Integrative Assessment of Bioenergy Production on the Yakama Reservation and Implications for the Intermountain West

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Introduction

Over half of US states have enacted renewable portfolio standards that specify the fraction of energy a utility must provide from renewable sources[1]. Biomass-based electric power production has outstanding attributes for meeting renewable standards, can be extremely efficient when integrated with industrial and commercial heating needs, and holds great promise for electrified transportation[2,3]. Many studies have evaluated biomass inventory at the state and national scales,[4] but these miss important details at the landscape-scale, where decisions about the biomass collection scheme impacts facility size, costs, environmental and social implications.

Case Study: Yakama Nation

The Confederated Tribes and Bands of the Yakama Nation occupy 1.2 million acres of forest, range and riparian areas in Washington State[5]. The 1855 Treaty of the Yakama ceded 11.5 million acres in return for sovereign rights on the reservation (see map). The Yakama people retain traditional-use rights throughout their ceded lands and broad forest stewardship rights dictated by the Tribal Forest Protection Act[6]. Our landscape-scale study has implications for the Intermountain West, owing to broadly similar patterns of climate, fire, land ownership and restoration needs.

Study Objectives

The Yakama Nation is interested in developing a 15 MW renewable biomass co-generation (heat and power) facility. Our objective is to estimate the sustainable biomass supply and examine the landscape-scale impacts on:

- Air Quality
- Invasive Plant Management
- Land Ownership

Methods:

Interdisciplinary Approach

Team participants included students from engineering and forest resources, several Yakama Enterprises (Power, Forest Products, Natural Resources, Tribal Council) and Grant County PUD. This interdisciplinary approach ensured an integrative assessment of techno-economic, environmental, and community impacts.

Learning about the land: students and Yakama tribal members on Signal Peak.

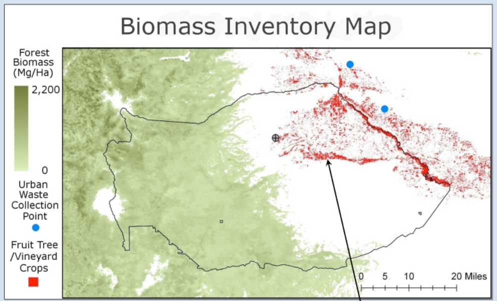
Analysis

Spatially explicit models were developed for the reservation and surrounding areas using ArcGIS and public datasets provided by the USDA, landsat image analysis, and Washington Department of Ecology. Transportation costs included details of road quality, speed, and distance. Aerial photos were provided by NAIP.

Thermophysical and chemical data were acquired experimentally for biomass sources that were unavailable in the literature.

Results and Discussion

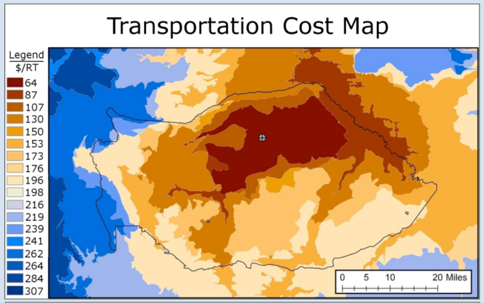
The Yakama co-gen facility will require about 130,000 bone dry tons (BDT) per year of biomass to supply a 15 MW plant. Our analysis shows this level of biomass is readily available from sawmill residues, forest residues, agriculture residues, waste wood, and invasive plant removal residues. Currently, forest, agricultural, and invasive residues are piled and burned at substantial expense and air quality impact.



Three major sources of biomass are illustrated above. The agriculture biomass are seasonal trimmings from fruit trees and vineyards. Urban waste is collected at specific locations. The forest supply was estimated using previous literature[8]. Facility location shown in grey

Biomass Costs

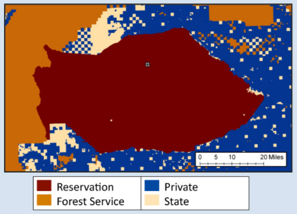
Transportation costs are critical for the overall viability of a biomass fuel source[7]. Our spatial map of the transportation costs uses specific road information to compute the travel time and distance to each point from the biomass plant site. The roads are categorized into four types, each with a corresponding speed: (i) dirt forest roads, 5 mph; (ii) gravel forest roads, 25 mph; (iii) paved roads, 45 mph; (iv) interstate highways, 60 mph. In addition to transportation costs, harvesting costs and loading/unloading costs influence the final delivered cost of the biomass. These costs are highly dependent on the biomass type.



The costs shown above represent the round trip cost of a truck to and from the biomass plant. The cost is calculated using an ArcGIS transportation model to calculate time of travel and distance traveled. Facility location shown in grey.

Land Ownership

Land ownership has far reaching implications for biomass supply and cost at the landscape-scale. Land ownership is highly fragmented throughout the Intermountain West; our case study illustrates this fact. The Land ownership map shown here demonstrates that large quantities of low cost biomass reside off-reservation, making them less reliable for inclusion in the biomass supply curve.



Invasive Management

Russian olive is the predominate woody invasive plant in this case study (see right). It grows in riparian areas, and is actively cut, piled, and burned as part of the ecosystem restoration efforts on the Reservation. Although a minor source of biomass, russian olive is found in low cost regions of the transportation cost map and its use in the biomass facility can subsidize additional restoration work.

Conclusions and Implications

This spatially explicit landscape-scale analysis has linked energy development, ecosystem restoration, air quality, and other community benefits by employing the interdisciplinary resource management approach of the Yakama Nation. We show that fragmented land ownership increases the cost and decreases the reliable supply of biomass, even for tribes that have treaty and legal rights beyond the reservation boundary. Development of this facility can subsidize ecosystem restoration work and improve air quality by creating a market for residues that are normally pile burned. Though not discussed, we estimate this facility will provide about 75 new tribal jobs and result in significant forest health benefits from thinning overstocked lands. Landscape-scale bioenergy issues addressed here for the Yakama Nation case study are found throughout the Intermountain West.

References:

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