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Energy and the Growth of Irrigated Agriculture in Southern Idaho

by

Joel R. Hamilton
Assoc. Professor of Agricultural Economics
University of Idaho

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Since the arrival of agriculture in the Northwest a century ago, water-use questions have stirred up passionate argument. One new thread is wound through the current version: energy. Society's energy consciousness, spawned by the events of the last few years, has complicated our understanding of water-use questions. Two events are bringing the issues into clearer focus: the growing realization of the impending disaster of Western drought, and the recent release of a State Water Plan advocating the development of 850 thousand new and 250 thousand supplemental acres of irrigated land in the Snake Basin of Idaho.

Historically, the Northwest had access to abundant hydroelectric power. In recent years nearly 90 percent of electricity generated in the Pacific Northwest has come from water power. Idaho Power generating capacity was 100% hydro based until 1974. The shape of the future, however, looks different. Most of the best hydroelectric sites have been developed. Development at other sites has been precluded by a national decision to preserve wild rivers rather than build dams.

With the number of hydroelectric dams now quite fixed, the amount of hydroelectricity generated now depends mostly on the volume of water dropped through the given structures. Obviously, if water is diverted and used consumptively for municipal, agricultural, or industrial purposes, it is not then available for hydropower production. Moreover, the removal and use of water consumes energy which must be obtained from the depleted electrical supply system.

The Snake-Columbia Hydroelectric System

Water from American Falls Reservoir in Southeast Idaho could potentially be passed through the power plants of 21 existing hydroelectric structures on its way to the Pacific (Fig. 1.) Of the 4,297 foot drop from the American Falls Reservoir pool to sea level, just under half (2,094) feet has been developed for power generation (Fig. 2. and Table 1.) An acre-foot of water dropped through one foot of head generates about .87 kilowatt-hours of electricity. Thus an acre-foot of water released from American Falls Reservoir could potentially generate 1,822 KWH of electric power if it passed through each of the 21 power plants.

If the Northwest hydroelectric system provides insufficient power to meet system loads, the only realistic way to make up the deficit is through conventional thermal and nuclear generating plants. Unfortunately it costs a great deal more to generate power this way then by hydro systems. When the Brownlee-Oxbow-Hells Canyon Complex was completed in the late 1960's this complex could generate power for about 4.2 mills. R. J. O'Connor of Idaho Power estimated in 1975 that his companies' hydro generating cost was then about 7 mills. The existing Jim Bridger coal plant runs at about 12 mills while the 4th unit of Jim Bridger will cost over 16 mills. O'Connor estimated the energy cost for the proposed Pioneer coal plant at 28 to 30 mills (Gladwell, et.al.,1975). The Idaho Society of Professional Engineers estimated that Pioneer energy would cost closer to 33 mills.

Figure 1: Location of Hydropower Dams on the Main Stem Snake and Columbia Rivers

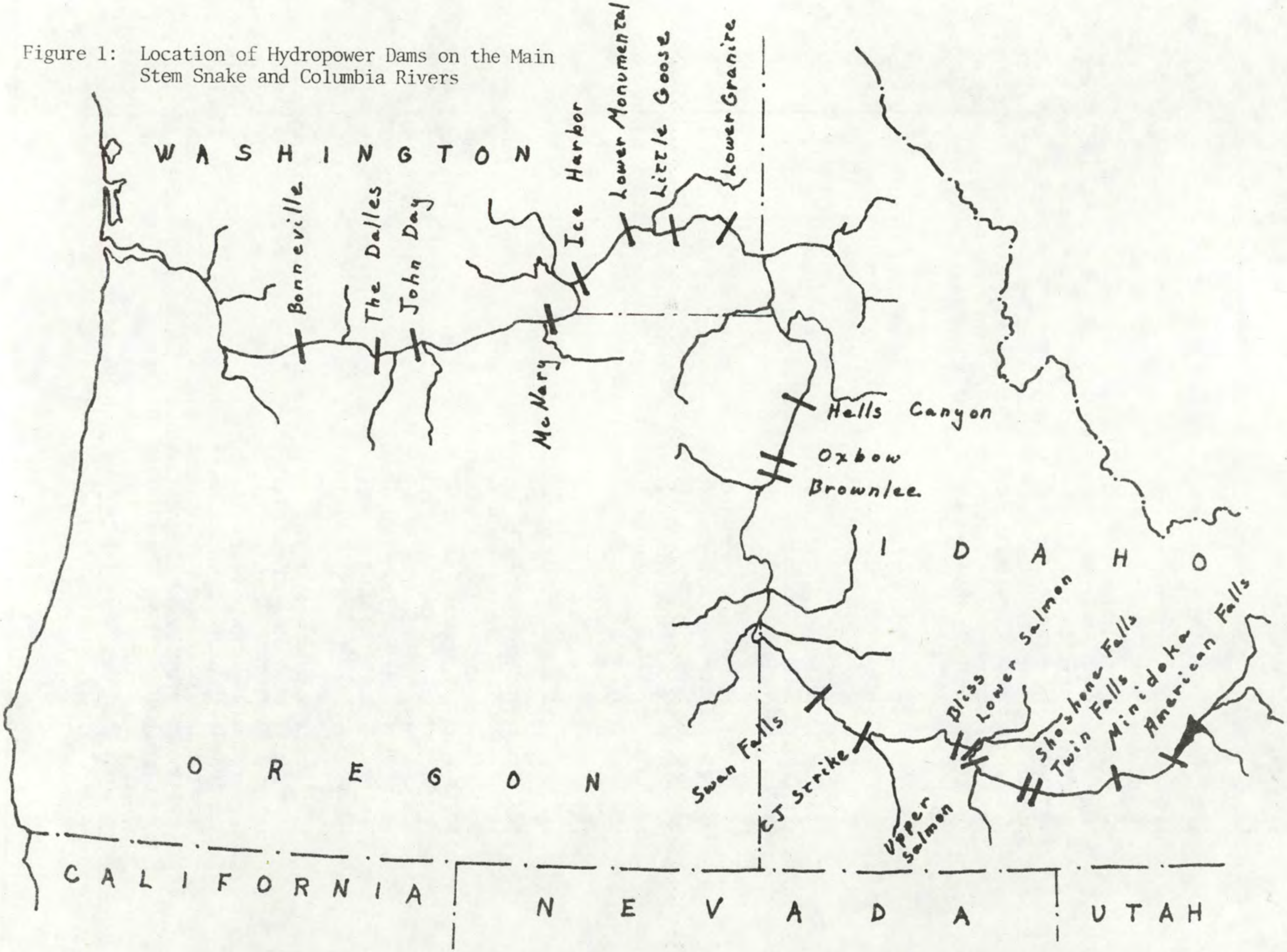
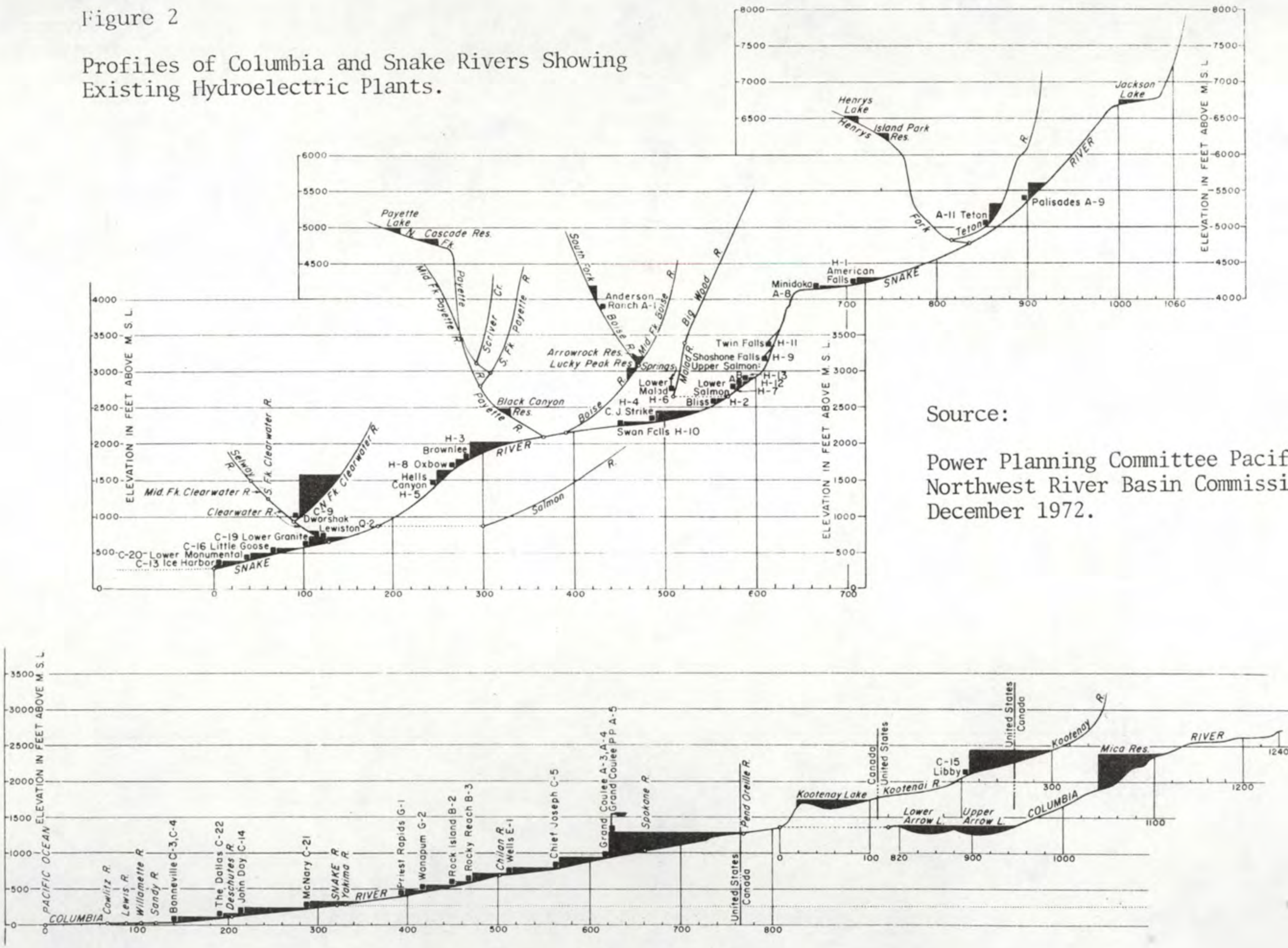


Figure 2

Profiles of Columbia and Snake Rivers Showing Existing Hydroelectric Plants.



Source:

Power Planning Committee Pacific Northwest River Basin Commission, December 1972.

Table 1. Existing Hydroelectric Power Structures on the Snake-Columbia System

	Pool Height (feet above sea level)	Gross Head (feet)	Cumulative Head (feet)	Cumulative Energy .87 KWH/Acre ft/ft. (KWH)
Columbia River (Wash.-Oregon)				
Bonneville	74	59	59	51.3
The Dalles	160	83	142	123.5
John Day	265	100	242	210.5
McNary	340	74	316	274.9
Snake River (Wash.)				
Ice Harbor	440	98	414	360.2
Lower Monumental	540	100	514	447.2
Little Goose	638	98	612	532.4
Lower Granite	736	98	710	617.7
Snake River (Idaho-Oregon)				
Hells Canyon	1668	210	920	800.4
Oxbow	1805	120	1040	904.8
Brownlee	2077	272	1312	1141.4
Snake River (Idaho)				
Swan Falls	2314	24	1336	1162.3
C. J. Strike	2455	88	1424	1238.9
Bliss	2654	70	1494	1299.8
Lower Salmon Falls	2799	59	1553	1351.1
Upper Salmon Falls "A"	2841	46	1599	1391.1
Upper Salmon Falls "B"	2878	37	1636	1423.3
Shoshone Falls	3362	214	1850	1609.5
Twin Falls	3519	147	1997	1737.4
Minidoka	4245	48	2045	1779.2
American Falls	4297	49	2094	1821.8

Table 2. Estimated Costs of Electricity Generation in Idaho Power System

Brownlee-Oxbon-Hells Canyon (When completed in 1969)	4.2 mills
Idaho Power Hydroelectric Cost in 1975	7.0 mills
Jim Bridger units 1-3	12.0 mills
Jim Bridger unit 4	16.0 + mills
Pioneer (Idaho Power's estimate	28-30 mills
Pioneer (Idaho Society of Professional Engineers estimate)	32.7 mills

Using a value of 30 mills for the replacement cost of hydropower potential lost due to irrigation diversion, the water consumptively used has a value ranging from 34 dollars per acre-foot if diverted from Brownlee, up to 55 dollars per acre-foot if diverted from American Falls Reservoir.

Irrigation and Energy Consumption in Idaho

Irrigated agriculture is itself a significant consumer of electrical energy in the Northwest. Electric power is used both to pump the water from the stream or well, and to provide the pressure needed to operate sprinklers.

The energy required by various irrigation systems can be estimated from engineering data. Requirements depend on the water use efficiency, on the lift height, and on the operating pressure of the respective systems. Conventional surface systems require very little energy except for lift pumping, but are very inefficient in their use of water. In this particular example (developed by the Utah State University), a surface system with a run-off water reuse system was the most energy efficient at almost all lift heights. The sprinkler systems, because of their high operating pressures, tend to use more electricity.

If, for example, newly irrigated land along the Snake River had an average pump list of 600 feet, and required 2 feet of net irrigation to satisfy consumptive use, then between 2,000 and 3,600 KWH per acre would be used, depending on the irrigation system chosen.

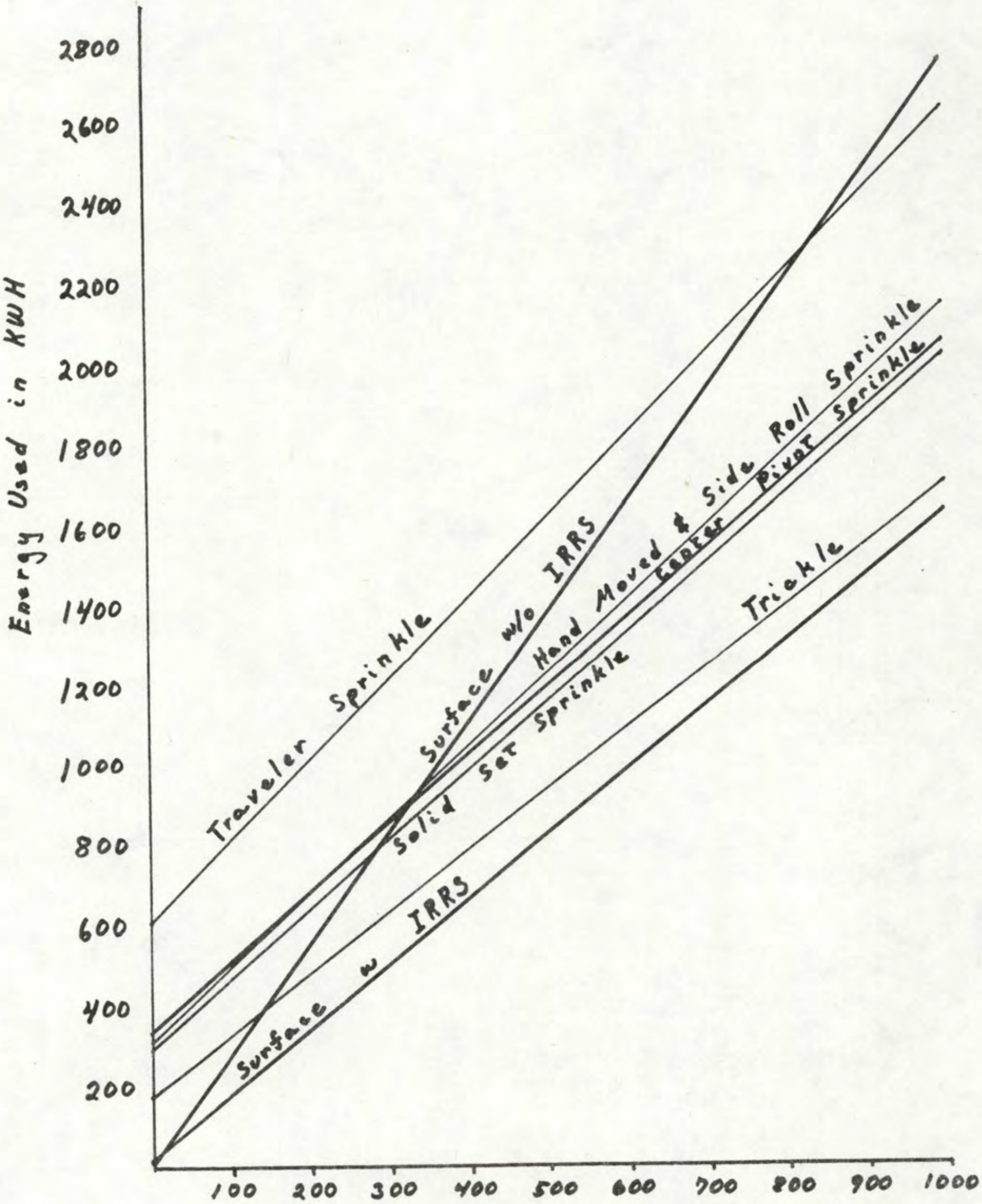
The Idaho Power Company is the major utility serving the irrigated farming areas in Southern Idaho. Data available from Idaho Power clearly illustrates the growing--even accelerating--irrigation power load. Figure 4 shows the acreage added each year to the Idaho Power Pumping load, and Figure 5 shows the installed horsepower per acre for that incremental acreage. This Idaho Power data suggest that there has been a significant shift in the horsepower required for each acre of newly irrigated land. This would correspond to the increasing lift heights required to deliver water to this new land.

In the Pioneer hearings, R.A. Hogg of Idaho Power noted that 490 thousand acres of land above the 1970 base could be developed between Bliss and Murphy before drying up the river at Murphy in a low flow year. They compute that this acreage would require 1.3 billion KWH of energy per year. The summer peak load would be 452 MW--nearly half of the out-put of the proposed Pioneer plant. These figures indicate an energy consumption figure of 2653 KWH/acre/year.

Table 2. Potential Energy Lost by Consumptively Diverting an Acre-foot of Water from the Snake-Columbia Reservoirs

	Cummulative Value of Potential Energy Lost
Columbia River (Wash.-Oregon)	
Bonneville	1.54
The Dalles	3.71
John Day	6.32
McNary	8.25
Snake River (Wash.)	
Ice Harbor	10.81
Lower Monumental	13.42
Little Goose	15.97
Lower Granite	18.53
Snaker River (Idaho-Oregon)	
Hells Canyon	24.01
Oxbow	27.14
Brownlee	34.24
Snake River (Idaho)	
Swan Falls	34.87
C.J. Strike	37.17
Bliss	38.99
Lower Salmon Falls	40.53
Upper Slamond Falls "A"	41.73
Upper Salmon Falls "B"	42.70
Shoshone Falls	48.29
Twin Falls	52.12
Minidoka	53.38
American Falls	54.65

Fig. 3 Energy Used for Irrigation Pumping per Acre-Foot of Net Irrigation at Typical Irrigation Efficiencies



Source: Adapted from Batty, C.J, S.N. Hamad, and J. Keller

Fig. 4 Acres Added per Year to Idaho Power Co.'s Irrigation Load

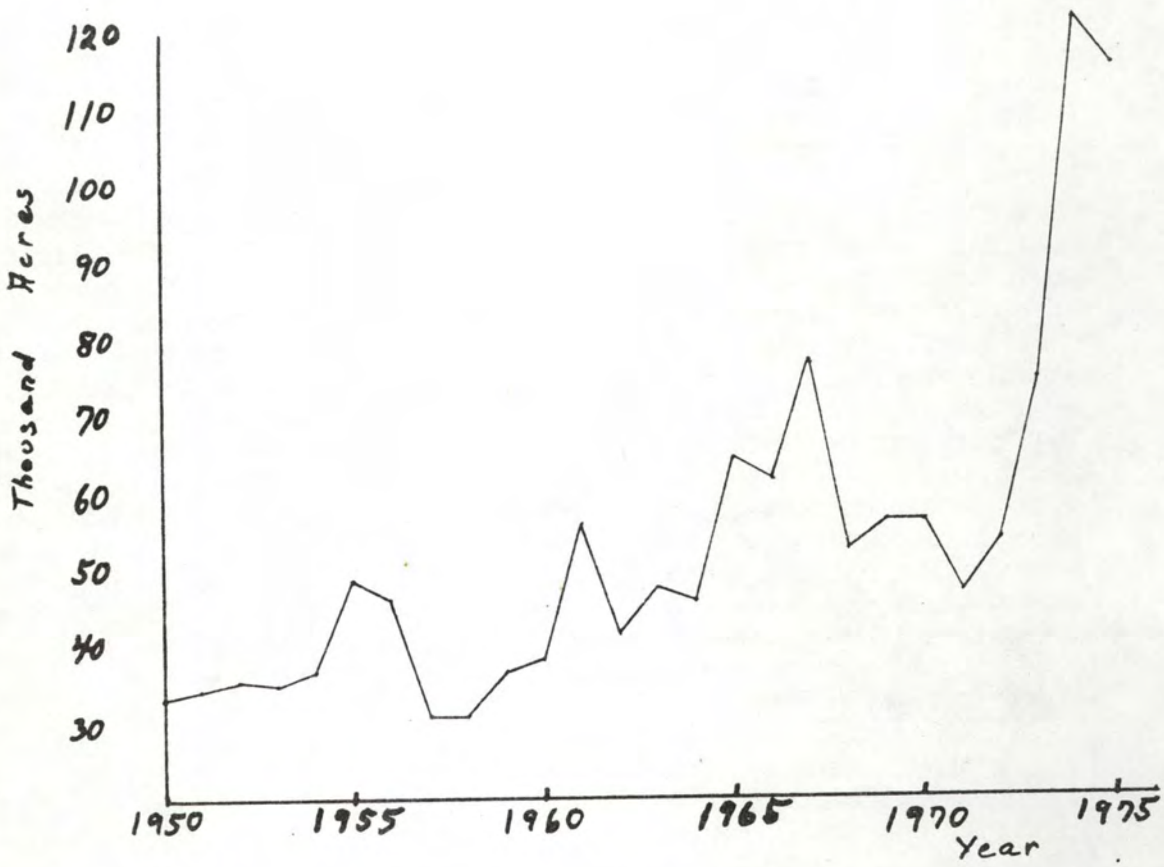
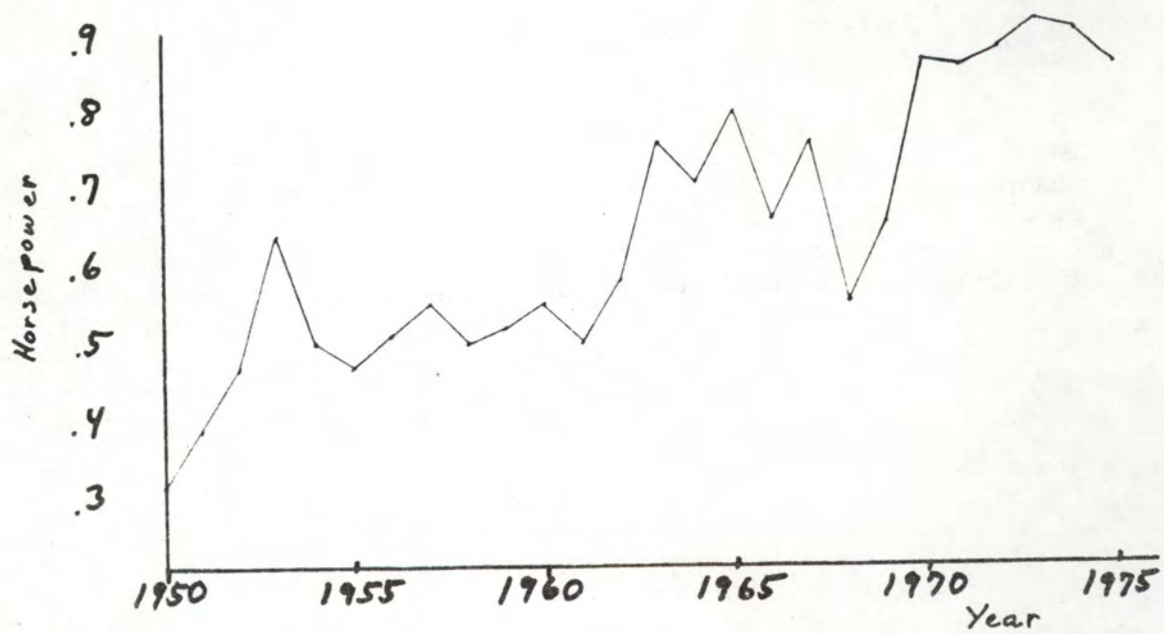


Fig. 5 Horsepower per acre for Annual Increments to Idaho Power Co.'s Irrigation Load



Source: Idaho Power Co.

Using the figures derived so far, one can calculate the replacement cost of electricity not generated and electricity consumed by new irrigation development. Development taking water out of the Central Snake Region would result in a loss of about 1,600 KWH per acre-foot of diversion. If the new diversion is 2.5 acre-feet per acre (net of runoff returned to river) then this means that 4,000 KWH of electricity will have to be generated by thermal power plants at a cost of 120 dollars per acre of development. Using Idaho Power figures on energy actually used by the development, an additional 2,653 KWH must be generated at a cost of 80 dollars.

Under the assumptions used here, each acre of new irrigation development consumes or prevents the production of 6,653 KWH of electricity which would cost 200 dollars to generate by alternate means. The system for pricing of electricity is based more on historical precedent than on economic rationality. Public utilities regulation generally allows the recovery of costs plus reasonable profits. In practice, this results in each of the electricity users assuming a fraction of the costs imposed on the system by new loads and the requisite new generating plants. Hence, higher average costs imposed by new thermal power generation are shared by all users rather than imposed on those people whose actions led to the cost increase. The farmers who impose the added load do pay a portion of this cost with their power bill--but probably no more than a third of the total. The rest of the cost imposed by this development is apportioned out to other electricity users (including other irrigators) through the working of the average cost pricing systems.

Electricity as a Production Expense

Although farmers are not required to pay the incremental cost of producing the electricity they use, this electricity is by no means a free good. Electric power bills can be a very significant portion of production costs for a high lift pumping operation. A recent Idaho Department of Water Resources study estimated typical pumping costs for South Idaho farms, comparing current rates to the increased rates likely if Pioneer were built (Ferebauer, 1976). Using their assumptions, current costs ranged from 17 to 45 dollars electricity cost per acre. The higher projected costs ranged from 43 to 112 dollars--an increase of over 67 dollars per acre in the most severe case.

Irrigated agriculture will be severely impacted if rising electricity use forces up the rate structure. Use of electricity in Idaho for residences, businesses, and industry, as well as for irrigation is increasing rapidly. Historically, U.S. electricity use has doubled every 6 to 7 years--a pattern that continues undisturbed by the energy crisis. An added factor in Idaho is the rate of population growth--among the fastest in the U.S. This increased power use can only be satisfied by new, high cost generating facilities. In spite of any policy decisions that might be made regarding the encouraging or restriction of new irrigation electrical loads, the existing electrical irrigation loads are likely to be faced with escalating rate structures.

Table 4. Energy Use and System Costs Consequences of New Irrigation in the Central Snake Region.

	Energy (KWH)	Value at 30 mills
Energy not generated because water is diverted	4000	$120.00
Energy required directly by development	2653	79.59
Total Impact	6653	199.59

Table 5. Estimated Effect of Pioneer Power Plant on Irrigation Pumping Costs of Typical Idaho Farms

	250' Lift	400' Lift	550' lift
	(Dollars per acre)		
Southwest Idaho			
Surface Water			
w/o Pioneer 1/	18.41	29.43	40.47
with Pioneer 2/	46.02	73.60	101.17
Ground Water			
w/o Pioneer	24.46	34.62	44.78
with Pioneer	61.15	86.55	111.95
South-central Idaho			
Surface Water			
w/o Pioneer	17.05	27.26	37.48
with Pioneer	42.62	68.15	93.69
Ground Water			
w/o Pioneer	23.55	33.33	43.10
with Pioneer	58.89	83.32	107.76

1/ Using Idaho Power rates as of January 28, 1976

2/ Assuming a 150 percent rate increase
Source: Adapted from (Ferebauer, J., 1976)

These rising power bills can be expected to have an effect on the growth of irrigated acreage in Idaho. At some point, higher power costs would slow down the development of new high lift irrigation. At some point, higher costs would slow the conversion to sprinkler systems. If rates were pushed high enough, presently irrigated land might revert to dryland crops or grazing as intensive crop production shifted to lower cost parts of the country watered by natural rainfall. The Idaho Power Company data on new irrigation loads shows that we are a long way from that point. The high farm product prices of recent years have allowed producers to shoulder the costs increases so far. The question then becomes: how high would power rates have to go or how low would farm product prices have to fall before the expansion of irrigated agriculture is halted or even reversed?

Summary and Conclusions--Irrigators Caught in the Crossfire

Idaho is an agricultural state. Agriculture is a significant--if not dominant--portion of its economy. At the moment, irrigated agriculture is a dynamic and growing component of the State's agricultural sector. This paper makes several points about the future of irrigated agriculture in Idaho and the Pacific Northwest.

1) The expansion of irrigated agriculture may involve a rather large social cost because of the actions of the average cost-pricing system used in setting electric power rates. The water diverted for irrigation use reduces the power generation potential of the hydroelectric power plants. The water pumping and sprinkler pressurization also consumes large amounts of electricity. The cost of building thermal power plants to replace the energy used and that foregone, is borne by all users of electricity. The total energy cost due to typical development in Southern Idaho may be as much as 200 dollars per acre.

2) Electric power bills are a significant portion of production expenses in high lift irrigation. As the move towards non-hydroelectricity generation proceeds, irrigator's power bills will move upward. This will hurt farmer's incomes. It will reduce the incentive to expand irrigated acreaged and to install sprinkler systems. And if carried far enough, these higher rates could force cutbacks in Idaho irrigated farming.

Economists tend to look at the price system for answers to resource allocation problems. Peak load pricing would be one step in the right direction. A more fundamental change in the rate structure that attempts to charge each marginal user the marginal costs he imposes on the system would lead to an economically more efficient allocation of electricity use. Realistically, however, we are a long way from the time when marginal increases in household and industry power use can be charged a rate of 30 mills or more. Applying such a rate to each new household, irrigation project, of factory would also be politically infeasible at this time.

There is then, at this time, no clear solution to the dilemma that changing electricity prices is imposing on Idaho. Whether time will create the political climate that will allow a solution, remains to be seen.

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