1

Direct and indirect contribution of the aluminium industry to GDP, Executive summary:

1. Direct and indirect contribution of aluminium industry to GDP was ISK 85-96bn on average at 2010 price levels. This is equivalent to approximately 6-6.8% of GDP. This assessment does not a take into account the demand effect of revenue created in aluminium production.

2. By comparison, the direct and indirect contribution of the seafood sector to GDP, without the demand effect, is 17.5%.

3. Around ISK 40-51bn of the above mentioned contribution of aluminium industry to GDP is indirect, i.e. value added by related activities. This is equivalent to about 3.6% of GDP.

4. The share of aluminium products of total goods exports has grown rapidly during recent years, reaching almost 40%. This ratio is not far from that for fish products.

5. An estimated 4,800 people are employed by the aluminium industry and related sectors, representing 2.7% of the total workforce. Of these, 2,000 work in the aluminium sector, and 2,800 in related sectors.

By assuming that other electricity intensive industries have same contribution to GDP per unit of electricity consumed as the aluminium industry, the figures from the study above can be extrapolated as shown in the following table:

Electricity intensive industries in Iceland		
	GWh	**Share of GDP**
Aluminium	12,02	6 - 6,8%
Aluminium foils	0,26	0,13-0,15%
Other EII	0,93	0,53%
Total EII	**13,21**	**6,6-7,5%**

Table 5.2 *Electricity intensive industries in Iceland* *Source: KPMG Iceland*

The manufacture of basic metals, in particular aluminium, has driven up electricity production and helped propel Iceland's economic growth, especially during and after the 2008-2011 crisis. As such, it has been a strong contributor to the country's recovery.

From 2003 to 2013, annual aluminium production has jumped from 280,000 tons to 836,000 tons, an increase of almost 200%. It is evident that the aluminium industry has become a major component of the Icelandic exports, nearly matching fish products, as illustrated in Figure 5.3.

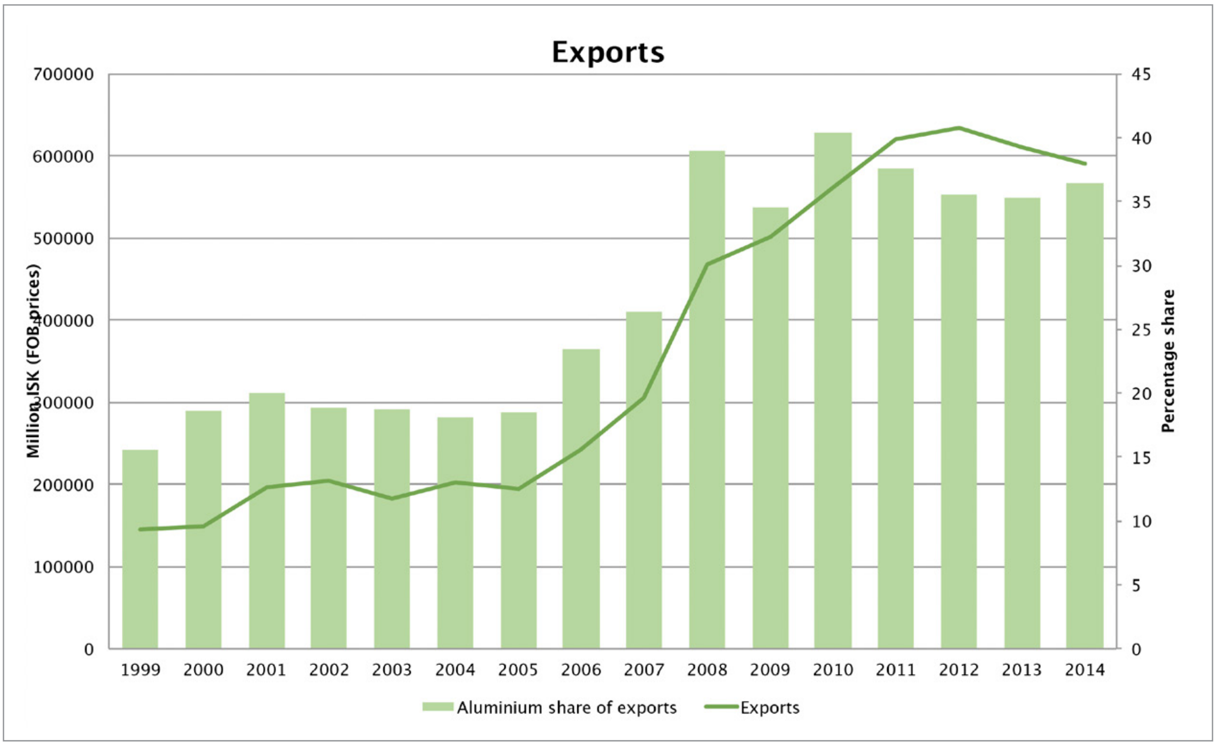

FIG 5.3: *Export growth and aluminium's share*

Source: Statistics Iceland, Gross consumption of electricity 1990-2014 & value of exports and imports 1999-2014

Iceland's energy sector is remarkably labour efficient. Despite a more than 100% increase of output between 2000 and 2014, the industry's share of the workforce remained constant at about 0.8-1.0% throughout the period, demonstrating a high level of productivity (see Figure 5.4 below). Together with abundant hydro and geothermal energy, this places Iceland in a unique position to attract energy intensive industries.

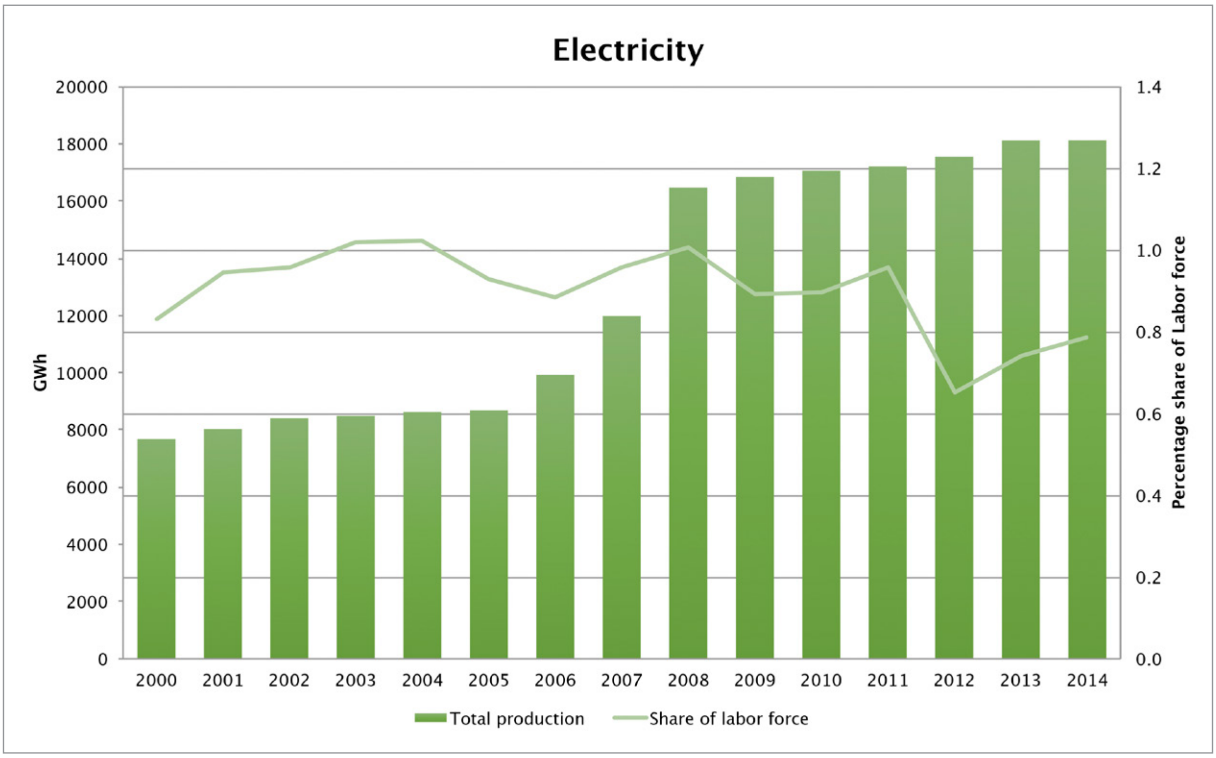

FIG 5.4: *Electricity output and labour share*

Source: Statistics Iceland, Employed persons by economic activity, sex and region 1991-2008 & 2008-2014, Gross consumption of electricity 1990-2014

Outlook for the world aluminium market

From 1970 to 2014, annual world primary aluminium consumption rose from 10 million tons to 50 million tons. Annual per urban capita primary aluminium consumption was relatively constant over the first three decades of this period. From 2000, per urban capita primary aluminium consumption began to rise and had increased by about 30% in 2014. The increase can mainly be attributed to China, where consumption rose more than 400%, while it remained virtually unchanged in the rest of the world.

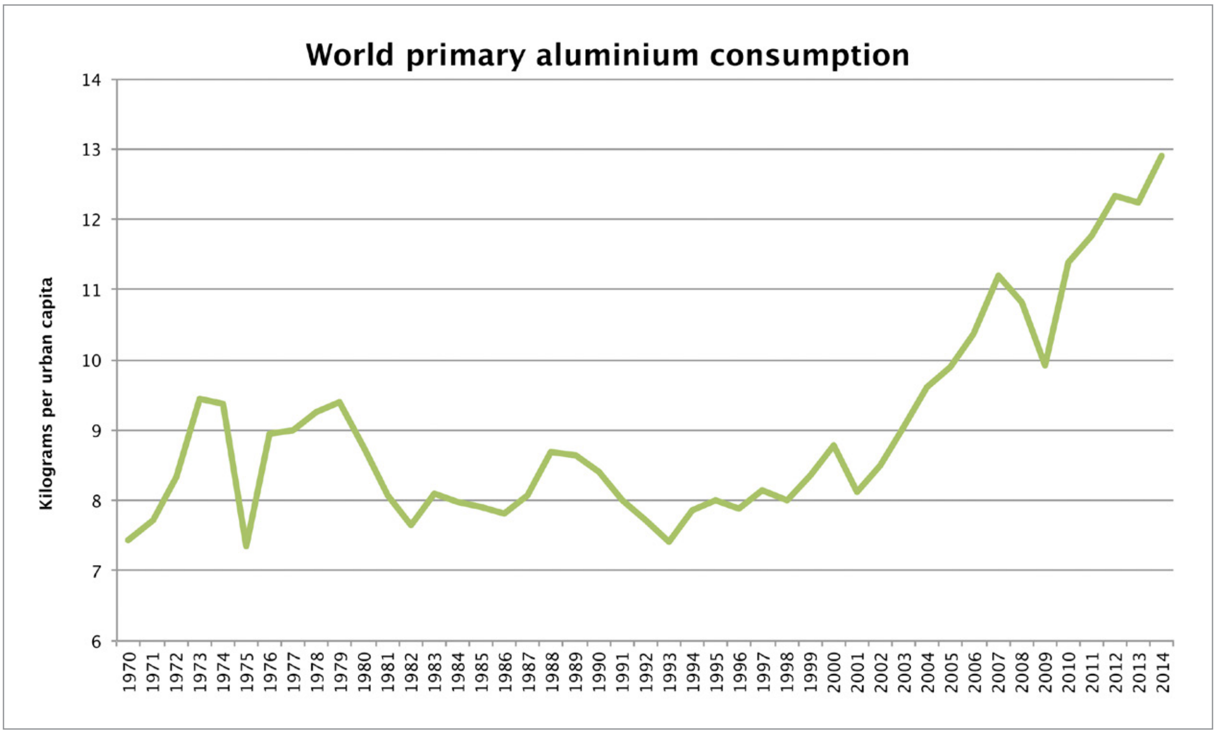

FIG 6.1: *World primary aluminium consumption per urban capita* *Source: WBMS, UNDESA, MOMA calculations*

The development over the past four decades suggests that a further increase in world urban population will lead to greater primary aluminium consumption. The United Nations Department for Economic and Social Affairs (UNDESA) projects that by 2030, total world population will have expanded by another 800 million to 1.5 billion. Over the same period, UNDESA projects world urban population to grow 1.2 billion to just above 5 billion, resulting in a world urbanisation rate of 60%.

A larger world urban population will lead to higher demand for housing, appliances and transportation, which all use aluminium as input. If per urban capita primary aluminium consumption remains constant at around the present level, annual world primary aluminium consumption will be grow by 10-15 million tons in 2030. If per urban capita primary aluminium consumption continues the trend growth since 2000, then world primary aluminium consumption could grow by as much as 20 million tons by 2030.

A continued rise in world urbanisation will rely on steady world productivity growth. In the 2000s, world GDP per capita growth was around 2% per year. However, since 2012 it has been close to half of that. This may be attributed to cyclical factors and not indicate a structural change. The OECD's 2012 medium and long term scenarios for global growth support this argument. Then OECD projected world potential labour productivity growth at 2.7% per year over the period 2018-2030, compared with 1.5% over the period 2001-2007.

With half of the world's current available bauxite reserves located in Australia and Guinea and another quarter found in Brazil, Indonesia, Jamaica and Vietnam, a prerequisite for continued growth among aluminium producers without access to bauxite resources is low barriers to trade in the global economy.

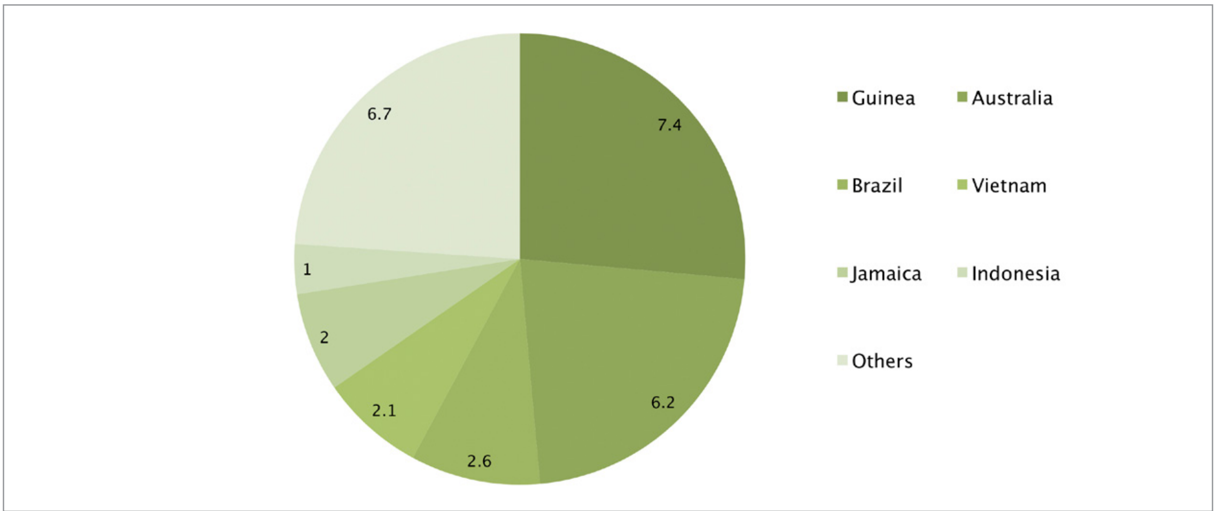

FIG 6.2: *World available bauxite reserves, million ton, 2015* *Source: USGS*

The world economy became increasingly globalised during the 1990s and 2000s, as measured by the share of goods trade in world GDP. Since 2008, total goods trade's share of world GDP has declined slightly. This may be due to cyclical factors, as the share of goods trade in GDP tends to fall during periods of lower economic growth or a structural break in globalisation. The recent Trans-Pacific Partnership agreement and the pending Transatlantic Trade and Investment Partnership agreement serve as evidence against the latter. On a micro level, the 2014 Indonesian ban on mineral ore exports does show that globalisation is facing protectionist headwinds.

Over the past two years, the price of oil has more than halved, falling more than the corresponding decline in world income denominated in US dollars. The oil price may now be regarded as close to its average real value during the past three decades. Consequently, the world purchasing power in oil has increased after being low for a number of years. This development has made fuel for transportation and oil for heating relatively cheaper. The former may have a positive impact on demand for cars and aircraft, both products that use a lot of aluminium in production.

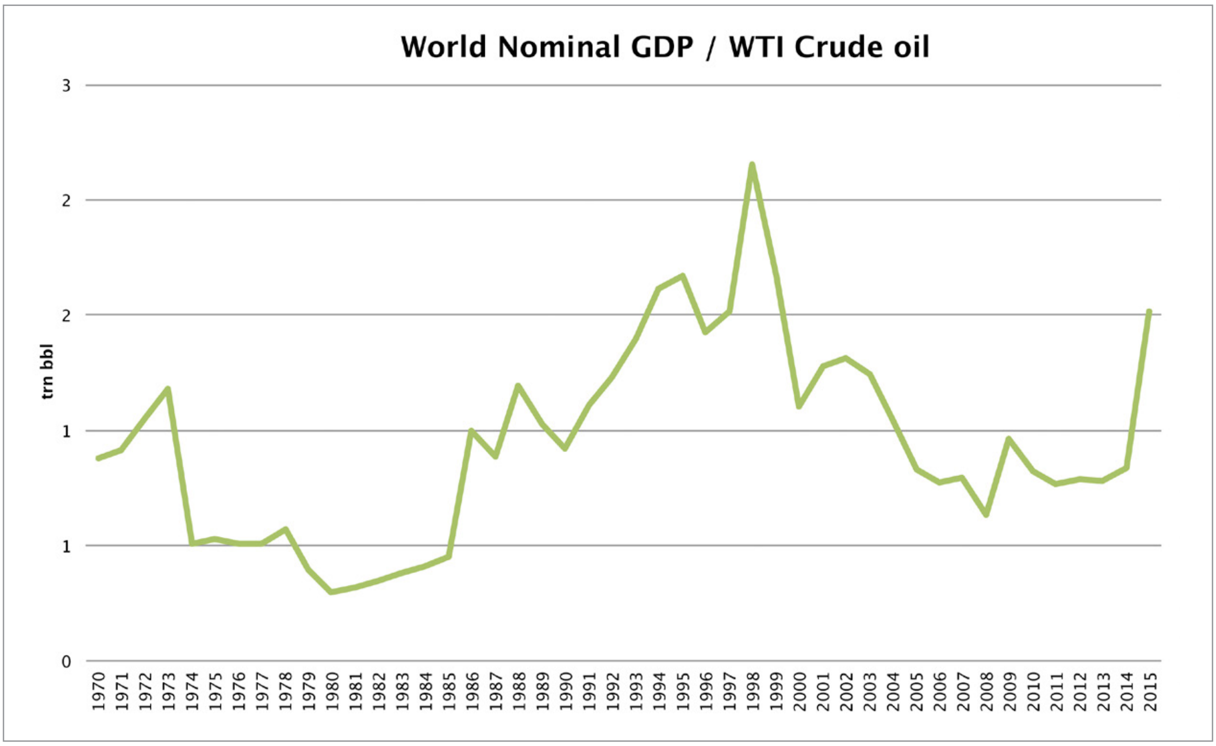

FIG 6.3: *World nominal GDP per capita / price on WTI crude*

Source: World Bank, MOMA calculations
NB: 2015 is MOMA estimate

World steel consumption remains higher than that of aluminium. For some purposes, the two metals are close substitutes. This is also reflected in their prices, which have moved closely together in recent years. The discount on steel in 2015 may be attributed to an increase in exports from China.

FIG 6.4: *World steel and aluminium prices* *Source: LME, NYMEX and MOMA calculations*

Current available bauxite and iron ore reserves would allow production to continue at current rates for another 100 and 25 years, respectively. However, the known reserves of both minerals are even larger. This suggests the market for primary aluminium should not face an upstream supply constraint for the next several decades.

Global aluminium demand set to decelerate

Over the past 15 years, the world's primary aluminium consumption has risen about 5% annually. Our base case for the annual growth until 2030 is about 2-3%, based on the assumptions described above. This estimate corresponds to the growth rates registered during the 1990s. Growth in world urban population will likely slow over the coming 15 years, which will make it difficult to maintain the high growth of recent years. On the other hand, a low oil price, more globalisation and higher productivity growth will support demand for aluminium.

Furthermore, we stress that if a construction boom, similar to that experienced in China over the past 15 years, occurs in another large developing economy, then aluminium consumption will likely exceed our base case and more closely approximate the growth rate of recent years. In this regard, we note that the urbanisation rate in populous countries such as Indonesia and Nigeria is about 55% and 45%, respectively, compared with only 30% in India and 40% in Pakistan.

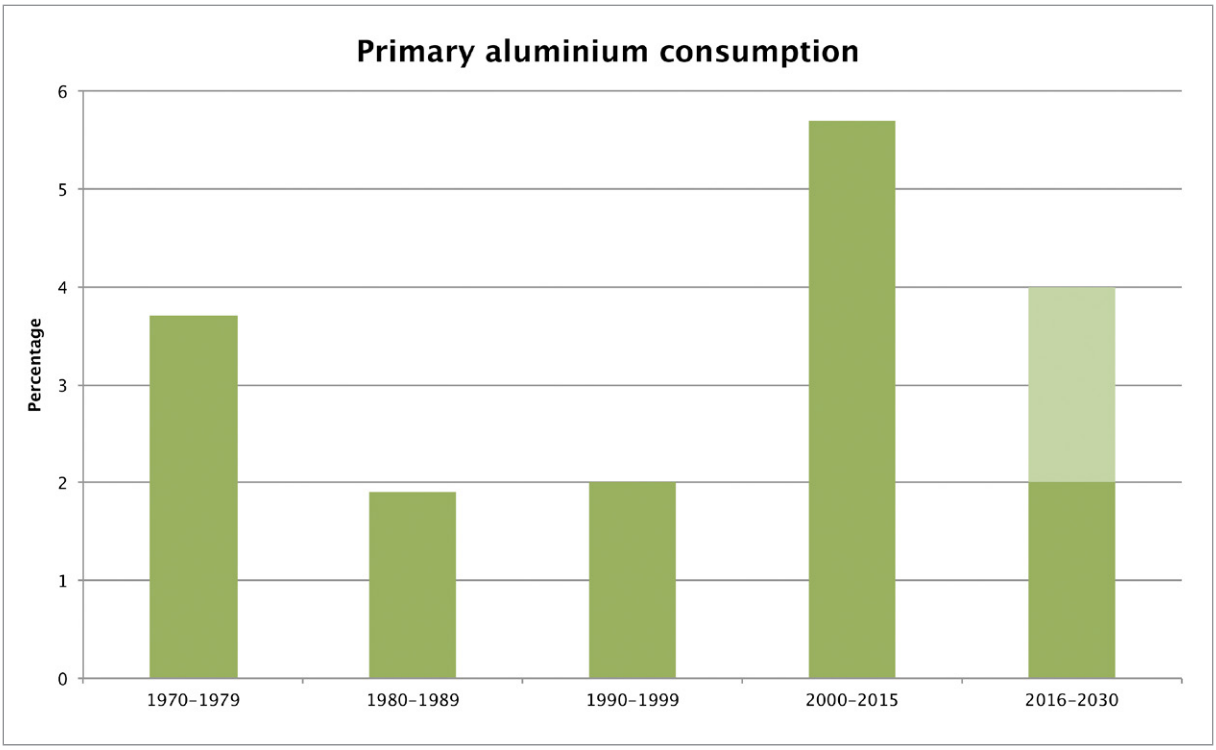

FIG 6.5: *Outlook for world primary aluminium consumption* *Source: WBMS, MOMA estimates*

Outlook for energy prices has been less supportive

Since about 80% of Iceland's total energy consumption is related to aluminium production, it is very likely that local power demand will continue to develop more or less in line with the global demand for aluminium. Accordingly, our main scenario calls for energy demand to grow by 2-3% annually through 2030, assuming there are no major changes in the technology of aluminium smelting.

While this certainly would not be a catastophic scenario, it is much less supportive for the power industry than during the 'boom years.' It seems reasonable to assume that Iceland's energy sector will not grow much faster than the rest of the economy for the next 15 years.

While we can construct plausible scenarios about future demand, it is much harder to hold firm convictions on the outlook for energy prices. In the short run, prices tend to be driven by imbalances between supply and demand, which by definition are impossible to forecast. That said, over the long run we should expect energy prices to reflect the marginal cost of production. It is reasonable to assume that these costs will evolve more or less in line with labour and capital costs in general.

Several factors should be highlighted when considering the outlook for electricity demand and prices:

1) Softer global demand growth
2) The "Merit Order" effect – subsidies for "green energy," particularly in Germany
3) CO2 emissions globally
4) Environmental standards in Iceland

These factors are related to the global energy demand, the relative demand for locally produced energy, as well as production costs.

Softer global demand growth

We have already discussed that global energy demand is likely to grow significantly more slowly than in the boom years. This obviously will help reduce the risk of "overheating" in the global energy markets, making the risk of "super spikes" in energy prices most likely smaller than during the boom period. Instead, the risk is that excess supply capacities could generate major slumps in energy prices during cyclical downturns in the global economy.

The Merit Order effect

Most European countries incentivize the build-up of renewable or "Green" energy. Different approaches are used, such as tax incentives or a secured minimum price for sold electricity. Germany, for example, has pioneered the latter methodology by offering renewable energy developers attractive Feed-in Tariffs (FiT) through 20-year contracts. Contracts for Differences (CfD's) are similar instruments offered in the UK.

Electricity generated from the power plants built under these schemes is fed into the grid, fulfilling part of overall demand. Germany is an example of a market that meets a significant amount of demand in this way: electricity from renewable sources has grown from 3.4% in 1990 to 28.8% in 2014. This additional power shifts the supply curve to the right and thus lowers settlement prices on the power exchange. Electricity prices have plunged due to this phenomenon, which is often referred to as the ***"Merit Order Effect"***.

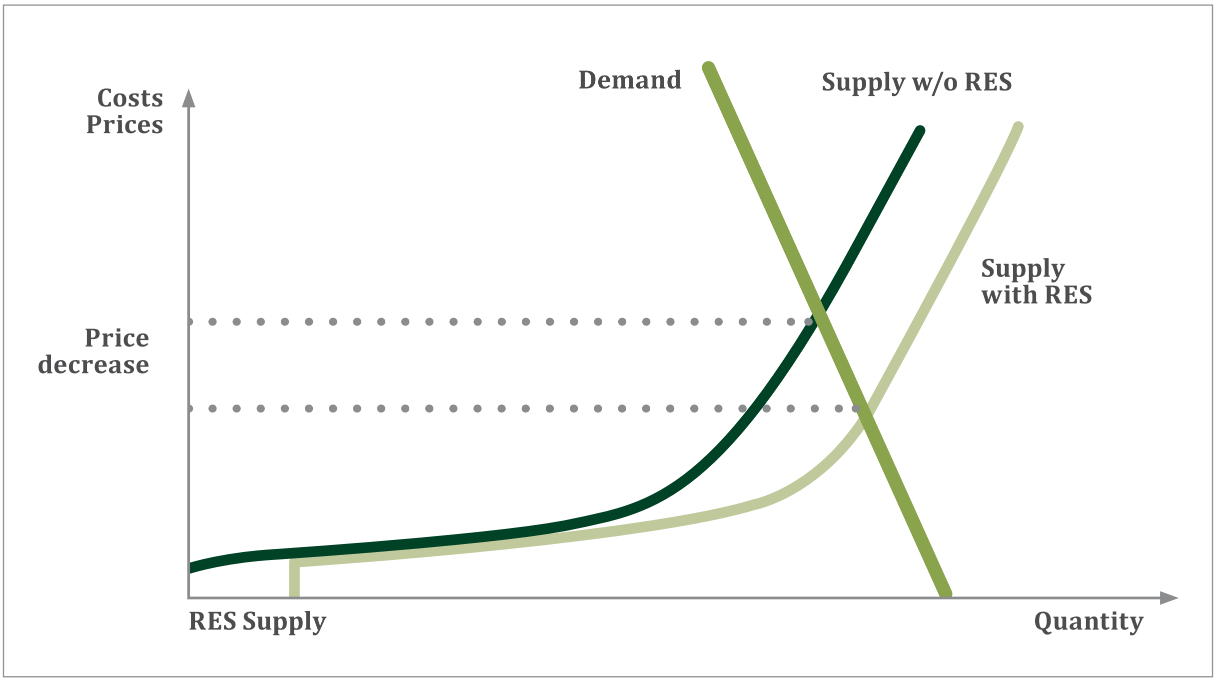

FIG 7.1

The additional cost burden of renewable energy is borne by end users through taxes such as Germany's EEG-levy (d. EEG Umlage). Most electricity users pay a higher price due to renewable energy incentive schemes. But this is not true for all customers. Large end users such as aluminium and silicon metal producers, paper mills and chemical companies are exempted from most, if not all, renewable energy surcharges. These exemptions allow them to enjoy lower market prices. The total effect in some cases is equivalent to granting state incentives to electricity intensive industries. This weakens the competitive position of countries like Iceland, which have not introduced similar incentives and are not connected to the European grid.

Stricter standards for global CO^2 emissions

The global community remains focused on reducing global CO^2 emissions. Even though it is hard to say how the global discourse will develop in coming decades, it seems reasonable to assume that the trend will continue towards even stricter global emissions standards.

This is bad news for global energy demand. However, from a relative perspective, tougher CO^2 emission standards could be good news for Iceland's position in the global energy markets. This is because Icelandic energy output generates significantly lower CO^2 emissions than alternative forms of energy production.

Environmental standards in Iceland

While the energy sector's positive effects on the Icelandic economy have generally been accepted by policy makers and the public, there has been increased opposition in recent years to its further expansion. This opposition is mostly based on concerns about the environmental impact of power generation and aluminium production.

Whatever one thinks of these concerns, there is no doubt that a substantial expansion of energy and aluminium output appears to be politically unacceptable for now.

Paradoxically, this situation could push local energy prices in either direction. Environmental demands could keep local power companies from winning new business (for example, from new aluminium smelters), which would tend to put downward pressure on Icelandic energy prices (relative to global prices). On the other hand, stricter environmental standards may also increase the marginal cost of Icelandic energy production, which could drive up energy prices over the medium term.

Iceland is likely to maintain a strong global position – but in a challenging market

There are factors that could exert both upside and downside pressures on Icelandic and global energy prices. On balance, we do not expect the same kind of spike in energy prices seen during the boom years. Instead, "soft" global demand growth is likely to moderate price movements in the period until 2030.

That said, Iceland's relative position remains very strong and there is every reason to expect the country will be able to defend its standing in the global energy markets. This will only happen, however, if the Iceland's energy sector continues to improve its efficiency and competive edge.

In the following chapter, we will take a close look at Iceland's market position through the lens of a SWOT analysis.

SWOT Analysis

In this section of the report, we will conduct a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the Icelandic energy sector in order to deepen our understanding of its position in the global energy markets.

Strength

- 100% renewable energy and low production cost.
- Unharvested renewable power potential available – both hydro and geothermal – and perhaps wind in the future.
- Financially strong companies with stable cash flow.
- Primary metal production cluster gaining strength through the build-up of new companies (mainly silicon metal these days) – Iceland to acquire one of the world's densest knowledge bases in aluminium + silicon metal production.

Weakness

- Iceland's distance from major markets. High transport costs of raw materials for production and finished goods to customers.
- Unclear government policy on how power potential will be exploited as the master plan (e. http://www.ramma.is/english) is still under political debate.
- Most energy locked in long term PPAs, leaving very little flexibility to establish transparent power trading (exchange market).
- Market structured as oligopoly; Landsvirkjun holds >70% market share and is the only company adding new capacity.

Opportunities

- Possible interconnection with the UK, where CfD prices for renewable energy are very attractive.
- Increase efficiency of hydro storage plants by developing wind energy.
- Electrification of transport sector, i.e. cars and ships.

Threats

- Lower metal prices may reduce demand from aluminium smelters or lead to plant closures.
- Lower power prices in competing countries due to the merit order effect (long term) and lower fossil fuel prices (short term).
- Less public acceptance of power plants and HV systems in Icelandic nature – increasing conflict with the very rapidly growing (+25% YoY) tourism sector.

Strength

Iceland clearly enjoys a very strong position in the global energy market thanks to its access to cheap local energy sources. The country is far ahead of most of its peers in solving the energy trilemma of reliable, renewable and affordable energy. All electricity is reliably produced from renewable sources at low cost.

Fully 100% of Iceland's electricity is generated from renewable energy sources; its hydro- and geothermal power plants operate at low costs and with minimal emissions of greenhouse gases. Despite a very significant build-up of production capacity, there is still plenty of economical renewable power potential available – both hydro and geothermal – while wind production is in a take-off phase.

Iceland's production profile means that unlike many other countries with a high renewables uptake, its energy output is both predictable and controllable. Rather than relying on wind or solar power, both of which are intermittent power sources, Iceland's renewable energy is manageable and reliable.

Geothermal provides a stable base load of 665 MW (24% percent of total capacity), while hydro accounts for 1,984 MW (72%), leaving ample scope to meet demand fluctuations. Wind power and emergency diesel back-up generators account for 117 MW (4%) and 3 MW (0%) respectively. That brings the total capacity of the Icelandic power system to 2,769 MW[7].

The flexibility of local energy production and stable demand lead to lower losses and give Iceland an economical power system.

Iceland is the runaway world leader in energy production per capita at 55 MWh in 2012, compared with Norway in second place with 23 MWh. In comparison, high-income OECD countries produce on average 9.1 MWh per capita, while Denmark – a renewable energy leader – produces 6 MWh[8]. Icelandic energy sector producers are also efficient, needing fewer workers than Norway per TWh[9].

Electricity generators in Iceland are financially strong companies with stable cash flow and minimal fluctuation in expenditures due to the absence of fuel costs. The high proportion of stable demand from energy intensive industries enhances the stability of the energy system and reduces the need for investment in transmission and distribution infrastructure.

Iceland is emerging from its status as a peripheral region, characterised by organisational thinness, and becoming an established industrial region with industrial lock-in, characterised by specialisation in mature industries and the dominance of large firms. Furthermore, the country's primary metal production clusters are still gaining strength through the build-up of new companies (mainly silicon metal).

7. Raforkutölfræði, Orkustofnun May 19th 2016
8. Electric power consumption, World Bank May 19th 2016
9. Charting a Growth Path for Iceland, McKinsey Scandinavia, McKinsey & Company (2012)

Human capital in the energy sector is very high and Icelandic expertise is sought around the world. Icelandic firms operate globally, exporting know-how and solutions to places as diverse as China, India, Africa and the Caribbean. Furthermore, educational institutions such as the Geothermal Training Programme of the United Nations University and the Universities of Iceland and Reykjavík offer energy-related programmes taught in English.

Iceland's transmission system delivers energy with reliability that is among the best in the world. The grid services to industry are very robust, which generates positive spin-off effects such as lower system losses and greater stability.

Compared with other renewables-based energy systems, Iceland's offers the benefit of having production and consumption in relatively close proximity. This decreases the need for investment in the grid and also lowers transmission losses. The grid is strongest where demand is highest. Very few redundant investments have been made.

The average cost of renewable energy production in Iceland has been and remains lower than average production costs in most other countries, regardless of production method. This gives Iceland a competitive advantage in both costs and environmental effects.

Weakness

Iceland is located far from other markets, which makes transportation of production inputs and of finished goods to customers costly.

Another key weakness is uncertainty about the regulatory framework for the industry. Because Iceland's Master Plan for Nature Protection and Energy Utilization[10] is still under political debate, it is far from clear whether its energy potential will be fully exploited.

In this regard, it should also be noted that Icelandic public opinion is sceptical about further expansion of the aluminium and energy sectors, mostly for environmental reasons. While these concerns certainly should not be ignored, uncertainty over government policy in this area has made new investment projects less predictable. Similarly, uncertainty has been increased by recent Supreme Court rulings about transmission upgrades and expansions.

Domestic politics are seen as playing an influential role in investment decisions, moving some energy projects forward while holding others back.

A frequently cited drawback of the Icelandic energy sector is the prevalence of long term PPAs, leaving very little flexibility to establish transparent power trading through an exchange market. In this sense, the fact that three-quarters of the country's power output is consumed by fewer than 10 buyers can be considered a weakness.

As already stressed in this report, Landsvirkjun's strong market position and its close ownership and funding relationship to grid operator Landsnet is a concern.

10. Master Plan for Nature Protection and Energy Utilization

We would also highlight the following problems:

- The transmission grid is ageing and requires new investments and upgrades.
- Large parts of Iceland are suffer from transmission capacity constraints, leading to lost opportunities in industry. This is especially true in the North, North-West, and South-East. (Landsnet, 2015)
- Some regions in Iceland do not have (N-1) security of supply, making them vulnerable to blackouts following incidents. (Landsnet, 2015)
- The lack of an extensive, reliable and authoritative central database on the energy industry and environmental affairs creates information asymmetry.
- The National Energy Authority has been criticised for being too weak.
- Geography places unusual stresses on the energy system. Frost and wind severely stress grid infrastructure. Exposure to the elements causes frequent breakdowns of regional transmission and distribution.
- The isolation of Iceland's power system means that reservoir management is suboptimal because of security of supply issues. In dry years, hydro facilities are at risk of water shortages. Conversely, in wet years, extra power generating opportunities are wasted due to lack of buyers.

Opportunities

While the strengths of the Icelandic energy sector are well-known, the opportunities are of a more speculative nature. Nonetheless, there are some obvious opportunities that the industry can seize in the coming decades.

A key opportunity – but also one subject to considerable uncertainty – is the possibility of an interconnection with the UK, where CfD prices for renewable energy are very attractive. Most power purchasing agreements in Iceland remain confidential, but on average, Landsvirkjun received 24.5 USD/MWh in 2015, including transmission costs. By comparison, the weighted average price for CfD´s at the February 2015 DECC auction was 80.5 GBP/MWh (123 USD/MWh[11]. This illustrates the potential gains from having an interconnection with the UK. That said, there are presently considerable uncertainties about such a potential project.

Iceland can harness wind power with greater efficiency than most because of the synergy between hydropower and wind. By ramping hydropower up or down depending on wind-generated output, it is possible to mitigate the intermittency that decreases the value of wind power. This interplay also increases the value of hydropower's flexibility, which is backed up by reservoirs. The result is greater production of zero marginal-cost energy, contributing to an economical power system.

Electrification of the transportation sector, especially cars and ships, would help Iceland become a world leader in decarbonisation. This unharnessed clean power potential could eliminate oil from the primary energy mix. In 2013, the share of oil was 12.1% of total primary energy, or ~8500 GWh. Of this, shipping and automobiles accounted for less than 6000 GWh, or 69% of oil consumption[12]. By comparison, Iceland generated 18,000 GWh of electricity in 2013[13].

11. Contracts for Difference (CFD) Allocation Round One Outcome, Department of Energy and Climate Change, May 20th 2016
12. Eldneytisnotkun , Orkustofnun, May 20th 2016
13. Raforkutölfræði, Orkustofnun May 19th 2016

As carbon policies become more influential, decarbonisation of power systems around the world will increasingly rely on intermittent energy sources. These are, as yet, more expensive and less reliable than the clean and renewable energy on offer in Iceland. This has the potential to lure a wider variety of producers and customers to the country. The trend has already started with wind power and a growing interest in small scale hydro. The demand side has been evolving as well. Previously, the Icelandic energy system grew by large steps, often pairing an aluminium smelter with a large hydropower plant, e.g. Búrfell and Alusuisse or Kárahnjúkar and Alcoa. Currently, the growth can be found in businesses like industrial greenhouses and data centres, which operate at a much smaller scale.

Recent trends in PPAs have also been towards shorter agreements, as evidenced by Century Aluminium´s four-year deal with Landsvirkjun, which replaced a more than 20-year agreement. This could lead to a more dynamic electricity market in Iceland.

Proposed grid upgrades and expansions along the coast or North-South through the highlands will open up new locations for both producers and consumers.

Geothermal energy provides many useful by-products. Further development of these resources holds significant promise of wealth and knowledge creation. Two very notable projects are the Carb-fix carbon capture and storage project at Hellisheiði and the Iceland Deep Drilling Project. Both are examples of international co-operation.

Icelandic energy expertise is sought around the world, but this export business has not reached maturity. At Landsvirkjun´s 2016 annual conference, the company announced very positive findings about the possibility of selling tours of the Icelandic energy system. This is in addition to Orkuveita Reykavíkur´s successful visitor centre at the Hellisheiði power plant.

Iceland is well-placed to become a world leader in electrified transport. As an island with cheap and clean energy, a small population and reliable distribution grids, it could become a test lab for new technologies in this sector.

With so many fjords and vast store of maritime knowledge, the possibility of developing tidal- and wave power cannot be ruled out. Iceland has the opportunity to become a leader in this emerging industry. The island's existing hydropower capacity is an asset in this regard, due to the intermittency of both tidal- and wavepower.

Reservoir management could be improved with a stronger grid, an interconnector to a foreign country, and more demand management.

Threats

While the Icelandic energy sector has performed strongly over the past decade, it also faces major challenges, or even threats. We particularly want to highlight the following:

- Lower metal prices may cut revenue via aluminium priced contracts or even lead to closure of metal plants.
- Lower power prices in competing countries due to the merit order effect (long term effect) and lower fossil fuel prices (short term effect).
- Less public acceptance of power plants and HV systems in Icelandic nature; increasing conflict with the very fast growing (+25% YoY) tourism sector.
- Climate change is increasing the risk of damage caused by lightning strikes.
- Climate change is expected to lead to more frequent and severe storms, increasing the frequency of incidents in the transmission grid.
- Natural disasters such as volcanic eruptions, flash floods caused by glacial melt, and earthquakes could threaten vital infrastructure.
- Foreign technological advances in renewable energy may erode Iceland's competitive advantage, especially if energy storage, solar and windpower become significantly cheaper.
- The Icelandic Master Plan for Nature Protection and Energy Utilization is threatened from two sides. Power generators are unhappy at the degree of conservation suggested by the master plan committee. The conservation movement, on the other hand, is unhappy with some options that have been put in the utilisation category. This dispute threatens to derail or at least delay the process, leading to greater uncertainty.
- Environmental Impact Assessments are becoming ever more difficult to implement for both power production and power transmission.
- The value of UK CfD strike price agreements appears to be declining. An auction in 2015 yielded a weighted average price of 80.5 GBP/MWh, significantly lower than previous price guidelines from DECC.
- The UK is pursuing other interconnector projects and is on course to fulfil their interconnection obligations without including Iceland.

Policy recommendation and conclusions

Conclusion: Policy scenarios

The energy sector plays a vital role in the Icelandic economy and that will undoubtedly also be the case in the coming decades. Hence, Iceland's geothermal energy is a clear comparative advantage for the Icelandic economy.

However, the analysis undertaken in this report also shows that there is room for improvement in terms of the regulatory framework for the Icelandic energy sector.

The purpose of the energy sector's regulatory framework should be to ensure the maximum possible contribution to the welfare of all of Iceland's citizens.

To help achieve this policy objective, we can define three sub-objectives for the sector:

- Increase competition
- Increase productivity
- Increase the transparency of local energy trading and pricing

Based on these objectives, we present the following policy scenarios for energy reform in Iceland:

Split up and privatise Landsvirkjun, set up a Natural Resource Fund

Government-owned Landsvirkjun today has a market share of about 70% and as such is the dominant player in Iceland's energy market. It is clearly problematic to give one market participant such a dominant role, particularly because power generation is not a natural monopoly (there are no major economies of scale).

The OECD has earlier suggested reducing Landsvirkjun's dominant market position by having the company sell off assets to restore competition to the energy sector. This option clearly should be considered.

To ensure that the sale of these assets benefits all Icelanders, consideration should be given to using any revenue to set up a Natural Resource Fund (NRF), which in the future could pay out a tax-free yearly or monthly Citizens Dividend to all Icelanders, based on the yield from the Fund.

Similarly, the NRF could also receive income from other energy, environment and resources taxes – for example, levies on the fishery industry and tourism. Over time, the Citizens Dividend could replace other income transfers such public pensions and social benefits.

Such a scheme would have the clear advantage of promoting competition and therefore likely improving the productivity in the energy sector. Furthermore, it would significantly de-politicise the industry, while ensuring that every Icelandic Citizen gets his or her "fair share" of the energy sector's returns

Separate Landsnet from Landsvirkjun

When looking at the Icelandic energy market, it is extremely important to grasp the key distinction between the production of energy and its transmission. While power generation can and should be considered as a normal competitive market, preferably with a number of producers operating under normal market conditions, that cannot be said for the "market" for energy transmission.

The power grid is what economists call a natural monopoly. As such, it should be regulated and to a large extent is so regulated today. Government-owned Landsnet controls Iceland's energy grid. However, it is partially owned by the dominant market player, Landsvirkjun.

This is unfortunate because it potentially gives Landsvirkjun a more favourable market position than other energy producers. The logical response would be to make sure that Landsnet and Landsvirkjun are completely separated in legal, economic and ownership terms.

Today, Landsnet is dependent on funding from Landsvirkjun. This is also highly unfortunate. There should be a full financial separation between the two companies, with Landsnet obtaining its funding through the financial markets – for example, by issuing bonds.

Thought should be given to privatising Landsnet as well, with the revenue going to the Natural Resource Fund. However, contrary to the energy producers, a privately owned Landsnet should continue to be tightly regulated. This would ensure that its prices reflect the marginal cost of energy transmission and guard against excess profits stemming from the use of monopoly power. One example of a privatised, but regulated, energy grid is the UK's National Grid Plc., which stopped being a state-owned company in 1990.

Set up an energy exchange

Energy in most European countries today is traded at exchange rates. That is not the case in Iceland, where energy prices are set on a bilateral basis between buyers and sellers. This reduces transparency in the marketplace and increases the risk that some players will misuse their market power to extract excess profits.

Another key advantage of establishing an energy exchange is that it opens the door for trading in energy futures and options, making it significantly easier for energy consumers to hedge against price risks.

It is therefore advisable that policies are put in place to establish an energy exchange in Iceland based on those in other European countries. There are numerous ways to accomplish this.

Breaking up Landvirkjun would probably help stimulate the need for an energy exchange. Another possibility could be to make it mandatory for the large energy producers to sell a certain percentage of their output through the energy exchange during the first 5-10 years of its existence This is essentially how the Polish energy exchange was established.