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Economic Feasibility of Solar Photovoltaic Irrigation System Use in Great Basin Forage Production

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Introduction

The Great Basin is primarily located in Nevada, western Utah, and small sections of southern Oregon and Idaho. The Great Basin is noted for its arid conditions and high percentage of publically owned land. The potential for solar energy generation in the Great Basin is vast. In Utah for example, a recent report released by the Utah Renewable Energy Zone Task Force (Berry et al., 2009) estimates that Utah's potential for generating concentrating solar power (CSP) is approx. 826 Gigwatts (GW) spread across 16,500 potential sites and 6,300 square miles. The report states that CSP in Utah could generate over 1.5 million GW hours per year or equivalent to the electricity used by 150 million average households.

In Nevada the 250 days of annual average sunshine has led to its recognition as the U.S. leader in per capita solar energy production (Nevada Clean Energy Summit, n.d.). Nevada has the highest solar energy generation potential. For example, the Department of Energy (DOE) estimates 100 square miles of commercial solar development in Nevada could supply all U.S. electricity needs.

Solar energy applications in agriculture are numerous, but primary examples include space and water heating, greenhouse heating, crop and grain drying, as well as powering electric fencing, lighting and water pumping (irrigation systems). The use of solar energy to generate electricity for power is performed with the use of a solar photovoltaic (PV) system. Solar PV systems can be an efficient source of energy in rural areas, as PV systems have been shown to be more cost effective than installing new electrical lines and transformers (UCS, n.d.). Additionally, solar PV systems do not have moving parts or require fuel, making them more convenient to operate and maintain than traditional fuel based generators.

Due to the prevalence of cattle grazing and alfalfa hay production in the Great Basin, solar PV systems may be most useful in bringing water to cattle and pumping water for irrigated crop purposes, especially in remote areas. This fact sheet examines the potential economic feasibility of implementing solar PV systems for irrigation pumping in Great Basin forage production.

Solar PV systems use semiconducator technology to convert sunlight directly into electricity. They can be used in conjunction with the existing electricity grid through net metering and interconnections with the local utility. Solar PV systems can also provide electricity independent of the electricity grid, known as an “off-grid” system, with batteries typically providing the needed storage and backup for times when the sun is not shining. On-grid systems can also be equipped with batteries to provide electricity when the grid goes down. Photovoltaic systems come in a range of sizes and types and are commercially available. – Source: Utah Clean Energy

Feasibility of Solar System Use in Great Basin Forage Production

To evaluate the potential economic feasibility of using solar PV systems for irrigated forage production in the Great Basin we use the production cost and returns study for alfalfa production in Humboldt County, Nevada (Curtis et al., 2005) and the production cost and returns study for forage production in Eureka County, Nevada (Curtis and Riggs, 2007). Both areas consist of an average farm size of 500 acres, four pivots in forage production. The primary difference between the two areas is the production of cool season grasses in addition to alfalfa in Eureka County. As the published studies are several years old, the studies were updated to reflect conditions in 2010. The updated studies now constitute Scenario 1, production using standard power. The annual irrigation pumping cost in both areas is $45,000 per year.

For Scenario 2, use of a solar PV system for irrigation pumping, we include the investment in a solar PV system to run all four pivots. The cost of the initial PV system was based upon a 2009 study completed in Humboldt County by Sustainable Energy Solutions. The solar PV system for each pivot is $420,000 installed or $1,680,000 for the entire farm. This cost can be reduced by taking advantage of a 25% USDA REAP grant of $420,000 and a 30% tax credit of $378,000, resulting in a total initial investment of $882,000. The annual maintenance cost for the PV system is estimated at 0.893% of the initial cost (Oregon Office of Energy, n.d.) and the useful life of the PV system is estimated at 30 years (Utah Clean Energy, 2009). Keep in mind that the cost of the solar PV system implementation will vary with irrigation system requirements, such as well depth and pump and piping system productivity. The energy demands for each system may vary and hence the size of the PV system will also vary.

As shown in Table 1 (Humboldt County), Scenario 2 lowers the initial establishment cost of the alfalfa stand, decreases annual operating costs, but increases annual ownership costs. Annual farm net returns to production also increase from $1,395.17 to $5,449.10, or $10.90 per acre. A similar result is found in Table 2 for Eureka County, but the magnitude of decrease in establishment costs and increase in annual farm net returns is less than that of Humboldt County.

Table 1: Scenario Comparison for Forage Production in Humboldt County, Nevada

Scenario	Establishment Cost	Annual Operating Cost	Annual Ownership Cost	Annual Net Returns
1 - Standard Power	$ 80,004.46	$ 197,077.16	$ 101,527.68	$ 1,395.17
2 - Solar PV System	$ 76,457.26	$ 158,988.20	$ 135,562.70	$ 5,449.10

Table 2: Scenario Comparison for Forage Production in Eureka County, Nevada

Scenario	Establishment Cost	Annual Operating Cost	Annual Ownership Cost	Annual Net Returns
1 - Standard Power	$ 101,933.73	$ 288,118.24	$ 111,573.26	$ 308.50
2 - Solar PV System	$ 98,386.54	$ 250,029.28	$ 145,405.59	$ 4,565.13

In the above analysis we assume stable energy costs for Scenario 1. However, it is more likely that energy costs will increase over the life of the solar PV system. If we increase the cost of irrigation pumping by 20%, annual farm net returns in Scenario 1 for Humboldt County fall to -$9,157.09, so the use of the solar PV system results in higher annual net returns of $14,607.08. If we conduct the same analysis for Eureka County, annual farm net returns in Scenario 1 fall to -$10,772.30 and hence the use of the solar PV system results in higher annual net returns of $15,337.43. Keep in mind that these results are based on point estimates and do not includes changes or variability in costs and revenues other than those related to irrigation pumping.

Conclusions

Based upon the assumptions used, the implementation of the solar PV irrigation system led to increased annual farm net returns in forage production both in Humboldt County and Eureka County. Forage producers facing increasing energy costs, large distances to existing lines and/or grids may find the implementation of solar PV irrigations systems a cost effective alternative. Information on determining PV system size and current state and national rebates and incentive programs can be found in the resources section below.

References

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Utah Clean Energy (2009). "Solar Photovoltaic Systems." Online at: http://utahcleanenergy.org/clean_energy_101/solar/solar_pv.

Resources

Vick, B. and R.N. Clark (2009). "Determining the Optimum Solar Water Pumping System for Domestic Use, Livestock Watering and Irrigation." Proceedings of the ASES National Solar Conference, Buffalo, New York, May 11-16.

Programs, rebates and incentives for renewable energy systems by state at http://www.dsireusa.org/.

USDA-Rural Development Rural Energy for American Program at http://www.rurdev.usda.gov/rbs/busp/9006loan.htm.

Utah Clean Energy at http://utahcleanenergy.org/clean_energy_101/solar/solar_pv.

Nevada State Office of Energy at http://energy.state.nv.us/.

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