L A X Á R V I R K J U N

THE HYDROELECTRIC DEVELOPMENT ON RIVER LAXÁ.

GENERAL INFORMATION AND ECONOMICAL SURVEY.

Compiled by:
THE STATE ELECTRICITY AUTHORITY
REYKJAVÍK, ICELAND.

APRIL 13TH, 1949.

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Republic of Iceland
Laxá Hydroelectric Development
5000 kW Installation
Basic Data Report

By

I. Introduction.

1. General Description of Project

(1-a) The 40 square km lake Mývatn is situated at elevation 277 m above sea level in the north-eastern area of Iceland (lat 65° 35', long 17° 0' approx). The river Laxá has its origin in the west end of the lake and flows northwards as shown on [redacted].

Of the total gross head of the river about 75 m are concentrated at a place called Brúar. Here the river falls from el. 107 to el. 32 m on a length of approx. 1800 m. ~~For different reasons~~ the last 8 m of this head will not be utilized so the gross head that will be developed at Brúar is 67 m, viz. from el. 107 to el. 40 m.

In the years 1938-1939 the municipality of Akureyri erected a 2000 H.P. hydroelectric development in the upper part of the waterfalls at Brúar, from el. 107 to el. 69 m. An extension of 4000 H.P. capacity was installed in 1944. The capacity of this development is thus 6000 H.P. now. This development does not utilize more than abt. 40% of the waterflow and can therefore be extended by approx 9,000 H.P.

Power from the present development is transmitted to Akureyri and Húsavík through 33 kV high tension transmission lines. The capacity of the development is now totally inadequate for the above mentioned municipalities, besides it is intended to extend the transmission system to the herring oil factories at Hjalteyri and Dagverdareyri and to the village Dalvik including different other localities.

The following three alternative hydroelectric developments can be taken into consideration for fulfilment of the increasing electric power demand, viz.

1. Full development of the upper parts of the falls at Brúar. Thus approx. 9,000 H.P. can be developed as mentioned above.

2. Full development of the lower part of the falls at Brúar, i.e. the head from el. 69 m to el. 40 m. The total capacity of such a development is approx. 11,500 H.P.

3. Development of the total head at Brúar from el. 107 to el. 40, utilized in one power house, the first stage being 16,000 H.P. and the second stage 10,000 alt. 11,000 H.P.

In the future different possibilities for further hydroelectric developments are at hand, e.g. a utilization of the waterflow in the river Laxá in the neighbourhood of Mývatn at a place called Sandvatn, where the gross head is abt. 100 m and capacity up to 40,000 H.P.

Investigations (showed (see 4-a) (was) ~~have shown~~ that it is advantageous to develop the lower part of the falls at Brúar now, i.e. the head between el. 69 m to el. 40 m. The transmission voltage to Akureyri will be 66 kV as shown on the map, Annexure 1. Later on a 66 kV line will be erected from Akureyri to a power plant at Skeidsfoss. The capacity of the power plant at Skeidsfoss is now 2,400 H.P. and machines for an extension up to 4,800 H.P. have already been ordered. ~~Power from~~

φ hereinafter called Laxa I.

this development, which is owned by the municipality of Siglufjordur, is transmitted to Siglufjord through a 22 kV transmission line. At Siglufjord the greatest herring oil factories are located. These factories have own dieselelectric and steamelectric plants of several thousand H.P. capacity. A transmission line to the municipality of Ólafsfjörður will probably be erected in the near future.

It is, however, difficult to say at the present moment when the distribution system from Laxá Plant will be extended to Siglufjörður and Ólafsfjörður and connected to the Skeidsfoss Plant. It is to be expected that this will be done before 1960. But it has been considered safer not to include the consumption of Siglufjörður and Ólafsfjörður in the following operation estimate, and base the financial prospects for the Laxá Plant on consumption in the area from Húsavík to Dalvík only. Similarly no demand from large industrial centres, which may be established in the distribution area, as e.g. an oilhydration plant, is included in the estimate, which only covers domestic demand and industrial requirements on a scale indicated by the development in the utilization of electricity at Akureyri since the first development on the Laxá River was completed. The distribution area is here classified into three categories:

1. Akureyri and the village of Glerá, which have been supplied from the Laxá Plant since the beginning of its operation.

2. Villages with more than 300 inhabitants. Húsavík, Dalvík and Hrísey. Húsavík has already been connected to the distribution system, with a limited load of 200 kW, and a normal growth in the demand is therefore not to be expected there, until the next development on Laxá is completed. It is estimated that Dalvík and Hrísey will be connected to the Laxá distribution system by the time the next extension begins operation.

3. The rural district excl. of the villages.
In this area the distribution system already reaches a few localities, and several additional lines in the area have been projected and approved. It is estimated that a population of 1,200 will be supplied in this area as soon as the plant extension is completed.

As mentioned above it is intended to extend the transmission system to the herring oil factories at Hjalteyri and Dagverdareyri. As the activities of these factories are confined to the summer months, when the domestic load is small, this extension will not make an increase of installed capacity necessary. The energy production will increase, and the transmission system economy therefore become more secure. This factor, however, does not mean any direct increase of revenue for the Laxá Development itself and is therefore disregarded in the power requirement estimate below. Besides the herring oil industry is a rather uncertain factor with regard to power consumption, as the power demand depends upon the amount of herring caught within reach of these particular factories each fishing season.

2. Population.

The number of inhabitants in the three parts of the distribution area detailed above, has in the past years, been as shown here:

TABLE I.

Population 1930 - 1947.

Year	1. Akureyri & Glerárþorp	2. Húsav. Dalv. & Hrísey	3. The Rural Districts
1930	4,300	1,424	6,429
35			6,295
36			6,270
37			6,298
38			6,215
39			6,236
40	5,723	1,702	6,361
41	5,783	1,689	6,294
42	6,064	1,708	6,278
43	6,271	1,886	6,042
44	6,380	1,989	5,881
45	6,483	1,998	5,737
46	6,646	2,050	5,649
47	6,990	2,088	5,520

On Annexure 2. attached hereto is a diagram representing the population. It shows that the number has grown evenly in Akureyri, Húsavík, Dalvík and Hrísey. On the other hand, a reduction has taken place in the rural districts since 1942. A continued growth is estimated for the two first parts of the area, similar to that of the past years, and the number of inhabitants in Akureyri and the village of Glerá will then be above 10,000 in the year 1960, and in Húsavík, Dalvík and Hrísey about 2,800. In the rural districts and lesser villages, the decrease has been so fast, that continued at the same rate the number of inhabitants will be reduced to about 4,200 in 1960. The reason for this decrease is not primarily a rapid desolation of the farms, but rather that the farms are run with a reduced number of people. The labour goes to the towns and seaports where the demand for labour has been heavy lately and the living is better. It is to be expected that this flow of labour from the countryside will slow down somewhat in the next years, and perhaps a lesser descrease should be estimated than indicated by the broken line on Annexure 1. The point, however, is not of any great importance, concerning the number of inhabitants in the 3. part of the distribution area, as the distribution system is not supposed to reach all the rural districts before 1960, and an estimate has not been made further than that. It is estimated here that by the time the plant extension

is completed the distribution system will reach 1,200 inhabitants in the rural districts, and from then on until 1960, extensions will reach 300 inhabitants annually, so that in 1960 the number of inhabitants connected will be 3,600 in this part of the distribution area.

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3. Energy Production, Power Requirements and Load.

The following Table shows how the power production for Akureyri has grown in the years 1940 to 1948, and the peak load in Laxá Plant. Based on that the power consumption per capita is calculated in kWhrs. and the load factor for Laxá Plant in hours.

TABLE II.

Energy Production, Peak Load and Load factor 1940 - 1948.

Year	Energy Production mill.kWhrs.			Population acc. to Table I.	Production per capita kWhrs.	Peak Load LaxáPlant kW.	Annual Load Factor Laxá Plant hours.
	Laxá	Glerá	Total				
1940	4.80	0.07	4.87	5,723	850	1,600	3,000
41	7.34	0.11	7.45	5,783	1,290	1,670	4,370
42	9.00	-	9.00	6,064	1,480	1,680	5.350
43	10.37	0.51	10.88	6,271	1,730	1,680	6,200
44	12,47	0,35	12.82	6,380	2,010	3,050	4,100
45	15,95	0	15.95	6,583	2,430	3,780	4,210
46	20.00	0.05	20.05	6,646	3,010	3,850	5,200
47	22.38	0.21	22.59	6,990	3,290	4,280	5,230
48	25.65	0.34	25.99	(7,200)	3,610	4,440	5,800

On Annexure 2 the energy production is shown in kWhrs. per capita in Akureyri. Since the Laxá Plant began operation the per capita production has grown rapidly, and is in 1948 3,600 kWhrs per capita. In 1949 this is estimated to reach 3,800 kWhrs per capita, but owing to power shortage this can go no higher until the plant extension in Laxá is completed. Following that the power production is estimated to grow slower than before and reach 6,000 kWhrs. per capita in 1960. For the villages and rural districts outside of Akureyri the power production is estimated at 1,000 kWhrs per capita in the first year of operation of the new plant, but should then grow at a rate similar to that of Akureyri in the first years. The power production for that section of the distribution area will then reach 3,200 kWhrs per capita in 1960, as shown on the diagram on Annexure 2.

On Annexure 3 are diagrams showing actual power production, peak load and annual load factor of the Laxá Plant in 1940 to 1948 as

set down in Table II, and continued as estimate up to 1960.

In the following Table is shown an estimate of population, power production, peak load and annual load factor of the Laxá Plant.

TABLE III.

Estimated Energy Production, Peak Load and annual Load Factor 1949 - 1960.

Year	Akureyri			Villages and rural district					Total Mill. kWh.	Annual Load Factor. Hours	Peak Load kW.
				Population			kWh.	Mill.			
	Population	kWhrs. pr. capita	Mill. kWh.	Hús. Dal. Hr.	Rural Distr.	Total	pr. capita	kWh.			
1949	7400	3,800	28.1								
50	7600	3,800	28.9								
51	7800	3,800	29.6								
52	8050	4,000	32.2	2400	1200	3600	1000	3.6	35.8	4000	9,000
53	8300	4,200	34.8	2450	1500	3950	1150	4.5	39.3	4200	9,400
54	8550	4,450	38.0	2500	1800	4300	1350	5.7	43.7	4400	9,900
55	8800	4,650	41.0	2550	2100	4650	1550	7.3	48.3	4600	10,500
56	9050	4,900	44.4	2600	2400	5000	1800	9.0	53.4	4800	11,100
57	9300	5,150	47.9	2650	2700	5350	2100	11.3	59.2	5100	11,600
58	9600	5,400	51.8	2700	3000	5700	2400	13.7	65.5	5400	12,100
59	9900	5,700	56.4	2750	3300	6050	2800	16.6	73.0	5700	12.800
60	10200	6,000	61.2	2800	3600	6400	3200	20.5	81.7	6000	13,600

As may be seen from Tables II and III and diagram on Annexure 3 the power production in Laxá Plant grows rapidly in the years 1940 - '48 and nearly all of the production goes to Akureyri. In 1949 - '51 the installed generating power will not be sufficient to allow the demand to grow at the same rate. In 1952 the plant extension is expected to be completed, and the installed generating power will then suffice to meet the demand from the distribution area for several years ahead. The diagrams on Annexure 3 also show the relation between peak load and annual load factor, when the power production grows evenly. When the first development in Laxá began operation, the generating unit was fully loaded at the outset, 1,600 kW in the year 1940, and could not rise above 1,680 kW until 1944 when additional machinery was installed. During this period the annual load factor increases from 3000 hours in 1940 up to 6,200 hours in 1943. It should be mentioned that the voltage had then been reduced to 5,100 Volt, i.e. the voltage drop was almost 23%. In 1944 new machines were installed, and for a time there was no power shortage. The annual load factor drops from 6,200 hours in 1943 to 4,100 hours in 1944, while the load increases up to 3050 kW. The generating power is again fully utilized in 1948, and the annual load factor reaches 5,800 hours. Until the next plant extension is completed, no further load increase can be taken in the Laxá plant,

but it is estimated that the annual load factor may increase to 6,600 hours, or about 75% of the year. It is however to be expected that this will entail a considerable voltage drop in the distribution system, and a serious power shortage is to be expected during the period. When the next plant extension is completed, sufficient power will again be available for a time. The annual load factor is then expected to drop to 4,000 hours, in 1952, to rise again and reach 6,000 hours in 1960. This equals a growth in demand from 9,000 kW. in 1952 up to 13,600 kW in 1960, based on the estimated energy production. Installed generating power in the Laxá plant, when the projected extension is completed, estimated 1952, will be 12,500 kW, and will, according to the above, be fully loaded in 1958. Should Siglufjörður and Ólafsfjörður be connected to the Laxá plant, or heavy industrial centres be established in the distribution area, the generating capacity of this development will be exhausted at an earlier date, and the next stage of development will have to take place correspondingly earlier.

4. Cost Estimate.

A plan view and a longitudinal section of the proposed development of the lower falls at Brúar is shown on Annexure 5. As mentioned above it is intended to utilize the fall in the river from elevation 69 m to el. 40 m. The dam is situated abt. 320 m downstream from the power house of present development. Gross head is 29 m, and full load output is computed 11,500 H.P. by 28 m net head.

The intake is in the eastern part of the dam. A 370 m long pipe of 4.0 m inside diameter conducts the water from the dam to the power house, which is situated on the eastern bank of the river by a small island in the river just below the road bridge. Abt. 100 meters above the power house a surge reservoir is erected. In the power house a vertical Francis turbine of 11,500 H.P. capacity is installed. Rated output of the alternator is 8,000 kW or 10,000 kVA by 0.8 p.f.

It is intended to operate the new power station from the existing one, and the outdoor 60 kV switching equipment will be situated nearby the power house of the present development.

Before the conclusion was reached, that the development outlined above was the most favorable one, different alternative plans and cost estimates were worket out. The total cost of the above development including the 60 kV H.T. line and the main transformer station in Akureyri is estimated kr. 25,240,000.-, based on the ruling price level in January 1949.

In table IV a tabulation of the estimated cost is shown, where the cost is split into local cost and foreign currency expenditure. In table V, below, the estimated distribution of local cost and the foreign currency expenditure over the erection period is shown.

The figures in these tables are estimated, but based on information gathered from various firms as regards purchase of machinery and equipment, and a firm schedule of cost cannot be made until definate offers are at hand, both as regards constructional work and mechanical and electrical equipment.

TABLE IV.

LAXÁRVIRKJUN 11,500 HP.

Cost Estimate.

	Total mill.kr.		Local cost mill.kr.		Foreign currency expenditure mill.kr.	
1. The Power Plant on Laxá						
Construction:						
Materials	3,102		-		3,102	
Freight, duty, transport, erection	7,421		7,421		-	
Machinery:						
Materials, freight, foreign labour	3,951		-		3,951	
Duty, transport, erection	1,437		1,437		-	
Construction and machinery:						
Preparation and supervision	1,378		0,943		0,435	
Banking and interest	1,901	19,190	1,074	10,875	0,827	8,315
2. The H.T. Transmission Line						
Materials	1,250		-		1,250	
Freight, duty etc.	0,590		0,590		-	
Transport and erection	1,310		1,310		-	
Preparation and supervision	0,230		0,230		-	
Banking and interest	0,370	3,750	0,230	2,360	0,140	1,390
3. The Transformerstation in Akureyri.						
Construction:						
Materials	0,100				0,100	
Freight, duty, transport, erection	0,292		0,292			
Electrical equipment materials,freight,foreign labour	1,142				1,142	
Duty, transport, erection	0,359		0,359			
Construction and el. equipment.						
Preparation and supervision	0,180		0,120		0,060	
Banking and interest	0,227	2,300	0,083	0,854	0,144	1,446
Laxá Development total		25,240		14,089		11.151

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TABLE V.

LAXÁRVIRKJUN 11,500 H.P.

Estimated Distribution of Local Cost and Foreign Currency Expenditure over the Erection Period.

	1949			1950			1951			Total		
	LOCAL THOUS KR.	FOREIGN THOUS. KR.	TOTAL THOUS KR.	LOCAL THOUS KR.	FOREIGN THOUS KR.	TOTAL THOUS KR.	LOCAL THOUS KR.	FOREIGN THOUS KR.	TOTAL THOUS KR.	LOCAL THOUS KR.	FOREIGN THOUS KR.	TOTAL THOUS KR.
Power Plant	3500	2315	5815	4500	3762	8262	2875	2238	5113	10875	8315	19190
Transmisson Line	100	400	500	1560	890	2450	700	100	800	2360	1390	3750
Main Transformer Station	-	366	366	600	580	1180	254	500	754	854	1446	2300
T o t a l	3600	3081	6681	6660	5232	11892	3829	2838	6667	14089	11151	25240

JANUARY 1949.

5. Operation Cost.

In order to make an estimate of eventual operation cost of the Laxá development, an examination has been made of the operation cost of the Sog power plant in the years 1938 - 1947. The Sog power plant, which supplies Reykjavík with electricity, is situated at approximately the same distance from its main source of demand as the Laxá plant, and is in the same class as regards generating power as the new development in Laxá, or 20,000 H.P., the lower falls in Laxá being 11,500 H.P. Maintenance of the High Tension line from Laxá to Akureyri will probably be higher than that of the Sog H.T. line, as conditions are less favourable in the north. Also, the maintenance of the Laxá penstock will probably be higher than that of the Sog plant, as the Sog penstocks are very short. Furthermore, maintenance has to be considered on the surge tank in Laxá, while the Sog plant has no such arrangement. Caretaking on the river Laxá is also to be expected to be higher than at Sog. On the other hand maintenance of plant machinery and substations should be comparatively less than at Sog, as Laxá will have only one generating unit, while the Sog plant has three.

In the following table is shown the operation cost of the Sogsvirkjun in 1938 - 1947.

The operation cost of Sog Plant 1938 - 1947.

	1938 1000 kr.	%	1939 1000 kr.	%	1940 1000 kr.	%	1941 1000 kr.	%	1942 1000 kr.	%	1943 1000 kr.	%	1944 1000 kr.	%	1945 1000 kr.	%	1946 1000 kr.	%	1947 1000 kr.	%	Total 1000 kr.	%
I. Maintenance.																						
a. Power Plant	29	23	22	21	35	30	37	23	46	20	53	17	149	29	306	44	109	20	250	32	1036	28.7
b. H.T. Line	14	11	1	1	1	1	1	1	2	1	11	3	29	6	9	1	2	-	7	1	77	2.1
c. Substation	1	1	2	2	1	1	4	2	1	-	1	-	5	1	17	2	21	4	40	5	93	2.6
d. Sundries	2	2	4	4	4	4	5	3	8	3	4	1	24	5	29	4	22	4	18	2	120	3.3
Total	46	36	29	27	41	36	47	29	57	25	69	22	207	40	361	52	154	28	315	40	1326	36.7
II. Operation and caretaking																						
a. Power Plant	28	22	32	30	33	28	46	29	76	33	123	38	157	31	157	23	208	38	229	30	1089	30.2
b. H.T. Line	1	1	-	-	-	-	3	2	-	-	3	1	-	-	3	-	7	1	24	3	41	1.1
c. Substation	6	5	5	5	6	5	10	6	20	9	39	12	18	4	19	3	21	4	23	3	167	4.6
Total	35	28	37	35	39	33	59	37	96	42	165	51	175	34	179	26	236	43	276	35	1297	35.9
III. Overhead Cost	32	25	12	11	12	10	20	13	22	9	27	8	46	9	47	7	52	10	62	8	332	9.2
IV. Other Expenses	14	11	29	27	25	21	34	21	56	24	61	19	85	17	108	15	107	19	138	17	657	18.2
Total	127	100	107	100	117	100	160	100	231	100	322	100	513	100	695	100	549	100	791	100	3612	100

A similar survey has been made of the Laxá Plant operation cost in the years 1940 - 1946 as shown in the following Table.

TABLE VII.

Laxá Plant operation cost 1940 - 1946.

	1940		1941		1942		1943		1944		1945		1946		Total	
	1000 kr.	%	1000 kr.	%	1000 kr.	%	1000 kr.	%	1000 kr.	%	1000 kr.	%	1000 kr.	%	1000 kr.	%
I. Maintenance.																
a. Power Plant	13	30	7	11	8	11	15	11	7	7						
b. H.T. Line	10	23	36	56	22	30	32	25	13	13						
c. Substation	1	3	-	-	-	-	3	2	-	-						
	24	56	43	67	30	41	50	38	20	20	55	27	72	29	294	3
II. Operation and caretaking.																
Salaries	12	28	17	27	37	50	66	51	65	64	102	50	107	44	406	4
III. Sundries.																
Overhead Cost	7	16	4	6	7	9	14	11	16	16	46	23	65	27	159	1
Total	43	100	64	100	74	100	130	100	101	100	203	100	244	100	[illegible]	10

On Annexure 4 is a diagram showing the operation cost of Sog Plant and the present Laxá plant. All the items included are subject to price fluctuations both in respect of spare parts from a foreign market, and the domestic price index, in particular the wages rate. The price index has not been calculated for the separate cost items, as it is doubtful if a factual conclusion could be reached. Based on the present cost of living it seems reasonable to estimate the operation cost, less interest and repayment of loans, at kr. 800,000.- for the Sog Plant, and kr. 300,000.- for the Laxá Plant. By comparing the operation and maintenance cost of these two developments and taking the particulars of the development of the lower falls at Brúar in account, it is estimated that the annual cost of this 11,500 H.P. dvelopment, less interest and annuties, will reach kr. 460,000.-.

In the following estimate of the annual expenditure for the lower falls in Laxá, the capital cost is set at 25 mill. kr.; and calculated with a 5 ½ % loan for a term of 25 years, to be repaid in annuties. It is also estimated that the proportionate cost of individual items will be similar to that of the Sog Plant:

Laxá development.

Lower Falls 11,500 H.P.

Operation Cost:

Maintenance.

a. Power Plant	kr.	130,000.-		
b. H.T. Line	"	10,000.-		
c. Main Transformer Station	"	15,000.-		
d. Sundries	"	15,000.-	kr.	170,000.-

Operation.

a. Power Plant	kr.	140,000.-		
b. H.T. Line	"	5,000.-		
c. Substation	"	20,000.-	kr.	165,000.-
Office expense			"	45,000.-
Other expenses			"	80,000.-
Interest and repayment of 5½% loan in 25 years, 7.45% of kr. 25 mill.			"	1.860,000.-
Unforeseen abt. 10%			"	230,000.-
			Total kr:	2,550,000.-

As pointed out before, it is to be expected that some cost items will be higher for the Laxá Plant than corresponding items for Sog Plant, and this would in particular refer to the H.T. Line. This higher cost is taken under the item unforeseen above.

It is proposed to operate the projected extension and the present plant as one undertaking. The operation cost of the present plant, including interest and repayment of loans is now about kr. 600,000.- annually. This cost is not expected to alter in future, and will be added to the above estimated cost. The total operation cost of the Laxá Plant, at the ruling price level is then estimated as follows:

Plant extension	kr.	2,550,000.-
Present plant	"	600,000.-
Total	kr.	3,150,000.-

6. Financial Survey.

Estimated Cost and Receipts for Laxá Plant in the First 9 Years of Operation after Development of the Lower Falls.

In the following Table (Table VIII) is shown a survey of the estimated income and expenses for Laxá Plant in the first 9 years of operation of the 11,500 H.P. development of the lower falls at Brúar. The year 1952 is set down as the first year of operation, and the estimated sale of power is taken from the last column in Table III above. Attention is drawn to the fact that in Table III the load peak is estimated to reach 12,800 kW in 1959 and 13,600 kW in 1960, while the installed generating power is only 12,500 kW. It is possible that the machinery can be overloaded to produce this amount of power, but in Table VIII, the Laxá Plant is not estimated to produce more than the stated generating capacity allows.

TABLE VIII.

Laxárvirkjun 12,500 kW. Financial Balance Estimate.

Loan for 25 years. Interest 5½%. Sinking funds period 25 years.

Year of operation	1.	2.	3.	4.	5.	6.	7.	8.	9 and later
Energy sold, kW.year	9000	9400	9900	10500	11100	11600	12100	12500	12500
Price: kr/kW.year	300	300	300	300	300	300	300	300	265
Revenue 1000 kr.	2700	2820	2970	3150	3330	3480	3630	3750	3315
Annual cost 1000 kr.	3150	3150	3150	3150	3150	3150	3150	3150	3150
Interest on deficit at 6% 1000 kr.	-	27	48	62	66	59	43	17	-
Total annual cost 1000 kr.	3150	3177	3198	3212	3216	3209	3193	3167	3150
Deficit 1000 kr.	450	357	228	62	-	-	-	-	-
Surplus 1000 kr.	-	-	-	-	114	271	447	583	165
Revenue Balance 1000 kr.	3150	3627	4005	4247	4313	4192	3905	3750	3315
Accumulated deficit 1000 kr.	450	807	1035	1097	983	712	275	-	-
Accumulated surplus 1000 kr.	-	-	-	-	-	-	-	308	473

As will be seen from the table above the price of the power produced is estimated to be kr. 300.- pr. kW.year, for the first 8 years, then to be reduced to 265.- kr./kW.year. According to the survey there is a loss estimated in the first four years, which is to be recovered in the next four years. The surplus in the 8th year is estimated at kr. 308,000.-, to be paid into the reserve fund of the development. Further it is estimated that 5% of the income or kr. 165,000.- will be paid to the reserve fund as of and from the 9th year of operation.

It should be mentioned that in the foregoing the generating power and price of electricity is based on plant conditions. It is to be expected that owing to transmission losses, the consumers' price will be higher. However, this difference is partly eliminated by the concurrent load factor as more than one consumer is concerned. This point is not to be enlarged upon here, as the operation estimate is only intended to submit a survey of the economic possibilities of the Laxá Plant itself.

The above loan terms are rather unfavorable as the interest is high, $5\frac{1}{2}$ %, and the sinking funds period is assumed to begin after the first year of operation. In Table IX below a financial balance estimate is shown when it is assumed that no annuities will be paid the first two years of operation, and the sinking funds period then 23 years. Besides the table shows the effect of decreasing rate of interest on the estimated financial balance. For the sake of comparision the price of energy, kr./kW.yr., remain unaltered from Table VIII.

TABLE IX.

LAXÁRVIRKJUN 12,500 kW.

Financial Balance Estimate.

Loan for 25 years. Interest 5 1/2 %, alt. 5 %, alt 4 1/2 %. Sinking funds period 23 years.

Year of operation		1.	2.	3.	4.	5.	6.	7.	8.	9.
Energy sold, kW.yrs.		9000	9400	9900	10500	11100	11600	12100	12500	12500
Price, kr./kW.yr.		300	300	300	300	300	300	300	300	265
Revenue, thous kr.		2700	2820	2970	3150	3330	3480	3630	3750	3315
	Annual cost, thous kr.	2665	2665	3230	3230	3230	3230	3230	3230	3230
5 1/2%	Surplus, " "	35	155	-260	-80	100	250	400	520	85
interest	Accumulated surplus " "	35	190	-70	-150	-50	200	600	1120	1205
	Annual cost, thous kr.	2540	2540	3140	3140	3140	3140	3140	3140	3140
5 %	Surplus, " "	160	280	-170	10	190	340	490	610	175
interest	Accum. Surplus " "	160	440	270	280	470	810	1300	1910	2085
	Annual cost, thous kr.	2415	2415	3060	3060	3060	3060	3060	3060	3060
4 1/2%	Surplus, " "	285	405	-90	90	270	420	510	690	255
interest	Accum. Surplus " "	285	690	600	690	960	1380	1950	2640	2895

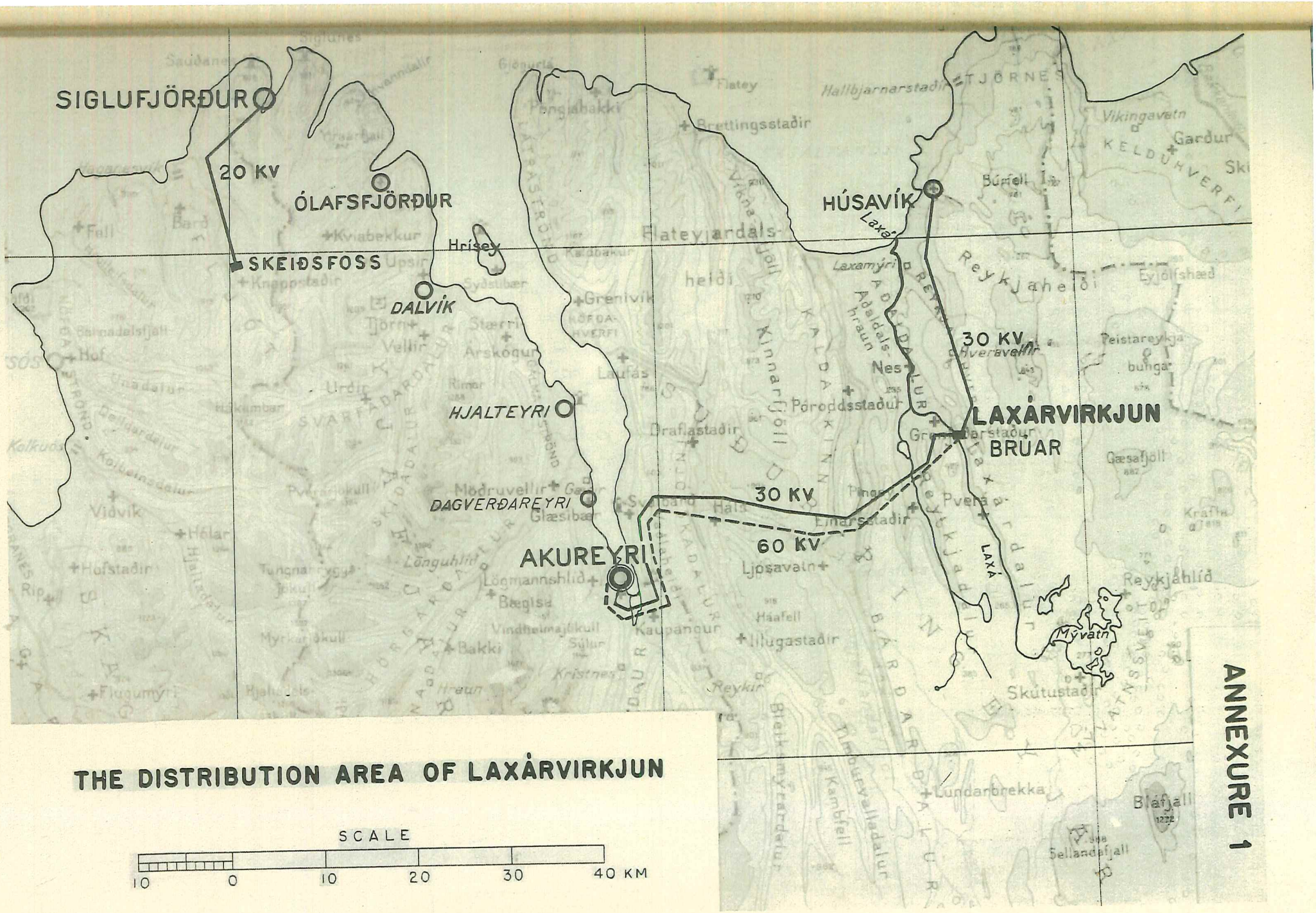
It is evident from Table IX, that the above financial terms are much more favorable for the Laxárvirkjun than the terms assumed in Table VIII. If the interest is 5½% a deficit is only expected in the 3rd and the 4th year, and the accumulated deficit is reaching its maximum totaling kr. 150,000.- the fourth year, decreasing to kr. 50.000.- during the fifth year and disappearing during the sixth year. If the interest is 5 or 4½% only the third year is showing a deficit. The accumulated surplus from the first two years, when no annuities are paid, is then, however, sufficient to cover the deficit of this third year, so a revenue balance deficit will not occur.

In the above financial survey the energy price, kr./kW.yr., has been determined in accordance with the loan terms assumed in Table VIII, and these prices retained in Table IX. According to the Act of the Laxárvirkjun the Development is only entitled to put 5% of the annual revenue aside to a reserve fund. The price of energy may therefore become somewhat lower if the more favorable loan terms assumed in table IX are obtained. In spite of that 300 kr/kW.yr. is considered a very moderate price of energy, a still lower price is very likely to stimulate increasing demand, and thus stabilze the financial foundations of the Development.

Reykjavík, April 13th, 1949.

Jakob Gíslason

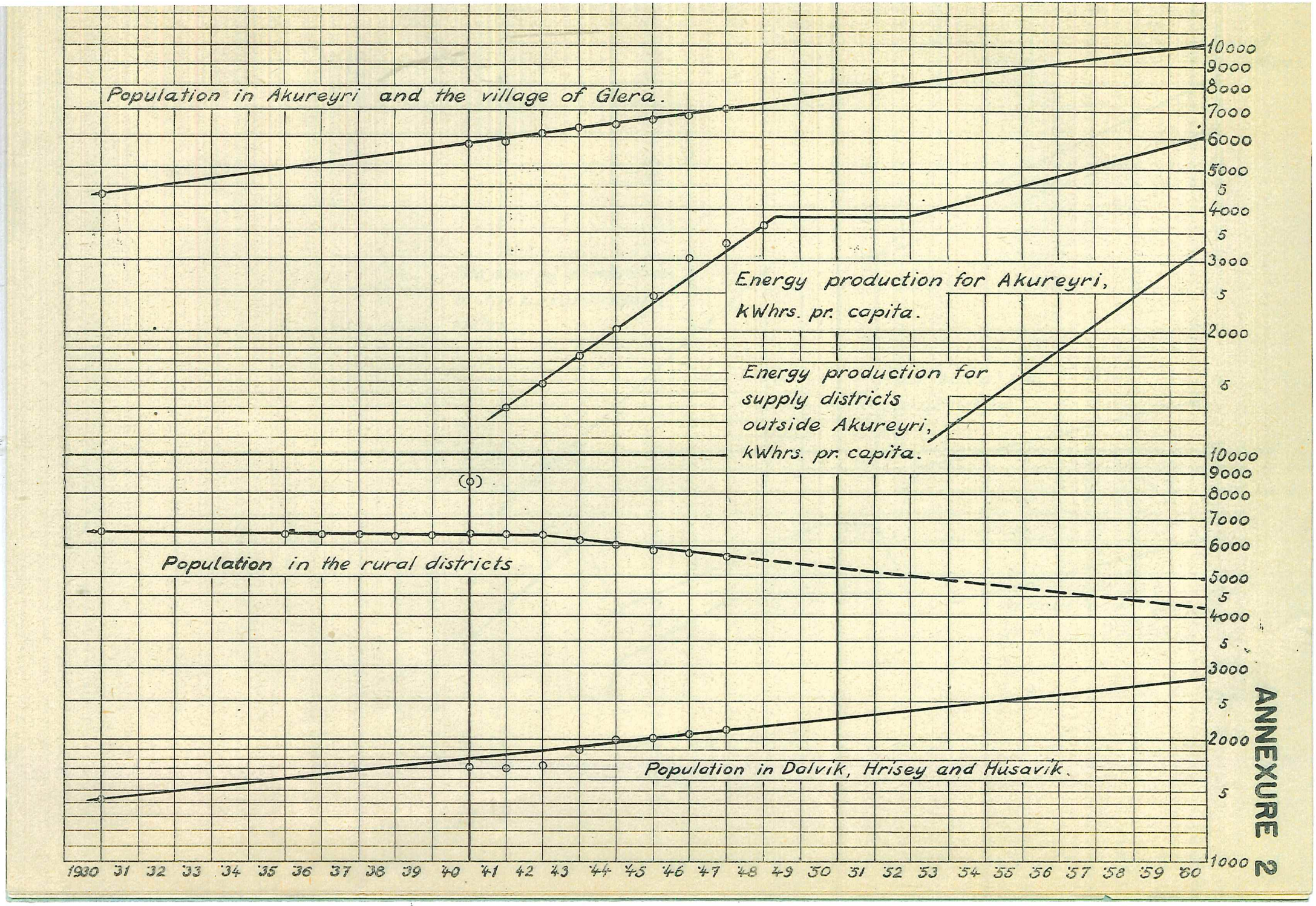
/ Páll Sigurðsson.



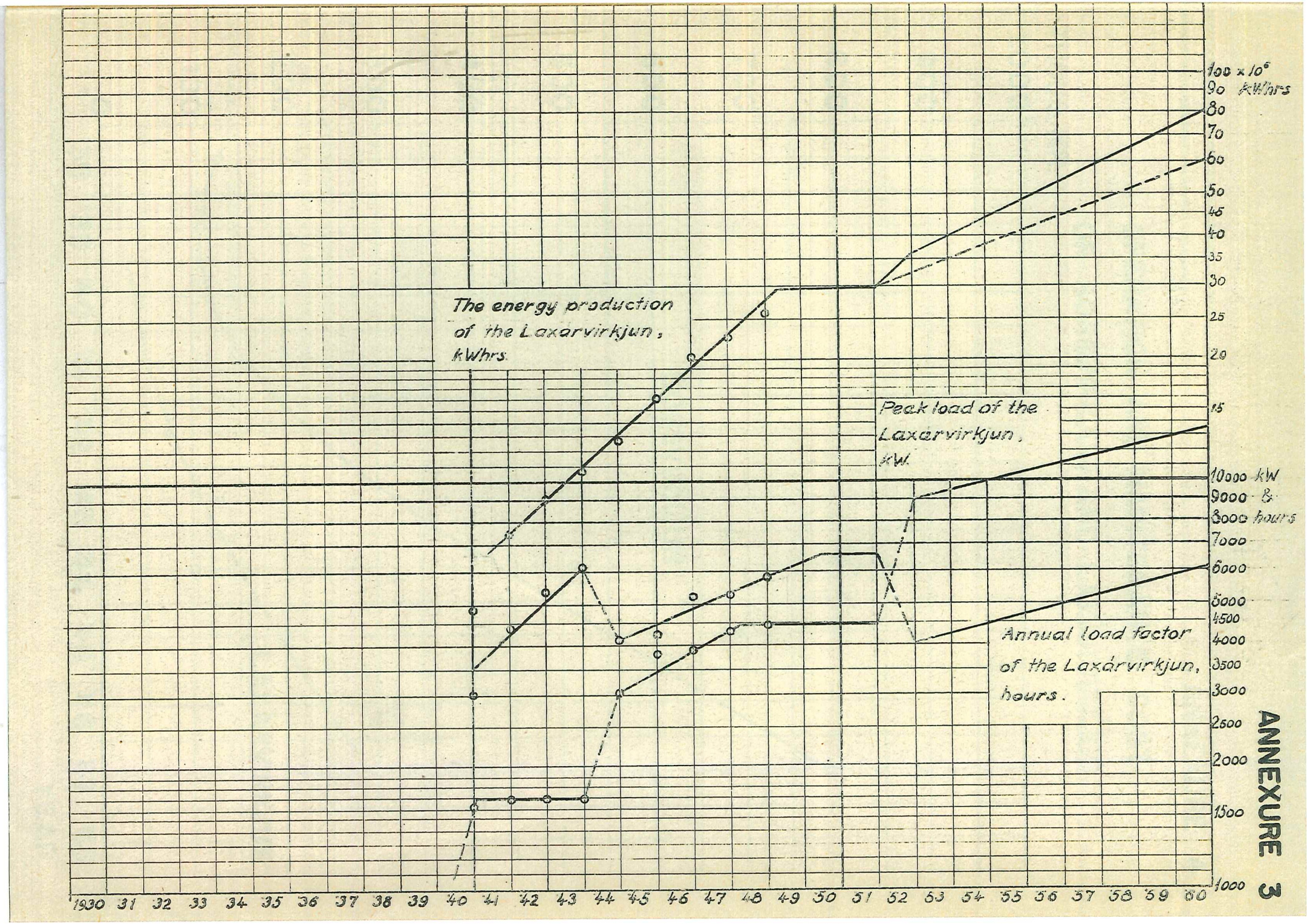
THE DISTRIBUTION AREA OF LAXÁRVIRKJUN

SCALE

10 0 10 20 30 40 KM


Population in Akureyri and the village of Glerá.
Energy production for Akureyri, kWhrs. pr. capita.
Energy production for supply districts outside Akureyri, kWhrs. pr. capita.
Population in the rural districts.
Population in Dalvik, Hrisey and Húsavik.
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1930 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

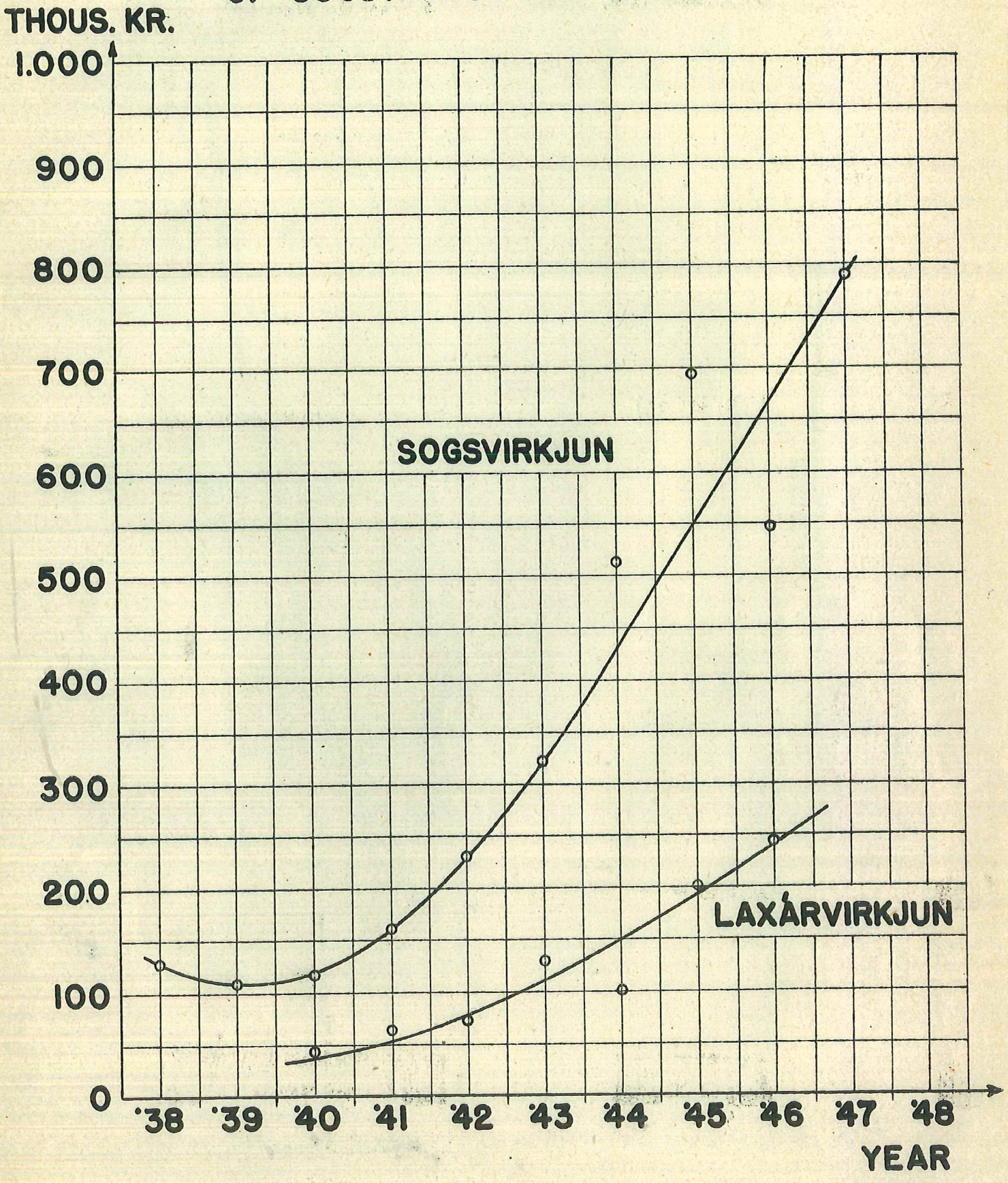
ANNEXURE 2

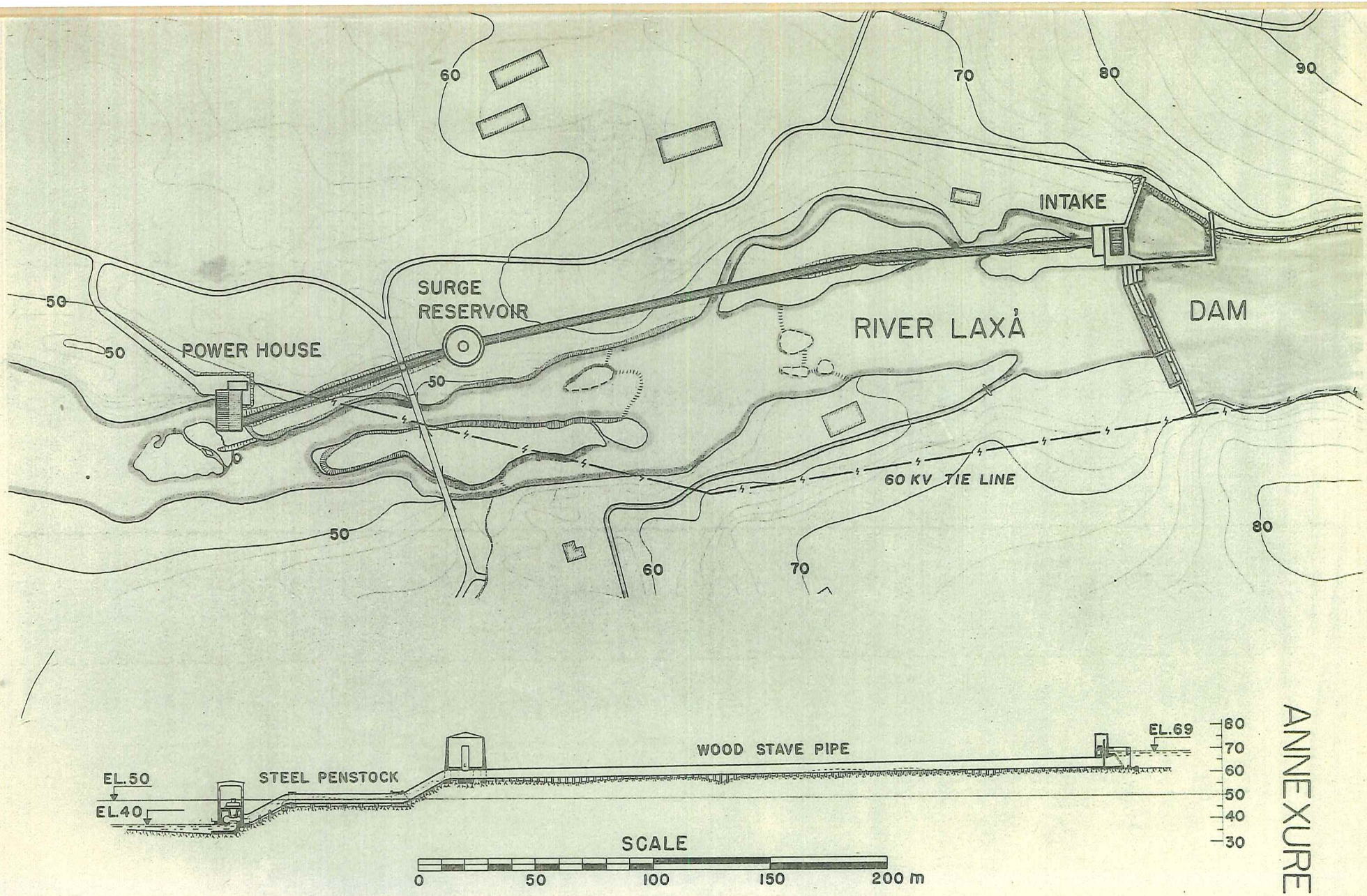

The energy production of the Laxárvirkjun, kWhrs.
Peak load of the Laxárvirkjun, kW.
Annual load factor of the Laxárvirkjun, hours.
100 x 10⁶ kWhrs
90
80
70
60
50
45
40
35
30
25
20
15
10000 kW
9000
8000 hours
7000
6000
5000
4500
4000
3500
3000
2500
2000
1500
1000
1930 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

ANNEXURE 3

ANNEXURE 4

OPERATION AND MAINTENANCE COST OF SOGSVIRKJUN AND LAXÁRVIRKJUN





ANNEXURE 5

LAXÁRVIRKJUN, 11,500 H.P.

DEVELOPMENT OF THE LOWER FALLS AT BRÚAR.

PLAN VIEW AND LONGITUDINAL SECTION.