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TECHNOLOGY AND DEVELOPMENT:
A Study of the Washington Public Power Supply System

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Introduction

Many in the policy and research communities project the imminent demise of nuclear power (Flavin, 1989; Campbell, 1988). Inefficient, costly, and unable to resolve the problems of plant decommissioning and waste disposal, nuclear power is portrayed as a technological failure. Yet, a close examination of the current energy and environmental policy debates suggests that eulogies for the industry may be premature. With international concern over global warming trends, there has been renewed advocacy for this technology as a "clean solution" to the greenhouse and other environmental problems associated with a carbon-based economy (New Scientist, 1988; Weinberg, 1989). Further, countries such as the Republic of Korea, which lack domestic energy sources regard the utilization of this technology as essential to industrial development (Choson Daily News, 1989). Finally, a new generation of what is termed "inherently safe" reactor technology is being heralded as providing a solution to the perennial problems of health and safety which have plagued nuclear power (New York Times, 1989; see also Weinberg, 1989-90).

What is striking about the debate over the second nuclear era is its unbroken continuity with that of the first era. In both, the focus has been on the "future tense" of what is promised by and what can be believed about nuclear power. In our view, this orientation misdirects the efforts of social evaluation and criticism by concentrating analysis on the relative costs and benefits of the technology's projected performance. Left out of such analysis is a "present tense" understanding (Noble, 1983) of the politics, economics and technics of nuclear power. This omission results in the actual social interests and values of nuclear power being made abstract, while its possibilities are treated as though they were concrete. Society as a whole, but especially those who are most immediately threatened by the advance of the technology--plant neighbors and workers--are placed in the untenable position of having to argue against progress. The study of specific case histories, such as the attempt by the Washington Public Power Supply System (WPPSS) to simultaneously build five nuclear power plants, offers one important method for developing a present tense understanding of the technology.

Our analysis is presented in four parts. In the first section, we provide a brief overview of the rise and apparent fall of WPPSS. We then locate the movement toward regionalization within an institutional and ideological context which equated social progress with increased energy production and consumption and with technical advance. Third, we document the resulting transference of autonomy over the specification of ends and the criteria for public policy decisions from the political to the technocratic sphere. The article closes with our assessment of future tendencies in regional energy policy.

Toward the Single Utility

On January 22, 1982, construction was terminated on two of five WPPSS nuclear power projects, setting in motion the largest municipal bond default in the history of the United States: $2.1 billion in bonds issued to finance two of five plants being built (Falk, 1985). Additional debt of $6.7 billion in principal and an estimated $23.8 billion in interest, which was accumulated to underwrite the five-plant project is also in jeopardy (Morrison, 1981; Loeb, 1982).

The WPPSS default can be located within the context of the centralizing tendencies historically present in the region. As early as 1937, when the federal government established the Bonneville Power Administration (BPA), steps were taken to organize the production, distribution and marketing of electricity on a regional basis. The trend toward regionwide cooperation accelerated during World War II as U.S. military planners sought to take advantage of the surplus of low cost electricity in the area for the manufacture of military aircraft. The federal government also built aluminum plants in the region to supply military needs, further adding to the demand for electricity (Balmer, 1983: 646). By 1942, 92 percent of BPA's load was committed to industrial producers of military hardware (Blumm, 1983: 203).

After the war these plants were privatized and the region's aluminum and aircraft manufacturers returned to civilian production. BPA responded to the burgeoning needs of its industrial customers by adopting a sales policy which offered large blocks of power at discount rates (Blumm, 1983: 206). It also initiated efforts to bring electricity users and providers together to plan for the post-war energy needs of the region. The Pacific Northwest Utilities Conference Committee (PNUCC) was organized by BPA in 1948 (the Northwest Power Pool having been created in 1942) and was charged with "the development of analytical tools to determine, on a rational basis, the relative costs and benefits of the various resources available to meet the Northwest's energy loads" (PNUCC, 1985). Together, the activities of the War Department, BPA and the PNUCC put the Pacific Northwest on a clear course toward regionalizing power supplies.

By the early 1950s many IOUs in the region which had previously depended heavily upon BPA for power supplies undertook joint projects to build and operate large-scale plants (Balmer, 1983: 649). These joint projects, together with efforts by the Eisenhower administration to weaken the preference clause in the BPA charter (which favored public power), were interpreted by public power providers as threats to their market share (Blumm, 1983: 210). In 1956, 17 Washington State public utilities and municipal authorities banded together as WPPSS in order to protect their collective interests. The technical and economic advantages of regional cooperation were demonstrated in 1964 with the completion of the Packwood Lake hydroelectric facility, a 27.5 MW plant. While the project ran 25 percent over budget and was seven months behind schedule (Leigland and Lamb, 1986: 4-5), it was viewed as a success because public power had established its capacity as an independent source of regional generation projects. Encouraged by this success, WPPSS sought to establish the ability of public power to operate at a scale and with technologies as sophisticated as those employed by IOUs. Planning was begun in 1962 to purchase and convert to electricity the excess heat from an 860 MW military reactor to be built at the Hanford Nuclear Reservation in northeastern Washington State (commonly known as the N-reactor). While the project, which went into commercial operation in November 1966, was significant for several reasons perhaps its most important contribution was that it demonstrated the viability of civilian nuclear power as a seemingly cheap and reliable source of electricity for the region.

The final step necessary for the completion of the regional electric network was the establishment of cooperative ventures among BPA, WPPSS and the IOUs. The Hydro-Thermal Power Program (HTPP) served this end. Initially discussed in a 1958 Corps of Engineers report, the proposal was not acted upon until 1968 when a way was found to establish joint participation and control by public and private producers over the Program. The HTPP incorporated the Army Corps plan to add 20,000 MW of hydropower by completing the Columbia River system, while simultaneously calling for public and private utilities to build a combination of 22 coal and nuclear thermal power plants with an output of 21,400 MW over the following twenty years.

In the following year, the Council program was refined into a Phase 1 plan to build seven plants by 1980 with a capacity of 7,930 MW. Carrying out even this scaled-down version, however, still required a substantial commitment to new plant construction. BPA proposed that WPPSS act as construction manager for three nuclear plants with a total rated output of 3,580 MW; the other 4,630 MW would come from IOU projects already planned or underway. Almost immediately, however, Phase I of the HTPP was diagnosed as insufficient. In 1970 the PNUCC forecasted electricity demand at almost 18,000 MW by 1979-80 (Gleckman, 1984: 10), which if true, would absorb all of the new capacity proposed under Phase I. By 1972 BPA was forecasting power shortages for the decade under low water conditions (Blumm, 1983: 225). The final blow to Phase I was a 1972 Internal Revenue Service ruling declaring "net billing" in violation of BPA's charter proscription against the direct purchase of electricity. Net billing, a critical factor in Phase I planning, was an arrangement among the utilities, BPA and WPPSS whereby participating utilities would purchase nuclear power at a price equal to the net difference between the cost of a utility's normal hydropower purchase from BPA and the cost of its share of output from the new plants.

In spite of these difficulties, by late 1973 BPA and the utilities agreed upon Phase 2 of the HTPP. Eleven plants with 11,300 MW of capacity would be added by 1987, of which 5,800 MW would come from nuclear facilities. These plants were in addition to the three Phase 1 projects. WPPSS agreed to build two nuclear plants with a rated output of 2,500 MW, while IOUs would construct six coal-fired and three nuclear units. Thus, by 1976 WPPSS was simultaneously building five nuclear plants with a combined rated output of 6,080 MW at a projected cost of $4.265 billion. The last plant was to come on-line in September 1987 (Heutte, 1982: 3).

Through the HTPP, a political milestone of regionwide cooperation in planning, forecasting, plant construction and power distribution and transmission was achieved. The Program joined rivals such as public and private power, BPA and the region's major electricity-using industries in a synergistic relationship. Interests which for 50 years had been perceived as conflicting, were now seen as complementary. Cooperation between BPA, WPPSS and the IOU's was essential: BPA to develop and sustain regional markets; and WPPSS and the IOUs, to build the plants which would complete the electrical network. In the HTPP disparate interests were combined to function as a single utility.

The Institutionalization of Megapower

The single utility framework that emerged in the Northwest in the 1960s and 1970s was dictated by the developmental requirements of a technological system. Distinguishing between the technical and the technological is necessary for understanding the evolution of the region's electrical system: "Technical refers primarily to tools, machines, structures and other devices...[F]actors embedded in technology besides the technical are the economic, political, scientific, sociological, psychological and ideological" (Hughes, 1980: 142). The problem for the Northwest was not whether and how to build large-scale power facilities. There already existed in the region knowledge, capital and organizations that could be combined to build and operate power plants. Moreover, BPA and the utilities had fashioned rate policies and distribution networks that could effectively market the power generated by their machines. If the HTPP is seen simply as a statement of technical need, it could have been implemented as a series of individual projects.

The HTPP was not a plan to build 22 or 7 or 11 power plants. Instead, the Program was part of a developmental sequence which was guided by the assumption that regional growth required the expansion of the electrical network. The HTPP represented a logical response to the region's energy needs within a technological system predicated upon the axiom that "civilization = k(energy);" or as Aldous Huxley once remarked, "because we use a hundred and ten times as much coal as our ancestors, we believe ourselves a hundred and ten times better, intellectually, morally, and spiritually" (for both see Basalla, 1980: 40). The attraction of megapower is deeply rooted in American myth and values. Throughout its industrial history, the society has equated national wealth with energy use, so much so that the two are often seen as synonymous (Ward, 1977). Electric power plants have occupied a special status in this ideological attitude, representing the technical archetype for the realization of cheap and abundant energy; the ideal "abundant energy machine" (Byrne and Rich, 1986). For seven decades, experience with electrical technology seemed to confirm the ideal. Average thermal efficiency of plants increased nearly eightfold from 1900 to 1970 while the size of facilities grew by a factor of eleven (Ross and Williams, 1977: 12-14). These technical achievements were matched by steady declines in the average price per kW from 1899 to 1969 (Bergman, 1982: 65).

The Northwest had for a long time experienced the advantages of megapower. Home to the largest hydroelectric system in the world, several of the world's largest dams, and the cheapest electricity in the United States, the region has routinely supported large-scale, centralized electrical generation. A BPA administrator reflected this regional consensus in a 1966 speech: "I am sure that I don't need to convince this group [of area utility executives] of the economies of scale. I don't think anyone here would urge the route of small, less efficient plants" (in Gleckman, 1984: 5). The region's adoption of nuclear power was a natural extension of the megapower ethos.

But nuclear power's institutional importance goes still deeper. A U.S. Department of Energy official spelled out the general rationale for the promotion of nuclear power in Western societies: "nuclear is the only nonfossil energy source that will be available to us in sufficient amounts to support our civilization and to fuel progress for the foreseeable future" (Agnew, 1983: 1). By this standard, even cost, the crucial capitalist measure of worth, cannot alone halt the pursuit of nuclear power since enthusiasm for the technology is not primarily rooted in its purportedly superior engineering or economic properties. Rather, nuclear power's appeal is explained by its compatibility with a particular technological system. Within the megapower paradigm, nuclear power, and possibly only nuclear power, can be understood as capable of meeting the region's "civilization needs." Seen in this light, the operant question is not whether or why but how the nuclear energy machine can be made to work. A technological society accepts the necessity of nuclear power and its inherent risks. In fact, it may seek to dismiss the risks, as when The Economist, one month before the Chernobyl accident, judged a nuclear plant to be "as safe as a chocolate factory" (1986: 11). A Soviet official similarly tried to minimize the risk after the Chernobyl accident: "[T]here is bound to be a technical incident...We can say that this is a normal incident, and there is nothing abnormal" (Associated Press, May 12, 1986). The New York Times in an August 25, 1986 editorial agreed: "Chernobyl is a lesson to improve safety, not throw in the towel...More accidents are certain."

Langdon Winner has observed that "technological society tends to arrange all situations of choice, judgement and decisions in such a way that only instrumental concerns have any true impact. In these situations, questions of 'how' tend to overpower and retailor questions of 'why' so that the two matters become, for all practical purposes, indistinguishable" (1977: 232-233). Northwest power development has adhered to this technocratic principle. Historic divisions of political and economic interest such as those underlying public versus private power and sagebrush resentment of federal control have regularly been superseded by the requirements of megapower. Despite deep suspicions and mistrust among electric generators, marketers and distributors, the region has witnessed an extraordinary proliferation of cooperative technocratic ventures. The Northwest Power Pool, the Pacific Northwest Coordination Agreement, the Western Systems Coordinating Council, the Mid-Columbia Hourly Coordination Agreements, as well as the alphabet organizations already discussed (the PNUCC, JPPC, WPPSS, and the HTPP), were all created to elevate regional discussion and action above the merely political so that the higher concerns of technological coordination could be met. The energy problem was framed by these ventures around issues of adequate and reliable supplies, transmission and distribution, and the capacity of the region to finance and manage a growing and more complex electrical network. These are questions of science, engineering and business management best handled by those with technical training. As Balmer suggests, the region has come to rely heavily upon its technical experts in policy matters. "We have seen the shift over time from a decidedly hostile coexistence of public and private power to a growing technological interdependence which...[has] led to an era of policymaking by relatively autonomous technocrats" (Balmer, 1983: 659).

Northwest power planning under the HTPP emphasized "technical virtuosity as a style" (Lee, 1980: 90). Managers at BPA and WPPSS tended to have engineering or other scientific backgrounds, adopted "scientific approaches" toward management matters, emphasized formal control in the organization of work and, above all, did not "play politics" (Leigland and Lamb, 1986: 75). To plan and manage the construction of five nuclear projects, several of the largest and most prestigious technology and investment firms were relied upon for technical counsel and management services (Leigland and Lamb, 1986: 60-67). Merrill Lynch, Paine Webber, Salomon Brothers and Blythe Eastman Dillon worked for WPPSS, as did Bechtel and the "big four" reactor vendors--General Electric, Westinghouse, Babcock and Wilcox and Combustion Engineering. Undergirding WPPSS was a transnational complex of corporations, interlocked with the largest U.S. banks, insurance companies and law firms (Leigland and Lamb, 1986: 183). The energy problem, as these organizations defined it, required specialized knowledge, planning and coordination to be solved.

This technocratic orientation largely precluded assessment of alternatives to large-scale centralized production. "By training and by tradition, all the utilities were growth oriented, concerned with meeting needs before they arose, and unreceptive to the idea that conservation...might be substituted for increased supplies of power" (Balmer, 1983: 651). The technocratic bias neglected two possibilities. First, it was assumed that the WPPSS projects would continue the pattern of low power prices for the region. In fact, the Pacific Northwest has discovered that megapower can be a major cause of spiraling prices. Second, the treatment of conservation as curtailment rather than as a supply option meant that the greatest advantages of the conservation strategy were ignored. In particular, the possibility that conservation investments might result in lower costs per kW saved than investments to supply a kW was overlooked.

Indeed, despite decade-long experience with significant construction delays, rising costs, and increasing electric rates (averaging over 86 percent in December 1979--see Sugai, 1987: 351), it was not until the approval of Initiative 394 in November 1981 that WPPSS bond sales were subjected to ratepayer referendum. Citizen protests were few and unorganized before late 1980--"any direct attack upon the Supply System would fail to elicit majority public support" (Sugai, 1987: 8)--and reached their peak in January 1982 with the termination of WNP 4 and 5. By that time, ratepayers had mobilized into a series of organizations, including "Irate Ratepayers" chapters, the "Don't Bankrupt Washington" coalition, and the "Progress Under Democracy" committee. But with the cancellation of two projects and mothballing of two others, activism quickly waned and in September 1982 efforts to form an umbrella coalition were dropped (Sugai, 1987: 363). This is not meant to diminish citizen activism in the Northwest. Rather, the short life of mass protest in the region and its limited accomplishments underscore the considerable problem faced by citizen groups in affecting, much less controlling, the activities and direction of a technocratic regime such as that ruling Northwest energy policy.

WPPSS, BPA and the HTPP together constitute a technostructure predicated upon the belief that the decision to create a regional electric power system represents the rational solution to the energy problem. This belief assumed the status of an imperative by the mid-1970s. Faith in nuclear power and in technocratic judgement, resigned acceptance of significant cost overruns and project delays, and an abiding belief in the energy-civilization equation express some of the requirements of this technological imperative.

Autonomous Technology

Arguments of technocratic ideology and technological imperatives are at variance with most social science frameworks of explanation which tend to rely upon rationality models (Byrne, 1987). In the latter, social choice about technology is conceived as being exercised through institutions such as markets or governments independently of existing technological systems. Explanations of this type preclude the possibility of a compulsive or deterministic quality in technology choice. The contrast between conventional social science and the approach taken here can be sharply drawn through an analysis of the economic relationships underlying the WPPSS episode.

Conventional economic analysis assumes that markets act as independent arbiters of the relative worth of alternative economic activities. Through the price mechanism, competition for resources is weighed and the most efficient mix, purportedly, is accepted. The trading of current versus future goods is not supposed to affect the "independence" or the efficiency of markets (Hahn, 1981). In this view, markets are self-governed by internal rules (the laws of supply and demand) and act upon social life rather than the other way around; that is, markets are seen as autonomous institutions.

A stylized account of energy decisions in the Northwest as market-determined hardly squares with the realities of megapower. The attempt to create such an account for the WPPSS projects unavoidably devolves to a series of explanations on why market processes didn't or couldn't work. After all, the WPPSS projects represent more than $30 billion in investments (with interest) made over ten years with the only tangible result to date being several nuclear plants "left to sit out in the rain" (Gleckman, 1984: 35). But it is not simply the magnitude of the economic "mistake" that challenges the validity of conventional market doctrine. A regression analysis of bond sales during 1973-82 (the period during which the WPPSS bonds were issued) indicates that at no time did the municipal bond market, the source of capital for all five nuclear projects, assign a measurable risk premium to the WPPSS securities compared to other revenue bonds floated in the same time period. That is, the market which was responsible for financing the projects never judged them a higher risk than competing users, much less a mistake.

Table 1 summarizes the results of the analysis. (For a fuller discussion of our statistical methods and results, see our "Nuclear Optimism and the Technological Imperative", **Bulletin of Science, Technology and Society**, Forthcoming.) Our equations were successful in accounting for a large percent of the variance in interest costs paid by bond issuers. All variables used in the equation had the expected signs. While the Durbin-Watson statistics indicate that homoscedasticity cannot be assumed (and therefore that the standard errors for the equations are underestimated), this is of little relevance to our analysis. The central issue is whether a statistically distinguishable interest cost premium can be found between WPPSS and non-WPPSS issues, not whether the estimates of individuals variable effects are efficient. Using the Chow test, it can be shown that the WPPSS and non-WPPSS equations can be pooled at a 0.01 confidence level for both the quadratic and logarithm size models. Differences in interest costs are not statistically significant and can be attributed to issue size (see the intercept tests--WPPSS averaged $197 million per float while the average for revenue bonds was $85 million and the average for electric-only revenue bonds was $100 million).

These results are surprising only if a theory of autonomous markets is maintained. There are ample reasons for assuming the reverse; namely, that market activity with respect to WPPSS was conditioned by and subsumed within a political economy of megapower. Markets cannot perform a general evaluation of megapower versus other energy options because this requires an assessment of what Amory Lovins has termed institutional "architectures" which are, by their nature, mutually exclusive and antagonistic (1977:59). As he has argued, it is not possible to pursue simultaneously a centralized system of power production and exploit fully the economics of conservation and renewables. System rationality and efficiency depend upon sustained commitment to one or the other, but not both. Economic analyses of nuclear power versus other "energy paths," such as those performed by Hohmeyer (1988), Keepin and Kats (1988) and Flavin (1983 and 1989), tend not to address this point. Based on comprehensive studies of the relative social benefits and costs of full scale nuclear and conservation alternatives, these researchers conclude that nuclear power fails the market test. However, these analyses presuppose the complete replacement of one system with a different one. This would involve a comparison not only of advantages at the margin, but of mutually exclusive and antagonistic technological infrastructures. These infrastructures cannot be reduced to their "sunk costs" and, for this reason, are economic incomparables. Only one infrastructure is reflected in current investments and it is dedicated to the support of megapower. Simply put, there is a functioning system for the delivery of "parts"--from nuts and bolts to laws, financing and public policies (e.g., the Price-Anderson Act)--to service the megapower machine. There is no equivalent to service conservation and renewables.

From a megapower perspective, conservation and renewables represent enormous costs, regardless of their relative energy economy after adoption. There are the investment costs in a new infrastructure, the losses to be suffered by the old energy regime and the transition costs in smoothing the changeover. Arguments that energy is more cheaply and efficiently provided and the environment more readily protected under a conservation/renewables regime are hardly persuasive under the logic of megapower. The beneficiaries of this logic understand this all too well. That is why the U.S. Committee on Energy Awareness, a lobby for the utility industry, represents nuclear power in its media campaigns as the long-term market choice. It is, so long as the elimination of the institutional apparatus of megapower is counted as a cost (Byrne and Rich, 1983: 176-181).

Conclusion

With the WPPSS default on two plants and construction postponement of two others, it might appear that the regional autonomy of megapower has been seriously shaken. In our view, however, a negative prognosis about the future of megapower in the Pacific Northwest would be premature. Notwithstanding passage of the 1980 Pacific Northwest Power Planning and Conservation Act, which required the region to exhaust cost-effective conservation and renewable options before building additional power plants, utility commitment to megapower remains strong. Shortly after the WPPSS default, several utilities proposed construction of eight new coal and nuclear plants "while seeking to retain the option of completing...WPPSS Nuclear Units 4 and 5" (Northwest Conservation Act Coalition, 1982: 3). The 1986 Northwest Conservation and Electric Power Plan sought to extend the commitment to WNP 1 and 3 through the year 2006. Advocating a continuation of the regional cooperation pioneered under the HTPP, the Plan forecasted $2.2 billion in energy savings over the next twenty years through coordinated power development and conservation. Thirty percent of these energy savings were contingent upon the completion of WNP 1 and 3. Net benefits of $630 million were projected if the region would commit an additional $2.8 billion (not including debt service) to the WPPSS nuclear program (Northwest Power Planning Council, 1986: pp. 2-1 and 7-12). The 1986 Plan remains the controlling energy policy document for the Northwest and its objective of retaining the nuclear option was recently reaffirmed by the Northwest Power Planning Council which found that "problems precluding further financing of these plants [WNP 1 and 3] apparently have been resolved" (1989).

Nuclear power continues as a future-tense idea for progress in the region. In spite of its practical problems, megapower still represents an imperative for all technical people.

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TABLE 1
All Revenue Issues
Quadratic Model

		C	S	S^2	R	T	R^2 (Adjusted)	Chow Test	Durbin-Watson Statistics
Non-WPPSS	D	2.0163	-.1874E-5	0.6046E-11	0.4553	0.1756	0.5160		
Issues	F-value		0.966	3.435*	59.819*	573.02*			0.4666
(n = 585)	S_e		0.0000	0.0000	0.0589	0.00734			
WPPSS	D	5.5782	-.1554E-4	0.2449E-10	0.2346	0.1368	0.7268		
only	F-value		5.831*	11.302*	0.962	27.741*			1.1689
(n = 42)	S_e		0.0000	0.0000	0.2392	0.0260			
All	D	2.2412	-.2288E-5	0.8294E-11	0.4163	0.1731	0.5241	F=2.271	
Issues	F-value		1.780	10.534*	55.720*	603.32*		p=0.046	0.4720
(n = 627)	S_e	0.0000	0.0000		0.5578	0.0071			

Logarithm Model

		C	LnSize	R	T	R^2 (Adjusted)	Chow Test	Durbin-Watson Statistics
Non-WPPSS	B	1.1748	0.7054E-1	0.4555	0.1748	0.5119		
Issues	F-value		0.284	59.254*	565.977*			0.4452
(n = 585)	S_e		0.1323	0.0073	0.0073			
WPPSS	D	-4.9822	0.6516	0.4017	0.1760	0.5541		
only	F-value		2.006	1.832	32.664*			0.6224
(n = 42)	S_e		0.4600	0.2968	0.0308			
All	D	-0.3911	0.2205	0.4161	0.1743	0.5089	F=2.092	
Issues	F-value		3.290*	53.991*	595.034*		p=0.082	0.4046
(n = 627)	S_e		0.1216	0.0566	0.0071			

*Significant at the .01 level of confidence