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Solar Street Lighting: Using Renewable Energy for Safety for the Turtle Mountain Band of Chippewa

Abstract

Renewable energy has grown throughout the years. It is not just something for today. With the United States power electrical grid being 100 plus years old, renewable energy is the future. There are many different types of renewable energy. Solar photovoltaic array units and wind turbines seem to be the most common community scale renewable energy systems. There are new solar and wind farms popping up in more and more places each day. It is said that installing the farms is a fast process as compared to dotting the “i’s” and crossing the “t’s” (paper work), which is really the most time-consuming part of the entire project.

During the internship at Sandia, the Indian Energy interns attended many field visits to various tribal reservations. On these field visits, the interns were able to experience first-hand some amazing renewable energy plans and projects which have now become a reality. With each site visit, the success of tribal projects is seen where hard work and persistence pays off. It brings joy to see these tribes making their dreams a reality. It is heartwarming to hear the stories of why the tribe chose to bring renewable projects to their people. It is also very informative because the tribal hosts encourage as many questions as can be asked. The field visits are what make ideas possible and to dream of what could be pursued. Research is a big part making these goals and dreams a reality. Without the field visits and knowledge shared by the tribal staff and leaders, a relevant research topic would have been difficult to focus on.

Returning for a second summer as an intern at Sandia National Laboratories’ Indian Energy program, several research topics were considered. Ultimately, this research paper’s focus is to incorporate renewable energy specifically to take care of Mother Nature as well as the Turtle Mountain Band of Chippewa Indian people.

There have been many deaths on North Dakota Highway 281, which it is the main road of the Turtle Mountain Band of Chippewa reservation. The highway has a high volume of traffic every day, in addition to many people who frequently walk this road. There is no walking or bike path along the road; most people tend to walk the shoulders of the road. This research paper is a way to help protect these pedestrians with an idea of lighting the highway from the west end of Belcourt to one of are housing developments that is 5.34 miles to the west of town. This research paper will look at the various types of street lighting methods and provide recommendations for a suitable and economical project.

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1. Introduction

The Turtle Mountain Band of Chippewa Indians reside in the lands of the Turtle Mountains in North Dakota. The reservation is 6 miles North to South and 12 miles East to West (72 square miles). The reservation is just 10 miles south of the Canadian border. Belcourt, North Dakota is the only town inside the reservation's boundaries.

Figure 1: Turtle Mountain Band of Chippewa Logo (Photo Credit: Groove Master)

The federally recognized tribe has just over 30,000 enrolled members. The Reservation is isolated and is about 120 miles from the nearest urban community. According to the 2000 census, there are about 5,800 members living on the reservation and another 2500 live just off the reservation on trust lands. Today, the reservation is still densely populated with about 100 people per square mile.

There is one main highway that runs through the reservation, this is North Dakota Highway 281. It is very busy road where many accidents have occurred and mostly in the evening when it is dark as there are no street lights. There have been many deaths on this road, cars hitting cars and cars hitting pedestrians. The accidents are mainly due to how dark it is along the highway. The most accidents occur between the west end of Belcourt to about a mile past the Sky Dancer Casino and Resort (tribal casino), and this is roughly a 5.5-mile stretch. Any time there is an accident on this road, it brings great tragedy to the community - a feeling known all too well. Specifically, in 2011, a friend was walking and was killed about a quarter of a mile past the casino. A year later in September and a half mile west of Belcourt, a close relative's vehicle was struck by another vehicle and her life was also taken. As if that was not enough tragedy in those two years, two other close relatives were killed a month after the first relative was killed. They were walking across the road and they were

Figure 2: HWY 281 running though Turtle Mountain Band of Chippewa Indian Reservation

struck by a car as well. These are only personal tragic stories; there have been 17 deaths on this highway from 2008 to 2017. Six of these deaths have been pedestrians and one bicyclist.

The Turtle Mountain Band of Chippewa have great respect for their community as well as Mother Earth. As a member of Turtle Mountain Band, new measures need to be made for a safer community and also to respect Mother Earth. A renewable and clean energy project can be added by installing street lights between mile markers 239 and 245 of this dangerously dark highway.

Figure 3: Turtle Mountain Band of Chippewa Street Light Path (www.googleearth.com)

2. Street Lighting

Street lighting has been around since humans began living together. As early as 500 BC, the ancient Romans used oil lamps filled with vegetable oil in front of their homes. In 1802, William Murdock used a gas light fueled with coal gas. Not long after that the city of London, England decided that instead of just having the lamps in front of homes, the use of the gas lights lit an entire street in 1807. The United States began to use these gas lights as well but not until 1816. The city of Baltimore, Maryland was the first city to use gas lights. From gas lights, improvements were made, and the gas lights were switched to electric lights which are more energy efficiency.

Yablochkov Candle, invented by Pavel Yablochkov in 1875, was the first electric street light to use arc lamps in 1878. Three years later in Paris, France, the city began switching out the gas lamps for electric lamps and had already replaced about 4,000 street lights. The United States followed suit and by 1890, 130,000 arc lamps were installed on many city streets. Once the electric street lights came along, improvements were made little by little. Today, there is many lights to choose from. There are many traditional street lights that are efficient, but some very old street lights still in use are not energy efficient. Solar photovoltaic street lights can be very energy efficient if the systems are set up correctly. Traditional lighting versus solar lighting will be described.

Figure 4:History of Street Lights (Photo Credit: elelamp2

2.1 Traditional Street Lighting

Traditional street lighting has been around for a very long time. The raised source of light on the edge of a road or path is used to help people see at night. Traditional street lights are connected to the electrical power grid and there will be a monthly bill for the electricity that the street lights use. Recent incorporation of LED light bulbs has improved energy efficiency and many cities have switched to LED street bulbs to save on operational costs.

2.2 Solar Street Lighting

Solar street lighting, unlike traditional street lighting, has not been around for many years. These street lights are not connected to the electrical power grid: the solar light will produce its own energy from the sun (photovoltaic panel) and store the energy in a battery until the light turns on once it is dark enough. There are a few different ways that solar lighting can be used off grid. One way the solar can be connected through a micro grid which essentially a mini power grid used specifically for the lights; another way is that each street light can be a stand-alone system.

3. Electrical Grid Systems

An electrical system delivers electricity from producers and consumers; it is an interconnected network. Generating stations are part of the grid and produce kinetic energy which is turned into electrical power. The produced kinetic energy or electricity is sent to a generating transformer where it is stepped up and converted to kilovolt amperes (kV). To carry this electricity, the grid uses high voltage transmission lines. The transmissions lines connect to a step-down transformer where the electricity flows from high voltage to lower voltages. The lower voltages vary depending on the customer and where the electricity is being sent. In the figure below, the steps of a power grid are illustrated.

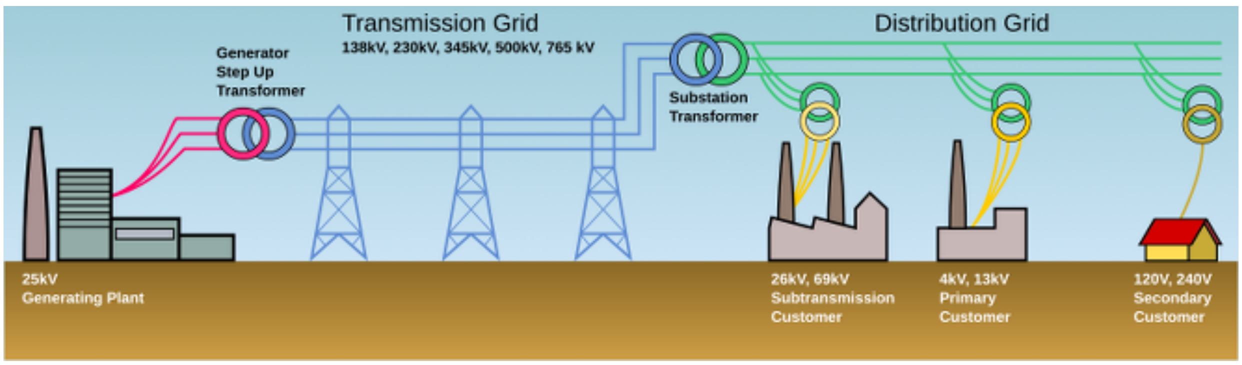

Figure 5: Electrical Grid Transmission and Distribution (Photo Credit: Gary R. Osgood)

3.1 United States Major Grid System

The United States (US) is connected by one power grid. It consists of three major interconnected grids. Although some consider Texas a minor grid (the smallest grid), the other two grids are known as the Eastern and the Western grids. The Eastern grid is the largest followed as a close second by the Western grid.

The main grid of the US is connected by 450,000 miles of high voltage transmission lines and 5.5 million located distribution lines. Of course, in between all these lines, there are thousands generating plants which are connected to facilities, homes, and businesses which requiring millions of miles of distribution lines. Power plants placed across the country create the energy to be transfer as electrical power across the US.

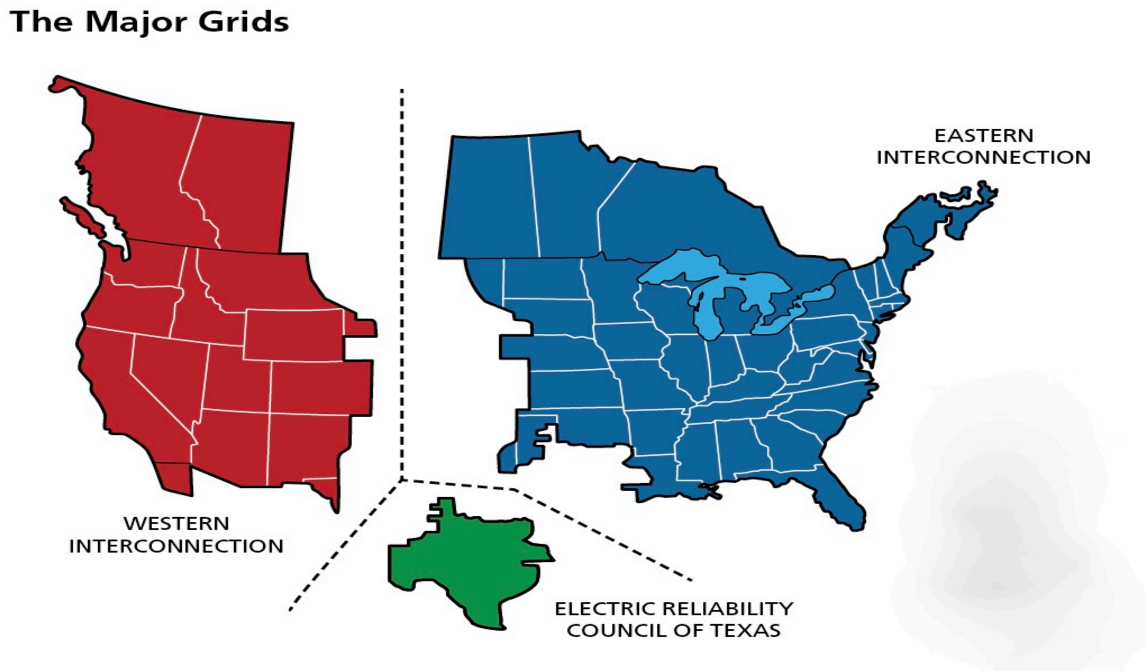

Figure 6:Main Grid Interconnected by Three Smaller Grids (Photo Credit: Jay Smith)

Either locally or nationally, the electricity is moved from the power plants by independently run control centers. The centers monitor the power needs and control the energy flow. It is important to constantly balance the supply and demand because energy cannot be stored effectively on a large-scale grid.

The US power grid is over 100 years old and most of the necessary balance of the infrastructure is over 50 years old. To rebuild the grid, it is estimated to cost over $5 trillion dollars. The aging grid is vulnerable to extreme weather, natural disasters, electro-magnetic pulse weapons, and cyber-attacks. Instead of spending money on rebuilding the grid, a “smart grid” can possibly prevent the vulnerability of the current grid.

3.2 Micro Grid System

A micro grid system is a basically a mini version of the electrical power grid system. A micro grid system can run with the traditional electrical grid system or stand-alone if batteries / energy storage is used. The system is a local grid with control capabilities. Generally, if the micro grid is connected to the main grid, the whole system will go down during an outage. If the micro grid is a stand-alone system with batteries as back up storage, it generates its own local energy when the grid is down during emergencies where there is power outages and bad weather outages.

Micro grid systems can be used when it’s too expensive to run distribution lines to homes or buildings or when distribution lines aren’t allowed to run to homes or buildings. An example of this scenario is a Native American village which prefers to follow their cultural ways and leave the villages as it was before there was electrical service. The Hopi Tewa community in Arizona built a large community center as it was planned to be connected to the main grid. A misunderstanding occurred, and the center could not obtain permission to electrically connect the building. The Tewa community had to come up with an alternative.

The alternative chosen was a micro grid that was powered by solar panels with battery storage. The first system built wasn't large enough to run everything in the building so the system was enlarged – more panels and more batteries. The center has a 33kW off-grid solar power system that would power the entire building. The building is heavily used during the day for administration offices and up to five nights a week for community meetings and youth activities. Operations are shut down before too late in the evening as a high electrical demand can run down the batteries or quickly discharges the batteries.

On a field visit in June 2018, the Hopi Tewa community informed the visiting group that the community center was finally able to connect to the main electrical grid in February. From all the energy efficiency modifications and operations, the community center should have a low electrical bill if there is one at all.

In the picture of the community center, the micro grid system can be large. The US military uses all sizes of micro grids when the troops are out in the field and there is no access to a main grid. The power needed will determine the size of the grid system. Other uses for grid systems could be a set of street lights, a cluster of homes, or even an entire district which some towns aiming for in the future.

Figure 7: Hopi Tewa Community Center (Photo Credit: The Solar Exchange Arizona)

3.3 Stand-Alone Power System

Stand-alone power systems (SAPS) are exactly as described: a stand-alone system is an off the grid electricity generating system for remote locations that could be far from the grid and it is too expensive to connect to the grid. The systems power is self-generating to supply electricity to uses in the remote areas. Stand-alone systems could be used as one electricity generating source or combined with other systems. There are many different systems used as SAPS:

- Solar photovoltaic units
- Wind turbines
- Geothermal heating units
- Geothermal water pumps
- Diesel or biofuel generators
- Micro combined heat and power
- Thermoelectric generator

Typically, a SAPS will have three basic elements to the system: the power source, the battery, and the power management center. However, a battery is not always needed for the use of the system.

A system that doesn't need a battery is known as a direct-coupled system. These systems are capable of powering Direct Current (DC) appliances like fans or water pumps only during the day. The basic model of a direct coupled system consists of a solar panel connected directly to a DC or direct current load.

SAPS systems can also be hybrid systems which uses one or more of the above systems to work together to supply the power (commonly used is solar and wind power). The battery allows autonomous operation by compensating for the difference between power generation and use. The power management center regulates power generation from each of the sources, controls energy use by classifying loads, and protects the battery from service extremes. Sometimes, a generator

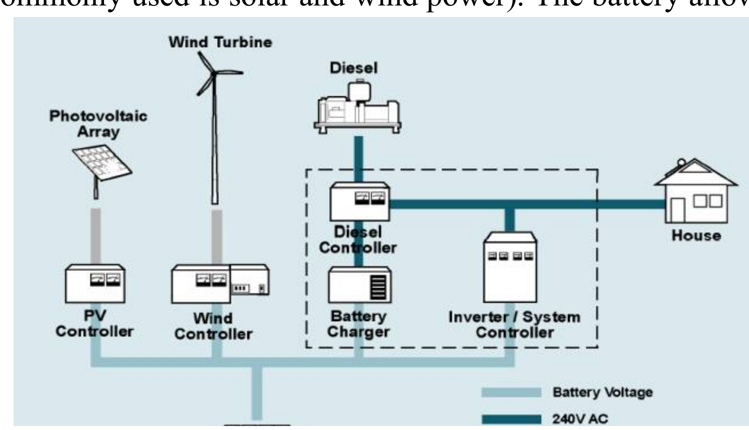

Figure 8: Example of Hybrid System with storage (Source: Murdoch University Sustainability Development Office)

may be a part of the hybrid system, and it will provide electricity to the unit if the batteries are drained and there is no wind or sun to generate the power.

4. Types of Solar Power Systems

For research, solar photovoltaic units and Microsystems Enabled Photovoltaics (MEPV) will be described. Solar photovoltaic units are common and traditional units of solar power. MEPV are new and are not common. Two systems will be described to better understanding of these systems and its applications.

4.1 Solar Glitter (MEPV)

MEPV are micro scale photovoltaic (PV) also known as solar glitter are cells which harness energy from a variety of light sources and power devices in flexible, moldable, or flat plate formats. If these PV cells are used, the cells could easily be molded or adhesively put on to the street light poles.

The microscale PC cells can be as small as 100-micrometers (μm) wide and 1μm thick. The tiny PV cells can generate electricity as a large PV cells or panels. The cells convert photons from the sun or any light source into electricity or electrons. The micro size of these cells helps to format and conform to the shapes and contours of any device being powered, thus enabling the tiny PV to blend into a device's look, feel, and functionality.

Figure 9: Each PV in this sheet is 300um (Source: Sandia National Laboratories)

As mentioned these cells can be flexible, molded, or flat plated formats and there are three different designs of these micro scale PV cell designs:

- **A silicon back-contacted interdigitated finger pattern.** This design is suitable for sunlight to electricity conversion without optical concentration. Solder bump bonds can be put onto flat surfaces with semiconductor pick and place tools. Examples of this would be concentrated PV (CPV) modules or flexible PV sheets. A specific application surface or material must be chosen as to where the cells will be place in order to receive the most light possible.
- **A silicon back-contacted radial pattern.** Similarly suited and close to the interdigitated finger pattern except, the symmetry of the radial back-contacted pattern enables the use of self-assemble approaches without needing rotational orientation of the cell. The way the cell is designed allows it to be placed anywhere and it will catch the full effect of the light.
- **An ultrathin single-junction gallium arsenide (GaAs) cell with back contacts.** This design is used for the conversions of diffuse, ambient light to electricity for high value applications like mobile or space power.

What makes these designs special? The cells can be embedded into highly flexible PV modules, incorporated into low cost micro-concentrator modules, or built into consumer electronic products. Examples of things the cells could be attached to are clothing, backpacks, roof top or vehicle materials. The list goes on and on because the cells are so small and can be embedded into flexible material.

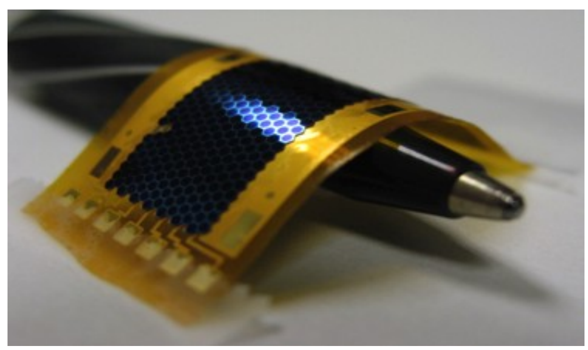

Figure 10:Slexible Solar Glitter (Source: mPower Technology)

When light shines on the semiconductors, it excites the electrons which drift and diffuse in the material and then the electrons are collected at the terminal. These are the steps that cause the microscale PV to generate electricity though the photovoltaic effect on a micro scale.

4.2 Solar Photovoltaic Array (PV) Units

Solar photovoltaic devices generate electricity directly from sunlight though an electronic process that occurs in certain types of material called semiconductors. The material frees the electrons when photons (particles of sunlight) hit the material; solar energy can be induced to travel though electrical circuits where it is sent out to power an electrical device or send electricity to the grid.

Solar cells today are mostly made from either crystalline silicon or thin-filmed semiconductor material. Silicon is pricey, but research has shown that it is very efficient at converting sunlight to electricity. Sometimes thin-film materials are used as these materials are less expensive. The downside is that these materials are not as efficient as silicon and require more area of material to generate electricity.

A solar panel is much like the micro PV flexible sheets as it consists of many small units called PV cells. These cells are linked together and allows photons to knock electrons free from atoms; this generates a flow of electricity.

Once these PV cells knock the electrons free, the electricity generated flows through the system. There are a few different stages the electricity will go through depending on if the system is an on grid or off grid system.

When the system is connected to the grid the following steps are as follows:

- The sun hits the solar panel and the electrons are knocked loose.
- The electricity produced by the electrons travels through to the inverter where it converts Direct Current (DC) to Alternating Current (AC).
- The AC will be sent to the power users - home, school, or business which require electricity.
- Any electricity not being used can be run through a bi-directional meter to the grid. A bi-directional meter indicates energy usage and excess energy.
- If there isn't enough energy being produced from the solar PV unit and unit is tied to the grid, then the grid will send more electricity where there is demand.

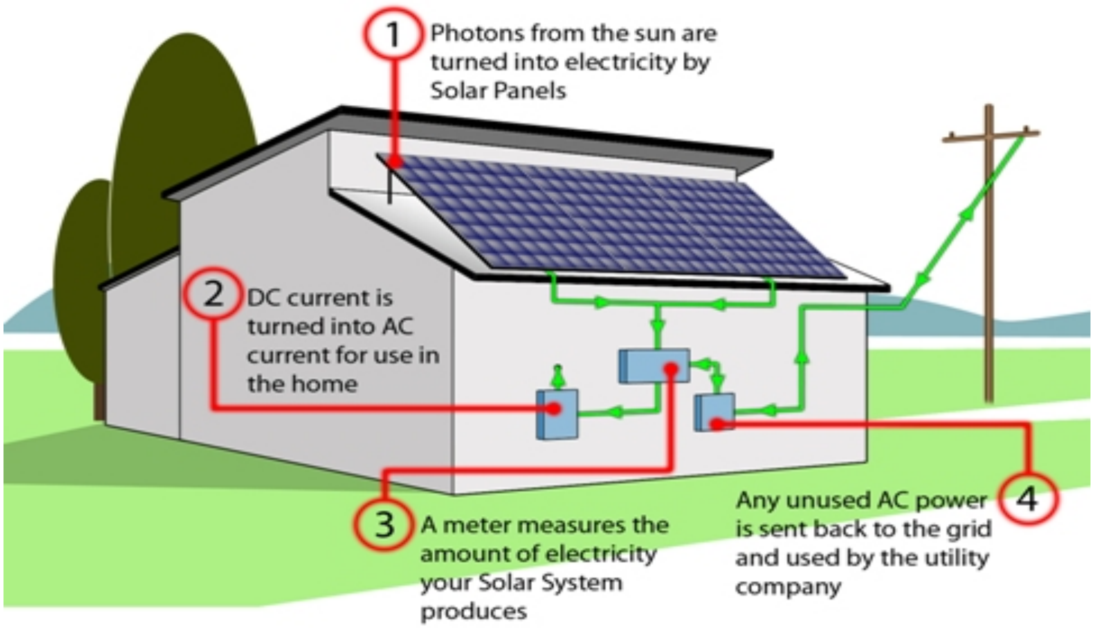

Figure 11: On-Grid Solar PV System Diagram (Source: Heat Serve)

Off-grid systems work a little differently than on grid systems. Most off-grid systems are used because it is difficult to get power from the grid in certain remote locations. Examples of these system would be in Kayenta, Arizona on the Navajo Nation. Some of the tribal members reside in the canyons where it would be very costly to run the power lines to a home. Navajo Nation's solution is for off-grid solar PV residential units to generate local electricity for remote residents.

The Navajo Tribal Utility Authority (NTUA) supplies the units by subsidizing cost to remote residents. Over time, the NTUA has seven-types of PV Systems available which are specified based on the service requirements requested by the customer:
(* discontinued)

Figure 12: Navajo Tribal Utility Authority unit, 8 Module Hybrid Wind Turbine that produces 2 KWH/day (Photo Credit: Christian Gould)

(1) Two modules DC systems*
(2) Four modules (0.7 KWH - per day) DC systems*
(3) Four modules (0.7 KWH - per day) AC systems
(4) Eight modules (1.7 KWH - per day) AC systems
(5) Eight modules (2 KWH - per day) Hybrid Wind Turbine
(6) Eight Modules (2 KWH - per day) Hybrid Propane Gas Generator

(7) 16 Modules (4 KWH - per day) Hybrid Propane Gas Generator.

Off-grid system have batteries and there is a battery meter which indicates much energy is have left in the batteries. The stages of off-grid systems are:

- The sun light hits the PV cells where the electrons are knocked loose
- This second stage is where it is a little different than on-grid. Instead of going straight to the inverter, the electricity will go through a charge control unit. The charge controller will prevent over charging the batteries as mentioned in the third stage.
- The third stage is where the electricity is sent to the batteries from the charge controller. The batteries will charge until full. The energy will be stored until it is need during periods of no sunlight or when the user is using more energy than what is generated.
- In the fourth stage, the electricity will either be sent out as direct current to DC appliances or to an inverter where the DC will be converted to AC for the AC appliances.
- In the home, there is a battery meter indicating much battery charge remains. If the indicator light is green, the stored electricity is okay. A yellow light indicates the batteries are getting low. A red light indicates the system needs to be shut off to let the batteries recharge or the batteries can damaged.

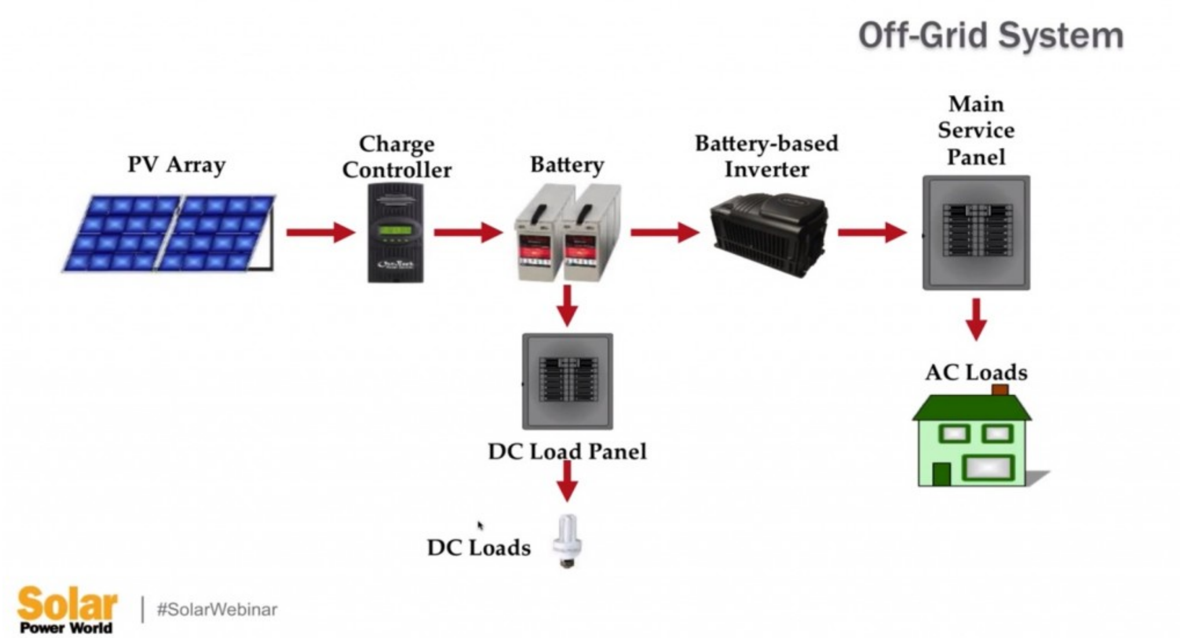

Figure 13:Of-Grid Solar PV System with DC and AC Loads (Source: Solar Power Wind)

5. Possible Street Light Systems for Highway 281

With the background information stated, the research focus is on what solutions makes the most sense. Listed below are the possible alternatives to be considered:

1. Traditional on-grid lighting
2. Solar PV lighting system with a micro grid
3. Solar PV Lighting Stand Alone Systems
4. Do nothing (This alternative should be eliminated; it is unsafe NOT to have street lights)

5.1 Traditional Lighting

To use traditional lighting, it is logical to use lights which are connected to the nearby grid; however, it would be very expensive to install new lights in addition to extending the grid to the area. There is a substation in the project area, so traditional lighting is possible.

When it comes to traditional lighting, the lights themselves are not too expensive. The major expenses for traditional street lighting come from the initial installation, maintenance, and on-going operation of the lights. The estimated street light pole and installation is $2000 to $3000 per light pole with an added cost of up to $1000 for an electrician to install. The cost of the light bulb itself is an important factor. Light-emitting diode (LED) bulbs cost about $110 each and have a life span of about 10 to 15 years which cuts down on electricity and maintenance costs.

There is a 5.5 mile stretch where the street lights will be used on North Dakota Highway 281. A rough estimate can be calculated to get a ball park figure of how much the project will cost. Assume the average cost of the light poles to be $2500 with the cost of the electrician labor to be $750 and use 400W EQ LED light bulbs which costs around $110. The total cost for the project including everything without the monthly cost of electricity is $361,387.

Total Cost of Traditional Street Lights on Highway 281 without Cost of Electricity						
Distance of Project on Highway 281 (Mi.)	Distance between lights (Ft.)	Installation and Unit 50 ft. Poles ($)	Electrician cost of Installation ($)	400 Watt EQ LED Light Bulb ($)	Number of Street light Units	Total Cost of TMBCI Project($)
5.5	270	2500	750	110	108	361387

Below is the cost of electricity per day, month and year (on-going operational cost):

Cost of Electricity Daily, Monthly, and Annually				
Number of Street light Units	Hourly Cost of Electricity in kWh ($)	Daily (12 hours) ($)	Monthly (30 Days) ($)	Yearly (365 Days) ($)
108	0.0937	10.12	303.59	110809.62

5.2 Solar Lighting with Micro Grid

Installing solar street lighting with a micro grid would be similar to installing traditional street lights. The cost would be the total cost of the traditional street lights, but the cost of the micro grid unit is added. With a total installation cost, a comparison with the annual cost of electricity and the period in which the electricity is now free as it is generated from the micro grid and assuming the system is paid in full. A 10kW system uses about 40 panels the system that would mean it is 4 panels per kW. About 372 panels for the 93kW system are needed for the TMBCI project. Although there are different venders and prices for these systems, a 10kW completely off grid system costs any where from $32,000 to $54,700. Since the system is 9 times greater, estimated cost would be to multiply the average 10kW system cost times 9 to get a rough estimate of what the 93kW system would cost.

Total Cost of Solar Street Lights w/Micro Grid on Highway 281 without Cost of Electricity									
Distance of Project on Highway 281 (Mi.)	Distance between lights (Ft.)	Installation and Unit 50 ft. Poles ($)	Electrician cost of Installation ($)	400 Watt EQ LED Light Bulb ($)	Number of Street light Units	Installation Cost of Solr Street Light Micro Grid for	Cost of Off-Grid Solar Systems (10kW) ($)	Estimated Cost of Off-Grid Solar Systems	Estimated Total Cost of Project ($)
5.5	270	2500	750	110	108	361387	43450	391050	752437

Below is a rough estimate of a pay off rate in years. This is the price of the light poles installation and the system. There are other factors would be added in depending on the tribe's situation. An example of extra cost would be if the tribe has to acquire the land from one of the enrolled members. This was a problem that Navajo Nation came across to build its 27.5-Megawatt PV farm. The Nation didn't have undesignated land to build on, so a deal was struck with one of the Navajo Nation families to acquire a piece of land from the family's grazing right land allocation.

Years the Project will take to pay itself off		
Estimated Total Cost of Project ($)	Yearly (365 Days) ($)	Pay Off (Yrs.)
752437	110810	6.79

5.3 Solar Lighting Stand-Alone Systems

To figure out the cost of a stand-alone system, it costs about $3500 for the lights and poles and another $1000 for the installation. If those numbers in the fore mentioned information, the total cost is about $48,400.

Cost of Solar Street Light Project on Highway 281					
Distance of Project on Highway 281 (Mi.)	Distance between lights (Ft.)	Lights and 50 ft. Poles ($)	Electrician cost of Installation ($)	Number of Street light Units	Total Cost of TMBCI Project($)
5.5	270	3500	1000	108	484000

With the cost of electricity at the current rate, the pay back amount can be calculated. Once the project is paid off, electricity cost savings is demonstrated as per every year as the system generates its own electricity which does not need to be purchased or energy saved.

Cost of Electricity Daily, Monthly, and Annually				
Number of Street light Units	Hourly Cost of Electricity in kWh ($)	Daily (12 hours) ($)	Monthly (30 Days) ($)	Yearly (365 Days) ($)
108	0.0937	10.12	303.59	110809.62

Below the total cost of the project is divided by the yearly cost of electricity saved or not needed. It would take a little over 4 years to pay the project off knowing the system self-generates its electricity. There will be some maintenance throughout the life of the project like new bulbs and batteries which are minor costs.

Overall Cost of Project/Cost of Electricity		
Total Cost of TMBCI Project($)	Yearly (365 Days) ($)	Pay Off (Yrs.)
484,000	110,810	4.37

5.4 Solar Glitter

Unfortunately, not much commercial information is available on solar glitter and the prices. One discussion at the 2018 American Solar Energy Society (ASES) was observed about solar glitter in that it could be adhered to the light pole itself. If tied to the grid and it had a net metering agreement with the electricity company, batteries would not needed. The electricity generated during the day is sent to the grid (metered generation) and then at night, the energy is sent back to the street light (metered use). This is assuming the amount generated is equal to or greater to the amount needed at night. A new inverter that was part of the system, but this alternative is still in the research development phase.

6. Comparing Costs of Alternatives

There are two of the alternative projects are very close in installation cost:

- traditional street lights ($361,387 installation cost only)
- stand-alone solar street lights ($484,000 installation cost and **no electricity on-going cost**).

The difference is that once the solar street lights investment is paid off, there is no electricity bill unlike traditional street lights where it would have an on-going cost of $110,809 per year to purchase the electricity. This is a permanent operational annual cost. A solar street light system with a micro grid cost is expensive and has a long pay off rate. Although this alternative has a seven-year payback for the project, it is noted that the costs could rise if the land for the micro grid would have to be purchased.

Cost Comparison of Alternatives		
Traditional Street Lights ($)	Solar Street Lights w/Micro Grid ($)	Stand Alone Street Lights ($)
361387	7527437	484000

Note: In this table, the cost of electricity ($110,809) for the traditional street lights is not listed

7. Conclusion

For this research paper, the conclusion is very straightforward as calculated in the project costs. **The recommendation is for the Turtle Mountain Band of Chippewa to install the solar street lights stand-alone systems between mile markers 239 and 245 on North Dakota Highway 281 as it is clearly the least expensive option.**

The Stand-Alone system is not only the lowest cost solution, but it would be a solution to help the Turtle Mountain Band of Chippewa to do their part in helping to keep Mother Earth safe using clean energy which demonstrates the Chippewa pride in respecting the environment and the safety of its tribal community.

This research topic was focused on solving a community safety problem and it is not as expensive as installing a huge solar PV farm or a wind turbine. The project would assist the community to take small steps in the use of renewable energy. A few other tribes have already installed stand alone solar street light systems; it was the logical project to pursue. One example is the Cheyenne River Sioux in Eagle Butte, South Dakota. The tribe installed the systems because there are many tribal people walking in the pitch-dark areas along the roads each night. It would have been too expensive to try to connect to the grid and the stand-alone systems were easier to work with versus a micro grid system.

A lesson learned is that Native people may be afraid to take that first step in trying something new. They may think other Natives can to try it first, then maybe they will think about it. In a way it is understandable, the tribes have something to lose in taking on risks. On the other hand, how are the tribes going to know what could have been if they never take the chance? The opportunities maybe missed on big ideas because the tribes were hesitant to take a chance.

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