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The Bad River Band of Lake Superior Chippewa Tribe
Solar Energy Assessment

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Resource Recycling Systems

Sustainable Systems for a Waste-Free Future

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INTRODUCTION & BACKGROUND

The Bad River Band of Lake Superior Chippewa Tribe has hired Short Eliot Hendrickson (SEH) to prepare an energy plan as part of the Tribe's Energy Efficiency and Conservation Block Grant Program. SEH has teamed with Resource Recycling Systems (RRS) to prepare this assessment of solar energy for the tribe. This assessment analyzes preliminary estimates of solar energy generation for the feasibility of operating a renewable energy system at various sites including the Bad River Casino, recycling center, daycare center, head start center and community center.

Solar energy is by far the Earth's most available energy source. Solar power is capable of providing many times the total current energy demand. But it is an intermittent energy source, meaning that it is not available at all times. However, it can be supplemented by thermal energy storage or another energy source, such as natural gas. The Bad River area located in Northern Wisconsin, does not offer the same solar potential as that in the southwestern United States. However, Germany houses a significant amount of the world's installed solar energy technologies and offers the similar solar potential as Alaska. In Figure 1, the red areas indicate a high solar potential while purple offers low potential. According to the National Renewable Energy Laboratory (NREL), the Bad River area would offer a moderate amount, which suggests that even Northern Wisconsin could benefit significantly from solar energy.

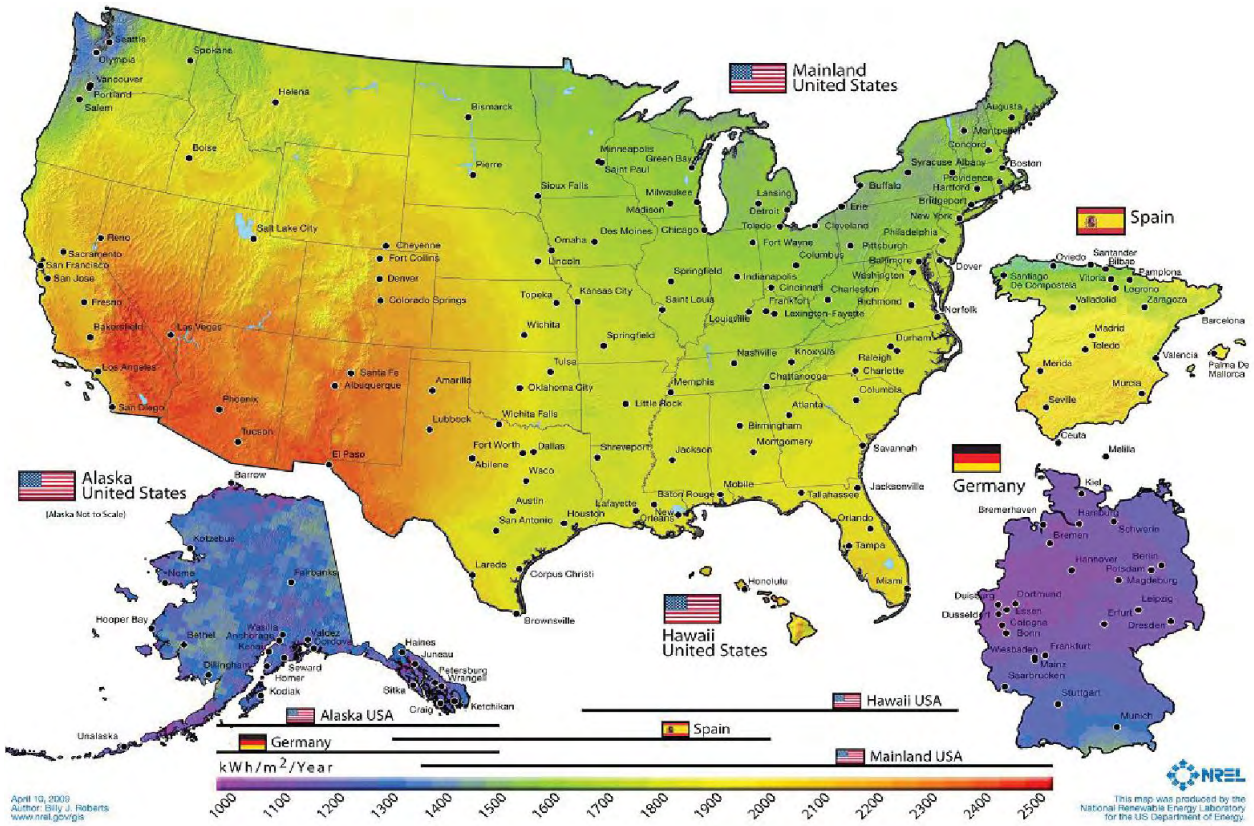

Figure 1 Insolation maps for the United States, Spain and Germany for comparison. Insolation is a measure of solar radiation energy received on a given surface area in a given time. It is commonly expressed as average irradiance in watts per square meter (W/m2) or kilowatt-hours per square meter per day(kW·h/(m2·day)) (or hours/day). In the case of photovoltaics it is commonly measured as kWh/(kWp·y) (kilowatt hours per year per kilowatt peak rating). Purple shows low insolation at 1000kWh/m2/year and red shows high insolation at 2500kWh/m2/year as shown in the bar legend at the bottom of the figure.

PHOTOVOLTAICS VS THERMAL

Solar thermal (heat) energy is often used for heating water used in homes and swimming pools and for heating the insides of buildings ("space heating"). Solar space heating systems can be classified as passive or active.

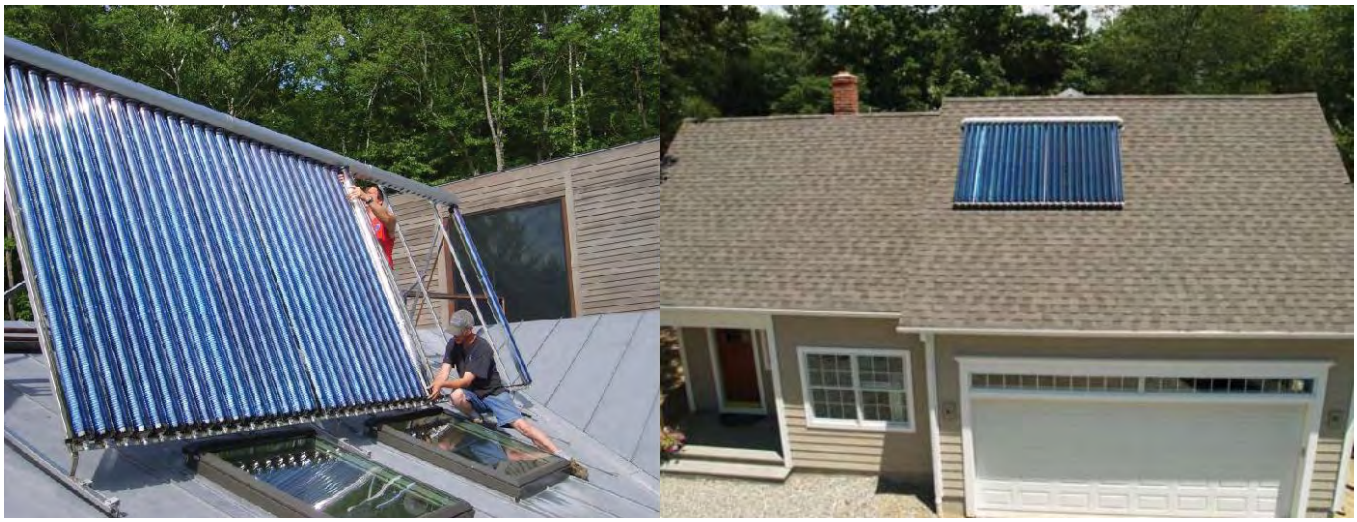

Figure 2 On the left, an Oventrop Solar Thermal system getting installed for commercial water heating. On the right, an American Solar Works solar thermal system installed in a residential area.

Passive space heating is what happens to your car on a hot summer day. The sun's rays heat up the inside of your car. In buildings, the air is circulated past a solar heat surface and through the building by convection (meaning that less dense warm air tends to rise while denser cool air moves downward).
No mechanical equipment is needed for passive solar heating.

Active heating systems require a collector to absorb and collect solar radiation. Fans or pumps are used to circulate the heated air or heat absorbing fluid. Active systems often include some type of energy storage system. In the case of Bad River's Casino and Community Center, active water heating systems may be very beneficial both economically and environmentally.

Solar energy can also be converted to electricity. Photovoltaic (PV devices) or "solar cells" change sunlight directly into electricity. Individual PV cells are grouped into panels and arrays of panels that can be used in a wide range of applications ranging from single small cells that charge calculator and watch batteries, to systems that power single homes, to large power plants.

Concentrating Solar Power Plants generate electricity by using the heat from solar thermal collectors to heat a fluid which produces steam that is used to power the generator. Out of the 11 known concentrating solar power generating units operating in the United States at the end of 2008, nine of these are in California, one in Arizona, and one in Nevada.

Benefits of solar energy:

- Eliminates fuel costs and almost all operating costs
- Reduce exposure to fluctuating natural gas and electricity prices
- Solar energy systems do not produce air pollutants or carbon-dioxide

Challenges of solar energy:

- Performance varies depending on location, time of day, time of year, and weather conditions.

- High upfront capital cost
- Longer payback times

SOLAR PHOTOVOLTAICS

Sunlight is composed of photons, or particles of solar energy. When photons strike a photovoltaic cell, they may be able to provide energy to generate electricity. When enough sunlight (energy) is absorbed by the material (a semiconductor), electrons are dislodged from the material's atoms. Special treatment of the material surface during manufacturing makes the front surface of the cell more receptive to free electrons, so the electrons naturally migrate to the surface.

Figure 3 On the left, a commercial PV system installed as a ground-mounted facility. On the right, a residential PV system installed matching the slope of the roof.

The performance of a photovoltaic array is dependent upon sunlight. Climate conditions (such as clouds or fog) have a significant effect on the amount of solar energy received by a photovoltaic array and, in turn, its performance. The simplest photovoltaic systems power many of the small calculators and wrist watches used every day. More complicated systems provide electricity to pump water, power communications equipment, and even provide electricity for homes and businesses.

FEDERAL, STATE AND LOCAL INCENTIVES

Although solar thermal and PV systems have the potential to reduce Bad River's exposure to natural gas price fluctuations, the technology would require a significant investment to make a noteworthy difference. Fortunately, the large capital costs involved could be mitigated using federal, state and local incentives and even private partnerships.

INCENTIVES FOR TRIBAL GOVERNMENT

The USDA offers the Rural Energy for American Program (REAP) Grants for renewable energy development assistance. The grants are awarded on a competitive basis covering up to 25% of total eligible project costs with a limit of $500,000 and are available for agricultural producers and small businesses (according to the Small Business Administration) in rural areas. The USDA also offers Rural Business Enterprise Grants (RBEG). These grants do not have a maximum level of grant funding but smaller projects have higher priority. The RBEG

program usually distributes grants between $10,000 and $500,000 and generally goes to rural public entities and rural private non-profit corporations.

The Tribal Energy Program Grant promotes tribal energy sufficiency, economic growth and employment on tribal lands through the development of renewable energy and energy efficiency technologies. The program provides financial assistance, technical assistance, education and training to tribes for the evaluation and development of renewable energy resources and energy efficiency measures. Unfortunately, this year's solicitation has passed its deadline but future opportunities remain likely. Grant size varies in each solicitation period.

The New Markets Tax Credit (NMTC) Program provides tax credit incentives to investors for equity investments in certified Community Development Entities, which invest in low-income communities. The credit equals 39% of the investment paid out (5% in each of the first three years, then 6% in the final four years, for a total of 39%) over seven years (more accurately, six years and one day of the seventh year) . A Community Development Entity must have a primary mission of investing in low-income communities and persons.[1]

Tribal governments may issue bonds for such projects. Holders of bonds would not have rights to participation in the management of the project entity, nor would they have an ownership interest in the profits of the project. These offer longer maturity dates than bank debt but pre-payment is often prohibited. Using Qualified Energy Conservation Bonds (QECB),[2] tribes are eligible to issue qualified energy conservation bonds if 100% of the available project proceeds are used for one or more qualified conservation purposes. The issuer repays the principal amount of the bonds plus a portion of the interest and the bondholder receives federal tax credits in lieu of the remaining interest. The 2010 HIRE Act also permits issuers of qualified energy conservation bonds to receive a cash payment from the federal government in lieu of a tax credit.

Tribal Economic Development Bonds remove the essential governmental function test and treats bonds as issued by a state. They expand the scope of renewable energy projects eligible for tax-exempt financing by a tribe. Currently the second tranche of allocations has passed but if the program receives more funding it could help greatly.

More conventional loans and debt might also be advantageous because Tribal governments could access tax exempt debt. Lenders will generally make loans at lower rates of interest than would otherwise be available. Organizations are permitted to issue tax-exempt debt if all of the proceeds are used in the exercise of an essential governmental function. There are a number of additional requirements and restrictions related to the issuance of tax-exempt debt that must be analyzed with respect to specific financing sources.

The USDA also offers a Business and Industry Guaranteed Loans (B & I). The percentage of guarantee, up to the maximum allowed, is a matter of negotiation between the lender and the Agency. The maximum percentage of guarantee is 80% and loans for equipment repayment will not exceed the useful life of the machinery and equipment purchased with loan funds or 15 years, whichever is less.

INCENTIVES FOR PRIVATE PARTNERSHIP

Some incentives remain unavailable to tribal governments; however, several strategies could make the incentives available to private and for-profit organizations available to a solar collector project on Tribal lands. These would require partnering with outside equity investors whom will often insist that the project entity be

[1] http://www.cdfifund.gov/what_we_do/programs_id.asp?programID=5
[2] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US51F&re=1&ee=1

organized under state law not tribal law. First, equity financing is possible where an arrangement with an outside group is made for partial facility ownership.

Many incentives require more private ownership and development. Investment Tax Credit (ITC), Section 48 IRS, is equal to 30% of expenditures, although solar pool-heating systems are *not* eligible. The entire amount of the ITC is available to the taxpayer in the year the energy property is placed in service. Private organizations interested in gaining the tax credit would be interested in a partnership under these conditions.

Under the Modified Accelerated Cost-Recovery System (MACRS), a grant for the value of the ITC may be available if the project begins construction before December 31, 2011. This system also allows for a bonus depreciation of 100% for projects beginning construction before December 31, 2011 or 50% before December 31, 2012.

The USDA's REAP program expands to both loan guarantees and grants for small, rural businesses. A partnership with one of these organizations would allow access to grants of up to 25% and loan guarantees of up to 75% of proposed expenditures.

Tribal-private partnerships could be done in a few different ways. In the 'Partnership-flip' structure, the project is owned by a partnership, limited partnership, or limited liability company for federal income tax purposes. Tax credit investor is initially allocated substantially all of the profits, losses and tax credits generated by the partnership until the tax credit investor achieves a negotiated return on its investment. Once a negotiated return is achieved, the ownership interests automatically flip and the developer and other equity investors are allocated substantially all of the profits and losses generated. However, the tribal portion of the property will be treated as tax-exempt use property subject to longer depreciation periods; equal to the largest ownership interest the tax-exempt partner will have in the partnership's items of income or gain during the life of the partnership. Bad River would be able to avoid tax-exempt use property treatment and limitations on ITCs by using a taxable corporate subsidiary for purposes of holding its interest in the partnership and making an election with respect to such corporation under IRC § 168(h)(6)(F)

With the 'Sale-Leaseback' structure, where the tribal government (the developer) sells the project to the tax credit investor, and the tax credit investor immediately leases the project back to the developer. If the project is leased to a tax exempt party then it will not qualify for ITCs and the leased property will be treated as tax-exempt use property subject to longer depreciation periods. Again, if Bad River formed taxable corporate subsidiary to participate in the sale-leaseback transaction the ITC would be become available to the third party. However, there is a higher tax burden using a taxable corporate subsidiary, and the application of these rules with respect to a corporate subsidiary of a tribe is not entirely clear at this time.

Finally in a 3rd party structure, the Tribe participates in the development, but sometime prior to service, the tribe transfers ownership of its interest in the project to an unrelated party (project owner). The project owner then completes the development of the project and sells the energy (in the form of electricity or hot water) to the tribe. In order to profit from this arrangement, Bad River could include one of the following in the contract:

- Negotiate a payment to recoup its development costs plus a development fee upon transfer
- Lease tribal land or space to project owner
- Tribe provides services to the project owner
- PSA (purchase of power by tribe) at a lower rate than natural gas prices
- Tribe/related entity finance a portion of the project by making a loan to the project owner. Made on terms and conditions that will support treatment as debt for tax purposes. Allows the tribe to participate in the project during the tax credit and depreciation period through interest payments.

- Agreement giving the tribe the right to acquire the project from the project owner after a certain period of time or upon certain events. Generally, the right to acquire the project will only be exercisable after the tax credits and depreciation associated with the project have been utilized by the project owner and any applicable tax credit recapture periods have expired.

PHOTOVOLTAIC BACKGROUND

PHOTOVOLTAIC UTILITY

Bayfield Electric provides power to the Bad River tribe facilities. They are a subsidiary of Dairyland Power. Neither Bayfield Electric nor Dairyland Power are part of Wisconsin's Focus on Energy program. Therefore no incentives are available through that program. As of July 1, 2011 all commercial rebates from that program have been suspended.

Working with Bayfield Electric & Dairyland Power

- Dairyland Power would be the purchaser of the power produced from any project 40 kW or larger
- Requires that Dairyland receive delivery of all of the energy produced with the associated environmental attributes (e.g. RECs)
- In the event that the project owner should determine that they intend to keep the environmental attributes (e.g. RECs) and/or use any of the energy for their own use, Dairyland Power would purchase the excess energy produced by the project on a monthly basis at its then-current avoided energy cost.
    - Excess $0.03262 per kWh, currently.
- On-Peak $0.105 per kWh, off-Peak $0.054 per kWh
    - Could average out to about $0.09 cents per kWh

Net metering allows the meter to turn backwards and excess power produced and sent to the grid is credited on your bill. Net metering will not allow any revenue to be paid to the owner of the PV system, but can reduce the power bills for the year close to $0.00. For Bayfield Electric, there is a minimum site charge of $32.50 per month.

MOUNTING OPTIONS

ROOF

Residential and commercial systems can be mounted directly to a roof. Roofs are often ideal places since they may be less prone to shading. For residential installations, a flat or south sloping roof is most advantageous for solar production and will be critical for systems in the far north. Systems on flat roofs can either be mounted flat or at an angle. Optimal production for this latitude would occur at a 45° but usually to save money on installation and maximize the area and aesthetics a more modest angle of 15° is used. It does not significantly affect year round performance. For commercial systems, ballast systems are often used to avoid roof penetrations that compromise the roof membrane. A ballast system uses weight to hold the panels down even in high winds. They will either be mounted flat or a small angle up to about 10°.

GROUND

For ground mounted systems, the support structure is constructed specifically for the PV array and can be positioned for optimal exposure and angle. However, large treeless areas must be available to ensure no shading anytime of the year.

COVERED PARKING

One specific type of ground mount that is becoming more common is the covered parking structure. These arrays are mounted over parking lots and in addition to providing electricity for the neighboring building, they provide shade for the cars to park under.

PHOTOVOLTAIC SITES & ANALYSIS

For each of the sites, RRS sized a PV system based on energy required and calculated a payback and levelized cost of energy under a difference incentive scenarios. For each scenario, we sized the PV system based on the National Renewable Energy Labs PVWatts tool. According to the output, 1kW of PV will produce approximately 1200 kWh of electricity.

- For the Grant scenario it was assumed that the tribe applied for a federal DOE grant that covered 50% of the cost of the system.
- For the Tax Credit scenario it is assumed that the tribe would form a partnership with an outside firm who would own the system and either sell it back to the tribe or sell the power to the tribe at a fixed rate. Wisconsin does not allow 3rd party ownership of net-metered systems and so the Tax Credit Scenario only works for systems larger than 40kW where Dairyland would purchase the power.

The levelized cost of energy (LCOE) is a measure of the average energy price but takes into account the time value of money. In other words cheaper energy costs now are better than cheaper energy cost later.

All systems are assumed to cost $6.00/Watt (DC) installed. This is the average price for commercial installations in Wisconsin. Actual prices may be higher due to remoteness or could be lower if a well bundled system was put out for bid.

CASINO & LODGE

The main meter for the casino and lodge consumes almost 3MWh of electricity each year. This would require a large 2.5MW power plant to offset this electricity. In addition, the electricity for that meter is cheaper than any other, averaging $0.05 per kWh, half of most other meters. Due to the required size and low cost for energy, a PV system is not economical for this meter. Similarly the main building meter would require a 100kW system and energy is currently purchased at $0.08 per kWh.

However, one option for a PV system at the Casino and Lodge is to power the main sign. This system could be mounted as a covered parking canopy. There is sufficient space to mount the system. The panel on the sign was not viewed during the site visit due to difficulty accessing it.

Figure 4 Photo of the main sign for the casino and the parking lot which could house the covered parking structure for the PV panels.

Casino - Main Sign			
Annual KWh usage	39,648		
Potential system size	33.04	kW	
System capital cost	$ 198,240		
	Grant	**Tax Credit**	
Incentive	$ 99,120	$ -	
Depreciation		$ -	
Net cost	$ 99,120	$ -	
Payback	17		years
Current electricity bill	$3,965		annual
Expected bill in 2036	$10,163		annual
Current energy cost	$0.10		per kWh
Average energy cost	$0.17		per kWh
LCOE over 25 years	$0.16		per kWh
Average cost with PV	$ 0.10	$ -	per kWh
LCOE for PV system	$ 0.18	$ -	per kWh

HOUSING AUTHORITY CENTER

The Housing Authority Center is a recently constructed building that has good solar exposure. Similar to many of the buildings on the reservation, they are not oriented ideally for solar energy production. They are approximately 45° west of south and so reduce potential for building mounted PV. To overcome this, the ideal situation would be to build a covered parking structure and orient the panels directly south. Otherwise there will be a 10- 20% drop in energy production for the system depending on the time of year. The array estimated in the table below would require about 5,000 sq. ft. if built as a covered parking structure. The roof area could hold an 8-10kW array.

Since the system is larger than 40kW, under the grant scenario it is still assumed to be net-metered, but under the tax credit scenario the power is assumed to be sold to the utility to offset the consumption. So although the tax credit scenario would require a lower investment, it will payback at a slower rate since the utility will only offer approximately $0.09 per kWh. This is true for the Community Center and Head Start Center as well.

Figure 5 Arial view of the Housing Authority Building and the large open roof space

Housing Authority Building			
Annual KWh usage	58,840		
Potential system size	49.03	kW	
System capital cost	$ 294,200		
	Grant	**Tax Credit**	
Incentive	$ 147,100	$ 88,260	
Depreciation		$ 97,364	
Net cost	$ 147,100	$ 108,576	
Payback	17	17	years
Current electricity bill	$5,296		annual
Expected bill in 2036	$13,574		annual
Current energy cost	$0.10		per kWh
Average energy cost	$0.17		per kWh
LCOE over 25 years	$0.15		per kWh
Average cost with PV	$ 0.10	$ 0.07	per kWh
LCOE for PV system	$ 0.18	$ 0.13	per kWh

RECYCLING CENTER

The recycling center is one building that is oriented ideally for PV with half of the roof facing almost directly south. The only concern is that the angle of the roof may not be steep enough to shed snow in the winter time. The panels could be mounted at a steeper angle to increase snow shedding. The recycling center is currently paying a higher cost for energy, averaging at $0.11 per kWh. It is likely that the 10kW array could fit on the roof. Since it is smaller than 40kW, the tax credit scenario is not available for this net-metered system.

Figure 6 Arial photo and site photo of the recycling center

Recycling Facility			
Annual KWh usage	13,100		
Potential system size	10.92	kW	
System capital cost	$ 65,500		
	Grant	**Tax Credit**	
Incentive	$ 32,750	$ -	
Depreciation		$ -	
Net cost	$ 32,750	$ -	
Payback	16		years
Current electricity bill	$1,441		annual
Expected bill in 2036	$3,694		annual
Current energy cost	$0.11		per kWh
Average energy cost	$0.18		per kWh
LCOE over 25 years	$0.15		per kWh
Average cost with PV	$ 0.10	$ -	per kWh
LCOE for PV system	$ 0.18	$ -	per kWh

DAYCARE CENTER

The daycare center does not have good southern exposure and it not recommended for a roof mounted PV array. The building is oriented almost completely north-south and will lose significant energy potential.

Figure 7 Arial photo and site visit photo of the Daycare Center

HEAD START CENTER

The Head Start Center has a large power consumption, but does not have significant usable roof space. The main roof could hold a 4-5kW PV array, assuming that it could be mounted over the roof vents without causing issue. In order to produce the same amount of energy that is consumed requires an array about 10 times bigger. This could be accomplished with a ground mounted or covered parking structure.

Figure 8 Arial photo and site photo of the main south facing roof area

Head Start			
Annual KWh usage	55,446		
Potential system size	46.21	kW	
System capital cost	$ 277,230		
	Grant	**Tax Credit**	
Incentive	$ 138,615	$ 83,169	
Depreciation		$ 91,748	
Net cost	$ 138,615	$ 102,313	
Payback	17	17	years
Current electricity bill	$4,990		annual
Expected bill in 2036	$12,791		annual
Current energy cost	$0.10		per kWh
Average energy cost	$0.17		per kWh
LCOE over 25 years	$0.16		per kWh
Average cost with PV	$ 0.10	$ 0.07	per kWh
LCOE for PV system	$ 0.18	$ 0.13	per kWh

COMMUNITY CENTER

The Tribal Community Center is a large consumer of energy and would require a large PV system to cover 100% of the electrical consumption. Based on the site visit, this system would need to be mounted on a covered parking structure. The roof of the community center would not provide enough usable south facing space for a decent size array and also looks to need replacing in the coming years. If the roof was replaced, the south facing area could likely hold about 8-10kW.

Figure 9 Photos of Community Center's south facing roof area and needed repairs

Community Center			
Annual KWh usage	170,279		
Potential system size	141.90	kW	
System capital cost	$ 851,395		
	Grant	**Tax Credit**	
Incentive	$ 425,698	$ 255,419	
Production Tax Credit		$ 14,463	
Depreciation		$ 281,764	
Net cost	$ 425,698	$ 299,749	
Payback	17	16	years
Current electricity bill	$15,325		annual
Expected bill in 2036	$24,649		annual
Current energy cost	$0.10		per kWh
Average energy cost	$0.13		per kWh
LCOE over 25 years	$0.16		per kWh
Average cost with PV	$ 0.10	$ 0.07	per kWh
LCOE for PV system	$ 0.18	$ 0.12	per kWh

CENTRAL SOLAR POWER PLANT

One potential plan to take steps toward energy independence for the tribe is to construct a large PV array to supply power to a number of facilities. In this option, the Tribe would continue to pay their electric bills as they currently do and would not be protected from cost increases. However, it would add a new revenue stream for the Tribe. Currently as listed above, the Utility, Dairyland Electric, would purchase the power at approximately $0.09 per kWh. Bringing in a tax credit investor to build a 1MW plant, including a 9% return for the investment could provide the tribe with approximately $1 million in revenue over the next 25 years. Here is a summary of a potential solar power plant project:

- Solar tax credit developer builds a 1MW power plant for approximately $6 million.
- The tribe would rent the land to the developer for approximately $20,000 per year for 7 years, 4-5 acres of land would be required.
- The developer would collect all tax benefits and energy sales for 7 years, including the Investment Tax Credit of 30%, Accelerated and Bonus Depreciation and New Market Tax Credits.
- After 7 years, the tribe would purchase the system for $1.1 million giving the tax credit investor a 9% return on their annual investment.
- For the remainder of the life of the power plant (at least 18 more years), the tribe would collect revenue for the sale of the electricity and pay the loan back for the purchase of the system. The tribe would have a revenue stream of $30,000 to $60,000 depending on the escalation of the power purchase agreement with the utility. After 23 years, the tribe would not have any payments and would receive a revenue stream of over $150,000 per year.

There are numerous hurdles to overcome to make this idea a reality. Next steps to explore this option are included in the Recommendations and Next Steps section.

SOLAR THERMAL BACKGROUND

ENERGY SAVINGS

For solar thermal water heating systems, the energy savings comes with avoiding use of natural gas for water heating. A natural gas boiler offers up to 85% efficiency while solar thermal water heating offers efficiencies up to 90% and does not require any fuel. The amount of the energy savings brought by a solar thermal system depends highly on the size and technology of the system installed. The technology involved can make a significant difference in price and size if a certain percentage of offset is to be attained.

During the summer months all technologies could perform easily because the solar thermal device would not need to overcome a significant temperature difference between the atmospheric temperature and the desired heated water temperature. Unfortunately, the winter months will require some help from a backup natural gas or electric water heater system. However, some collectors perform better than others during these colder months offsetting more natural gas and thus providing more financial savings over time.

MOUNTING OPTIONS: ROOF, GROUND, COVER PARKING

Similar to photovoltaic equipment mounting, solar thermal collectors simply require placement with clear line-of-sight to the sun for a majority of the day. Mounting on roofs allows for less disruption from trees and other buildings, adds security to the equipment and allows more direct access to the building's water infrastructure. Ground mounted collectors could also work but have the disadvantage of requiring water pipes to be exposed to ambient air or ground temperatures which are lower than ambient indoor temperatures of most occupied building spaces. The exposure would lower the system's efficiency and thus provide lower savings and longer payback periods. These issues would also arise given a covered parking installation, although both provide relatively easier maintenance since they would not obstruct regular maintenance and checks as with a roof mounted system.

SOLAR THERMAL SITES & ANALYSIS

The main site that could benefit from a solar thermal system is the casino with their high water usage for the hotel and swimming pool.

CASINO

HEATED WATER USAGE

The Bad River Casino currently uses approximately 47,850 hundred cubic feet (ccf) of natural gas to heat water every year, which relates to over $50,000 annually. The amount of natural gas usage that could be replaced by a solar thermal collector array varies in both the size of the system and the efficiency of the type of collector. Over the year, the best performance for any system will be in the summer and during the winter some help from a conventional water heater will be needed. Figure 10 shows the performance over a year for three different brands. Any brand could be sized to produce the desired amount of heated water.

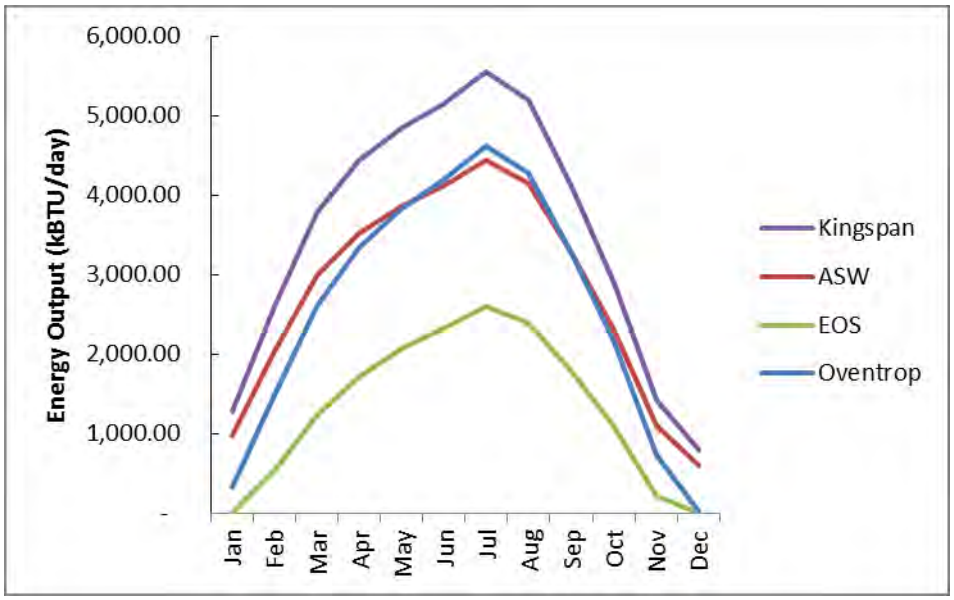

Figure 10 Energy production of different solar collector system performance throughout the year.

THERMAL ARRAY SIZES

In fact to get the small general performance levels some less efficient systems would need to be over twice the size. For example to gain 100% replacement over eight months in a year a Kingspan collector would require about 5000 gross square feet (system size, not including actual placement, while an EOS collector may require up to 13,300 gross square feet). With average installed pricing in the Wisconsin commercial sites at $90 per square feet, the efficiency of the collector becomes a significant issue with regards to capital investment.

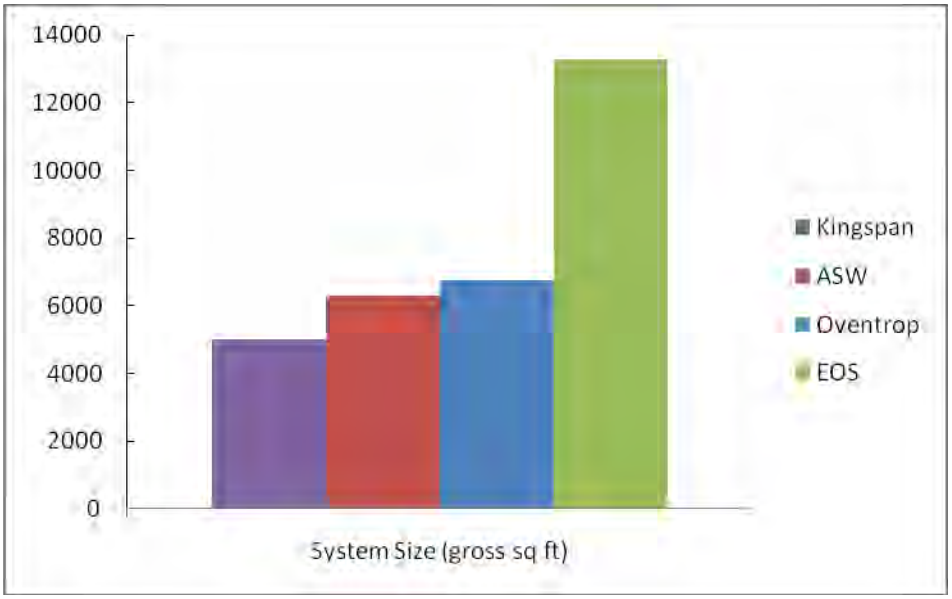

Figure 11 To gain the same natural gas replacement in a year a Kingspan collector would require substantially less space than an EOS collector.

PAYBACK & FINANCING

Payback periods for solar thermal collectors, given some of the incentives mentioned above, incentives could range between 6 and 18 years depending on efficiency and capital costs. Figure 12 depicts the payback period path from construction (year 0) to the end of its projected life (year 25). The incentives can be seen on the left showing a faster path for the first two years. The ITC and Bonus Depreciation periods are shown given a Tribal-private partnership for the first two years after which, Bad River would assume ownership of the system.

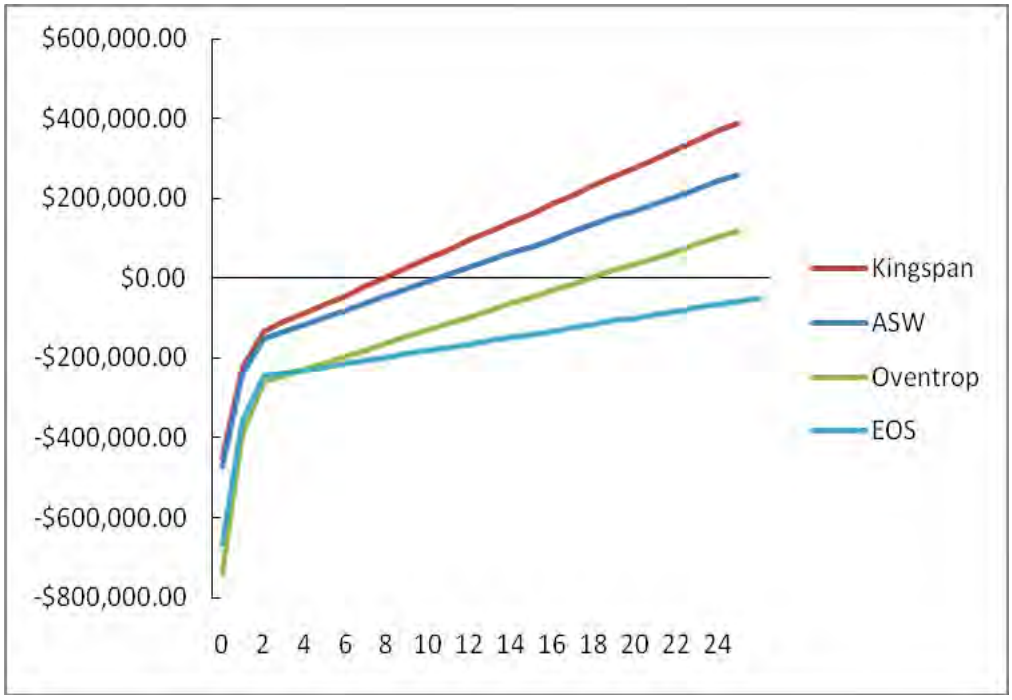

Figure 12 Payback periods for solar collectors can range from 6 to over 18 years depending on the efficiency and price of the system.

The chart below summarizes two options for the solar thermal system. The grant option assumes that the tribe purchases the system and receives a grant to cover 50% of the capital costs of approximately $450,000. The payback comes to about 11 years assuming an annual escalation of 4% in energy costs. The system would cover about 50% of the total natural gas bill over the life of 25 years. If the tribe was able to get a 15 year low interest loan to cover the cost of the system, there would be immediate savings of up to $5,000 per year. This savings grows each year if the price of natural gas increases.

The tax incentive option assumes that the tribe brings in a tax credit investor to own the system for the first seven years. After that the tribe would purchase the system for between $100,000 and $200,000 depending on the deal with the tax credit investor. Assuming a low interest loan or clean energy bond for the tribe's portion of the equipment, the tribe could save $10,000 immediately each year which would increase as natural gas prices increases.

Casino - Hot Water			
Annual Therms usage	13,072		
Potential system size	5,000 sq ft		
System capital cost	$ 450,000		
	Grant	**Tax Credit**	
Incentive	$ 225,000	$ 135,000	
Depreciation		$ 212,750	
Net cost	$ 225,000	$ 102,250	
Payback	11	6	years
Current natural gas bill	$52,245		annual
Expected bill in 2036	$139,277		annual
Current energy cost	$1.87		per Therm
Average energy cost	$3.24		per Therm
LCOE over 25 years	$2.44		per Therm
Average cost with ST	$0.68	$0.31	per Therm
LCOE for ST system	$1.23	$0.56	per Therm

Based on the site visit there are three areas on the roof that could likely hold 5,000 – 7,000 square feet of solar thermal panels total. The boiler room did not have significant extra space, but could be reconfigured to accommodate the new solar thermal equipment.

Figure 13 Arial photo and norther portion of the casino roof with approximately 1,500 square feet of usable space

Figure 14 Southern portion of the Casino roof (left) with approximately 3,000 – 4,000 square feet of usable space and Middle portion of the casino roof (right) with approximately 2,000 – 3,000 square feet of usable space

Figure 15 Boiler room area that would need to be re-configured to allow space for solar thermal equipment

RECOMMENDATIONS & NEXT STEPS

For solar PV systems, RRS has the following recommendations:

- In general covered parking structures or ground mounted arrays will provide better direct southern exposure, and allow for steeper angles to shed snow. Ground mounted arrays, if they can be located to eliminate tree shading would allow for the snow to be cleaned off safely in the winter time.
- A 5-10kW array could be done as a demonstration project near the Community Center, Head Start Center and Daycare that would be highly visible and reduce energy costs for one of those buildings.
- Due to the lack of state incentives with Bayfield Electric, the paybacks are longer than would be seen in other parts of the state. Encourage the local utility to join the Wisconsin Focus on Energy Program.

The tribe has two strong options to move ahead with solar energy:

- Solar Thermal for the Casino
- 1MW Central Powerplant

For both of these projects, RRS recommends the following steps. These are critical for the PV powerplant and would help the solar thermal project as well.

1. Determine if the tribe can apply for further allocation of the New Market Tax Credits after the recent housing/geothermal project. NMTCs are critical to the PV powerplant option and would further reduce costs of the solar thermal project.
2. Determine the Tribe's ability and desire to apply for Qualified Energy Conservation Bonds (QECBs) for both of these projects. This could give the tribe very low interest (2.5%) and longer terms (16 years) to increase immediate savings.
3. Determine other available capital funds that could help finance either project.
4. Meet with potential developers to determine if changes to tribal law are needed to increase developers' confidence in making large investments.

SOLAR THERMAL FOR THE CASINO

Next steps for the solar thermal would include:

1. Request quotes from installers for the capital cost for the system, focus on high efficiency brands such as Oventrop, ASW and Kingspan.
2. Request quotes from potential owner-operators such as Resource Solar in Madison that could structure a 3rd Party financing deal.
3. The Tribe could also do a formal Request For Proposals (RFP) process to solicit a wide variety of pricing and financing structures.

1MW CENTRAL POWERPLANT

Next steps for the central powerplant include:

1. Determine if there are any 4-5 acre sites that would be available, have good solar exposure and access to powerlines.
2. Meet with potential solar developers to discuss issues such as snow shedding, winter operation and maintenance and deal structure.