Case Study: Planning Hydropower Operations in High Renewable-Energy-Penetration Power Grid

The Ethics of Hydropower Operations in High Renewable-Energy-Penetration Power Grid

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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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I. Introduction

As climate change is becoming increasingly problematic and irreversible, the need for energy continues to climb and many have turned towards renewable energy sources as a solution. In the Pacific Northwest one of the biggest suppliers of renewable energy is the Columbia River Basin (CRB) which runs through seven states and one Canadian Province, supplying drinking water and electricity to millions (Columbia River, 2019). My technical project is a case study looking specifically at the Grand Coulee Dam, the largest dam in the CRB, and will explore how alternative hydropower operations could balance increasing supply of energy from renewables throughout the West Coast to reach a 100% renewable grid by 2030, while mitigating impacts on flood control and freshwater in the CRB.

While creating a plan for the Grand Coulee to support the transition to a 100% renewable grid, it's important to also investigate the impact added hydropower operations will have on the surrounding environment, ecosystem, and communities, especially the effect on salmon populations and other freshwater wildlife. Dams and reservoirs can have a huge impact to the natural flow of rivers, reducing water flow and hindering the migration of fish as well as harming the Columbia River estuary. This area is crucial to lots of wildlife, including salmon, as it is where freshwater meets salt water tide, creating an area for wildlife to gradually adjust to salt water in the pacific (Columbia River, 2019). In addition to wildlife and the surrounding ecosystem, communities that rely on these staying consistent for their lifestyle are greatly affected by these changes as well. Specifically, lots of indigenous communities rely on salmon beds for food and as salmon population declines, so does their livelihood. The aim for this project is to research specifically how a plan for creating a 100% renewable energy grid in the CRB will affect the surrounding environment, such as increased potential of flooding, and the

decline of the surrounding ecosystem. Also, how these effects have negative consequences for surrounding populations, such as indigenous communities in the Pacific North West.

II. Technical Project

Hydropower is becoming an increasingly large player in the race to creating a 100% renewable energy grid and dams in the CRB produce around 40 percent of electricity for the Pacific Northwest and around half of British Columbia's hydropower generation (Socio-Hydrological Modeling, 2021). The CRB has a large significance and because of this, seemed to be a great system for our case study, specifically it's largest dam, Grand Coulee. Through a case study analysis, the team's goal is to find a hydropower-based solution for the CRB to be powered by 100% clean energy. The study includes power grid assessments, water resource analysis, environmental and societal analysis, and hydropower planning. The use of an optimization algorithm will help to create the most accurate solution. This algorithm combines data from a reservoir simulation model, California and West Coast Power (CAPOW) systems model, Vancouver water level model, BPA revenue data, and data on flood environmental spill violations and hydropower production.

Our first focus is on refining and improving the existing optimization model to include pump storage, as hydropower storage is vital for reaching the 100% renewable grid. Then, using the improved model and other data we will develop various scenarios depending on current and prospective socioeconomic, environmental, and technical factors. The optimal solution, or a few optimal solutions, will be found once we combine findings from electricity cost and economic/environmental factor risk analysis. Our hope is to use the models and resources to find

an optimal scenario that has a goal for each year to move towards the 2030 100% renewable grid goal.

In addition to hydropower created by Grand Coulee, a large focus of our renewable energy scenario is combining hydropower with existing solar energy resources in the area. Solar and hydropower can be great compliments to one another, especially with solar being so reliant on the day-by-day weather and environment. There is much uncertainty with weather patterns making the use of solar unreliable as a source of renewable energy on its own. Part of our project is to implement hydropower storage that can support the use of solar and create a 100% renewable energy grid in the CRB.

III. STS Project

Moving forward towards a renewable energy grid is critical for society to combat climate change, but it's just as important to make sure specific groups and communities aren't hurt or set back by the effects of renewable energy infrastructure. The STS portion of this research looks at the CRB, focusing on the Grand Coulee dam, and how it's contribution to a 100% renewable grid could have negative repercussions for the surrounding ecosystems and communities. The construction of the Grand Coulee Dam has impacted the area around it in many ways since it began in 1933. It took land from indigenous communities like the Spokane and Colville Tribes and its negative impact on their lives didn't stop there. The wildlife that these communities rely on for food and wellbeing were also affected greatly, especially the decline in salmon population the dam has caused (Office, U.S. Government Accountability, 2003). Reduced flows caused by the dams have harmed the Columbia River estuary by reducing the river's freshwater plume. This area is important for a variety of fish, especially salmon, as it allows gradual adjustment

from freshwater to saltwater. Salmon migration has also been blocked by dams in upper parts of the Columbia River (Columbia River, 2019). Flooding risk is also projected to increase due to climate change, and the infrastructure in the CRB is no longer designed to protect these communities (Ubiquitous Increases in Flood…, 2021).

The groups research is aimed to focus on are indigenous communities as they seem to be the most effected by changing ecosystems. In addition to these communities, research will be conducted to learn about other communities in the CRB that may be affected by an increase in flooding projections. The government is also an important group to look at as they control the policies regarding infrastructure and water, as well as are in charge of holding people accountable for disproportionately harming specific people. They are an important part of this research to gain knowledge about the effects of hydropower infrastructure on indigenous communities, specifically the Committee on Indian Affairs of the U.S, Senate. Unfortunately, having concise research may mean not being able to go as far as to look into engineers of hydropower infrastructure, or groups that have lots of influence regarding the government and water policy. Both would be interesting to look into, but with lack of time and hopes to have a concise paper it may not be feasible to include much information about these groups in the research.

The main framework that research will use is risk analysis, which is a framework that investigates the negative impact different things may have. This aligns well with my focus on discovering negative impacts of hydropower in the CRB and more specifically, Grand Coulee Dam. Two methods can also be explored through this research: public policy and ethics. It's important to understand how policy falls short to protect communities that are impacted by renewable energy sourcing. Also, ethics are important here to decide the weight of worth of the

different components in this research from the communities, workers, renewable energy, and ecosystem. A case study can be explored to look at specific communities hurt, or to look at one system if infrastructure, the Grand Coulee Dam, and how it follows policy but falls short in protecting the surrounding communities and ecosystem of the CRB.

Having a technical understanding of flood risks and how climate change plays a part in this is important for understanding how communities will be affected in the future. This is a critical first step for diving into the project. As the technical project progresses, more ideas might be discovered surrounding this that would be influential in a case study looking at Grand Coulee. This includes discovering through simulations more environmental factors in the hydropower operations. After gaining a stronger understanding of the technical background, the next step is looking for more information on indigenous communities affected by flooding risk around the CRB. This is also crucial for creating a case study centered around ethics.

IV. Key Texts

Salmon population decrease has been an issue since the start of hydropower infrastructure in the CRB in the 1930s. “A River in Common: The Columbia River, the Salmon Ecosystem, and Water Policy” by John M. Volkman is a great source to learn about policy that exists to protect freshwater environments like the CRB, and how they are very out of date considering the current state of the Columbia River. It discusses the current state of the River and Basin area, and describes the decline it has experienced throughout the past decades, focusing specifically on salmon and policy. The policy is helpful because a lot of the book argues that the policies are outdated and explores why. Volkman discusses issues with the river being international, as part of it flowing through a Canadian Province, as well as powering much if the province with

hydropower created. It seems to be a good resource for information of general policies regarding the preservation, where they fall short, and how salmon is affected by this. “Salmon and Social Ethics” By John Hart is another useful journal that talks about the ethics of infrastructure in the CRB that affects salmon population. It argues the importance of preserving species because of their own intrinsic value, and the importance of this over human wants and needs. This seems to align well with my STS project, where hydropower infrastructure is created to advance society, but at the sacrifice of salmon populations in the CRB.

“Indian Issues: Spokane Tribe's Additional Compensation Claim For The Grand Coulee Dam” is written to the US Senate’s Committee on Indian Affairs outlining the effects of the Grand Coulee Dam on the Colville and Spokane tribes. This would be a great case study to look into to learn about indigenous communities that were affected. As a proposal for gaining monetary compensation, it goes in depth about the issues they faced over the past few decades, with examples and stories to grow my knowledge of affected communities.

“Ubiquitous Increases in Flood Magnitude in the Columbia River Basin under Climate Change” is a study that uses simulations to prove an increase in flood risk because of climate change, especially in the Pacific Northwest. It talks about how current infrastructure set up for flood control in the past will not be sufficient in the future with climate change increasing risk of flooding (Ubiquitous Increases in Flood…, 2021). It also describes short comings in the Columbia River Treaty and how renegotiation is necessary for accounting for the increase in flood risk throughout the region, due to climate change (Ubiquitous Increases in Flood…, 2021). Diving into this reading will provide more background on flood risk and the intense effect of climate change on flood risk in the CRB.

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