Karahnjukar Hydropower Project

Estimate of Profitability

Extract

Prepared for the Iceland Nature Conservation Association

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Introduction

Landsvirkjun, the state-owned electric power company in Iceland has for some time been planning a large hydropower plant in the area north of Vatnajokull, Europe ´s largest glacier in the east of Iceland. The facility would be built to produce electricity for a 390,000 ton aluminium smelter in Reydarfjördur on the east coast of Iceland.

Until recently a consortioum of Icelandic banks, pension funds and the Norwegian company Norsk Hydro planned to build and run the Reydarfjordur smelter, a prerequisite for initiating the Karahnjukar project. Early 2002 Norsk Hydro decided to postpone its final decision on the project. Subsequently the Icelandic government decided to seek other investors. In september Alcoa and the government signed an agreement to take up talks to build a 295,000 ton smelter in Reydarfjordur run on electric power from the Karahnjukar plant.

According to a previous study conducted for the Iceland Nature Conservation Association the Karahnjukar plant would not be financially viable when valued based on market rates of interest and return on equity expected for a comparable project. As a state owned company Landsvirkjun does however enjoy full financial backing from the state of Iceland and is able to borrow at sovereign rates. The Sumitomo Mitsui Banking Corporation prepared an assessment of Landsvirkjun´s plans in September 2001 confirming that the project could support the cost of capital demanded by Landsvirkjun based on Landsvirkjun´s estimate of future power prices.

There are considerable differences between the current and earlier plans. The size of the power plant is different as well as the expected investment. The buyer profile is different which no doubt has an effect on interest rates and the construction timeline for the Karahnjukar plant is considerably shorter according to the current plans.

This report aims to compare the financial characteristics of the earlier plans for the Karahnjukar plant with the current plans. This includes an analysis of buyer risk profile, estimate of probable power price based on current and forecasted aluminium prices and the constraints provided by the general cost structure in the aluminium industry.

Earlier plans and estimates of profitability

Project characteristics

According to earlier plans Landsvirkjun was to build a 750 MW hydropower station in the Vatnajokull area by damming several rivers and creating a 57 km^2 reservoir in the area. In addition Landsvirkjun planned to increase the capacity of the geothermal power station at Krafla to fulfill smelter requirements of 5,500 gwhrs/year.

Landsvirkjun´s estimate of profitability

Landsvirkjun has conducted estimates of profitability for the project. In 2001 the company commissioned the Sumitomo Mitsui Banking Corporation[1] to prepare an analysis of their estimates. According to the Sumitomo Mitsui report the expected investment was USD 1,200 million, or ISK 102,000 million, with annual maintenance cost of USD 12 million and revenues of approximately USD 100 million. The WACC[2] provided by Landsvirkjun was set at 5.23% in real terms[3], 10% on equity and 3.6% on debt with a debt ratio of 75%. The conclusion of the Sumitomo Mitsui report was that the project could sustain a WACC of 5.9% based on a constant aluminium price of USD 1,300/ton over the life of the project. When modelled based on a consensus estimate of 1.1% annual long term decrease in aluminium price this implies a price of 19 US mills/kwh. at the start of the project.

Profitability analysis conducted for the INCA

A study commissioned by the Iceland Nature Conservation Association, published in June 2001, focussed on analyzing the proper rates of return for the Karahnjukar project. According to generally accepted principles of corporate finance the financial circumstances of Landsvirkjun as a state monopoly bears no relevance to the investment decision. Based on this principle proper return was derived from the financing rates for the Reydaral project and general rates for utilities similar to Landsvirkjun.

According to this analysis the project would give a negative net present value (NPV) of USD 180 million, given a starting energy price of 20 US mills[4]/kwh and a negative NPV of USD 270 million given a more realistic price of 17,5 US mills/kwh.

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[1] Sumitomo Mitsui Banking Corporation: "Report on the Karahnjukar Hydroelectric Project", London 2001. (Available from www.lv.is)
[2] Weighted Average Cost of Capital – an average of the required return on debt and equity.
[3] All real figures based on a 1.8% long-term inflation estimate.
[4] The most common measurement unit for price to heavy industry. A US mill is 1.000th of a US dollar.

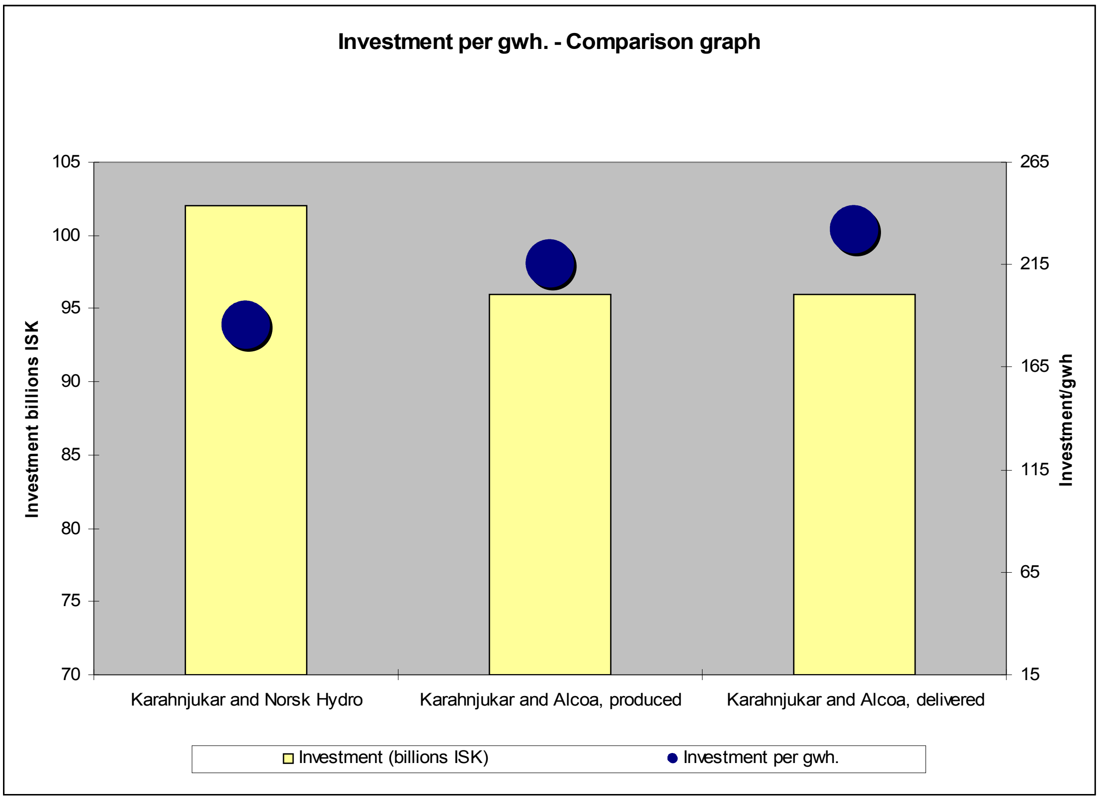
New plans with participation of Alcoa – What has changed

Changed project characteristics

The aluminium smelter planned by Alcoa in Reydarfjordur will be considerably smaller than the one planned by Norsk Hydro earlier, 295,000 ton/year instead of the 390,000 ton smelter originally planned. According to Landsvirkjun´s published figures the revised size of the Karahnjukar power plant is 630 MW producing 4,450 gwh/year. As before the power plant would be built specifically to serve the smelter but according to the electricity usage per ton of aluminium produced of 14,000 kwh the smelter will need 4,130 gwh/year, which means the power plant will not be fully utilized by the smelter.

Cost structure

The original investment of ISK 102,000M decreases to ISK 96,000M, a reduction of 5.9%. Thus the cost per gwh produced goes up from ISK 185.5M to 215M, an increase of roughly 16%. Accounting for the smaller smelter size the cost per gwh. delivered goes to ISK 232M, an increase of 26%.



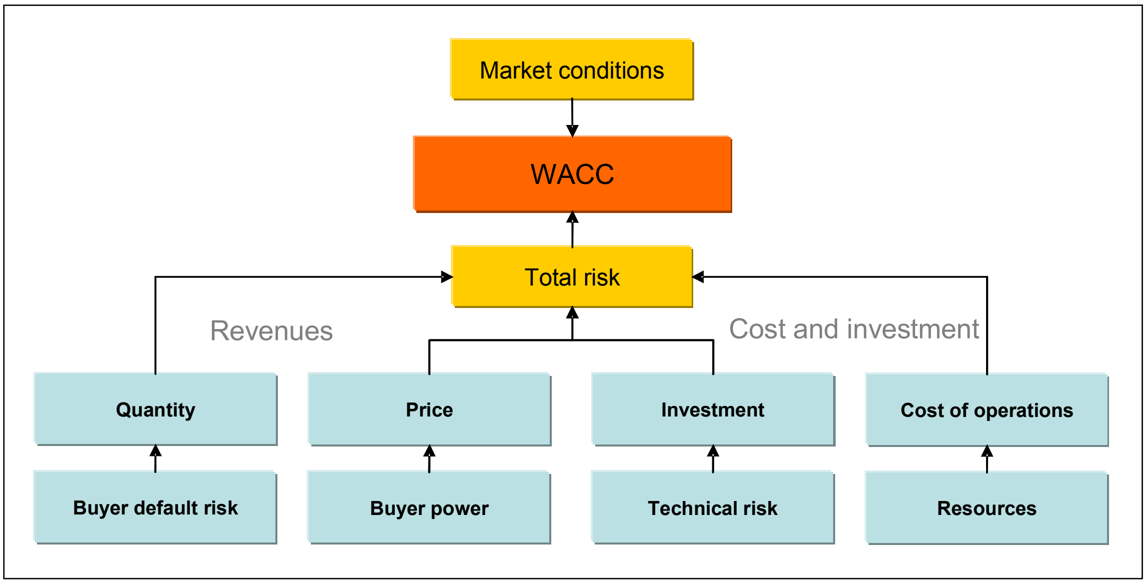
Construction time

According to the original plans the hydropower plant was expected to be built in two phases. The first phase would have been finished in 2006, but construction of the latter was expected to finish in 2013. This reflected a two-phased plan for the smelter itself.

According to the current plans the power plant will be constructed in one phase, starting in 2003 and finishing in 2007. Some minor changes have been made to the plans reflecting demands made by the Ministry of Environment in 2001.

Risk profile

The risk profile for the Karahnjukar project has two main characteristics. The first is the risk arising from the complexity of the project which includes damming and redirection of several rivers. Secondly the power plant will be to a large extent dependent on the aluminium smelter for revenues.



Framework for assessing project WACC

According to previous plans the aluminium smelter in Reydarfjordur was to be built and run by Reydaral, a new limited company owned by Norsk Hydro and Icelandic investors. According to the current plan the smelter will be built and operated by Alcoa.

According to an analysis[5] prepared by Dresdner Kleinwort Benson for Haefi hf., a limited company established to prepare the smelter project, the WACC for Reydaral was estimated 11.8% - 17.65% on equity and 8.79% on debt.

When considering the risk profile for the planned Alcoa smelter it should be taken into account that Alcoa is one of the two largest aluminium producers in the world

[5] An unpublished document. Available from the author at thorsteinn@annata.is.

with long experience in building and operating smelters around the globe. Alcoa also enjoys a considerable size advantage towards suppliers which Reydaral would not have had.

Based on long term risk-free securities, long term market risk and Alcoa´s beta, the equity cost of capital for Alcoa lies in the region of 11-12% in real terms. Current average long term debt rates for an A rated company are around 4.8% in real terms[6]. This indicates a 6,5-7% WACC for Alcoa.

Still, the project risk for the power plant would probably be higher than Alcoa´s average risk. Firstly, the average risk of Alcoa is not necessarily a proper indication for the risk in the Reydaral project as such. Secondly, according to the Sumitomo Mitsui project analysis the Reydaral project has a risk profile of BB+ / BBB. Compared with Alcoa´s current A2 rating[7] this implies a higher interest rate than previously mentioned. This also indicates a higher cost of equity.

The usual way to find a proper discount factor is to identify comparable projects financed in an open market and use their required return. In the case of Karahnjukar a comparable project would be a hydroelectric power plant built and maintained to supply energy to one aluminium smelter. However comparable projects are scarce and in general such projects tend to be government financed. Thus, other methods must be used to assess the true opportunity cost of capital.

The key factors that could determine the project risk are offtaker, or buyer, risk on the one hand, and risk involved in building and maintaining the power plant on the other.

According to studies carried out for Landsvirkjun, interest rates on the company´s long term debt would increase only slightly were the company excluded from state-secured borrowing as a result of energy-market liberalization. Splitting the company in two parts would however result in a dramatic increase in interest rates. In other words, by splitting the company in two, it would lose its dominant position in the Icelandic energy market, leading to a dramatic increase in interest rates.[8] This indicates that the primary factor behind the risk assessment is market position rather than risk from operations and maintainance. Experience from liberalization in other countries seems to indicate this as well.

Assuming the key factor determining risk is market risk, not operations risk it seems logical to use required return for the smelter itself as a starting point.

In general, the WACC for new aluminium smelters lies between 8-9% in real terms.[9] Based on a capital structure similar to Reydaral this might give debt rates in the region of 6-7% and ROE of up to 13-15%, in real terms.

Apart from sensitivity to aluminium price which characterizes both the smelter and the power plant, revenues to the power plant would be stable even in spite of

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[6] See: Moodys.com
[7] See: Moodys.
[8] See: “Fjarmognun og samkeppnishaefni islensks orkuidnadar”, Landsvirkjun 2001 (slides 13-14) (Available at www.lv.is)
[9] “Primary Aluminium: A Medium Term Outlook & Longer Term Perspective”, CRU, London 2002. (Available from the author at thorsteinn@annata.is)

short term difficulties in smelter operations. Any medium to longer term difficulties would however probably lead to power price revisions. Were Alcoa to cease smelter operations energy sales would cease as well, so with no apparent alternative market power plant risk is identical to smelter risk in this respect.

Were Alcoa to discontinue smelter operations Landsvirkjun might be able to find a new buyer, which might indicate a lower required return than in the case of the smelter itself. However, due to slow growth in general electicity use and high cost of connecting the power plant to the company´s main grid the most probable option would be finding a new large industrial buyer, most probably with a similar or higher risk profile.

Based on the above considerations a real WACC of 6,5-8% for the power plant is certainly not too high.

Project Revenues

The single most important success factor for the project is energy price. This is also the most difficult to estimate since energy price is entirely dependent on evolution of aluminium price over the life of the project.

Smelter cost structure

The power price depends on two factors. One is the price of aluminium which will determine the power price. The other is the smelter cost structure which acts a constraint determining the maximum power price the smelter can sustain.

Cost structure - Greenfield smelter

Aluminium $/ton	$1.500	$1.200	$1.350
Alumina	$375	$352	$364
Anodes	$110	$110	$110
Labour	$100	$100	$100
Other costs	$75	$75	$75
Return on capital	$440	$440	$440
Energy	$400	$150	$262
Total	$1.500	$1.200	$1.350
Energy mills/kwh	26,7	10,0	17,4
Energy ISK/kwh	2,3	0,9	1,5

Source: RSI

Several analyses of cost structure in the aluminium industry have been studied during the preparation of this report. The main sources of information are a report prepared for the Australian Government in 2001[10] and several reports on aluminium cost structure, both from RSI International and CRU. Various other industry reports have been studied as well for reference and validation.

[10] Strategic Leaders Group: "Australia Leading the Light Metals Age", Canberra 2001. (Available from the author at thorsteinn@annata.is)

Table 1: Comparative costs of greenfields production (US$/tonne).

	Canada	Brazil	Africa	India	Australia	Australia
Aluminium price			$1 550			$1 200
Alumina cost	387	387	387	387	387	300
Alumina transport cost	38	38	38	38	5	5
Energy cost	330	303	206	413	240	180
Labour cost	96	30	38	32	110	85
Anodes	143	143	143	143	143	120
Other costs	258	258	258	258	258	210
Total operating cost	1 252	1 159	1 070	1 271	1 143	900
Aluminium price	1 550	1 550	1 550	1 550	1 550	1 200
Return on capital	298	391	480	279	407	300
Required return on investment	400	400	400	400	400	300

Source: ACIL Consulting 2001.

According to the RSI study the maximum energy price at an aluminium price of USD 1500/ton is just below 0,27 US mills/kwh. At USD 1200/ton the maximum price is only 0.1 US mills/kwh. The Australian study gives a considerably lower price of 16 mills/kwh. based on USD 1500/ton. According to a 2001 study the energy cost for selected countries ranges from USD 180/ton for Africa to USD 413/ton in India. According to another study the average world price in 1998 was 16,2 mills/kwh.

The price range used in the previous report for the INCA was 0.15-0.2 US mills/kwh. Extrapolating from the conclusions in the Sumitomo Mitsui report gives a starting energy price of 19 mills/kwh. taking into account a generally agreed minimum long term drop in aluminium price of 1.1% annually. Using constant aluminium prices gives an average price of 16 mills/kwh. for an NPV of 0.

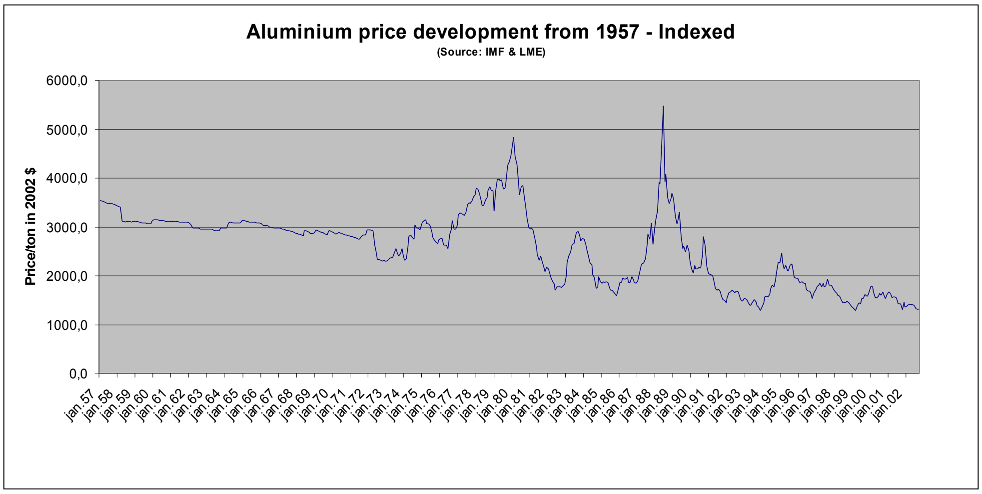
Probable Cost Structure for the Alcoa Smelter

Aluminium Price	$1.350
Alumina	$330
Carbon	$105
Labour	$63
Other Costs	$160
Required return	$413
Overhead	$25
Energy	$255
Total	$1.350
Mills/kwh	18,2
ISK/kwh	1,55

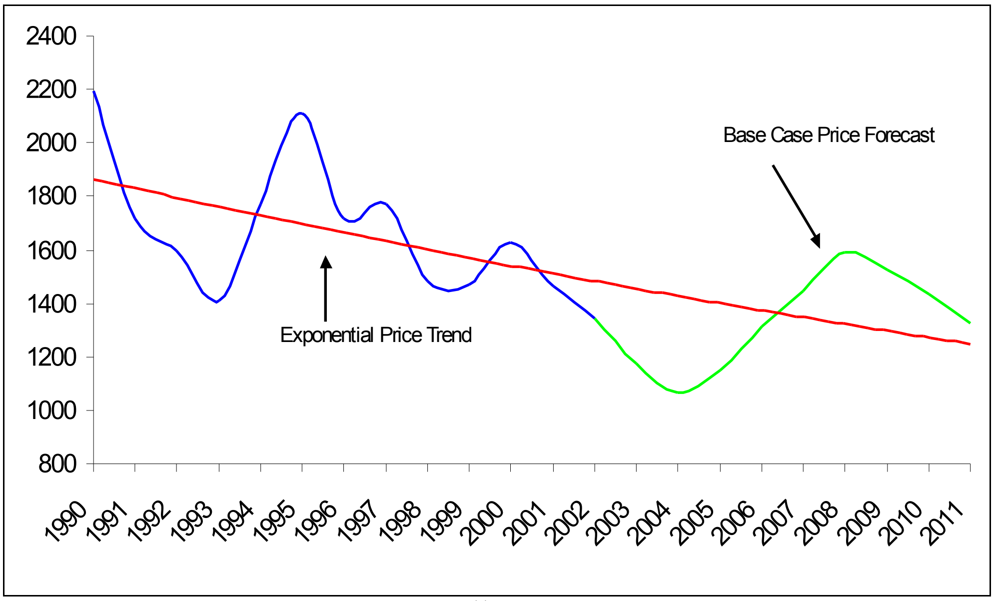
Based on a CRU study
(Long-Run Marginal Costs, Middle East)

Aluminium price development

The energy price at the start of the project will be affected by the aluminium price at that time. Thereafter the price will be linked to fluctuations in aluminium price. It will be assumed here that these fluctuations are direct, that is the energy price fluctuations will not exaggerate the aluminium price fluctuations.

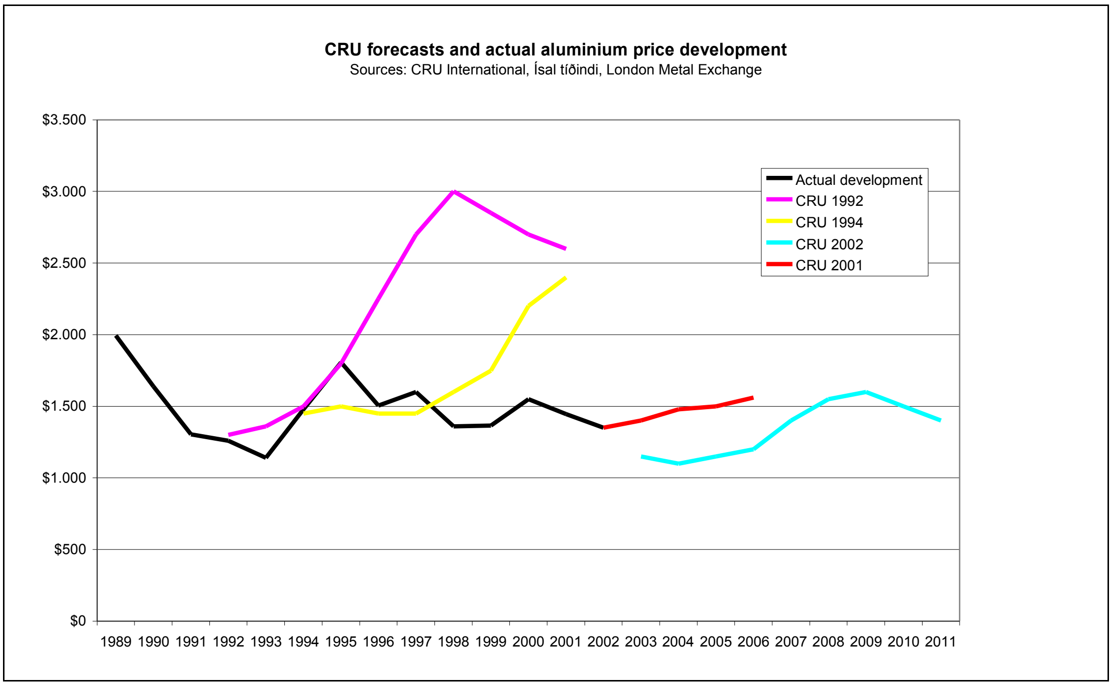


According to the Sumitomo Mitsui report average aluminium price throughout the project lifetime will have to remain constant at USD 1300/ton to achieve the required WACC. It is unclear which lifetime is referred to, the investment horizon for the smelter or for the power plant. Based on a 25 year horizon for the smelter this gives a starting price of USD 1500/ton assuming a 1.1% average annual reduction in aluminium price. Based on a 50 year lifetime of the power plant the aluminium price would have to be above USD 1600/ton at the start of the project. Based on this and previous conclusions regarding the energy price it seems Landsvirkjun expects a price of 19 mills at an aluminium price of approximately USD 1600/ton.



CRU Base Case Forecast 2002[11]

[11] CRU: "Primary Aluminium: A Medium Term Outlook & Longer Term Perspective", London 2002.



According to long term forecasts from 2001 there seems to have been a consensus on an average price of USD 1400-1450/ton over a period of 20 years or so. Prices have, however, continued to fall and there seems no reason to expect a giant upsurge in the coming years to justify a starting price of USD 1600/ton for the Reydarfjordur project. According to the latest forecasts by CRU a price of USD 1450/ton might be expected in 2008. Medium term forecasts have however tended to be quite inaccurate. Looking at the exponential long-term price trend a realistic estimate might be a price of $1350/ton in 2008, falling by approximately 1,1% annually after that.

Project NPV

To find the actual NPV of the project a WACC must be found that can be considered appropriate based on the risk inherent in the project itself. In this case the return demanded is similar to the return an independent investor would require based on the inherent risk and the return required from other investments with a similar risk profile. This gives a project NPV that should be considered by the owners of Landsvirkjun.

The net present value of the project is calculated using a real WACC of 6-8% at a 1,8% inflation rate. The calculation is based on Landsvirkjun´s estimated investment of 96 billion ISK, annual operating expense of 1.2 billion ISK and energy sales of 4.130-4.430 gwh/year[12] Project lifetime is estimated 50 years in accordance with generally accepted methods for valuing similar projects. Energy price is expected to fall by 0.9%-1.1% annually after the start of the project.

Pessimistic Scenario	
Starting Price mills/kwh	14
WACC	8,00%
Gwh sold / year	4130
Annual Decrease in Aluminium Price	1,10%
NPV ISK	-50,25
NPV USD	-591,2

By a negative estimate, using an energy price of 14 mills (ISK 1,19) the NPV of the project is negative by USD 590M (50 billion ISK). At a price of 20 mills the NPV is negative by USD 410M (31 billion ISK). In order to reach an NPV of 0 energy price at the start of the project would need to be around 34 mills/kwh (ISK 2,85).

Optimistic Scenario	
Starting Price mills/kwh	20
WACC	6,00%
Gwh sold / year	4450
Annual Decrease in Aluminium Price	0,90%
NPV ISK	-17,07
NPV USD	-200,9

A optimistic scenario gives a negative NPV of roughly USD 200M (17 billion ISK) at a real WACC of 6%. In order to reach an NPV of 0 at the 6% WACC energy price needs to be around 25 mills/kwh, probably requiring an aluminium price of above 1500 USD/ton at the start of delivery.

[12] This is based on average aluminium production of 295.000 ton using 14.000-15.000 kwh of electricity/ton.

An 8% real return is probably the most realistic required return estimate for the project. Based on previous negotiations and taking into account the less optimistic assumptions for aluminium price development a price of 18 mills/kwh is probably relatively realistic.

Realistic Scenario	
Starting Price mills/kwh	18
WACC	8,00%
Gwh sold / year	4430
Annual Decrease in Aluminium Price	1,00%
NPV ISK	-36,10
NPV USD	-424,8

Based on those assumptions, along with an estimated 1% real drop in aluminium prices annually a negative NPV of approximately USD 425 million.

Based on the same assumptions, average annual loss will be just over USD 36 million.

Comparison with previous project plans

The project NPV has been calculated based on the same assumptions as Landsvirkjun´s calculation, verified by Sumitomo Mitsui. As described before the Sumitomo analysis assumes a starting price of roughly 19 mills/kwh to reach a 0 NPV.

Using the same assumptions for the current project plans gives a negative NPV of USD 259 million (ISK 22 billion).

Change from previous plans

Based on Landsvirkjun´s assumptions	Previous plans	Current plans	Difference
NPV of revenues	85,31	59,03	-31%
Investment	-102,00	-96,00	-6%
Energy sales	5.500,00	4.130,00	-25%
Investment pr. gwh, millions ISK	185,4545	232,4455	25%
NPV of investment, billions ISK	-85,24	-80,94	-5%
NPV in billions ISK	0,07	-21,91	
NPV as % of investment	0%	-27%	

A quick analysis of the difference reveals that a 25% lower energy sales is the key factor driving down profitability. The investment is slightly lower in now than in the previous scenario, but far from covering the decrease in revenues. Shorter construction time is clearly not an important factor.

Assuming a constant price of 19 mills/kwh in accordance with Landsvirkjun´s assumptions the project would sustain a WACC of 3,25%, roughly 10% below the state secured rate assumed.

Conclusion

As shown in the above analysis the Karahnjukar hydroelectric power plant can hardly sustain a WACC consistent with the inherent project risk. When compared with previous plans project revenues are 31% lower than in the previous case while the investment is only 6% lower. Even when valued based on a state guaranteed interest rate, insufficient return on equity and quite unrealistic power price assumptions, the project is not viable while the previous one would have been given the same assumptions.