Systematic Change for the Bonneville Power Administration in Columbia's Renewable Energy Market to Ensure Societal Benefit and Economic Viability

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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The Columbia River System in the Pacific Northwest has over thirty dams and reservoirs managing its water flow. The Federal Columbia River Power System (FCRPS) comprises ten of these reservoirs, which account for 91% of the system's hydroelectric energy, managed by the Bonneville Power Administration (BPA) (Tan, 2017, p. 72). The BPA, a federal power marketing agency within the US Department of Energy, manages the operation of these reservoirs and distributes the energy as a public utility. The Mid-Columbia energy market, occupying the same geographical and economic region as the Columbia River System, is comprised of thermal, wind, and solar energy producers. These three renewable energy sources, along with hydroelectric energy, carry significant market share (Su, et al., 2020, p. 8). Present day reservoir operations are advised by proven simulation models, managing multiple objectives like energy production, water flow, flood prevention, the survival of the keystone species of salmon, and others.

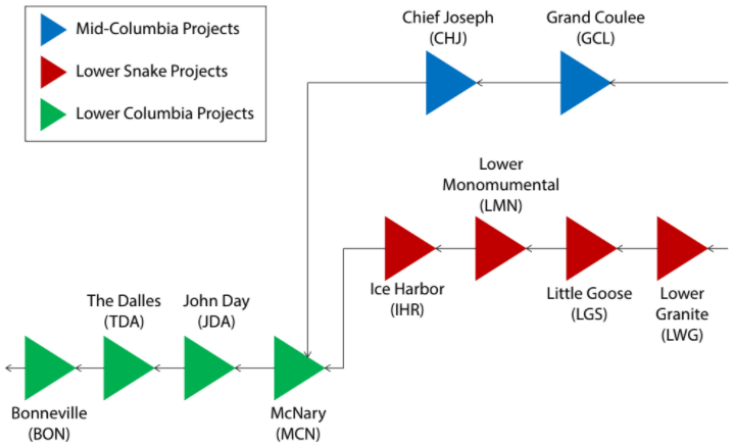

Figure 1: The 10 FCRPS Reservoirs Operated by the BPA

The BPA currently acts as a price-setter among hydroelectricity producers, carrying 60% of hydroelectric market. However, the BPA is not solely dedicated to efficient price-setting due to the previously mentioned objectives that often conflict with energy yield and profit. To maintain system equilibrium for another objective such as flood prevention, an "oversupply"

event is the result. Oversupply events occur for a variety of reasons yet their consequence is consistent. Operators release water to meet another objective and produce energy that oversaturates the power grid, flush with energy from other suppliers. The BPA incurs a cost to pay off other renewable producers and this cost is eventually passed down to the consumer (Su et al., 2017, p. 174). As it stands, there is no conclusive evidence that the BPA's price-setting authority is either helping or hurting the production of other viable renewable energy options. Rather, the full extent of the effects the BPA has on the renewable energy market as a whole are unknown (Tan, 2017, p. 73). The ability of the BPA to confidently continue as a fair price-setter is in question however, as the compound effects of climate change introduce more uncertainty in multiple settings. For instance, in a study from 1951 to 2008, the peak month of June has seen a 40% reduction in water flow (Forbes et al., 2019, p. 25). Climate change will continue to be a driving cause for uncertainty in this system, for both hydroelectric energy and the comprehensive renewable energy system. And, despite its ability to profit off a public good, the BPA is in a tough financial position, with debts up to 88% of its annual revenue (Karier, 2019). Without having changed its practices in several years, both in its approach to economic viability and ability to meet the multiple objectives of the Columbia River System, the BPA is at a crossroads. The major question the BPA must answer is if it will continue to maximize profit as one of its objectives, or will it restructure and operate outside economic bounds. In addition to this tough question, there are significant barriers to changing the BPA that must be considered.

As mentioned above, oversupply events negatively impact the BPA and the consumer, while the true effects on other renewable energy producers is unclear. Maximizing profit is no longer be feasible if these oversupply events occur with more frequency and intensity. Especially as a federal agency, maximizing societal benefits means employing a stable, rather than profit

optimized, price, which is also the economically efficient solution (Tan, 2017, p. 4). Because of the effects of climate change, namely changes in temperature and precipitation that affect runoff in the Columbia River, the BPA may need to reconsider placing profit maximization at the forefront of its practices. The BPA aims for economic viability but also states they are conscious of changing conditions and redirecting their approach (BPA 2018-2023 Strategic Plan). Essentially the consequence of not adopting new policies will lead to continuous stress on the BPA to ethically and appropriately maintain market presence, reducing their ability to benefit society for good. The BPA is stretched thin. There is no reasonable way for it to balance all of the conflicting objectives of the system in its current state and building pressure will force change in the near future.

My current technical research outside of this paper advises the BPA in adopting reservoir operation policies that are resilient to climate change. Therefore, the energy supply is consistent among variable demand projections while still meeting its current objectives. However, that does not directly answer the question on how the BPA should continue with or alter its profit-driven approach. A possible resolution is to look at ways at which the BPA can change its business practices to a more suitable role as a price-taker. By letting the market decide the price of energy instead of the BPA setting the price, then there is a true free market that allows the growth of renewable energy market and could potentially mitigate the oversupply event issue. Methods to achieve this include removing profit as an objective for the BPA, extending transmission lines to the California energy system, exploring energy storage investments, or possibly reworking the dam infrastructure. This paper will consider these alternatives and outline how the BPA can continue to meet its objectives while ensuring benefit for its customers, people, businesses, and society alike.

In the US, most states have public utilities commissions that have jurisdiction over production and distribution of energy within the state, overseen federally by the Federal Energy Regulatory Commission (FERC) (Sundback, et al., 2020). As previously mentioned, the BPA is one of a few examples of federal agencies handling the duties that typically fall to state appointed monopolies. For nearly a century, state appointed and privately owned companies operate in a monopoly, deemed acceptable because energy distribution was formerly seen as a natural monopoly. While state-level organizations are also better equipped to tackle the intricacies of a regional issues, new technology mostly in renewable energy has allowed smaller electrical companies to challenge the state-allowed monopolistic companies (Corneli & Kim, 2016). There is little precedent for states to break up their energy monopolies and essentially none for how a federal agency should handle the apparent transition to growing energy competition, meanwhile the pressure felt by the BPA is also being exacerbated by the growth of these smaller, private companies.

Figure 2: BPA Energy Production and Transmission in a Multi-state Service Area

The administration faces economic uncertainty and so far has been operating without subsidization or significant funding from state or federal government. Previously mentioned alternatives are a start to solving this energy problem, but the region's energy reliance can also

be shifted to a plethora of smaller companies. These smaller companies are the same ones that the BPA pays off during oversupply events, typically solar and wind energy producers. The Columbia River Treaty with Canada, signed in 1961, expires in 2024 with no significant headway in renewal. This treaty outlines how Canada operates dams that feed into the Columbia River System and effects BPA operations (Bureau of Western Hemisphere Affairs, 2020). This uncertainty is another challenge to the BPA's economic viability.

There are many considerations in how the BPA should handle changing its pricing and economic motivations. With very little precedent and added pressure from climate change and financial instability, there might simply be no perfect answer. However, the goal of this paper is to use STS teachings to determine a realistic alternative for the BPA and FCRPS. Suggestions will likely be unprecedented, just as the situation is, but the approach to filling this gap will be considering the best use of technology for societal good. Another factor that leads to unprecedented alternatives is the slow-moving nature of public infrastructure. This factor, including the variety of numerous public and private players, leads to the realization that change will be slow and systematic.

Emmanuel Mesthene's chapter on "Economic and Political Organization" abstracts many of the challenges faced in this situation. The "introduction of computerized information-handling procedures" being utilized by the BPA qualifies as advanced technology, defined as having large scale influence and ramifications that extend into other aspects of society. To broaden the scope of this problem, it is necessary to view the BPA as a "political" organization, included in the "decision making structures and procedures that have to do with the allocation and distribution of wealth and power in society" (Mesthene, p.63). A government agency channeling and dictating energy deployment in a large region is synonymous to distributing wealth and power, so

regardless of partisanship, the BPA does carry political weight. Judging by its inability to effectively and economically resolve overflow events, too much weight. Mesthene attributes issues like this to a misunderstanding of how advanced technology has changed society, a "blurring of once clear distinctions between the public and private sectors of society" (p.64). The BPA sees the conflicts of interest in its ability to economically release water, with the smaller, privatized renewable energy producers competing in a market that does not have valid political procedures to prioritize an affordable, reliable public good. Absorbing the cost of energy production is currently differed to the consumer, through the previously mentioned oversupply process in the Columbia River. Mesthene recommends "restructuring our political institutions and political making mechanisms," (p.68) and this paper will hypothesize how this restructuring should move forward.

First and foremost, experts and regulators alike must simultaneously accept the solutions provided by advanced technology. This seems like an obvious step, but there are valid hesitations regarding immediate acceptance of new practices. For instance, many reservoir operators are slow to adopt optimization models over the long-used simulation models. Optimization models are better equipped to meet the multiple objectives of reservoirs, however their complexity is much higher than that of the widely used simulation models (Labadie, 2004, p.94). This situation draws parallels to issues in political and economic organizations, technology outpaces the ability of decision-making structures, particularly people, to adapt. Undoubtedly, these operators will come to accept optimization models with more time, education, and advancements in the field. A faster way to adopt advanced technology in this scenario would be to take the decision-making out of reservoir operators' hands, essentially forcing immediate adoption of optimization models.

Given the current structure of the BPA and the FCRPS, these bodies are the decision-makers that can enforce the use of these models.

However, there is another way for adoption of optimization models to be hastened and incentivized. The BPA is recognized as being a major player in the region's renewable energy market and the "mechanism of the market" is described by Mesthene as one of the decision-making structures in society. However, Mesthene also notes that the market mechanism is remarkably more efficient for private goods than public goods (p. 71). Given that there are multiple other renewable energy providers in the Columbia River area, there is a join private-public market providing electricity. While electricity is a public good, the means of producing it have become more privatized, again blurring the lines between public and private sectors of society. Tan (p. 64) asserts that reservoir operation models that maximize revenue "will lead to monopolization behavior by a (public) utility with a large share of the generation in a particular area." If the private markets are proven to facilitate the production of goods more effectively, the BPA cannot continue to force other entities to respond to a public, and inherently monopolistic, market.

How to go about restructuring the role of the BPA is a difficult task, however there is more context to consider when thinking of the end goal. Beyond increasing reactivity to market conditions, there are other ways in which this system must become more reactive. Climate change models spell a variety of scenarios for the Columbia River. As is the current trend, the Columbia's peak flow months have changed from historical averages, shifting from June to May (USBR, p. 37). Most models also point to an increase in annual water flow. This bodes poorly for market prices as well, as it is "most sensitive to periods of extreme abundance (over supply)" that are more likely with increased annual flow (Su et al., 2017, p. 172). With an expectation that

over supply events that pressure price negatively will occur more frequently, and the understanding that many compound effects of climate change will not be understood proactively, there will be unseen strains on the BPA. Uncertainty in climate change will also affect wind and solar power production, the primary competitors in the renewable energy market. Across, low, medium, and high growth rates of wind energy capacity in the BPA system, the suggested short to midterm solution is to continue with curtailment of wind energy production during hydroelectrical oversupply events (Su et al., 2017, p. 182). Given the other issues the BPA faces and the immense losses that these oversupply events incur, continuing the status quo is not a satisfactory solution.

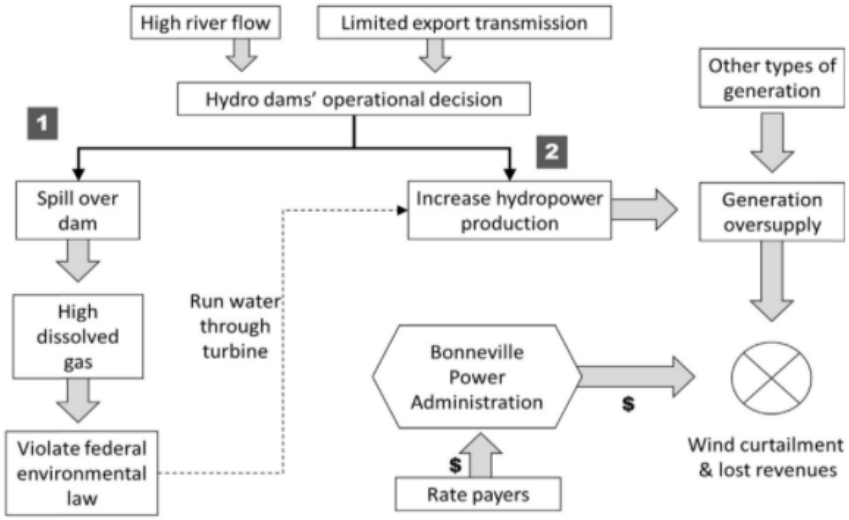

Figure 3: Hydroelectric Oversupply Events Lead to Revenue Loss

As previously mentioned, the BPA is considering change in dramatic fashion (BPA 2018-2023 Strategic Plan). There are looming financial issues the BPA must confront as well as long term economic viability. There is a changing market for renewable energy and energy as a whole. Climate change will continue to put pressure on a system that acts only reactively, not proactively. While not a perfect comparison although arguably the best framework to confront these problems, Mesthene asserts that systematic change and continued confidence in advanced

technology is the answer. While ambiguous in theory, the BPA can lead the way among energy producers in preparation for the next generation of energy production. Possible solutions include dividing the BPA into two agencies, one for regional energy regulation and one for continuing energy operations, privatizing many public energy production firms, removing the maximization of profit from reservoir operation objectives, and fronting major initial cost to revamp the region's energy infrastructure. All of these options hold merit in confronting societal issues that continue to grow in breadth and this paper will analyze each to advise the BPA in a new and unprecedented direction.

The proposal to divide the BPA as it exists is to establish an operational agency to continue reservoir operations and also a regulatory agency overseeing energy production, specifically renewable within the Columbia River area. This would allow the operational agency to continue to meet multiple objectives as well as assume a price-taking role as it no longer has responsibility over multiple organizations. The regulatory side can oversee all the renewable energy producers that participate in the market, and with the BPA out as a price-taker, set procedures that ensure reliable and affordable access to electricity. These procedures might also include forced adaptation of optimization models instead of simulation models. However, the regulatory part would be a burden on tax payers as it will not be achieving a profit. Perhaps this tax burden is negligible next to increased performance of the renewable energy system and the societal good gained from an organizational change. This question of profitability might also continue for the operational side, as one of the solutions proposed is a removal of price maximation from its multiobjective function.

There is also the option of removing public ownership of the BPA and its subsidiaries. While this is undoubtedly mired in legal proceedings as well, the BPA is now the only owner of

reservoirs in the Columbia River system, so there is precedent for private ownership. This recommendation might also be applied in tandem with a splitting of the BPA. While this paper has no more specific recommendations beyond privatization, looking to potential benefits can show why it is a potential step. Other producers within the same market, for both hydroelectric and other sources of renewable energy, currently exist as private entities. This being the only public body, also the current price-setter, disrupt the system that the market mechanism promotes. While electricity may be a public good, Mesthene proposes that a private market, and this paper proposes the adequate public regulation alongside a private market, might be the best system to produce this good.

Understanding the impact of removing profit maximization from the objectives of reservoir operation is simple in concept; run the exact same proven models but remove profit from the equation. This would place greater weight on the other, arguably more important functions the BPA hopes to meet such as flood prevention, salmon run maximization, and water quality and quantity assurance. There are impacts beyond the improvement of the other objectives. The energy the BPA produces would be a compliment to the energy market, rather than the driving force that dictates price and can force other producers to curtail their production. There is serious future research to understand how this market would exist with the complete removal of the BPA in an economic sense, and how the BPA could continue to exist without its profit source. However, depending on the future of public goods such as electricity and the desires of the constituents that the BPA serves, this could see considerable benefit.

And the final potential recommendation of this paper is dramatically revamping the current energy market structure but with large amounts of public funding directed at infrastructure. By expanding transmission lines to underserved markets, the BPA can

simultaneously fill the need of other citizens' energy needs and allow growth of other energy producers by mitigating oversupply events. This investment in energy infrastructure can take place in many forms and over varying time ranges. However, it is clear that eventually some monetary strongarming must be applied to this particular energy market. Regarding the other recommendations, energy infrastructure should be viewed as a compliment to other options. Although this paper views no one solution as the sole solution to a complex problem, energy infrastructure investment is paramount in improving the BPA and the Columbia River energy market's contribution to society.

This paper and its research have aimed, among to find solutions for the BPA to, among other benefits, better achieve societal good. The current financial situation of the BPA, current public and private marriage of a complex system, the current price-setting practices of the BPA do not reflect what is best for the energy market, customers, and the BPA itself. Oversupply events cannot forever be dismissed as an inevitable burden on the system. Climate change is an ever-present threat to the delicate equilibrium of this economic and environmental system. Changing expectations of the energy market in general call for organizations, political and economic in nature, to absorb new responsibilities. The expected results and hypothesis of this research essay do not derive that a unicorn solution, solving every problem with one fell swoop, exists. However, there are concrete recommendations that this paper has covered. Division of the BPA into two separate entities with more specified functions has the potential to remove pressure from the BPA. Privatization has the potential to yield a more effective energy market, undeniably better for the consumer, as long as the correct public oversight is steadfast and ready. As far as drastic change goes, removing profit from the BPA's optimization equation is a large shift. However, given the existence of other objectives, and the ability of other producers to fill the

void in the market, it should be given consideration with adequate research. And beyond all the other considerations, improvement of the energy infrastructure, despite its associated cost, is the most direct answer to many of the BPA's issues. While advanced technology is pushing the capabilities of the BPA and the Columbia River energy production forward, technology can as well push forward the entire system. To many experts, these recommendations will come as a stark contrast to a very stable history in the region, but given the growing expectations of the system, the BPA and will rely on unprecedent solutions.

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