THE RELATION OF ARIZONA'S MINING INDUSTRY TO POWER DEVELOPMENT IN THE STATE

A study of the power development in Arizona shows how the mining industry's consumption of power has made possible the huge water storage for irrigation together with cheaper power for the cities, farming communities and manufacturing industries. Few people have thought of the mining industry's contribution to water and agricultural development in providing a market for surplus power. The benefits have worked both ways, for hydroelectric power has been an important factor in trimming costs of copper production by the low-grade mines.

The low-grade mines of Arizona account for ninety percent of the state's copper production, and their margin of profit is so small that lower power costs can sometimes mean the difference between success and failure. On the other hand, the income from the sale of surplus power by the hydroelectric installations has helped to assure the success of the agricultural developments in the state.

The Salt River Valley agricultural area consists of the district surrounding Phoenix. Through the Salt River project, water is supplied to a rich agricultural area by irrigation ditches, the water being controlled by a series of dams on the Salt River. The dams collect the water in the rainy season and permit regular distribution throughout the year. These dams are: the Roosevelt, completed in 1911; the Horse Mesa, in 1927; the Mormon Flat Dam in 1925; the Stewart Mountain Dam in 1930; the Granite Reed Diversion Dam in 1908. Two other dams, located on the Verde River which discharges into the Salt at the Granite Reef Dam, are the Horseshoe Dam, completed in 1946 and the Bartlett Dam completed in 1939.

On the Gila River, near Safford, is located the Coolidge Dam, completed in 1929, and known as the San Carlos Project. It furnishes water for the Florence, Casa Grande and Eloy agricultural area. Further down on the Gila is the Gillespie Dam, completed in 1923, which serves the Gila Bend area.

On the Colorado River are: the Hoover Dam, completed in 1936; the Davis Dam, in 1950; the Parker Dam, in 1938; the Imperial Dam, in 1938; and the Laguna Dam in 1909. The Wellton-Mohawk Canal, completed this year, 1952, takes off from the Colorado River at Yuma and serves an area along the Gila River, beginning 15 miles east of Yuma and extending up the river for about 40 miles. The Imperial and Laguna Dams serve the Yuma area.

A large amount of hydroelectric power is generated by many of the above dams, and the sale of this by-product power makes possible the delivery of water to the agricultural areas at a cost that permits the raising of crops on a commercial basis. If it were not for the power sales, the cost of water would be prohibitive, and the mines made possible the erection of the dams by providing a market for the power. Two agencies handle reclamation power distribution: The Arizona Power Authority, which contracts for and handles transmission of Colorado River power; and the Salt River District, which markets and distributes power from the Salt River Project. Reclamation power constitutes more than one-third of the state's present power supply, turning the

wheels of machinery in most of the large copper mines of the state, as well as other industry, and miscellaneous domestic uses.

In many sections of the state, power is converted into water through the operation of more than 4,500 irrigation pumps. These pumps, using power from dams on the Colorado River 200 and 300 miles away, draw water from the ground to irrigate more than 500,000 acres.

The Salt River Valley project is unique in that it has been an economic success, and has been steadily paying off its debt to the Government. It has grown from one storage dam and 180,000 acres when it was turned over to the Salt River Valley Water Users Association in 1917, to six storage dams and 242,000 acres.

With the starting of Arizona's two generators at Hoover Dam, the Arizona Power Authority will accomplish the purpose for which it was created. It is bringing 900 million kilowatt hours of electric energy annually from Davis and Hoover Dams at rates of from 4½ to 5 mills. The first power received by the Authority and wheeled over the reclamation lines came from Davis Dam March 1, 1951. During the past year it has handled more than 500 million kilowatt hours. Its sales have totaled $2,132,000.

All the big mining companies of the state have purchased hydroelectric power at some time or other. Practically all of it has been purchased from the Salt River Valley Water Users' Association. Inasmuch as there were many times when hydroelectric energy was not sufficient to keep the mines and mills operating, all of the big companies built their own power plants and generated their own power from waste-heat steam boilers at their smelters and from direct-fired boilers using successively coal, fuel-oil and natural gas for fuel.

In the early days of hydroelectric power generation in Arizona, the purchase of this power by the mines was an important factor in the successful development of the irrigation projects. But in recent years, with the development of other manufacturing industries in Arizona, there has been a good market for hydroelectric power. Indeed, the irrigation projects themselves, with their huge pumping installations, have been an important user of power, and some of the mining companies, with their modern steam-generating plants have sold cheap power to the Water Users! The Salt River Project's Reports for 1950 and 1951 showed the following concerning their operations in 1949, 1950 and 1951:

Kilowatt Hours Generated and Purchased - 1949, 1950, & 1951

	1949	1950	1951
Hydro Electric Generation	162,974,019	276,061,633	117,009,910
Diesel Generation	15,106,980	300	154,740
Steam Generation	243,932,467	258,078,350	282,100,262
Purchased energy	413,117,274	362,001,793	483,675,289
	835,130,740	896,142,076	882,940,201

According to the Arizona Power Authority, the major mines and mills of the state represent over 45% of the installed power generating capacity, and they generate over 60% of the total energy generated in the state. In addition they purchase considerable amounts of energy from the state's distributors. This amount of purchased power is determined to a great extent by the avail-

ability of energy, and, of course, is controlled by the operating requirements of individual developments.

* "In 1948 the mines and mills use was 1,067,987,000 kwh. During this year they generated 910,000,000 kwh thus requiring the purchase of 157,987,000 kwh.

It is expected that 39,400 kw of steam and diesel generating capacity will become obsolete within the next few years because of age and generation cost, and will be replaced with modern and more efficient generation, or energy now generated by this equipment will be purchased from the Authority or from other sources."

There are no available records of the purchase of hydroelectric power by the mining companies during the early years of the hydroelectric power development, but the Water Users have the following record of such purchases from 1930 to 1951, incl.:

Power Purchased by Mining Companies from Water Users

Year	Millions of KW Hrs.
1930	83
1931	100
1932	40
1933	20
1934	20
1935	40
1936	96
1937	180
1938	78
1939	103
1940	141
1941	167
1942	188
1943	220
1944	205
1945	147
1946	166
1947	160
1948	162
1949	92
1950	88
1951	85

These records show that the mining companies have purchased an annual average of about eight hundred thousand dollars' worth of hydroelectric power from the Salt River Project. This revenue has been enough to take care of the interest on the long term debt, as well as provide for the investment of a large surplus in plant expansion.

A "Power Market Survey of Power Requirements" published by the Federal Power

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* Arizona Power Authority report to Interstate Stream Commission, March 28, 1949.

Commission in May, 1950 gives the following table of "Annual Past Power Requirements in Arizona, 1929-1948:*

Annual Past Power Requirements in Arizona, 1929-1948

	Utility Systems		Industrial Plant Generation for Own Use		Totals	
	Energy in Millions KW Hrs.	Peak Demand Thousands KW	Energy in Millions KW Hrs.	Peak Demand-Thousands KW	Energy in Millions KW Hrs.	Peak Demand Thousands KW
1929	325.8	72.8	480.1	94.4	805.9	167.2
1930	375.4	79.6	333.2	66.1	708.6	145.7
1931	382.9	83.0	205.0	42.0	587.9	125.0
1932	267.6	56.5	83.0	19.3	350.6	75.8
1933	289.0	65.7	39.5	9.6	328.5	75.3
1934	341.6	78.6	90.0	18.0	431.6	96.6
1935	360.9	83.6	141.0	26.2	501.9	109.8
1936	499.9	104.9	248.4	46.7	748.3	151.6
1937	639.9	142.0	316.9	58.5	956.8	200.5
1938	611.2	132.3	282.2	52.1	893.4	184.4
1939	620.3	136.4	420.7	82.6	1041.0	219.0
1940	741.9	152.5	504.2	95.0	1246.1	247.5
1941	702.2	162.8	464.6	85.7	1166.8	248.5
1942	939.2	188.7	604.2	108.3	1543.4	297.0
1943	1127.9	211.4	676.1	127.3	1804.0	338.7
1944	1185.5	227.5	638.7	134.9	1824.2	362.4
1945	1238.0	246.1	559.5	124.5	1797.5	370.6
1946	1321.8	264.1	546.0	123.9	1867.8	388.0
1947	1612.2	305.5	575.4	127.7	2187.6	433.2
1948	1766.2	353.2	683.9	134.8	2450.1	488.0

During the period 1929 to 1948, generation for own use of the industrial plants in Arizona varied greatly, ranging from a low of 39.5 million kilowatt-hours in 1933 to a maximum of 684 million kilowatt-hours in 1948. The variations have closely followed the trend of the price of copper, a circumstance to be expected since most of this industrial plant generation was by plants of Arizona's copper mining and smelting companies.

Conclusion

It may be of interest to note that the mining companies purchased an average of 125,000,000 kilowatt hours per year for the last six years, and that the revenue from this at seven mills per kwhr was approximately $875,000 per year. According to the Salt River Project's Annual Reports for 1950 and 1951, the net income transferred to surplus account averaged $890,000 for the same six-year period.

Thus, it is evident that the mining industry has contributed in a substantial way to agricultural development in the Salt River Valley.

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* Table 5 - page 51.

To be sure, there was never enough hydroelectric power available to the mines, and it was necessary that the mining companies generate their own power. However, there was always a market for hydroelectric energy whenever it was available, and in the early days of hydroelectric development, the mineswere a very important market.

As mentioned on page 3 it is expected that the large mine generating systems will become obsolete within the next few years because of age and generation cost, and will have to be replaced with modern and more efficient generation, or energy now generated by this equipment will be purchased from the Arizona Power Authority or from other sources. The new power coming from the Colorado River will furnish a source of power which will be of great value to future mines.

Arizona Department of Mineral Resources

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