Carl J. Bauer*

"THE LONG VIEW OF THE WATER/ENERGY NEXUS: HYDROPOWER'S FIRST CENTURY IN THE U.S.A."

This paper offers a historical overview of the first century of hydropower in the US from today's perspective of the water/energy nexus. Hydropower emerged as a technology in the 1880s and its development expanded until large dam building ended in the US in the 1970s-1980s. I summarize the century from the two different angles of the water sector and the electric power sector, as the roles and strategic importance of hydropower changed dramatically in the two sectors, in the parallel histories of water development and electric power development. The paper emphasizes the electricity side of the hydropower story because the water and environmental aspects are more widely known. During the first 50 years, hydropower dams were far more important to the electric power sector than they were to the water sector. Dams were juicy economic prizes that were fought over by private and public power utilities, politicians and government officials, and other interest groups, and that were built into the core of regional power grids during their foundational decades. Control of hydropower symbolized the deeper political and economic conflicts between public and private interests in the power sector, with hydropower becoming strongly identified with public power. In both sectors, there was a major turning point in the 1930s because of the growth and intervention of the Federal government in the New Deal. The earlier trends reversed and over the next 50 years hydropower became essential in the water sector – scaling up rapidly as the critical factor in paying for Federal multi-purpose water projects – and secondary in the power sector (with regional exceptions). In the power sector, hydropower's trajectory after the 1930s was paradoxical. It boomed in absolute terms, quadrupling in generating capacity as Federal agencies built hundreds of large dams, but hydropower's relative importance in the power sector declined steadily as the rest of the sector grew even faster. The half-century of hydropower's greatest

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expansion ended by its taking a smaller role in the overall power grid. Over the long run, the dynamics of the energy sector have dominated the water sector, a lesson that may apply to other examples of the water/energy nexus in the US and abroad.

INTRODUCTION

Dams for hydroelectric power are a conflictive topic in much of the world, because of their many social and environmental impacts. Hydroelectric power ("hydropower") is a technology that requires building dams on rivers. By its nature hydropower is simultaneously a use of water and a source of energy, which means that hydropower is important in two different contexts: water systems and energy systems. In today's world of global warming and changing climates, how water and energy systems work and how they interact are changing too, in ways we are only beginning to understand. These relationships are now often called the "water/energy nexus."

In this paper, I step back to look for the big historical picture of the water/energy nexus. I offer a historical overview of the first century of hydropower in the United States of America, combining law, geography, and political economy. The technology emerged around 1880, worldwide. Although the basic story of U.S. hydropower is well known to historians, my focus on the water/energy nexus over the long term is unusual. I want to tell the story of hydropower from the two different perspectives of water development and electric power development. I pull together existing literature to answer the following questions:

⇒ How have water law and policy affected hydropower development and operation over time? What have been the roles of hydropower in the water sector over time?
⇒ How have electricity law and policy affected hydropower development and operation over time? What have been the roles of hydropower in the electric power sector over time?
⇒ How have the water and power sectors' laws and policies about hydropower interacted over time?
⇒ Finally, what lessons can we learn for governing hydropower in an era of changing climates, in the U.S. and abroad?

I will summarize the first century of hydropower in the U.S., first from the water angle and then from the electric power angle. In both sectors, there was a major turning point in the 1930s, halfway through the century, because of the massive growth and intervention of the Federal government in the New Deal, led by President Franklin Roosevelt. In part I, I review the role and significance of hydropower in the history of water development, especially in the Western U.S. In part II, I review the role and significance of hydropower in the parallel history of electric power. The environmental impacts of hydropower became prominent in public debate during the last few decades of this period (after 1950) and led to major legal and policy changes affecting both water and energy sectors.

Part II is the heart of the paper, reflecting my emphasis on the electricity side of the hydropower story. Part I is brief because the water and environmental aspects of the hydropower story are widely known, while the electric power aspects

are little known except to specialists. I am writing primarily for people who know about water and who need to know more about electric power. The final section summarizes the overall argument and points to a few messages for both U.S. and international policies.

Hydropower's roles and strategic importance in the water and power sectors changed dramatically over the long term. During the first 50 years, from roughly 1880 to 1930, hydropower dams were far more important to the electric power sector than they were to the water sector. Those trends reversed in the 1930s, and over the next 50 years hydropower became essential in the water sector and secondary in the power sector (with regional exceptions). The 1970s-1980s were marked by major changes in water, electricity, and environmental laws and policies, which were closely tied to broader changes in technology and political economy. One basic change was the end of the era of building large dams. Because of those changes, the paper ends in the 1980s, 100 years after the advent of hydropower. Analyzing the trajectory of hydropower since the 1980s is a task for another project, for which this paper serves as background.

Some brief technical background may be useful. Hydropower technology depends physically on dams, which are large plugs of concrete, earth, and steel that people build to control or modify the natural flow of rivers, often for multiple purposes. Hydropower dams have been built in different ways, depending on the physical setting and the specific economic and social purposes. Some dams create a reservoir upstream which can store water and release it later. Other dams are called "run-of-river," which means they do not have storage capacity, although many such dams divert water from rivers for long distances to run through turbines before returning to the river channel far downstream from the original diversion.[1] When I use the term "hydropower dam" in this paper, I mean any dam for which hydropower is an important purpose, whether or not there are other water uses as well. Finally, note that hydropower technology can be owned and managed in different ways, by different political and economic interests.

I. Hydropower and water development in the U.S.

During the 50 years from roughly 1880 to 1930, hydropower dams in the U.S. were built for the single purpose of generating electricity.[2] They were nearly all of small to medium size and generally had limited capacity to store river flow.[3] Hydropower dams grew steadily in number and size after the 1880s, even during bad

1. *See generally* Sarah Kelly-Richards et al., *Governing the Transition to Renewable Energy: A Review of Impacts and Policy Issues in the Small Hydropower Boom*, 101 ENERGY POLICY 251 (2017); Off. of Energy Projects, Hydropower Primer: A Handbook of Hydropower Basics (Fed. Energy Reg. Comm'n, April 1, 2017)*;* DAVID GILLILAN & THOMAS BROWN, INSTREAM FLOW PROTECTION: SEEKING A BALANCE IN WESTERN WATER USE (Island Press 1997). The analytical approach to hydropower used in this article was applied to the case of Chile in Carl Bauer, *Dams and Markets: Rivers and Electric Power in Chile*, 49 Nat Res J 583 (2009).

2. *See generally* DUNCAN HAY, HYDROELECTRIC DEVELOPMENT IN THE UNITED STATES, 1880-1940 (Edison Electric Institute 1991).

3. *Id*.

economic times when other water-using sectors, especially agriculture, were in trouble or in decline.[4]

State water rights laws recognized hydropower as a valid, legally protected water use, whether or not it was in a separate legal category as a non-consumptive use.[5] Under both the riparian and prior appropriation water rights doctrines, people found ways to promote hydropower in different parts of the country, even in places where irrigation was the predominant water use.[6] In fact, in the pre-electric era (1700s-1800s), waterpower for industrial purposes like milling grain, lumber, or textiles in the Eastern U.S. was critical to the evolution of property rights in favor of capitalist economic development.[7] State governments and courts favored waterpower development even when it damaged other property owners by flooding land or changing flows.[8]

After 1900 there was a long and bitter political debate about whether the Federal government should develop hydropower directly, especially on interstate rivers and public lands, where Federal authority was most obvious, or instead allow private power companies to do it.[9] There was also conflict among different Federal government agencies and their various stakeholders about whether river basin development should be comprehensive and combine multiple water uses, or not.[10] In 1920 the answer was not. The U.S. Congress and President Woodrow Wilson reached a compromise in passing the Federal Water Power Act ("FWPA"), which gave the Federal government authority to issue licenses and charge fees to private hydropower developers, who would build and operate dams. Multi-purpose river development was not approved.[11] (We return to the FWPA in part II.)

Since the 1930s, however, hydropower has been at the heart of large-scale multi-purpose river development.[12] From the water perspective, that is the main story of hydropower's second half-century. President Roosevelt's New Deal marked the entrance of hydropower to a leading role in river development. Boulder Dam on the

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4. *See, e.g.*, Carl Bauer, *Water, Property Rights, and the State: The United States experience*, 49 CEPAL Rev. 75 (1993).

5. *See generally* Swiger, Sensiba, White & Wood, *Hydroelectric Power*, *in* Energy Law and Transactions at 1-196 (LexisNexis Matthew Bender vol. 2 2016); Dan Tarlock, *The Legacy of Schodde v. Twin Falls Land and Water Company: The Evolving Reasonable Appropriation Principle*, 42 ENVIR. L. 37 (2012).

6. Bauer, *supra* note 4 at 79-83; GILLILAN & BROWN, *supra* note 1, at 24-34.

7. *See generally* MORTON HORWITZ, THE TRANSFORMATION OF AMERICAN LAW, 1780-1860 (Harvard Univ. Press 1977); Gary Kulik, *Dams, Fish and Farmers: Defense of Public Rights in 18th Century Rhode Island*, *in* The Countryside in the Age of Capitalist Transformation 25-50 (UNIV. OF NORTH CAROLINA PRESS 1985); Carol Rose, *Energy and Efficiency in the Realignment of Common Law Water Rights*, 19 J. LEGAL STUDIES 261 (1990).

8. HORWITZ, *supra* note 7, at 31-62.

9. SAMUEL HAYS, CONSERVATION AND THE GOSPEL OF EFFICIENCY: THE PROGRESSIVE CONSERVATION MOVEMENT, 1890-1920 (Harvard Univ. Press 1959) at 73-81, 114-121.

10. *See generally* Hays, *supra* note 9; Martin Reuss, *Coping with Uncertainty: Social Scientists, Engineers, and Federal Water Resources Planning*, 32 NATURAL RESOURCES JOURNAL 101 (1992).

11. Hays, *supra* note 9, at 219-240; *see generally* Swiger et al., *supra* note 5.

12. MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (Viking 1986); Gilbert F. White, *A Perspective of River Basin Development*, 22 LAW AND CONTEMPORARY PROBLEMS 157 (1957); Francois Molle et al., *Hydraulic Bureaucracies and the Hydraulic Mission: Flows of Water, Flows of Power*, 2 WATER ALTERNATIVES 328 (2009).

lower Colorado River (later re-named Hoover Dam) was the world's first example of a large multi-purpose dam and storage reservoir, and it set the pattern for what became known as a "cash register dam."[13] A cash register dam generated and sold electric power as its main source of income, much of which went to subsidize other uses of water that were financially costly, such as irrigation, flood control, and navigation.[14] Those other water uses might or might not be part of the same multi-purpose water project. This approach to basin-wide planning was also called "river basin accounting," and it depended on a strong centralized government to coordinate different water-using sectors at the basin scale.[15]

The history of the U.S. Bureau of Reclamation illustrates the rise of hydropower during the first decades of the 20th century. The Bureau (originally called "Service") was created by the Reclamation Act in 1902 with the mission of promoting irrigation development in the arid West – that is, water development for agriculture.[16] The hard experience of local and private efforts to build irrigation systems in the late 1800s had shown that future irrigation development depended on the legal and financial powers of the national government, as described in the Reclamation Act.[17] For decades the U.S. Congress funded the Bureau to subsidize irrigation projects that could rarely pay for themselves financially. By the late 1920s, the political will to keep supporting this expensive policy was weakening.[18]

The Bureau was able to reinvent itself in the 1930s as the builder of multi-purpose dams in the service of the reclamation mission.[19] Those dams became the quintessential New Deal project: putting thousands of people to work building the public infrastructure for future economic growth.[20] Without hydropower, the dam projects were usually not economically feasible.[21] In the words of a semi-official history of the Bureau, power was "the paying partner of irrigation."[22] In that sense, hydropower was the essential water use in many projects, despite being defined as legally secondary to other water uses in specific cases (including Hoover Dam on the Colorado River).[23]

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13. Reisner, *supra* note 12, at 125-175 (Congress approved the plan for Boulder Dam in 1928, and the project was completed soon after Roosevelt took office).

14. *Id.*; *see generally* DONALD WORSTER, RIVERS OF EMPIRE: WATER, ARIDITY, AND THE GROWTH OF THE AMERICAN WEST (Pantheon 1985).

15. REISNER, *supra* note 12, at 125-175; WORSTER, *supra* note 14, at 189-256.

16. Hays, *supra* note 9, at 5-26; REISNER, *supra* note 12, at 108-124; WORSTER, *supra* note 14, at 127-188.

17. *Id*.

18. REISNER, *supra* note 12, at 108-124; WORSTER, *supra* note 14, at 127-188.

19. REISNER, *supra* note 12, at 125-175; WORSTER, *supra* note 14, at 189-256.

20. *Id*.

21. *See generally* Jay Brigham, *From Water to Water and Power: The Changing Charge of the Bureau of Reclamation*, 2 Bureau of Reclamation: History Essays from the Centennial Symposium 697 (2008); William Rowley, *The Bureau of Reclamation: Origins and Growth to 1945*, (U.S. Dept. of Interior vol 1. 2006).

22. William Warne, The Bureau of Reclamation (Praeger Pub. 1973) at 86. The same process played out at local and state levels in the West in the late 19th and early 20th centuries: irrigation development was expensive and economically risky, while hydropower development was often profitable. As a result, state and Federal governments intervened differently in the two water uses over time. *See* Bauer, *supra* note 4 at 83-87 (discussing the case of Washington State).

23. *See generally* Boulder Canyon Project Act, 43 U.S.C. §§ 617 et seq., (1928).

Until the 1940s the intense political conflict over the "public power movement" shaped the role of hydropower in multi-purpose dams.[24] The conflict was a major constraint on the big Federal projects built in that period, such as the Central Valley Project, and Hoover, Bonneville, and Grand Coulee Dams.[25] We return to public power in Part II.

This model of large-scale water development – the multi-purpose dam and reservoir bankrolled by hydropower – spread rapidly across the U.S. from the 1930s to the 1970s: first as part of the New Deal, then in the wartime industrial effort during World War II, and then during the post-war economic boom.[26] Marc Reisner called this time of epic dam-building "the go-go years."[27] The U.S. also exported this model to developing countries, along with U.S. expertise and technology.[28] From the standpoint of water users and water policy, the fact that hydropower found a seemingly unlimited market for its electricity through the first three quarters of the 20th century was simply a given. The dynamics of the electric power sector were little known.

The go-go years – the big dam era – helped trigger the rise of the U.S. environmental movement in the 1950s-1960s, as more people came to know about and oppose the environmental impacts of dams.[29] Since the 1970s very few large dams have been built in the U.S. because of the high economic, environmental, and political costs.[30] The Western U.S. entered an "era of reallocation" of water that continues today: because existing water supplies had reached their limits and projects to create new supplies were not feasible, any new demands for water must be met by reallocating some of the existing supplies.[31] This included new demands for environmental purposes.[32] Water markets and water rights transactions emerged as mechanisms to favor reallocation, with many local variations.[33] A common theme across the West has been the competition and conflict between growing cities and rural, agricultural water uses, as played out in water markets and how they have been regulated.[34] Hydropower has generally not been an important factor in water markets, with some exceptions in the Columbia River basin.[35]

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24. See *infra*, part II.A.2.

25. *Id.*

26. WORSTER, *supra* note 14, at 189-256. *See generally* Molle et al., *supra* note 12.

27. REISNER *supra* note 12, at 151.

28. *See generally* Christopher Sneddon, Concrete Revolution: Large Dams, Cold War Geopolitics, and the U.S. Bureau of Reclamation (Univ. Chicago Press 2015); Molle et al., *supra* note 12.

29. *See generally* John McPhee, Encounters with the Archdruid (Farrar, Straus & Giroux 1971), at 153-245.

30. *See generally* Sarah Bates et al., Searching Out the Headwaters: Change and Rediscovery in Western Water Policy (Island Press 1993).

31. Bates et al., *supra* note 31, at 73-90, 152-198; GILLILAN & BROWN, *supra* note 1, at 1-7; Ellen Hanak et al., *Managing California's Water* (Public Policy Institute of California 2011).

32. *Id*.

33. *See generally* KENNETH D. FREDERICK, SCARCE WATER AND INSTITUTIONAL CHANGE at (Resources for the Future 1986).

34. *Id.*; Bates et al., *supra* note 31 at 152-198.

35. Walter Butcher et al., *Competition Between Irrigation and Hydropower in the Pacific Northwest*, SCARCE WATER AND INSTITUTIONAL CHANGE 25 (1986).

In addition to water markets, environmental protection has been another major theme in Western water policy since the 1970s, especially policies to increase in-stream flows to benefit river ecosystems.[36] Protecting environmental flows affects other existing economic uses of water, which has led to complicated water rights conflicts with multiple actors, values, and interests.[37] The more extreme cases are often called "train wrecks," such as the Klamath basin "water war" in Oregon and California, and the Bay-Delta crisis in California.[38] In these complex water conflicts, hydropower is but one of several factors affecting water governance.[39]

According to Dan Tarlock, eminent natural resources law scholar, since the 1960s hydropower policy in the U.S. has been dominated by responding to hydropower's environmental impacts.[40] He describes the "environmental-recreational-tribal network of constraints" that emerged to oppose hydropower from the 1960s on.[41] Hydropower projects came to symbolize fundamental trade-offs between economic benefits vs. environmental and social costs, and they have been the subject of many landmark court decisions about environmental law since the 1960s.[42] In short, by the 1980s, hydropower's role and importance in the water sector had been strongly defined by its environmental problems and by relations negotiated with other major water users, especially in the case of multi-purpose dams.

II. Hydropower and electricity development in the U.S.

The first major national law about hydropower was passed in 1920, the Federal Water Power Act ("FWPA"), after four decades of rapid but uneven local and private hydropower development. In this section, I review those decades, first by summarizing the history of the electric power sector in general, and then by focusing on the specific role of hydropower in that context.

II.A. First 50 years (1880s-1930s)

II.A.1. Historical development of electric power

The early decades of modern electricity technology were so transformative in social and economic terms that many historians have been drawn to the tale.[43] A

36. Bates et al., *supra* note 31 at 152-198; *see generally* GILLILAN & BROWN, *supra* note 1.

37. *Id*.

38. HOLLY DOREMUS & DAN TARLOCK, WATER WAR IN THE KLAMATH BASIN (Island Press 2008); Jay Lund et al., *Comparing Futures for the Sacramento San Joaquin Delta* (University of California Press and Public Policy Institute of California 2010).

39. *Id*; Hanak, *supra* note 31.

40. Dan Tarlock, *Hydro Law and the Future of Hydroelectric Power Generation in the U.S.*, 65 VANDERBILT L. REV. 1723 (2012).

41. *Id.* at 1744.

42. McPhee, supra note 29, at 153-245. See, e.g., *Scenic Hudson v. Federal Power Commission* in 1965 and *Tennessee Valley Authority v. Hill* in 1978.

43. For books written for a popular audience, *see generally* GRETCHEN BAKKE, THE GRID: THE FRAYING WIRES BETWEEN AMERICANS AND THEIR ENERGY FUTURE (Bloomsbury Pub. 2016); DAVID BODANIS, ELECTRIC UNIVERSE: THE SHOCKING TRUE STORY OF ELECTRICITY (Crown Publishers, 2005); Jack Casazza & Frank Delea, Understanding Electric Power Systems: An Overview of Technology, the Marketplace, and Government Regulation (2nd ed. IEEE Press 2003); Martin Melosi, Coping with

few scientists in Europe had investigated electrical phenomena in previous centuries, but the breakthrough came in the 1820s-1830s when Michael Faraday (in England) and Joseph Henry (in U.S.) discovered essential principles of electromagnetism and force-fields.[44] Understanding these principles led to the invention of electric generators and electric motors, both of which are machines built around the relationship between motive power and electric power.[45] A generator is a cylinder wrapped in a coil of copper wire, which is made to rotate in relation to magnets by some physical force such as moving water or steam (or animal muscle-power).[46] That rotation induces an electric current. An electric motor is the reverse: electric current is used to rotate a cylinder and whatever else may be attached to it.[47]

After 1880, electric power technology developed and expanded rapidly in the U.S. and Europe.[48] Over the next few decades, the new technology went from being a curious luxury item to a widespread and basic necessity of modern life.[49] The use of electric power transformed many aspects of social and economic life, and the electric power industry itself became part of the backbone of the U.S. economy (including massive financial requirements).[50] Electric power was also the subject of intense political conflict throughout this period, reflecting its tremendous economic and social importance.[51]

To convey a better sense of this foundational period, I will summarize three books by prominent historians of electricity. The books focus on different aspects of technology, economy, society, and culture. All three books end their stories around 1930, which their authors agree was a major turning point and the start of a new era in electric power.[52]

Thomas Hughes describes electricity as a large and complex system made up of both social and technological elements.[53] In his massive tome, *Networks of Power: Electrification in Western Society, 1880-1930*, Hughes writes about the history of technology in its social context, combining an overall systems perspective with rich empirical background.[54] His comparison of the three cases of the U.S., Great Britain, and Germany shows different combinations of technology and politics,

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Abundance: Energy and Environment in Industrial America (Temple U. Press 1985); PHILIP SCHEWE, THE GRID: A JOURNEY THROUGH THE HEART OF OUR ELECTRIFIED WORLD (Joseph Henry Press 2007).

44. Melosi, *supra* note 43, at 57-67; SCHEWE, *supra* note 43, at 14-19; BODANIS, *supra* note 43, at 61-70.

45. Melosi, *supra* note 43, at 57-67; Casazza & Delea, *supra* note 43, at 27-48.

46. *Id*.

47. *Id*.

48. *See generally* THOMAS HUGHES, NETWORKS OF POWER: ELECTRIFICATION IN WESTERN SOCIETY, 1880-1930 (Johns Hopkins Univ. Press 1983); LOUIS HUNTER & LYNWOOD BRYANT, A HISTORY OF INDUSTRIAL POWER IN THE UNITED STATES, 1780-1930, VOL.3, THE TRANSMISSION OF POWER (MIT Press 1992); DAVID NYE, ELECTRIFYING AMERICA: SOCIAL MEANINGS OF A NEW TECHNOLOGY (MIT Press 1990).

49. *Id.*

50. *Id.*

51. See *infra* II.A.2.

52. See *infra* II.B.1. The three books are cited *supra* note 48.

53. HUGHES, *supra* note 48.

54. *Id.*

which took different paths to the common result of regional electrification in the 1920s.[55] As Hughes begins his book:

> A great network of power lines which will forever order the way in which we live is now superimposed on the industrial world. Inventors, engineers, managers, and entrepreneurs have ordered the man-made world with this energy network. The half-century from 1880 to 1930 constituted the formative years of the history of electric supply systems, and from a study of these years one can perceive the ordering, integrating, coordinating, and systematizing nature of modern human societies.[56]

Hughes describes five overlapping phases in the evolution of electric power systems from 1880 to 1930, in the U.S., Great Britain, and Germany.[57] The first phase was the invention and development of a new system, led by inventor-entrepreneurs.[58] The second phase was technology transfer from one region or society to another, which relied on inventors and entrepreneurs as well as investors, business managers, and government officials.[59] In the U.S., these two phases (1880s-1890s) were marked by technical advances in electric lighting, generators, and motors, which were applied to a rapidly growing range of purposes and activities.[60] Transmission networks were local in scale, limited by the technology of direct current ("DC"), which lost power and efficiency when transported beyond short distances.[61]

System growth was the third phase, which began in the 1890s and included the emergence of critical problems which had to be solved or overcome (Hughes uses the military term "reverse salient" to describe these problems, which were bypassed by a general advance and remained to be solved).[62] One such problem was the high cost and inefficiency of long-distance transmission of power, which was eventually solved by the invention and adoption of alternating current ("AC").[63] The competition between DC and AC technologies, each backed by rival engineers and business interests, was a critical early chapter in the history of the power sector.[64] The advantage of AC was that power could be transmitted at high voltage with much less power loss, and then changed by transformers to low voltage for the end uses.[65]

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55. *Id.*

56. *Id.* at 1.

57. *Id.*

58. *Id.* at 14 (famous examples of inventor-entrepreneurs were Thomas Edison, George Westinghouse, and Nicholas Tesla).

59. *Id.*

60. *Id.*

61. *Id.*

62. *Id.*

63. *Id.* at 14-15.

64. *Id.*

65. Another critical problem was called the "load factor," which was the ratio of the average use of electricity over a given period of time to the maximum load during the same period. Power companies made no money when their machinery was idle and so they had a strong incentive to promote electricity demands around the clock, thereby increasing their load factor. *See generally* Richard Hirsh, Technology and Transformation in the American Electric Utility Industry (Cambridge Univ. Press 1989); HUGHES,

Phase 4 was technological momentum, in the 1900s-1910s: "As a system grows, it acquires momentum."[66] World War I was a huge historical event that reinforced the electric power system's existing momentum towards larger generators and regional interconnections.[67] Finally, phase 5 was a qualitative shift in the power system's regional development in the 1920s, when all three countries built regional transmission grids, also called "power pools," whose management was centrally controlled.[68] These regional grids were the foundation of the next half-century's tremendous expansion of electric power.[69]

David Nye's book, *Electrifying America: Social Meanings of a New Technology*, covers the same period as Hughes but emphasizes the social and cultural aspects of electrification in people's daily lives.[70] Nye describes the chronology of the spread of electrification into different spheres of social and economic life: first public lighting (1880s), then streetcars (late 1880s-1910s), then factories, homes, and buildings in cities and towns (1890s-1920s), and lastly rural areas (1930s).[71]

Nye also describes the range of viewpoints people held about what electricity was and what it should be.[72] From the beginning in the 1880s, electric power in the U.S. was dominated by private enterprises and widely considered to be a commodity for sale.[73] This contrasted with European countries, where electric power systems were typically owned by governments and operated for purposes of public policy.[74] Nye describes the views of four important groups in U.S. society: businessmen, intellectuals, the general public, and technical reformers.[75] Nearly all of them agreed that electrification was a crucial part of modernity and progress, although some people had misgivings.[76] Businessmen were quick to see the profit-making potential of electric power and they promoted its development while insisting that it belonged in the private sector.[77] The general public embraced electric power enthusiastically as an item of consumption, while intellectuals were more ambivalent about the social meanings and consequences.[78] Finally, a small group of progressive reformers saw electricity in broader social terms and argued for more government regulation.[79]

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supra note 48; HUNTER & BRYANT, *supra* note 48, at 276-283; Valery Yakubovich et al., *Electric Charges: The Social Construction of Rate Systems*, 34 THEORY AND SOCIETY 579 (2005).

66. HUGHES, *supra* note 48, at 15.

67. *Id.*

68. *Id.* at 17.

69. *Id.*

70. NYE, *supra* note 48. *See also* Paul Hirt, The Wired Northwest: The History of Electric Power, 1870s-1970s (Univ. Press of Kansas 2012); Richard White, The Organic Machine: The Remaking of the Columbia River (Hill and Wang 1995) (*discussing* the social and cultural aspects of electrification during these early decades).

71. *See generally* NYE, *supra* note 48.

72. *Id.* at 138-184.

73. *Id.* at 138-141; HUNTER & BRYANT, *supra* note 48, at 140-141.

74. *Id.*

75. *Id.* at 141-142.

76. *Id.*

77. *Id.* at 168-176.

78. *Id.* at 142-157.

79. *Id.* at 157-168.

Those different people had different answers to the question, "What was electricity?"

> [D]espite its ubiquity, electricity seemed to defy definition, and remained a mystery to the citizenry who saw it every day in the street . . . . In the years between 1890 and 1920 a dialogue on electricity took place within American society, in which some voices were louder and more persuasive than others. In part the discussion occurred because electricity was ubiquitous yet inscrutable, but the dialogue was also necessary because Americans had to choose whether to construct many small generating stations or a centralized system, whether to use alternating current or direct current, whether to place ownership in public or private hands, whether to establish rates that favored the small or large consumer, whether to give control over the system to technicians or to capitalists or to politicians . . . .
> The average citizen had a slender practical understanding of electricity, and grasped it only in the general sense as a mysterious new energy source that would make everything better.[80]

Where Nye emphasizes the conflicting social and political views of electrification during its first few decades, Louis Hunter and Lynwood Bryant focus on what made the power industry so important in economic and technological terms.[81] By the 1890s experts in the U.S. were defining electricity as a commodity for the market but even so, it was a new kind of commodity that raised new legal and technical questions.[82] How should people define the product being sold? How should it be measured? How should prices be calculated?[83]

The new electric power industry was unprecedented; all previous forms of energy to do mechanical work, such as water power and steam power, were sharply limited in how far they could transmit power.[84] Individual factories and buildings had to provide their own power systems.[85] Electricity solved this problem once the technology of alternating current was developed in the 1890s, and from then on it was possible to transmit power over long distances.[86] This transmission technology went hand in hand with another new idea, the development of "central stations," which generated the power that was distributed through wires to different users.[87] The electric power industry was:

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80. NYE, *supra* note 48, at 138, 150. *See also* Melosi, *supra* note 43, at 52-67.

81. HUNTER & BRYANT, *supra* note 48, at 140-141 (This is Vol. 3 of Hunter's encyclopedic trilogy, *A History of Industrial Power in the United States, 1780-1930*. Vols. 1 and 2 are about the prime movers, waterpower and steam power, with Hunter as sole author; Vol. 3 is about the transmission of power (i.e., electricity) and includes Bryant as co-author).

82. *Id*; *see also* Mark Granovetter & Patrick McGuire, *the Making of an Industry: Electricity in the United States*, THE LAW OF MARKETS 147-173 (Blackwell 1998); Yakubovich et al., *supra* note 65.

83. HUNTER & BRYANT, *supra* note 48, at 140-141, 272-283; *see also* Granovetter & McGuire, *supra* note 82, at 149-153; Yakubovich et al., *supra* note 65, at 579-612.

84. HUNTER & BRYANT, *supra* note 48.

85. *Id.*

86. *Id.*

87. *Id.*

> [S]omething new under the sun, an industry devoted to the commercial production of energy and its distribution to a wide variety of users throughout the economy . . . . What alternating current did for the electric power industry was essentially what the railroads had done for the industrial economy at large.[88]

Inventing and developing the new technology went hand in hand with creating new legal and economic categories for a new industry. For example, the modern accounting practice of separating fixed costs from variable costs originated in large part through the needs of the early electric power industry.[89] Central-station power required very large capital investment for generators and transmission lines, which together formed a *grid*.[90] The biggest technical challenge then is still a critical problem today: humans do not have the technology to store electric power on a large scale, with the exception of hydropower reservoirs that store water.[91] In any given power grid, therefore, supply must equal demand at all times – that is, at every moment of the day – which is a constant struggle to manage in a system with many and varying demands.[92] In this complex and technical setting, legal security was essential to guarantee financial returns to the private firms that dominated the power industry.[93]

By 1910, according to Hunter and Bryant, the focus of attention in the power industry shifted from the technological aspects to the legal and business aspects.[94] In regions throughout the country, private companies competed and were consolidated into a shrinking number of larger firms.[95] Utility holding companies emerged as dominant forms of corporate organization, which crossed state lines.[96] Meanwhile the use of electrical technology kept expanding. According to historian Paul Hirt, total national electrical generation increased *tenfold* from 1902 to 1922, while per capita consumption increased sevenfold.[97]

World War I triggered an industrial boom in the U.S. that greatly increased demand for electric power, far more than existing systems could supply.[98] Wartime power shortages led the national government to promote the building of large generating stations and to force the interconnection of local and regional systems.[99] Greater interconnections effectively increased the available power supplies in the

88. *Id.* at 242, 254.

89. Hirsh, *supra* note 65, at 17-19; Yakubovich et al, *supra* note 65, at 586-591.

90. Bakke, *supra* note 43; Casazza & Delea, *supra* note 43, at 15-25; SCHEWE, *supra* note 43.

91. See Bakke, *supra* note 43; Casazza & Delea, *supra* note 43, at 15-25; SCHEWE, *supra* note 43; *see generally* Timothy J. Brennan, et al. A SHOCK TO THE SYSTEM: RESTRUCTURING AMERICA'S ELECTRICITY INDUSTRY (Resources for the Future 1996).

92. See BAKKE, *supra* note 43; Casazza & Delea, *supra* note 43, at 15-25; SCHEWE, *supra* note 43.

93. HUNTER & BRYANT, *supra* note 48, at 241-315.

94. *Id.*

95. *See generally* HUGHES, *supra* note 48; Melosi, *supra* note 43.

96. *See generally* HUGHES, *supra* note 48; Melosi, *supra* note 43.

97. Hirt, *supra* note 70, at 66.

98. HUGHES, *supra* note 48, at 15-17; Melosi, *supra* note 43.

99. White, *supra* note 70, at 50-51.

grid as a whole.[100] These lessons lived on after the war.[101] Throughout this period, private utilities generated more than 90% of the nation's electric power.[102]

II.A.2. Political conflict over electric power: Public vs. private

By the early 1900s, the enormous stakes and impacts of electric power technology were obvious, but the future was hard to foresee. Thus emerged a major political question: should electric power systems be *public or private*?[103] The different answers people gave to that question became one of the nation's overarching political conflicts for more than a generation, until World War II forced a consensus.[104] Public power vs. private power was a critical issue in political debates and electoral campaigns at local, state, and national levels.[105] Throughout this period, the electric power industry developed along the same lines as the U.S. economy overall, following trends of increasing concentration of wealth, scale of production, and monopoly power.[106] The Federal government's role in the electric power industry was quite limited until the 1930s.[107]

At state and local levels of government, there were two rival approaches to electricity policy, which merged over time: one was *public regulation* of private utilities, and the other was *public ownership and generation*, also known as "*public power*."[108] Public regulation by state governments was the predominant approach, starting in 1907 when New York and Wisconsin led the way by creating public utility commissions.[109] These commissions were patterned after state railroad commissions, which had been created decades earlier to regulate the railroads' monopoly power.[110] The basic function of public utility commissions was to regulate rates (prices) and conditions of service within state boundaries.[111] Other states soon followed the same pattern.[112]

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100. *See generally* HUGHES, *supra* note 48; HUNTER & BRYANT, *supra* note 48, at 361-367; Melosi, *supra* note 43, at 118.

101. Many historians emphasize World War I's major impact on the power sector. *See* HUGHES, *supra* note 48, at 285-323; Hirt, *supra* note 70, at 166-185; Melosi, *supra* note 43; White, *supra* note 70, at 50-51.

102. Hirt, *supra* note 70, at 50, 150; NYE, *supra* note 48, at 180.

103. *See generally* Jay Brigham, Empowering the West: Electrical Politics Before FDR (U. Press of Kansas 1998); Melosi, *supra* note 43, at 117-137; NYE, *supra* note 48, at 138-184.

104. *Id.*

105. *Id.*

106. Melosi, *supra* note 43.

107. *Id.*

108. Brigham, *supra* note 103; Melosi, *supra* note 43.

109. Hirt, *supra* note 70, at 97-131; Richard Hirsh, Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System (MIT Press 1999) at 11-31.

110. Independent regulatory commissions have been an important model in the broader history of regulation in the U.S.; *see generally* THOMAS K. MCCRAW, PROPHETS OF REGULATION (HARVARD UNIVERSITY PRESS, 1984); Morton Keller, *The Pluralist State: American Economic Regulation in Comparative Perspective, 1900-1930 in*, Regulation in Perspective: Historical Essays 56-94 (T. McCraw, 1 ed. 1981).

111. Hirt *supra* note 70, 109 at 97-131.

112. *Id.*

The economic argument for regulation was that power companies were "natural monopolies," to use the term coined at the time.[113] Overall, it was economically more efficient to have only one network of costly infrastructure, but whoever owned that network had monopoly power and would raise prices unfairly to consumers if not regulated by state government (that is, by public utility commissions).[114] After some initial opposition to such regulation, the owners of private power companies came to embrace it because it guaranteed them good financial returns, protected them from competition, and stabilized the industry.[115] Both private companies and state regulators shared the goal of increasing electricity production and consumption, which meant keeping prices low.[116] Historian Richard Hirsh calls this the "utility consensus," which was forged in the early 20th century and did not break down until the 1970s.[117]

State commissions, however, lacked authority over the large utility holding companies that operated in more than one state.[118] Holding companies were legal and financial arrangements that allowed control of a wide network of companies, typically crossing state lines and hence avoiding state public utility regulation.[119] Their proponents argued that holding companies were necessary to operate large regional power grids.[120] In the words of historian Ronald Tobey, "[t]he rise of the holding company in the electrical industry in the 1920s effectively neutralized the power of the state regulatory commissions."[121] In consequence, the public power movement called for a stronger government role. "[T]he basic assumption of the public power movement [was] that electricity would transform society as fundamentally as had the steam engine in the industrial revolution."[122]

Before the 1930s, public power was limited to certain municipal governments scattered around the country, as allowed by different state laws.[123] These cities, of which Seattle and Los Angeles were famous examples, established public power utilities that competed successfully with private companies.[124] These public utilities had a great deal of symbolic political importance, whether as hero or

113. Brigham, *supra* note 103, at 1-27; Hirsh, *supra* note 109, at 11-31.

114. *Id*.

115. *Id*.

116. *Id*.

117. Natural monopoly is a familiar economic concept today, but few people know that the term originated in the context of the early 20th century electric power industry. Brigham, *supra* note 103, at 1-27; Hirsh, *supra* note 109, at 11-31. Samuel Insull was the key person who articulated the alliance and shared interests between private utilities and state regulators, as discussed in many of the historical references cited here.

118. Hirt, *supra* note 70, at 97-131; Melosi, *supra* note 43; Joseph Tomain & Richard Cudahy, Energy Law in a Nutshell (2nd ed. 2011).

119. Brigham, *supra* note 103; Hirt, *supra* note 70, at 97-131; Melosi, *supra* note 43.

120. *Id.*

121. Ronald Tobey, Technology as Freedom: The New Deal and the Electrical Modernization of the American Home (Univ. of California Press 1996) at p.44. *See also* Brigham, *supra* note 103.

122. Tobey, *supra* note 121, at 51. *See also* White, *supra* note 70 (*discussing* the socially transformative impact of electric power).

123. Brigham, *supra* note 103.

124. *Id.*

villain, but they rarely dominated local power systems.[125] In 1932, they produced only 5% of the total national electric power.[126]

In the 1920s, public power versus private power became one of the defining political issues of the age.[127] According to Gifford Pinchot, who was the first head of the U.S. Forest Service and later Governor of Pennsylvania, "[e]ither we must control electric power, or its masters and owners will control us."[128] Through the decade the conflict deepened into a long-running stalemate as, "each group was too weak to win but too strong to lose."[129] Meanwhile, electricity use and the grid kept growing faster than the economy as a whole.[130] People with clashing political views often agreed on the overall goal – to increase the production and consumption of electric power.

"Giant power" and "super power" were the terms used in the 1920s for the competing public and private visions of regional integrated power systems.[131] Private utilities kept growing while their ownership became more concentrated.[132] Whatever arguments there might be in favor of holding companies, they became notorious examples of corruption and abuse of power during 1928-1935, when the Federal Trade Commission and the House Commerce Committee investigated holding companies and held public hearings about their dubious activities.[133]

II.A.3. Role of hydropower in the growth of the power sector

Hydropower was fundamental throughout the formative decades of electric power development, and it became even more so in the 1920s-1930s.[134] Hydropower dams were the largest generators possible in the early years.[135] As local power systems expanded into regional grids, hydropower facilities were built into the systems' core.[136]

The earliest important hydropower in the U.S. was in California, where by the early 1890s it supplied mining activities in the Sierra Nevada mountains, as well as cities on the coast.[137] These projects included long-distance transmission lines that

125. *Id*.

126. NYE, *supra* note 48, at 180.

127. *See generally* MCCRAW, TVA and the Power Fight, 1933-1939 at 110 (J.B. Lippincott 1971); Melosi, *supra* note 43, at 52-67, 117-137; Tobey, *supra* note 121; Brigham, *supra* note 103; ARTHUR SCHLESINGER, JR., THE CRISIS OF THE OLD ORDER: THE AGE OF ROOSEVELT, 1919-1933 (Houghton Mifflin 1957), at 117-124; Philip Funigiello, Toward a National Power Policy: The New Deal and the Electric Utility Industry, 1933-1941 (U. Pittsburgh Press 1973).

128. Melosi, *supra* note 43, at 120. *See also* Gifford Pinchot, *The Long Struggle for Effective Federal Water Power Legislation*, 14 GEO.WASH. L. REV. 9 (1945).

129. MCCRAW, *supra* note 127, at 18.

130. Melosi, *supra* note 43.

131. Brigham, *supra* note 103; Melosi, *supra* note 43.

132. *Id.*

133. Brigham, *supra* note 103, at 46-49; *see generally* Funigiello, *supra* note 127; HUNTER & BRYANT, *supra* note 48, at 304-305.

134. *Infra*, part II.B.3.

135. Hay, *supra* note 2, at 117-119; HUNTER & BRYANT, *supra* note 48, at 350-364.

136. *Infra*, part II.B.3.

137. *See* HUGHES, *supra* note 48, at 262-284; James Williams, Energy and the Making of Modern California (U.Akron Press 1997), at 168-198.

were among the longest in the world at the time (up to 100 miles).[138] Electricity historians Hughes, Hunter, and Bryant (discussed above) emphasized the importance of early hydropower in the West.[139] Hughes devotes a chapter to "California white coal" (hydropower) in his volume about the U.S., Great Britain, and Germany.[140] In 1912 California was a world leader in high-voltage hydroelectric power plants.[141] California had eight of the world's total of 55 power plants generating 70,000 or more volts; 49 of those 55 were hydropower, including all eight of California's.[142] California hydropower differed from the Eastern U.S. in having rivers that are smaller and steeper – that is, less water but higher head (elevation change) – which presented different engineering challenges.[143] At the turn of the century, nowhere else in the world had California's combination of large-capacity generators with transmission lines 100 miles long or more.[144]

Despite California's lead, the first large hydropower dam in the nation was built at Niagara Falls, New York, and finished in 1895.[145] It was "by far the most impressive hydroelectric venture of the time and one of the leading engineering events of the 19th century," according to Hunter and Bryant.[146] The success at Niagara Falls triggered a "boom in hydroelectricity that for two decades overshadowed the steam-electric branch of the industry."[147] Hydropower generation increased by a factor of five from 1902 to 1912 and provided one-third of the nation's total electric power during this period.[148] Nearly all of the rest was generated by steam-turbines fueled by coal.[149]

The relationship between hydropower and steam power became critical after World War I, as regional power grids expanded. The two kinds of generators, known as "prime movers," had different advantages and disadvantages.[150] Hydropower's advantages were that its fuel was free – that is, water law could define it as free – and the capacity of its generators was initially larger than steam turbines.[151] Hydropower's disadvantages were its higher initial investment and fixed costs, its reliance on natural stream-flows that varied over time, and the fact that

138. *See* HUGHES, *supra* note 48; Williams, *supra* note 138.

139. *See* HUGHES, *supra* note 48, at 262-284; HUNTER & BRYANT, supra note 48, at 216-217, 255-257, 352-361.

140. HUGHES, *supra* note 48, at 262-284.

141. *Id*. at 262-265.

142. *Id*. at 280.

143. Charles Coleman, PG&E of California (McGraw-Hill 1952) at 92-101; HUNTER & BRYANT, *supra* note 48, at 255-257, 360; Williams, *supra* note 138, at 168-178.

144. HUGHES, *supra* note 48, at 262-284.

145. HUNTER & BRYANT, *supra* note 48, 254-272.

146. *Id.* at 257.

147. *Id.* at 352-353.

148. Hirt, *supra* note 70, at 54; HUNTER & BRYANT, *supra* note 48, at xxiii; Bakke, *supra* note 43, at 54 (According to Gretchen Bakke, the Niagara Falls hydropower plant marked the beginning of America's grid, since it included all the elements of large-scale generation, long-distance transmission, alternating current, parallel circuits, and incandescent lighting).

149. Hirt, *supra* note 70, at 54.

150. HUNTER & BRYANT, *supra* note 48, at 352-364.

151. *Id.*

waterworks were complicated to build and hard to modify later.[152] As steam turbines improved in size and efficiency, their share of electric power generation increased.[153] Steam turbines burned coal, oil, or gas as fuels.[154]

Because of their different economic and technical features, hydropower and steam turbines could be competitive or complementary, or both.[155] To operate a large-scale power system, balancing supply and demand at all times, the use (dispatch) of different generators had to be centrally controlled.[156] As Hunter and Bryant explain in writing about this period:

> In the early planning of systems with different kinds of prime movers, waterpower was ordinarily thought of as carrying the base load, with the more expensive steam power called on to help with peak loads. As the size and efficiency of steam plants increased beyond the capacity of the available waterpower in a region, the roles of steam and waterpower were reversed: it became common practice to use steam for carrying the base load, with hydro capacity employed for handling the peak periods . . . .The design and control of a suitable mix of prime movers became an important part of the art of managing a system of power stations.[157]

Hydropower was at the heart of the political conflict between public power and private power that emerged after 1900 and intensified in the 1920s.[158] Private individuals and companies sought the rights to build dams and manage the flow of rivers, and many people opposed a strong government role in producing power.[159] For many other people, however, hydropower was an inherently public matter because rivers were inherently public resources, as recognized in water law for many centuries.[160] Steam power was different and did not seem as inherently public.[161]

In terms of their use of water, hydropower and steam power are quite different. Hydropower uses water and changes its flow without consuming it, so the water is available later to other users downstream.[162] Steam power consumes water to make steam and cool the machinery; most of this water is returned to the stream at a warmer temperature.[163]

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152. *Id.*

153. *Id*. at 330-352.

154. *Id*.

155. *Id*., at 352-367; HUGHES, *supra* note 48, at 324-362 (*discussing* the "energy mix," which differed notably from one region to another); Hay, *supra* note 2, at 117-121.

156. HUNTER & BRYANT, *supra* note 48, at 352-367; HUGHES, *supra* note 48, at 324-362; Hay, *supra* note 2, at 117-121.

157. HUNTER & BRYANT, *supra* note 48, at 364.

158. *See generally* Brigham, *supra* note 103; MCCRAW, *supra* note 127; Melosi, *supra* note 43, at 117-137.

159. See *infra*, following pages.

160. Hirt, supra note 70, at 132-165; MCCRAW, *supra* note 127, at 12-18.

161. Hirt, supra note 70, at 132-165; MCCRAW, *supra* note 127, at 12-18.

162. GILLILAN & BROWN, *supra* note 1, at 64-70.

163. *Id.*

At the national level, the U.S. Congress was stuck for over a decade arguing about what national hydropower policy should be.[164] Hydropower obviously raised issues of Federal law, since rivers crossed public lands, involved different states and nations, and affected navigation. The U.S. Forest Service was an early arena of struggle over hydropower.[165] Forest Service head Gifford Pinchot argued that the Federal government should issue permits for private companies to develop hydropower on National Forest lands, for a specified period of time and with payment of an annual fee.[166] Private companies and conservative politicians protested the requirements.[167] After a long political stalemate that included the years of World War I, Congress and President Woodrow Wilson finally reached a compromise in 1920 with the Federal Water Power Act ("FWPA"), which essentially codified Pinchot's approach.[168] The FWPA, however, was a defeat for people who had advocated for multi-purpose river basin development.[169] The FWPA also created the Federal Power Commission ("FPC"), a new regulatory agency.[170] The FPC did relatively little in its first decade, reflecting the underlying political stalemate.[171]

"Hydropower" was the rallying cry of the public power movement in the 1920s-1930s.[172] Critics of private power companies argued that state regulation had proven too weak and they called instead for public ownership of power infrastructure.[173] Specific dam-sites around the country became famous and symbolic controversies, in which hydropower became synonymous with public power.[174]

A leading example was Muscle Shoals on the Tennessee River.[175] The U.S. government started building a dam on the Tennessee River during World War I for military purposes – to produce power to make explosives – but the war ended before the dam was finished.[176] After the war, the project was completed, but its operation was stalled for a decade due to the wider political stalemate over public versus

164. Hays, *supra* note 9, at 73-81, 114-121; Hirt, *supra* note 70, at 175-178; Melosi, *supra* note 43, at 117-137 .

165. Hays, *supra* note 9, at 73-81; Hirt, supra note 70, at 132-165; Pinchot, *supra* note 129, at 11-12.

166. Hays, *supra* note 9, at 73-81; Hirt, supra note 70, at 132-165; Pinchot, *supra* note 129, at 11-12.

167. Hays, *supra* note 9, at 73-81, 114-121; Hirt, supra note 70, at 132-165; Williams, *supra* note 138, at 237-267.

168. *Id*.

169. Hays, *supra* note 9, at 73-81, 114-121.

170. *See* James McGrew, FERC: Federal Energy Regulatory Commission at 18-19 (American Bar Association, Section of Environment, Energy, and Resources, 2ed. 2009). *See generally* Swiger et al., *supra* note 5.

171. *See also* Michael Blumm, *The Northwest's Hydroelectric Heritage: Prologue to the Pacific Northwest Electric Power Planning and Conservation Act*, 58 Wash. L. Rev. 175-244 (1982); Funigiello, *supra* note 127; Tobey, *supra* note 121; Brigham, *supra* note 104.

172. *See generally* Brigham, *supra* note 103; Melosi, *supra* note 43, at 121-125; White, *supra* note 70, at 48-58.

173. *See generally* Brigham, *supra* note 103; Hirsh, *supra* note 109.

174. See *infra*, II.A.3

175. *See generally* Brigham, *supra* note 103; MCCRAW, *supra* note 127; Melosi, *supra* note 43, at 122-124).

176. *Id.*

private power.[177] The dispute over Muscle Shoals was national headline news for many years.[178] Eventually, the dam was taken over by the Tennessee Valley Authority in 1933 (discussed below).[179]

The other famous example was Boulder Canyon Dam on the Colorado River (later renamed Hoover Dam).[180] Congress approved the dam in 1928, primarily for purposes of controlling floods and storing water for irrigation and cities, mainly in southern California. Hydropower was an important but secondary purpose.[181] Hoover Dam was the first large multi-purpose dam and storage reservoir built and run by the Federal government – in fact, it was the first such dam in the history of the world.[182] Although hydropower was not the dam's main purpose, it was nonetheless a major economic benefit to the southern California electricity grid.[183]As historian Jay Brigham sums it up:

> These common themes reveal the political meaning of Muscle Shoals and Boulder Dam: development of natural resources for the public good, fighting private electrical utilities to ensure lower rates, and positive governmental intervention into the economy to further the social good through electrical modernization.[184]

The conflict between public and private power intensified through the 1920s but was not resolved before the Great Depression hit the U.S. in 1929.[185] Arthur Schlesinger, Jr. devotes a brilliant chapter to "the struggle for public power" in the first volume in his sweeping history of *The Age of Roosevelt*.[186] He concludes that:

> many liberals felt that public power, more than any other question, summed up the larger issue between the business community and the people. "The power issue," said John Dewey, "is the most weighty single issue in the political field." "Hydroelectric power," Felix Frankfurter wrote Franklin Roosevelt in 1929, "raises without a doubt the most far-reaching social and economic issues before the American people, certainly for the next decade."[187]

Roosevelt was then Governor of New York, having been elected in 1928 on a public power platform.[188] His election as President in 1932 marked the end of the

177. *Id.*

178. *Id.*

179. See *infra* II.B.1.

180. Brigham, *supra* note 103; Reisner, *supra* note 12; Melosi, *supra* note 43, at 124-125.

181. Boulder Canyon Project Act (1928).

182. Reisner, *supra* note 12; White, *supra* note 13, at 162.

183. *See generally* Kevin Starr, Material Dreams: Southern California Through the 1920s (Oxford Univ. Press 1990); Kevin Starr, Endangered Dreams: The Great Depression in California (Oxford Univ. Press 1996); Brigham, *supra* note 103.

184. Brigham, *supra* note 103, at 55.

185. See *infra*, II.B.1.

186. SCHLESINGER, *supra* note 127, at 117-124.

187. *Id.* at 124.

188. *Id*, at 389-390; Melosi, *supra* note 43, 120-127.

first half-century of electric power in the U.S., and the beginning of a new model that dominated the electric sector until the 1970s.[189]

II.B. Second 50 years (1930s-1980s)

II.B.1. The New Deal marks a new era of Federal regulation

The second half-century of the nation's electric power sector began with President Roosevelt's New Deal. When Roosevelt took office in 1933, in the depths of the Great Depression, his government attempted major reforms in nearly all areas of social and economic policy.[190] The power sector was a high priority as Roosevelt's government and the Congress made major structural changes, finally ending the long stalemate of the 1920s.[191]

The New Deal included several political victories for public power. The regulatory framework established in 1935 remained intact for over 40 years, as the national electricity system expanded throughout World War II and the economic boom that followed.[192] Large-scale Federal hydropower emerged as a major factor in national electricity politics in the 1930s, and hydropower capacity increased rapidly during the next few decades as part of an epic boom in government dam-building.[193] Paradoxically, however, by the end of this period in the 1980s, hydropower's role in the electricity sector had shrunk significantly.[194] In Dan Tarlock's words, "hydro triumphs but its market share steadily declines."[195] We will return to this paradox later.

President Roosevelt was a strong advocate for public power.[196] As governor of the State of New York he had made public power one of his signature political issues, and in New York that debate revolved around hydropower – particularly development of the St. Lawrence River, which was shared with Canada.[197] Roosevelt made famous the word "yardstick" as a slogan for public power.[198] "Yardstick" meant a standard of comparison: the idea was that public power companies would offer lower prices than private monopolies, which would force the private companies to compete.[199] In a famous campaign speech in Portland, OR, in 1932, he declared:

> I do not hold with those who advocate Government ownership or Government operation of all utilities. I state to you categorically that as a broad general rule the development of utilities should

189. See *infra* II.B.

190. SCHLESINGER, *supra* note 127. *See generally* ARTHUR SCHLESINGER, JR., THE COMING OF THE NEW DEAL: THE AGE OF ROOSEVELT, 1933-1935 (Houghton Mifflin 1958).

191. Ibid; *see also* Blumm, *supra* note 171; Brigham, *supra* note 103; Funigiello, *supra* note 127; Melosi, *supra* note 43; Tobey, *supra* note 121.

192. Melosi, *supra* note 43, at 199-216; Tomain & Cudahy, *supra* note 118, at 360-384.

193. *Supra*, part I.

194. See *infra*, II.B.2.

195. Tarlock, *supra* note 40, at 1723, 1727.

196. Hirt, *supra* note 70, at 223-229; MCCRAW, *supra* note 127, at 30-34; Melosi, *supra* note 43, at 120-137; Schlesinger, *supra* note 127, at 117-124, 389-390.

197. *Id.*

198. Brigham, *supra* note 104, at 5, 26, 50-53; MCCRAW, *supra* note 127, at 30-34, 70-74.

199. *Id*.

> remain, with certain exceptions, a function for private initiative and private capital.[200]

The yardstick, in short, was public hydropower. Roosevelt called public hydropower an "essential 'birch rod' in the cupboard," which could be used to correct private companies' misbehavior.[201] As he explained:

> Here you have the clear picture of four great Government power developments in the U.S. – the St. Lawrence River in the Northeast, Muscle Shoals in the Southeast, the Boulder Dam project in the Southwest, and finally . . . the Columbia River in the Northwest. Each one of these, in each of the four quarters of the U.S., will be forever a national yardstick to prevent extortion against the public and to encourage the wider use of that servant of the people – electric power.[202]

The New Deal's electricity programs included three related areas: regulatory reform, public power, and rural electrification.[203] Hydropower was especially crucial to the latter two areas.[204] In *regulatory reform*, Roosevelt worked with Congress to pass two major laws in 1935. One law amended the 1920 Federal Water Power Act, now renamed the Federal Power Act, to strengthen the authority of the Federal Power Commission ("FPC") over interstate power business.[205] The FPC had been created by the 1920 Act but had played a limited role since then. The other law was the Public Utility Holding Company Act, which gave regulatory power over private holding companies to the newly-created Securities and Exchange Commission ("SEC").[206] The SEC's general mission was to clean up the abusive and corrupt practices of Wall Street and the stock market.[207] In the electric sector, the SEC wielded broad authority to regulate corporate finances and simplify legal and organizational arrangements – in short, to clamp down on holding companies.[208]

The new Federal electricity laws were compatible with the existing "utility consensus" at the state level.[209] State utility commissions continued to carry out their traditional functions of regulating the rates of private monopolies within state boundaries.[210] Federal regulations focused on interstate issues and shared the overall goal of growth in power production and consumption.[211] The FPC continued to

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200. Quoted in MCCRAW, *supra* note 127, at 33 (The exceptions were local municipal systems and hydropower sites owned by the Federal government).

201. *Id.* at 33.

202. *Id.* at 34.

203. Hirt, *supra* note 70, at 230-265; Melosi, *supra* note 43, at 134-137.

204. Brigham, *supra* note 103; Melosi, *supra* note 43.

205. *Supra* notes 164-171 and accompanying text.

206. Melosi, *supra* note 43, at 126-129; *See generally* Funigiello, *supra* note 127; Blumm, *supra* note 171, at 191-195; *see generally* McGrew, *supra* note 170.

207. *Id.*

208. *Id.*

209. Hirsh, *supra* note 109, at 11-31.

210. *Id*. Tomain & Cudahy, *supra* note 118, at 369-378.

211. *See generally* Melosi *supra* note 43; Funigiello, *supra* note 127; Blumm, *supra* note 171, at 191-195.

promote and regulate all private and local public hydropower projects, while projects built by other Federal agencies were exempt from the Federal Power Act because they were regulated by other Federal legislation.[212]

In *public power*, the landmark event was the creation of the Tennessee Valley Authority ("TVA") in 1933.[213] TVA was approved as part of President Roosevelt's initial barrage of legislation in the first months after taking office.[214] In Schlesinger's words, "[p]erhaps no law passed during the Hundred Days expressed more passionately a central presidential concern."[215] One of TVA's cornerstones was the Muscle Shoals hydropower dam, discussed above, which was finally confirmed as an, emphatically, public project.[216] The TVA was a unique political experiment: a new government agency whose tasks were to plan and implement regional economic development through comprehensive development of a river basin's water resources.[217] In the next 20 to 30 years, TVA built dozens of dams for purposes of hydropower, flood control, and navigation, and since then TVA has been the world's most famous example of centralized river basin development.[218]

One of TVA's primary objectives was to produce cheap and abundant electric power, and over time, this became the agency's dominant mission.[219] When the Tennessee River basin's maximum hydropower potential was reached, the agency moved aggressively into nuclear and coal-burning power-plants, as its broad social mission was refocused as a public power utility.[220] The story of the TVA is complex and controversial, and the agency's results have been mixed, but one thing is clear: TVA vastly increased electricity production and consumption in its region.[221]

In his book about TVA and the politics of electric power in the 1930s, historian Thomas McCraw argues that hydropower was unique and different from other sources of electric power.[222] Because hydropower involves flowing rivers and streams, it was subject to Federal government authority under the U.S. Constitution.[223] Federal authority was based primarily on the power to regulate navigable waters and interstate commerce.[224] Hydropower sites involving public lands and international rivers were also subject to Federal authority.[225] Hydropower was further complicated in the 1930s by the growing trend of building dams for

212. *Id.*; *see also* Keller, *supra* note 10 at 85-87.

213. Melosi, *supra* note 43, at 130-134; SCHEWE, *supra* note 43, at 93-106; SCHLESINGER, *supra* note 190, at 319-334.

214. *Id.*

215. SCHLESINGER, *supra* note 190, at 319.

216. MCCRAW, *supra* note 127; Melosi *supra* note 43.

217. SCHLESINGER, *supra* note 190, at 319-334.

218. MARTIN DOYLE, THE SOURCE: HOW RIVERS MADE AMERICAN AND AMERICA REMADE ITS RIVERS, 230-254 (W.W. Norton 2018); *see generally* Molle et al., *supra* note 12.

219. SCHEWE, *supra* note 43, at 93-106.

220. *Id*; Doyle, *supra* note 218, at 235-254.

221. *Id.*; McCraw, *supra* note 127.

222. MCCRAW, *supra* note 127, at 15-18, 30-34, 70-74.

223. *Id.*

224. *Id.*

225. *Id.*

multiple purposes, which involved making trade-offs among different water uses.[226] The specific trade-offs varied from case to case.[227] For all these reasons, McCraw argues that the idea of using public hydropower as the yardstick for private utilities was deeply flawed; it was comparing apples with oranges.[228]

Rural electrification was the third area of New Deal policies, and it reflected a social and political vision that electricity use should spread to farms and countryside as part of modern progress in the quality of life.[229] Private utilities had not done this because it was too costly to be profitable.[230] The Rural Electrification Administration ("REA") provided money to local public utilities and preferential access to cheap power from Federal dams.[231] The effectiveness of the REA was one of the New Deal's greatest successes.[232]

Finally, the Bonneville Power Administration ("BPA") was another key example of New Deal electricity policies.[233] The BPA was a regional Federal agency created to distribute the vast amount of electric power generated by Federal dams in the Columbia River basin.[234] BPA offered low wholesale rates to public utilities, and often to private utilities as well.[235]

In short, four laws passed in 1933-1935 greatly increased the role of the Federal government in the electric power sector, both as overall regulator and as producer of hydropower.[236] Nevertheless, private power companies maintained their dominant position in the sector as a whole.[237] This framework stayed in place until the late 1970s.[238]

II.B.2. World War II and the post-war boom: The paradox of hydropower

The U.S. took its mixed, private/public power system into World War II and the wartime industrial boom.[239] As demands for power increased sharply in the late 1930s, both public and private utilities cooperated to meet the shared national goal of increasing electricity supplies while keeping prices low.[240] The Federal

226. *Id.*

227. *See generally* Reisner, *supra* note 12; Reuss, *supra* note 11.

228. MCCRAW, *supra* note 127, at 15-18, 30-34, 70-74. Two other essential differences with private companies involved how public hydropower was taxed (or not), and what its financial and debt obligations were.

229. *See generally* Melosi, *supra* note 43, at 134-137; Funigiello, *supra* note 127, at 122-173.

230. *Id.*

231. *Id.*

232. *Id*. In terms of the water/energy nexus, however, the REA promoted a massive increase in groundwater pumping. Christopher Scott, Professor, University of Arizona, personal communication, March 20, 2019.

233. Hirt, *supra* note 70, at 266-326; Funigiello, *supra* note 127, at 122-173; White, *supra* note 70, at 59-88; Blumm, *supra* note 171, at 191-209.

234. *Id*.

235. *Id*.

236. *See generally* Brigham, *supra* note 103; Funigiello, *supra* note 127; Hirsh, *supra* note 110, at 33-54; Melosi, *supra* note 43, at 126-137.

237. *Id.*

238. *Infra*, II.B.3.

239. Melosi, *supra* note 43, at 136-137; Hirsh, *supra* note 110, at 33-54.

240. *Id*.

government's building of large hydropower dams in the West was a potent patriotic symbol in those years, as Boulder, Bonneville, Grand Coulee, and Shasta Dams became household names as part of the war effort.[241] Federal dams sold their power at low wholesale rates to both public and private utilities to distribute.[242] The Federal government also pushed greater regional interconnections and expanded the larger transmission grids.[243] A pending question at the time was whether there would be enough demand for such huge power supplies after the war ended; the answer turned out to be yes.[244]

The mixed power system emerged from World War II strong and consolidated. Federal regulation broke up the large utility holding companies and instead favored vertically integrated private monopolies, which were regulated by both state and Federal governments in different arenas.[245] The political debate over public versus private power lost much of its urgency as the country entered several decades of sustained growth in electricity production and consumption. The period of 1935-1965 was "the 'golden age' of the electric industry," according to an energy law textbook.[246] Public power generation grew enough to maintain its minority share of the total system, while private power generation grew even more and continued to dominate the sector overall.[247] The basic structure of Federal electricity policy remained the same during this post-war period, although the clarity of the public power mission became diffused among different and partially competing government agencies.[248]

After 1945, regional power grids across the U.S. expanded while generation capacity continued to grow.[249] Electricity prices remained low, thanks to economies of scale.[250] Energy development was especially dramatic in the West.[251] Eminent natural resources law scholar Charles Wilkinson describes what he calls the "Big Buildup" of the Colorado Plateau during 1955-1975: a "grand plan" made by a coalition of private and public utilities across the Southwestern states, including California and Texas.[252] The plan had several interlocking parts: to mine coal for large thermal power plants in the Four Corners area; to mine uranium for nuclear power plants on the California coast; to build hydropower dams on the Colorado River and its tributaries; and to tie it all together with long-distance transmission

241. Reisner, *supra* note 12.

242. Hirsh, *supra* note 109, at 33-54.

243. Hirt, *supra* note 70, at 266-326; Tomain & Cudahy, *supra* note 118, at 373-377; *see generally* McGrew, *supra* note 170.

244. *Id*.; Blumm, *supra* note 171, at 202-204.

245. *See generally* Melosi *supra* note 43, at 199-216; Hirsh, *supra* note 110, at 33-54.

246. Tomain & Cudahy, *supra* note 118, at 377.

247. Hirt, *supra* note 70, at 296-326; Melosi, *supra* note 43, at 199-216.

248. Melosi, *supra* note 43, at 202-209; *see also* Alex Radin Public Power, Private Life (American Public Power Association, 1ed. 2003).

249. Hirt, *supra* note 70, at 327-355; Melosi, *supra* note 43, at 199-216.

250. *Id*.; Hirsh, *supra* note 109, at 55-70.

251. *See generally* Charles Wilkinson, Fire on the Plateau: Conflict and Endurance in the American Southwest (Island Press 1979); Peter Booth Wiley & Robert Gottlieb, Empires in the Sun: The Rise of the New American West (G.P. Putnam's Sons 1982).

252. Wilkinson, *supra* note 251, at 172-185, 207-229.

lines.[253] California utilities were the biggest players and driving force of this coalition, counterbalanced by the other states.[254] The net flow of electricity went to Southern California.[255]

The paradox of hydropower in the post-war decades can be illustrated by a few key numbers. National hydropower generating capacity grew 5% per year from 1945 to the early 1970s .[256] That impressive number reflects the ambitious and long-term national campaign to build dams.[257] However, generation in the electric sector as a whole grew more than *8% per year*, as the use of fossil fuels and nuclear power expanded rapidly, and so hydropower's share of the total fell steadily – from 35% in 1946 to 16% in 1970.[258]

Total national hydropower capacity grew from about 20,000 megawatts in 1930 to about 80,000 MW in the 1970s, according to the U.S. Department of Energy, which was a four-fold increase in 50 years.[259] Since the 1970s the total has held steady (many small hydropower projects were built in the 1980s but they added up to little capacity).[260] In relative terms, hydropower varied from 30 to 40% of total national power generation from 1900 to 1950.[261] After 1950, hydropower's share declined steadily to about 10% in 1990, where it remains today.[262] According to the Department of Energy, 10% was also hydropower's share of generation over the entire period 1950-2015.[263] Thus, hydropower's post-war trajectory in the power sector was paradoxical: even as it reached new heights of production in absolute terms, its role in the sector overall became smaller and secondary.[264]

Other numbers summarize the situation around 1980, numbers which have not changed much since then. About 50% of total national hydropower belongs to the Federal government (Army Corps of Engineers, Bureau of Reclamation, and Tennessee Valley Authority); 25% belongs to other public organizations and 25% belongs to private companies. (Private companies have the largest number of

253. *Id.*

254. *Id.*

255. *Id*. Although Wilkinson is a critic, he tips his hat: "One can hardly overstate the magnitude of the accomplishment that began to be realized when Four Corners [Power Plant] went on line. It took supreme creativity and conceptual clarity to imagine and plan a reliable power grid spanning the Southwest from the Pacific to the Pecos. Implementing the elaborate scheme required the highest measure of single-minded efficiency and industrial brawn." *Id*., at 207-208. *See also* PHILIP FRADKIN, A RIVER NO MORE: THE COLORADO RIVER AND THE WEST 149-153 (Alfred A. Knopf 1981); Wiley & Gottlieb, *supra* note 253, at 41-51, 89-90.

256. Melosi, *supra* note 43, at 201.

257. *Supra* Part I.

258. Melosi, *supra* note 43, at 201. Hay, *supra* note 2, at xi (*asserting* that hydropower supplied 1/3 of national power in 1940).

259. *See* Uría-Martinez, O'Connor, & Johnson, *2014 Hydropower Market Report* at 3-9 (Oak Ridge Nat'l Laboratory and U.S. Dept. of Energy 2015); O'Connor et. al, Hydropower Vision: A New Chapter for America's 1st Renewable Electricity Source at 73-80 (U.S. Dept of Energy 2016).

260. *Id.*

261. *Id.*

262. *Id.*

263. O'Connor et. al, *supra* note 259 at 77.

264. Tarlock, *supra* note 40, at 1723, 1727 ("hydro triumphs but its market share steadily declines").

hydropower plants, but they are smaller.)[265] In addition, 50% of the national total is in the three Pacific Coast states of Washington, Oregon, and California.[266]

II.B.3. Energy and environmental crises in the 1970s: The close of hydropower's first century

After 1965, the U.S. electricity sector was shaken by dramatic political, economic, and technological changes, all of which led to rising energy costs and prices.[267] A widespread blackout in the Eastern U.S. in 1965 revealed structural weaknesses in the national power grid.[268] Environmental conflicts became the power sector's over-arching political problem, as the public power versus private power debate faded.[269] All sources of electric power generation have major environmental impacts, whether from mining and burning coal or uranium, or from damming rivers.[270] Dam projects became symbolic targets of protest for the growing U.S. environmental movement, which led to the wave of Federal environmental legislation that was passed in the late 1960s and early 1970s.[271]

There were economic and technical problems as well as environmental problems. The continued advances in steam-power generation technology reached a plateau, making it so that utilities could no longer increase power supplies at low costs as they had been able to do in preceding decades.[272] Historian Richard Hirsh calls this "technological stasis."[273] Moreover, nuclear power was proving much more costly and conflictive than its proponents expected and the 1973 world oil crisis opened a new era of uncertain global oil markets and supplies.[274]

Hirsh tells the story in two chapter titles in his 1989 book: from "The mid-1960s: At the pinnacle of success" to "The mid-1970s: Near the bottom."[275] He concludes that "the electric utility industry had been radically transformed in just ten years."[276] It was a period of "regulatory failure" in the power sector when the model forged in the 1930s began to break down under economic and political stress.[277]

The first century of hydropower in the energy sector ended with the Public Utility Regulatory Policy Act ("PURPA"), which was passed in 1978.[278] PURPA

265. *See* Uría-Martínez et al., *supra* note 259 at 12-13. *See also* O'Connor et al., *supra* note 259 at 73-80.

266. GILLILAN & BROWN, *supra* note 1, at 65-66. *See* Uría-Martínez et al., *supra* note 259 at 5-6. *See also* O'Connor et al., *supra* note 259 at 73-80.

267. *See generally* Hirsh, *supra* note 66; Hirsh, *supra* note 109, at 55-70.

268. Schewe, *supra* note 43, at 115-156.

269. Hirsh, *supra* note 109, at 55-70; Melosi, *supra* note 43, at 202-212. See also Radin, *supra* note 248.

270. Hirsh, *supra* note 109, at 55-70; Melosi, *supra* note 43, at 202-212.

271. McPhee, supra note 29, at 158-167.

272. *See generally* Hirsh, *supra* note 65; Hirsh, *supra* note 109, at 55-70.

273. Hirsh, *supra* note 109, at 55.

274. Hirsh, *supra* note 109, at 55-70; Tomain & Cudahy, *supra* note 118, at 378-379.

275. Hirsh, *supra* note 65, at 82, 139.

276. Hirsh, *supra* note 65, at 2.

277. Tomain & Cudahy, *supra* note 118, at 378-379; *see generally* Federal Power Commission, *National Power Survey* (U.S. Gov't Printing Office 1964) (discussing an important government report that exemplifies the over-confidence of the early 1960s).

278. *See* Public Utility Regulatory Policies Act, 16 U.S.C. §§ 2601 et seq., (1978).

was one of a series of energy laws passed by the government of President Jimmy Carter, the first President elected after the 1973 oil crisis.[279] Carter made energy policy one of his government's highest priorities, aiming to reform the national energy and electric power sectors by lowering costs, increasing efficiencies, and reducing dependence on foreign oil supplies.[280] The U.S. Department of Energy was created in the process, incorporating several existing agencies including the Federal Power Commission, which was renamed the Federal Energy Regulatory Commission ("FERC").[281]

PURPA was crucial because it opened the door to what became electricity deregulation and restructuring in the 1990s and later.[282] "The ostensible goal of PURPA was to obtain more electricity without using more fuel," as Philip Schewe puts it.[283] PURPA encouraged states to adopt more market-driven pricing for electric power (i.e., marginal cost pricing), and also encouraged power generation by independent producers and unconventional sources that were not part of traditional power utilities (private or public).[284] The law required utilities to buy power produced by non-utility generators at a good price, the "avoided cost," i.e., what it would cost the utilities to produce that additional power themselves.[285]

The big surprise of PURPA was the success of the non-utility generators.[286] Using various technologies, including gas turbines, co-generation, small hydropower, and wind, non-utility generators produced power at costs that the traditional utilities could not match.[287] As a result, both private and public utilities bought increasing amounts of power from other producers rather than building their own new generating capacity; "PURPA, unintentionally, discovered a new generation market."[288] These trends undermined the traditional argument in favor of regulated monopolies – i.e., that overall they were cost-effective and hence in the public interest – and instead fostered political debate about additional reforms to open power markets and promote competition.[289] Thus, PURPA marked the

279. *See* Brennan et al., *supra* note 91 at 26-30; Tomain & Cudahy, *supra* note 118, at 379-384.

280. *See* Brennan et al., *supra* note 91 at 26-30; SCHEWE, *supra* note 43, at 171-173.

281. *See generally* Swiger et al., *supra* note 5; *see also* McGrew, *supra* note 170 at 144.

282. *See generally* Brennan et al., *supra* note 91, at 26-35.

283. SCHEWE, *supra* note 43, at 172.

284. *See* Brennan et al., *supra* note 91 at 21-35; Tomain & Cudahy, *supra* note 118, at 379-384; John Echeverria et al., Rivers at Risk: The Concerned Citizen's Guide to Hydropower (Island Press 1989), pp.24-25; *see* McGrew, *supra* note 170 at 144; SCHEWE, *supra* note 43, at 171-173; *see generally* Swiger et al., *supra* note 5; *see generally* Hirsh, *supra* note 109 (discussing PURPA, its historical background and its wider significance).

285. "Avoided cost" was basically equivalent to marginal cost. I am using "independent producers" and "non-utility generators" as synonyms; they were called "qualified facilities" in the law. "PURPA provided a potpourri of 'nuts and bolts' reform and conservation guidelines to be undertaken at the state level" Richard Rudolph & Scott Ridley, Power Struggle: The Hundred-Year War Over Electricity (Harper & Row 1986) at 200.

286. Hirsh, *supra* note 109, at 71-131; Tomain & Cudahy, *supra* note 119, at 379-384.

287. *Id*.

288. Tomain & Cudahy, *supra* note 118, at 381.

289. Hirsh, *supra* note 109, at 71-131; SCHEWE, *supra* note 43, at 172-173.

beginning of the end of the "utility consensus" that had been established in the early decades of the 20th century.[290] Schewe calls the impact of PURPA:

> one of the great ironies of grid history. Here was a piece of social engineering, a law passed by Congress, aimed at wringing out a bit more efficiency from the power production process. In this it succeeded but with a gigantic unintended consequence; what had started out as only a small provision of the 1978 energy legislation would become a lever that would pry open the entire century-old electricity business.[291]

In addition to its broader impacts, PURPA had specific provisions to promote small-scale hydropower development.[292] The law exempted small hydropower projects from regulation by the FERC, which meant that they were not required to get a license under the Federal Power Act as all other non-Federal hydropower projects were required to do.[293] This exemption triggered a nationwide boom in small hydropower that was strongly opposed by environmental groups.[294] According to three environmental lawyers in 1989, PURPA was "the single most important force driving the hydropower gold rush of the 1980s."[295] Hundreds of projects were built although the total generation capacity was fairly small.[296]

The next major Federal legislation regarding hydropower was passed in 1986 and confirmed that a new era had begun.[297] The Electric Consumers Protection Act changed the FERC's mission when granting or renewing licenses for hydropower dams, such that FERC was required to give "equal consideration" to environmental issues as to power production.[298] Since the 1980s, a critical topic in U.S. hydropower regulation has been FERC re-licensing of dams that were built many decades ago and whose original licenses have expired.[299] FERC re-licensing has involved complex legal and administrative procedures and many different stakeholders, water users, and environmental interests.[300]

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290. Hirsh, *supra* note 109.

291. SCHEWE, *supra* note 43, at 173. On electricity restructuring in the 1990s, *see* Brennan et al., *supra* note 91; *see generally* Timothy J. Brennan, et al., *Alternating Currents: Electricity Markets and Public Policy* (Routledge 1ed. 2002).

292. *See generally* Echeverria, Barrow, & Roos-Collins, *Rivers at Risk: Concerned Citizen's Guide to Hydropower* (Island Press 1ed. 1989); *see also* Uría-Martínez et al., *supra* note 259 at 3, 8.

293. *See generally* Echeverria et al., *supra* note 292.

294. *Id.*

295. *Id.* at 24.

296. Uría-Martínez et al., *supra* note 259 at 8-9 (after PURPA was passed, there was dispute about whether its benefits to small hydropower applied to new hydropower projects or only to modifications of existing projects. Congress settled the question in the Electric Consumers Protection Act (1986) by restricting PURPA to existing projects only).

297. *See* Electric Consumers Protection Act, 16 U.S.C. 791a et seq. (1986).

298. *Id.*

299. *See* GILLILAN & BROWN, *supra* note 1, at 248-253; DOREMUS & TARLOCK, *supra* note 38, at 176-180. *See generally* Swiger et al., *supra* note 5; *see generally* McGrew, *supra* note 170; *see generally* Echeverria et al., *supra* note 292.

300. *See generally* GILLILAN & BROWN, *supra* note 1; DOREMUS & TARLOCK, *supra* note 38; Swiger et al., *supra* note 5; McGrew, *supra* note 170; Echeverria et al., *supra* note 292.

This paper concludes in the 1980s, 100 years after hydropower technology emerged on the national scene. New Federal energy and environmental laws marked a turning point in hydropower regulation. The story of hydropower in the U.S. since then, from the 1980s to the present, remains to be told.

CONCLUSIONS

In this paper I have offered a historical overview of the first century of hydropower law, policy, and development in the U.S. I have tried to answer the questions I posed at the beginning, about the changing roles of hydropower in the two different contexts of the water sector and the electric power sector. My goal was to describe the historical background and context for problems of hydropower governance today – to understand the deeper and long-term trends that have shaped the water/energy nexus. There is nothing magical about ending the story after 100 years, but several major changes in water and energy policies came together in the 1970s-1980s that make that period a turning point and the beginning of a new historical chapter for hydropower. One major change was the end of building large dams, whether for hydropower or for other water uses.

I described the historical arcs of hydropower development from the different perspectives of water and electric power. Hydropower's roles and strategic importance in the water and power sectors changed dramatically over the long term. During the first 50 years, from roughly 1880 to 1930, hydropower dams were far more important to the electric power sector than they were to the water sector. Those trends reversed in the 1930s, and over the next 50 years, hydropower became essential in the water sector and secondary in the power sector (with regional exceptions, particularly the Pacific Northwest).

During the first half-century, hydropower was secondary to other water uses in the water sector. Hydropower dams were small to medium in size and built for a single purpose. They rarely had storage capacity and they had limited effects on most river flows. They often caused some interference with other water uses, such as navigation, irrigated agriculture, and fisheries, but inter-sectoral water conflicts involving hydropower were not a major problem. Water was not yet scarce enough relative to demand.[301]

In contrast, hydropower was a dominant theme in the electric power sector during this period. Dams were juicy economic prizes that were fought over by private and public power utilities, politicians and government officials, and other interest groups. Hydropower plants were built into the core of regional power grids during their foundational decades. Control of hydropower symbolized the deeper political and economic conflicts in the power sector between public and private interests. Hydropower was strongly identified with public power and therefore it was controversial for decades.

These trends reversed in the 1930s for the second half-century. In the water sector, hydropower scaled up rapidly and became essential, especially as the critical factor in paying for the Federal government's building large multi-purpose dams throughout the big dam era (1930s-1970s). Federal laws and administrative agencies

301. I am writing here about hydroelectric power, not the long earlier history of waterpower and its conflicts with other water uses. *See, e.g.*, Kulik, *supra* note 7; Rose, *supra* note 8; Doyle, *supra* note 218.

used revenues from hydropower sales to subsidize other water uses such as navigation, flood control, irrigated agriculture, and urban supplies.

In the 1960s the environmental movement emerged as a political force in the U.S. and led to the passage of modern environmental legislation, such as the National Environmental Policy Act and the Endangered Species Act. Hydropower's environmental impacts triggered major public conflicts. Most of those impacts were caused by changing water flows, and so stronger environmental regulations typically meant new rules for operating dams and generating power.

Environmental laws joined other pressures on the Federal budget to end the era of building large dams by the late 1970s. With new water supplies no longer available, the Western U.S. entered an era of water reallocation that continues today. New and growing demands for water for both economic and environmental purposes led to increased competition and conflict among many different stakeholders. In the context of those long-term changes in water governance, hydropower dams became subject to increasing constraints in both development and operation. Those constraints have reduced hydropower's revenues, and hence its potential ability to subsidize other water uses.[302]

In the electric power sector, in contrast, hydropower's trajectory was paradoxical after the 1930s. Under the New Deal, Federal regulatory authority over the nation's electric power system increased sharply and Federal hydropower development took center-stage. Hydropower boomed in absolute terms, quadrupling in capacity as Federal agencies built hundreds of large dams over the next half-century. Yet hydropower's relative importance in the power sector declined steadily as the rest of the sector grew even faster. The trend nationwide throughout this period was the expansion of the mixed system of private and public utilities, whose common goal was to increase the production and consumption of electric power. Private utilities continued to dominate the national grid, relying heavily on coal, natural gas, and nuclear energy. By the 1980s, hydropower amounted to about 10% of total national power generation (higher in some regions, such as the Northwest).

In short, the half-century of hydropower's greatest expansion ended with its taking a smaller role in the overall power grid. The stupendous growth of electric power grids was one of the biggest technological stories of the 20th century.[303] Growing electricity use transformed basic aspects of technology, economy, society, and geography over a period of two or three generations, with massive impacts on landscapes and environments. The distinctive technical and economic features of hydropower have been incorporated into the grid's operation, e.g. its capacity to store power and to generate power on instant notice. In that sense, hydropower plays a strategic role in the power sector that is greater than its small percentage of total power generation. But even so, that role is determined by the needs and dynamics of the grid: the special features of hydropower as a water use are more of a detail than a driving factor. In the context of the vast national expansion of the power grid, hydropower was only a piece of the puzzle.

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302. Surabhi Karambelkar, Hydropower on the Colorado River: Examining Institutions, Conflicts and Consequences of Changing Dam Operations (2020) (published Ph.D. dissertation, University of Arizona) (on file with the University of Arizona).

303. *See generally* Bakke, *supra* note 43; SCHEWE, *supra* note 43.

Over the long run, the dynamics of the energy sector have dominated the water sector in political and economic terms. From 1990 to the present (2020), the U.S. electric power sector has been transformed by state and Federal policies favoring restructuring and market forces.[304] The impacts on hydropower are not well understood.[305] Moreover, these last few decades have been marked by long periods of drought, especially in the Western U.S., and the resulting scarcity of water has intensified conflicts among different users, including environmental uses such as in-stream flows. These trends for water supplies seem likely to continue under changing climates. Many state and national energy policies in recent decades have focused on renewable sources of electric power, and in that context hydropower can play a variety of roles.

The U.S. historical experience may also apply to contemporary international debates about hydropower. As dam-building slowed to a stop in the U.S. and Europe in the 1970s-1980s, the emphasis shifted to developing countries in Asia, Africa, and Latin America.[306] Since the 1990s there has been intense international debate about the pros and cons of large dams, with their benefits and costs for different people.[307] Most of these dams include hydropower as one of their purposes, often the primary purpose. Despite frequent conflicts, hydropower development has boomed internationally since the early 2000s, benefitting from public concerns about global warming and climate change.[308]

The boom has included both large and small hydropower dams. International climate policies have promoted hydropower projects because they emit little carbon and so do not contribute to global warming.[309] There is an obvious risk in promoting hydropower to help address climate change at the same time that climate change is making water resources more uncertain and variable.[310] Future conflicts among different water uses seem inevitable.

Among international organizations dealing with hydropower, the contrast is clear. Organizations focused on energy issues tend to favor more hydropower development, while organizations focused on water issues are more cautious and critical. An example of the former is the International Energy Agency ("IEA"), which was created in 1974 in response to the first global oil crisis and whose members include most of the world's developed (and oil-importing) countries. According to the IEA, hydropower accounted for 16% of world electricity generation

304. Brennan et al, *supra* note 91; SCHEWE, *supra* note 43.

305. RESTRUCTURED RIVERS: HYDROPOWER IN THE ERA OF COMPETITIVE MARKETS (Phillip Raphals, Helios Centre 2001).

306. World Commission on Dams, Dams and Development: A New Framework for Decision-making (Earthscan Pub. Ltd. 2000).

307. *Id.*

308. Kelly-Richards, *supra* note 1; Bauer, *supra* note 1; Robert Fletcher, When Environmental Issues Collide: Climate Change and the Shifting Political Ecology of Hydroelectric Power, 5 PEACE AND CONFLICT REVIEW 1 (2010).

309. *Id*.; Arun Kumar et al., Hydropower, IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (Cambridge University Press 2011) at 437-496; Dan Arvizu et al., Technical Summary, IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (Cambridge University Press 2011) at 80-87.

310. *Id.*

in 2008, and 19% of world hydropower potential had been developed.[311] The IEA published a *Technology Roadmap for Hydropower* in 2012 in response to pressures about global climate change, as part of a "series of roadmaps for the most important technologies needed to achieve a global energy-related CO2 target in 2050 of 50% below current levels" – an ambitious target.[312]

The IEA Roadmap "considers that both annual hydropower capacities and generation should *by 2050 roughly double from current levels.*"[313] IEA's argument for hydropower is made in terms of *energy*, emphasizing hydropower's "several advantages over most other sources of electrical power, including a high level of reliability, proven technology, high efficiency, very low operating and maintenance costs, flexibility and large storage capacity."[314] Hydropower is a "mature" source of renewable energy—it is uniquely able to "help stabilize fluctuations between [electricity] demand and supply," and this function will become even more important in the next few decades as wind and solar power increase, since their electricity production varies so much over time.[315] In short, says the IEA:

> The contribution of hydropower to decarbonising the energy mix is thus twofold: the primary benefit is its clean, renewable electricity. The secondary benefit is as an enabler to greater contribution of other renewables on the grid.[316]

Despite these advantages, "hydropower is too often overlooked in energy policies" because many policy-makers today think that hydropower's economic potential is "exhausted", and its environmental costs are high.[317]

The IEA Roadmap has an upbeat assessment of hydropower's benefits in terms of *water* management. Dams and reservoirs can be managed for multiple water uses in addition to hydropower: "These objectives can conflict at times, but are more often complementary. Providing such multiple outcomes from sustainable hydropower development is central to this roadmap."[318] The claim is repeated in discussing the energy/water nexus and the impacts of climate change: other water users can benefit from hydropower's capacity to store and regulate river flows, as we all adapt to a changing climate.[319]

A second example is the Inter-governmental Panel on Climate Change ("IPCC"), which published a report in 2011 about hydropower in the context of

311. INTERNATIONAL ENERGY AGENCY, TECHNOLOGY ROADMAP: HYDROPOWER at 1, 7 (International Energy Agency 2012).

312. *Id.* at 1. "Current levels" meant 2005. These roadmaps were requested in 2008 by the energy ministries of the G8 countries as well as China, India, and Korea. IEA's *Roadmap for Hydropower* was done in collaboration with Brazil's Ministry of Mines and Energy, an organization with extensive experience in the field of hydropower.

313. *Id*., at 1. Emphasis added.

314. *Id*. at 5.

315. *Id.*

316. *Id.* at 7.

317. *Id.*

318. *Id.*

319. *Id.* at 5, 36-37.

renewable energy resources and climate change mitigation.[320] The general argument favors a major increase in hydropower development worldwide.[321] The authors (a team of international scientists) recognize the environmental and social conflicts triggered by dam projects, but nonetheless they emphasize the significant technical advantages of hydropower as a source of electricity.[322] They write that only 25% of the world's hydropower capacity has been developed and the remaining potential awaits, especially in Asia, Africa, and Latin America.[323]

The IPCC report emphasizes the water/energy nexus and the fact that multi-purpose dams must coordinate different water demands.[324] Like the IEA, the IPCC has a positive view of the prospects for coordinating multiple water uses in "harmonious and economically optimal operation." But the authors note the problems as well:

> In a context where multipurpose hydropower can be a tool to mitigate both climate change and water scarcity, multipurpose hydropower projects may play an enabling role beyond the electricity sector as a financing instrument for reservoirs, thereby helping to secure freshwater availability. However, multiple uses may increase the potential for conflicts and reduce energy production in times of low water levels.[325]

In contrast, organizations focused on the multiple uses of water and rivers have often been more critical of hydropower's impacts on river-flows. The World Commission on Dams is an important example, illustrative of recent international debates.[326]

In the U.S. and abroad, people governing hydropower in the next few decades will have to balance trends in the water and electric power sectors that are changing fast both separately and together. International water/energy experts have warned that recent efforts by many governments to reform *energy* policies and promote renewable energy development have had unintended and negative consequences for *water* systems.[327] According to the Pacific Institute, "water and

320. Kumar et al., *supra* note 309; Arvizu et al., *supra* note 309.

321. *Id*.

322. *Id*.

323. Arvizu et al., supra note 309, at 82, 86. Kumar et al., *supra* note 309, at 441-446.

324. Arvizu et al., supra note 309, at 85-87*;* Kumar et al., *supra* note 309, at 441, 488-490.

325. Kumar et al., *supra* note 309, at 488-489. *See also* Arvizu et al., *supra* note 309, at 85-87.

326. *See generally* World Commission on Dams, *supra* note 306; Sandra Postel & Brian Richter, Rivers for Life: Managing Water for People and Nature (Island Press 2003); Ken Conca, Governing Water: Contentious Transnational Politics and Global Institution Building (MIT Press 2006); Navroz Dubash et al., *A Watershed in Global Governance? An Independent Assessment of the World Commission on Dams*, 21 POLITICS AND LIFE SCIENCES 42 (2002); Deborah Moore et al., *The World Commission on Dams +10: Revisiting the Large Dam Controversy*, 3 WATER ALTERNATIVES 3 (2010).

327. *See generally* Jamie Pittock, *National Climate Change Policies and Sustainable Water Management: Conflicts and Synergies*, 18 ECOLOGY AND SOCIETY (2011); Karen Hussey & Jamie Pittock, *The Energy-Water Nexus: Managing the Links Between Energy and Water for a Sustainable Future*, 17 ECOLOGY AND SOCIETY (2012); PACIFIC INSTITUTE, WATER SCARCITY AND CLIMATE CHANGE: GROWING RISKS FOR BUSINESSES AND INVESTORS (2009); Christopher Scott & Martin Pasqualetti, *Energy and Water Resources Scarcity: Critical Infrastructure for Growth and Economic Development in Arizona and Sonora*, 50 NATURAL RESOURCES J. 645 (2010).

energy oftentimes compete with one another . . . .With increasing frequency, we value energy production over water protection."[328] This kind of climate "maladaptation" is why it is so important to think through the water/energy nexus in legal and policy terms as well as technical terms. Policies responding to climate or environmental change in one resource sector can unintentionally cause or worsen problems in other resource sectors.[329]

These global concerns today bring us back to the message of this paper. The history of hydropower in the U.S. shows that in the long run, the dynamics of the energy sector have dominated the water sector. The future sustainability of hydropower depends on the balance in that relationship.

328. PACIFIC INSTITUTE, supra note 327, at 8.

329. *Id*; Bauer, *supra* note 1.