Gwichyaa Zhee Gwich'in Tribal Government

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Fort Yukon, Alaska DOE Implementation Grant Gwich'in Solar and Energy Efficiency in the Arctic Final Report

A Project to Increase Sustainability and Reduce Energy Costs in Fort Yukon, Alaska

Project Location: Fort Yukon, AK 99740

Duration of Project: July 1st 2014 – Dec 31st 2016

Tribe submitting report: Gwichyaa Zhee Gwich'in Tribal Government

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Executive Summary

Gwichyaa Zhee Gwich'in Tribal Government (GZGTG) applied for funding in 2014 under the U.S. Department of Energy Office of Indian Energy Deployment of Clean Energy on Tribal Lands funding opportunity. They were awarded 50% of the project costs for the construction of an 18kW, grid-tied solar PV array on the fort Yukon Tribal Hall, the construction of a 3kW solar PV array on the tribally owned greenhouse, the replacement of inefficient florescent lighting fixtures in the tribal hall to higher efficiency LED lights and the addition of blow in cellulose insulation to the attic of the tribal hall to assist with heat retention. Total DOE Funding for the project was $124,735. Total GZGTG funding for the project was $133,321 for a total project cost of $258,056. The Project was completed with 100% local labor on the tribal hall solar PV installation, the LED lighting retrofit and the insulation on the tribal hall. Based on the results at the tribal hall/office, the tribe also used their own tribal funding to retrofit the lighting in the community hall from florescent to LED lights. The resulting project was completed by the end of Sept 2016 and results have shown a decrease in fuel used at the tribal hall/office of **35%** and a decrease in electric costs at the tribal hall of **68%.** The total energy costs before the project were approximately $28,000 a year and the energy equivalent of 385 MMBTU/yr. After the project the total energy costs decreased to $11,200/yr. and an energy equivalent of only 242 MMBTU. This represents an overall decrease in energy use of 38%. All in all the tribe and the community regard this project as a huge success!

Figure 1. Gwichyaa Zhee Gwich'in Tribal government Employees working on the construction of the Fort Yukon 18kW Solar PV array on the Fort Yukon Tribal Hall in May of 2015. from top left down and to the right Jacob wright, Clayton Tackett and Gerald Alexander

Project Overview

Fort Yukon, Alaska marks the farthest north point of the Yukon River, the 4th largest River basin in North America and the longest un-inhibited run of Salmon left anywhere on the continent. The community of Fort Yukon was originally settled as a fur trapping outpost in 1847 by the Hudson Bay Company though the Gwich'in people had come to the confluence of the Porcupine and Yukon Rivers to camp and fish for generations. Fort Yukon's extreme temperatures make living in the community a challenge. The hottest temperature ever recorded in the state was recorded in 1915 at 100 degrees F in Fort Yukon and until the 1970's the community also had the lowest record in the state at -78 F. Nearly each year temperature swings of 155F occur (-65 F to 90F are fairly common). These massive temperature swings and 16000 annual heating degree days, make the community a difficult place for energy independence. Tribal independence and self-sufficiency is paramount to the community's leadership as evidenced by their Mission Statement:

> "Exercise governmental authority to promote economic and social development, advocate and secure tribal rights, to secure tribal lands, to enhance educational opportunities and to protect traditional cultural values with a unified voice on behalf of tribal members"

Figure 2 Old view of the Gwichyaa Zhee Gwich'in Tribal Gov't main office building in the background with the community hall in the foreground. Note this is before a pre-scheduled paint job and before the solar PV panels were installed.

In 2013, the GZGTG with the support of the Yukon flats school district, the Council of Athabascan Tribal Governments (CATG) and other groups in town became interested in harnessing the abundant solar energy that falls across the Yukon Flats, which has very few clouds or precipitation during the summer months, for electrical generation.

The Gwichyaa Zhee Gwich'in Tribal Government reached out to the local tribal consortia for the interior the, Tanana Chiefs Conference (TCC), and their energy program. The TCC energy program staff met with GZGTG leadership, and completed evaluations of the different options available to the community. They also worked with GZGTG leadership to look at the resources available within the tribal government. A project that focused on

A. Energy Efficiency
B. Renewable Energy
C. Local Employment

was important to the community and the corresponding project titled Gwich'in Solar and Energy Efficiency in the Arctic was put together and completed between 2014 and 2015.

Figure 3. The above photo shows the old fiberglass insulation that was existing in the tribal hall, the photo to the right shows the new even layer of blow-in cellulose insulation that was installed as part of the project to reduce heat loss and reduce fuel costs

To tackle the most important item, energy efficiency, the tribe completed an energy audit of the building and identified the most cost effective measures are being increase attic insulation and converting inefficient florescent lights to high efficiency LED lighting. This involved the transport of over 100 bags of blow in cellulose insulation and an insulation blower out to the community and the installation of additional insulation throughout the attic of the tribal hall.

Figure 4. GZGTG Realty Specialist Shirley Fields gives the thumbs up when asked how she likes the new LED lighting, shown above, that significantly brightened up the office space

In addition to the insulation at the tribal hall, LED lighting was identified as an easy way to reduce electric costs in the tribal hall. Installed in the office was a mix of inefficient T12 and t8 florescent lights. With new LED lighting technology both improved light output and decreased energy costs would be realized. Over 100 LED tubes were purchased and shipped out to Fort Yukon for installation in the tribal office building and employees reported they liked the additional light output. The tribal finance officer reported she noticed the decrease in electric costs and the tribe decided, based on the success of re-lamping the tribal office, that they would use other funding they had available to also retrofit the lighting in the nearby community hall, which is used for public meeting, potlatches, funerals etc.

In addition to the Energy Efficiency measures that were completed on the Tribal hall, the community was also eager to install solar PV panels to reduce their energy use. Solar PV has been expanding rapidly throughout the lower 48 and even in Alaska more systems are popping

up on businesses and homes in the main hubs of Anchorage and Fairbanks. It is hard to travel anywhere and not see the increasingly larger solar PV arrays that are offsetting costs for their owners'. Because Fort Yukon generates 100% of its electricity from imported fossil fuels (diesel) the community is very sensitive to sudden price increases in the world oil markets. This happened dramatically in 2007 and 2008 and even in subsequent years. Due to the high cost of imported diesel and the high operating costs electric rates for electricity purchased from the local electric utility are $.67/kWh and the tribe wanted to save themselves money and also introduce new technology to the community, which before this project only had one small solar PV array on the elders center that had no data available from it.

Figure 5. The 18kW Solar PV array installed with 100% local labor on the roof of the Fort Yukon Tribal Hall

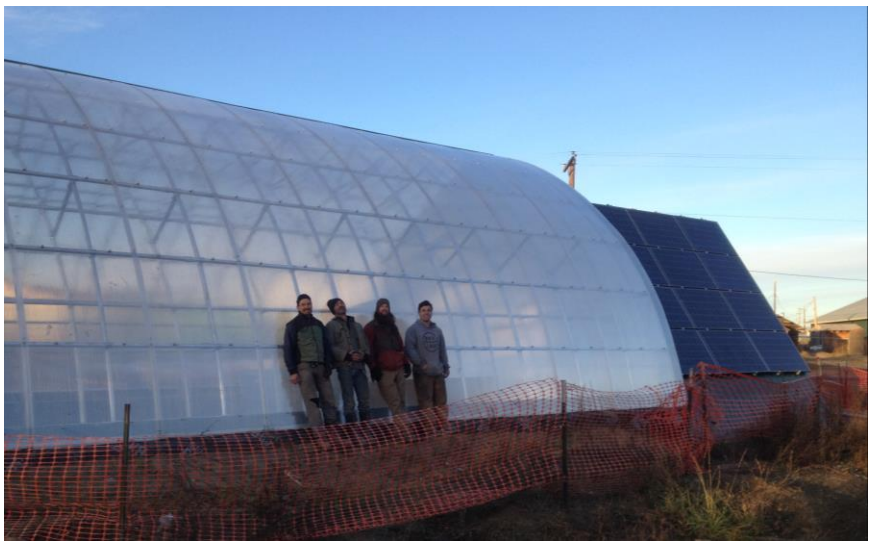

Figure 6. 3kW solar PV array installed on the tribe's greenhouse in Fort Yukon. Reina LLC Contracting crew in the foreground

An 18kW grid-tied solar PV array was installed on the roof of the tribal hall by GZGTG hired carpenters and a 3kW grid-tied solar PV array was installed on the tribe's new greenhouse by GZGTG contractors. Importantly, solar PV monitoring was hooked up to the solar PV array on the tribal hall through the SMA sunny web portal and the tribal administrator is diligently keeping track on the reporting. To date, the project is performing in line with expectations and a web-site is available for residents in Fort Yukon, students at the school and anyone interested in the project to collect data from.

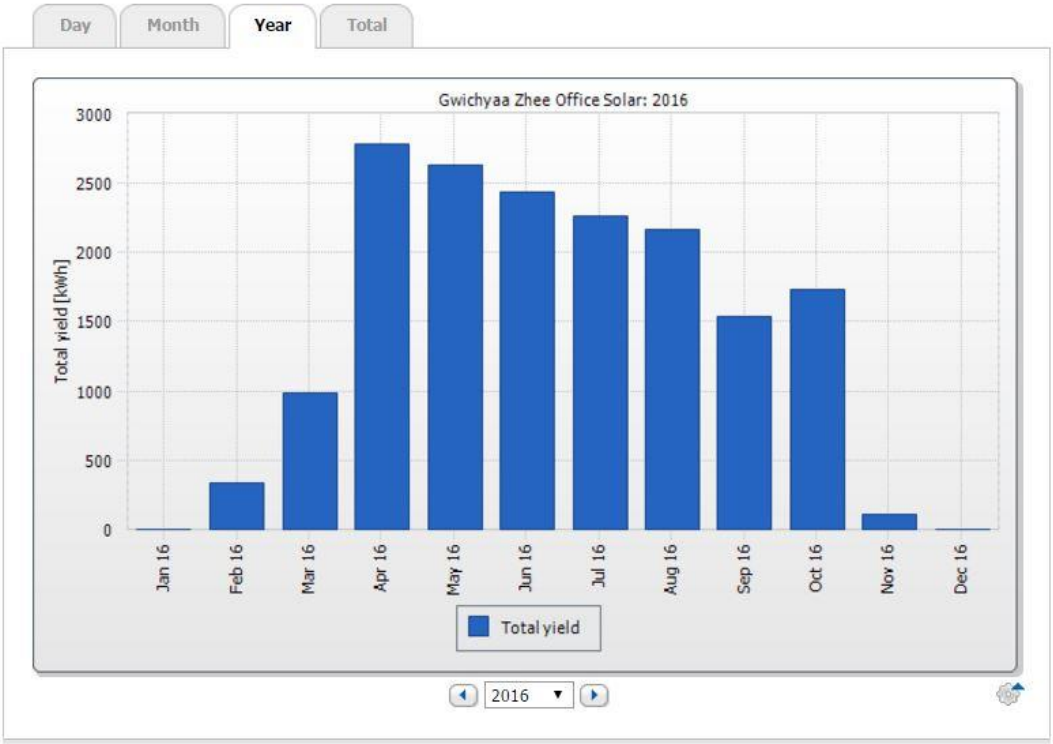

Figure 7. Snapshot of Fort Yukon Sunny web-portal web monitoring of the 18kW Solar PV monitoring page

All of these projects were completed by the summer of 2016 and local tribal members were employed for the vast majority of the work. At present the community is happy with the outcome, their tribal leadership is excited to be on the cutting edge of PV-diesel micro grids and residents from around the Yukon Flats are taking notice of the solar PV array and asking how they can implement solar PV in their own communities.

Objectives

The Major objectives under the project are as follows:

1) To reduce the Gwichyaa Zhee Gwich'in Tribal Government's dependence on imported Diesel Fuel to run tribal operations and services;
2) To lower operating costs and improve the economic sustainability of the Gwichyaa Zhee Gwich'in Tribal Government; and
3) To serve as a model of sustainability for our youth and our surrounding communities, so that they may follow where we have led.

The Gwichyaa Zhee Gwich'in Tribal Government is proud to say that all of the project objectives have been met and their expectations were exceeded.

Figure 8. TCC staff and community planning partners in the classroom in Fort Yukon with a grounp of 2nd graders teaching them about solar and energy in their community

The Gwichyaa Zhee Gwich'in Tribal Government was able to reduce its dependence on imported diesel by 800 gal in heating fuel and reduce the dependence of over 1400 gal of fuel that would otherwise have been burned for electric generation in diesel generators in the community powerhouse. The majority of the diesel reduction for heating fuel came from increased insulation in the attic of the tribal hall and the decrease in electric use came from decreased energy use efficient LED lighting and the installation of an 21kW worth of solar PV on the community greenhouse and the tribal hall. These 2 systems collectively produce over 19000 kWh of electricity per year that flows back into the community electric grid or offsets electricity in tribal buildings.

In addition to the reduced electric use and the importance of the free electricity being generated by the solar PV panels on their buildings the project had the added benefit of getting the tribe into the state's Power Cost Equalization (PCE) Program. This effectively reduced the rates that the tribal council paid on its facilities from $.67/kWh to $.22/kWh, which helped tremendously in reducing the tribe's yearly electric bills. Since this product was a direct result of the overall Gwich'in Solar and Energy Efficiency in the Arctic project we certainly count this as a project success. Without the DOE funded project the tribe may never have looked at their electric bills and known they could get into the PCE program. Overall the tribe's operating costs related to fuel and electricity have been significantly reduced through the implementation of this project.

As is illustrated by the photo of TCC staff and community planning partners in the classroom in Fort Yukon speaking with a group of 2nd graders about the Solar PV project, the project had a significant impact on the Yukon Flats School District. As a direct result of this project, the Yukon Flats School District purchase LED lighting for their own office building and is enjoying the benefits of reduced operating costs. It is very likely that they will move to convert their schools to LED lighting in the future throughout the Yukon Flats region. We believe the education in the classroom in Fort Yukon is also responsible for the safety of the solar PV panels. None have been damaged throughout any part of the project and we hope that trend will continue.

Description of Activities Performed (Including Photos and Graphs)

The Fort Yukon Tribal Building was constructed in the mid 80's originally for a different purpose and was retrofitted as a tribal hall in the 1990s with space for various GZGTG Program offices. GZGTG runs their housing program, realty program, elder's nutrition, education program, IGAP and transportation program out of the tribal building as well as administration. The project was straight-forward but required the assistance of the TCC energy program to complete. Regular updates were provided to the tribal council and the project was inter-woven with the coinciding construction of the GZGTG greenhouse. The process/activities performed are outlined here:

1. Determine the most cost effective/energy efficient solar PV setup – ground mount near the tribal building or roof mount on the tribal building
2. Create a scope of work and bid document for the parts and wiring diagram for the 18kW solar PV system on the tribal hall, distribute out to 3 vendors in Fairbanks and collect estimates.
3. Contract out the construction of the 3kW solar PV array on the tribal greenhouse. Sign contract and oversee the work was completed to the correct standards.
4. Complete order of Solar PV equipment for Fort Yukon Tribal Office and stage in Fairbanks awaiting charter to Fort Yukon
5. Complete order of LED lighting and insulation and stage in Fairbanks
6. Charter solar PV racking and supplies, LED lighting and insulation out to Fort Yukon and stage in transportation warehouse during the winter/stage in the transportation garage until breakup/construction season.
7. Contract with local electrician and run through the wiring schematic of the tribal hall solar PV array, order any miscellaneous parts.
8. Renovate storage closet in the tribal hall and build out a dummy wall to support solar PV inverters and hang inverters
9. Hire local tribal labor for the installation of the solar PV array on the tribal building, install racking and solar PV panels and wire panels into the solar PV inverters
10. Once wiring is complete insulate the attic space in the tribal hall up to R-80

11. Install LED lighting throughout the tribal hall, dispose of old florescent tubes through the GZGTG IGAP program
12. Turn solar PV system on and ensure connectivity with the local electric grid and the installation of a backup electric meter to track energy use produced by the PV array.
13. Hookup monitoring to the internet so the system information can be accessed and monitored remotely and viewed by the tribal council and administrator
14. Put together a maintenance schedule for the solar PV panels and clear it with the tribal administrator and tribal maintenance staff
15. Complete the change out of a 10kVA transformer outside of the tribal office and convert the transformer to a 15kVA transformer to handle the larger load and solar PV array.

Overview of Data

The data collected during the project is shown and discussed briefly in this section. Electric data was easy to collect throughout the project but heating data was more difficult to collect because of the way the tribe records their fuel usage. There are multiple fuel tanks for the buildings and multiple furnaces that keep it heated during the winter months. Thus it is challenging for the tribe, which hauls its own fuel, to track all of the fill-ups. The electric data is much easier to collect and can be collected from the electric utility. Two important factors however, made the electrical data more difficult to understand. These factors will be explained below:

1. The Power Cost Equalization (PCE) Program – The PCE program is a statewide program that reduces the electrical costs for residents and community facilities in Alaskan communities outside of the rail-belt electric grid. Through the course of this project it was discovered that GZGTG facilities did not receive PCE, although they could begin to! As a result, while we were completing the solar PV array we also submitted applications to the state of Alaska PCE program for inclusion into the program and were accepted since the buildings are community facilities. This brought the electric rate that the tribe paid down from $.67/kWh to $.22/kWh.
2. Before the project started, in order for the community to ensure that it had the support of the GZ Corporation, the local electric utility. The TCC energy program manage spoke to the GZ Corporation asking for guidance on interconnection standards and information on how the solar PV electricity produced by the array would be integrated

and accounted for. They did not receive a definitive response other than the assurance that the utility would not under any circumstances pay the tribe for electricity from the solar PV array. The tribe agreed to that condition and was under the impression that the utility would follow the same setup as the only other solar PV array in town - the Addie Shewfelt Elders Center. The Elders center is a true net-metering setup where the meter goes forward and backward depending on which way electricity flows. The utility allows for net metering on the building, but it is a very small customer. Unfortunately after approx. 8 months, the utility realized it was losing revenue and installed a bi-directional meter at the tribal hall. Only electricity that is consumed by the building at the time it is produced by the PV array benefits the tribe. The remaining electricity goes back onto the electric grid and reduces diesel consumption but does not save the tribe money.

Information in the below graphs can be explained by the above factors. The system was installed in May 2015 and a bi-directional meter was installed in spring 2016. Summer 2015 saw the elimination of the tribe's electric bill because there was a true net metering situation. That fact can be seen both on the electric consumption information, shown in kWh and the cost graph, shown in dollars. The addition of the building into the PCE program happened in fall 2015 and can be seen on the cost graph. Regardless of the above factors however the trend in electrical use and costs to the tribe is definitively downward, which proves that the project achieved its intended goals of reduced electrical usage.

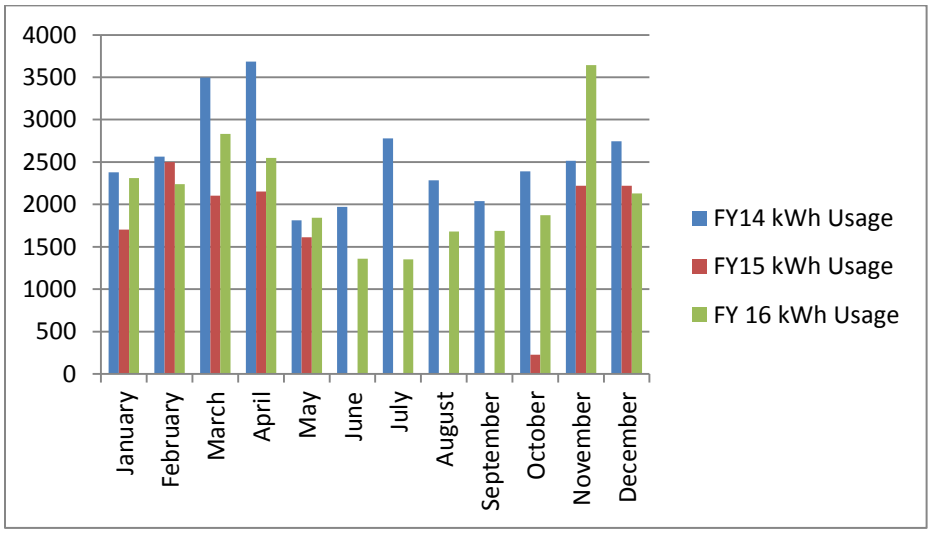

Figure 9. Electric Usage for Tribal Admin Building FY 14, FY15 and FY16 Information is in kWh.

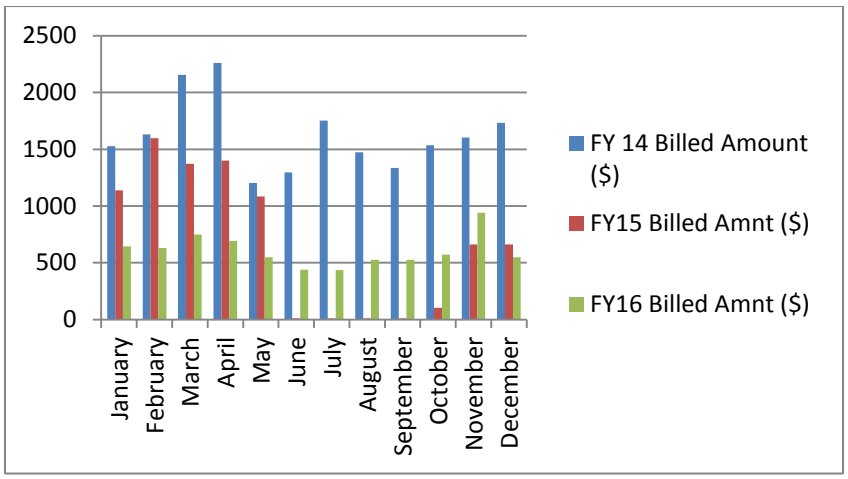

Figure 10. Electric Bills for GZGTG Tribal Hall. Note the significantly lower electric bills and the lack of bills in June-Sept 2015 before GZ Corp switched the electric meter. Information is in Dollars

The below graph shows the fuel usage (in gallons) for the Gwichyaa Zhee Gwich'in Tribal Hall on the right side and the costs (in dollars) on the left side of the graph. It should be noted that winter 2015/16 was a historically warm year for the interior of Alaska and averages need to be taken over a longer period of time to show anything conclusively. Still, our best information on fuel usage data from the tribal hall shows that fuel use from 2014 – 2015 decreased by approximately 33% and from 2015 to 2016 it decreased by an additional 44%.

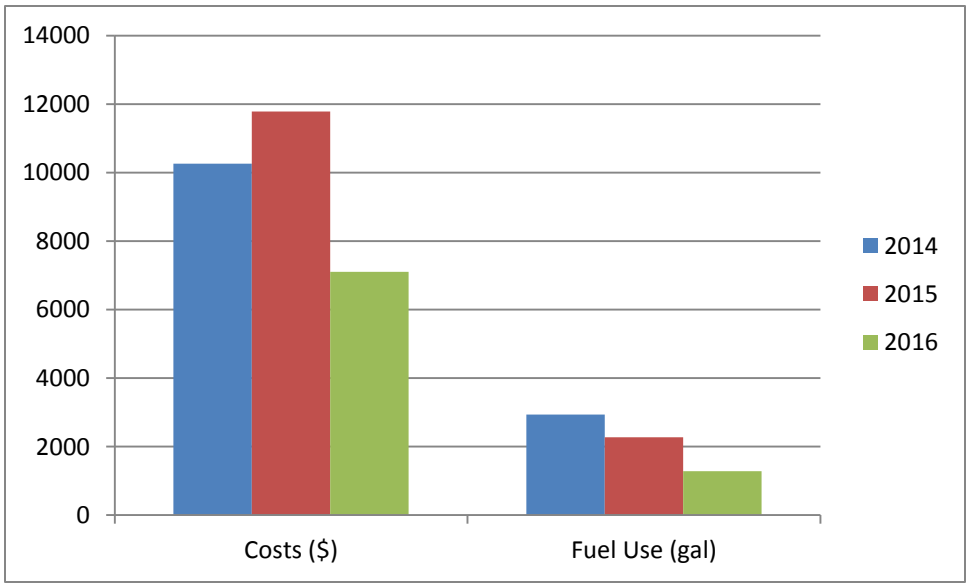

Figure 11. Fuel use by year in GZGTG Tribal Hall. These are from GZGTG Records

Solar PV Data

One of the most interesting pieces of information from this project showed the accuracy of the PV watts estimating tool for interior Alaska. PV watts is a free tool that is used to estimate average solar gain for different areas of the country using historical weather data. We inputted the azimuth, tilt and zip code and the program came up with an estimate of solar PV production. This was the tool we used to analyze the energy "price" we would pay when deciding to locate the solar PV array on the ground at 180 deg. due south Vs. on the roof of the tribal hall at approx. 210 deg. due SW. The graph below shows the comparison between the solar PV production that was observed through the SMA sunny portal monitoring system and the solar PV gain that was estimated through the PV watts calculator for the 18kW solar PV array.

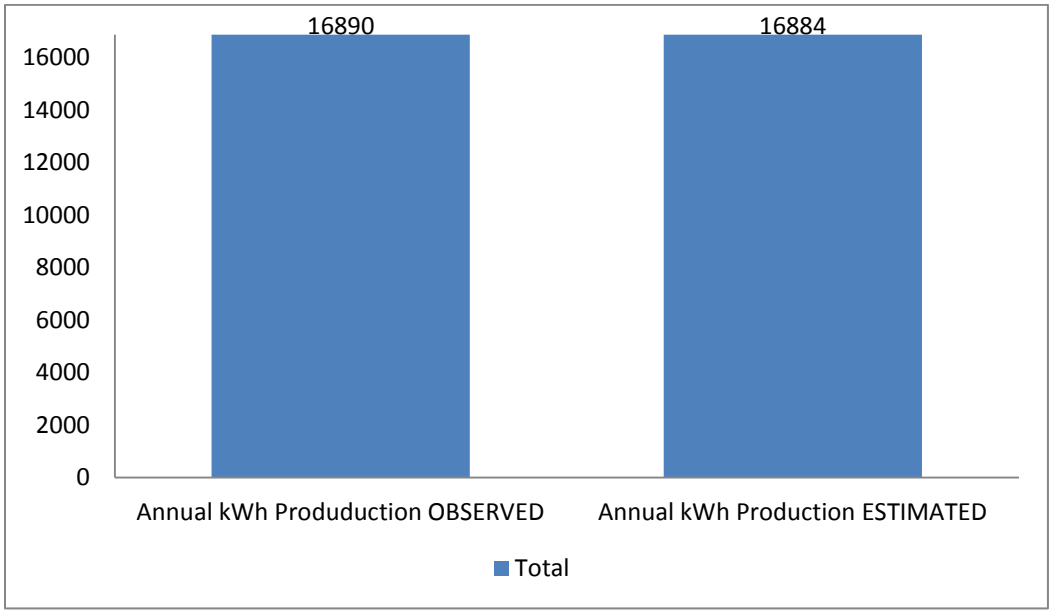

Figure 12. Data shown in kWh Observed is from Sunnyportal during the first full year of the project, "ESTIMATED" is from the PV watts calculator

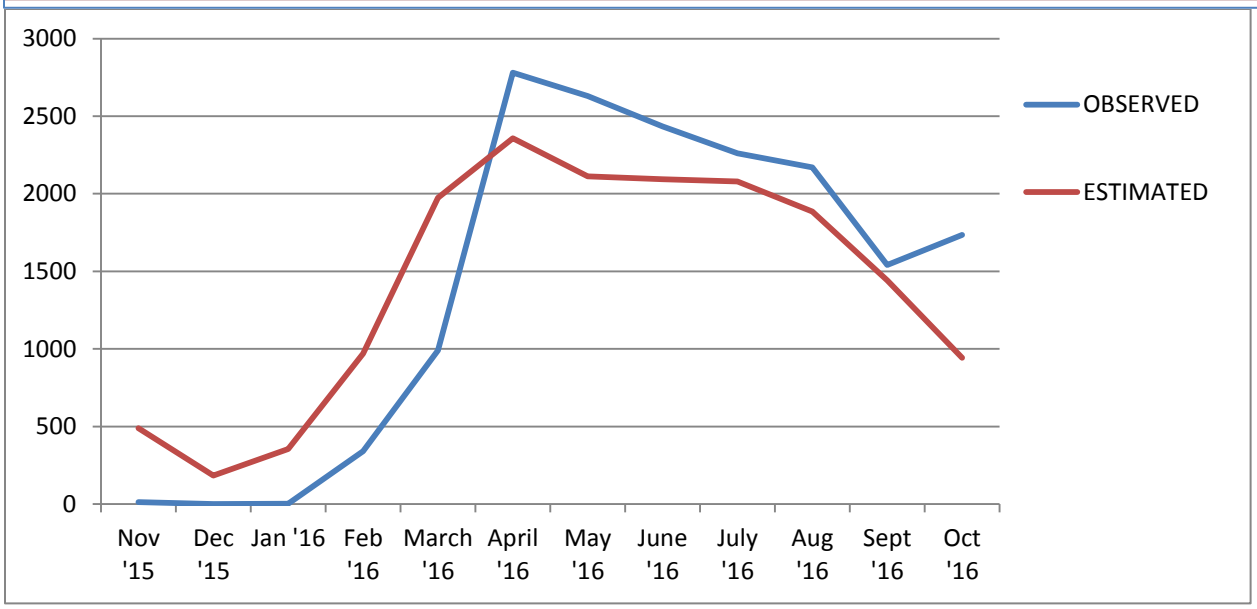

Figure 13. This graph shows the observed data from the Sunny Portal monitoring of the 18 kW PV array Vs. the estimated data from the PV Watts Calculator on a month to month basis

The line graph above shows that in some months estimation beat observed for production, in other months, the observed beat out the estimated. Typically the winter months were less productive than the program anticipated while the summer months, at least in this year were more productive. One possible reason could be snow buildup on the rear solar PV Panels which made up 50% of the installed capacity. The way the panels were oriented it was not possible to brush snow from the back row of panels, but the tribe can brush snow from the front row of panels and the tribe did add this job responsibility to their janitor's job description and it doing this work. Those results are shown in more detail in the graphic below.

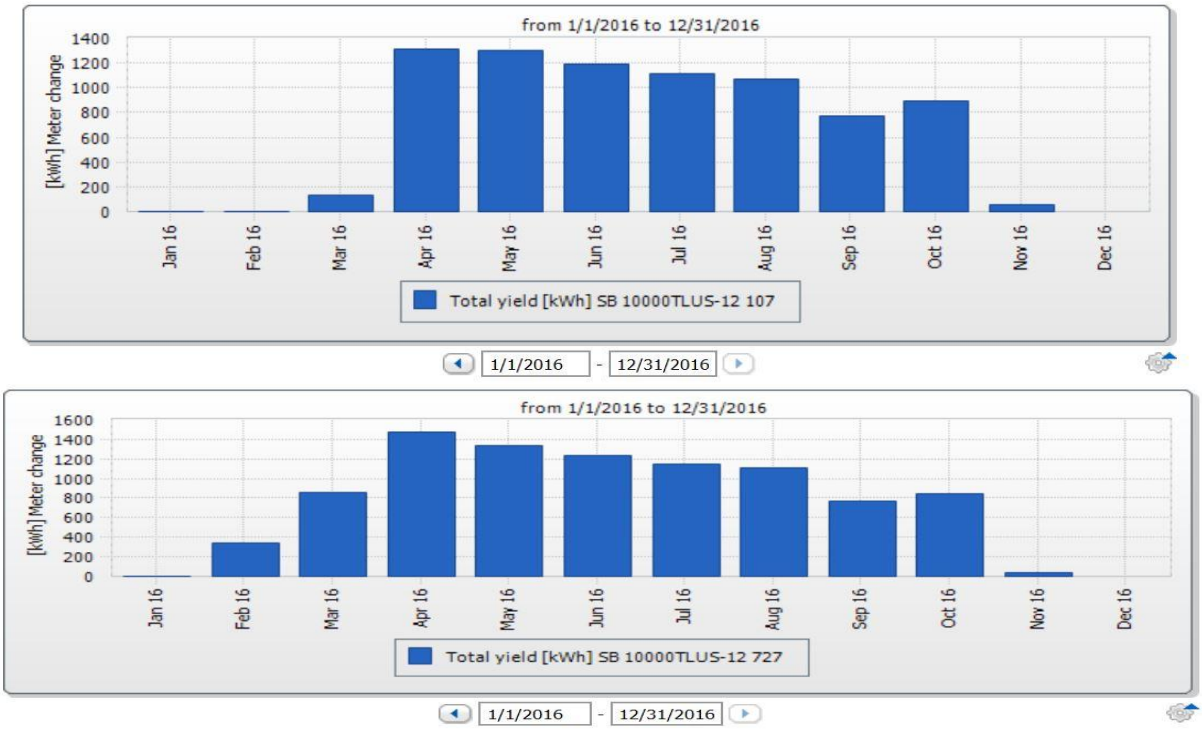

Figure 14. The above bar graphs show data from each string inverter. The top string inverter represents the 9kW string closest to the peak of the roof which could not be reached with a snow brush. The bottom graph represents the lower 9kW which were cleared of snow regularly

It is clear from the above graphs that there is a significant advantage to keeping the panels clear from snow and ensuring that one row does not shade the other row. Given this data we would still likely have located the panels where and how we did due to concerns about panel safety. The "cost" to not brush off the top row of panels amounts to approximately 1000kWh/yr. representing roughly $220 in cost and 75 gal of diesel used at the utility.

Conclusions and Recommendations

Conclusions

The Gwichyaa Zhee Gwich'in Tribal Government and the community of Fort Yukon would like to express their sincere thanks and appreciation to the Dept. of Energy Office of Indian Energy for awarding funding to the project. The project has brought a great deal of pride to the community since they are now home to the largest solar PV array north of the Arctic Circle in the state of Alaska and it was installed by tribal members. The project also helped the community achieve one of their strategic goals - to lessen their dependence on imported diesel.

An important part of the project was to prove to the local village corporation-owned electric utility that solar PV is a viable resource in the arctic for electrical production. The head of the utility, Franny Hughes, is a tribal council member and has seen the results of the project as has the corporation board of directors. We are hopeful that moving forward their leadership will look toward solar PV as a viable and useful technology that has the capacity to reduce diesel consumption when it can be implemented on a utility scale.

Recommendations

The Gwichyaa Zhee Gwich'in Tribal Government views this project as a success for their community and for their buildings. It is very unlikely that the project would have taken place without the support of the US Dept. of Energy and the funding they provided. The only recommendation that the tribal council would consider for the project funding and staff is to continue to provide the services that they have been providing. This project was invaluable for the community and data/lessons learned are being used for other projects that have been and will be developed throughout Alaska.

Lessons Learned

It is very important to note the lessons learned in this project and it is the hope of the Gwichyaa Zhee Gwich'in Tribal Government and their technical partner, TCC, that this information can be used to assist other communities with solar PV projects

1. When selecting a solar PV site for any future array it is important to consider protection of the solar PV panels. Originally the array was planned as a ground mount system, as we moved forward with the planning, the idea of putting the system on the roof of the tribal hall for protections of the panels was brought up and taken into consideration during the final system design.
2. Communication with the local utility is paramount to the success of any project. In Fort Yukon we worked with the utility to present them with information on the project but in hindsight we should have met with the board and clarified exactly what relationship we were hoping to get out of the project and exactly what results we planned to see from the solar PV array. This should have taken the form of a formal letter to the board complete with estimates on production and information on the buildings current usage on a month to month basis. Had we done this, it is possible the utility would not have

changed their metering system and the tribe could have continued to receive the benefits of net metering.

3. Ensure that the transformer your building is connected to is large enough to handle the load of your solar PV array. We installed an 18kW solar PV array on a 10kVa transformer and later had to go back and change out the transformer to a larger transformer to ensure there were no sizing issues.
4. If you are in a snowy climate, if at all possible, locate the solar PV arrays in a manner where both racking systems can be reached to clear snow off of the panels
5. Have good quality monitoring on all of your solar PV arrays, it would be possible to see exactly what is happening without good data from both of the solar PV inverters. It was an excellent choice to orient them as we did because now the community can see the difference between the shaded panels that cannot be brushed off and the unshaded panels that can be cleared of snow.
6. Always make regular updates to the tribal council. The Tribal Administrator, throughout the course of this project changed 3 times. Without regular information and updates to the whole council, the project may not have succeeded as it did.
7. Ensure that heating data is accounted for regularly and consistently. In a community like Fort Yukon where the tribe purchases heating fuel from the fuel distributor and then fills up each of their tanks on their own, it is difficult to determine how much fuel is going to each building, especially if the people filling the tanks and recording the information change. Consistent data keeping is very important for reliable information sharing.
8. Steel racking in the arctic is preferable over aluminum because aluminum racking has a tendency to expand and contract more than steel. Over time, this can loosen bolts. In a community like Fort Yukon where they have temperatures swings each year of 150 deg F. (+90F to -60 F) expansion and contraction of your materials is important. We would also suggest using copper wiring for a system like this since copper expands and contracts less than aluminum. As we were completing this project, we saw 2 instances in other communities where aluminum racking had caused issues with a system.

Dear Department of Energy Masee' Cho (Thank you!) for all of your support of this important Project!