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LARGE HYDRO-ELECTRIC POWER RESOURCES IN ICELAND

Written for the Icelandic Ministry  
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by

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## LARGE HYDRO-ELECTRIC POWER RESOURCES IN ICELAND

According to surveys which have been made of Icelandic hydro-electric power resources (1) the following rivers are most promising for inexpensive large blocks of electric power: (See map 1)

	Maximum Obtainable Power Kilowatts
1. Thjórsá with branch rivers	1,500,000
2. Jökulsá á Fjöllum .....	700,000
3. Hvítá .....	240,000
4. Jökulsá á Brú .....	240,000
5. Vatnsdalsá with Blanda ...	185,000
6. Lagarfljót .....	185,000

Besides, there are known to be several other rivers with promising possibilities for smaller scale hydro-electric projects. Except for the rivers Sog and Laxá, which are now being utilized, most of these rivers have not been much studied and will not be discussed here.

On the following pages, the above six rivers will be discussed with references to available studies. In general, there is rather limited information available about most of the large projects listed above, but some of them, however, need only minor additional surveys to be ready for engineering detailed planning.

Statistics are steadily being obtained about all of the rivers. Although projects have not yet been planned based on some of the latest information, the trend seems to be, among the more careful engineers, to somewhat reduce the figures of earlier studies. This will be discussed in the conclusions.

Some references are listed at the end.

### 1. Thjórsá:

Thjórsá is a glacial river which is located in the south-southwestern part of the country. (See map 1).

It has its origin in glaciers in central Iceland and runs to the south-west.

The first engineering study of hydro-electric developments in Thjórsá was made by a Norwegian engineer, Mr. G. Sætersmoen, in the years 1915 to 1917. Mr. Sætersmoen planned five power plants in the Thjórsá river, itself, and one in its branch river, Tungnaá. The total power obtained was estimated 832,000 kw. for seven months and 520,000 kw. for five months. This was without large dams and extensive water control. In general, not enough statistics were available at that time for accurate planning. Later studies have shown Mr. Sætersmoen's surveys not to be of much value now, due to the lack of basic statistics and greatly improved technical knowledge.

A more recent study was made of Thjórsá by the Icelandic engineer Sigurdur Thoroddsen during the years 1949 to 1951 (2).

Mr. Thoroddsen's studies are based on much more accurate statistics of Thjórsá than Mr. Sætersmoen had available. The State Electric Authority had, for a few years, measured the flow of the river and the area of the surrounding land which feeds into it. Mr. Thoroddsen studied two possibilities for developing the river. The total power obtained is, in both cases, about 1,450,000 kw. in base power. One scheme has 13 power plants in Thjórsá and its branch river, Tungnaá, the largest one being 470,000 kw. These are shown on maps 2 and 3. The other scheme has 8 power plants in the two rivers with the largest plants being 575,000 kw. and 390,000 kw. Mr. Thoroddsen estimates the cost of the larger part of the project and comes to the conclusion that this would, in both cases, be about Kronur 3,350 per kw., or \$ 205.00 per kw. (\$ 1 = kr. 16.32).

Since Mr. Thoroddsen published his report, studies have been continued by the State Electric Authority. A preliminary geographical survey has been made, the descent of the river has been mapped, and the river area is being photographed from air for accurate mapping. Although no later detail studies have been made on the development of Thjórsá, it is, in general, believed that Mr. Thoroddsen's

plans are too optimistic and must be considered as theoretical maximum figures, as discussed in the conclusions. Truer values would probably be obtained by reducing Mr. Thoroddsen's figures by about 25%.

The harbour closest to Thjórsá is Reykjavík. The airial distance from Reykjavík to Urridafoss is about 45 miles (see map 1), and to Fossalda about 75 miles. The terrain is good for transmission lines. A closer harbor might be developed at Thorlákshöfn which is 22 miles from Urridafoss and about 60 miles from Fossalda.

## 2. Jökulsá á Fjöllum:

Jökulsá á Fjöllum is located in the north-eastern part of the island (see map 1). It is a glacial river, but is relatively clear since it is fed extensively by under-surface streams. It is originated in a glacier in south-eastern Iceland and runs to the north.

Recently, much added emphasis has been put on the survey of Jökulsá á Fjöllum, as many experts believe it to be an excellent source of hydro-electric power. The State Electric Authority has just completed flow measurements. This summer accurate mapping and surveying of its descent is intended. A preliminary geographical study has been made.

Upon the request of the State Electric Authority Mr. Sigurdur Thoroddsen has studied the development of Jökulsá á Fjöllum based on available information (3). Mr. Thoroddsen's report was available last month.

Although the flow of the river is more even through the year than is the case with most other Icelandic glacial rivers, considerable water storage is needed. Mr. Thoroddsen suggests four possible damsites. The one he selects is shown on enclosed map no. 4 along with the power plants.

As shown on the map, there are planned 2 power plants. The first one, or the upper one, has between 137 and 157 meter fall with a  $225 \text{ m}^3/\text{sec}$ . flow, or a capacity of about 245 mw. to 280 mw. The second power plant has about 160 m. fall and a capacity of about 290 mw.

Mr. Thoroddsen estimates the cost of the developments as follows:

Dam at Selfoss, underground	
tunnels and station .....	\$ 24,500,000
Machinery .....	\$ 19,600,000
Roads and harbor .....	\$ 1,200,000
<u>Total, upper project</u>	<u>\$ 45,300,000</u>
Dam at Réttarfoss .....	\$ 3,350,000
11.5 km. tunnel - 125 m <sup>3</sup> /m .....	\$ 13,200,000
Intake-dam and control, station	
intake and discharge tunnels	
and machinery .....	\$ 26,350,000
<u>Total, lower project</u>	<u>\$ 42,900,000</u>

The total cost is, thus, estimated about \$ 88,200,000, or about \$ 150 per kw.

The harbor closest to the above projects is Húsavík which is about 30 miles by air from Dettifoss. (See map). A better harbor, and an excellent one, would be Seydisfjördur, which is on the east coast, about 80 miles, by air, from Dettifoss.

In general, it is believed that Mr. Thoroddsen's plans of Jökulsá á Fjöllum are realistic; much more so than his plans for Thjórsá. It seems, though, possible that the over two-mile-long and over thirty-meter-high dam, which he plans at Selfoss, is not economical. It might be more feasible to build a smaller dam and not fully utilize the flow.

### 3. Hvítá:

Hvítá is a glacial river, located just west of Thjórsá. (See map 1). It has its origin in glacial lakes in central Iceland and runs parallel to Thjórsá.

Of the six rivers discussed, here, most information is probably available about Hvítá. Since 1950, the State Electric Authority has carried out extensive surveying of the area. Good information is available about the flow of the river. The area has been mapped to the scales 1:2000, 1:5000 and 1:10000. The descent of the river has been mapped

and a preliminary geographical survey has been done. In general, the State Electric Authority feels that Hvítá is ready for a detailed geographical and engineering study and planning of hydro-electric projects.

Based on the information gathered, the following scheme has been suggested for the development of Hvítá.

Location of Power Plant (See Map)	All Year Power With Regulation Kilowatt	All Year Power Without Regulation Kilowatt
Ábóti .....	33,500	22,400
Bláfell .....	52,000	37,600
Gullfoss .....	112,000	74,600
Hauksholt .....	33,500	22,400
Total	231,000	157,000

The harbor closest to these power plants is Reykjavík. The distance, by air, from Gullfoss to Reykjavík is about 56 miles. In general, the terrain is good for transmission lines, although of course, the lines would have to be somewhat longer.

#### 4. Vatnsdalsá with Blanda, Jökulsá á Brú and Lagarfljót.

The locations of these rivers are shown on map number 1. All of them, except Vatnsdalsá, which is the smallest one, are glacial rivers.

Only very limited statistics have been gathered concerning these rivers. Mr. Thoroddsen estimated the power which could be obtained, to be as listed on page 1. Some survey has, though, been done on Vatnsdalsá with Blanda and it seems to indicate favorable conditions.

#### Conclusions

The rivers listed on page 1 have been discussed with reference to available studies. Additional information is constantly being gathered and more engineers are studying the problems. Most engineers believe that the values stated in older reports, regarding the utilizable power, are too

optimistic.

The following list shows a comparison between the approximate energy corresponding to the values on page 1 and values which are felt to be more realistic:

River	E n e r g y	
	Old Values Million kw.hr. Per Year	Revised Values Million kw.hr. Per Year
Thjórsá .....	13,000	9,000
Jökulsá á Fjöllum	6,000	5,000
Jökulsá á Brú ....	2,000	1,500
Hvítá .....	2,000	1,500
Seven Smaller Glacial Rivers ...	5,500	4,000
Sog and Laxá .....	1,200	1,000
Many Smaller Clearwater Rivers	8,300	4,000
Total	38,000	26,000

Of these, the small clearwater rivers could be omitted, as their developments are too expensive to compete with the larger projects.

It may be concluded that studies and available information, about Icelandic water resources, clearly indicate that large and inexpensive blocks of power may be obtained. The surveys are now coming to the point of permitting detailed geographical study and engineering planning of promising hydro-electric projects. Therefore, it is now also necessary to investigate the possibilities for utilizing this electric power in industry.

Reykjavík, April 29, 1954

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