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Irrigation and Early Hydropower Development in the Salt River Valley

Abstract

Water and power have always had an intricate relationship throughout the modern history of the American West. The limited availability of reliable sources for irrigation and accessible traditional means of energy production led residents of Arizona's Salt River Valley to take extreme measures to guarantee water and power. Without the development of these two resources in the early decades of the 1900s, the reality of the post World War II boom in central Arizona would have remained an impossibility.

Experiments with hydropower development in western US reclamation projects at the turn of the century provided a glimpse of the dividends water storage could offer in energy production and revenues. In the Salt River Valley, the success of early power generating plants on the canal system and at Roosevelt Dam led developers to seek an expansion of reservoir capacity and hydropower generation. As a result, the Salt River Project constructed three dams below Roosevelt and above the canal diversion dam at Granite Reef. Through the operation of generating stations at these sites, the Salt River Valley Water Users Association sought a rapid and significant increase in power revenues to fuel further project expansion and ease governmental debt.

In the case of the Salt River Valley, however, the goals of hydropower generation and efficient irrigation were divergent during periods of the 1920s and 1930s. In times of drought, farmers often demanded additional water to be released from dams on the upper Salt to water their fields. When requests went unheeded, many of the farmers claimed that SRP was holding water to be used for power generation, which provided much higher revenues that irrigation. Farmers' organizations argued that the project was catering to power buyers rather than focusing on their primary mission, providing a reliable and sufficient water supply for irrigation. Until the development of additional reservoirs and the implementation of pump storage technology, times of drought renewed the underlying tensions between hydropower and irrigation.

Although much has been written on water in the West, the relationship between western irrigation and hydropower is a topic often neglected. Focusing on the decades of the 1920s and 1930s, the paper reveals how the character of a project changes when irrigation and generation not only coexist, but compete. Such a study offers needed insight into not only the history of the Bureau of Reclamation, but reveals much about the nature of the twentieth-century arid West.

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Irrigation and Early Hydropower Development in the Salt River Valley

Water and power have always had an intricate relationship in the history of the American West. These two elements were the cornerstone for the creation of modern Arizona and the Salt River Valley. Without the development of each of these resources in the early part of this century, the reality of the post World War II Valley boom would have remained an impossibility.

Aridity, according to many western scholars, is the defining characteristic of the American West. For early residents of the Valley in the late nineteenth century, aridity represented a primary obstacle to permanent settlement. The Salt River, the major water source for central Arizona, varied in flow from raging torrent to a small stream. Early settlers, such as the Swilling party, based the first recorded attempts to irrigate the flatlands along the Salt River upon a system of irrigation ditches constructed by prehistoric Valley residents. The Hohokam left a legacy of over 600 to 700 miles of primary irrigation canals and laterals. Many of these ditches became the foundation for the modern network of Valley waterways.[1] Like the Hohokam, modern settlers began damning, diverting and ditching the Salt to make the most efficient use of limited water resources.

As the population grew and more irrigation enterprises depended on the erratic flow of the Salt, better control over the water supply became a necessity. Farmers along the river witnessed cycles of flood and drought that compromised their ability to prosper. Flood meant not only damage to crops, but, more importantly, was seen as a waste of valuable river water. Drought brought conflict over water rights and dramatic drops in farm production. A solution to the problems of flood and drought required a comprehensive irrigation plan for reducing loss and increasing supply. An answer to the question of how to develop the irrigation resources of the Valley came with the passage of the federal Reclamation Act of 1902. The act funded the construction of Roosevelt Dam at the confluence of the Salt River and Tonto Creek, 77 miles east of Phoenix. The dam impounded floodwaters for agricultural use during dry years and

served as the keystone of the new irrigation system. With the creation of the Salt River Project, local farmers had hope that triumph over the obstacle of aridity was close at hand.

Along with the challenge aridity presented in much of the West, western power generation development was an equally formidable task. In the Salt River Valley, the inaccessibility of traditional power sources, such as timber and coal deposits, caused developers to look for alternatives for energy. Steam plants that used fuel oil to operate boilers provided an early, yet expensive, alternative. The development of western US reclamation projects provided glimpses of the dividends that water storage could provide in energy production and revenues. The first reclamation projects, including the Salt River Project, used hydroelectric power in the construction of irrigation features. As Bureau of Reclamation Director Elwood Mead would later note, the earlier government effort made "extensive use of the opportunities which existed on many mountain streams, to cheapen the cost of excavating canals by employing hydroelectric power to displace coal and gasoline, horses and mules."[2]

Soon after planning began for Roosevelt Dam construction, reclamation engineers realized that hydropower could provide the most reliable and efficient source of energy for construction. Developers noted that the energy produced at Roosevelt could not only be used for construction, but also wholesaled to the nearby Globe area mines, sent to the Valley as power for pumping, or transmitted to Phoenix as a municipal energy source.[3] The hydroelectric units installed at Roosevelt started the Salt River Project in the power business and created the first multi-purpose project under the Reclamation Act.

As the Bureau of Reclamation continued to develop irrigation features throughout the Valley, the work at Granite Reef diversion dam and along the canal system required a new network of transmission lines to power construction and excavation equipment. The lines

erected during this period would later form the main distribution system reaching out to all corners of the Valley.[4] The water distribution network thus determined the structure of the early power grid for the valley. As work continued, additional hydropower plants were created along the canal system to supplement the primary generation at Roosevelt.

In 1917, US Secretary of Interior Franklin Lane insisted that the project cease to be federally operated and that control be turned over to the landowners. He argued that government paternalism had no place in such a local concern. Although many local representatives were hesitant about the change, Karen Smith argues that one of the factors that led them to agreement was a recent "reinterpretation of reclamation policy which allowed profits from the sale of power to be used in any way the water users wanted."[5]

The prospect of future hydropower development was an important factor in rallying local support for the Salt River Valley Water Users' Association assumption of project control. The revenues created by hydropower sales could be used by the Association to pay off government debt and subsidize the cost of water storage and transmission. Although plans for expanded power production were not yet widely considered, the revenues being generated by the power production system in place indicated the profit potential that might be available from an expanded system.

In 1917, the generation system included the Roosevelt units and four small hydro plants in the canal system. The principal power development of the project remained at Roosevelt, where the Association operated a generating station with an installed capacity of 16,000-horse power. The Association, in accordance with a 1910 contract with the government, created the four smaller plants, Crosscut, South Con, Arizona Falls, and Chandler. Built in 1914 at the junction of the New Arizona Crosscut and the extension of the Grand Canal, the Crosscut hydro-

plant was the closest generating station to metropolitan Phoenix. The South Con, built in 1910, served as a generating station at the junction of the Eastern and Consolidated Canals, a few miles below Granite Reef diversion dam. Arizona Falls, an older facility on the Arizona Canal, was fitted with two hydroelectric units in 1912. Originally a steam plant, the Chandler Power Plant was converted to hydropower around the beginning of the decade at the existing site on the Tempe Canal.[6] All four generating stations operated on the existing canal network and did not involve any significant retention or diversion of water that was to be used for irrigation. Together with Roosevelt, the five generating stations had a total capacity of 27,000-horse power.[7] The small network of power producing hydro-plants would soon prove inadequate to satisfy the growing demand for industrial and residential power.

Soon after taking control of the project, the leadership of the Association began to realize the unique positioning of the project in relationship to power for Arizona. TA Hayden, an Association engineer, noted that, in 1920, 80% of the total annual power load for the state of Arizona was "used within a radius of less than 100 miles of the Association's plants; half of this load being already in touch with the Association's existing transmission lines."[8] Project leadership recognized that a ready and accessible market needed new power sources and the unused hydropower potential of the Salt could provide the answer.

One of the leading proponents for the expansion of hydropower generation on the Salt River Project was CC Cragin, the general superintendent and chief engineer of the Association in the 1920s. Cragin, who was recently named one of Energy Markets Most Influential People in Electricity and Gas, had a bold vision of what the Association generation system could become with new developments. In a proposal for additional hydropower development submitted to the Association board in 1922, Cragin provided a detailed analysis of the power situation for the

Association board. His *Report on Proposed Additional Hydro-Electric Power Development in the Salt River* included a brief analysis of the early relationship between hydropower and irrigation. In the report, the engineer acknowledged that the superior right to the waters of the Salt had been and should always be for irrigation. Cragin argued, however, that the centrality of irrigation did not preclude the development of power resources. For Cragin, the Association could no longer ignore the unused power potential of the Salt. He noted that it had become "quite evident that large quantities of power are now going to waste while the water drawn from Roosevelt Reservoir, for irrigation use, drops to the lower level of the Valley."[9]

Early proponents of energy development such as Cragin recognized the difficulties of matching the goals of an irrigation project and a hydropower generation venture. The water movement patterns for irrigation were by no means ideal for power generation. Water releases through Roosevelt and the canal system vary greatly throughout the year. In Summer, when the agricultural demand for water was high, generation capacity could exceed demand, while in Winter, the electricity available plummeted with the drop in irrigation. Any future development of hydropower had to deal with a heavy water flow for 7 months of the year and a very light flow for 5 months. Cragin argued that the relationship between irrigation demand and hydropower production forced the Association to choose between three alternatives: contract for a variable power supply depending on irrigation demand, waste water for power, or build additional storage to regulate water releases for power purposes.[10] In considering a course of action, the Association's concern regarding competing power suppliers made contracting for variable power an unattractive alternative and wasting water went against the fundamental nature of the project.

Although proponents of hydropower expansion spoke of the usefulness of the new power for residential and agricultural purposes, a large consideration in pursuing additional energy

development was the potential industrial load. Some of the larger enterprises in the market for additional hydropower at the time included the Inspiration Consolidated Copper Company, Ray Consolidated Copper Company, Magma Copper Company, and Southwest Cotton Company. These firms represented potential markets for power as well as partners that could be used to help finance new developments. As HJ Lawson, president of the Association in the 1930s, would note "the Project was most fortunately situated as regards to power development, being far from any other source of power or fuel supply and in a fast developing country with a very considerable and industrial mine load."[11]

It became evident by the early 1920s, that a new source of energy was required to supply the growing needs of the developing Valley. Many members of the Association were of the opinion that if the Project did not provide the desired energy, outside interests would take advantage of the opportunity. The introduction of new competitors in power production could not only have resulted in a loss of revenue due to lower rates and less customers, but could have caused an interference with the existing irrigation system.[12] Additional hydropower development was necessary both to reach new markets and protect established ones.

Additional reservoir construction along the Salt seemed to be the only acceptable solution for the power generation situation encountered by the Association. More storage could ease the complications presented by attempting to generate hydropower on a system with a single dam. With additional water storage, irrigation water passed through Roosevelt Dam could not only generate power and be captured by lower dams until needed, but also generate additional hydropower when passed through the lower dams. The additional water storage would bring power production to an underutilized 45-mile long, 604-foot drop from Roosevelt Dam to Granite Reef Diversion Dam. Once water left Roosevelt, it could be used for power several

times before entering the canal system. Just as waste had been an overriding concern in developing the irrigation system, it became a central theme in developing the Valley's power resources.

The first dam constructed on the new system was built approximately 17 miles below Roosevelt in a box canyon near Mormon Flat. The construction of Mormon Flat Dam, 1923 to 1925, began the fundamental shift of the project from one devoted exclusively to irrigation to an irrigation/hydropower development. According to Cragin, the value of the Mormon Flat Dam would be that it "permits the generation of hydro-power during times when there is no irrigation draft on Roosevelt."[13] Of secondary importance, the new dam could stabilize the daily and weekly fluctuations in power development at Roosevelt by offering additional irrigation storage downstream.

Along with the Mormon Flat Dam, the Association constructed two additional storage reservoirs on the lower Salt and gated the Roosevelt spillways in the 1920s. Horse Mesa, built 1924 to 1927, and Stewart Mountain, constructed 1928 to 1930, completed a seven-year period of aggressive hydropower expansion. Horse Mesa, located between Mormon Flat and Roosevelt, and Stewart Mountain, built below Mormon Flat above the Granite Reef Diversion Dam, contributed both additional water storage and hydropower generation to the Project. Through manipulating the water levels at the four generating dams on the Salt, the Association could better maximize energy production.

Power, which in the early days of reclamation was viewed as primarily for construction and pumping, was now supplied to towns, homes, cotton gins and mines. As a result of the additional development, the Project increased the generating capacity of the hydroelectric system from 23,000-horse power to 103,000-horse power. The gross annual power revenues escalated

from approximately $500,000 annually to yearly revenue of nearly $2,500,000.[14] The additional revenue proved important in many ways; to subsidize water delivery costs, to pay portions of the expansion costs, and to repay government debt. As Association President HJ Lawson would later note, "the only reason why the Salt River Project has been able to meet its obligations to the government can be given in one word—power."[15]

The expansion of the power system increased the electricity available to both the urban and rural areas of the Salt River Valley. For the Salt River Valley farmer, the benefits provided by the new development were many. By 1930, 2,000 farms had electricity with approximately 50 new connections per week. Power was used not only for pumping, but for "cooking ranges, water heaters, ensilage cutters, milking machines, cream separators, feed grinders, incubators, brooders and a host of other farm appliances."[16] Advertisements for the latest in home electrical appliances were prevalent in local newspapers as retailers claimed the ways in which new products, such as the vacuum cleaner and the washing machine, could lessen manual work and improve the quality of life in the Valley.

Despite the gains in rural electrification realized through the expansion of the hydropower system, some argued that the irrigation/hydropower relationship remained strained. The dual objectives of maximizing hydropower generation and efficiently providing irrigation were often at cross-purposes. Although the development of additional storage below Roosevelt Dam was proposed as a way to reconcile the variant goals of irrigation and hydropower, the expansion served to increase the tension within the relationship by raising the importance of hydropower to the Project.

In a 1932 journal article in the *American Society of Civil Engineers Papers*, CC Cragin reflected on the dynamics of developing hydropower on an irrigation project. He noted three

fundamental restrictions that must be honored when embarking upon combined development: power development is justified only when there is little or no interference with the irrigation system, generation expansion is only warranted when the profit margin assured is significantly greater than that required in an independent power concern, and an irrigation project is justified to enter the general power business only in the most unusual of circumstances.[17] Although he argues that the Salt River Project's hydropower expansion considered these three restrictions, Cragin was conscious of the many tensions inherent in the creation of a dual-purpose project.

In the early 1930s, some Salt River Valley farmers' groups argued that the Project had forgotten its true purpose and lost its way. Critics protested that the pursuit of hydropower distracted the Association leadership from the heart and soul of the Project, water storage and irrigation. In times of drought, unmet demands for water releases from Valley farms caused some to accuse the Association of catering to power buyers over irrigation interests. By holding water, critics argued, the Project was timing releases for the generation and sale of power, which provided much higher revenues that irrigation.

In some cases, the Association offered to sell power to Valley farms for the pumping of irrigation water rather that release reservoir storage. Farmers often objected to this new policy based on claims that the land was legally entitled to river flow, which they argued was of a much higher quality than pump water. In a 1936 court case, *EC Adams vs. Salt River Water Users' Association*, the plaintiff sued maintaining that "crop yields have for a number of years been gradually going down, down, down and that these things are a direct result of what the Association had done."[18]

Critics of the changing character of the Project contended that the relationship between hydropower and irrigation was irreconcilable. Some argued that a farmers' organization had no

place in such a highly competitive business such as energy; an endeavor that required a great deal of long term planning and management as well as the development of new sources of capital for expansion.[19] The local division of opinion regarding the future role of the Association in hydropower was so prevalent that it eventually reached Washington. In a 1937 memo, Bureau of Reclamation Commissioner John C. Page noted that in light of the dispute, Association directors "might well consider the basis on which they would be willing to release all power facilities to the United States."[20]

The Association hydropower development of the 1920s became a heated political issue in Valley political debates during the 1930s. The argument over the irrigation/hydropower relationship created warring factions vying for control. Critics attempting to gain control of the organization contended that the leadership of the previous decade guided the Association down the incorrect path of hydropower expansion. Defenders of hydropower countered that their reactionary opposition preferred to eschew progress for a return to the horse-and-buggy age. They argued that, for whatever flaws may exist in the hydropower system, "it is a utopian condition too good to be lost, just because some petty conspirators are trying to paint the picture far blacker than it really is."[21]

Tensions in the relationship between hydropower and irrigation remained high until several new developments in the Valley in the late 1930s. Three changes that quieted the controversy were the creation of additional water storage on the Verde River, the implementation of pump storage technology, and the development of alternative power sources. Bartlett Dam, completed in 1939, had no hydropower generation and offered water storage exclusively for irrigation. The new dam on the Verde was also situated below Salt River generation and could release water directly to Granite Reef and into the canal system. Pump storage technology made

it possible for the Project to use inexpensive, off-peak power to pump from the tailwaters below dams back up into the reservoir at night. Pump storage allowed the Project to replenish reservoir capacity with waters that had already been released for power generation. The development of additional steam plants in the late 1930s and the completion of transmission lines for Colorado River power in 1940 eased the reliance on Salt River generation by providing a variable load not dependent on irrigation demands. The Association now had alternative answers to the often challenging problem of supplying a reliable source of energy.

With the transformation of the Valley following World War II, the relationship between hydropower and irrigation changed dramatically. In the context of the new rapid residential and industrial growth the earlier hydropower expansion was seen as a critical development for the future success of central Arizona. Upon reflecting on the changes of the 1920s and 1930s, the period was not just one of the evolution of the Salt River Project, but the beginnings of a Valley metamorphosis from an agricultural/rural area with a priority of irrigation to a non-agricultural/urban region with a need for energy.

In 1998, only 22 percent of the water deliveries from the Salt River Project went to agricultural customers. Although agricultural production still exists in the Valley, the urbanization of the Valley has changed the basic function of the Project. In the 1930s, critics argued against attempts to build hydropower on a project devoted to irrigation. By the end of the twentieth century, irrigation now exists as somewhat of an adjunct on a project much of the population perceives as devoted to power generation.

Only through knowledge of the early relationship between hydropower and irrigation can one realize the dramatic changes that have taken place in the Salt River Valley. Such awareness provides a new angle on the well told story of the West and its water. Understanding the

dynamics of the relationship between hydropower and irrigation offers needed insight into not only the history of central Arizona, but much of the twentieth-century arid West.

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