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Snohomish County Public Utility District No. 1— Geothermal Energy Exploration in the North Cascade Region, Washington State

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ABSTRACT

Snohomish County PUD No. 1 is the second largest publicly owned utility in the Pacific Northwest and the twelfth largest in the nation in terms of customers served. Snohomish PUD (the District) has a rapidly growing service load and an obligation to meet the Washington State renewable portfolio standard requirements. The District believes that geothermal energy development in the region is of substantial importance to meeting these challenges.

While little to no geothermal exploration has occurred in the northern Cascade mountain range, it has long been recognized as a region of high potential -- the District's territory encompasses a wide swath of this area. The District has recently worked with Black Mountain Technology to conduct a preliminary assessment of geothermal potential in/near Snohomish County. The results of the assessment are favorable and warrant continued activities to pursue both hydrothermal and enhanced geothermal system exploration and development.

Introduction

Snohomish County Public Utility District No. 1 (the District) is the second largest publicly owned utility in the Pacific Northwest and the twelfth largest in the nation in terms of customers served. The District is a municipal corporation of the state of Washington, formed by a majority vote of the people in 1936 for the purpose of providing electric and/or water utility service. The District began providing electric service in 1949 and currently serves an area of 5,700 square kilometers, encompassing all of Snohomish County and Camano Island. The District's service territory is growing rapidly, with nearly 8,000 new connections per year and a resulting annual load increase of 15 to 20 average megawatts (aMW).

In November 2006, Washington State enacted a Renewable Portfolio Standard (RPS) requiring large utilities, including the District, to obtain 15 percent of their electricity from new renewable resources by 2020, as well as to undertake all cost-effective conservation. As reflected in Figure 1, The District currently receives more than 80 percent of its energy from traditional hydropower resources, which under Washington State RPS rules will not count towards the 15 percent RPS requirement.

The District estimates that even with a robust conservation program it will still need to acquire approximately 140 average MW of new renewable energy resources by 2020 to meet both its load growth and RPS requirements.

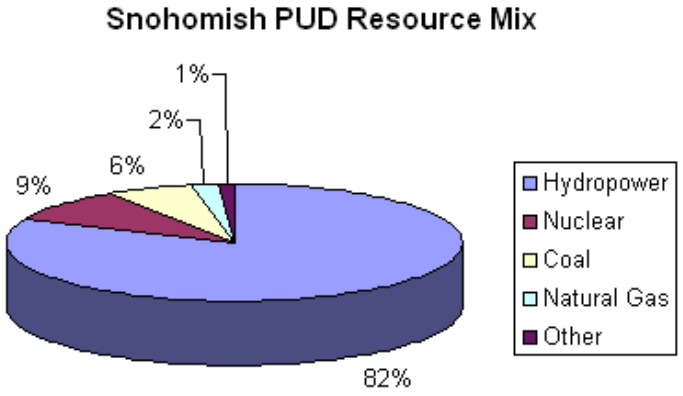

Figure 1. Snohomish PUD Resource Mix.

While wind energy will clearly contribute significantly to achieving this objective, wind faces a number of constraints (intermittency, integration, transmission, competition for resources, siting challenges, etc.) which will likely limit its contribution.

The District believes that meeting its energy challenge will require a richly diversified portfolio of conservation initiatives and renewable energy resources, of which both hydrothermal and Enhanced Geothermal Systems (EGS) have the potential to contribute substantially. Additionally, the District believes that the Cascade Region represents a unique and important opportu-

nity to both advance geothermal development in a new area of the country, as well as to facilitate EGS technology development in general.

Geothermal Potential Assessment

Snohomish County, shown in Figure 2, encompasses a broad swath of the North Cascade Mountain Range including the Glacier Peak volcanic region and numerous hot/mineral springs. The Glacier Peak region has long been recognized as an area of significant potential/interest, but no comprehensive geothermal exploration had ever been conducted.

The District has recently completed a preliminary assessment of potential geothermal resources in the region conducted by a team from Black Mountain Technology led by Ms. Susan Petty. The results of this study are favorable and warrant progressing to more detailed resource evaluation, definition, and assessment. Ms. Petty and the District particularly believe that the opportunity for pursuing enhanced geothermal energy development in the region would have important and far-reaching benefits for the overall development of EGS in the United States. While EGS activities will clearly occur in the Basin and Range region, the diverse learning and experience that can be gained from EGS development work in the distinctly different Cascade region will provide immense value and benefits, while simultaneously opening up a new and important region of the country to significant geothermal development.

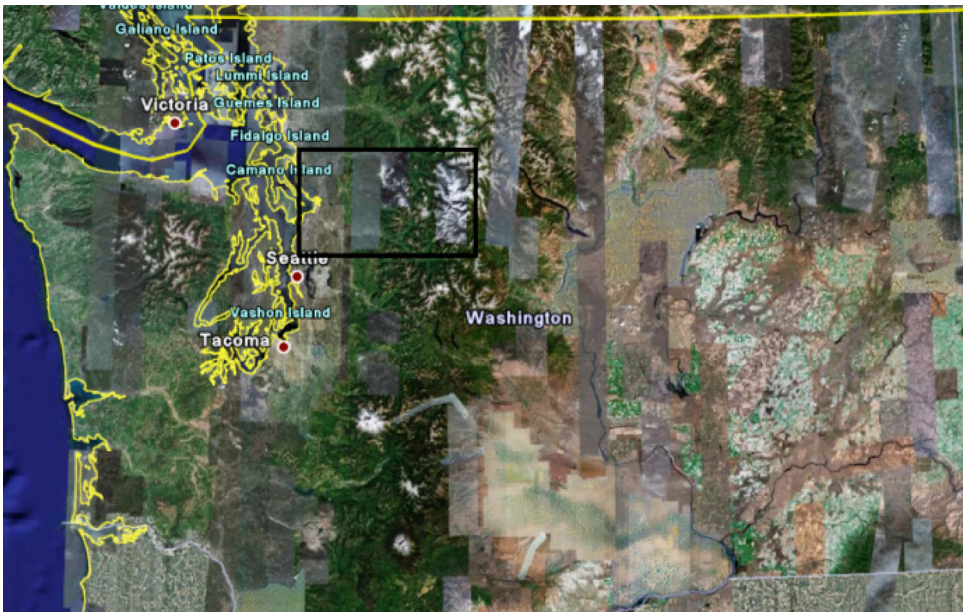

Figure 2. Snohomish County, Washington State.

To support the preliminary assessment Black Mountain Technology utilized a geothermal favorability mapping tool, using data available from existing sources and newly collected information. This tool was used to assess both the size of the geothermal resource and to associate that resource with estimated costs to develop. This assessment was conducted for both hydrothermal and EGS potential.

To support this effort, the team collected as much data as possible relevant to the geothermal resource in Snohomish County. Geology, geophysics, tectonic stress information, seismic data, temperature data from wells and springs, geochemistry, terrain and accessibility data and land use information were all reviewed for the study. A major block of data was contained on tapes developed by the Washington State Department of Natural Resources for the Bonneville Power Administration (BPA) study of the geothermal resources of the Pacific Northwest conducted by Bloomquist et al. (1985) and updated for another assessment done in 1995. This data was transferred to a modern, digital GIS database to facilitate the analysis. New data from geochemical analysis of water samples from hot, warm and cold springs and water wells in Snohomish County were included in the study. Samples for analysis of helium isotopes were also taken.

A geographic information system method was applied that combines diverse data from various sites. Modeling the county as a regular grid of locations, the study scored each location for several attributes that influence geothermal potential. A total score, given by a weighted sum of the attribute scores, indicates the favorability of a location for geothermal development. Displaying the favorability scores on a color-coded map allowed for quick visual identification of favorable regions.

Review of Existing Data

While there is a wealth of existing geothermal data from wells drilled for temperature and for exploration in the Oregon Cascades, including a study of temperature gradients and geology at Mt. Hood, only a small amount of data exists for the Washington Cascades. The single previous study used fairly shallow temperature gradient holes to look at the geothermal resource in the Indian Heaven area near Mt. St. Helens. As a result, the data available to determine the feasibility of geothermal energy production in Snohomish County was sparse. However, it is possible to look at other areas of the world with similar geology and infer the potential for Snohomish County from their experience.

During the period of high oil prices in the early 1980s, a large body of data was collected to better understand the geothermal resource in the US and around the world. Temperature gradient holes were drilled using state and federal funds to identify thermal anomalies associated with local upwelling of hot water or areas of high heat flow. Existing data used for the Snohomish PUD study came from the following sources:

- BPA sponsored study of geothermal potential of the Pacific Northwest (Bloomquist, et al, 1985) and subsequent study of direct use projects in 1995. (Schuster and Bloomquist, 1995).

- MIT study of the Future of Geothermal Energy (Tester, 2007) providing temperature-with-depth maps developed with Southern Methodist University.
- State of Washington Department of Natural Resources geologic maps, land status, landside and earth stability map and digital terrain model.
- Washington State Geospatial Data Archive providing additional topography, older faulting and bedrock geology.
- Geomorphology and slope information as well as some of the transmission line mapping data from University of Washington geomorphology department.
- Transmission line shape file drawn from topographic maps (DRGs) of Snohomish County and a geo-referenced map of transmission routes in Snohomish County.
- Southern Methodist University database of geothermal gradient and heat flow with updates as of September 2007.
- Fault mapping from USGS Earthquake Hazards Program mapping of Quaternary faults.
- Seismicity data from the Advanced National Seismic System catalog of historic earthquake data.
- Gravity data from Pan American Center for Earth and Environmental Sciences (PACES) at University of Texas–El Paso.

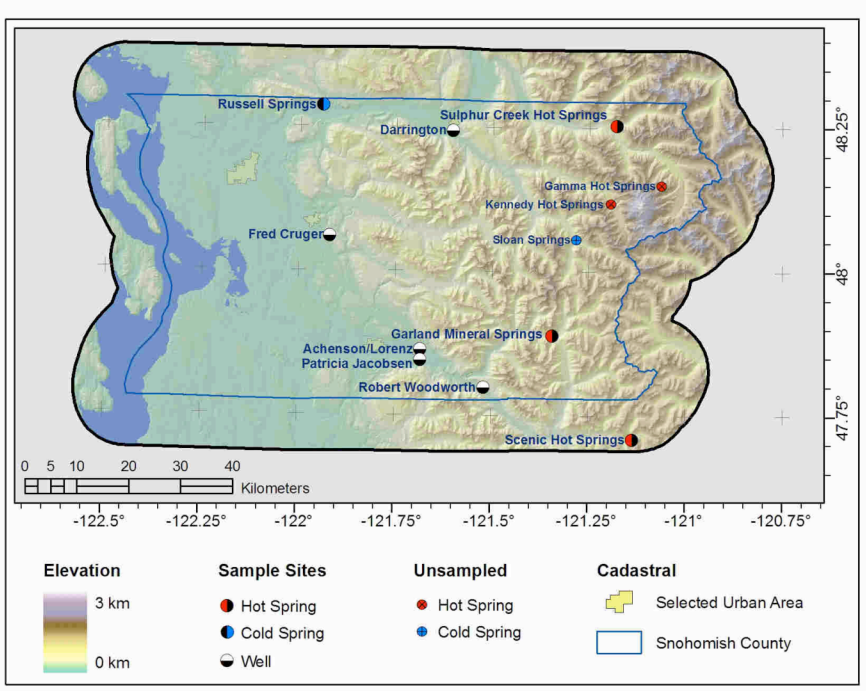

Figure 3. Snohomish County sampling sites and spring locations.

Collection of New Data

New data collected for this project consisted of temperature measurements and water and gas samples taken from wells and springs in the project area. Wells that had been drilled into the basement rock were selected from the Department of Natural Resources database of well information at http://apps.ecy.wa.gov/welllog. Helium isotope analysis was included for selected samples. Helium isotope analysis has been studied for a number of years as a potential diagnostic for the presence of rocks at depth that may either be hot or have a high radioactive element content that could be a heat source. Recently, Kennedy and Soest (2007) presented a study showing how the isotope ratios varied systematically with favorable tectonics and deep rock permeability.

Figure 3 shows the locations where measurements were made and samples were gathered. Also shown are two springs (Sloan Springs and Gamma Hot Springs) that could not be accessed because of weather. Also shown is Kennedy Hot Springs, which is no longer accessible as the result of an avalanche.

Conclusion

The study resulted in the identification of several specific areas in and around Snohomish County which warrant additional exploration and assessment for both hydrothermal and EGS potential. The District is currently developing its strategic plans for continued activities and identifying potential exploration partners and funding for this next phase. It is anticipated that the next phase of exploration will include the identification of specific locations for exploratory well drilling, followed by the drilling and assessment of a small number of exploration wells.

The District's vision is that through this exploration it can not only develop needed renewable energy resources for its own portfolio, but will simultaneously further the progress of geothermal energy advancement and technical development in the United States.