FOREST COUNTY POTAWATOMI ENERGY

Priority Climate Action Plan

In Partial Fulfillment of the US Environmental Protection Agency's Climate Pollution Reduction Planning Grant

February 2024

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1. Introduction

1.1 Introduction to the Forest County Potawatomi Community

The Forest County Potawatomi Community (FCPC or Tribe) is a federally recognized Indian tribe. It is formally organized under the Indian Reorganization Act of 1934. Its governmental structure operates according to a Constitution adopted on June 5, 1982, and approved by the Secretary of Interior on July 14, 1982. The Tribe is governed by a body of elected officers comprised of a six-person Executive Council. The duties of the Executive Council are enumerated in Article IX of FCPC's Constitution and include responsibility for and authority over all administrative and economic affairs, negotiations, and contracts, including those between the Tribe and federal agencies.

The Tribe descends from the original inhabitants of Southeastern Wisconsin, Michigan, and Illinois around the shores of Lake Michigan. It ceded territory through a series of treaties, and rather than marching west, many Potawatomi sought refuge in Wisconsin's Northwoods, eventually forming the Forest County Potawatomi Community. The Tribe has a land base of 18,486 acres, predominantly in Forest County, Wisconsin.

FCPC is commit ed to protecting the environment, sustaining natural resources, and serving as a leader in responsible energy use, planning, and development. The Tribe has established a long-term goal of achieving energy independence through adopting energy efficiency and clean, environmentally friendly, renewable energy. The Tribe's commitment stems from its environmental ethic, which is reflected by the Tribe's Environmental Mission Statement, formally adopted by the Executive Council in 2007 and states:

> *"The traditional values of the Forest County Potawatomi Community teach us to respect all living things, to take only what we need from Mother Earth, and to preserve the air, water, and soil for our children. Reflecting these values, we take leadership in creating a sustainable and healthy world. We resolve to reduce our own environmental impacts and to take steps to remedy the impacts of others. We encourage others to do the same. We also seek legislative and policy changes that protect the environment for all people, including generations to come."*

This mission drove FCPC to create an Energy Department, conduct a comprehensive energy assessment to determine a community-wide energy baseline, and develop a Strategic Energy Plan. These steps led to adopting policy designating a long-term energy sovereignty goal using 100% carbon-neutral renewable energy resources. To achieve this goal, the Tribe has consistently invested in energy efficiency measures, LEED construction practices, and installing renewable energy generating systems throughout Tribal buildings. The Tribe's commitment to renewable energy is evidenced by its 2.47 MW of solar PV and an additional 0.77 MW scheduled to be installed in 2024 for a total of 3.24 MW. As an interim step towards energy sovereignty, FCPC has historically purchased renewable energy certificates (REC) from certified wind energy facilities annually to offset its electricity use.

1.2 FCPC Organizational Units and Workforce

The Forest County Potawatomi Community consists of four primary organizational units. The first unit, the General Council (1), includes all FCPC Tribal Members, totaling around 1,700 enrolled Tribal

Members. Approximately 53% of Tribal Members live in Forest County and adjacent counties, and 86% live in Wisconsin. On Tribal Lands, there are a total of 238 homes.

The General Council elects the Executive Council and votes on important governmental mat ers.

The second unit, the Tribal Government (2), consists of all Tribal Government employees who work on behalf of the General Council. The Tribal Government provides numerous services and is divided into the following divisions: Administrative, Capital Projects, Community Center, Education, Executive Council, Family Services, Finance, Health, Human Resources, Information Technology, Land & Natural Resources, Legal, and Public Works. There are currently around 600 employees who work for the Tribal Government, some of whom are also Tribal Members.

In Forest County, where the Tribal Government operates, there is a workforce of 3,286 individuals. Of those, approximately 18% are employed by the Tribal Government[1], making it one of the largest employers in the county. The Tribal Government includes 39 primary buildings that occupy over 560,000 ft^2, operates two wastewater treatment facilities equipped with pumps, and provides public street lighting. Additionally, the Tribe manages 15,447 acres of forested land zoned for Forest, Conservation, or Unzoned use and 971 acres of land zoned as farmland. The Tribal fleet has approximately 100 vehicles, of which 3 are electric (EVs).

The third organizational unit is the Tribe's two Casino-Hotels (3) located in Milwaukee, WI, and Carter, WI. These establishments provide the essential revenue to sustain the Tribal Government and the social services it offers to Tribal Members.

The Potawatomi Bingo Casino (PBC) in Milwaukee spans 1,326,425 ft^2. It employs nearly 2,000 workers, ranking the facility amongst the top 25 employers in Milwaukee[2]. On the other hand, the Potawatomi Carter Casino Hotel (PCCH), located south of Wabeno, WI, is smaller, has a footprint of 149,500 ft^2, and employs approximately 170 people.

Combined with the Tribal Government, FCPC collectively employs approximately 23%–nearly a quarter—of all Forest County residents, making the Tribe an essential economic engine for the county. The Casino-Hotels operate approximately 13 vehicles, of which 0 are EVs.

Lastly, the fourth unit is the Tribally-owned Potawatomi Business Development Corporation (PBDC, 4). Although the FCPC Energy Department (the "Department") possesses less information about PBDC operations and staffing, the primary facilities owned and operated by PBDC are in either Milwaukee, Wausau, or Forest County, Wisconsin.

PBDC is responsible for developing and managing new businesses for the Tribe that are not involved in gaming. PBDC's primary activities include general contracting (Greenfire Management LLC), government contracting (numerous subsidiaries), the Data Holdings Data Center, and the management of two convenience stores (c-stores)/gas stations in Forest County. PBDC's primary energy-using asset is the 46,000 ft^2 data center in Milwaukee. PBDC operates approximately 3 vehicles, of which 2 are EVs.

[1] See Appendix C for specific calculations.
[2] ht ps://careers.paysbig.com/us/en?_ga=2.239583235.1084306022.1708278949-855592449.1708278949&_gl=1*18b2m1p*_ga*ODU1NTkyNDQ5LjE3MDgyNzg5NDk.*_ga_HDFF75V5ZF*MTcwODI3ODk0OC4xLjEuMTcwODI3OTA2NS4yNC4wLjA.

1.3 Scope of the PCAP

1.3.1 Tribal Organizational Unit Boundaries

The Tribe's greenhouse gas emissions are primarily atr ibuted to the operations of the Tribal Government (2), Casino-Hotels (3), and PBDC (4). The scope does not, however, include the General Council (1) due to the difficulty of quantifying emissions from individual households, where site-specific data is unavailable. Nevertheless, the Department has ate mpted to quantify emissions from the General Council for Tribal Members living on Tribal Lands.

1.3.2 Geographical Boundaries

The geographical boundaries are defined as FCPC Tribal lands, encompassing Tribal Trust Land, Tribal Fee Land, and all Proclaimed Reservation Lands. It is important to note that PBDC operates some offices located outside Tribal Lands, and these facilities are *not* included as part of the scope of the PCAP.

As a general practice, the Tribe operates its facilities on Tribal Lands. It acquires land for its new facilities if existing land is unavailable. The only buildings utilized by FCPC for operations outside of its Tribal Lands are those falling within PBDC operations. Utility bills for these facilities are paid for by PBDC and are included in the scope of the PCAP. However, the Department is aware of 2 PBDC buildings located off Tribal Lands, which were not included in the scope of this study.

1.3.3 Scope 1 and 2 Emission Boundary

The project scope only includes Scope 1 and 2 emissions. Scope 1 and 2 emissions are much easier to measure and quantify than Scope 3. The main areas of interest excluded by Scope 3 emissions are employee commuting and the sale of gasoline at the C-Stores.

1.3.4 Data Priority Boundaries

The Department worked at length to ensure that the development of a Greenhouse Gas Inventory would be comprehensive; however, several limitations existed that prevented the Department from conducting a comprehensive inventory. The data that was not included as part of the PCAP includes:

- C-Store electric and gas use (Data limitation from the utility)
- Tribal fleet vehicle gasoline use
- Farm emissions / sequestered carbon
- Forest land use change

2. Approach to Developing the PCAP

2.1 Identifying and Engaging Key Stakeholders

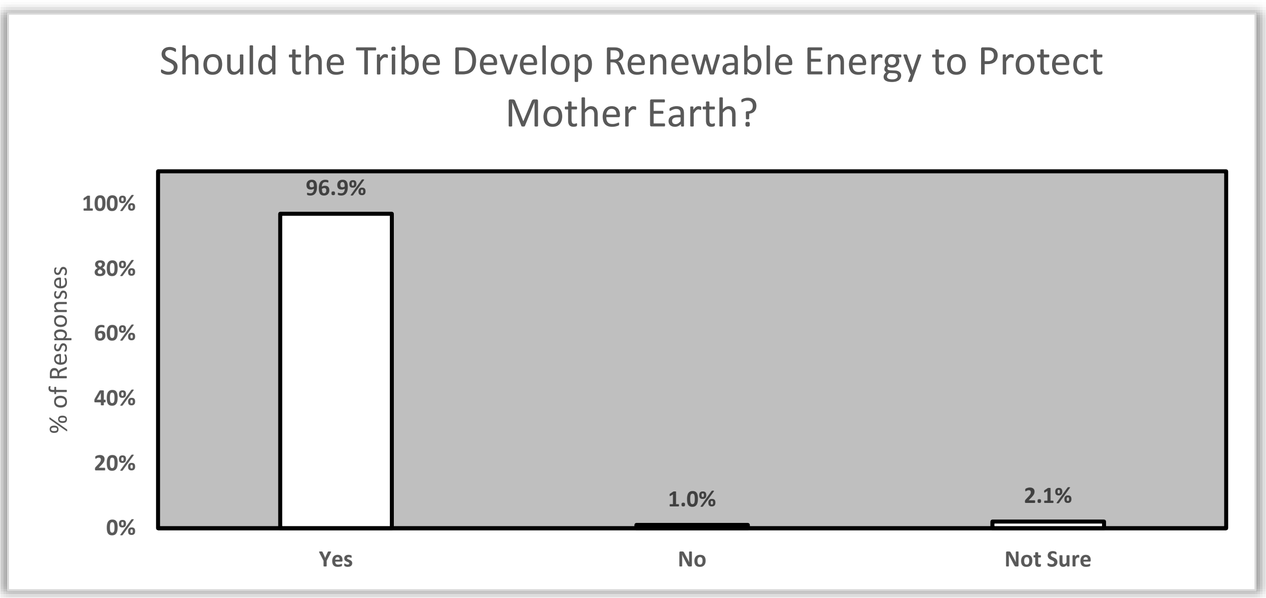
2.1.1 General Council

The most important stakeholder group is the General Council. The Tribal Government, Casino-Hotels, and PBDC were all created to serve the General Council. While the Tribe created its Environmental Mission Statement in 2007 and began building its energy program soon after, the General Council was never surveyed directly about its attitudes toward sustainable development until 2022.

Due to historically low turnout for surveys, the Department applied for and received a grant from Focus on Energy (FOE) to conduct paid surveys of FCPC Tribal Members and to create an Energy Plan. The survey yielded 97 responses, providing valuable insights that form the basis for informing future energy projects. The full survey report is included in Appendix A and is the cornerstone document used to guide energy decision-making on behalf of the General Council.

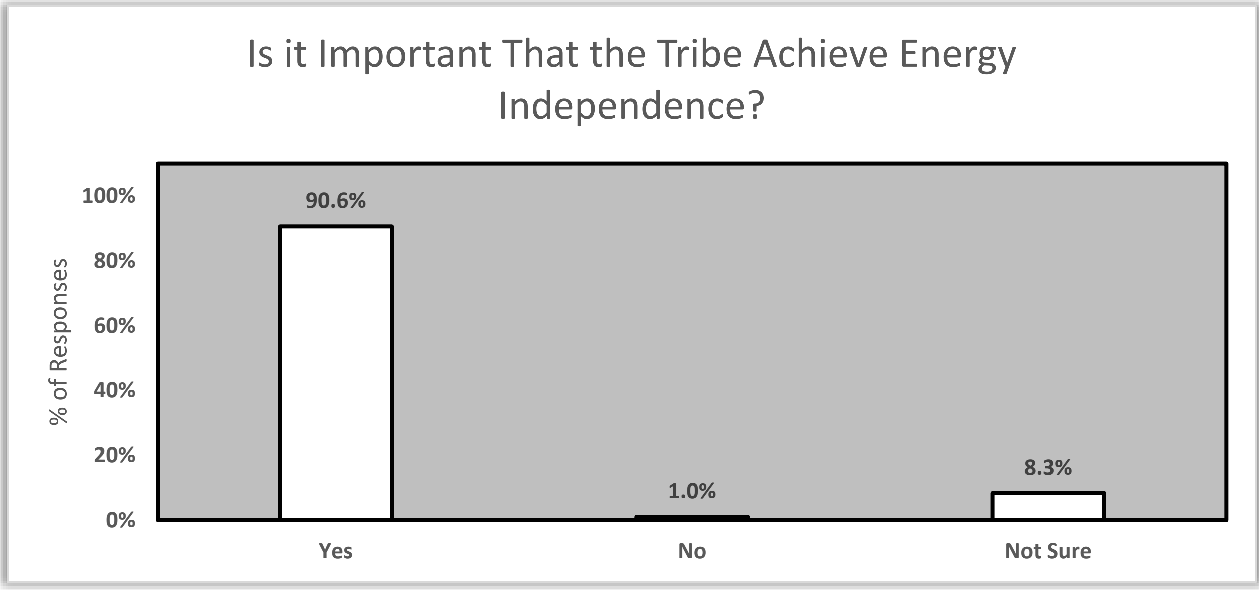
The survey found broad support for renewable energy and energy independence goals, as depicted in Figures 1 and 2 below. The survey found that 96.9% (93.5% - 100%) of Tribal Members support developing renewable energy, and 90.6% (84.8% - 96.4%) of Tribal Members support the pursuit of energy independence, which is a key tenant of the overarching value of maintaining or expanding Tribal sovereignty.

Figure 1: *General Council Support for Renewable Energy*



Margin of Error (95% Confidence) for Development of Renewable Energy: 3.4%

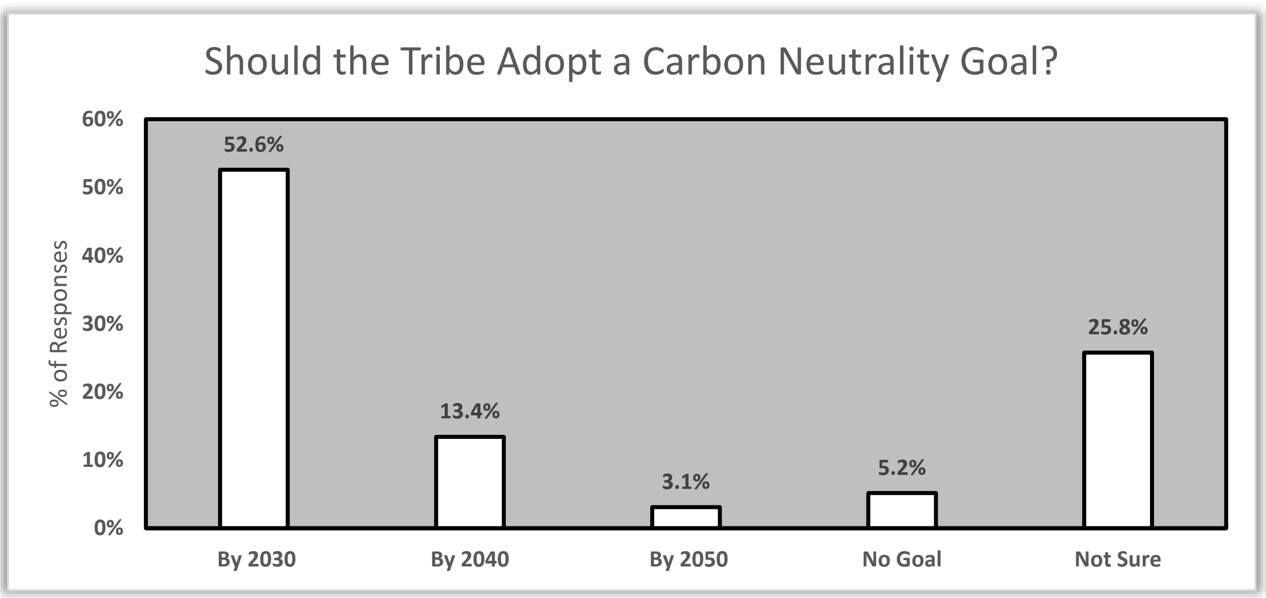
Figure 2: *General Council Support for Energy Independence*



Margin of Error (95% Confidence) for Achieving Energy Independence: 5.8%

The Department also asked if the Tribe should have a goal for carbon neutrality. The survey found that 69.1% (59.9% - 78.3%) of Tribal Members support a carbon neutrality goal by 2050, with the majority (52.6%) supporting a goal by 2030, as shown in Figure 3. However, a significant portion of respondents were not sure (25.8%), indicating that the concept of carbon neutrality was either novel, confusing, or both to this group of survey respondents, as the result was not congruent with the results found for renewable energy development. Given that most respondents indicated they would like to reach carbon neutrality by 2050 or sooner, the Department set a target to achieve carbon neutrality by 2050.

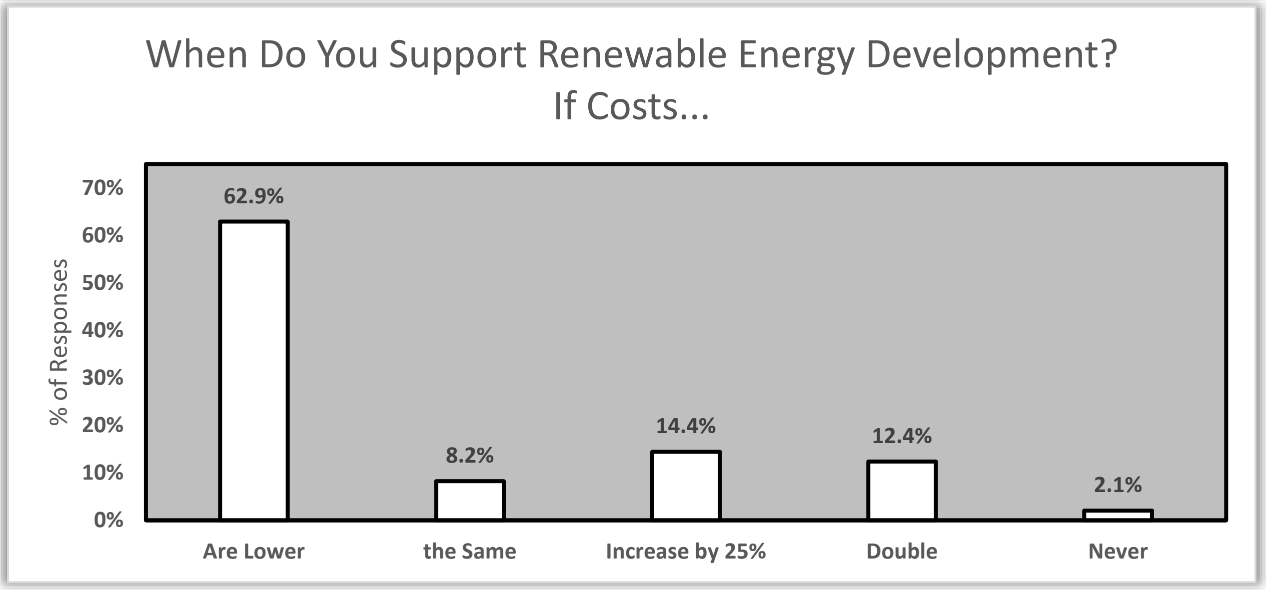
Figure 3*: General Council Support for a Carbon Neutral Goal*



Margin of Error (95% Confidence) for Any Carbon Neutral Goal: 9.2%

When Tribal Members were queried about their willingness to pay more money to achieve sustainability goals, the survey found that 71.1% (62.1% - 80.1%) of respondents favor renewable energy development only if their costs remain stable or decrease. This mandate effectively eliminates more expensive renewable energy projects that do not pay for themselves over their lifetimes, presenting a challenge for decarbonizing heat. The results are shown in Figure 4.

Figure 4*: General Council Support for Increased Costs Due to Renewable Energy Development*



Margin of Error (95% Confidence) for Costs Staying the Same or Lower: 9.0%

<u>2.1.2 Leadership</u>

For any energy project to be successful, it must first receive approval from divisional leadership, as well as from facilities managers who would be responsible for assuming project maintenance. The Department routinely meets with the Facilities Managers at the Tribal Government, PBC, PCCH, and PBDC. Additionally, the Department collaborates with the Fleet & Transit Manager for EV implementation projects.

Projects with potential environmental impacts undergo an Environmental & Cultural Review performed within the Land & Natural Resources Division, which also houses the Department. This step ensures that any feasibility issues are appropriately addressed prior to an Executive Council decision.

<u>2.2.3 Executive Council</u>

The Department and Legal Division regularly update the Tribe's Executive Council on developments in the Energy sector. All major energy projects are presented to the Executive Council, which is responsible for approving projects and ensuring they are funded; however, the budgeting process is separate. Any major project seeking approval within the PCAP must first undergo presentation to the Executive Council.

To date, the Executive Council has not approved any Greenhouse Gas reduction measures for implementation. The Department will seek approval for each project when due diligence is fully completed, which includes a budget estimate to approve or deny funding.

2.2 Establishing Greenhouse Gas Reduction Goals

Per results from the FCPC Energy Future Survey (Discussed in Section 2.1.1), the Department has the following goal:

PCAP Overarching Goal: Achieve net zero carbon emissions by 2050

As part of the FOE Tribal Nation Energy Plan Grant, the Department created baseline energy use data. It developed a plan to reduce the Tribe's energy use. This exercise has been combined with the FOE Tribal Nation Energy Plan Grant deliverable to minimize redundancy between the 2 projects[3]. To achieve the Tribe's goal of net zero carbon emissions by 2050, the Department met several times to develop more specific objectives. These objectives are broken down by their focus area as follows:

2.2.1 Decarbonize Tribal Member Homes

The primary goal in achieving net zero emissions by 2050 is prioritizing the decarbonization of Tribal Member homes. Thus, Objective 1 is *to decarbonize Tribal Member homes*. This will be accomplished by performing energy audits of all homes and providing weatherizing for eligible homes by 2030 (Obj 1.1 & 1.2), understanding that not all homeowners will opt for this invasive process. Next, all homes on propane will be transitioned to heat pumps by 2035 (Obj 1.3), as these devices offer cost savings for homeowners. By 2050, all homes on natural gas will also shift to heat pumps (Obj 1.4), allowing time for technology improvements to enhance cold climate performance and reduce homeowner expenses. Weatherizing homes before heat pump installation minimizes costs as the heating load and required pump size will be smaller.

Additionally, all willing homeowners will receive EV chargers to help facilitate the transition to low-carbon EVs by 2035 (Obj 1.5). Finally, the Department will install 50 solar arrays on Tribal Member homes by 2027 (Obj 1.6) and another 50 by 2030 (Obj 1.7), covering most of the feasible solar array locations on Tribal Lands.

Objective 1: Decarbonize Tribal Member Homes

- Objective 1.1: Conduct energy audits on all willing Tribal Member homes by 2025.
- Objective 1.2: Weatherize all willing Tribal Member homes by 2030.
- Objective 1.3: Transition all homes on propane to heat pumps by 2035.
- Objective 1.4: Transition all homes on natural gas to heat pumps by 2050.
- Objective 1.5: Install EV chargers on all homes by 2035.
- Objective 1.6: Install solar PV on 50 homes by 2027.
- Objective 1.7: Install solar PV on 100 homes by 2030.

[3] Note that while the FOE Tribal Nation Energy Plan grant has been used to fund part of the staff time that resulted in the creation of an energy baseline and Energy Plan, the Department has not used any CPRG funding for the creation of the PCAP, and thus there is no duplicative funding.

2.2.2 Enhance Energy Efficiency

The most cost-effective way to lower greenhouse gas emissions is often to focus on energy efficiency. EEMs typically offer paybacks shorter than their lifespans, thus paying for themselves, with some measures paying back in a year or less. Objective 2 is *to enhance energy efficiency*.

The Department aims to conduct ASHRAE Level 2 or 3 energy audits on all major energy-consuming facilities by 2025 (Obj 2.1). Currently, several high energy-consuming facilities are undergoing ASHRAE Level 2 and 3 audits, some of which are supported with funding from the CPRG Planning Grant. The energy audits will set a roadmap of feasible energy efficiency measures (EEMs) for the Department to implement. The Department will then obtain cost estimates for all EEMs (Obj 2.2) to ensure that paybacks can be calculated accurately for decision-making and create a prioritized EEM Implementation Plan for all EEMs across all projects by 2025 (Obj 2.3).

The Department aims to implement all feasible and profitable EEMs three years later by 2028 (Obj 2.4). This process will be repeated, at minimum, every 10 years (Obj 2.5); however, given the recent pace of innovation in energy efficiency, it may be warranted to audit buildings at a higher frequency every 5 years, assuming that a sufficient budget is available. Finally, the largest facilities with a Building Automation System (BAS) should receive routine Retrocommissioning (RCx) studies to ensure that buildings operate efficiently. The FOE RCx program can provide partial funding for this process, and most RCx studies should be profitable over their lifespan.

Objective 2: Enhance Energy Efficiency

- Objective 2.1: Conduct ASHRAE Level 2 or 3 energy audits on all significant energy-using facilities by 2025.
- Objective 2.2: Obtain firm cost estimates for all feasible EEMs proposed in energy audits.
- Objective 2.3: Create a prioritized EEM Implementation Plan by 2025.
- Objective 2.4: Install all feasible EEMs by 2028.
- Objective 2.5: Conduct energy audits on all major energy-using facilities at least every 10 years.
- Objective 2.6: Conduct RCx on all buildings with a BAS at least every 5 years.

2.2.3 Decarbonize Heat

While WEC Energy Group strives to be net carbon neutral by 2050[4], their plan still heavily relies on using fossil natural gas. Further, the utility plans to inject renewable natural gas (RNG) captured from dairy farms into its gas infrastructure to claim carbon-neutral status. This is based on the comparatively higher global warming potential (GWP) of avoided methane emissions (28[5]) compared to CO_2 (1). By incorporating less than 4% of RNG into its gas supply, WEC can claim net-zero natural gas status, assuming the RNG capture process is carbon-free, which is an over-simplification.

If FCPC decreases its natural gas use, it will still have the net effect of lowering CO_2e emissions, despite WEC's claims of carbon neutrality in its natural gas supply. Further, assuming WEC contracts for a fixed amount of RNG, with natural gas use remaining the same, a marginal decrease in FCPC natural gas use

[4] ht ps://www.wecenergygroup.com/csr/cr2022/wec-corporate-responsibility-report-2022.pdf
[5] ht ps://www.epa.gov/ghgemissions/overview-greenhouse-gases

should entirely fall under avoided fossil gas emissions. While doing nothing to the Tribe's electricity supply is anticipated by WEC to emit net zero carbon emissions by 2050, there is no such stated plan for natural gas beyond the limited supply of RNG. Therefore, Objective 3 is *to decarbonize the Tribe's heat*.

Heat decarbonization is best accomplished by ensuring that the building envelope is airtight and well-insulated, particularly in the cold climate of northern Wisconsin. The first step towards reinforcing the building envelope involves conducting a comprehensive audit of the building envelope itself. This step will be completed on all major energy-using buildings by 2028 (Obj 3.1). While ongoing energy audits may include a building envelope component, they may lack a comprehensive perspective on deep energy retrofits capable of reducing heating and cooling loads by 30% or more. Standards such as Passive House[6] offer one such roadmap to achieve such deep energy retrofits.

Retrofitting building envelopes is a costly endeavor, often best paired with other upgrades, such as new roofing or siding. The Department aims to retrofit all financially feasible building envelopes by 2035 (Obj 3.2), continuing this process as opportunities arise. For the purposes of this section, energy and heat recovery are considered to be an EEM rather than a Heat Decarbonization Measure (HDM) central to the focus of this objective.

The final step is to install air-source or ground-source heat pumps, which will use low-carbon or zero-carbon electricity to heat buildings more efficiently than electric resistance heat. Solar-thermal technology is also under exploration. The Tribe has explored the potential for bio-energy on several occasions, and the consensus of these studies is that wood-based heat would be costly and increase air emissions. Additionally, a 2 MW biodigester operated at PBC from 2015 to 2020, supplying renewable electricity and heat to PBC; however, this facility was ultimately shut down because of operational difficulties and was running at a loss. The current plan does not include speculative technologies such as hydrogen and others.

Objective 3: Decarbonize the Tribe's Heat

- Objective 3.1: Audit the building envelope of all major energy using Tribal buildings by 2028.
- Objective 3.2: Retrofit all financially feasible building envelopes by 2035.
- Objective 3.3: Install air-source or ground-source heat pumps on all buildings by 2040.

2.2.4 Generate Renewable Energy Where Feasible

Objective 4 is *to generate renewable energy where feasible*. By spring of 2024, the Tribe will have installed 3.24 MW of solar PV. While some locations are left on which to install solar PV, most prime sites have already been utilized. Solar PV has created land use conflicts in the past, with some Tribal Members not supporting ground-mounted solar PV.

To solve this problem, the Department explored installing Vertical Bifacial (VB) solar PV, which is mounted at a 90-degree tilt and takes up minimal land. This allows the technology to be paired with agriculture and plowing, resulting in minimal land use change on these sites. The Department submit ed a let er of interest to be considered for funding for a USDA PACE loan. If invited to apply, the Department will request funding to install 23.8 MW VB solar PV at 5 locations on FCPC farmland. The planning

[6] ht ps://www.phius.org/standards/retrofit

document for this study is included in Appendix B. Installation of a 23.8 MW VB project has the potential to generate 29,858 MWh / year, equivalent to 51% of the Tribe's 2023 electricity use!
Based on these initial results, the Department set an objective to install a 23.8 MW VB solar project by 2030 (Obj 4.1).

FCPC Tribal lands offer potential for many other renewable energy projects. For example, the Stone Lake campus, situated atop a 300-foot hill, may be ideal for wind energy generation to power significant loads in that area. Advances in geothermal technology may enable intstalling Geothermal Anywhere[7], such as the 3.5 MW Fervo Energy Pilot Project[8], which could be paired with electricity generation and district heating to decarbonize entire campuses.

Additionally, installing more solar PV on parking areas may be financially feasible. Still, limitations arise from the necessary uses of the parking areas, such as plowing, and the often prohibitive cost of the racking structure. Finally, the Department will explore the feasibility of additional land purchases or creating a joint venture with WEC Energy Group to install more significant amounts of renewable energy. The Department sets an objective to complete all of these studies by 2028 (Obj 4.2).

Objective 4: Generate Renewable Energy Where Feasible

- Objective 4.1: Install VB solar PV at all available sites by 2030.
- Objective 4.2: Conduct a comprehensive assessment of all renewable generation potential by 2028.

2.2.5 Transition to Electric Vehicles

Objective 5 is *to transition to electric vehicles*. Transitioning to EVs requires both promoting charging infrastructure and purchasing electric vehicles. Collaborating with the Public Works Division, the Department is piloting four Ford F150 Lightings, an electric Ford E-Transit, a plugin-hybrid Chrysler Pacifica minivan, and a hybrid dump truck. However, installing charging infrastructure has proven challenging due to the high ampacity required for EV chargers to be used with large vehicles. This has necessitated 2 electric panel upgrades thus far, with more expected in the future.

To effectively plan for a future charging expansion, the Department intends to conduct a comprehensive charging needs assessment by 2025 (Obj 5.1). Preliminary work, which included surveying all FCPC Government Employees on their desire for charging infrastructure, has been conducted as part of a grant application for the Charging and Fueling Infrastructure (CFI) Grant Program. It can be found in Appendix C.

Upon completing the comprehensive charging needs assessment, the Department will deploy Level 2 (Obj 5.2) and DC-Fast Charging (Obj 5.3) infrastructure at selected sites. The Electric Vehicle Charging Project indicates that EV adoption is more likely with DC-Fast Charging infrastructure and higher charging speeds. Thus, deploying a combination of slower and faster charging options is essential to make potential users feel more confident about their EV purchases.

[7] ht ps://www.nrel.gov/geothermal/anywhere.html
[8] ht ps://www.canarymedia.com/articles/geothermal/americas-first-enhanced-geothermal-plant-just-got-up-and-running

The Department also began an EV pilot project in 2023, facilitating the acquisition of the Ford Lightnings, e-Transit, and Pacifica. The EV pilot will run for three years, until 2025 (Obj 5.4). The current pilot has found that winter performance is a significant constraint, particularly for long-distance trips, such as between Forest County and Milwaukee. Findings from the pilot will be used to determine which vehicles are best suited for EV conversions in the short term and which vehicles may need to wait for bet er technology before they can transition. The Department expects to transition all eligible vehicle purchases to EVs by 2030 (Obj 5.5).

Objective 5: Transition to Electric Vehicles

- Objective 5.1: Evaluate charging and electric supply needs across FCPC locations by 2025.
- Objective 5.2: Install public Level 2 charging at all occupied FCPC buildings by 2030.
- Objective 5.3: Install DC-Fast Charging facilities in Stone Lake, Carter, the Wgema Campus, and at PBC by 2030.
- Objective 5.4: Complete the EV Pilot by 2025.
- Objective 5.5: Transition all eligible fleet procurement to EVs by 2030.

2.2.6 Enhance Resilience to Climate Change

Objective 6 is *to enhance resilience to climate change*. While the PCAP is a plan focused on mitigation, it is also essential to acknowledge and prepare for the inevitable warming of the planet. To this end, The Tribe applied for and received a Bureau of Indian Affairs (BIA) Tribal Climate Resilience Grant to fund a Climate and Sustainability Resilience (CSR) Coordinator position.

The CSR Coordinator will be responsible for updating the Tribe's Climate Change Plan and assessing vulnerability to climate change (Obj 6.1). Additionally, they will develop an adaptation plan (Obj 6.2) and pursue climate adaptation solutions (Obj 6.3). There are potentially many pathways for the CSR Coordinator to collaborate on mitigation projects, as resilience often requires backup energy storage. Moreover, there may be additional opportunities for integration with rural homes using electric vehicles as backup power sources.

Objective 6: Enhance Resilience to Climate Change

- Objective 6.1: Complete climate vulnerability assessment by 2024.
- Objective 6.2: Complete the plan for climate adaptation by 2026.
- Objective 6.3: Implementation of climate adaptation solutions by 2030.

2.2.6 Change Tribal Policy

Objective 7 is *to change tribal policy*. The Department currently has limited reach in shaping the energy efficiency of new projects. The Department will work with the Legal Division to develop a set of policies aimed at ensuring that the Tribe either achieves net zero emissions, or is ready to achieve net zero emissions in the future. Existing motions require that all new construction follow Leadership in Energy and Environmental Design (LEED) principles, and all roofs are to be designed to be solar-ready. However, additional steps are needed to further reduce emissions. This includes updating building codes to ensure that all new construction utilizes the most energy-efficient equipment and that building envelopes are designed to minimize heating and cooling loads most cost-effectively (Obj 7.1).

To further this goal, the Department will advocate for all new construction to be fully electric by 2035 (Obj 7.2). While this may not be practicable for all cases, electrifying buildings during construction is more economical than trying to retrofit fossil-based heating systems with electric alternatives afterward. In conjunction with Objective 5.5, the Department will pursue a policy mandating the purchase of all EVs by 2030 (Obj 7.3). Note that the Executive Council must approve any policy solution; therefore, the stated policy goals are aspirational.

Objective 7: Change Tribal Policy

- Objective 7.1: Update tribal building codes to require the highest cost-feasible standards in energy efficiency by 2025.
- Objective 7.2: Create a policy requiring all new construction to be fully electric by 2035.
- Objective 7.3: Create a policy requiring EV purchasing whenever practicable by 2030.

2.2.7 Enhance Energy Education

Objective 8 is *to enhance energy education*. The FCPC Energy Future Survey, presented in Section 2.1, revealed a significant portion of the FCP Community lacks a sufficient understanding of carbon neutrality. The Department has plans to develop a public-facing energy website aimed at community education by the end of 2024 (Obj 8.1).

The Department has been and will continue to give lectures on energy topics at local public schools that serve Tribal Youth (Obj 8.2). In 2023, the Department began hosting quarterly educational events that engage the community in a 2-way discussion about various energy topics. During these meetings, the Department presented its progress on various topics. It will use these meetings to plan future projects requiring stakeholder feedback (Obj 8.3).

Finally, the Department plans to renovate a vacant property to become a sustainable energy demonstration center for public education (Obj 8.4). The site will showcase multiple renewable energy technologies, all-electric appliances, and building envelope enhancements that reduce energy use.

Objective 8: Enhance Energy Education, Outreach, and Engagement

- Objective 8.1: Create a public-facing energy website by 2024.
- Objective 8.2: Present four to eight lectures each year about energy at local public schools.
- Objective 8.3: Hold quarterly energy outreach & engagement sessions for FCPC Tribal Members.
- Objective 8.4: Create a renewable energy demonstration house by 2026.

2.2.8 Summary of Decarbonization Objectives

A summary of each decarbonization objective is presented in Table 1 below.

***Table 1**: Summary of FCPC Decarbonization Objectives*

Objective	Description	Due Date
Objective 1: Decarbonize Tribal Member Homes		
1.1	Conduct energy audits on all willing Tribal Member homes.	2025
1.2	Weatherize all willing Tribal Member homes.	2030
1.3	Transition all homes on propane to heat pumps.	2035

1.4	Transition all homes from natural gas to heat pumps.	2050
1.5	Install EV chargers on all homes.	2035
1.6	Install solar PV on 50 homes.	2027
1.7	Install solar PV on 100 homes.	2030
Objective 2: Enhance Energy Efficiency		
2.1	Conduct ASHRAE Level 2 / 3 energy audits on all major energy-using facilities.	2025
2.2	Obtain firm cost estimates for all feasible EEMs proposed in energy audits.	2025
2.3	Create a prioritized EEM Implementation Plan.	2025
2.4	Install all feasible EEMs.	2028
2.5	Conduct energy audits on all major energy-using facilities at least every 10 years.	Every 10 Years
2.6	Conduct RCx on all buildings with a BAS at least every 5 years.	Every 5 Years
Objective 3: Decarbonize the Tribe's Heat		
3.1	Audit building envelopes of all major energy-using Tribal buildings.	2028
3.2	Retrofit all financially feasible building envelopes.	2035
3.3	Install air-source or ground-source heat pumps on all buildings.	2040
Objective 4: Generate Renewable Energy Where Feasible		
4.1	Install VB solar PV at all available sites.	2030
4.2	Conduct a comprehensive assessment of all renewable generation potential.	2028
Objective 5: Transition to Electric Vehicles		
5.1	Evaluate charging and electric supply needs across FCPC locations.	2025
5.2	Install public Level 2 charging at all occupied FCPC buildings.	2030
5.3	Install DC-Fast Charging facilities at Stone Lake, Carter, the Wgema Campus, and PBC.	2030
5.4	Complete EV Pilot.	2025
5.5	Transition all eligible fleet procurement to EVs.	2030
Objective 6: Enhance Resilience to Climate Change		
6.1	Complete climate vulnerability assessment.	2024
6.2	Complete plan for climate adaptation.	2026
6.3	Implementation of climate adaptation solutions.	2030
Objective 7: Change Tribal Policy		
7.1	Update tribal building codes to require the highest cost-feasible standards in energy efficiency.	2025
7.2	Create a policy to require all new construction to be all-electric.	2035
7.3	Create a policy requiring EV purchasing whenever practicable.	2030
Objective 8: Enhance Energy Education		
8.1	Create a public-facing energy website.	2024
8.2	Give 4 – 8 lectures each year about energy at local public schools.	Quarterly
8.3	Hold quarterly energy outreach & engagement sessions for FCPC Tribal Members.	Quarterly
8.4	Create a renewable energy demonstration house.	2026

2.3 Identifying Measures to Reduce Greenhouse Gas Emissions

As discussed in Section 2.2, the Department has already conducted extensive work to devise strategies for decarbonizing Tribal operations. Due to staffing constraints, the Department opted to formally quantify GHG reductions solely at its largest energy-consuming facility, PBC. All identified GHG reduction measures stem from an ongoing ASHRAE Level 3 energy audit of PBC performed by Michaels Energy, funded through the Tribe's CPRG Planning Grant allocation. The contract commenced in December 2023 and is scheduled to produce final deliverables, including formal cost estimates, by mid-March 2024, in alignment with the Tribe's CPRG Implementation Grant application timeline.

3. Greenhouse Gas Inventory

3.1 History of Greenhouse Gas Inventories at FCPC

FCPC has at various times created carbon emissions inventories for its scope 1 and 2 emissions in the utility sector, including reporting Tribal-wide electricity usage and REC offsets to the EPA Green Power Partner Program. The Tribe established an energy baseline in 2007 and contracted for the creation of carbon reports until what the Department's last record shows was received in 2014. Also, in 2007, the Executive Council passed a motion to receive quarterly energy reports, which was being fulfilled by the contractor until 2014. Subsequently, the responsibility was transferred to the nascent FCPC Energy Program. The Energy Program could never deliver these reports quarterly due to the extensive effort required to manually compile all of the Tribe's energy use data.

With additional staff resources acquired in 2021, the Department pushed forward a new effort to quantify utility emissions from all business units, supported by the Tribal Nation Energy Plan grant from FOE. However, obtaining the data in the required format for an energy database was challenging. Before 2020, the Department could only access its utility energy data by navigating from account to account in the Energy Information System (EIS) provided by WEC Energy Group, which oversees WE Energies and WPS electric and gas service. Further, the EIS did not list all accounts paid for by WPS, and thus data was inevitably missing.

To address the data gap issue, comprehensive audits of all bills FCPC paid were conducted across its organizational units. These audits found numerous previously unaccounted-for accounts and uncovered accounts that were paying tax on tax-exempt Trust Land and overpayments totaling hundreds of thousands of dollars. The Department worked to consolidate all of its bills into one group bill, which solved the overpayment issues and secured tax refunds on multiple accounts. However, any time a new electric or gas account is set up, it is not included in the group bill. It could still erroneously charge sales tax; thus, maintaining the Tribe's energy data is a never-ending affair.

The last obstacle to obtaining energy data was the Tribe's solar PV. Through two separate DOE grants, FCPC installed 17 solar arrays, all connected to the 3G cell phone or Wi-Fi networks. These arrays are equipped with meters to measure solar generation and feed the solar data into an online database. Unfortunately, around 2021, the 3G wireless network was discontinued, rendering 14 of the solar array's Locus Meters unable to transmit data. Further, the arrays on Wi-Fi had frequent data disruptions that led to data loss.

To address this issue, the Department applied for a US Department of Commerce (DOC) broadband grant to restore internet connectivity to these arrays via a hard-wire broadband connection. The Department assumed it could restore service to its Locus Meters and regain access to its solar data, but the company was sold, and the meters are no longer supported. Regret ably, this was discovered after broadband installation to the solar arrays. Thus, an alternative solution was required to access the Tribe's solar data. Ultimately, the Department chose eGauge meters as an alternative solution. The grant funded the installation of the eGauge meters, and all 17 arrays are now transmitting solar data in 2024, albeit with historical data lost.

Had the Department known beforehand about the viability issues of the Locus Meters, eGauge meters would have been installed at each solar array's electric panel. This approach would have been a cheaper installation and facilitated metering the total building energy use for real-time comparison with solar utilization versus building energy use. Moving forward, this approach should be considered a best practice with any new solar array installed at FCPC.

Finally, the Department is working to convert all solar array generation data to eGauge meters to ensure uniform data collection and upload it directly to the new energy database. Using only eGauge will save staff time when pulling data and ensure that data is never lost again, as eGauge does not require support from eGauge to run the meters. Thus, if eGauge goes out of business as Locus did, the Tribe will still have free access to its data. Efforts are ongoing to retrofit several newer solar arrays installed after 2021 with eGauge meters.

Once the Department gained access to its energy data, it explored two potential solutions to quantify the Tribe's emissions. Firstly, the Department considered utilizing a subscription to the EnergyCAP database management software, purchased in 2019, that could deliver quarterly energy reports. However, upon review, it was found the EnergyCAP software required a significant amount of setup and training to learn how the system works. While EnergyCAP could give energy reports, these reports would not be able to present the desired data in a consistent format across all business needs. The software also could not deliver custom report solutions, including calculations for the true cost avoided by installing solar PV.

The Department then reviewed the Portfolio Manager by Energy Star as an alternative solution. Portfolio Manager is an industry-wide standard for building benchmarking. It can log and report several metrics of interest to the Department and Executive Council. However, this solution was also not pursued because it cannot report the true cost avoided by installing solar PV.

While many other solutions could also be used to create an energy database, the Department eventually opted for a custom energy database solution. Given the magnitude of accounts (104 electric, 32 gas, 28 solar, 30 propane) sourced from different platforms and in diverse formats, an automated approach was needed to streamline the staff time required to generate quarterly energy reports. The Department ultimately decided to construct an energy database using Python that relies on Microsoft PowerBI for custom report creation.

This solution not only enabled the Department to estimate the true cost savings from solar PV but also allowed for the creation of any custom report desired. Moreover, the custom energy database solution eliminated human errors by automating the data upload and manipulation process. It further significantly sped up the staff time required to generate a report. The PCAP is the Department's first Greenhouse Gas Inventory report to use the custom energy database solution, completed in 2024.

3.2 Energy Database Methodology

3.2.1 Scope

The scope of the PCAP and energy database are defined in Section 1.3.

3.2.2 Comprehensive Audit of Accounts

The Department thoroughly audited all utility accounts paid by the Tribe's applicable organizational units. To achieve this, the Department reviewed all utility bills each organizational unit's Accounting Department paid. For data related to PBC and PCCH, which was not shared directly with the Department, updates were made to the WEC EIS system, which reflects all accounts paid by the Casino-Hotels. The Department then cross-referenced this information with the Land Information Department's database of addresses on FCPC Tribal Lands. This allowed the Department to validate known addresses with account numbers, which were not always clearly linked. Finally, the Department visited most of the utility meters physically to confirm that the meter number on the bill corresponded accurately to the respective building.

3.2.3 Creation of a Master Building List

Next, the Department created a *Master Building List*, which serves as the backbone of the energy database. The *Master Building List* is an Excel file that contains all relevant information for each building account. The Department updated all addresses in the EIS system to ensure each account address was unique. This uniqueness is essential for establishing a one-to-one mapping of each address to each bill or solar generation data row.

While the data from WEC Energy Group contains the exact address within the energy database, the bill information lacks the additional details necessary for proper data filtering and generating reports. Examples of filter categories are shown in Figure 5, which include the *Business Unit, Use Category, City / Town, County, Benchmarking Eligibility, Electric Utility, Electric Tariff*, and several other fields. The *Group Building Name* field facilitates the aggregation of multiple utility accounts associated with the same building. These can involve multiple electric or gas accounts for the same building. Thus, the Group Building Name allows filtering by total building energy use or other metrics of interest.

Note that in Figure 5, multiple accounts all show the same floor area, which ensures that the aggregation of data at the *Group Building Name* level is normalized to the total floor area of the entire building.

***Figure 5**: Excerpt of the Master Building List for the Energy Database*

Group Building Name	Address	Floor Area (ft2)	Business Unit	Use Category	City / Town	County	Benchmark EUI	Electric Utility	Electric Tariff
PBC Milwaukee Casino & Hotel	1611 W CANAL ST	1,326,245	Casino / Hotel	Casino / Hotel	Milwaukee	Milwakee	YES	WE Energies	WE_Cp1
PBC Milwaukee Casino & Hotel	1721A W CANAL ST	1,326,245	Casino / Hotel	Casino / Hotel	Milwaukee	Milwakee	YES		
PBC Milwaukee Casino & Hotel	1721C W CANAL ST	1,326,245	Casino / Hotel	Casino / Hotel	Milwaukee	Milwakee	YES	WE Energies	WE_Cp1
PCCH	618A STATE HIGHWAY 32	149,500	Casino / Hotel	Casino / Hotel	Wabeno	Forest	YES	WPS	WPS_Cg20
PCCH	620 STATE HIGHWAY 32	149,500	Casino / Hotel	Casino / Hotel	Wabeno	Forest	YES		
Community Center	5471 THE PLACE WHERE EVE	108,916	Government	Community Gathering	Crandon	Forest	YES	WPS	WPS_Cg20
Wgema Wgetthta & Cafeteria	3201 W STATE ST	77,281	Government	Office / General	Milwaukee	Milwakee	YES	WE Energies	WE_Cg2
Wgema Wgetthta & Cafeteria	944 N 33RD ST	77,281	Government	Office / General	Milwaukee	Milwakee	YES	WE Energies	
Wgema Wgetthta & Cafeteria	3136 W KILBOURN AVE	77,281	Government	Office / General	Milwaukee	Milwakee	YES	WE Energies	WE_Cg2
Health & Wellness Center	8201 MISH KO SWEN DR	69,000	Government	Healthcare	Crandon	Forest	YES	WPS	WPS_Cg20
Executive Building	5416 EVERYBODYS RD	44,940	Government	Office / General	Crandon	Forest	YES	WPS	WPS_Cg20
Wgema Wunder Hall	3215A W STATE ST	34,720	Government	Office / General	Milwaukee	Milwakee	YES	WE Energies	
Wgema Wunder Hall	3215B W STATE ST	34,720	Government	Office / General	Milwaukee	Milwakee	YES	WE Energies	WE_Cg2
Assisted Living & Turtle House	5456 KAK YOT LN	28,360	Government	Healthcare	Crandon	Forest	YES	WPS	WPS_Cg5
Ka Kew Se Gathering Grounds	3934A FERRY RANCH LN	25,447	Government	Community Gathering	Wabeno	Forest	YES	WPS	WPS_Cg1
Wgema Gym	3232 W KILBOURN AVE	18,090	Government	Office / General	Milwaukee	Milwakee	YES	WE Energies	WE_Cg1
Tribal Center / Public Works	8000A POTAWATOMI TRL	13,950	Government	Office / General	Crandon	Forest	YES	WPS	WPS_Cg1
Farm Wash & Pack	3389B COUNTY ROAD H	13,050	Government	Office / General	Laona	Forest	YES	WPS	WPS_Cg5

The *Master Building List* also contains a list of electricity, gas, propane, and solar meter/account numbers. The meter/account numbers are used to map propane and solar data to each building because the data do not contain any identifying information as to which building they belong to. Thus, the *Master Building List* links that data to the filter categories.

3.2.3 Greenhouse Gas Accounting Method, Mapping of Emissions and Solar Avoided Costs

The current setup of the energy database focuses on accounting for Scope 1 and 2 emissions. Emissions from gasoline and diesel are not currently tracked due to a lack of data availability, but will be added in the future. However, gasoline and diesel emissions contribute to a small fraction of the Tribe's overall emissions.

The Department calculates emissions for all utility data that the Tribe is responsible for paying. As such, only the bills in the Accounting Department's payment system are counted for Scope 1 and 2 emissions. While the Tribe operates as a lessor for certain properties, the majority of properties used by the Tribe are owned and operated by the Tribe. The Department follows the guidance provided by the GHG Protocol[9], such that when the Tribe is a lessor, the emissions are considered Scope 3 and thus are not accounted for in Scope 1 and 2 emissions. In such cases, obtaining utility bills directly from WEC Energy Group or contacting the lessee for energy bills is necessary. Still, this process has not been pursued for rented properties, with no current plans to do so.

There is one notable exception to this rule, which is for Tribal homes located on Tribal Lands. The Department has not counted these emissions in its inventory; however, the Tribe owns several rented homes on Tribal Lands that the Department will quantify as part of its Scope 1 and 2 emissions, even though renters are responsible for their bills. This is because the buildings are rented only to FPC Tribal Members and not to a third-party lessee with no affiliation with the Tribe.

Emissions factors for electricity data and avoided electricity costs are mapped from the *Electric Tariffs & Emissions Factors* file. This file contains a list of electric tariffs and electric costs by year for each active tariff. For emissions factors, the database only differentiates between WE Energies and WPS by each year. The database uses emissions factors from two years prior, as this is the shortest delay interval between the current year and when the data are published to the EPA. Emissions factors are published

[9] ht ps://ghgprotocol.org/sites/default/files/2022-12/Chapter8.pdf

directly on the WE Energies and WPS websites. Emissions factors for natural gas and propane are based on the EIA[10].

Using the *Electric Tariffs & Emissions Factors* file allows the Department to calculate the exact avoided cost of electricity based on the measured amount of peak hour generation and off-peak generation for solar PV. An excerpt of the *Electric Tariffs & Emissions Factors* file is shown in Figure 6. If a tariff is flat all year, all cost data is considered *Winter Off Peak*. Note that the *WE_Gl1* and *WPS_LS1* tariffs are exclusively for lighting only tariffs and never have solar arrays associated with them, so all of their cost data is blank. As with the *Master Building List*, data is linked between the *Electric Tariffs & Emissions Factors* file through the *Electric Tariff*, which is added to solar generation data from the *Master Building List*.

***Figure 6**: Electric Tariffs & Emissions Factors File Excerpt*

Year	Electric Tariff	Electric Emissions Factor (kg CO2e / kWh)	Solar Net Meter Sellback ($ / kWh)	Solar Summer On Peak Value ($ / kWh)	Solar Summer Off Peak Value ($ / kWh)	Solar Winter On Peak Value ($ / kWh)	Solar Winter Off Peak Value ($ / kWh)
2024	WE_Gl1	0.416					
2024	WE_Rg1	0.416					$0.172
2024	WE_Cg1	0.416					$0.158
2024	WE_Cg2	0.416		$0.126	$0.090	$0.126	$0.090
2024	WE_Cg3	0.416		$0.091	$0.057	$0.091	$0.057
2024	WE_Cg6	0.416		$0.233	$0.106	$0.233	$0.106
2024	WE_Cp1	0.416		$0.094	$0.060	$0.082	$0.060
2024	WPS_Ls1	0.562					
2024	WPS_Rg1	0.562	$0.035				$0.132
2024	WPS_Cg1	0.562	$0.035				$0.119
2024	WPS_Cg5	0.562	$0.035				$0.112
2024	WPS_Cg20	0.562	$0.035	$0.073	$0.043	$0.073	$0.043
2023	WE_Gl1	0.445					
2023	WE_Rg1	0.445					$0.166
2023	WE_Cg1	0.445					$0.154
2023	WE_Cg2	0.445		$0.124	$0.089	$0.124	$0.089
2023	WE_Cg3	0.445		$0.087	$0.054	$0.087	$0.054
2023	WE_Cg6	0.445		$0.228	$0.104	$0.228	$0.104
2023	WE_Cp1	0.445		$0.092	$0.058	$0.080	$0.055
2023	WPS_Ls1	0.621					
2023	WPS_Rg1	0.621	$0.048				$0.136
2023	WPS_Cg1	0.621	$0.048				$0.123
2023	WPS_Cg5	0.621	$0.048				$0.117
2023	WPS_Cg20	0.621	$0.048	$0.078	$0.046	$0.078	$0.046

3.2.4 Quantification of Solar Generation by Tariff Structure

The final step in quantifying the value of solar PV is to define the periods for *Summer* and *Winter* hours, along with distinguishing between *On Peak* and *Off Peak* hours. The Department read through each tariff and thresholded for applicable peak hour times, excluding weekends and certain holidays. These timeframes were explicitly defined in the Python scripts to ensure accurate quantification of *Peak Hours*, thereby yielding a highly precise estimate of the true value of solar generation. *Peak Hours* are defined in the *Peak Hours* file for each tariff. An excerpt of the *WPS_Cg20 Tariff* is shown in Figure 7.

[10] ht ps://www.eia.gov/environment/emissions/co2_vol_mass.php

Figure 7*: Peak Hours File Excerpt*

Winter Month	Winter Hour	Summer Month	Summer Hour
1	8	6	8
1	9	6	9
1	10	6	10
1	11	6	11
1	12	6	12
1	17	6	17
1	18	6	18
1	19	6	19
1	20	6	20
2	8	7	8
2	9	7	9
2	10	7	10
2	11	7	11
2	12	7	12
2	17	7	13
2	18	7	14
2	19	7	15

Notes WPS_Rg1 WPS_Cg1 WPS_Cg5 WPS_Cg20

<u>3.2.5 Estimation of Solar Generation</u>

As discussed in Section 3.1, there were significant gaps in the data available for 17 of the Tribe's solar arrays. Consequently, the Department had to rely on model data instead of actual data, which was unavailable for the selected 2023 Base Year. When actual data was absent, the Department used a combination of available historical data with an educated guess about the timing of solar generation during winter. While the summer generation usually followed the expected NREL PVWats generation when data was available, winter generation was not close to NREL PVWats estimates. Figure 8 illustrates how solar generation was discounted from default NREL PVWat s[11] data to account for the significant winter solar shading experienced in Northern Wisconsin. The timing of these adjustments is crucial as it informs the calculation of the true avoided cost of solar. On certain tariffs, summer rates are higher, resulting in a higher value associated with avoided summer electricity use than winter.

[11] ht ps://pvwat s.nrel.gov/

***Figure 8**: Modified NREL PVWatts Hourly Solar Generation Dataset*

PVWatts Hourly PV Performance Data		**Discount Value**	
Requested Location	54541, USA	January	0.2
Location	Lat, Lng: 45.57, -88.66	February	0.2
Latitude (DD)	45.57	March	0.4
Longitude (DD)	-88.66	April	0.95
Elevation (m)	480.2	May	1
DC System Size (kW)	1	June	1
Module Type	Standard	July	1
Array Type	Fixed (open rack)	August	1
Array Tilt (deg)	30	September	1
Array Azimuth (deg)	180	October	1
System Losses (%)	14.08	November	0.96
DC to AC Size Ratio	1.2	December	0.2
Inverter Efficiency (%)	96		
Ground Coverage Ratio	NA	**Total kWh / kW**	**1,050**
Albedo	From weather file		
Bifacial	No (0)	Enter kW	49.6
Monthly Irradiance Loss (%)			
		Total kWh	**52,084**

In instances where solar generation data was unavailable, the total solar generation closest in proximity to the location and angle of the solar array was utilized, which is shown in Table 2. The 30-degree tilt array is typical of a ground mount, which will shed snow at the best of all angles at FCPC. The 20-degree tilt array is typical of a roof-mounted array, which holds onto snow more than the 30-degree array. Meanwhile, the 10-degree tilt array, representing ballasted roof mount arrays often found on flat roofs, typically remains covered in snow for most of the winter. The Milwaukee County array's generation is significantly higher than Forest County because of the much lower annual snowfall in Milwaukee County compared to Forest County and the warmer winters that promote quicker snow melt.

***Table 2**: Summary of Modeled Solar Generation by Tilt Angle and Location*

Zip / County	Tilt (deg)	Generation (kWh / kW)
54541 – Forest County	30	1,050
54541 – Forest County	20	1,000
54541 – Forest County	10	950
53233 – Milwaukee County	30	1,150

3.2.6 Calendarization

Calendarization is breaking an energy bill into the portion of each month that the bill spans. It is important because energy bills come in sporadic times and often bisect monthly. While the energy database could have been set up to allocate energy usage to the month when the bill was incurred, this would have resulted in a choppier picture of building monthly energy use, as sometimes there are 2 bills in the same month and none in another. In the case of propane, one bill could span over a year between the current and previous fill-up, making calendarization important. While the data is not weather normalized, as EnergyCAP performs, it is still bet er than raw data.

The energy database uses the same methodology as the Energy Star Portfolio Manager[12], which assigns a flat percentage of energy use to the percentage of each month that a bill falls into. All calendarization operations are performed within Python.

3.2.7 EUI Calculations

Energy conversions to Btu follow the Energy Star Portfolio Manager Thermal Energy Conversions Technical Reference[13]. Energy conversions to source emissions follow the Energy Star Portfolio Manager Source Energy Technical Reference[14].

3.2.8 Data Format

The final data format in PowerBI is shown in Figure 9. Final calculations of carbon emissions, EUI, and other metrics are made within PowerBI. For example, within the *Electric Total Use (kWh)* and *Electric Building Use (kWh)* columns in Figure 9, both buildings have solar installed. Still, the columns are the same values, even though billed electric use does not include all building energy use because solar also provides building electricity. The data is the same in Figure 9 because the solar generation data is in a different row. The operation to add solar generation data to the *Electric Total Use (kWh)* column doesn't total until filters are applied, such as calculating building energy use over 12 months for 1 building. The same functionality applies to buildings that have multiple accounts on the same building.

Figure 9*: Final Data Format of the Energy Database in PowerBI*

Electric Tariff	Heat Utility	Heating Method	Solar Installed	Benchmark EUI	Floor Area (ft2)	Electric Total Cost ($)	Electric Total Use (kWh)	Electric Building Use (kWh)
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1655.38	12898.8	12898.8
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1460.62	11381.2	11381.2
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1542.07	12005.5	12005.5
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1252.93	9754.5	9754.5
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	937.81	7101.9	7101.9
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	879.19	6658.1	6658.1
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1668.74	13007.7	13007.7
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1374.26	10712.3	10712.3
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	3004.85	24835.9	24835.9
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	1036.15	8564.1	8564.1
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	3098.97	25414.1	25414.1
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	332.03	2722.9	2722.9
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	2644.29	21618	21618
WPS_Cg5	Northwoods LP	Propane	Yes	YES	13050	440.71	3603	3603
WPS_Cg5	WPS	Natural Gas	Yes	YES	10686	1631.87	13814.1	13814.1
WPS_Cg5	WPS	Natural Gas	Yes	YES	10686	421.13	3564.9	3564.9
WPS_Cg5	WPS	Natural Gas	Yes	YES	10686	1172	9419.4	9419.4

3.2.9 Data Review

Before any data is uploaded to the Energy Database, the Energy Sustainability Analyst thoroughly reviews the data quality. In general, the data received by each data source is of excellent quality; however, the Department did uncover an error in the number of billing days from 1 WEC Energy data sheet. The number of billing days was on the order of years instead of 1 month, which triggered the

[12] ht ps://energystar.my.site.com/PortfolioManager/s/article/How-does-Portfolio-Manager-calendarize-bills#:~:text=How%20does%20Portfolio%20Manager%20calendarize%20bills%3F,-How%2Ddoes%2DPortfolio&text=Portfolio%20Manager%20performs%20a%20calendarization,the%20bill%20you've%20entered
[13] ht ps://portfoliomanager.energystar.gov/pdf/reference/Thermal%20Conversions.pdf
[14] ht ps://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf

calendarization program to calendarize the energy use for all erroneous billing days instead of the 1 month period it should have been. The Department corrected this error by replacing the erroneous number with “30 days” instead.

Most of the data review required was in the setup of the energy database itself. The database requires carefully configuring the Master Building List and all files. If something is entered incorrectly, this would result in data that would not have filter categories and would thus not show up if any filters were applied. The Department checked for mapping errors by filtering the data for rows with no filter categories applied to them. This allows the Department to identify any missing links between the Master Building List and the WEC Energy data sheet, for example. The Department further found that a solar meter was entered for the wrong building, which resulted in a Python error because it was trying to find an electric tariff on a gas account that didn’t exist on the Master Building List. Correcting for setup errors was a normal and expected process, which is now working seamlessly.

Finally, the Department is not in a position to verify the accuracy of utility-metered account information. All data received by the Department is assumed to be accurate, and outside of installing separate FCPC-owned meters on each account, the Department must accept the accuracy of the metered information.

3.2.10 Limitations

The energy database is mostly complete, but there are a few notable limitations of the database. These limitations include:

1. Solar sellback data is not available yet from the utility company. All solar generation is treated as building energy use when added to the *Electric Building Use (kWh)* column in PowerBI. The Department is working with the utility to receive the sellback data in its monthly pull, but it is currently unavailable. Thus, total building energy use is overestimated. This only affects EUI calculations. This also means that despite the Department’s best efforts to get an exact value of solar, it relies exclusively on avoided electricity costs and not on sellback to the utility. In 2023, the sellback rates were higher than retail rates on some accounts. Sellback tends to be a small fraction of total generation, but this nevertheless makes the value of solar not as precise as it could be if the data was available from WEC Energy Group.

2. As discussed in Section 1.3, data for the Tribe’s 2 C-Stores are not currently available in the 2023 baseline dataset. The Department is working with WEC Energy Group to obtain these data, but they were unavailable in time for the PCAP report. The two buildings, while somewhat high energy users, will not significantly skew the energy database, as they are expected to contribute less than 1% of all the Tribe’s emissions.

3. Square footage data was not available for all buildings. This means that the benchmark dataset does not reflect all buildings. These data are currently being compiled and will be included in the Department’s next database update.

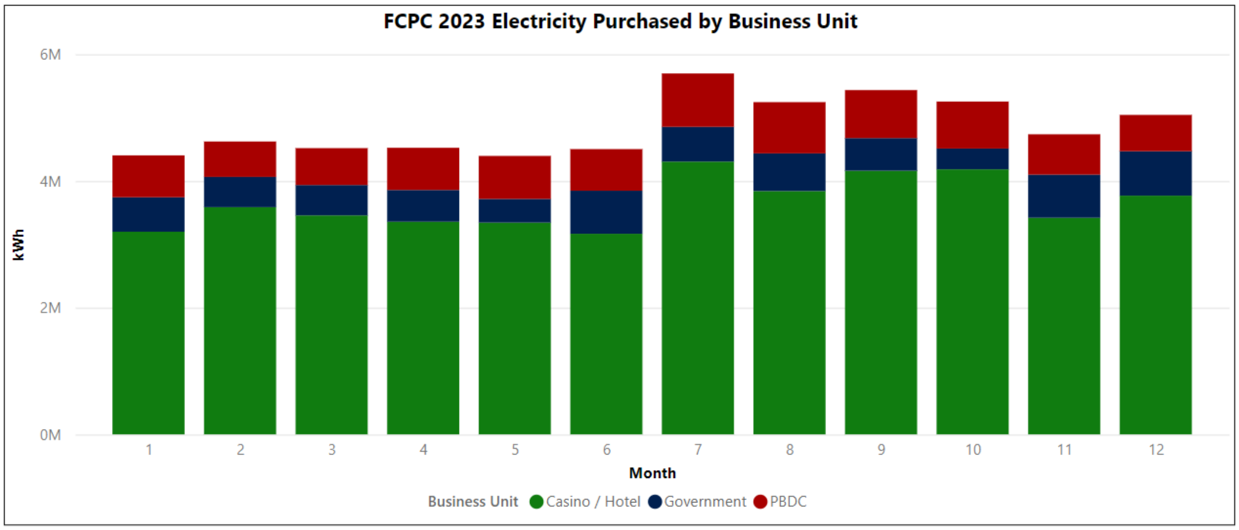
3.3 Selection of the Base Year - 2023

The Department initially planned to create a three-year historical dataset, but due to time limitations, only 1 year was compiled. Changes in the account structures and available historical data made extending the database difficult before 2023. Therefore, the energy database only relies on 2023 data; thus, 2023 is the selected base year for the PCAP.

3.4 Energy Use

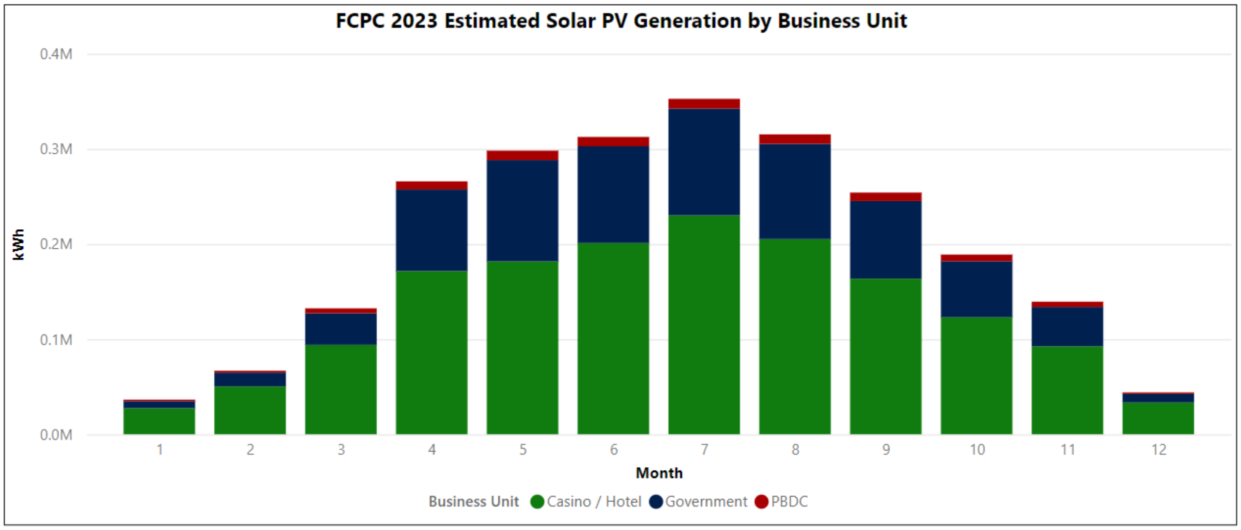
In 2023, the Tribe purchased 58,372 MWh of electricity from WE Energies and WPS. The Casino-Hotels purchased 43,786 MWh (75.0%), the Tribal Government purchased 6,423 MWh (11.0%), and PBDC purchased 8,162 MWh (14.0%). The results are shown in Figure 10.

Figure 10*: FCPC 2023 Electricity Purchased by Business Unit*



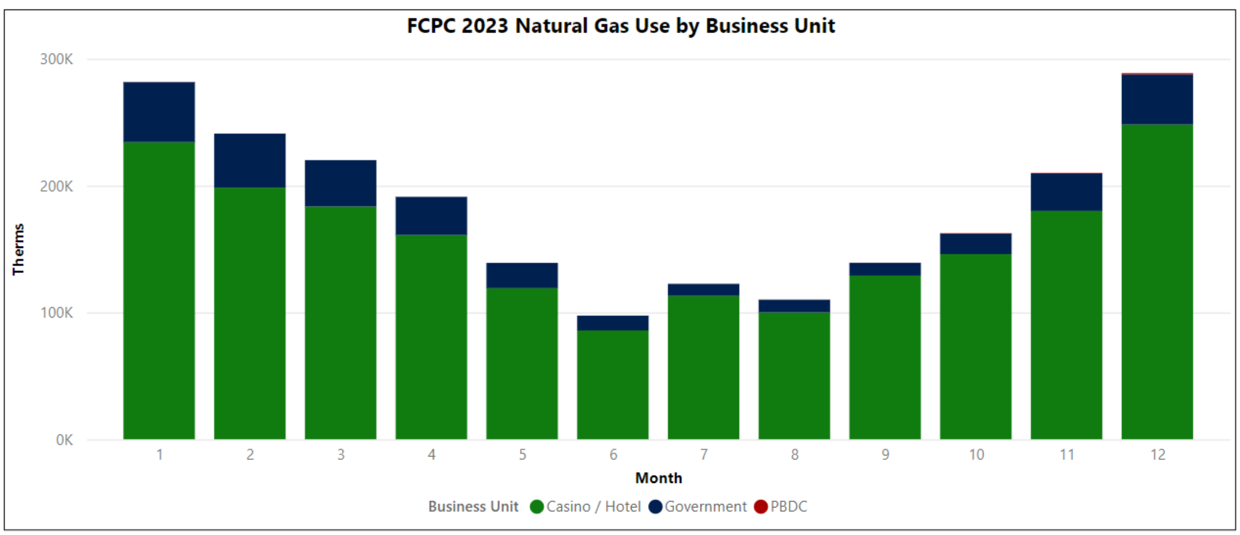
In 2023, the Tribe is estimated to have generated 2,406 MWh from solar PV. The Casino-Hotels generated 1,574 MWh (65.4%), the Tribal Government generated 752 MWh (31.3%), and PBDC generated 80 MWh (3.3%). The results are shown in Figure 11. When combined with purchased electricity, the Tribe used 60,778 MWh (4.0% solar), the Casino-Hotels used 45,360 MWh (3.5% solar), and PBDC used 8,242 MWh (1.0%).

***Figure 11**: FCPC 2023 Estimated Solar PV Generation by Business Unit*



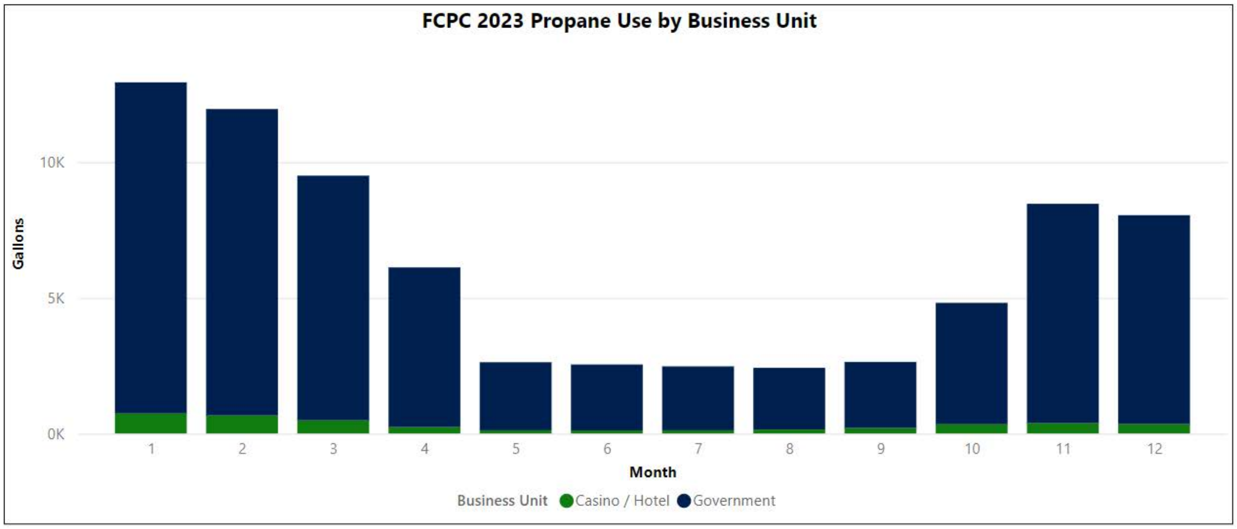
In 2023, the Tribe used 2,203,645 therms. The Casino-Hotels used 1,898,442 therms (86.2%), the Tribal Government used 302,882 therms (13.7%), and PBDC used 2,321 therms (0.1%). The results are shown in Figure 12.

***Figure 12**: FCPC 2023 Natural Gas Use by Business Unit*



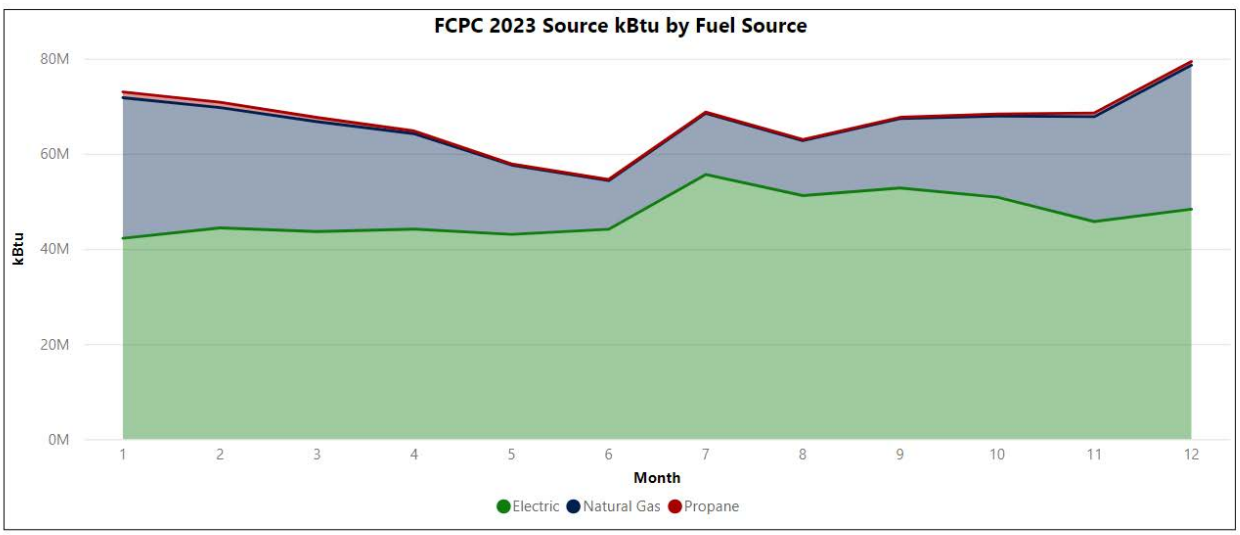
In 2023, the Tribe used 74,558 gallons of propane. The Casino-Hotels (PCCH) used 3,878 gallons (5.2%), and the Tribal Government used 70,680 gallons (94.8%). Note that the spring months are skewed because tanks are filled all year. For example, tanks that would be filled in March 2024 but didn't have a previous fill until October 2023 would not show up in the data. The results are shown in Figure 13.

***Figure 13**: FCPC 2023 Propane Use by Business Unit*



Accounting for source energy, which includes primary fuel use at the power plant and losses therein, is shown in Figure 14. In 2023, the Tribe used 677,055 MMBtu, of which 520,310 MMBtu (76.8%) was used for electricity, 152,044 MMBtu (22.5%) was used for natural gas, and 4,701 MMBtu (0.7%) was used for propane.

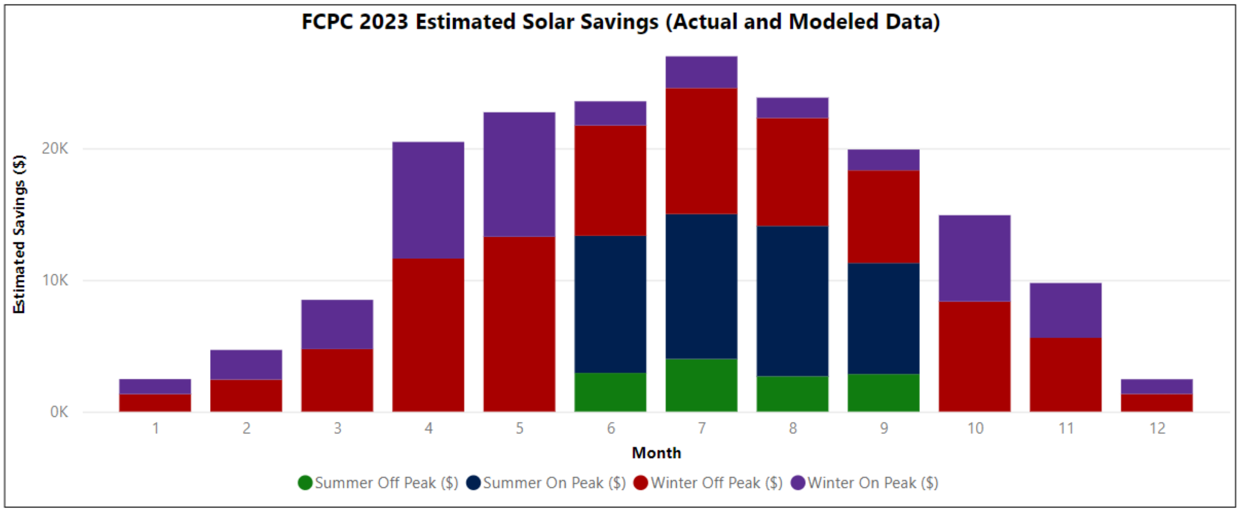
***Figure 14**: FCPC Source kBtu by Fuel Source*



3.5 Value of Solar PV

The value of solar PV is a major reason the Department chose to develop a custom database solution. Many Tribal Members have requested data on how much money solar is saving the Tribe, which prompted this feature to be included in the energy database. In 2023, solar PV was estimated to have saved the Tribe $180,207. Note that this savings figure does not include operation and maintenance costs, and it does not include the cost of capital. Figure 15 shows a breakdown of how the energy database assigns peak hour value of avoided utility purchases based on tariffs and generation time of day. Note that tariffs with year-round cost structures are allocated to *Winter Off Peak*.

***Figure 15**: FCPC 2023 Estimated Solar Savings (Actual and Modeled Data)*

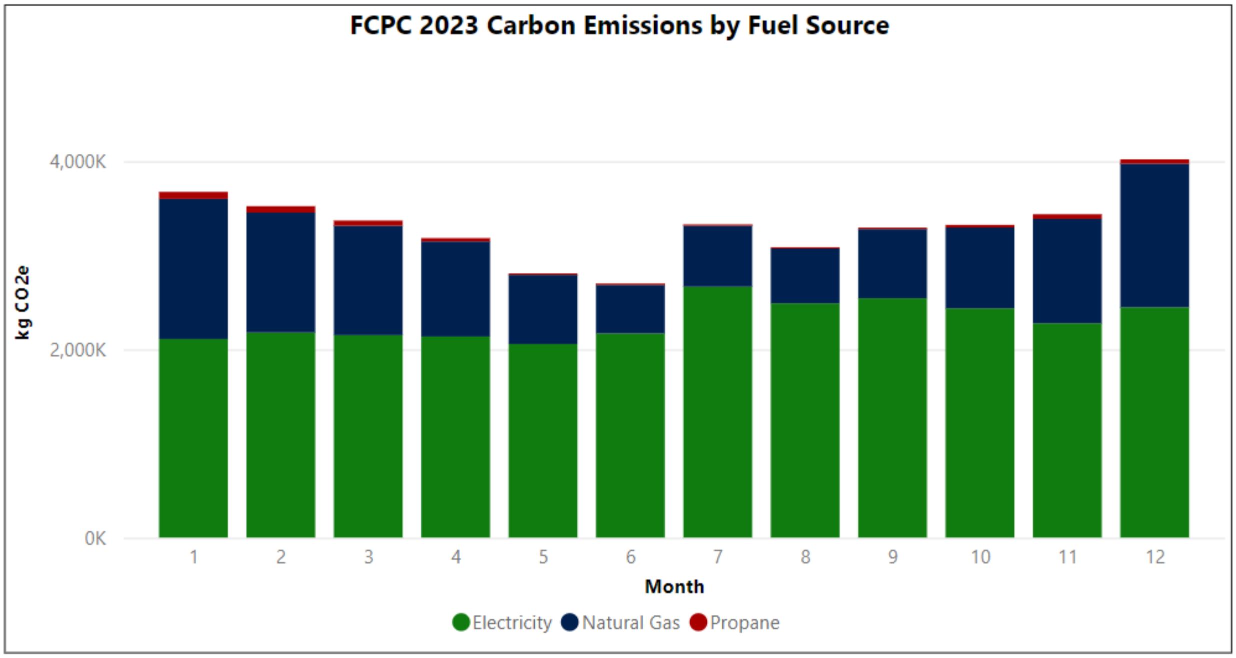


3.6 Carbon Emissions

3.6.1 FCPC Total Carbon Emissions

In 2023, FCPC emit ed 39,736 metric tonnes (MT) of CO_2e. The largest source of emissions was from electricity, with 27,659 MT CO_2e (69.6%), followed by natural gas, with 11,648 MT CO_2e (29.3%), and finally, propane, with only 429 MT CO_2e (1.1%). The results are shown in Figure 16.

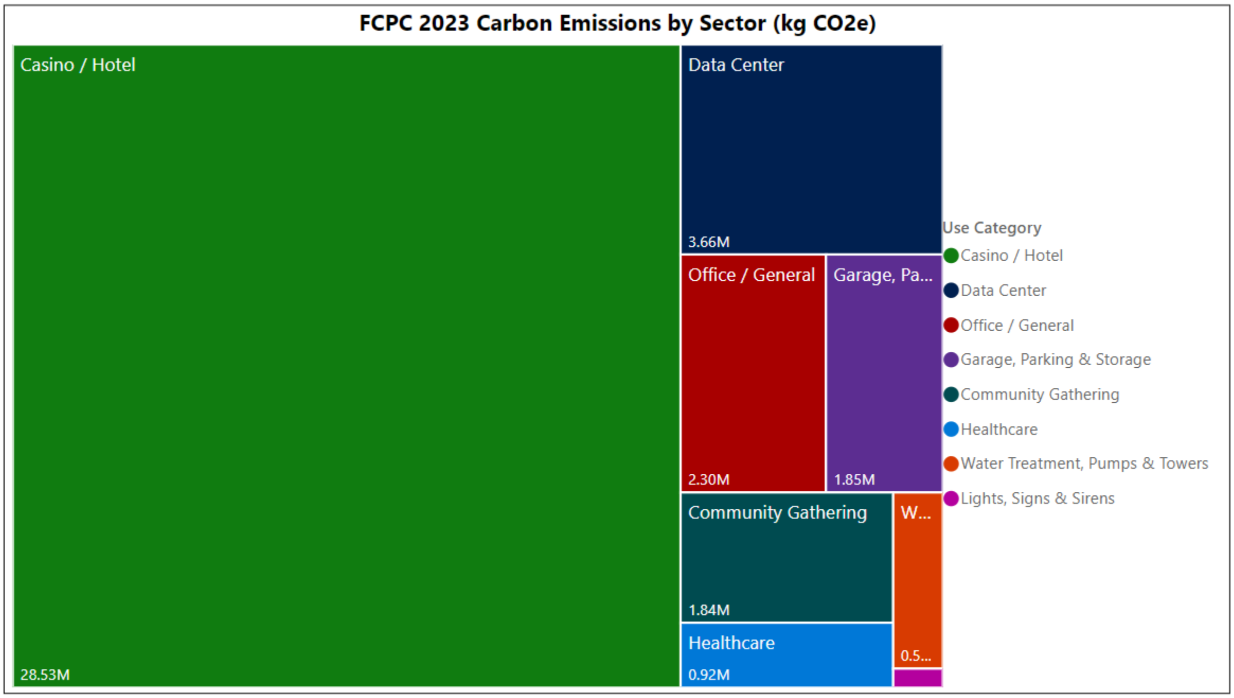
***Figure 16**: FCPC 2023 Carbon Emissions by Fuel Source*



3.6.2 FCPC Carbon Emissions by Sector

In 2023, *Casino-Hotels* emit ed by far the most carbon, with 28,531 MT CO_2e (71.8%). The second largest sector, the *Data Center,* which has a category of its own, emit ed 3,659 MT CO_2e (9.2%). The third largest sector is *Office / General*, which emit ed 2,299 MT CO_2e (5.8%). The fourth largest sector is *Garage, Parking & Storage*, which emit ed 1,848 MT CO_2e (4.7%). The fifth-largest category is *Community Gathering*, which emit ed 1,840 MT CO_2e (4.6%). The sixth largest sector is *Healthcare*, which emit ed 916 MT CO_2e (2.3%). The seventh largest sector is *Water Treatment, Pumps & Tower*s, which emit ed 581 MT CO_2e (1.5%). Finally, the eighth largest sector is *Lights, Sirens, & Signs*, which emit ed 63 MT CO_2e (0.2%). These results are shown in Figure 17. When dividing by business, which includes the Casino-Hotels, the PBC Garage, and PBDC, and government, business contributed to nearly 85.7% of all the Tribe's carbon emissions.

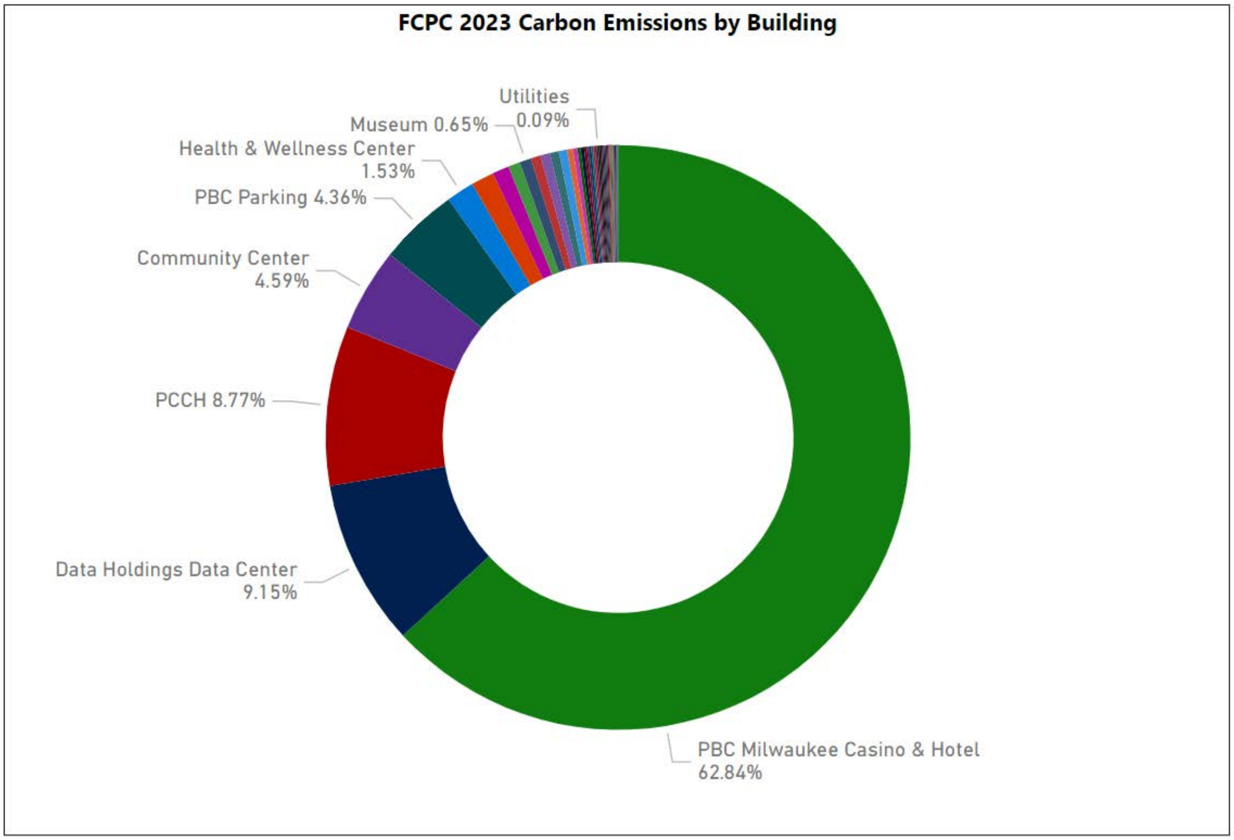
***Figure 17**: FCPC 2023 Carbon Emissions by Sector*



3.6.3 FCPC Carbon Emissions by Building

80 unique buildings/locations contribute to carbon emissions at FCPC. The top 5 buildings emit 89.7% of all the Tribe's carbon emissions. The next 5 buildings emit only 5% of the Tribe's emissions. The remaining 70 buildings/locations contribute just 5.3% of the Tribe's emissions. By far, the largest source of emissions is the PBC Milwaukee Casino & Hotel, which emit ed 24,970 MT CO_2e (62.8%). Combined with the PBC Parking Garage, the PBC facility is responsible for 26,703 MT CO_2e (67.2%), or just over two-thirds of the Tribe's emissions. A breakdown of carbon emissions by building is shown in Figure 18.

Figure 18: *FCPC 2023 Carbon Emissions by Building*

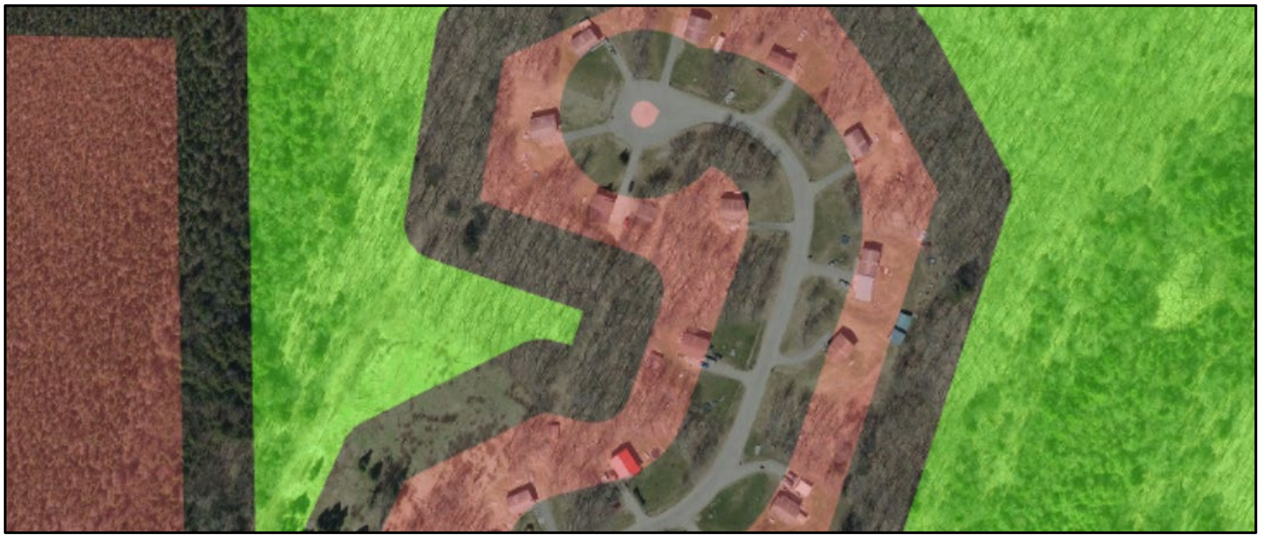


3.6.4 Urban Forestry Carbon Sequestration

The Tribe owns 15,447 acres of fully forested land zoned as *Forest*, *Conservation*, and *Unzoned*, which equates to 62.51 km^2. This information was provided by the Tribe's Land Information Department, which has an inventory of land use by type. A visual analysis by the Department showed that edge effects are not generally present on the map and that significant portions of land zoned for other purposes are also forested, as shown in Figure 19. Forested areas contain some non-forest areas, such as small roads, power lines, or ponds. The forested land not designated as forest is anticipated to be more than offset for these omissions. Note that areas that don't appear to have full tree crowns in Figure 19 are deciduous forests with no leaves, as opposed to coniferous, and thus appear to be barren, but these areas are fully forested.

***Figure 19**: Sample of FCPC Forest (Green) VS Non-Forest (Red) Land Use Zoning.*

Uncolored areas represent buffer zones between zoning types.



The forested land area was entered into the EPA Community Greenhouse Gas Inventory Tool, assuming 100% forest cover. For calculating urban forest carbon sequestration, the Department relied on the Wisconsin value provided by the EPA Land Use, Land Use Change, and Forestry State Inventory Tool, the designated data source referenced by the EPA Tribal Community Greenhouse Gas Inventory Tool. The default value for the Carbon Sequestration Factor of 2.23 MT Carbon/hectare/year is higher than the Wisconsin value of 1.67 MT Carbon/hectare/year listed in the EPA Land Use, Land Use Change, and Forestry State Inventory Tool.

The calculation of annual carbon sequestration, as per the full formula detailed in Figure 20, was conducted using the more conservative carbon emissions factor. This adjustment resulted in the EPA Community Greenhouse Gas Inventory Tool estimating an annual carbon sequestration of 38,277 MT CO_2e / year, which offsets 96.3% of the quantified emissions.

***Figure 20**: Equation Used to Calculate Annual Carbon Sequestration[15] from the EPA Land Use, Land Use Change, and Forestry State Inventory Tool.*

Equation 2. Urban Trees Equation

$$\boxed{\begin{array}{c}\textbf{Sequestration (MMTCO}_2\textbf{E) =}\\ \textbf{Total Urban Area (km}^2\textbf{)} \times \textbf{Urban Area with Tree Cover (\%)}\\ \times\ \textbf{100 (ha/km}^2\textbf{)} \times \textbf{C Sequestration Factor (metric tons C/ha/yr)} \times \textbf{44/12 (ratio of CO}_2\textbf{ to}\\ \textbf{C)} \div \textbf{1,000,000 (to yield MMTCO}_2\textbf{E)}\end{array}}$$

The Department notes that a tree cover analysis would yield a more accurate result than using the zoned land area. However, conducting a tree cover analysis would require a prolonged modeling exercise to threshold trees from satellite images. This process would need to be iterative, as setting the sensitivity

[15] ht ps://www.epa.gov/system/files/documents/2024-02/land-use-change-and-forestry-users-guide_508.pdf

too high would result in an underestimation of litle tree cover, and setting the sensitivity too low would yield the opposite result.

Due to time constraints, the Department does not currently have the resources to deliver a tree-cover thresholded map. Therefore, the zoned area is sufficient for the PCAP despite the likelihood of underestimating the forested land area. However, this approach is preferable to overestimating the cover.

3.6.5 Net Carbon Emissions

The quantified Tribal-wide carbon emissions are 39,736 MT CO_2e, and the urban forestry sequestered carbon is estimated at 38,277 MT CO_2e, which yields a net carbon emission of 1,459 MT CO_2e.

3.4 Unquantified Carbon Emissions Estimates

3.4.1 Employee Commuting – Scope 3

The Department has some visibility on employee commuting distance for its Government Forest County Employees. A survey conducted as part of the Electric Vehicle Charging Survey (At achment C) found that the average employee commutes 38.6 miles per workday. The at achment outlines the assumption that an estimated 539 vehicles commute approximately 4 days per week. This would result in approximately 8,029 vehicle miles traveled (VMT) annually, which is 4,327,523 miles for all vehicles.

Assuming these are all passenger cars from the Tribal Community Greenhouse Gas Inventory Tool, the average fuel economy is 24.1 MPG, which results in 179,565 gallons of gasoline used annually, which is 1,596 MT CO_2e/year[16]. Additionally, PCCH has an additional 155 vehicles, and PBC could have as many as 1,922 additional vehicles. However, the survey results are not valid, particularly for PBC or PBDC[17] employees who likely have shorter commutes and bet er public transit access but also work 5 days per week instead of 4. However, as a general estimate, PCCH and PBC employee commuting could contribute as much as an additional 7,687 MT CO2e/year[17], totaling 9,283 MT CO2e/year, equivalent to 23.4% of the quantified emissions.

Employee commuting emissions are optional for the CCAP and represent Scope 3 emissions. Formal quantification of these emissions would necessitate conducting an employee commuting survey at PBC or utilizing demographic and commuting data for the Milwaukee area to properly estimate all of the Tribe's Scope 3 emissions from employee commuting.

3.4.2 Tribal Homes – Scope 1 and 2

The Department has previously provided an estimate of the carbon emissions of Tribal Member homes on FCPC Tribal lands, which are defined within the system boundaries stated in Section 1.3. This estimation was based on data collected from a previous US Department of Energy – 2017 First Steps grant, which allowed the Tribe to perform energy audits on 117 homes, covering nearly half of all Tribal

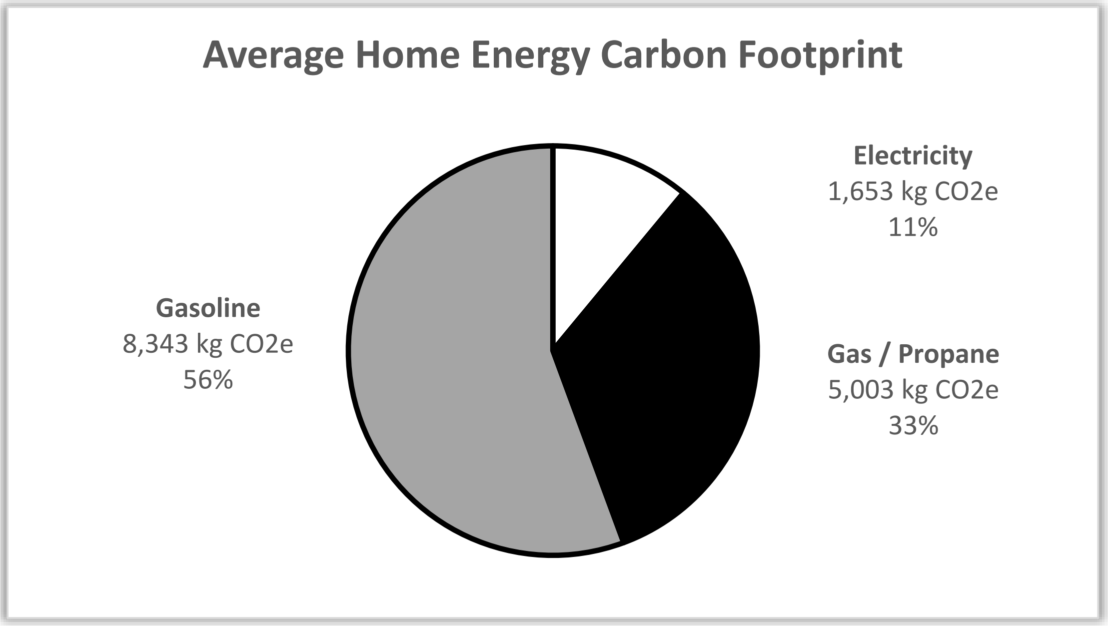
[16] 8.887 kg CO_2e / gallon based on https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

[17] The Department does not currently have data on the number of employees at PBDC.

Member homes. Through this initiative, the Department obtained energy bills from each participating household, facilitating the quantification of average Tribal Member home emissions with high accuracy.

The Department then combined data from its Energy Future Survey (Appendix A) to estimate driving emissions, giving a whole-home carbon emissions estimate. The main finding relevant to this section is shown in Figure 21. The average Tribal Member home is estimated to emit 14,999 kg CO_2e, based on its Scope 1 and 2 emissions. All assumptions behind these calculations are discussed in Appendix D.

Figure 21*: Average Tribal Member Home Scope 1 and 2 Emissions*



There are currently 238 homes on FCPC Tribal lands. Applying the average home emissions results in Scope 1 and 2 emissions of 3,570 MT CO_2e. Compared to the quantified building emissions, the Tribal Member home emissions are equivalent to 9.0% of the quantified emissions estimated.

These emissions are listed as unquantified because the data used to calculate baseline energy use for each home that received an energy audit was entered manually. Further, the former staff member who entered the data was not known for their at ention to detail. Thus, the quality of the data entered does not meet the QAPP standards that the Department agreed to. The Department will audit the entered data to ensure its accuracy. Then, the revised data will be presented in the CCAP as quantified emissions.

<u>3.4.3 Fleet Vehicles – Scope 1</u>

As discussed in Section 1.2, there are approximately 116 fleet vehicles operated by FCPC. The Department was unable to verify the exact number of vehicles in time for the PCAP, and it was also unable to verify the make, model, and annual mileage of each vehicle. The existing mileage records for each vehicle do not allow the Department to quantify yearly mileage, as the vehicles do not have mileage trackers installed. Therefore, to estimate the amount of emissions from the Tribe’s estimated 116 vehicles, the Department assumes the average emissions of a passenger vehicle or 4.6 MT CO_2e

based on EPA estimates[18]. The Department estimates a fleet vehicle emission of 534 MT CO2e based on the EPA estimate.

The EPA estimate uses an average mileage of 11,500 miles per year and an average fuel economy of 22 mpg. However, considering the Tribe primarily uses larger vehicles like pickup trucks and vans and may drive its vehicles on average more than 11,500 miles per year, emissions may exceed the EPA estimate. Nevertheless, the Department does not anticipate emissions to be more than double the provided estimate. Further, five of the Tribe's existing vehicles are electric, contributing lower emissions than conventional vehicles. With this initial estimate, the 534 MT CO_2e of fleet vehicle emissions represents approximately 1.3% of the quantified emissions.

3.4.4 Backup Generators – Scope 1

Backup generators are not extensively utilized by FCPC, except for occasional instances such as power restoration, testing, and maintenance. In general, the Tribe's buildings do not rely on a backup generator long enough to make this a significant source of emissions. One notable exception at PCCH is that the generator sees substantial use due to poor end-of-the-line connection to the substation and poor power quality. The facility frequently loses power, and as a proactive measure, it turns on its generators to ensure sufficient power availability during storms. The uninterruptable power supply (UPS) system no longer works in the building, so the generator is proactively run. The Department is currently exploring installing a new UPS system to avoid this problem. Despite the somewhat frequent use of the backup generator at PCCH, the Department does not expect diesel emissions from backup generators to significantly contribute to the Tribe's emissions. These emissions are anticipated to be less than 1% of the Tribe's emissions.

3.4.5 FCPC Farms – Scope 3

The Department does not provide an estimate of farm emissions. This will be included in the CCAP. However, the farms are not anticipated to contribute significantly (<1 %) to the carbon footprint of the Tribe.

3.4.6 Solid Waste – Scope 3

FCPC does not own or operate any landfills; therefore, emissions from this sector are not quantified. The Department does have data on solid waste collected, but it is not expected to significantly contribute (<1 %) to the Tribe's carbon footprint. This information will likely be included in the CCAP for comprehensive reporting.

3.4.7 Wastewater Treatment – Scope 3

The Department does not provide an estimate of wastewater control emissions. The Tribe does own 2 wastewater treatment facilities in Forest County; however, these facilities are relatively small and serve a relatively small number of people (< 5,000). Emissions from the wastewater treatment facilities will be included in the CCAP. Wastewater treatment is not anticipated to contribute to contribute significantly (<1 %) to the carbon footprint of the Tribe.

[18] https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

3.4.8 Estimated Quantified and Unquantified Emissions

The Department quantifies an estimated 4,104 MT CO_2e of additional unquantified emissions. If Scope 3 emissions are added, the Department expects emissions to be no higher than 9,283 MT CO_2e from employee commuting and not more than 2% (795 MT CO_2e) of annual emissions for all other sources, including backup generators, farming, solid waste, and wastewater treatment.

In total, the Department expects that its CCAP will show Scope 1, 2, and 3 emissions no higher than 39,736 MT CO_2e of quantified emissions plus an estimated 14,182 MT CO_2e, which totals 53,918 MT CO_2e. Combined with the Tribe's Urban Forestry carbon offset, the tribe's net emissions are expected to be no higher than 15,641 MT CO_2e.

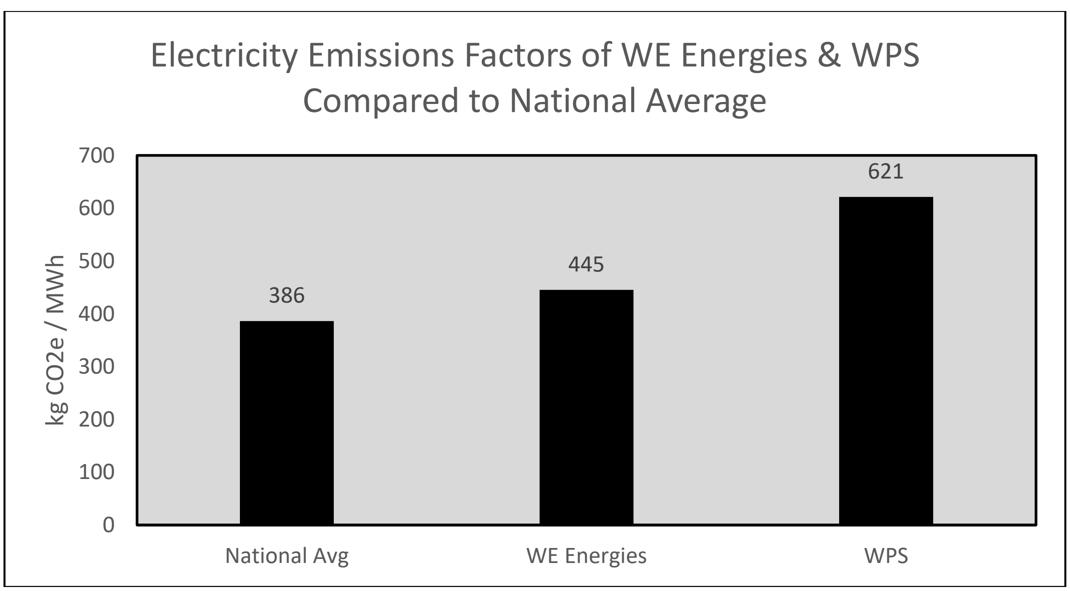
4. Greenhouse Gas Reduction Measures & Benefits Analysis

4.1 Emissions Factors

4.1.1 Electricity Emissions Factors

Despite the Tribe being able to offset the majority of its emissions with its forests, there exists a significant opportunity for the Tribe to lower its carbon emissions to benefit all of society. Both WE Energies and WPS have significantly higher emissions than the national average. WE Energies, with an emissions factor of 445 kg CO_2e/MWh, is 15.3% higher than the national average. WPS has an emissions factor of 621 kg CO2e/MWh, which is 60.9% higher than the national average, see Figure 22. This is because both power systems are still heavily reliant on coal power. Therefore, any reduction in electricity use has a likely probability that it will offset coal power generation, although this is far from guaranteed.

***Figure 22**: Summary of Emissions Factors for the National Average, WE Energies, and WPS*



4.1.2 Summary of All Air Pollution Benefits and Emissions Factors

The Department at empted its best job to compile 3 additional avoided air emissions sources, which include SO_x, NO_x, and $PM_{2.5}$. The availability of the data was of varying quality, sometimes reported with only 1 significant digit. Most notably, eGrid only reports emissions in $PM_{2.5}$. At the same time, the Compilation of Air Emissions Factors from Stationary Sources (AP – 42)[19] did not bin PM based on particle size. Instead, AP-42 includes the categories of "Filterable" and "Condensable." The EPA states that nearly all condensable PM is less than 2.5 microns in size[20]. Thus, these sources are not congruent, but they appear similar enough to bin into the $PM_{2.5}$ category. The results of the emissions factors used by the Department are shown in Table 3.

***Table 3**: Summary of Emissions Factors Complied From Different Government Sources*

Energy Source / Unit	kg CO_2e / Source	kg SO_x / Source	kg NO_x / Source	kg $PM_{2.5}$ / Source
Electricity (MWh)	**445 / 621** (WE Energies[21] / WPS[22])	**0.02 / 0.09** (WE / WPS)	**0.14 / 0.17** (WE / WPS)	**0.030 / 0.019** (eGrid RFCW / MROE[23])
Natural Gas (Therm)	**5.29** (EIA[24])	**0.00003** (AP 42 – Natural Gas[25])	**0.000028** (AP 42 – Natural Gas[26])	**0.00025** (AP 42 – Natural Gas)
Propane (Gal)	**5.75** (EIA)	**0.000008** (AP 42 – LPG[27])	**0.0059** (AP 42 – LPG)	**0.0002** (AP 42 – LPG)

4.2 Greenhouse Gas Reduction Measures

4.2.1 Ongoing Efforts to Reduce Greenhouse Gases

The Department has ongoing efforts to reduce greenhouse gases on Tribal lands, not all of which can be discussed in the PCAP. Most notably, the Department has ongoing Level 3 energy audits at PBC, PCCH, the Executive Building, and Health & Wellness. Together, these sources represent 74.4% of the Tribe's carbon emissions. The Tribe has an ongoing Level 2 energy audit at the Data Center, which adds another 9.2%. Finally, as part of a US DOE Grant, the Community Center already received several energy

[19] ht ps://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources
[20] ht ps://www.epa.gov/air-emissions-inventories/what-are-parts-particulate-mat er-and-how-do-they-relate
[21] ht ps://www.we-energies.com/environment/epa-greenhouse-gas-reporting
[22] ht ps://www.wisconsinpublicservice.com/company/epa-greenhouse
[23] ht ps://www.epa.gov/egrid/egrid-related-materials#eGRID%20PM2.5
[24] ht ps://www.eia.gov/environment/emissions/co2_vol_mass.php
[25] ht ps://www.epa.gov/sites/default/files/2020-09/documents/1.4_natural_gas_combustion.pdf
[26] Assume Controlled-low-NOx burner
[27] Assume the sulfur content of butane given in footnote e. ht ps://www.epa.gov/sites/default/files/2020-09/documents/1.5_liquefied_petroleum_gas_combustion.pdf

efficiency upgrades when it was built in 2020, bringing the total of all buildings audited to 88.1% of the Tribe's carbon emissions.

Further, all of these recent energy audits requested that Heat Decarbonization Measures (HDMs) be considered, which study not just energy-saving opportunities but also the ability to switch fuel to low or zero-carbon sources. Particularly in the context of the net zero goals of the utilities that serve FCPC, any effort to electrify heat will eventually result in zero-emission heat, albeit not in the timeframes under consideration for the CPRG. Unfortunately, all of the recent efforts to audit Tribal buildings are still ongoing. The Department cannot submit completed, or in some cases, any energy audit reports that the Department had hoped to include in its PCAP. The following list represents the larger energy projects that could reduce the Tribe's Carbon footprint by at least 1% annually.

4.2.2 Vertical Solar Farms Project

The FCPC Vertical Solar Farms project would install 23.8 MW of solar PV at 5 Forest County, WI agricultural sites. The project has received significant due diligence, with initial approval from the Executive Council to request a loan with possible forgiveness through the USDA PACE Program. The details of the project are outlined in Appendix B. The project has completed environmental reviews within FCPC, which would be required for 4 out of the 5 locations if the project is self-funded. However, the final location is on FCPC Fee land, which would have to go through the normal permitting process. Finally, the Department has not yet applied for an interconnection study, as the cost of this study could be nearly $100,000. Thus, a final feasibility determination is still pending from WPS.

The project installed with 90% bifacial modules would generate an average of 29,858 MWh/Year over its lifespan, equivalent to 51.1% of the Tribe's electricity emissions. The project is estimated to save 18,542 MT CO_2e/Year, equivalent to 46.7% of the Tribe's annual emissions. Note that the estimated emissions offset is considerably higher than the energy use because the project is located in Forest County under WPS, which has a much higher emissions factor, as discussed in Section 4.1. The results are shown in Table 4.

Finally, Vertical Bifacial panels significantly alleviate land use concerns, and winter snow shading disbenefits from traditional solar PV. The modules allow for the Tribe to continue to use its agricultural lands for existing grazing and hay production.

Table 4*: FCPC - Vertical Solar Farms Project*

Measure 1: FCPC Vertical Solar Farms Project	
Implementing Agency	FCPC, State of Wisconsin, Forest County, WI
Implementation Milestones	1. Apply for WPS Interconnection Study 2. Complete Final Engineering Design and Cost Estimate 3. Apply for Permits 4. Competitively Bid Project 5. Start Construction 6. End Construction 7. Interconnection Facilities
Geographic Location	Forest County, WI
Electric Utility	WPS

Funding Sources	USDA PACE, USDA REAP (Demonstration), IRA Incentives up to 50%, Self Funded / Loan
Metrics Tracking	1. Initial Kickoff Meeting 2. Permitting Approval 3. Receipt of Interconnection Study Report 4. Interconnection Application Submitted 5. Quarterly Progress Report Updates 6. Measurement & Verification 7. Final Report
Lifespan	30 Years
Cost	Varies depending on whether the project is Buy America Compliant or not. The estimated cost is between $35 million and $60 million.
Payback	The cost varies depending on the funding source and construction cost.
Estimated MWh Reduction	29,858 MWh
Estimated Therm Reduction	0 therms
Estimated Gal Propane Reduction	0 Gallons
Estimated Gal Gasoline Reduction	0 Gallons
Estimated Gal Diesel Reduction	0 Gallons
Estimated CO_2e Reduction*	MT CO_2e /Year | MT CO_2e Lifetime
Estimated SO_x Reduction*	kg SO_x /Year | kg SO_x Lifetime
Estimated NO_x Reduction*	kg NO_x /Year | kg NO_x Lifetime
Estimated $PM_{2.5}$ Reduction*	kg $PM_{2.5}$ /Year | kg $PM_{2.5}$ Lifetime
Implementation Authority	If all 5 locations are required, the project must go through several state-required permitting processes. Most of these processes are anticipated to last 1 year or less, except for USDA Forest Right of Way permitting to upgrade distribution line capacity, which would have to go through Federal Channels. The permit would be applied for by WPS; however, the timeline would still affect the project implementation. Final approval to proceed with the project will require a vote to approve a loan from the General Council and approval from the Executive Council.
* Assumes current grid emissions will not change for lifetime calculation. This is for illustrative purposes only, as the Department expects its utilities to reach their 2050 carbon-neutral goals.	

4.2.3 Milwaukee Casino – Hotel

The Milwaukee Casino-Hotel stands out as the Tribe's primary energy consumer, utilizing 36,970 MWh and 1,606,614 therms in 2023. To address this, the Department prioritized a Level 3 energy audit of the facility through the CPRG Planning Grant. While ongoing, the audit has explored numerous energy-saving options detailed in Appendix E. The aim is to identify strategies to reduce carbon emissions by 25% and building energy intensity by 2%. However, final implementation costs, carbon emissions reduction potential, and site viability are still under evaluation.

The evaluated measures include efficiency improvements to the gaming space's air distribution system, server room UPS and cooling unit upgrades, demand-controlled ventilation for restaurants, unoccupied set-backs, exhaust heat recovery, consolidated exhaust in the building, optimized dishwashing steam use, LED retrofitting, solar thermal hot water system installation, heat recovery chiller installation, geothermal wall installation tied to heat recovery chillers, electrification of kitchen equipment, solar PV canopy, solar PV wall, and upgrading end-of-useful-life equipment to high-efficiency alternatives. Technical details are outlined in Appendix E.

All cost and carbon values from the preliminary report are tentative pending further evaluation to refine cost information and address energy and building interactions between recommended measures. This comprehensive set of recommendations presents a significant carbon savings potential of 8,028 MT CO_2e /Year, equivalent to 21.4% of the Tribe's carbon emissions. If all measures are implemented, natural gas usage could decrease by 1,444,851 therms/year (89.9%), while electricity use would decrease by 865 MWh (2.3%). However, increased electricity use from switching to electric-based heating options offsets some electric efficiency plans.

Measure selection is ongoing, with some options likely to be eliminated due to cost-effectiveness or facility requirements. Initial findings indicate the potential for deep decarbonization at the facility, prompting consideration of optimal resource investment to achieve this goal. Below is an illustrative scenario depicting the adoption of all recommendations.

Table 5*: PBC -Suite of Decarbonization and Efficiency Strategies*

Measure 2: Suite of Efficiency and Decarbonization Strategies.	
Implementing Agency	FCPC, PBC, City of Milwaukee
Implementation Milestones	1. Water or Construction Permitting Approval (Possible) – Milwaukee 2. Construction Start 3. Construction End 4. Commissioning
Geographic Location	Milwaukee, WI
Electric Utility	WE Energies
Funding Sources	CPRG, IRA Possible.
Metrics Tracking	1. Initial Kickoff Meeting 2. Receipt of Permitting Approval (If applicable) 3. Quarterly Progress Report Updates 4. Measurement & Verification 5. Final Report
Lifespan	30 Years
Cost	$89,327,000
Payback	68 Years
Estimated MWh Reduction	4,202 MWh/Year | 126,061 MWh Lifetime
Estimated Therm Reduction	1,314,107 therms/Year | 39,423,210 therms Lifetime
Estimated Gal Propane Reduction	0 Gallons
Estimated Gal Gasoline Reduction	0 Gallons
Estimated Gal Diesel Reduction	0 Gallons
Estimated CO_2e Reduction*	8,028 MT CO_2e/Year | 240,846 MT CO_2e Lifetime

Estimated SO_x Reduction*	161 kg SO_x /Year | 4,846 kg SO_x Lifetime
Estimated NO_x Reduction*	626 kg NO_x /Year | 18,776 kg NO_x Lifetime
Estimated $PM_{2.5}$ Reduction*	387 kg $PM_{2.5}$ /Year | 11,614 kg $PM_{2.5}$ Lifetime
Implementation Authority	Permitting may be required by the City of Milwaukee for construction activities and for water. Ground disturbance would be involved only when installing geothermal wells if that strategy is selected. This project would involve standard construction processes and is not anticipated to have any possibility of being rejected by the City of Milwaukee. Final approval will be dependent on the Executive Council.
* Assumes current grid emissions will not change for lifetime calculation. This is for illustrative purposes only, as the Department expects its utilities to reach their 2050 carbon-neutral goals.	

4.2.4 PCCH

The Department also has an ongoing Level 3 energy audit at PCCH. PCCH used 3,863 MWh and 201,641 therms in 2023. The physical building has several inefficiencies, particularly its HVAC system, which is configured extremely inefficiently. Recognizing this, the Department prioritized addressing these inefficiencies to capitalize on the excellent opportunity for energy savings at this location. The energy audit contractor proposed a suite of 5 EEMs grouped here for brevity. These options include 1) Rebuilding the rooftop units (RTUs) 1 and 2 with variable flow exhaust, 2) Modifying RTU-3 (no rebuild) with variable flow exhaust, 3) Schedule the VAVs for RTU-6, 4) Controlling the restaurant makeup air, and 5) Installing occupancy sensors at RTU-7. A preliminary audit report with more information is included in Appendix F. Together, these measures are anticipated to save 599 MWh/Year (15.5%) and 63,400 therms/ Year (31.4%). Implementing this suite of EEMs would reduce the Tribe's carbon footprint by 707 CO_2e/Year, equivalent to 1.8% of the Tribe's emissions. The project is summarized in Table 6.

Table 6*: PCCH - 5 EEM Package*

Measure 3: PCCH 5 Energy Efficiency Measure Package	
Implementing Agency	FCPC, PCCH
Implementation Milestones	1. Construction Start 2. Construction End 3. Commissioning
Geographic Location	Wabeno, WI
Electric Utility	WPS
Funding Sources	DOE Deployment Grant, IRA Incentives, Self-Funded
Metrics Tracking	1. Initial Kickoff Meeting 2. Quarterly Progress Report Updates 3. Measurement & Verification 4. Final Report
Lifespan	20 Years
Cost	$265,000
Payback	2.4 Years
Estimated MWh Reduction	599 MWh
Estimated Therm Reduction	63,400 therms

Estimated Gal Propane Reduction	0 Gallons
Estimated Gal Gasoline Reduction	0 Gallons
Estimated Gal Diesel Reduction	0 Gallons
Estimated CO_2e Reduction*	707 MT CO_2e /Year | 14,147 MT CO_2e Lifetime
Estimated SO_x Reduction*	56 kg SO_x /Year | 1,116 kg SO_x Lifetime
Estimated NO_x Reduction*	104 kg NO_x /Year | 2,072 kg NO_x Lifetime
Estimated $PM_{2.5}$ Reduction*	27 kg $PM_{2.5}$ /Year | 545 kg $PM_{2.5}$ Lifetime
Implementation Authority	This project is located on FCPC Tribal Trust lands. There is no permitting authority required. The project only requires approval by the FCPC Executive Council.
* Assumes current grid emissions will not change for lifetime calculation. This is for illustrative purposes only, as the Department expects its utilities to reach their 2050 carbon-neutral goals.	

4.2.5 Purchase Hybrid Dumptruck

In partnership with FCPC's Public Works Division and FCPC's Land & Natural Resources Division, the Department has analyzed the environmental benefits of adding a Class 8 Triple Axle Mack Truck fite d with a Odyne Hybrid system to the Tribal Fleet. Such an addition would be beneficial in bolstering the Tribe's efforts under the Clean Water Act Section 319, focusing on the Non-Point Source (NPS) Pollution Program to identify and mitigate pollution from diffuse sources. Erosion and sediment accumulation from stormwater runoff and hydrological blockages at road-stream crossing points pose significant concerns, especially as weather events have increased in intensity and frequency. To address these issues, the Tribe has implemented projects to stabilize riverbanks, repair degrading roadway banks, and promote the ecological restoration of native plants in washed-out areas.

The Tribe has been using a small-capacity dump truck to haul materials to make these repairs, requiring many trips to haul the same amount of material the Mack Truck could do in one trip. Adopting a hybrid truck for these tasks would significantly diminish the environmental impact of these necessary activities and represent a substantial advancement in the Tribe's environmental stewardship. Compared to a standard Class 8 dump truck, the hybrid system would increase the mile per gallon of diesel from 6.17 miles/gallon to 10.45 miles/gallon. While the increased miles per gallon of fuel is significant, the hybrid system greatly decreases fuel consumption during idling periods by using bat ery power to operate the dump box.

The hybrid dump truck is projected to reduce carbon emissions by 18.28 MT CO_2 and NO_x by 80.09 kg annually, which translates to a reduction of both emissions by 48% compared to a conventional truck of equal size without a hybrid drive system.

***Table 7*: Purchase Hybrid Dump Truck**

Measure 4: Purchase Hybrid Dump Truck	
Implementing Agency	FCPC
Implementation Milestones	1. Purchasing Hybrid Dump Truck
Geographic Location	Crandon, WI
Electric Utility	
Funding Sources	CPRG, Self-Funded
Metrics Tracking	1. Onboard computer will track fuel consumption and number of operating hours and mileage.

Lifespan	750,000 miles
Cost	$300,000
Payback	
Estimated MWh Reduction	0 MWh
Estimated Therm Reduction	0 Therms
Estimated Gal Propane Reduction	0 Gallons
Estimated Gal Gasoline Reduction	0 Gallons
Estimated Gal Diesel Reduction	89,785.59 Gallons Lifetime
Estimated CO_2e Reduction*	18.28 MT CO_2e /Year | 457 MT CO_2e Lifetime
Estimated SO_x Reduction*	140.272 kg SO_x /Year | 7,013.601 kg SO_x Lifetime
Estimated NO_x Reduction*	80.09 kg NO_x /Year | 2,002.25 kg NO_x Lifetime
Estimated $PM_{2.5}$ Reduction*	kg $PM_{2.5}$ /Year | kg $PM_{2.5}$ Lifetime *dependent on vehicle
Implementation Authority	The project only requires approval by the FCPC Executive Council.
* Assumes current grid emissions will not change for lifetime calculation. This is for illustrative purposes only, as the Department expects its utilities to reach their 2050 carbon-neutral goals.	

4.2.6 Tribal Member Home Decarbonization Project

The Department has ongoing efforts to weatherize Tribal Member homes, funded through the Focus On Energy program. The Department has weatherized 20 Tribal Member homes, but there are 238 homes in total, and significant work remains. The Department also piloted 2 heat pump installations in 2022 and has plans to pilot several more in 2024. If this project is successful, the Department will roll out the program to all homes on propane due to the more favorable economics and to natural gas homes by 2050.

Although plans were initially made to install 70 solar arrays on Tribal Member homes with a US DOE grant, the application was never submit ed the application because of concerns over the Department's liability in installing its own solar arrays instead of hiring a contractor. However, the Department remains commit ed to restarting this project and decarbonizing Tribal Member homes, including preparing them for electric vehicles. All of these efforts are summarized in Appendix D.

5. Low-Income Disadvantaged Communities Benefits Analysis

The Forest County Potawatomi Community is a Federally recognized Indian tribe designated as a Disadvantaged Community. Therefore, any benefits received by the Tribe would directly benefit a Disadvantaged Community. Because the Tribe's lands offer only limited jurisdiction within Tribal lands, the Tribe cannot perform a benefits analysis outside its influence area. For example, the Tribe cannot decide about development or energy projects adjacent to Tribal lands. Therefore, the Department believes this section is not required for Tribes applying to the general CPRG Competition. Hence, the Department proposes that all benefits analysis stated in Section 5 apply to any consideration for this section.

5.1 Identify LIDACs and Climate Impacts and Risks

The main census tracts affected by the proposed energy projects are shown in Figures 23 - 26. All census tracts are designated as Disadvantaged, except for census tract 55041950300; however, this tract contains a substantial amount of FCPC Tribal Lands and is therefore eligible for consideration of benefits as a Disadvantaged Community.

Figure 23*: FCPC Tribal Lands at the Stone Lake Campus in Forest County, WI. Screenshot Taken From the Climate and Economic Justice Screening Tool.*

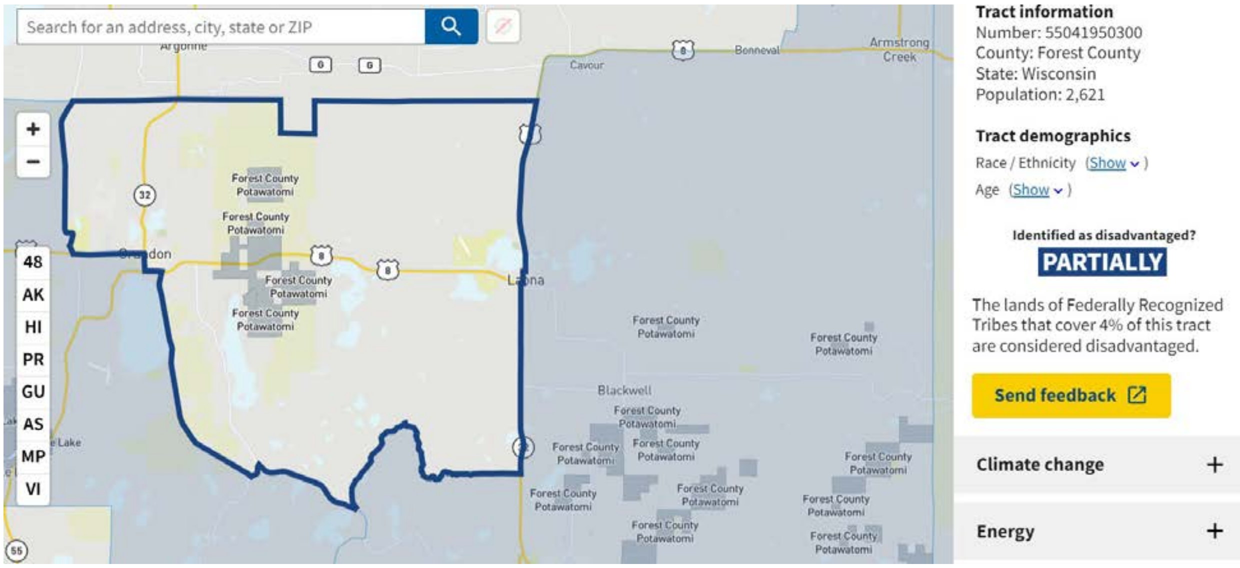


Figure 24*: FCPC Tribal Lands at the Blackwell and Carter Campuses in Forest County, WI. Screenshot Taken From the Climate and Economic Justice Screening Tool.*

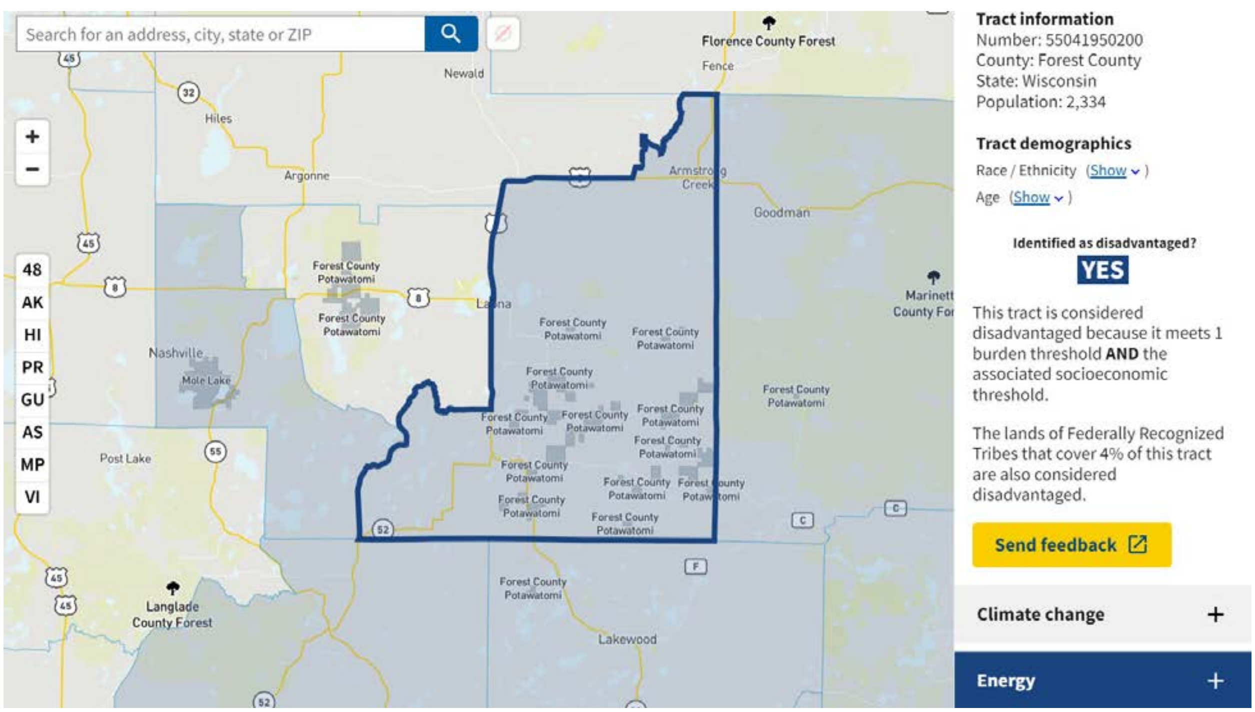


Figure 25*: FCPC Tribal Lands at the PBC Milwaukee Casino-Hotel Area. Screenshot Shot Shows the Potawatomi Hotel, Which Was Taken From the Climate and Economic Justice Screening Tool.*

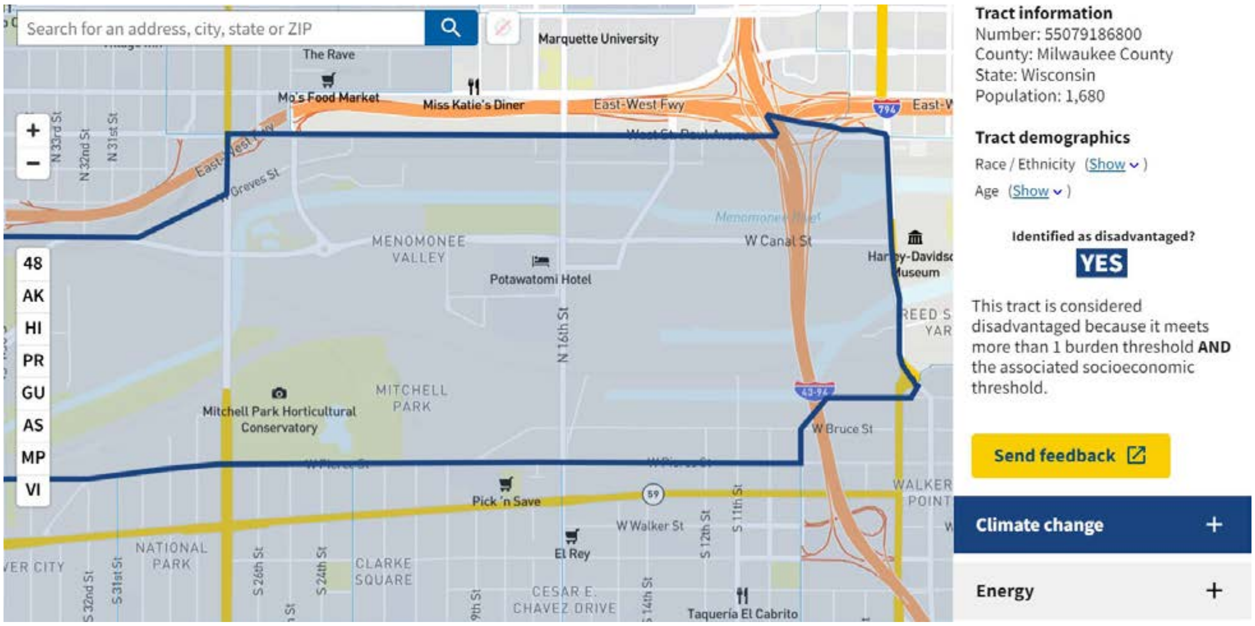
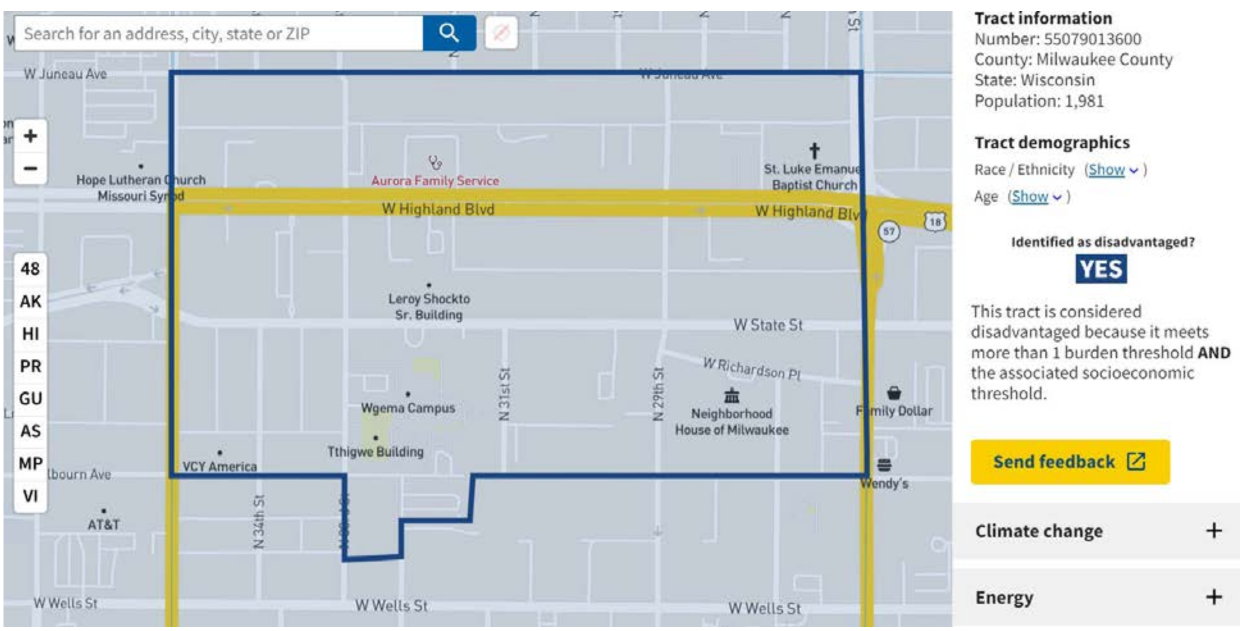


Figure 26*: FCPC Tribal Lands at the Wgema Campus. Screenshot Shots Show the Wgema Campus and Tthigwe Building, which were taken from the Climate and Economic Justice Screening Tool.*



The Tribe faces primary climate vulnerabilities, including increased precipitation, drought events, and exposure to extreme heat. In Forest County, the Tribe is vulnerable to the increased risk of forest fires and invasive species, which could harm or even destroy large parts of the Tribe's forested lands. In addition, Forest County is also accustomed to long winters, which are modeled to get shorter and wet er, which increases snowfall and related hazards but also lengthens the season for pathogenic insects such as mosquitoes and ticks in a heavily forested area. Therefore, the Tribe considers its Forest County population the most vulnerable to climate change. This is why the Tribe applied for and received a Bureau of Indian Affairs Tribal Climate Resilience Grant to prepare the Tribe for climate change. This project is ongoing and is scheduled to last at least 5 years.

5.2 Engage With LIDACs to Understand Community Priorities

As mentioned in this section, the Department does not believe it can meaningfully engage with LIDACs outside Tribal lands. The Department has provided consultation with its own Members (Section 2.1) and has a plan to meaningfully engage with Tribal Members. These goals were stated in Objective 8: Enhance Energy Education in Section 2.2. Specifically, the Department has held and will continue to hold educational seminars, which are open forums for Tribal Members to ask questions and engage with the Department on various energy topics. The seminars include updates on existing projects at FCPC and plans for new ones.

Most projects the Department pursues are not well suited for public engagement, such as energy efficiency upgrades, on-site solar, or fleet EV charging. There are significant opportunities for public engagement, such as with the Electric Vehicle Charging Project and the Vertical Solar Farms Project. The VB project specifically requires transforming a large area of land at FCPC, which is deeply valued by the FCP Community. If the project is found feasible by the electric utility, WPS, then the Department plans to engage the community in the project and sitting. Further, the Electric Vehicle Charging Project includes a plan to hire a consultant to conduct community outreach to understand local EV charging needs. The Department has already undertaken outreach for Tribal Government Employees, as At achment C outlines.

5.3 Estimate Potential Benefits of GHG Emission Reduction Measures to LIDACS

The Department defers to Section 4 for a discussion of benefits received by FCPC. The Department does expect local benefits to accrue to communities surrounding FCPC Tribal lands. These benefits mostly include increases in local employment and bet er air quality. Any reductions in natural gas used on site will improve the surrounding community's air quality. Further, reductions in electric use will most likely result in reduced coal or natural gas use. There is, in fact, a natural gas peaker plant located less than a mile away from the PBC Casino. The benefits of reduced reliance on power plants are more likely to have a regional effect.

6. Review of Authority to Implement

The Tribe is required to follow federal regulations but is not bound by state or local regulations. While it doesn't have energy-specific regulations, it follows an energy code. All projects require approval from the Tribe's Executive Council, and external authorities have no jurisdiction over their implementation beyond any applicable permitting processes.

At PBC's Milwaukee Casino-Hotel, adherence to state and local regulations is voluntary to maintain positive relations with the municipality. Projects there undergo standard approval procedures. Any ground-disturbing projects must comply with environmental and water permitting processes mandated by the City of Milwaukee, especially as the site is on a remediated brownfield. Remediated brownfield site.

For the FCPC Vertical Solar Farms Project, which includes a site on FCPC Fee Land, the Tribe must comply with state and local regulations for project approval, including Wisconsin's extensive permitting process.

Regarding financing, projects needing loans must be approved by the Tribe's General Council, considering the Tribe's debt capacity and project benefits. While projects funded by CPRG may bypass this, significant loans, like the FCPC Vertical Solar Farms Project, require General Council approval.

Finally, grant applications, including CPRG funding, need Executive Council approval before submission. For major projects, a presentation outlining the scope and benefits precedes Executive Council decision-making.

FCPC Energy Future Survey

This report was commissioned by the Forest County Potawatomi Community (FCPC, or Tribe) Energy Department, in cooperation with the FCPC Energy Working Group.

Date of Release: December 28, 2022

Introduction

The FCPC Energy Future Survey was conducted between May 14, 2022 and June 29, 2022. Participants were paid $25 to take the survey, and were allowed to choose between an online gift card, or a physical gift card, to be delivered in person after taking the survey. All responses received were from FCPC Enrolled Tribal members. In total, 97 respones were received.

Survey Design and Limitations:

The survey was designed by the FCPC Energy Department. The survey was peer reviewed, internally within the FCPC Land & Natural Resources Division, as well as presented for additional review at the Energy Working Group.

The survey was designed using the online survey platform, Qualtrics. Links to the survey were available with a QR code, as well as through a direct website link. If a respondent selected they were not a FCPC Tribal Member or affiliated with the Tribe, they would be exited from the survey. Surveys were also printed on paper, which allowed participants to ignore the logic programmed into the online survey, such as filling out all required fields or only answering one field. All written surveys were transcribed into a spreadsheet for analysis.

Several questions were grouped into “Check All That Apply.” This design was chosen to shorten the time required to take the survey, so that it could be completed within 10 minutes or less. However, this design choice also allowed respondents to check only 1 option out of multiple options available, which may not represent the full range of preferences for questions that allowed for multiple responses. Therefore, questions with multiple available responses likely do not fully represent the preference of the respondent for all available choices.

Finally, as the survey asks about many issues in the energy transition, it is possible that the sample is biased with respondants that have strong opinions about the energy transition, either positive or negative. However, the $25 payment was intended to reach a larger audience, and likely mitigates some of this source of bias.

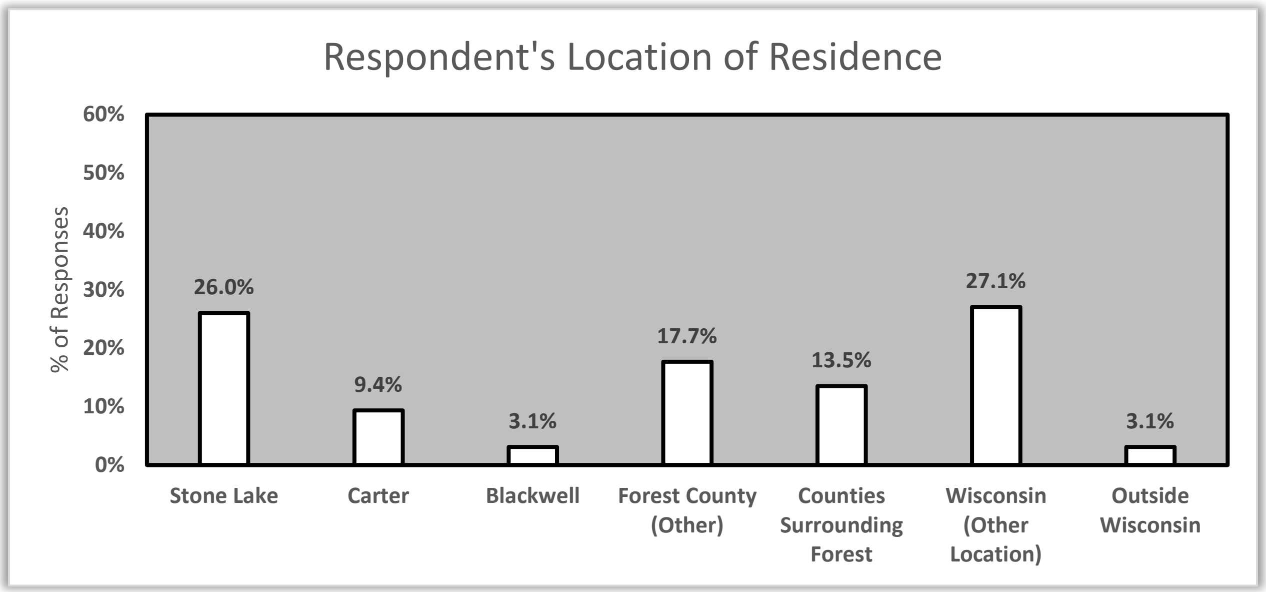
Survey Distribution:

The survey was initially distributed at the FCPC General Council Meeting held in May, 2022. Participants were able to scan a QR code on their phone, and were given tablet computers to fill out the survey. Participants were also provided paper surveys, upon request. After the General Council Meeting, the surveys were distributed publicly and privately on Facebook, and flyers were posted at main FCPC buildings.

Within an hour of posting the survey publicly on Facebook, one or more malicious actors attempted to fill out fraudulent survey respones to obtain the $25 gift card. The survey received several hundred responses within the first hour, before it was shut down. All responses received were vetted with Enrollment to ensure that only complete Tribal member responses were eligible for payment. The survey was then re-launced, with an additional field to verify the participants Tribal ID, which could then be verified with Enrollment. After the fraud attempt, the survey was not advertised again publicly, which limited the ability of the Energy Department to obtain additional responses.

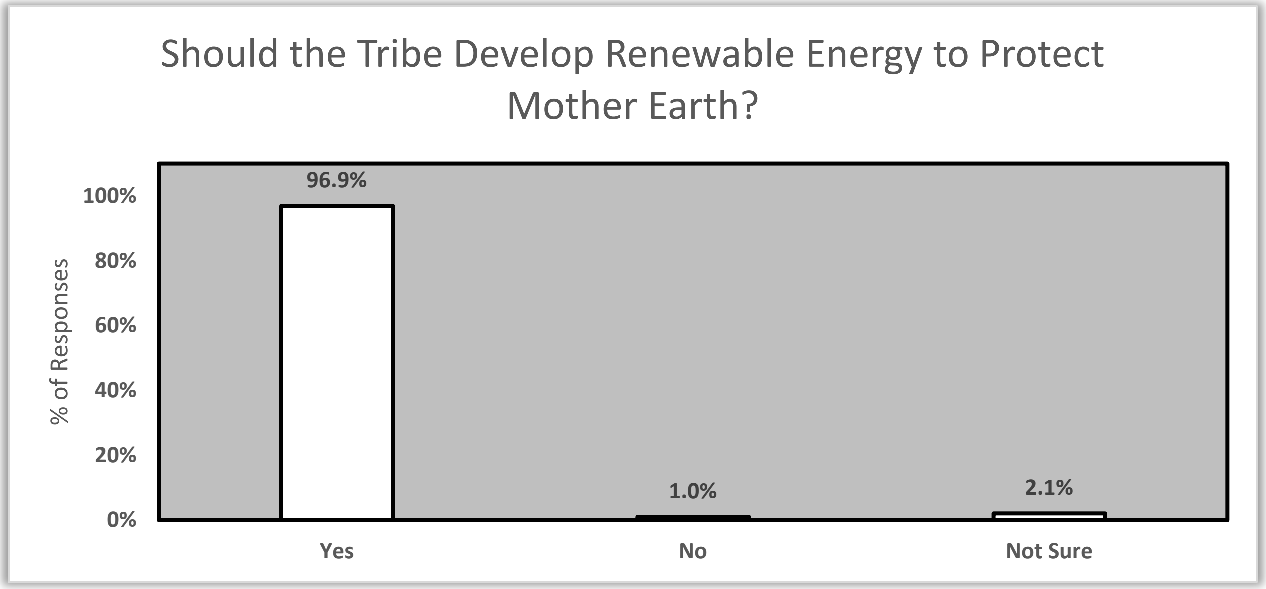
Sample Description:

38.5% of respondents live in Stone Lake, Carter, or Blackwell, and 56.2% of respondents live in Forest County. In total, 96.9% of all responses received live in Wisconsin. In order to shorten the survey length, additional demographic questions, such as age, sex, etc. were not asked.



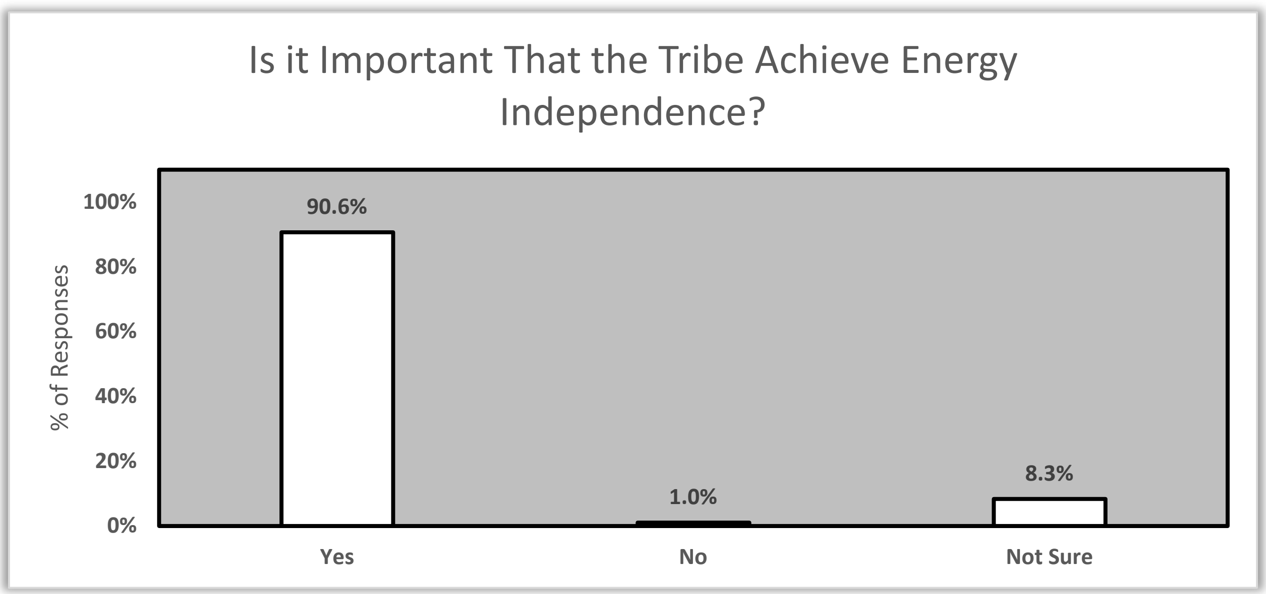
Survey Results and Discussion

Respondents overwhelming indicated that the Tribe should develop renewable energy to protect mother earth, with 96.9% (93.5% - 100%) of respondents indicating support.



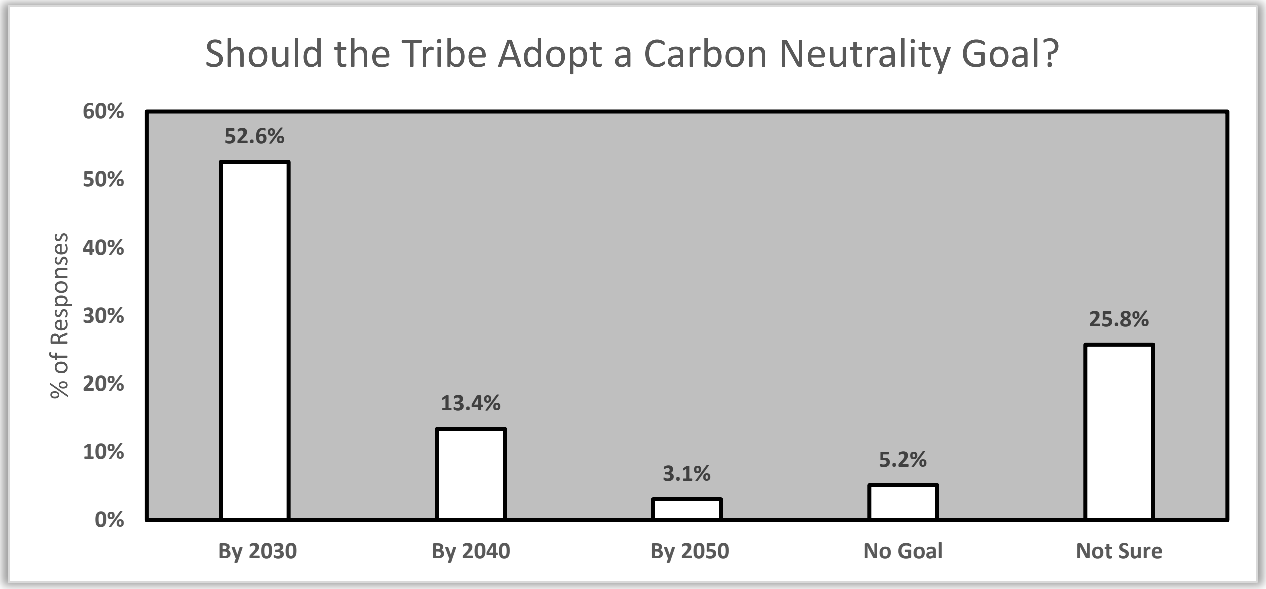
Margin of Error (95% Confidence) for Development of Renewable Energy: 3.4%

Respondents also overwhelming indicated that the Tribe should attempt to achieve energy independence, with 90.6% (84.8% - 96.4%) of respondents indicating support.



Margin of Error (95% Confidence) for Achieving Energy Independence: 5.8%

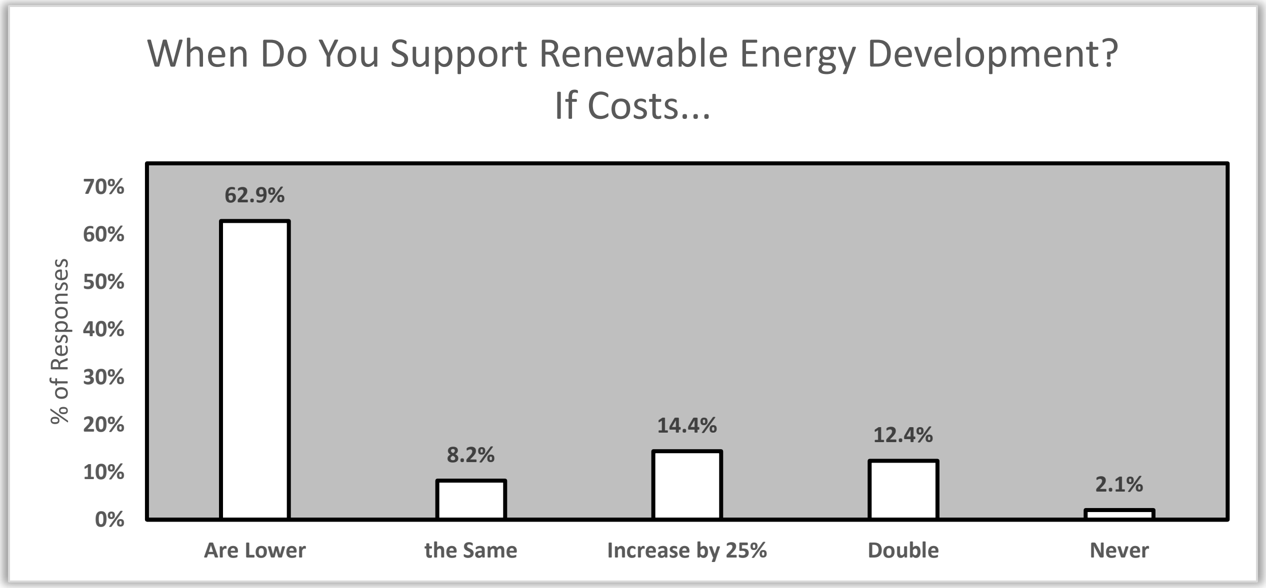
A majority of respondents would like the Tribe to adopt a carbon neutrality goal, with 69.1% (59.9% - 78.3%) indicating support of a neutrality goal by 2050, and the majority of these respondents (76%) prefered a goal by 2030. However, 25.8% of respondents were unsure if the Tribe should adopt a carbon neutrality goal, which likley represents difficulty understanding the abstract concept of carbon neutrality. Only 5.2% of respondents opposed a carbon neutrality goal.



Margin of Error (95% Confidence) for Any Carbon Neutral Goal: 9.2%

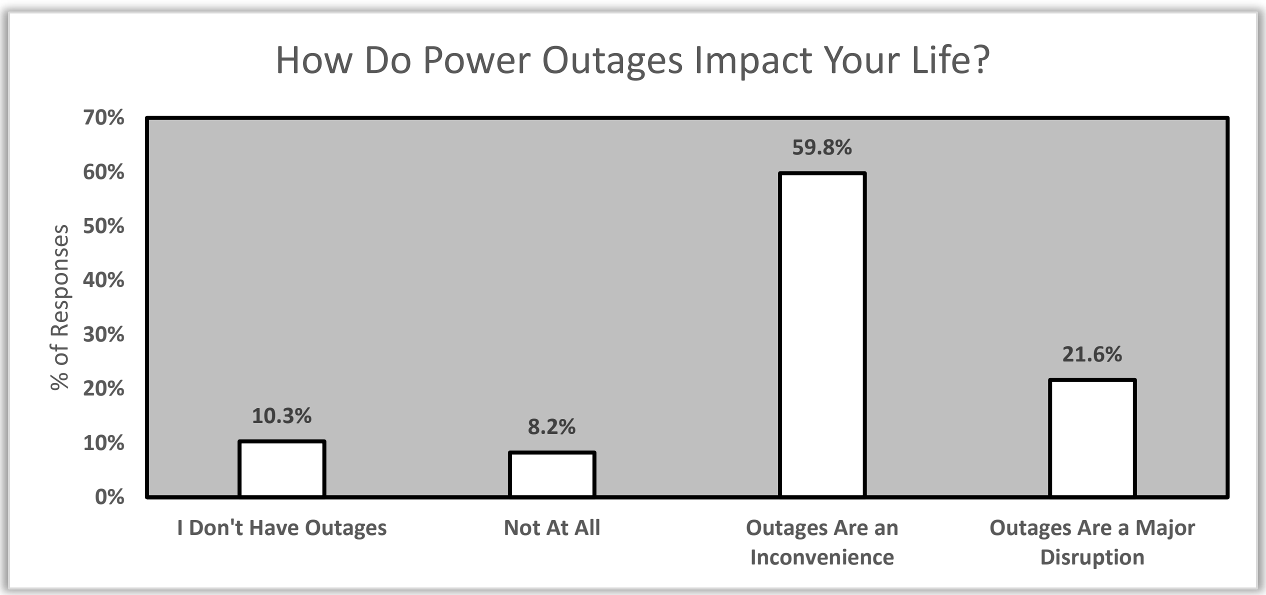
When asked about the potential cost of renewable energy, a majority of respondents indicated they support renewable energy development if costs stay the same or are lower than current costs, with 71.1% (62.1% - 80.1%) of respondents selecting one of these options. However, a majority of these respondents (87.7%) supported renewable energy only if costs were lower. Only 26.8% of respondents indicated support for renewable energy development if costs increased.

Given the design of this question, it is possible that respondents chose the lower cost option because it would be the most appealing to any respondent. The method by which the question was asked could have created confusion as to the intention of the question, which is to gauge tolerance for cost increases to develop renewable energy. Therefore, the results may not reflect the true preference of the respondents due to the structure of the question. However, the results, as presented, indicate a clear direction of the development of renewable energy projects, which is to save costs.



Margin of Error (95% Confidence) for Costs Staying the Same or Lower: 9.0%

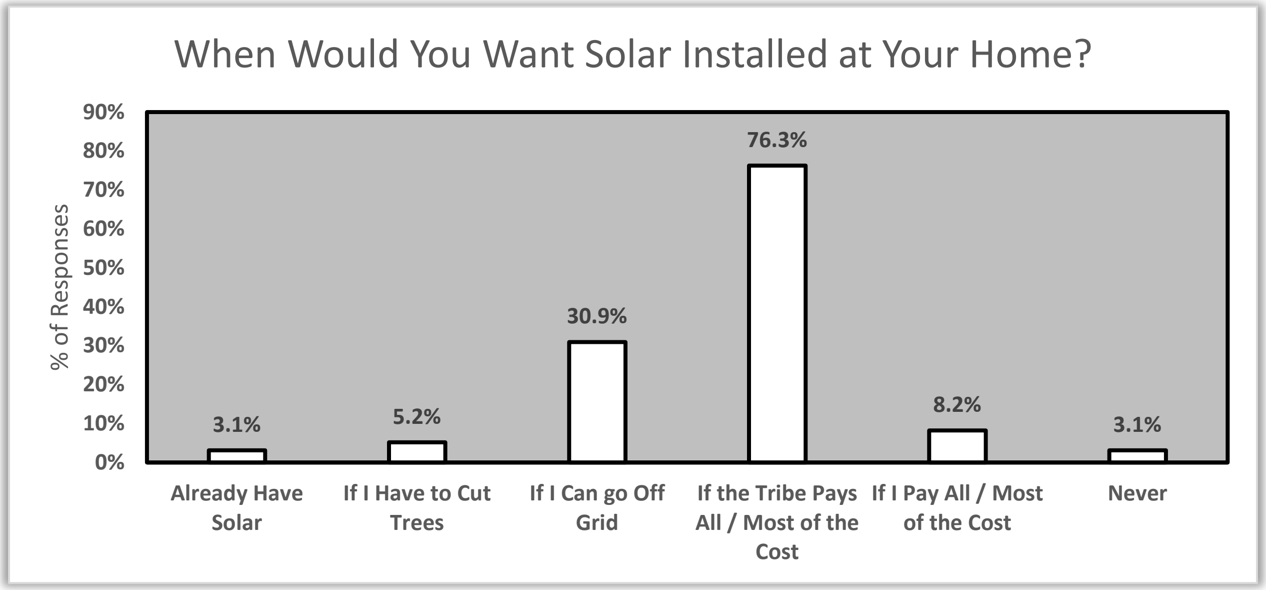
When asked about grid reliability, a majority of respondents indicated that power outages impact their lives, with 81.4% (73.7% - 89.1%) indicating that outages were either an inconvenience, or a major disruption. However, the majority of this group (73.5%) indicated that outages were an inconvenience, rather than a major disruption. It should be noted that 21.6% of respondents indicated that outages are a major disruption, which is a significant number of households experiencing energy insecurity.



Margin of Error (95% Confidence) for Power Outages Impacting the Respondent's Life: 7.7%

When respondents were asked what factors would encourage or discourage them from installing solar at their homes, a majority of respondents indicated that funding was a key limitation, with 76.3% (67.8% - 82.1%) of respondents indicating the Tribe would need to pay for all or most of the costs. Only 8.2% of respondents indicated they would be willing to pay themselves for all or most of the costs. Notably, 30.9% of respondents indicated they would install solar to be able to go off grid, and only 5.2% of respondents indicated they would be willing to cut trees in their yard to install solar, which means that any array would need to work with the surrounding landscape, rather than modify it. In addition, 3.1% of respondents indicated they already have a solar array installed, which represents 3 respondents.

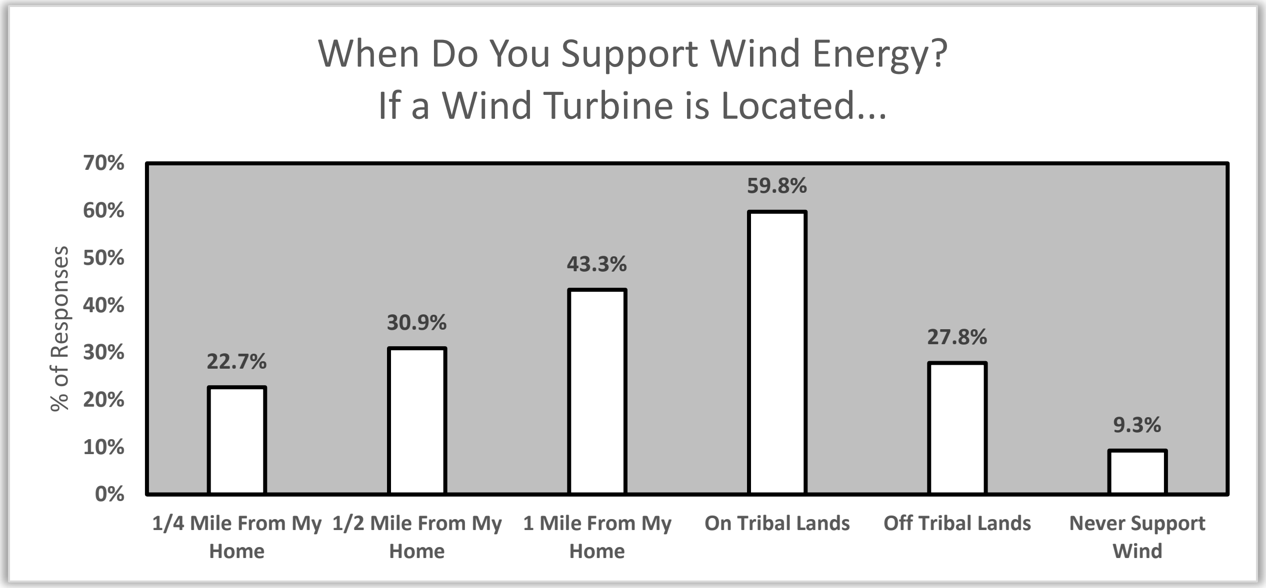
The multi-response format of this question may have prevented respondents from selecting options other than “If the Tribe Pays All / Most of the Costs.” In particular, “If I Can Go Off Grid,” and “If I have to Cut Trees” could be underrepresented if respondents preferred to choose just one option.



Margin of Error (95% Confidence) for the Tribe Paying All / Most of the Cost: 8.5%

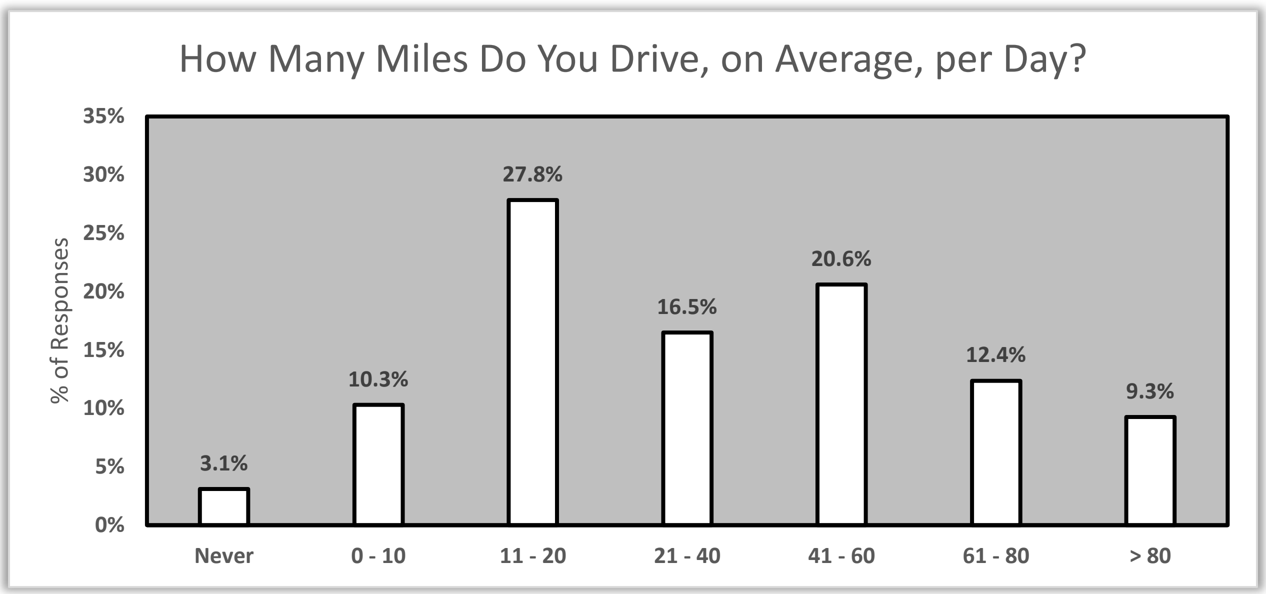
When respondents were asked about their preference for wind energy development, a majority of respondents indicated they supported wind development, with 90.7% (84.9% - 96.5%) selecting at least one option for wind energy development, and therefore a minority of respondents (9.3%) never support wind energy development. Only 43.4% (33.4% - 53.2%) of respondents indicated they would be willing to live with a wind turbine located 1 mile away from their home. Despite this limitation, respondents indicated a preference for potential wind turbines to be located on Tribal lands (59.8%) as opposed to off Tribal lands (27.8%).

The multi-response format of this question may have prevented respondents from selecting options other than “On Tribal Lands.” In particular, “Off Tribal Lands” may be under-represented as respondents could have thought of the choice as either / or, rather than both being possible responses.



Margin of Error (95% Confidence) for any support of wind energy: 5.8%
Margin of Error (95% Confidence) for turbine located 1 Mile From My Home: 9.9%

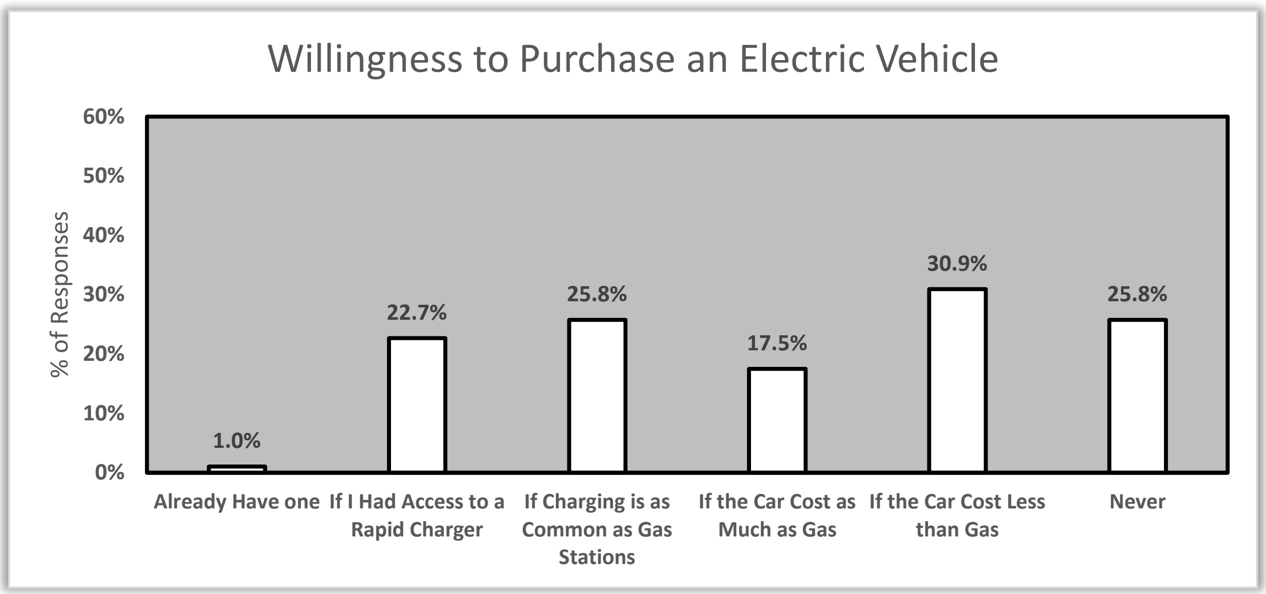
In order to plan for a future with more electric vehicles, respondents were asked how much they drive, on average, per day. A majority of respondents indicated they drive "11 – 20" miles per day (27.8%), followed by "41 – 60" miles per day (20.6%), and then "21 – 40" miles per day (16.5%), which forms the basis for the mean daily miles, at a weighted average of 37.0 miles per day. Only 3.1% of respondents indicated they don't drive, while 9.3% of respondents indicated they drive over 80 miles per day, which represents the challenges of transportation in rural areas.



Average Miles Driven Per Day: 37.0
Note: Average miles based on midpoint of bin size

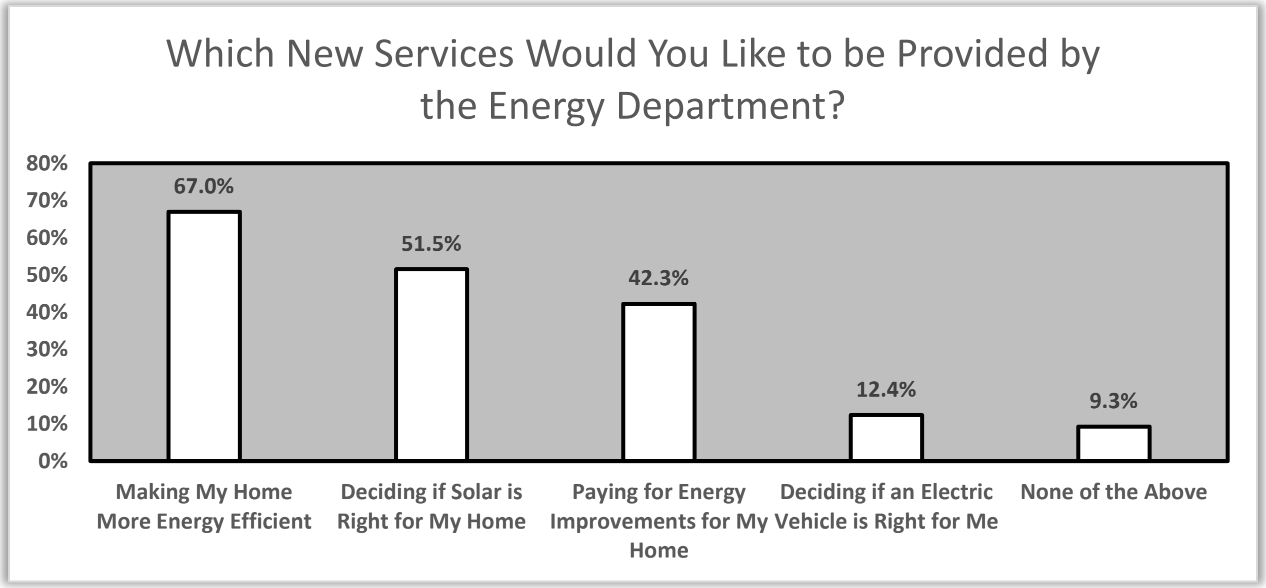
Respondents were asked about their willingness to purchase an electric vehicle (EV). A majority of respondents indicated they would be willing to purchase an EV at some point, with 74.2% (65.5% - 82.9%) selecting at least one response for adoption. More respondents indicated that charging stations would need to be as common as gas stations before they purchased an EV (25.8%), as compared to respondents who only wanted a charger nearby (22.7%). More respondents indicated that an EV would need to cost less than a gas version (30.9%) than respondents who indicated they would pay the same amount for an EV (17.5%). A sizeable portion of respondents (25.8%) indicated they would never buy an EV.

The multi-response format of this question may have prevented respondents from selecting multiple options. If a respondent answered a charging question, they may have ignored the cost question, and vice versa. However, the responses received represent a roughly equal share of respondents who feel charging is important (48.5%), as compared to cost (48.4%).



Margin of Error (95% Confidence) for willingness to buy an EV: 8.7%

Finally, respondents were asked about which new services, if any, respondents would like to see be offered by the Energy Department. A majority of respondents indicated they would like help “Making My Home More Energy Efficient” (67.0%), as well as help “Deciding if Solar is Right for My Home,” with 51.5% if respondents selecting this response. A significant number of respondents indicated they would like help “Paying for Energy Improvements in My Home,” at 42.3% of results. Only a minority of respondents indicated they would like help “Deciding if an Electric Vehicle is Right for Me,” or who wanted no additional services (9.3%).



Conclusion

The FCPC Energy Future Survey has provided key insights for the desired direction of energy projects at FCPC. While FCPC leadership has consistently provided support and funding for energy projects, it was unknown how FCPC Tribal members felt about energy projects. The results provide a clear mandate for the continued development of renewable energy projects at FCPC, with clear goals to protect mother earth, and to achieve energy independence. While carbon neutrality results are not entirely congruent with the protection of mother earth and energy independence, a majority of Tribal members do support having a carbon neutrality goal that prioritizes action sooner than later.

Despite these goals, respondents repeatedly confirmed that cost is a key limiting factor towards deploying renewable energy in general, with solar at home, and for EV adoption. Given that power outages are impacting a majority of respondents, the lowest cost option to increase resilience without adding cost could be to deploy EVs that are capable of serving as backup power during an outage. While support for both solar and wind is high among respondents, there are signs of hesitancy towards EVs, both in willingness to buy, as well as in interest to help decide on an EV from the Energy Department. In addition, energy efficiency was the most desired home energy improvement, and should continue to be incorporated into the energy program.

Given these results, future energy projects should focus on renewable energy deployment, particularly solar at home, energy efficiency, and cost effective efforts to become more energy independent. These results will be presented to the Energy Working Group, and Executive Council, and will be incorporated into the Energy Department Strategic Plan.

FCPC Vertical Solar Farms Project
Attachment B

Project Sites & Analysis

Prepared on September 2023 in support of the Forest County Potawatomi Community's USDA PACE Let er of Interest Submission

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Attachment B – Project Sites & Analysis

FCPC Vertical Solar Farms Project

1. Introduction

The Forest County Potawatomi Community (FCPC or Tribe) has a goal to become energy independent by deploying renewable energy resources. In order to achieve this goal, FCPC has studied various renewable energy technologies, including solar photovoltaics (PV), wind, woody biomass, and a food waste biodigester. The majority of the Tribe's Tribal lands are in Forest County, WI, which is a heavily forested area with limited potential for land conversion due to a scarcity of productive land for agriculture or renewable energy development. The Tribe owns 2 plots of farmland that are used for cows and bison, and 3 additional plots of land that are only used for hay production. Due to the scarcity of land, these sites are not possible to convert into an alternative land use, and hay is already being imported from other farms, which reduces the Tribe's ability to be food independent. Therefore, large scale land use conversion to reach the Tribe's goal of energy independence is not a viable option.

By the end of 2023, the Tribe will have deployed 3 MW_{DC} of monofacial solar PV in ballast-mounted and ground-mounted fixed tilt solar PV, however there are few areas left to install solar that would not result in land use change. Small scale wind was explored previously, but the study performed concluded that wind was not economically feasible. Large-scale wind remains a topic of interest for further study due to some FCPC Tribal lands being on a 300 foot hill, however this would require a wind study that has not been started, to date. Woody biomass has been examined in 4 separate studies, and each study concluded that it would increase energy costs for the Tribe. Finally, the Tribe ran a 2 MW biodigester for food waste in Milwaukee, but this power plant had to be shut down because it was not able to run at a profit.

The Tribe has thus been forced to purchase renewable energy credits to meet its renewable energy goals, but this strategy runs counter to the Tribe's goal for energy independence. With limited renewable energy technologies available, the Tribe currently only has the option to develop an agrivoltaic project that does not result in farmland conversion.

The following document outlines the FCPC Vertical Solar Farms project, which seeks to install 23.8 MW_{DC} across 5 agricultural sites on FCPC Tribal lands, which would both help the Tribe to meet its renewable energy goals, as well as provide needed revenue for Tribal Government operations that benefit FCPC Tribal members.

2. Technology Selection

2.1 Available Solar Technologies:

The FCPC Energy Department (FCPC-ED) identified four (4) main solar racking technologies and two (2) main module technologies that could potentially be used in an agrivoltaic project. These technologies are displayed in Table 1. Monofacial fixed tilt solar PV still remains an at ractive technology for small-scale solar due to its ease of installation and maintenance, however in most applications where there is a potential for the back side of a solar module to receive reflecting sunlight, which is known as bifacial technology. Bifacial technology will almost always outcompete monofacial modules, and particularly in snowy environments such as Forest County, WI. Therefore, any application other than low tilt ballasted roof mount systems should employ bifacial technology to boost performance by an average of 7%

globally, with higher production in snowy climates with higher albedos [16]. While Rodriguez-Gallegos [16] reported that the levelized cost of energy (LCOE) is 3% higher for bifacial compared to monofacial, this study was published in 2020, and bifacial modules have come down in price. However, dual axis tracking is still not cost competitive, and is prone to breaking with extra moving parts. The study concludes that single axis tracking with bifacial modules is the most cost effective technology to deploy currently. Finally, the study did not examine Vertical Bifacial (VB) technology, as this technology has not yet deployed utility-scale applications.

***Table 1**: Current Solar Racking and Module Technologies*

Solar Racking Technologies	Solar Module Technologies
Fixed Tilt (15° - 45°)	Monofacial (Single-Sided)
Vertical Tilt (90°)	Bifacial (Dual-Sided)
Single Axis Tracking (0° - 45°)	
Dual Axis Tracking (Various Tilts)	

All of the solar technologies listed in Table 1 have the potential for agrivoltaic applications. However, with the exception of VB, in order to achieve an agrivoltaic operation where a tractor could plow fields, each of the solar racking systems would have to be elevated to a height of 15 feet or higher. Racking systems are commercially available to achieve elevated solar arrays, with the exception of the dual axis tracking system. Solar modules can be mounted as fixed tilt or with single axis tracking at an increased height, but these systems are subject to higher wind sheer loads and require significantly greater materials for framing and anchoring. The cost is also significantly higher to deploy elevated agrivoltaic solar. Therefore, the FCPC-ED concluded that VB solar is the least risky and lowest cost option, because the technology does not require any moving parts and is resistant to snow, which is estimated by the FCPC-ED to result in around 10% annual losses for fixed tilt arrays in Forest County.

2.2 Comparison of Solar Technologies:

The FCPC-ED performed its base solar generation modeling with the System Advisor Model (SAM) [3], provided by the National Renewable Energy Laboratory (NREL). The FCPC-ED performed modeling in the NREL PVWat s Calculator [17] and in Helioscope [18], and only SAM was able to accurately model the expected performance of all solar technologies. As dual axis tracking is not currently considered a viable technology, this technology was excluded from analysis. Table 2 shows the SAM model inputs used to compare different solar technologies. Only VB was modeled with a 90% bifaciality, as the technology is heavily reliant on a higher bifacial efficiency to achieve greater performance, whereas with all other technologies, it provides a much smaller marginal gain in performance (10% vs 80%). Typically, bifacial modules are available with 70% back side efficiency, but modules with 90% bifaciality are available, and are more ideal for a VB application. The VB systems are mounted at a row spacing of 33 ft, which would allow for two 16 foot wide tractor passes and leave a 6 inch buffer around the solar arrays. VB also needs higher row spacing due to larger inter-row shading with a vertically mounted system compared to lower tilt angles. The Ground Coverage Ratio (GCR) was set to 0.30 for Fixed Tilt and Single Axis Tracking, which is generous inter-row spacing for most applications in Forest County. All systems were modeled based on the weather file for the Bodwewadmi Ktegan Farm, located at 3389 County Hwy H, Laona, WI 54541.

Attachment B – Project Sites & Analysis

FCPC Vertical Solar Farms Project

***Table 2**: System Advisor Model (SAM) Inputs for Various Solar Configurations*

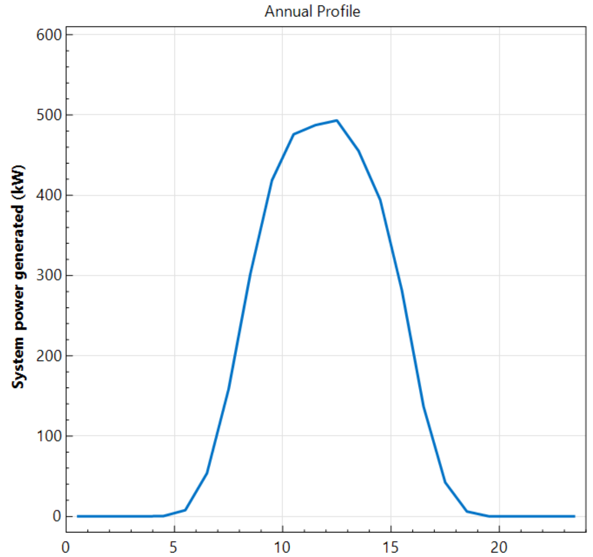
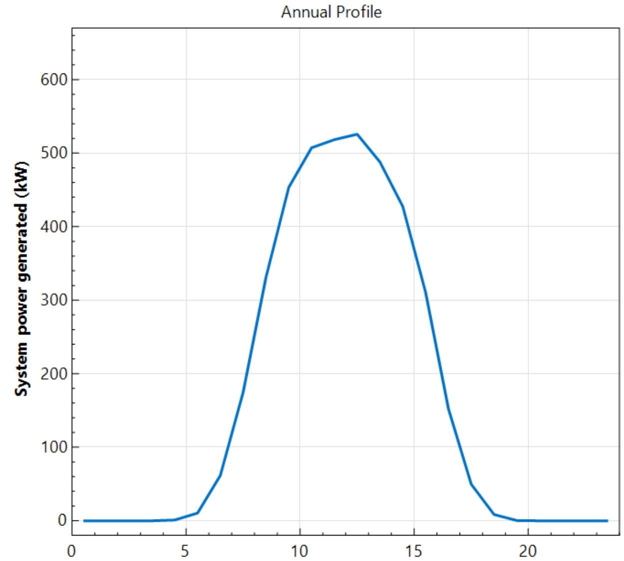
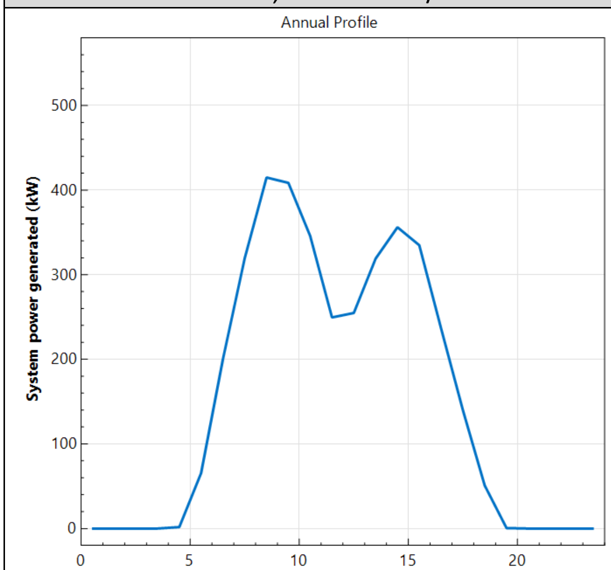
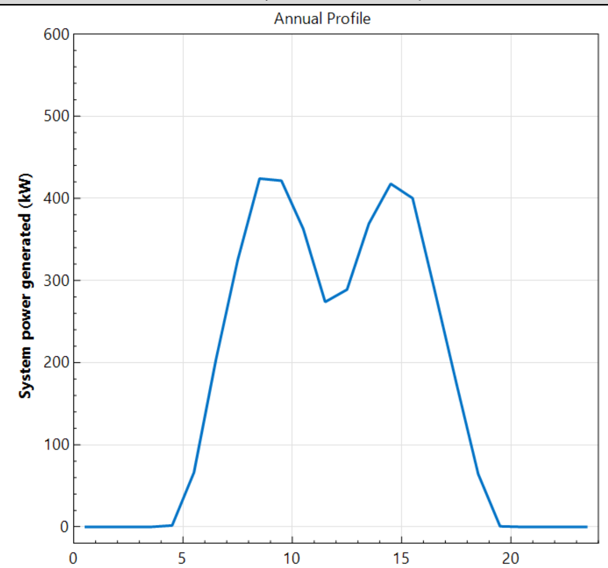
SAM Parameter	Fixed Tilt Monofacial (0%)	Fixed Tilt Bifacial (70%)	Vertical Bifacial (70%)	Vertical Bifacial (90%)	Single Axis Tracking Bifacial (70%)
System Size	1.0 MW_{DC}	1.0 MW_{DC}	1.0 MW_{DC}	1.0 MW_{DC}	1.0 MW_{DC}
PV Module	Hanwha Q Cells 480W	Hanwha Q Cells Duo 480W	Hanwha Q Cells Duo 480W	Hanwha Q Cells Duo 480W	Hanwha Q Cells Duo 480W
Bifacial Efficiency	0%	70%	70%	90%	70%
Inverter	Yaskawa SGI 750XTM	Yaskawa SGI 750XTM	Yaskawa SGI 750XTM	Yaskawa SGI 750XTM	Yaskawa SGI 750XTM
Inverter Load Ratio (ILR)	1.34	1.34	1.34	1.34	1.34
Azimuth	180°	180°	90°	90°	180°
Tilt	30°	30°	90°	90°	0°
Ground Coverage Ratio (GCR)	0.30	0.30	0.193	0.193	0.30
Row Spacing	21.2 ft	21.2 ft	33 ft	33 ft	21.2 ft
Inter-Row Shading	Standard	Standard	Standard	Standard	Standard
Backtracking	NA	NA	NA	NA	ON

Table 3 shows the annual average hourly production curves for the five different technologies. The Fixed Tilt arrays produce the highest peak power production, achieving around 500 kW for a 1 MW_{DC} system, which is due to the optimal tilt angle during solar noon as compared to VB or Single Axis Tracking. The VB arrays have the lowest peak power production, around 420 kW on the top side of the module. However, the VB system has 2 peaks, as compared to only 1 peak for all other technologies. This is because at solar noon, there is no direct sun exposure to the modules, and thus power production drops, and picks up earlier in the day and later in the evening, which is bet er matched to typical utility peak loads. The VB (90%) system shows nearly identical peaks, as the evening peak is only 10% lower intensity than the morning peak. Finally, Single Axis Tracking has a flat er, but longer peak, reaching around 450 kW as the system is able to maintain peak hour production for longer due to tracking.

Attachment B – Project Sites & Analysis

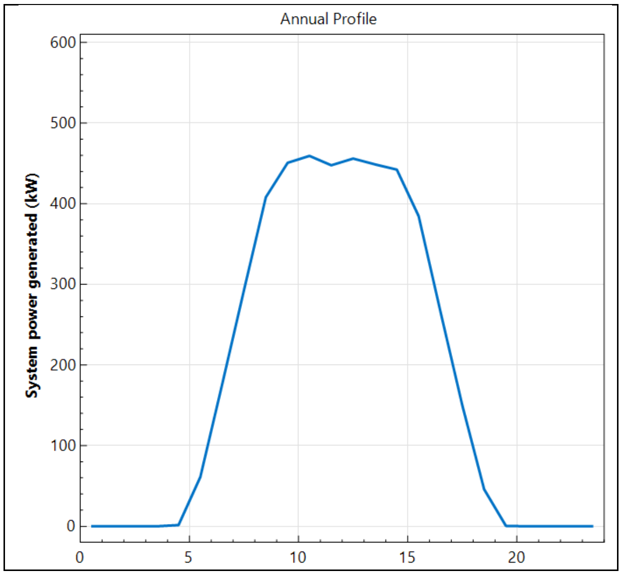
FCPC Vertical Solar Farms Project

***Table 3**: Comparison of Annual Generation and Hourly Generation Profiles of Different Solar Configurations.*

Fixed Tilt Monofacial (0%)	**Fixed Tilt Bifacial (70%)**
Annual Generation: 1,354.5 MWh / MW	Annual Generation: 1,465.7 MWh / MW
	
Vertical Bifacial (70%)	**Vertical Bifacial (90%)**
Annual Generation: 1,348.6 MWh / MW	Annual Generation: 1,489.0 MWh / MW
	
Single Axis Tracking Bifacial (70%)	
Annual Generation: 1,639.7 MWh / MW	

Attachment B – Project Sites & Analysis

FCPC Vertical Solar Farms Project



The different solar configurations also result in different annual generation amounts. The Single Axis Tracking (70%) with 70% Bifaciality configuration has the highest base generation (1,639.7 MWh / MW), followed by VB with 90% Bifaciality (1,489.0 MWh / MW), and Fixed Tilt Bifacial (1,465.7 MWh / MW), which are nearly equal. The VB with 70% Bifaciality (1,348.6 MWh / MW) performs nearly equal to the Fixed Tilt Monofacial Array (1,354.5 MWh / MW).

However, base generation is not the only consideration for siting solar PV in Forest County, WI. Forest County receives an average annual snowfall of 81.6 inches per year [4], and is expected to receive around 10% higher winter-time precipitation by 2050 [19], much of which will fall as snow. The FCPC-ED estimated a 4.0% snowfall loss at a 447 kW ballasted roof mount array in Milwaukee, which only receives an annual snowfall of 48.7 inches per year, and has much warmer winters that promote snow melt. None of the Tribe's Fixed Tilt Monofacial arrays in Forest County, WI generate over 1,100 MWh / MW, and snowfall is estimated to reduce production by 10 – 15%, combined with inter-row shading and tree shading. Therefore, snowfall represents a significant source of generation loss in Forest County, and any modeled system needs to account for snow losses. The FCPC-ED estimates that snow losses for VB would be the lowest, at only 2%, with only ice storms resulting in snow losses, which will be removed by gravity relatively quickly. A 45° tilt angle for Single Axis Tracking Bifacial (70%) is estimated to have slightly higher snow losses, at 4%, due to increased time to shed snow when the modules become shaded and there is not as strong of a force of gravity to remove snow at 45° compared to 90°. Fixed Tilt Bifacial (70%) is estimated to lose 7% of production because the back side of the modules will generate an additional 3% in the winter months, whereas Fixed Tilt Monofacial (0%) modules are estimated to lose 10% of production. This results in an adjusted performance of 1,574.7 MWh / MW for Single Axis Tracking Bifacial (70%), followed by 1,459.2 MWh / MW for Vertical Bifacial (90%). Fixed Tilt Bifacial (70%) generates 1,363.1 MWh / MW, which is closely followed by Vertical Bifacial (70%) at 1,321.6 MWh / MW. Fixed Tilt Monofacial is outperformed considerably, with only 1,219.1 MWh / MW. Therefore, VB is expected to perform as good or bet er than fixed tilt arrays in Forest County, WI, with performance estimated 7.3% lower compared to Single Axis Tracking Bifacial (70%).

Table 4*: Modeled Solar Generation by Technology With Snow Loss.*

Technology	Base Generation (MWh / MW)	Estimated Snow Loss (%)	Adjusted Generation (MWh / MW)
Single Axis Tracking Bifacial (70%)	1,639.7	4%	1,574.7
Vertical Bifacial (90%)	1,489.0	2%	1,459.2
Fixed Tilt Bifacial (70%)	1,465.7	7%	1,363.1
Vertical Bifacial (70%)	1,348.6	2%	1,321.6
Fixed Tilt Monofacial (0%)	1,354.5	10%	1,219.1

2.3 Field Results of Vertical Bifacial

Next2Sun [5] published results for several VB agrivoltaic arrays that it has constructed in different countries. Results from all 8 arrays are summarized in Table 5. Reported results ranged between 1,000 – 1,290 MWh / MW, with an average generation of 1,122 MWh / MW. However, solar generation was mostly reported in northern Europe as compared to northern Wisconsin, and thus the observed results would be expected to be higher in Wisconsin. These results demonstrate that the VB system has been commercially proven in a variety of agrivoltaic settings.

Table 5*: Summary of Reported Generation for Installed VB Systems by Next2Sun [5]*

Location	Year of Installation	System Size (kW_{DC})	Annual Generation (MWh / Yr)	Capacity Normalized Annual Generation (MWh / MW / Yr)
Baden, Germany	2020	4,100	4,850	1,183
Saarland, Germany	2018	2,000	2,150	1,075
Channay, France	2021	237	256	1,080
Valpuiseaux, France	2021	111	124	1,117
Guntramsdorf, Austria	2019	22.5	23	1,000
Vasteras, Sweden	2021	33	37	1,121
Seongnam, Korea	2020	30	38.7	1,290
Saarland, Germany	2015	28	31	1,107
Average		**820**	-	**1,122**

3. Solar Generation Modeling Assumptions

3.1 Typical Section:

A typical section was developed based on published plans for utility-scale solar arrays from the Wisconsin Public Service Commission (PSC). These plans showed an average of around 300 foot sections of PV modules before a service road was added. The FCPC-ED used a 15 foot buffer around each section, such that a 30 foot access road could be added between rows, which was observed in the PSC published plans. Further, inter-row spacing was set to 33 feet so that two 16 foot tractors could pass to mow for hay, leaving a 6 inch buffer on either side of the PV arrays. This is also the optimal row spacing recommended by Next2Sun. Modules were set to a height of 4 feet, which is only relevant for tree shade modeling. A frame spacing of 0.755 feet was used with modules mounted in portrait, per the specifications provided for the Sunzaun system [1], which is able to meet BABA requirements, and is a US-based company. The Hanwha Q Peak Duo 480 W modules were used for the typical sections. Typical sections, and fractions thereof, were used to refine the final system capacity used to estimate the total system size for each site. An example typical section is shown in Figure 1.

VB systems have been tested with animal grazing successfully. However, should animal encounters with the solar arrays become problematic, the FCPC-ED plans to install electric fence barriers to deter animals from rubbing on solar arrays.

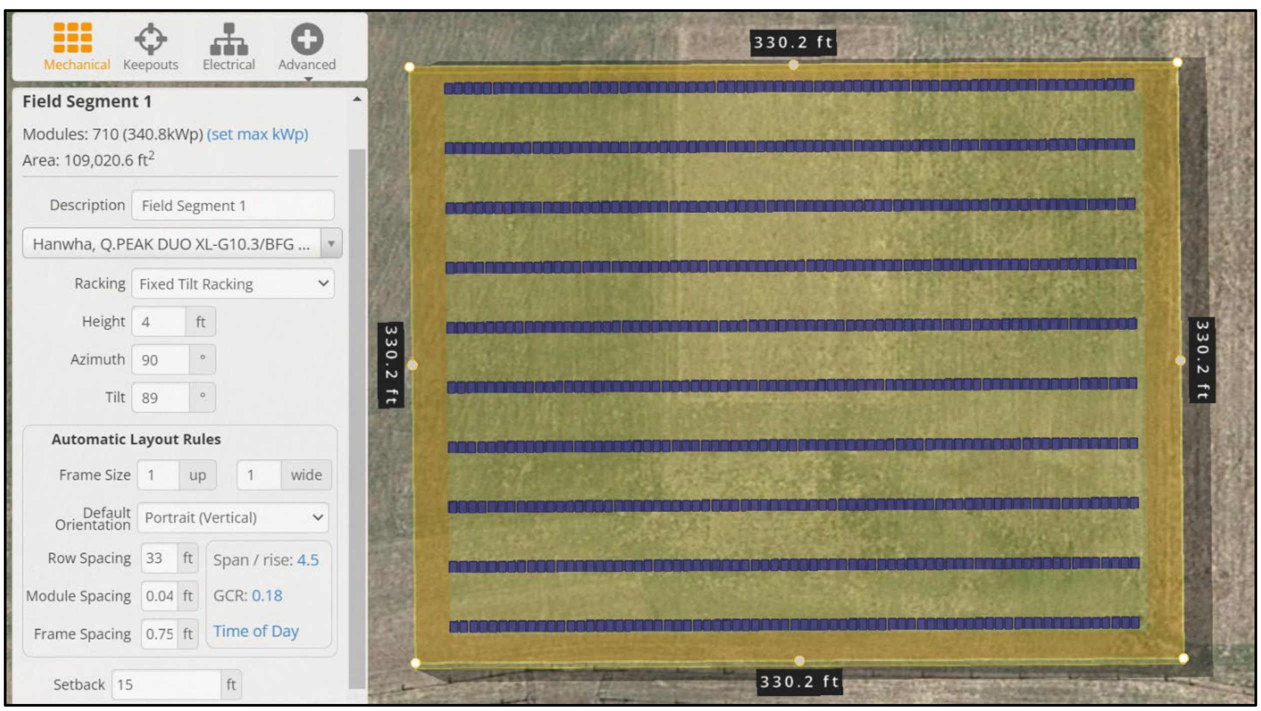


***Figure 1**: Typical Section for a Solar PV Array. Screenshot from Helioscope [18].*

3.2 Shade Modeling:

The FCPC-ED modeled tree shade in Helioscope. The following assumptions were made for tree shading:

- Forest Edge: 70 ft
- Wind Break: 50 ft
- Homes: 25 ft

The majority of forest edge trees are not anticipated to reach over 70 feet without competition for sunlight at the forest edge. Wind break trees have direct exposure to sunlight, and are not expected to exceed 50 feet. Finally, 25 feet accounts for the height of most homes.

Helioscope cannot accurately model inter-row shading, and thus inter-row shading was ignored, and inter-row shading from SAM was used instead. Shade loss estimates were run for arrays facing 90° East, and then all array subsections were oriented to 270° West and were re-run. The average of both the East and West facing arrays was used to determine total shade losses.

Finally, the FCPC-ED used the standard Helioscope setting to keep out solar modules from areas of strong shade, which usually resulted in a tree-line buffer of 100 feet or greater.

3.3 Bifacial Modeling:

Bifaciality is averaged between east-facing and west-facing rows of solar modules. In areas closer to tree lines, the FCPC-ED assumes that the lower efficiency face of the module will face the area with higher shade, such that local generation is optimized. Local shading was not optimized in the proposed site designs, however the proposed designs incorporate low-shading site plans. Modeling was performed for both the 70% bifacial modules that are readily available now, as well as for 90% bifacial modules that are more ideal for a VB application.

3.4 Snow Shade:

As per Section 2.2, snow shade losses are estimated at 2%.

3.5 Base Generation and Annual Degradation:

The FCPC-ED uses generation estimates provided by SAM, as presented in Table 2. Annual degradation is assumed at 0.5%, as per industry standards.

4. Solar Site Selection and Generation

The FCPC-ED reviewed all available land at FCPC for potential solar generation sites. Only land zoned as "Agriculture" were considered for solar PV. The FCPC-ED was instructed that no significant land use change could result from the installation of solar PV. This means that only mild clearing of obstructive trees could be considered. Further, as discussed in Section 1, the FCPC-ED could not consider standard solar technologies that would take productive agricultural land out of production in order to install solar. The FCPC-ED was able to find 5 locations that met these criteria, along with having a large enough land area to make large-scale solar production financially feasible. A summary of each site is presented in Table 6.

***Table 6**: Summary of Selected Project Locations*

Site	Address	Latitude	Longitude	Array Size (MW_{DC})	Array Size (MW_{AC})
Bodwewadmi Ktegan Farm	3389 Co Hwy H Laona WI 54566	45.495846 N	-88.613176 W	6.00	5.00
Rudloff Farm	9094 Keith Siding Rd. Crandon, WI 54520	45.511955 N	-88.891765 W	6.00	5.00
Rummels Rd. Field	4446 Rummels Rd. Wabeno, WI 54566	45.464431 N	-88.658258 W	6.00	5.00
Huettl Farm	2320 Co Hwy H Wabeno, WI 54566	45.458566 N	-88.644711 W	3.83	3.19
Cemetery Rd. Field	Cemetery Rd. & Co Hwy H Wabeno, WI 54566	45.451008 N	-88.644930 W	1.97	1.64
Total	-	-	-	**23.8**	**19.83**

Each location is on FCPC Tribal lands in Forest County, WI. A map of each site's relative location is shown in Figure 2.

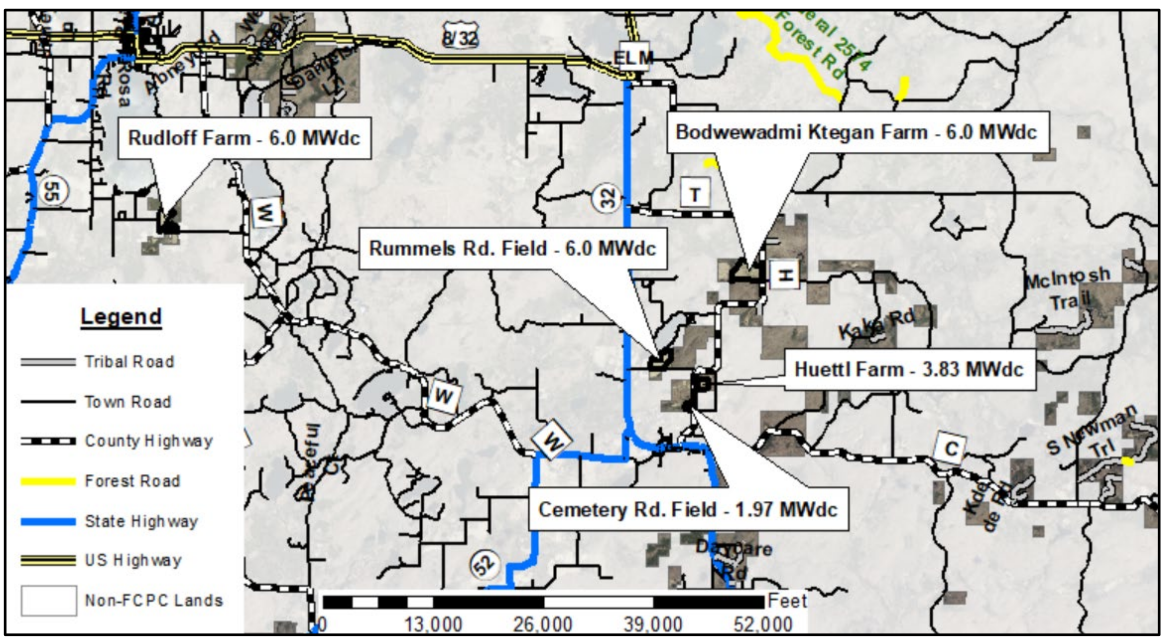


***Figure 2**: Project Locations*

4.1 Bodwewadmi Ktegan Farm:

Tribal Land Designation: Trust Land (Exempt from state permitting requirements on site)

Potential Disturbance Area: 158 Acres

The Bodwewadmi Ktegan Farm is currently used for a number of agricultural activities, including raising beef, bison, pigs, chickens, as well as for corn, and vegetable production. The majority of the land is used for animal grazing. This site is not located near any wetlands or other areas of conservation concern that could impact project implementation. The potential disturbance area map is shown in Figure 3.

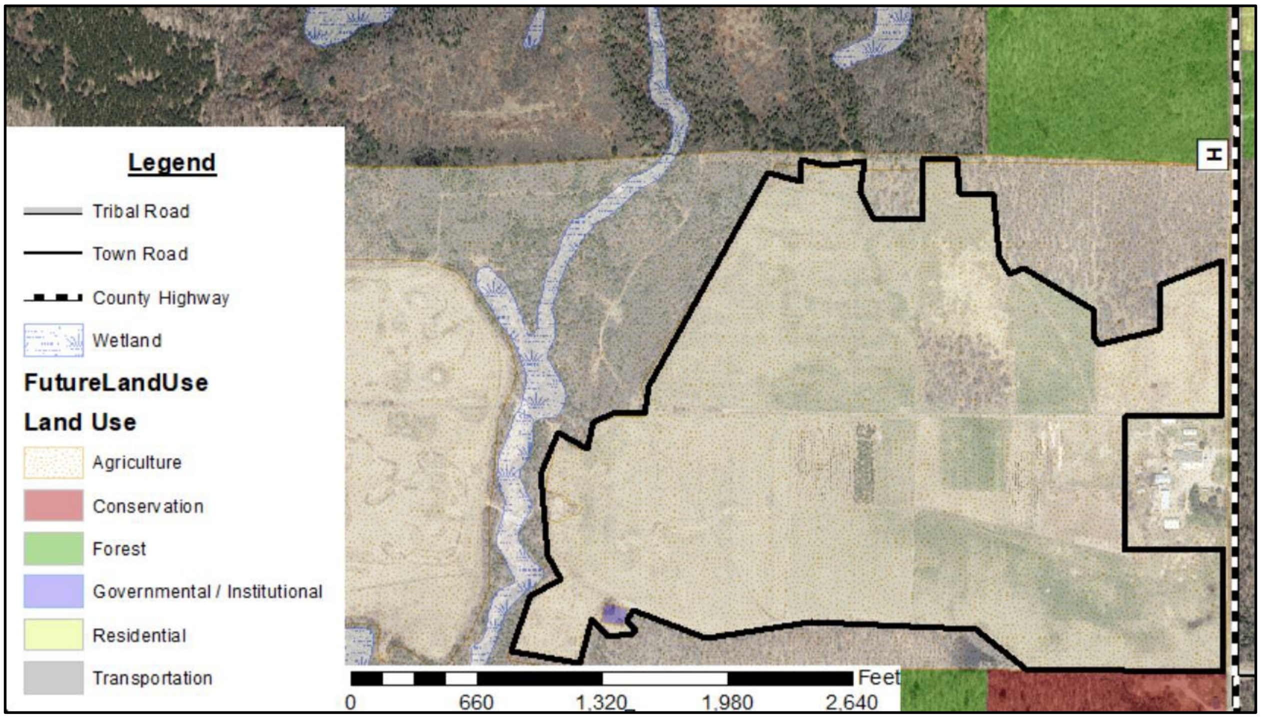


***Figure 3**: Potential Disturbance Area for the Bodwewadmi Ktegan Farm Array*

Electrical Service: 3-Phase 25 kV overhead power lines at 100 amps. The nearest 530 amp connection is in Laona for power line upgrade connection. If combined with the Rummels Rd. Field, the total reconductor run is 11.1 miles.

System Design: 6.0 MW_{DC} / 5.0 MW_{AC}

The Bodwewadmi Ktegan Farm is surrounded by a border of trees. The site includes tree plantations for fruit trees, which were avoided in the system design. The site is not spatially constrained, and thus the final design may incorporate solar in different locations than proposed. The system design in Helioscope is shown in Figure 4.

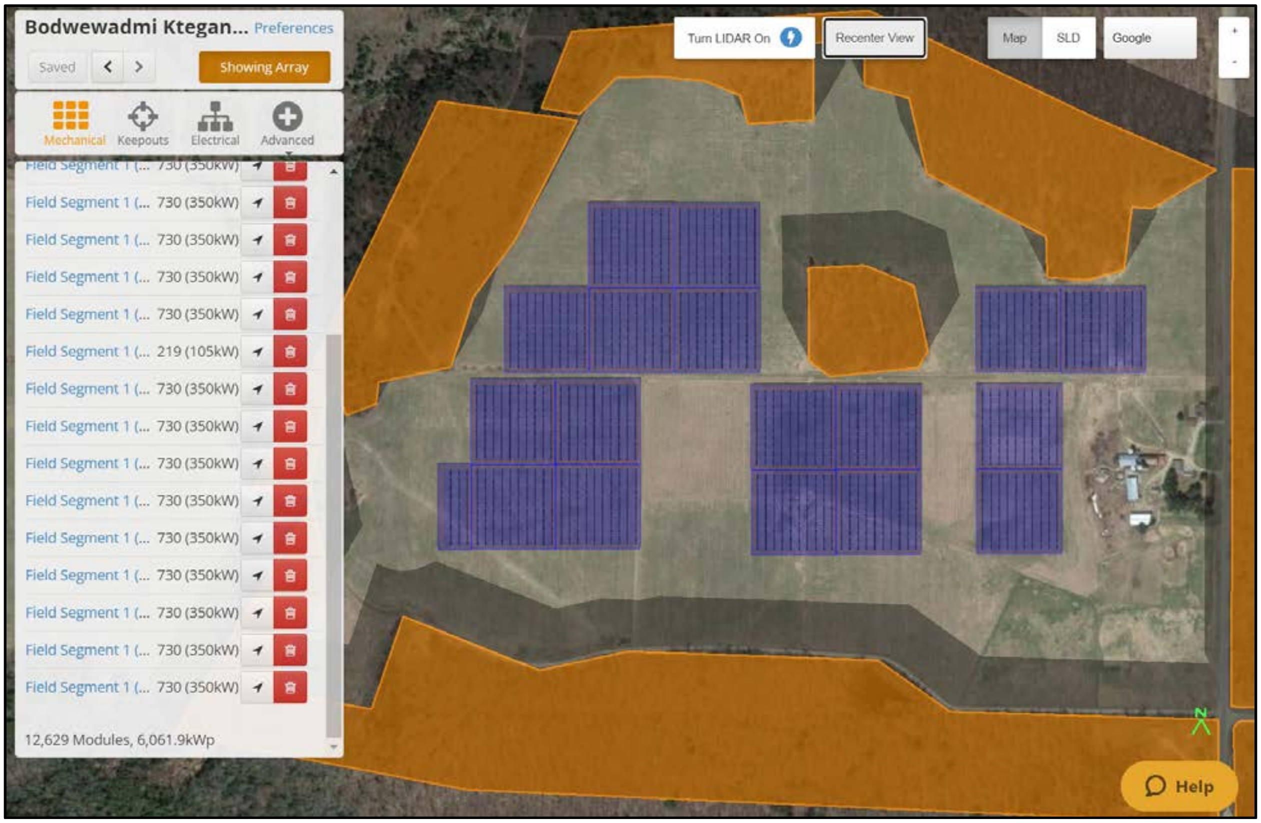


Figure 4*: System Design of the Bodwewadmi Ktegan Farm Array*

Estimated Generation:

Estimated 30 year average generation for the VB (70%) and VB (90%) arrays are estimated at 7,055 MWh / yr and 7,787 MWh / yr respectively. All system generation results are outlined in Table 7.

Table 7*: Modeled Generation for the Bodwewadmi Ktegan Array*

Bodwewadmi Ktegan Farm	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System size	6.0	6.0
Base Generation (MWh)	Unobstructed generation	8,094	8,934
East Tree Shade Loss (%)	Shade loss from tree shade	4.2%	4.2%
West Tree Shade Loss (%)	Shade loss from tree shade	4.7%	4.7%
Average Tree Shade Loss (%)	Average of east & west tree shade	4.5%	4.5%
Generation With Tree Shade Loss (%)	Net generation after tree shade	7,734	8,536
Generation With Snow Loss (MWh)	At 2% snow loss - net after weather	7,579	8,366
30 Year Average Generation (MWh)	At 0.5% annual degradation	7,055	7,787

4.2 Rudloff Farm:

Tribal Land Designation: Fee Land (Requires state permitting)

Potential Disturbance Area: 100 Acres

The Rudloff Farm is used for hay production only. The site is bisected by a wetland, which may require state permitting reviews, however the FCPC-ED does not propose to disturb the wetland. Erosion and runoff may need to be studied at this site prior to permitting approval. An additional wind break north of the wetland would be removed. The potential disturbance area map is shown in Figure 5.

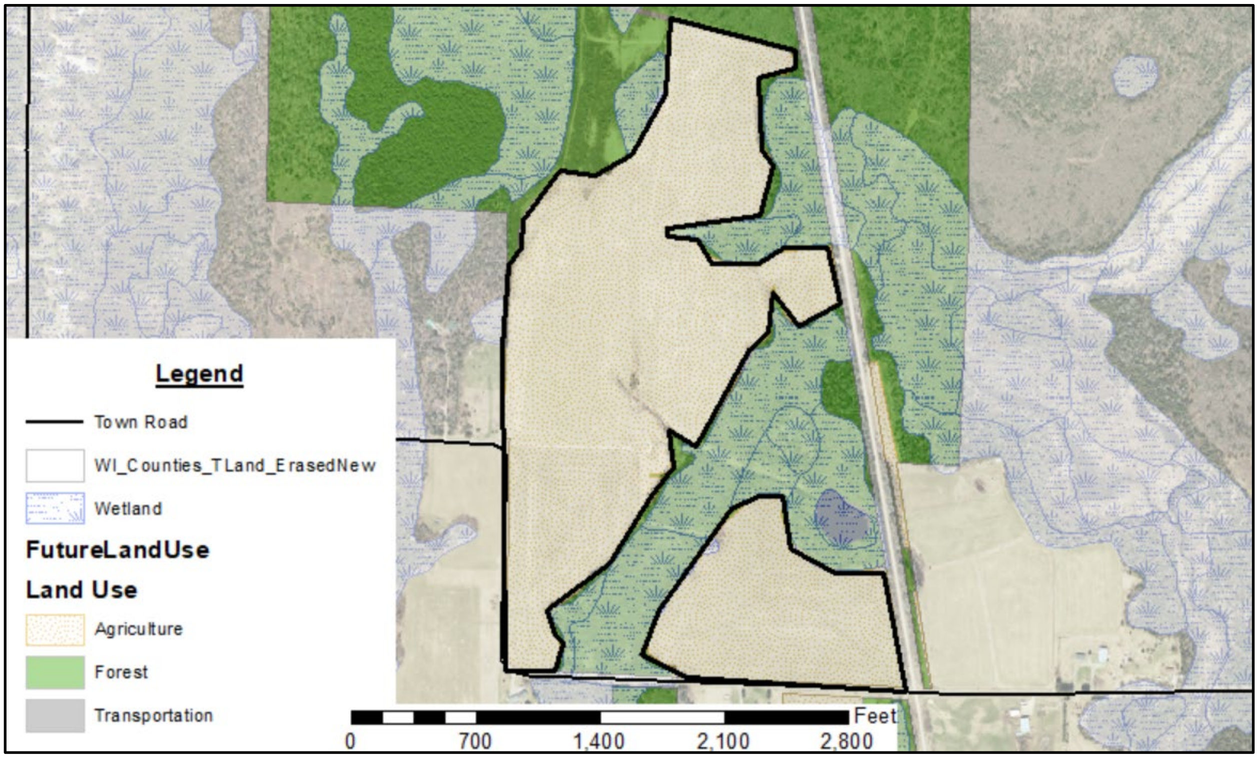


***Figure 5**: Potential Disturbance Area for the Rudloff Farm Array*

Electrical Service: 1-Phase 14.4 kV overhead power lines at 50 amps (est). The nearest 530 amp connection is in Crandon for a power line upgrade. This site would likely have to upgrade underground single phase lines to reach Crandon. The total reconductor run would be around 4.5 miles.

System Design: 6.0 MW_{DC} / 5.0 MW_{AC}

The Rudloff Farm is surrounded by a border of trees. The site is not spatially constrained, and thus the final design may incorporate solar in different locations than proposed. The system design in Helioscope is shown in Figure 6.

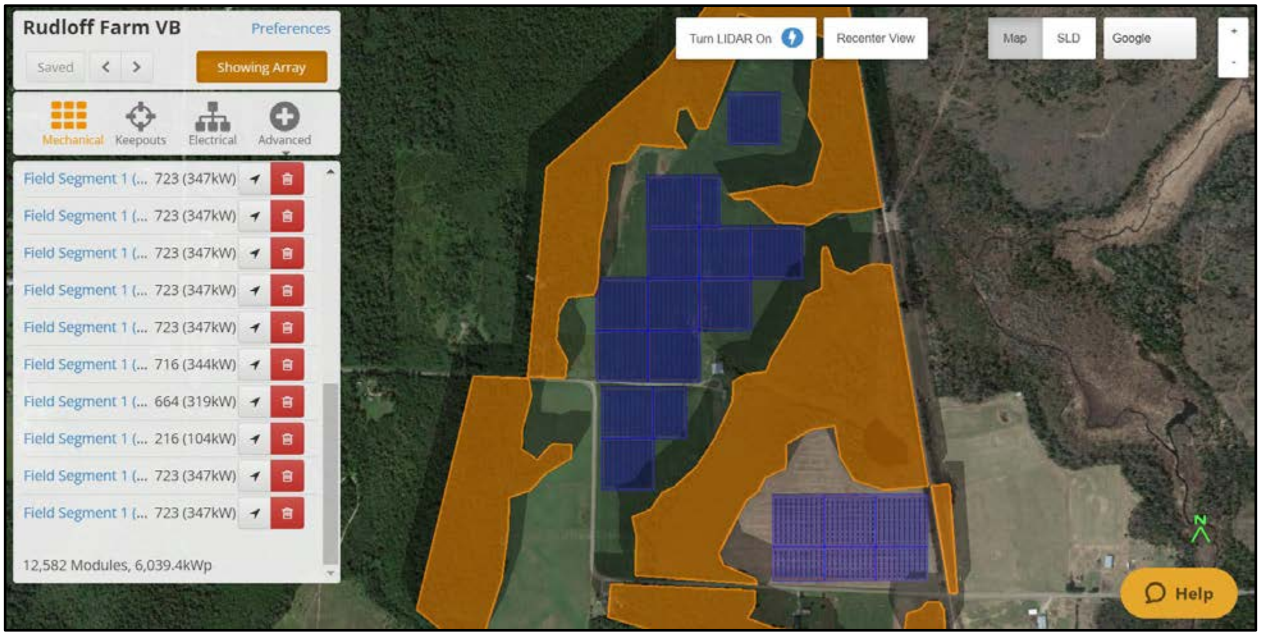


Figure 6*: System Design of the Bodwewadmi Ktegan Farm Array*

Estimated Generation:

Estimated 30 year average generation for the VB (70%) and VB (90%) arrays are estimated at 6,759 MWh / yr and 7,461 MWh / yr respectively. All system generation results are outlined in Table 8.

Table 8*: Modeled Generation for the Rudloff Farm Array*

Rudloff Farm	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System size	6.0	6.0
Base Generation (MWh)	Unobstructed generation	8,094	8,934
East Tree Shade Loss (%)	Shade loss from tree shade	8.6%	8.6%
West Tree Shade Loss (%)	Shade loss from tree shade	8.3%	8.3%
Average Tree Shade Loss (%)	Average of east & west tree shade	8.5%	8.5%
Generation With Tree Shade Loss (%)	Net generation after tree shade	7,410	8,179
Generation With Snow Loss (MWh)	At 2% snow loss - net after weather	7,262	8,015
30 Year Average Generation (MWh)	At 0.5% annual degradation	6,759	7,461

4.3 Rummels Rd. Field:

Tribal Land Designation: Trust Land (Exempt from state permitting requirements on site)

Potential Disturbance Area: 75 Acres

The Rummels Rd. Field is used for hay production only. The site is located near homes, but not near any wetlands. The potential disturbance area map is shown in Figure 7.

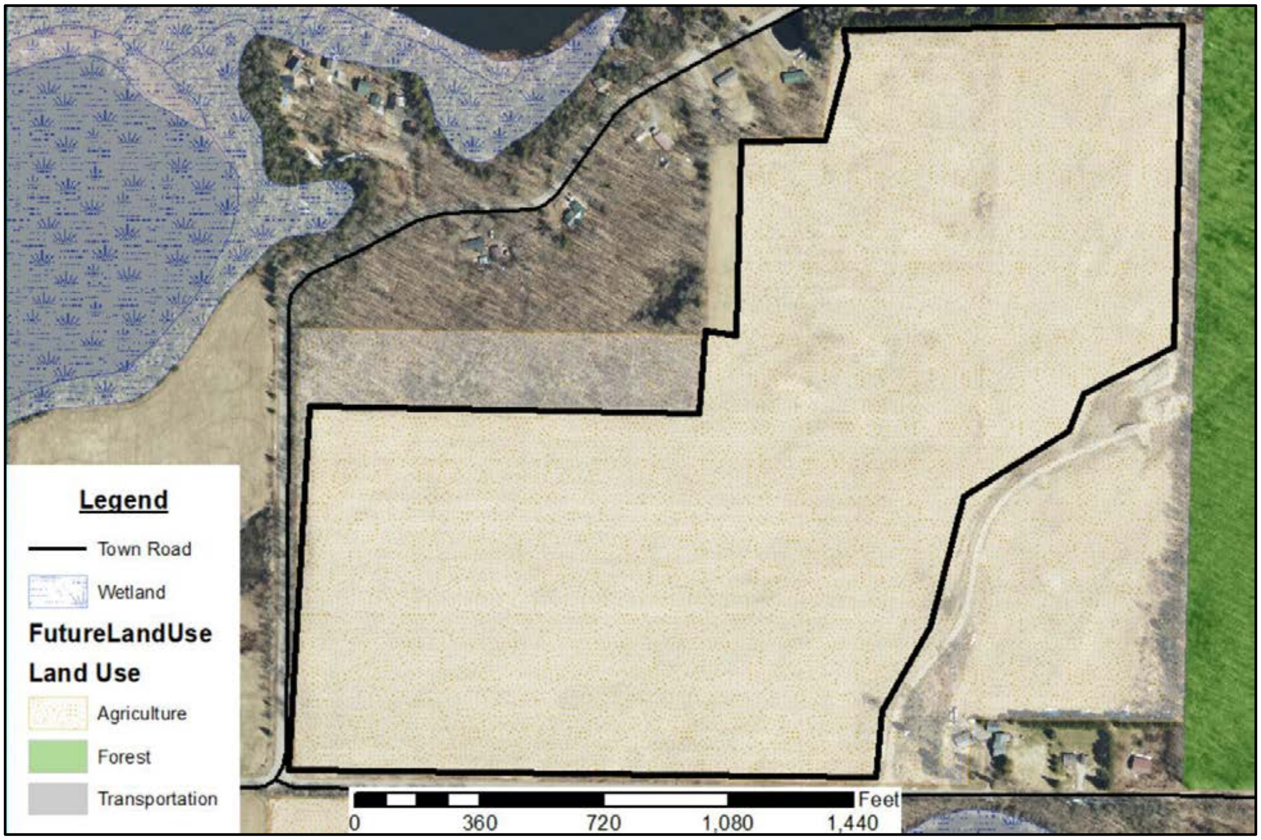


***Figure 7**: Potential Disturbance Area for the Rummels Rd. Field Array*

Electrical Service: 1-Phase 14.4 kV overhead power lines are 2.6 miles away from 3-Phase power lines that connect to the Bodwewadmi Ktegan Farm. These connecting lines are 3-Phase 25 kV overhead power lines at 100 amps. The nearest 530 amp connection is in Laona for power line upgrade. If combined with the Rummels Rd. Field, the total reconductor run is 11.1 miles. Note this run is longer than the Huet l Farm & Cemetery Rd. Field because there is anticipated to be not enough line capacity to connect all sites one 530 amp power line, and thus 2 runs are currently estimated to provide enough electrical service for all 4 sites.

System Design: 6.0 MW_{DC} / 5.0 MW_{AC}

The Rummels Rd. Field is surrounded by a border of trees. The site is not spatially constrained, and thus the final design may incorporate solar in different locations than proposed. The system design in Helioscope is shown in Figure 8.

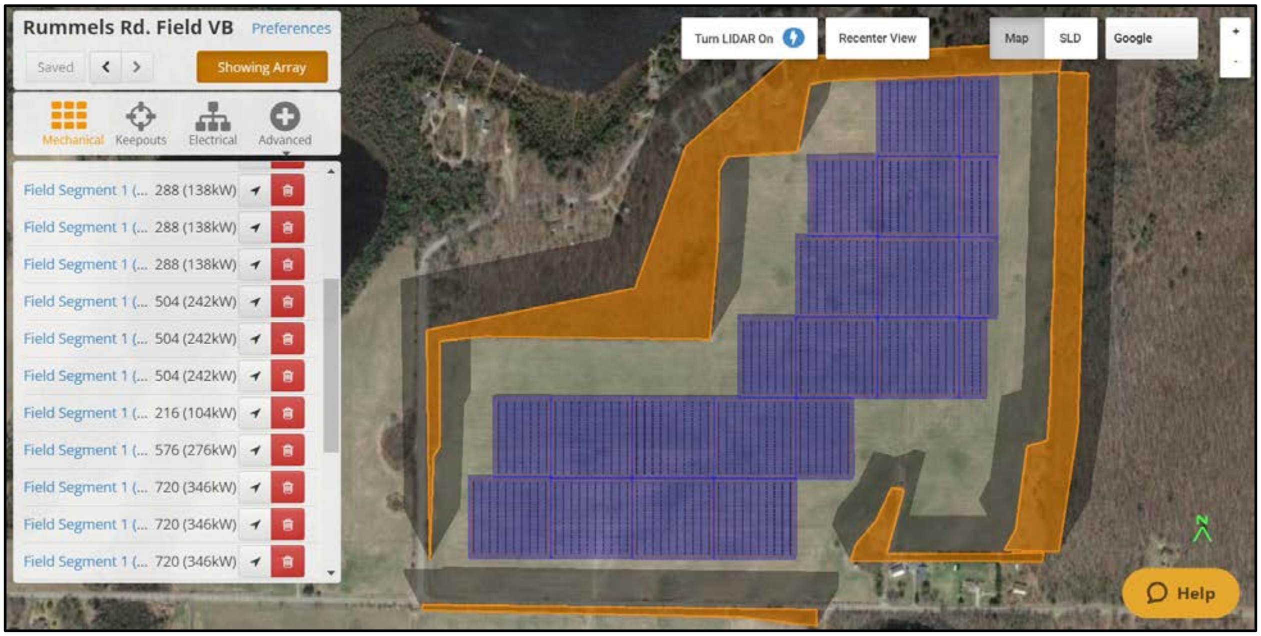


Figure 8*: System Design of the Rummels Rd. Field Array*

Estimated Generation:

Estimated 30 year average generation for the VB (70%) and VB (90%) arrays are estimated at 6,944 MWh / yr and 7,665 MWh / yr respectively. All system generation results are outlined in Table 8.

Table 9*: Modeled Generation for the Rummels Rd. Field Array*

Rummels Rd. Field	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System size	6.0	6.0
Base Generation (MWh)	Unobstructed generation	8,094	8,934
East Tree Shade Loss (%)	Shade loss from tree shade	5.8%	5.8%
West Tree Shade Loss (%)	Shade loss from tree shade	6.1%	6.1%
Average Tree Shade Loss (%)	Average of east & west tree shade	6.0%	6.0%
Generation With Tree Shade Loss (%)	Net generation after tree shade	7,612	8,402
Generation With Snow Loss (MWh)	At 2% snow loss - net after weather	7,460	8,234
30 Year Average Generation (MWh)	At 0.5% annual degradation	6,944	7,665

4.4 Huettl Farm:

Tribal Land Designation: Trust Land (Exempt from state permitting requirements on site)

Potential Disturbance Area: 37 Acres

The Huet l Farm is used for hay production and grazing of cows and bison. The site is located near one home, but is not near any wetlands. The proposed disturbance area includes an area on the east side that would be disturbed. This area is not a forest, but does include some trees that would be removed and there is a windbreak in the middle of the field that would also be removed. The potential disturbance area map is shown in Figure 9.

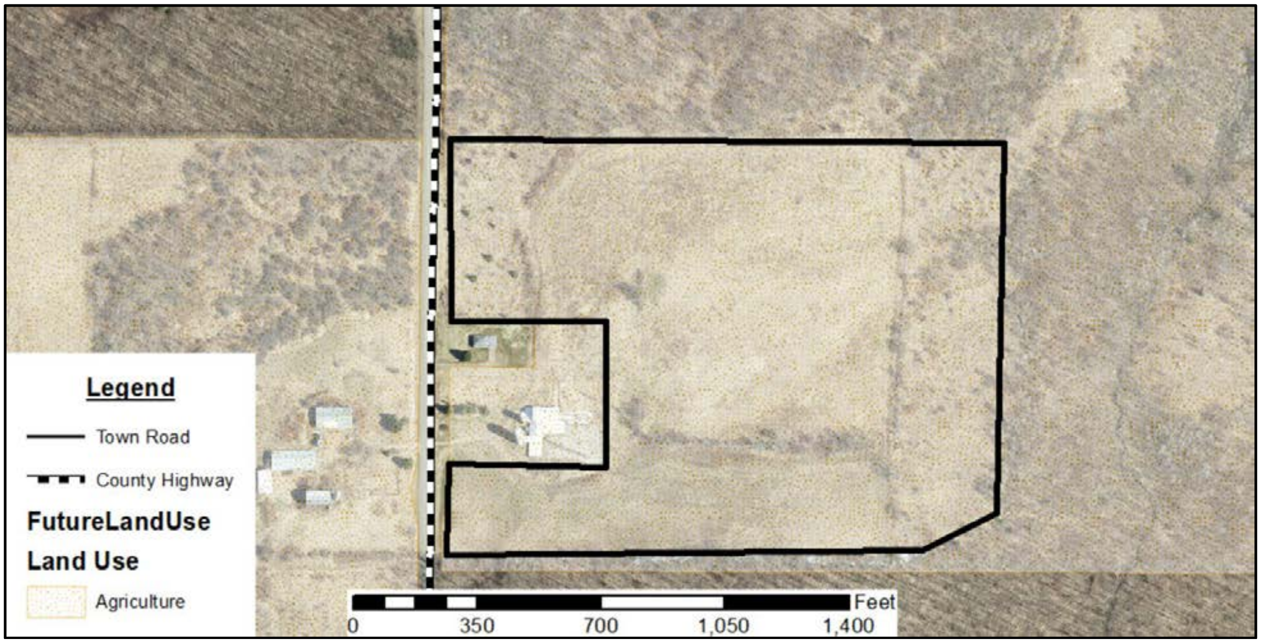


***Figure 9**: Potential Disturbance Area for the Huettl Farm Array*

Electrical Service: 1-Phase 14.4 kV overhead power lines at 50 amps (estimated). Approximately 0.5 miles to reach the Cemetery Rd. & County Hwy H intersection where there are 3-phase power lines at 100 amps. The nearest 530 amp connection is in Carter, located south of the Town of Wabeno for a power line upgrade. If combined with the Cemetery Rd. Field array, the total reconductor run is 4.9 miles.

System Design: 3.83 MW_{DC} / 3.19 MW_{AC}

The Huet l Farm is surrounded by a border of trees. The site is spatially constrained, and thus the final design will closely resemble the proposed design. The system design in Helioscope is shown in Figure 10.

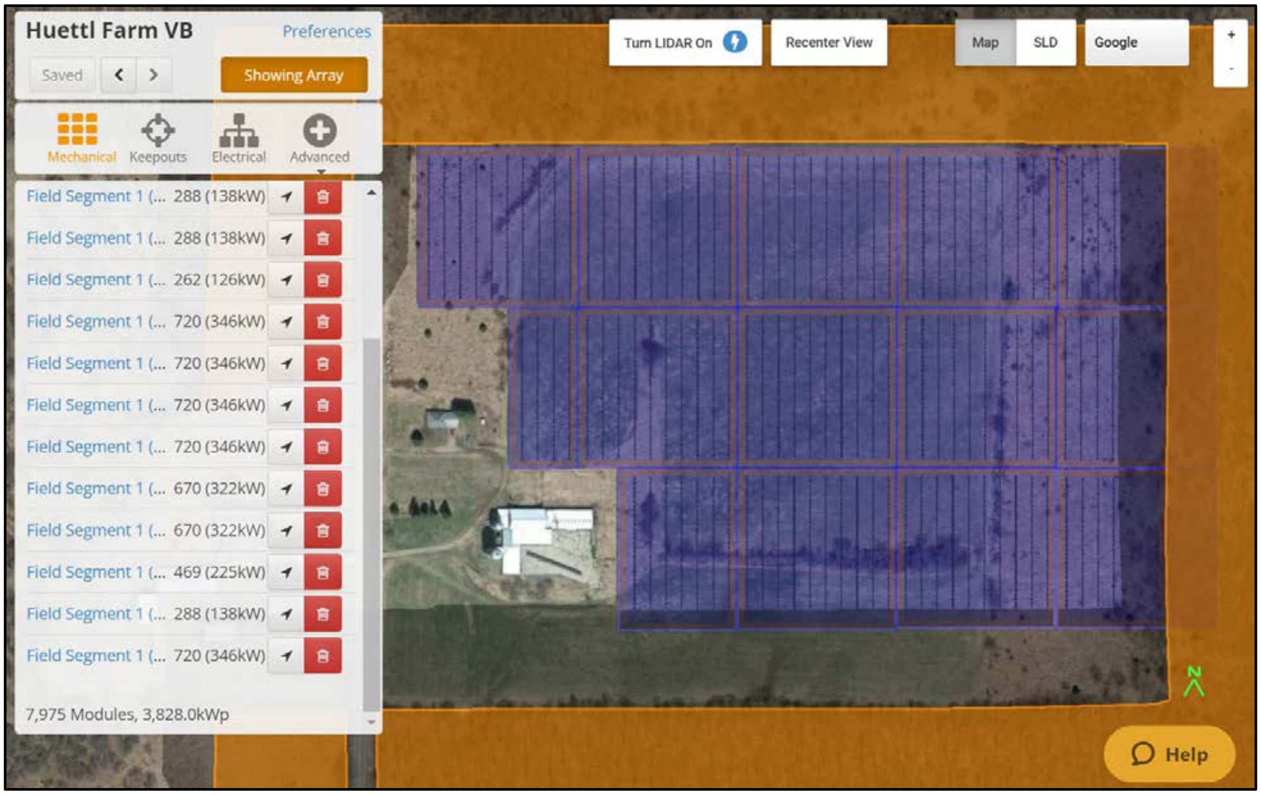


***Figure 10**: System Design of the Huettl Farm Array*

<u>Estimated Generation</u>:

Estimated 30 year average generation for the VB (70%) and VB (90%) arrays are estimated at 4,220 MWh / yr and 4,658 MWh / yr respectively. All system generation results are outlined in Table 10.

***Table 10**: Modeled Generation for the Huettl Farm Array*

Huettl Farm	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System size	3.8	3.8
Base Generation (MWh)	Unobstructed generation	5,126	5,658
East Tree Shade Loss (%)	Shade loss from tree shade	12.6%	12.6%
West Tree Shade Loss (%)	Shade loss from tree shade	6.9%	6.9%
Average Tree Shade Loss (%)	Average of east & west tree shade	9.8%	9.8%
Generation With Tree Shade Loss (%)	Net generation after tree shade	4,626	5,107
Generation With Snow Loss (MWh)	At 2% snow loss - net after weather	4,534	5,004
30 Year Average Generation (MWh)	At 0.5% annual degradation	4,220	4,658

4.5 Cemetery Rd. Field:

Tribal Land Designation: Trust Land (Exempt from state permitting requirements on site)

Potential Disturbance Area: 20 Acres

The Cemetery Rd. Field is used for hay production only. The site is located near one home, but is not near any wetlands. The proposed disturbance area includes two wind breaks on the property that would be removed. The potential disturbance area map is shown in Figure 11.

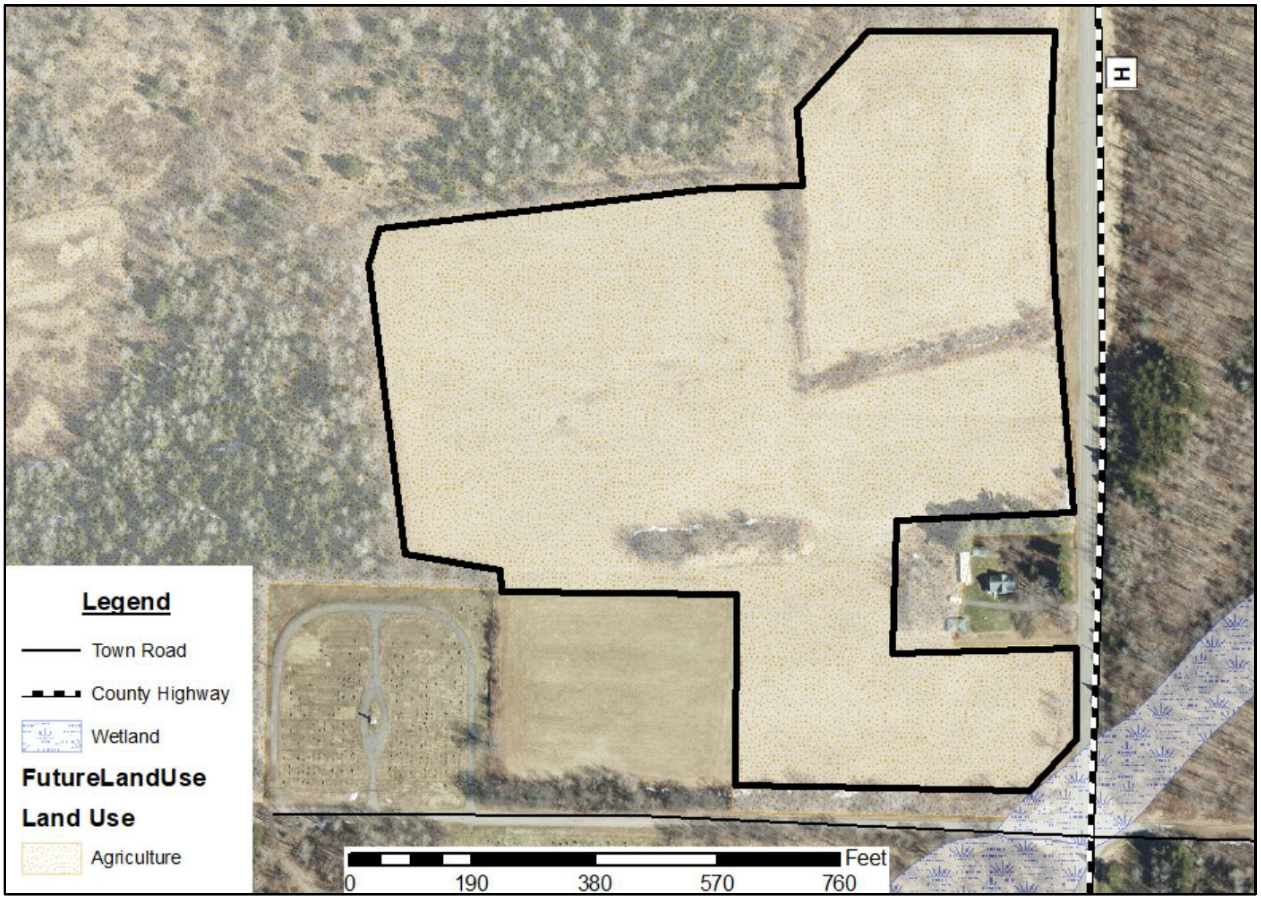


***Figure 11**: Potential Disturbance Area for the Cemetery Rd. Field Array*

Electrical Service: 3-Phase 25 kV overhead power lines at 100 amps. The nearest 530 amp connection is in Carter, located south of the Town of Wabeno for power line upgrade. If combined with the Cemetery Rd. Field array, the total reconductor run is 4.9 miles.

System Design: 3.83 MW_{DC} / 3.19 MW_{AC}

The Cemetery Rd. Field is surrounded by a border of trees. The site is spatially constrained, and thus the final design will closely resemble the proposed design. The system design in Helioscope is shown in Figure 10.

***Figure 12**: System Design of the Cemetery Rd. Field Array*

<u>Estimated Generation</u>:

Estimated 30 year average generation for the VB (70%) and VB (90%) arrays are estimated at 2,073 MWh / yr and 2,288 MWh / yr respectively. All system generation results are outlined in Table 11.

***Table 11**: Modeled Generation for the Cemetery Rd. Field Array*

Cemetery Rd. Field	**Notes**	**70% Bifacial**	**90% Bifacial**
System Size (MWdc)	System size	2.0	2.0
Base Generation (MWh)	Unobstructed generation	2,658	2,933
East Tree Shade Loss (%)	Shade loss from tree shade	14.3%	14.3%
West Tree Shade Loss (%)	Shade loss from tree shade	14.7%	14.7%
Average Tree Shade Loss (%)	Average of east & west tree shade	14.5%	14.5%
Generation With Tree Shade Loss (%)	Net generation after tree shade	2,272	2,508
Generation With Snow Loss (MWh)	At 2% snow loss - net after weather	2,227	2,458
30 Year Average Generation (MWh)	At 0.5% annual degradation	2,073	2,288

5. Project Economics

5.1 Installed System Cost:

The FCPC-ED obtained price quotes from two separate vendors to deliver a turnkey installation for all five proposed projects. Both vendors were instructed to ensure that all final components met Davis-Bacon Wage provisions, as well as Build America Buy America (BABA) provisions in their price quotes. Sunstall Inc. provided a price quotation for the manufacturing of racking and for installation of the racking and modules. Telamon Energy Solutions provided a price quote for modules, inverters, electrical contracting, and engineering. Together, the two vendors provided a price of $1.95 / Wat.

5.2 Interconnection Cost:

The FCPC-ED is currently preparing documentation to submit for a utility capacity energineering study of each site. The capacity study would examine current power line capacity and would evaluate all five sites for power line upgrade costs. The FCPC-ED expects results from the capacity study by the end of 2023. However, Wisconsin Public Service (WPS) provided cost estimates to reconductor existing power lines, including single phase power lines. WPS quoted a cost of $150,000 - $300,000 per mile, depending on the complexity of the line upgrade. WPS confirmed that it would be possible to upgrade single phase power lines located above-ground or below-ground to three phase, which could potentially supply the full proposed project transmission needs, pending the capacity study.

The highest ampacity power lines in the region go up to 530 amps. At a voltage of 25 kV, these lines could hold up to 13.25 MW_{AC}. Along the County Hwy H corridor, which encompasses all proposed project locations, with the exception of the Rudloff Farm, the FCPC-ED is proposing to install 14.83 MW_{AC}, which is more than the potential capacity that only 1 power line reconductor could transfer. Therefore, the FCPC-ED anticipates that 2 utility lines will need to be reconductored to be able to deliver all the required power proposed by the FCPC Vertical Solar Farms Project. As the FCPC-ED does not currently have the cost estimate for utility line upgrades, the higher estimate is used for cost estimation. The total estimated interconnection costs are outlined in Table 12, with an estimated project cost of $6,150,000.

***Table 12**: Estimate of Utility Interconnection Costs by Site*

Location	Reconductor Run (mi)	Reconductor Cost (Low)	Reconductor Cost (High)	$ / MW (Low)	$ / MW (High)
Bodwewadmi Ktegan & Rummels Rd. Field to Laona	11.1	$1,665,000	$3,330,000	$138,750	$277,500
Huetl Farm & Cemetery Rd. to Carter	4.9	$735,000	$1,470,000	$126,724	$253,488
Rudloff Farm to Crandon	4.5	$675,000	$1,350,000	$112,500	$225,000
Total	**20.5**	**$3,075,000**	**$6,150,000**	**-**	**-**

5.3 Contingency Cost:

The FCPC-ED includes a 10% contingency cost to its construction and interconnection estimates to account for unforeseen costs in the future. These costs could include added construction costs that were not anticipated in the final design cost estimate, as well as the costs of inflation. Construction is not scheduled to begin for around 3 years, and a 2% compounded inflation rate would result in an added cost of 6.1% alone.

5.4 USDA PACE Grant Award:

The FCPC-ED anticipates a USDA PACE loan forgiveness of 60% of the 75% loan, which totals a 45% award of the capital costs of the project.

5.5 Inflation Reduction Act Tax Credits:

The FCPC-ED anticipates a tax credit of 30% for the Inflation Reduction Act (IRA) Investment Tax Credit (ITC), as well as a 10% bonus for Domestic Content. The Tribe is also eligible to receive the 10% bonus credit for the Community Bonus Credit Program due to the project being located on Tribal lands, however this program has an annual cap, and the Tribe is not guaranteed to receive the credit.

5.6 Summary of Capital Costs and Credits:

A summary of the total project capital costs is shown in Table 13. Construction is estimated to cost $46,411,000, interconnection is estimated to cost $5,475,000, and contingency is estimated to cost $5,188,600. In total, the project is estimated to cost $57,074,600.

Table 13*: Summary of Project Capital Costs*

Project	Construction Cost	Interconnection Cost	Contingency Cost	Total Cost
Bodwewadmi Ktegan Farm	$11,700,000	$1,665,000	$1,336,500	$14,701,500
Rudloff Farm	$11,700,000	$675,000	$1,237,500	$13,612,500
Rummels Rd. Field	$11,700,000	$1,665,000	$1,336,500	$14,701,500
Huet l Farm	$7,469,000	$735,000	$820,400	$9,024,400
Cemetery Rd. Field	$3,842,000	$735,000	$457,700	$5,034,700
Total	**$46,411,000**	**$5,475,000**	**$5,188,600**	**$57,074,600**

The Tribe is eligible to receive a $42,805,950 PACE Loan, which would result in a $25,683,570 loan forgiveness. The Tribe would then receive $17,122,380 in IRA tax credits at 40% of total costs. The Tribe's liability after loan forgiveness and IRA tax credits is estimated at $14,268,650. These results are summarized in Table 14.

***Table 14**: Summary of Costs After Available PACE Funding and Tax Incentives*

Project	Construction Cost	PACE Loan (75%)	PACE Loan Forgiveness (60%)	IRA Minimum Tax Credit (40%)	FCPC Cash Balance (15%)
Bodwewadmi Ktegan Farm	$14,701,500	$11,026,125	$6,615,675	$4,410,450	$3,675,375
Rudloff Farm	$13,612,500	$10,209,375	$6,125,625	$4,083,750	$3,403,125
Rummels Rd. Field	$14,701,500	$11,026,125	$6,615,675	$4,410,450	$3,675,375
Huettl Farm	$9,024,400	$6,768,300	$4,060,980	$2,707,320	$2,256,100
Cemetery Rd. Field	$5,034,700	$3,776,025	$2,265,615	$1,510,410	$1,258,675
Total	**$57,074,600**	**$42,805,950**	**$25,683,570**	**$17,122,380**	**$14,268,650**

5.7 Operation and Maintenance Costs:

The FCPC-ED assumes an annual Operation & Maintenance cost of $16.32 / kW_{DC} / yr, as per the NREL Comparative Photovoltaic Levelized Cost of Energy Calculator [20] for a utility-scale fixed tilt array in Madison, Wisconsin. This cost converts to $16,320 / MW_{DC} / yr, and $489,600 / MW_{DC} / 30 yrs.

5.8 Sale of Energy Revenue:

Per the PG-2A tariff with WPS, the Tribe is eligible to receive an energy production credit of between $0.04640 - $0.05480 / kWh depending on the time of year for primary transmission service on 14.4 kV power lines. The FCPC-ED assumes an average cost of $0.050 / kWh for its revenue forecasts.

While the annual compensation cost is subject to change, the FCPC-ED anticipates that the $0.050 / kWh cost assumed is conservative and in line with historical and future projected trends in the wholesale power market for WPS.

5.9 Avoided Capacity Revenue:

Per the PG-2A tariff with WPS, the Tribe is eligible to receive an avoided Cost of New Entry (CONE) credit for the MISO Subregion 2. The 2023 rate is $8.809 / kW / month for the first year. This credit is applied at a rate of 50% of rated capacity for solar, and thus the rate annualizes to $52,854 / MW / yr.

The MISO capacity market is subject to change, and depends on a number of factors such as power plant retirements, new transmission capacity, and the rate of increase in electricity demand. Currently, MISO Zone 2 is constrained on its ability to deliver new power, and thus the price is currently high. It is unclear how long this situation will last, but current CONE prices have been stable for the last 3 years and are not expected to change significantly in the next 10 years. However, due to potential CONE price volatility, the FCPC-ED discounts the CONE Revenue at a rate of 10% annually to account for near time price stability. The 30-year average discounted rate is 31.4% of the total revenue, which results in a 30-year average revenue of $16,596 / MW / yr.

5.10 Net Revenue Forecast by Location:

Bodwewadmi Ktegan Farm:

The Bodwewadmi Ktegan Farm array is expected to generate a lifetime revenue of $8,426,451 for the 70% VB System, and $9,524,657 for the 90% VB system, which would result in an annualized return of 12.7% and 14.4%, respectively. Without any incentives, the system would operate at a loss. With only the USDA PACE incentives, the lifetime revenue would be $2,545,851 for the 70% VB system, and $3,644,057 for the 90% VB system, which would result in an annualized return of 1.0% and 1.5%, respectively. Given the low margin of returns dependent on a volatile wholesale energy market, the FCPC-ED concludes that the project would only be viable with full PACE + IRA incentive funding. These results are summarized in Table 15.

Table 15: *Bodwewadmi Ktegan Farm Summary of Project Site Economics*

Bodwewadmi Ktegan Farm	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System Size	6.00	6.00
Total System Cost	Total Capital Cost	$14,701,500	$14,701,500
FCPC System Cost	Cost After Forgiveness & Credits	$2,205,225	$2,205,225
Average Annual Generation (MWh / Yr)	Net Generation After Losses	7,055	7,787
30 Year Sale of Energy Revenue	At $0.050 / kWh	$10,581,996	$11,680,202
30 Year CONE Revenue	At $16,596 / MW / yr (Discounted 10%)	$2,987,280	$2,987,280
Operating Expenses	At $16,320 / MW / yr	$2,937,600	$2,937,600
Lifetime Net Revenue (Base)	Revenue Forecast From Total Cost	-$4,069,824	-$2,971,618
Lifetime Net Revenue (PACE Only)	Revenue Forecast W/ PACE Forgiveness	$2,545,851	$3,644,057
Lifetime Net Revenue (Full Incentives)	Revenue Forecast After All Incentives	$8,426,451	$9,524,657
Annualized Return (Base)	Annualized Return From Total Cost	-7.6%	-7.3%
Annualized Return (PACE Only)	Annualized Return W/ PACE Forgiveness	1.0%	1.5%
Annualized Return (Full Incentives)	Annualized Return W/ Full Incentives	12.7%	14.4%

Rudloff Farm:

The Rudloff Farm array is expected to generate a lifetime revenue of $8,146,808 for the 70% VB System, and $9,199,040 for the 90% VB system, which would result in an annualized return of 13.3% and 15.0%, respectively. Without any incentives, the system would operate at a loss. With only the USDA PACE incentives, the lifetime revenue would be $2,701,808 for the 70% VB system, and $3,754,040 for the 90% VB system, which would result in an annualized return of 1.2% and 1.7%, respectively. Given the low margin of returns dependent on a volatile wholesale energy market, the FCPC-ED concludes that the project would only be viable with full PACE + IRA incentive funding. These results are summarized in Table 16.

***Table 16**: Rudloff Farm Summary of Project Site Economics*

Rudloff Farm	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System Size	6.00	6.00
Total System Cost	Total Capital Cost	$13,612,500	$13,612,500
FCPC System Cost	Cost After Forgiveness & Credits	$2,041,875	$2,041,875
Average Annual Generation (MWh / Yr)	Net Generation After Losses	6,759	7,461
30 Year Sale of Energy Revenue	At $0.050 / kWh	$10,139,003	$11,191,235
30 Year CONE Revenue	At $16,596 / MW / yr (Discounted 10%)	$2,987,280	$2,987,280
Operating Expenses	At $16,320 / MW / yr	$2,937,600	$2,937,600
Lifetime Net Revenue (Base)	Revenue Forecast From Total Cost	-$3,423,817	-$2,371,585
Lifetime Net Revenue (PACE Only)	Revenue Forecast W/ PACE Forgiveness	$2,701,808	$3,754,040
Lifetime Net Revenue (Full Incentives)	Revenue Forecast After All Incentives	$8,146,808	$9,199,040
Annualized Return (Base)	Annualized Return From Total Cost	-7.5%	-7.2%
Annualized Return (PACE Only)	Annualized Return W/ PACE Forgiveness	1.2%	1.7%
Annualized Return (Full Incentives)	Annualized Return W/ Full Incentives	13.3%	15.0%

Rummels Rd. Field:

The Rummels Rd. Field array is expected to generate a lifetime revenue of $8,260,329 for the 70% VB System, and $9,341,294 for the 90% VB system, which would result in an annualized return of 12.5% and 14.1%, respectively. Without any incentives, the system would operate at a loss. With only the USDA PACE incentives, the lifetime revenue would be $2,379,729 for the 70% VB system, and $3,460,694 for the 90% VB system, which would result in an annualized return of 1.0% and 1.4%, respectively. Given the low margin of returns dependent on a volatile wholesale energy market, the FCPC-ED concludes that the project would only be viable with full PACE + IRA incentive funding. These results are summarized in Table 17.

***Table 17**: Rummels Rd. Field Summary of Project Site Economics*

Rummels Rd. Field	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System Size	6.00	6.00
Total System Cost	Total Capital Cost	$14,701,500	$14,701,500
FCPC System Cost	Cost After Forgiveness & Credits	$2,205,225	$2,205,225
Average Annual Generation (MWh / Yr)	Net Generation After Losses	6,944	7,665
30 Year Sale of Energy Revenue	At $0.050 / kWh	$10,415,874	$11,496,839
30 Year CONE Revenue	At $16,596 / MW / yr (Discounted 10%)	$2,987,280	$2,987,280

Operating Expenses	At $16,320 / MW / yr	$2,937,600	$2,937,600
Lifetime Net Revenue (Base)	Revenue Forecast From Total Cost	-$4,235,946	-$3,154,981
Lifetime Net Revenue (PACE Only)	Revenue Forecast W/ PACE Forgiveness	$2,379,729	$3,460,694
Lifetime Net Revenue (Full Incentives)	Revenue Forecast After All Incentives	$8,260,329	$9,341,294
Annualized Return (Base)	Annualized Return From Total Cost	-7.6%	-7.4%
Annualized Return (PACE Only)	Annualized Return W/ PACE Forgiveness	1.0%	1.4%
Annualized Return (Full Incentives)	Annualized Return W/ Full Incentives	12.5%	14.1%

Huetl Farm:

The Huet l Farm array is expected to generate a lifetime revenue of $5,008,238 for the 70% VB System, and $5,665,189 for the 90% VB system, which would result in an annualized return of 12.3% and 14.0%, respectively. Without any incentives, the system would operate at a loss. With only the USDA PACE incentives, the lifetime revenue would be $1,398,478 for the 70% VB system, and $2,055,429 for the 90% VB system, which would result in an annualized return of 0.9% and 1.4%, respectively. Given the low margin of returns dependent on a volatile wholesale energy market, the FCPC-ED concludes that the project would only be viable with full PACE + IRA incentive funding. These results are summarized in Table 18.

***Table 18**: Huettl Farm Summary of Project Site Economics*

Huettl Farm	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System Size	3.83	3.83
Total System Cost	Total Capital Cost	$9,024,400	$9,024,400
FCPC System Cost	Cost After Forgiveness & Credits	$1,353,660	$1,353,660
Average Annual Generation (MWh / Yr)	Net Generation After Losses	4,220	4,658
30 Year Sale of Energy Revenue	At $0.050 / kWh	$6,330,186	$6,987,136
30 Year CONE Revenue	At $16,596 / MW / yr (Discounted 10%)	$1,906,880	$1,906,880
Operating Expenses	At $16,320 / MW / yr	$1,875,168	$1,875,168
Lifetime Net Revenue (Base)	Revenue Forecast From Total Cost	-$2,662,502	-$2,005,551
Lifetime Net Revenue (PACE Only)	Revenue Forecast W/ PACE Forgiveness	$1,398,478	$2,055,429
Lifetime Net Revenue (Full Incentives)	Revenue Forecast After All Incentives	$5,008,238	$5,665,189
Annualized Return (Base)	Annualized Return From Total Cost	-7.7%	-7.4%
Annualized Return (PACE Only)	Annualized Return W/ PACE Forgiveness	0.9%	1.4%
Annualized Return (Full Incentives)	Annualized Return W/ Full Incentives	12.3%	14.0%

Cemetery Rd. Field:

The Cemetery Rd. Field array is expected to generate a lifetime revenue of $2,370,087 for the 70% VB System, and $2,692,739 for the 90% VB system, which would result in an annualized return of 10.5% and 11.9%, respectively. Without any incentives, the system would operate at a loss. With only the USDA PACE incentives, the lifetime revenue would be $356,207 for the 70% VB system, and $678,859 for the 90% VB system, which would result in an annualized return of 0.4% and 0.8%, respectively. Given the low margin of returns dependent on a volatile wholesale energy market, the FCPC-ED concludes that the project would only be viable with full PACE + IRA incentive funding. These results are summarized in Table 19.

***Table 19**: Cemetery Rd. Field Summary of Project Site Economics*

Cemetery Rd. Field	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System Size	1.97	1.97
Total System Cost	Total Capital Cost	$5,034,700	$5,034,700
FCPC System Cost	Cost After Forgiveness & Credits	$755,205	$755,205
Average Annual Generation (MWh / Yr)	Net Generation After Losses	2,073	2,288
30 Year Sale of Energy Revenue	At $0.050 / kWh	$3,108,981	$3,431,632
30 Year CONE Revenue	At $16,596 / MW / yr (Discounted 10%)	$980,824	$980,824
Operating Expenses	At $16,320 / MW / yr	$964,512	$964,512
Lifetime Net Revenue (Base)	Revenue Forecast From Total Cost	-$1,909,408	-$1,586,756
Lifetime Net Revenue (PACE Only)	Revenue Forecast W/ PACE Forgiveness	$356,207	$678,859
Lifetime Net Revenue (Full Incentives)	Revenue Forecast After All Incentives	$2,370,087	$2,692,739
Annualized Return (Base)	Annualized Return From Total Cost	-7.9%	-7.7%
Annualized Return (PACE Only)	Annualized Return W/ PACE Forgiveness	0.4%	0.8%
Annualized Return (Full Incentives)	Annualized Return W/ Full Incentives	10.5%	11.9%

5.11 Net Revenue Forecast For the FCPC Vertical Solar Farms Project

The entire 5 projects that compose the FCPC Vertical Solar Farms Project is expected to generate a lifetime revenue of $32,211,914 for the 70% VB System, and $36,422,918 for the 90% VB system, which would result in an annualized return of 12.5% and 14.2%, respectively. Without any incentives, the system would operate at a loss. With only the USDA PACE incentives, the lifetime revenue would be $9,382,074 for the 70% VB system, and $13,593,078 for the 90% VB system, which would result in an annualized return of 1.0% and 1.4%, respectively. Given the low margin of returns dependent on a volatile wholesale energy market, the FCPC-ED concludes that the entire FCPC Vertical Solar Farms project would only be viable with full PACE + IRA incentive funding. These results are summarized in Table 20.

***Table 20**: FCPC Vertical Solar Farms Project Summary of Total Project Economics*

FCPC Vertical Solar Farms Project Total	Notes	70% Bifacial	90% Bifacial
System Size (MWdc)	System Size	23.80	23.80
Total System Cost	Total Capital Cost	$57,074,600	$57,074,600
FCPC System Cost	Cost After Forgiveness & Credits	$8,561,190	$8,561,190
Average Annual Generation (MWh / Yr)	Net Generation After Losses	27,050.7	29,858.0
30 Year Sale of Energy Revenue	At $0.050 / kWh	$40,576,040	$44,787,044
30 Year CONE Revenue	At $16,596 / MW / yr (Discounted 10%)	$11,849,544	$11,849,544
Operating Expenses	At $16,320 / MW / yr	$11,652,480	$11,652,480
Lifetime Net Revenue (Base)	Revenue Forecast From Total Cost	-$16,301,496	-$12,090,492
Lifetime Net Revenue (PACE Only)	Revenue Forecast W/ PACE Forgiveness	$9,382,074	$13,593,078
Lifetime Net Revenue (Full Incentives)	Revenue Forecast After All Incentives	$32,211,914	$36,422,918
Annualized Return (Base)	Annualized Return From Total Cost	-7.6%	-7.4%
Annualized Return (PACE Only)	Annualized Return W/ PACE Forgiveness	1.0%	1.4%
Annualized Return (Full Incentives)	Annualized Return W/ Full Incentives	12.5%	14.2%

6. References

All references are included in At achment D – References.

Attachment D – References

FCPC Vertical Solar Farms Project

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Attachment D – References

FCPC Vertical Solar Farms Project

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FOREST COUNTY POTAWATOMI ENERGY

FCPC Electric Vehicle Charging Project Report

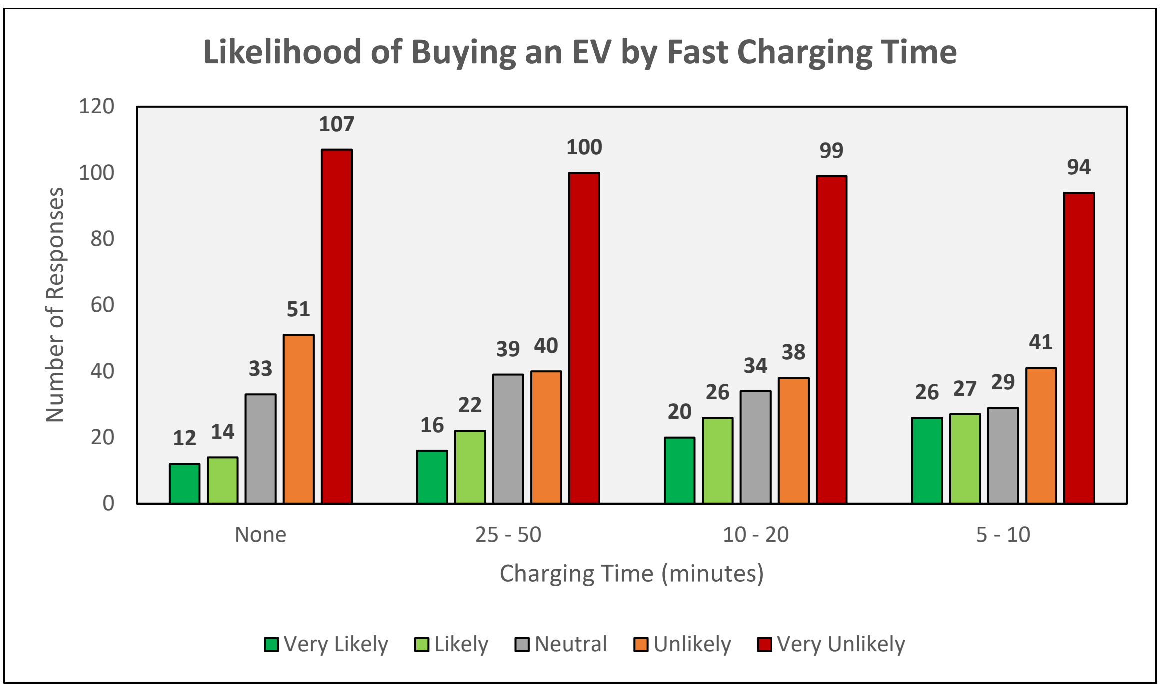
Prepared to fulfill requirements of the US Department of Transportation Charging and Fuel Infrastructure Grant

May 2023

Executive Summary

The Forest County Potawatomi Community (FCPC) Energy Department proposes to install sixteen (16) dual 7.7 kW Level 2 electric vehicles chargers and two (2) dual 60 kW Level 3 electric vehicle chargers in its *FCPC Electric Vehicle Charging Project*. The project scope was designed based on the results of the FCPC Electric Vehicle Charging Employee Survey, conducted by the Energy Department in April and May of 2023. The Survey received 217 valid responses for FCPC Government Employees working in Forest County, WI, which represents 36.7% of all FCPC Government Employees.

The results of the FCPC Electric Vehicle Charging Employee Survey showed that 9.4% of FCPC Employees working Forest County could be expected to purchase an electric vehicle in the next 5 years. If the Tribe were to build a 350 kW DC fast charger, the number would jump to 13.3% of FCPC Employees who would purchase an electric vehicle, which is an increase of 3.9 percentage points, or 41.4%. The main result of the survey, asking about the likelihood of purchasing an electric vehicle under different DC fast charging speeds is shown in the figure below, which converts the charging speeds of 150 kW, 350 kW, and 700 kW to charging times: "*25 – 50 minutes*," "*10 – 20 minutes*," and "*5 – 10 minutes*," respectively.



The Energy Department extrapolated these results to estimate that 104 to 125 electric vehicles could be expected in Forest County by 2028, which includes FCPC Government Employees, Potawatomi Carter Casino Hotel (PCCH) Employees, and FCPC Tribal members living in Forest County.

After considering five (5) data sources on the number of electric vehicle charging ports needed per electric vehicle, the Energy Department determined that three (3) charging ports would be recommended per electric vehicle, with a focus on employee charging needs that were confirmed by the FCPC Electric Vehicle Charging Employee Survey results. The Energy Department also found favorable economics to install four (4) 60 kW Level 3 charging ports at PCCH.

After an analysis of the current FCPC Fleet and optimal siting locations, the Energy Department determined seven (7) locations to receive charging infrastructure, which are shown in the table below.

Project Site	# of Charging Ports Needed	# of Charging Ports Proposed
1 – Executive Building	(7) Level 2	(6) Level 2
2 – Health & Wellness	(5) Level 2	(6) Level 2
3 – Community Center	(3) Level 2	(4) Level 2
4 – Caring Place	(3) Level 2	(4) Level 2
5 – Land & Natural Resources	(3) Level 2	(4) Level 2
6 – Tribal Hall	(4) Level 2	(4) Level 2
7 – Potawatomi Carter Casino Hotel	(5) Level 2 & (4) Level 3	(4) Level 2 & (4) Level 3
Total	**(30) Level 2 & (4) Level 3**	**(32) Level 2 & (4) Level 3**

The preliminary results presented in the FCPC Electric Vehicle Charging Project Report are used to justify the installation of the proposed sixteen (16) dual 7.7 kW Level 2 electric vehicles chargers and four (4) dual 60 kW Level 3 electric vehicle chargers, which represent confirmed needs for electric vehicle charging by 2028. This project represents Phase 1 of the *FCPC Electric Vehicle Charging Project*. As the current study was only able to analyze the charging needs of FCPC Government Employees, a more detailed study is required, with a focus on design and final site selection. The Energy Department proposes the inclusion of a Feasibility & Design Study that would examine the entire population of potential electric vehicle users, which includes the FCP Community, PCCH Employees, local residents, and tourists. This study would examine the feasibility of a 600 kW+ NEVI-Compliant DC fast charger, as well as the additional charging needs of the entire population going to 2033, over the expected lifespan of the proposed infrastructure. Implementation of additional infrastructure would represent Phase 2 of the project.

The Energy Department spoke with several subject mat er experts to obtain price quotes or estimates for the design, installation, and operation of the proposed charging infrastructure. The proposed project is being submit ed to the US Department of Transportation – Charging and Fueling Infrastructure (CFI) Grant program. The grant budget is:

- Total Project: $796,599
- DOT Grant: $637,279
- FCPC Match: $159,320

If the proposed infrastructure is built, the Energy Department projects that 233.6 short tons of CO_2e would be avoided annually, which greatly supports the Tribe's environmental goals. This estimate was provided by using the AFLEET Tool provided by the US Department of Transportation.

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1. Introduction

1.1 Background:

The Forest County Potawatomi Community (FCPC or Tribe) Energy Department, driven by the Tribe's Environmental Mission Statement, has set a goal to reduce the Tribe's environmental impact by pursuing energy efficiency and renewable energy generation. The Environmental Mission Statement is:

> *"The traditional values of the Forest County Potawatomi Community teach us to respect all living things, to take only what we need from Mother Earth, and to preserve the air, water, and soil for our children. Reflecting these values, we take leadership in creating a sustainable and healthy world. We resolve to reduce our own environmental impacts and to take steps to remedy the impacts of others. We encourage others to do the same. We also seek legislative and policy changes that protect the environment for all people, including generations to come."*

One of the most effective means to achieve this goal is to pursue electric vehicle adoption, as electric vehicles are more energy efficient than conventional gasoline powered cars (FuelEconomy.gov, 2023A), and can be run on a grid that is transitioning towards a carbon neutral electric supply by 2050 (WEC Energy Group, 2023). In addition, employees with access to workplace charging were found to be six times more likely to purchase an electric vehicle (US Department of Energy, 2017), which makes a workplace-focused electric vehicle charging project highly efficacious.

In pursuit of the Energy Department's goal, the Energy Department proposed to the Tribe's Executive Council that due diligence begin for an electric vehicle charging pilot project. The Executive Council motioned on November 28th, 2022 to begin due diligence on the Electric Vehicle Charging Pilot Project. This effort resulted in the creation of the FCPC Electric Vehicle Charging Employee Survey, which forms the basis of the proposed FCPC Electric Vehicle Charging Project. The following report outlines the results of the FCPC Electric Vehicle Charging Employee Survey, and forms the preliminary foundation of Phase 1 of the Tribe's Electric Vehicle Charging Project. Phase 1 outlines anticipated charging needs from FCPC Employees and the FCPC Fleet, with reserve capacity for expected visitors. However, this report outlines the preliminary need for charging infrastructure, and does not constitute the final selection of charging infrastructure equipment or selected final sites to receive charging infrastructure. Rather, this report outlines a confirmed need for charging infrastructure, which requires a higher level of analysis from a proposed Feasibility & Design Study.

The Feasibility & Design Study will provide final siting recommendations, and will include all stakeholder groups, which include the greater FCP Community, Potawatomi Carter Casino Hotel (PCCH) Employees, local residents, and tourists. The study will examine the need for Level 3 NEVI-Compliant DC fast chargers, and the ability to convert the FCPC Fleet to electric. The study will provide recommendations for future electric vehicle charging needs in Forest County that would constitute a second implementation phase with expanded infrastructure, in Phase 2 of the project. Finally, the study will produce engineering plans that will be used to competitively bid out a final project.

The Electric Vehicle Charging Project Report was writ en to plan for the *FCPC Electric Vehicle Charging Project* that would fulfill the requirements of the US Department of Transportation – Charging and Fueling Infrastructure Grant.

1.2 Study Population:

In order to project the potential need for charging infrastructure, the Energy Department analyzed the number of potential electric vehicles that could use any proposed charging infrastructure. On April 26, 2023, the FCPC Government had 592 employees working in Forest County (FCPC Government Data). The number of employees needs to be converted to the number of vehicles in order to estimate the need for charging infrastructure. The survey did not ask participants to name the mode of transportation to work, and thus the Energy Department used US Census Data available instead. The Energy Department used the Census Table B08203 – Means of Transportation to Work By Vehicles Available for Workplace Geography (US Census, 2021A) for Forest County to estimate the number of workers who commute by different modes. All census data were retained, with the exception of the "*Working From House"* category, as the Tribe does not allow majority working from home for nearly all of its workers. Carpool drivers were assigned a value of 0.5 vehicles (1 vehicle per 2 commuters), while all other categories were assigned a value of 0 vehicles. In total, there are an estimated 2,758 vehicles used to commute to work in Forest County and there were 3,035 commuters, which results in 0.91 vehicles per commuter to FCPC. This estimate is expected to be a conservative estimate, as the FCPC Government campus has poor access to walking or public transportation for commuting. The results are shown in Table 1 below. With 592 employees, there are an estimated 539 vehicles used to commute to the FCPC Government in Forest County.

Table 1*: Estimation of FCPC Employee Commuting Number of Vehicles Used per Commuter*

Commute Mode	FC Census Population	FCPC Eligible	# Vehicles
Drive Alone	2,603	2,603	2,603
Carpool	310	310	155
Walk	92	92	0
Other	30	30	0
Work From Home	251	0	0
Total	**3,286**	**3,035**	**2,758**

There are also an additional 170 employees who work at PCCH, which is also located in Forest County, near the Town of Wabeno. Applying the same conversion factor of 0.91 vehicles per commuter, there are an estimated 155 vehicles used to commute to the PCCH.

In addition to employees, by 2028 there will be 539 Tribal member adults living in Forest County between the ages of 18 to 74 (FCPC Government Data, 2023). Based on an adult population of 7,372 adults (US Census, 2021B), and an estimated 7,143 vehicles in Forest County (US Census, 2021C), there are an estimated 0.969 vehicles per adult in Forest County, which results in an estimated 522 vehicles driven by Tribal members. Some of the Tribal members living in Forest County will also work for the FCPC Tribal Government or PCCH. This number is estimated to be around 100 employees. After subtracting for potential duplication, there are an estimated 422 vehicles driven by Tribal members in Forest County.

In total, there are an estimated 1,116 vehicles that could be affected by the installation of charging infrastructure on FCPC Tribal buildings. The breakdown of each population, and estimated number of vehicles is shown in Table 2 below.

***Table 2**: Estimated Study Population and Number of Vehicles Applicable*

Demographic	Population	# Vehicles
FCPC Government Employees	592	539
PCCH Employees	170	155
FCPC Tribal Members (Non-Employees)	439	422
Total	**1,201**	**1,116**

1.3 Report Structure:

The report presents the design of the FCPC Electric Vehicle Charging Employee Survey in Section 2. The report then outlines the results and interpretation of the survey in Section 3. The report then describes the estimated need for charging infrastructure and selections preliminary sites in Section 4. The cost to install the estimated charging infrastructure, along with the Feasibility & Design Study is covered in Section 5. The environmental impact of the proposed infrastructure is described in Section 6. References are listed in Section 7. The report also includes two (2) appendices. Appendix A includes the proposed scope of work for a Feasibility and Design Study recommended before project implementation. Appendix B includes cost quotes that were used to form the basis of the cost estimate for the FCPC Electric Vehicle Charging Project.

2. Survey Design:

2.1 Survey Invitation:

The FCPC Electric Vehicle Charging Employee Survey was designed by the Energy Department. The survey was designed to be able to derive the following quantitative metrics from the survey population:

- Average commuting distance
- Current vehicle class
- Desired electric vehicle class
- Current fuel consumed to commute to work
- Electric vehicle fuel consumed to commute to work
- Willingness to purchase an electric vehicle
- Willingness to purchase an electric vehicle with different DC fast charging speeds
- Ability to charge at home
- Willingness to pay for electric vehicle charging at FCPC

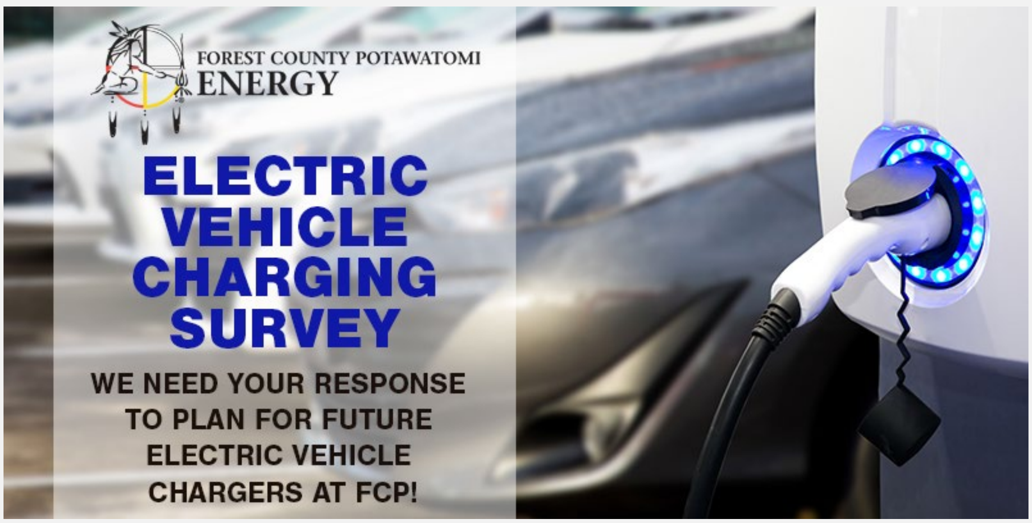
The Energy Department reviewed the US Department of Energy (2023) Sample Employee Survey for Workplace Charging Planning to inform the Department's development of the survey questions. Questions were altered to be able to provide more concrete metrics for survey analysis that were bet er catered to FCPC needs.

After the survey was designed, FCPC Employees were given two weeks to fill out the FCPC Electric Vehicle Charging Employee Survey. The first email was sent to all FCPC Government Employees on Tuesday April 18th, 2023. The second email was sent one week later on Tuesday, April 26th, 2023. The survey was closed on Wednesday, May 3rd. The email invitation subject and body are shown below:

Subject: Take 5 Minutes to Help FCPC Plan for Electric Vehicle Charging

Good Morning,

Excited for electric vehicles, skeptical, or never want one? The FCPC Energy Department needs your feedback to plan for electric vehicle chargers. **This 7 to 11 question survey should take you less than 5 minutes to fill out**. Your responses will be kept anonymous. You can fill out the survey by clicking this link, or by clicking on the image below:



Thank you for your participation!

Forest County Potawatomi Energy Department

Jerry Hauber | Energy Manager
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P: 715-478-4704 | C:715-889-6043 | Main: 715-478-7222
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Office hours are Monday through Thursday, 7:00 am – 5:00 pm. The office is closed on Fridays.

Primer:

The Energy Department decided to use an educational primer at the beginning of the survey. In rural northern Wisconsin, there is a greater stigma towards electric vehicles than in urban areas, which is supported by the survey results between FCPC employees in Milwaukee vs Forest County (See Section 3.6). In addition to the stigma, it was also assumed that the majority of FCPC employees were not aware of the economic advantages of electric vehicle ownership. Furthermore, any effort to administer an electric vehicle survey requires an educational component, as subjects around charging time and charging costs are foreign concepts for many survey respondents. The survey primer is shown below:

Welcome to the FCPC Electric Vehicle Charging Employee Survey!

This survey will help the FCPC Energy Department plan to install future electric vehicle chargers. Before you take the survey, please consider the following information about electric vehicles:

1) The price of many electric vehicles is expected to equal gasoline vehicles between 2023 and 2028. For further information, see: S&P Global, Bloomberg, International Council on Clean Transportation.

2) Fuel and maintenance costs of electric vehicles are estimated to be around 50% lower compared to gasoline vehicles, which makes the total cost of ownership less expensive for some electric vehicles today. Kelly Blue Book's Cheapest Cars to Own by Class: Ford F150 Lightning, Tesla Model 3, Chevy Bolt. For further information, see: Consumer Reports, Argonne National Laboratory.

Your responses are anonymous, and will be kept confidential. Only grouped data will be shared to plan for electric vehicle charging infrastructure.

The choice to use a primer was made with the knowledge that the primer would affect the survey results. Consistent with the Tribe's Environmental Mission Statement, the fostering of electric vehicle adoption promotes the use of renewable energy and results in reduced environmental impacts, and therefore the primer assists the Energy Department in achieving the Tribe's Environmental Mission Statement.

2.2 Section 1 - Survey Logical Structure:

The survey was designed to elicit actionable information from survey respondents. The first two questions of the survey asked a respondent where they live and where they work. These questions would allow the Energy Department to estimate the commuting distance of employees, as well as potential fuel consumption. These questions would also allow the Energy Department to determine if an employee worked in Forest County or in Milwaukee. The first two questions of the survey are shown below:

Question 1: Where is the nearest city or town to where you live?

FILL IN EMPTY BOX

Question 2: Which building do you currently work in?

FILL IN EMPTY BOX

The next survey question asked survey respondents what class of vehicle they currently drive. Specific vehicle models were not requested in order to preserve the anonymity of the survey respondent. This response allows the Energy Department to estimate fuel economy of existing vehicles. The inclusion of this question was also intended to potentially weight survey results, however subsequent statistical analysis of likelihood to purchase an electric vehicle by class revealed no statistically significant association (See Section 3.3). The third survey question is shown below:

Question 3: What class of vehicle do you currently drive?

- Pickup Truck
- Large SUV
- Small SUV / Crossover
- Minivan
- Car

The next series of 4 questions utilized a test re-test format to determine the likelihood of a respondent to purchase an electric vehicle based on whether the Tribe built a NEVI-compliant DC fast charger at different charging speeds. The first question, Question 4, asked survey respondents how likely they are to purchase an electric vehicle in the next 5 years. If respondents answered, "*I Already Have One*," the respondent was then directed to the end of the survey, as the remaining survey questions were not relevant to the survey respondent. All questions were put on a 5-point Likert-style scale for probability to allow for quantitative analysis.

The remaining respondents were then asked the same question, with the following statement below the likelihood question, "*If the Tribe built a public charger that could charge a car in 25/10/5 minutes, or a truck in 50/20/10 minutes.*" The charging times were based on an electric vehicle requiring a charge of 60 kWh, or approximately 210 miles of range, and an electric truck requiring a charge of 120 kWh, or approximately 240 miles of range. Charging times were based on a 150 kW charge for 25 or 50 minutes, 350 kW for 10 or 20 minutes, and 700 kW for 5 or 10 minutes. These times did not include the slower top-off time when a bat ery is almost full. The 150 kW charger is the minimum required for a NEVI-compliant EV charger, while the 350 kW charger represents a single car charging on a dual station. The 700 kW question was intended to elicit the ideal charging time for those who may not be satisfied with a 150 or 350 kW charger, however no passenger vehicle can currently accept charging power this high.

If a respondent answered they were "*Very Unlikely*" or "*Unlikely*" to purchase an electric vehicle in the next 5 years in Question 6, they were then directed to the end of the survey, after answering Question 7. Therefore, if a respondent was unlikely to purchase an electric vehicle with a 350 kW charger, which could feasibly be installed, then the respondent would not be requested to answer questions about charging a hypothetical electric vehicle in the second section of the survey. In addition, if a survey respondent answered that they were "*Very Likely*" to purchase an electric vehicle in Question 5 or 6, they were then directed to Question 8, which is the beginning of Survey Section 2, because additional charging speed would not influence the respondent to increase their likelihood of purchasing an electric vehicle. Questions 4, 5, 6 and 7 are shown below:

Question 4: How likely would you be to purchase an electric vehicle in the next 5 years:

- I Already Have One → Skip to End of Survey
- Very Likely
- Likely
- Neutral
- Unlikely
- Very Unlikely

Question 5: How likely would you be to purchase an electric vehicle in the next 5 years:

If the Tribe built a public charger that could **charge a car in 25 minutes** or a **truck in 50 minutes**?

- Very Likely → Skip to Question 8
- Likely
- Neutral
- Unlikely
- Very Unlikely

Question 6: How likely would you be to purchase an electric vehicle in the next 5 years:

If the Tribe built a public charger that could **charge a car in 10 minutes** or a **truck in 20 minutes**?

- Very Likely → Skip to Question 8
- Likely
- Neutral
- Unlikely → Skip to End of Survey After Answering Question 7
- Very Unlikely → Skip to End of Survey After Answering Question 7

Question 7: How likely would you be to purchase an electric vehicle in the next 5 years:

If the Tribe built a public charger that could **charge a car in 5 minutes** or a **truck in 10 minutes**?

- Very Likely
- Likely
- Neutral
- Unlikely
- Very Unlikely

2.3 Section 2 – Survey for Potential EV Buyers:

Respondents who answered “*Maybe*,” “*Likely*,” or “*Very Likely*” in Questions 5 or 6 went on to answer an additional 4 questions in Section 2. These questions were designed to help the Tribe bet er understand the need for charging infrastructure at work. The first question, Question 8, again asked respondents for what class of electric vehicle they would be interested in buying. This question was intended to look for rebound effects of purchasers buying a less efficient vehicle because an electric vehicle is more environmentally friendly.

Question 9 asked if a respondent would be able to charge their vehicle at home. Not all respondents would be able to charge at home because they could be renting their home, or might not have parking access to an area with electricity, such as a garage. Respondents who answered “*Maybe*” or “*No*” would be more reliant on charging infrastructure installed at FCPC compared to respondents who could charge at home. In addition, respondents who could charge at home would be less likely to pay more for charging at work than they would at home.

Question 10 asked how often a respondent would want to charge their electric vehicle at work. Charging frequency would dictate how many chargers the Tribe would need to install per electric vehicle. Some employees may want to charge their vehicle every day, even if they are only charging for 5 or 10 miles of driving.

Question 11 asked how much a respondent would be willing to pay to charge their electric vehicle at work. Respondents were given the average gas mileage of a car (25 mpg; US Department of Transportation, 2023) and a 3-year average midwest cost of gasoline of $3.01 / gallon (From April 20, 2020 – April 10, 2023; US Energy Information Administration, 2023), as they compare to an electric vehicle that gets 2.68 miles / kWh (see Table 3 below) at the current utility residential cost of electricity of $0.136 / kWh. This information would be used to determine the maximum feasible charging cost, should the Tribe decide to charge money for charging. Note that the National Renewable Energy Laboratory (Blonski et al., 2021) assumes that 80% of charging will be at a Level 2 or slower charger, which best aligns with the residential energy cost assumption.

In order to estimate the average fuel economy of an electric vehicle, the Energy Department visited FuelEconomy.gov, and filtered all vehicle models with all electric engines for the model year 2023 (FuelEconomy.gov, 2023B). The fuel economy of multiple trims was averaged for each vehicle model. The Energy Department then took the average of each vehicle model for each vehicle class. There were no all electric minivans listed, so the fuel economy of the plug-in hybrid Chrysler Pacifica was used as a substitute, which is the only plug-in hybrid minivan. Similarly, there were only 2 trucks listed as all electric. The proportion of vehicles is based on a survey of new car sales in Wisconsin between June 2021 and May 2022 performed by iSeeCars.com (2023). Based on this analysis, the average vehicle mileage is 2.68 miles / kWh, which is shown in Table 3.

Table 3*: Average New Electric Vehicle Fuel Economy Estimated by the FCPC Energy Department*

Vehicle	# Models	Miles / kWh	Proportion	Weighted
Car	18	3.05	0.278	0.85
SUV	14	2.78	0.473	1.31
Minivan	1	2.43	0.036	0.09
Truck	2	2.02	0.213	0.43
Total	35		1.00	**2.68**

Questions 8, 9, 10, and 11 are shown below:

Question 8: What class of vehicle would you be interested in buying?
- Pickup Truck
- Large SUV
- Small SUV / Crossover
- Minivan
- Car

Question 9: Would you be able to charge your electric vehicle at home?

Note: If you rent your home, you likely would not be able to install a charger.
- Yes
- Maybe
- No

Question 10: How often would you want to charge your vehicle at work?
- Daily
- Weekly
- Monthly
- Never

Question 11: What is the most you would be willing to pay to add 100 miles of charge while at work?

Note: The average US car (25 mpg) at the 3-year average cost of gasoline ($3.01 / gallon) costs $12.04 / 100 miles.

Note: The average US electric vehicle (2.68 miles / kWh) at the residential cost of electricity ($0.136 / kWh) costs $5.07 / 100 miles.

3. Survey Methods, Results, and Discussion:

3.1 Survey Response Cleaning:

The survey received 246 responses in total. Of these results, 7 employees indicated they worked at one of the Tribe's casinos, which were not intended to be surveyed. There are FCPC Government Employees who work on gaming related mat ers and could be located within a casino, but this information could not be verified, and thus these results were excluded from further analysis. An additional 7 results contained information that could not be interpreted accurately, such as living in cities that are over 3 hours away, or working in unknown buildings. Due to a verified discrepancy between responses in Forest County VS in the Milwaukee area (see Section 3.7), these responses were removed in order to not skew survey results. An additional 16 results were from employees in the Wgema Campus located in Milwaukee, and were excluded from the primary dataset in Forest County (FC) because these employees work in a non-publicly accessible location. There were 217 remaining responses that were used to analyze survey results, which represents 36.7% of all FCPC Government Employees living in Forest County.

3.2 Probability of Purchasing an Electric Vehicle:

The probability of purchasing an electric vehicle is based on Risen & Risen (2008) who present the likelihood of making a purchase based on the ACNielson probability of making a purchase on a 5-point scale. The scale is applied from Risen & Risen (2008) as follows in Table 4:

***Table 4**: Operationalization of Survey Responses for the Probability of Buying an Electric Vehicle. Table Adapted From Risen & Risen (2008).*

Response	Probability of Making a Purchase
Very Likely	0.75
Likely	0.25
Maybe	0.10
Unlikely	0.05
Very Unlikely	0.02

As the probability of making an electric vehicle purchase is the greatest survey response variable of interest, this metric is analyzed in place of the percentage of survey responses, for Questions 4, 5, 6, and 7.

3.3 Survey Weighting:

All survey results presented are unweighted. The survey design was intended to capture maximum participation in favor of collecting more personally identifying information that could be used for survey weighting.

The survey left open the opportunity to weight survey results by the class of vehicle driven. On a probability scale, "*Car*" drivers were the most likely to purchase an electric vehicle ($\bar{x}$ = 0.124, n = 52), followed by "*Pickup Truck*" drivers ($\bar{x}$ = 0.092, n = 54), "Large SUV" drivers ($\bar{x}$ = 0.090, n = 31), "*Small SUV/Crossover*" drivers ($\bar{x}$ = 0.08, n = 77) and "*Minivan*" drivers ($\bar{x}$ = 0.040, n = 3). It was initially hypothesized that larger vehicle drivers would be the most reluctant to purchase an electric vehicle, and particularly pickup truck drivers, but the observed means do not support this hypothesis. The smallest vehicle classes occupied the highest and lowest probabilities of purchasing an electric vehicle, which suggests that observed differences could be random. In order to test if these differences were statistically significant, a Kruskal Wallis non-parametic ANOVA was performed on all vehicle classes, with the exception of minivans, which only received 3 results. The test resulted in an H-statistic of 4.936, and a p-value of 0.126, indicating that the differences observed in the likelihood of purchasing an electric vehicle by current vehicle class are not significant indicators of the likelihood of purchasing an electric vehicle.

Based on these results, the respondent's vehicle class should not be used to weight survey results. As the survey did not collect further data that could be used to weight survey results, the results are presented as unweighted.

3.4 Employee Distance From Work (Questions 1 & 2):

The Energy Department used Google Maps (n.d.) to determine the commute distance between the nearest town that an employee lives in and the building they work in. Four (4) responses indicated multiple or unknown workplaces, and these distances were assumed at the Health and Wellness Center, which is at the center of the Stone Lake Government Campus that contains most FCPC Government Buildings. Figure 1 shows a frequency distribution of employee distance from work. The distribution is multi-modal, with 57 employees indicating they live less than 5 miles away, mostly in Crandon, and a second relative maximum at 30-35 miles from work with 33 responses. The distribution also has a long tail, with employees commuting as far as 78 miles to reach work. **The average distance from work is 19.3 miles**.

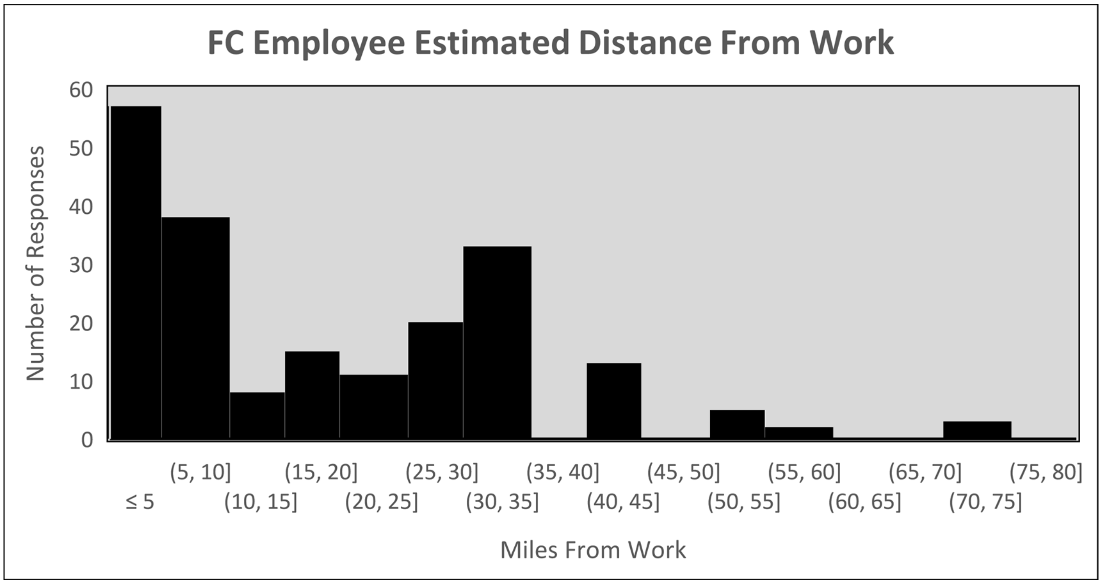

Figure 1*: Frequency Distribution of Employee Estimated Distance From Work*

Validity and Error Checking:

The Energy Department cross referenced employee zip codes with survey results, which is shown in Table 5. There are 3 main towns that Tribal members live in, which are Crandon, Laona, and Wabeno. In each town, there were fewer employees who responded compared to registered zip codes. In total, the survey received 114 out of 217 responses (52.5%) from Crandon, Laona, and Wabeno, as compared to 366 out of 592 employees (61.8%) by zip code. Note that the distances from Crandon, Laona, and Wabeno to Stone Lake are 3.6, 9.6, and 17.9 miles respectively, which are all lower than the sample mean distance of 19.3 miles, and thus a skew away from these locations likely indicates that more survey respondents answered the survey who live further away than the population of all FCPC employees.

Table 5*: Employee Location Survey Responses VS Employee Zip Codes*

Location	Survey Results	Employee Zip Codes
Crandon	76 (35.0%)	238 (40.2%)
Laona	20 (9.2%)	65 (11.0%)
Wabeno	18 (8.3%)	63 (10.6%)

With a 9.3 percentage point difference in respondent locations, the Energy Department investigated whether this difference would have an effect on survey responses. The Energy Department performed a correlation analysis of distance from work on the probability of purchasing an electric vehicle without a DC fast charger. A Pearson's Correlation Analysis resulted in an R-value of 0.175, and a two-tailed p-value of 0.012, indicating that there is a significant correlation between the two variables. An increase of 1 mile is associated with a 0.0018 increase in the probability of making a purchase. If the sample mean skews 9.3% longer distance than the population mean, the estimated error would equal 1.8 miles, or a 0.003 increase in the probability of purchasing an electric vehicle. As the average probability of purchasing an electric vehicle for the whole baseline sample population is 0.093, the estimated error would skew the sample mean by 3.2%.

Note that this is merely an exploratory exercise in trying to understand the potential error of a sample that could skew longer distance than the population of all FCPC employees who work in Forest County. The true error rate cannot be reliably estimated due to the granularity of zip code data compared to town/city level data, with potential error rates up to 5 miles or more spanning each zip code. Given that the error of a potential distance skew is small, the effect of the significant result found is not considered to be of major influence to the subsequent reporting of results, as siting decisions do not require a high level of precision.

3.5 Employee Vehicle Class (Question 3):

The most popular vehicle class was a "*Small SUV / Crossover*" with 77 (35.5%) responses. "*Pickup Trucks*" were the second most popular vehicle class, with 54 (24.9%) responses. "*Cars*" were the third most popular vehicle class, with 52 (24.0%) responses. "*Large SUVs*" were the fourth most popular vehicle class, with 31 (14.3%) responses. "*Minivans*" were the least popular vehicle class, with only 3 (1.4%) responses. The results are summarized in Figure 2 below.

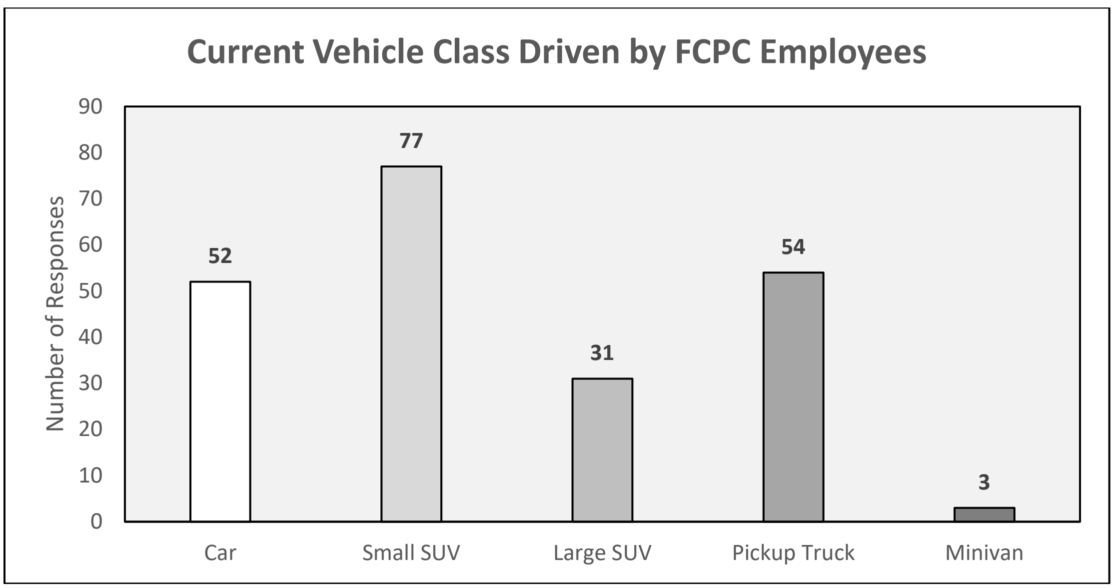

***Figure 2**: Current Vehicle Class Driven by FCPC Employees*

3.6 Likelihood of Purchasing an Electric Vehicle in the Next 5 Years (Questions 4, 5, 6 & 7):

The primary survey result of interest is the likelihood of purchasing an electric vehicle in the next 5 years. The two survey responses of greatest interest are "*Very Likely*," and "*Likely*," which correspond to the equivalent of 37.5 and 12.5 "*Very Unlikely*" responses, respectively. At the baseline, 26 (12.0%) respondents answered they were "*Very Likely*" or "*Likely*" to purchase an electric vehicle, without being asked if there would be a DC fast charger available, which represents the "*None*" category in Figure 3. The number of "*Very Likely*" or "*Likely*" responses increased as charging time decreased, with 38 (17.5%)

responses for "*25 – 50 Minutes*" or 150 kW, 46 (21.2%) responses for "*10 – 20 Minutes*" or 350 kW, and 53 (24.4%) responses for "*5 – 10 Minutes*" or 700 kW.

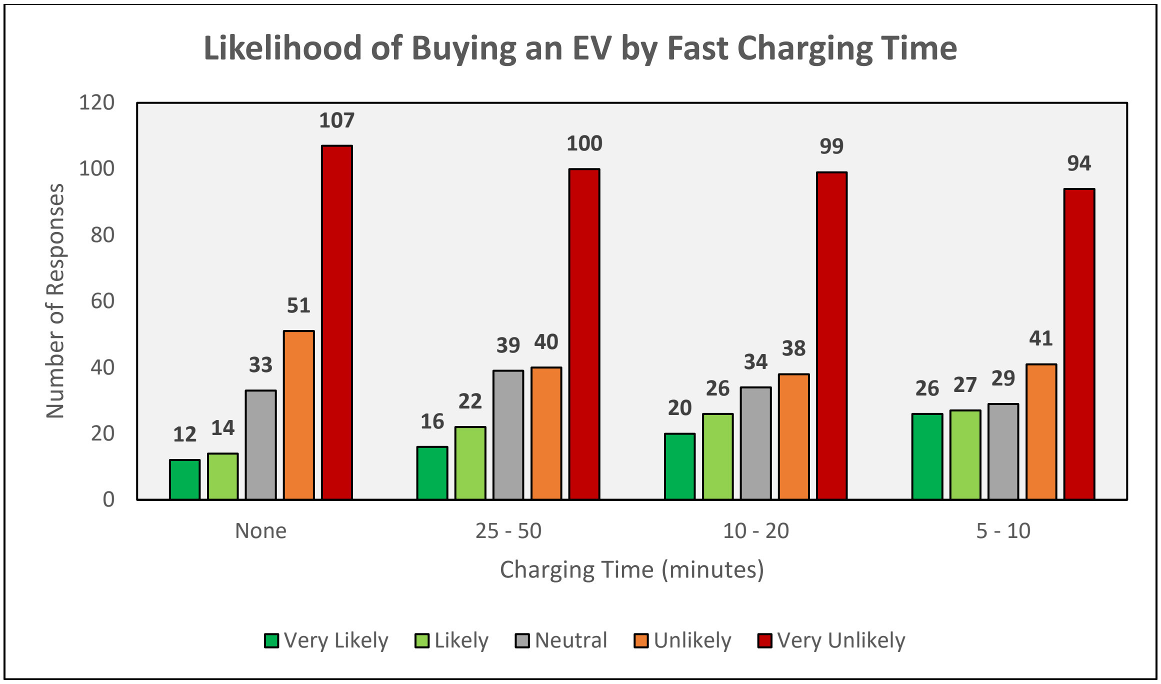

***Figure 3**: Likelihood of Purchasing an Electric Vehicle by Charing Speed*

Conversion to Probabilities:

The responses in Figure 3 translate to probabilities from the conversions listed in Table 4. If no DC fast charger is installed, 9.4% of survey respondents would purchase an electric vehicle in the next 5 years, which would result in 51 electric vehicles, assuming 539 employee vehicles (see Table 2). If a 150 kW charger is installed, 11.7% of survey respondents would purchase an electric vehicle, which would result in 63 electric vehicles, or a 23.5% increase. If a 350 kW charger is installed, 13.3% of respondents would purchase an electric vehicle, which would result in 72 electric vehicles, or a 41.2% increase over the baseline. Finally, if a 700 kW charger were to be installed, this would result in 15.2% of respondents purchasing an electric vehicle and 82 electric vehicles, which is a 60.8% increase over the baseline. Note that the 700 kW option is only hypothetical, as no car or charger is available at that speed for passenger vehicles. As Figure 4 shows, there is a linear increase in the probability of purchasing an electric vehicle as charging speed increases.

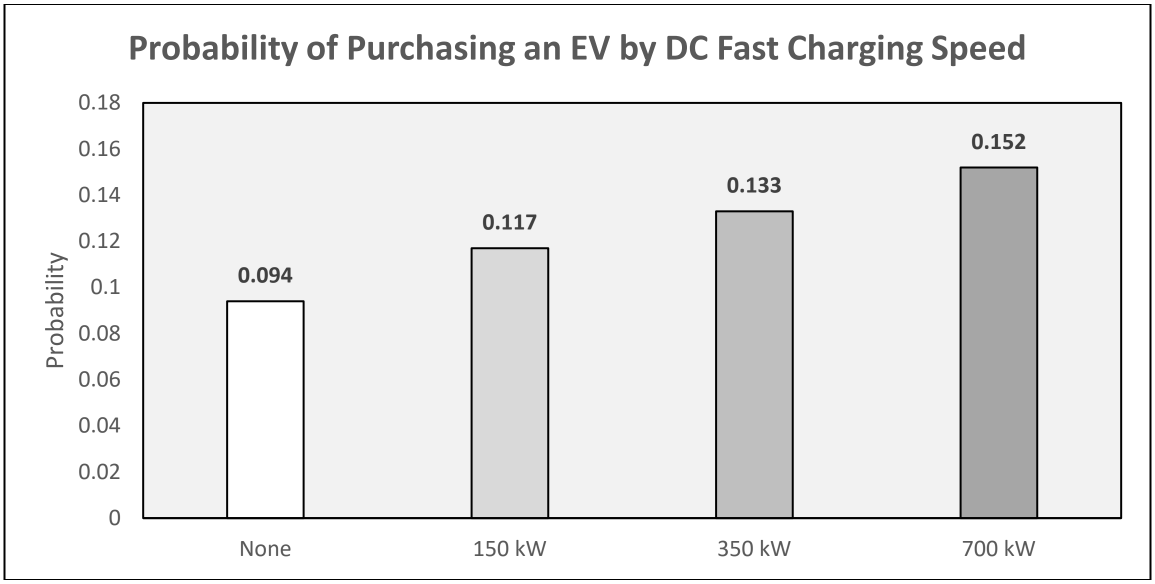

Figure 4*: Probability of Purchasing an Electric Vehicle by Charging Speed*

Statistical Significance and Validity:

The Energy Department explored whether the trend in charging speed is statistically significant. The "*None*," "*150 kW*," and "*350 kW*" datasets all failed a Shapiro-Wilk test of normality (W = 0.459, 0.529, 0.560, $p < 0.000$), which is evident in the skewed distributions presented in Figure 3. Due to this result, the non-parametic Wilcoxon Signed-Rank Paired Sample Test was used to test for differences between groups. At 150 kW, the signed-rank test resulted in a statistically significant effect size of $r = 0.191$ ($p < 0.000$). At 350 kW the signed-rank test also resulted in a statistically significant effect size of $r = 0.250$ ($p < 0.000$). The significant test results indicate that the mean differences for the 150 kW and 350 kW chargers of 0.023 and 0.039 respectively, are very likely not to be the result of chance. These mean differences account for a 2.3 and 3.9 percentage point increase in electric vehicle purchases, which would result in 12 and 21 additional vehicles on the road respectively, if each relative DC fast charger is installed.

The validity of this result was compared to market studies on electric vehicle adoption. The Edison Institute (2022) performed a review of 4 forecasts for EV adoption, and assumed a midpoint adoption of 10.2% of electric vehicles on the road by 2030, which was performed before the passage of the Inflation Reduction Act (IRA) that provides up to $7,500 for the purchase of electric vehicles. This study also noted that auto manufacturers and the Biden Administration are commit ed to a higher share of EV sales than was forecast by the Edison Institute. Alternatively, S&P Global (Brinley, 2023) assumes there will be 10.9% of electric vehicles on the road by 2030, which was performed after the passage of the Inflation Reduction Act (IRA), and represents a more conservative estimate. Therefore, while the survey estimate for electric vehicle adoption is higher than modeled, and particularly for a rural area, the results are generally in the range of industry forecasts, and should be considered valid for electric vehicle adoption forecasting.

Effect of Charging Speed on the Number of Induced Electric Vehicle Purchases:

Table 6 shows the expected number of electric vehicles at the baseline, and with the addition of a 150 kW and a 350 kW DC fast charger. As presented in Table 2, there are an estimated 539 vehicles from

FCPC Government Employees, 155 vehicles from PCCH Employees, and 422 vehicles from FCPC Tribal Members who are not employees, for a total of 1,116 vehicles. For the survey population, the Energy Department expects 51 electric vehicles to be purchased by 2028, with the addition of 12 electric vehicles if a 150 kW charger is installed, and an additional 21 vehicles if a 350 kW fast charger is installed. The survey did not test for the effect of increasing the distance to a DC fast charger by more than the distance within Stone Lake, and thus effects from installing a DC fast charger are not included for PCCH Employees or for FCPC Tribal Members who are not employees. For these populations, only the baseline conversion of 0.094 is assumed, totaling 104 vehicles at the baseline, 117 vehicles with a 150 kW charger, and 125 vehicles with a 350 kW charger. Finally, while some Tribal members who live in Forest County also live in Stone Lake, the effect of the fast charger is not considered for this population as a conservative assumption.

***Table 6**: Number of Electric Vehicles Expected With and Without a DC Fast Charger*

Demographic	Baseline	150 kW	350 kW
FCPC Government Employees	51	63 (+12)	71 (+21)
PCCH Employees	14	14	14
FCPC Tribal Members (Non-Employees)	40	40	40
Total	**104**	**117 (+13)**	**125 (+21)**

Comparison With Results in Milwaukee:

Finally, probability results were compared between the Forest County Employee population and the Milwaukee Employee population. The sample sizes were highly unequal, with n = 217 employees in Forest County compared to n = 16 employees in Milwaukee, and the means were very different from each other, with Forest County Employees answering a baseline average probability of $\bar{x} = 0.094$ and Milwaukee Employees answering with a baseline probability of $\bar{x} = 0.314$. With non-normal data and unequal variances, the Manny-Whitney U-Test was used to test for statistical differences between the subpopulations. The test resulted in a U value of 613.5, and had an effect size of r = 0.301, which was statistically significant ($p < 0.000$). The test result indicates that employees in Milwaukee answered the survey differently from employees in Forest County, which supports their exclusion from Forest County survey results. The reason for the observed difference in means is not analyzed in this report, but could be due to the low sample size in Milwaukee, or due to urban-rural differences in attitudes about electric vehicles.

<u>3.7 What Class of Electric Vehicle Would You Want to Buy? (Question 8):</u>

Respondents who answered that they were "*Neutral*," "*Likely*," or "*Very Likely*" to purchase an electric vehicle in the next 5 years, if a 350 kW DC fast charger was built, answered questions 8, 9, 10, and 11. There was a subset of 79 (36.4%) respondents who gave these responses.

As anticipated, respondents indicated that they wanted larger and heavier electric vehicles than they are currently driving, which is shown in Figure 5. The number of respondents who drive a "*Car*," but also wanted an electric "*Car*" dropped by 50% from 28 responses to 14. The majority of the respondents would prefer to drive a "*Small SUV / Crossover*," rising from 24 responses to 34 responses. The remaining 4 responses were divided between "*Large SUVs*" and "*Pickup Trucks*." This trend would have a moderating effect on the carbon savings of switching to electric vehicles, as larger and heavier vehicles get worse fuel consumption. However, as cars and small SUVs get similar gas mileage, this trend is not expected to affect carbon savings in a substantial way. It should be noted that stated preferences for larger vehicles may not materialize due to the higher costs of larger vehicles, and in particular heavier vehicles that require larger bat eries, which can drive up costs even higher.

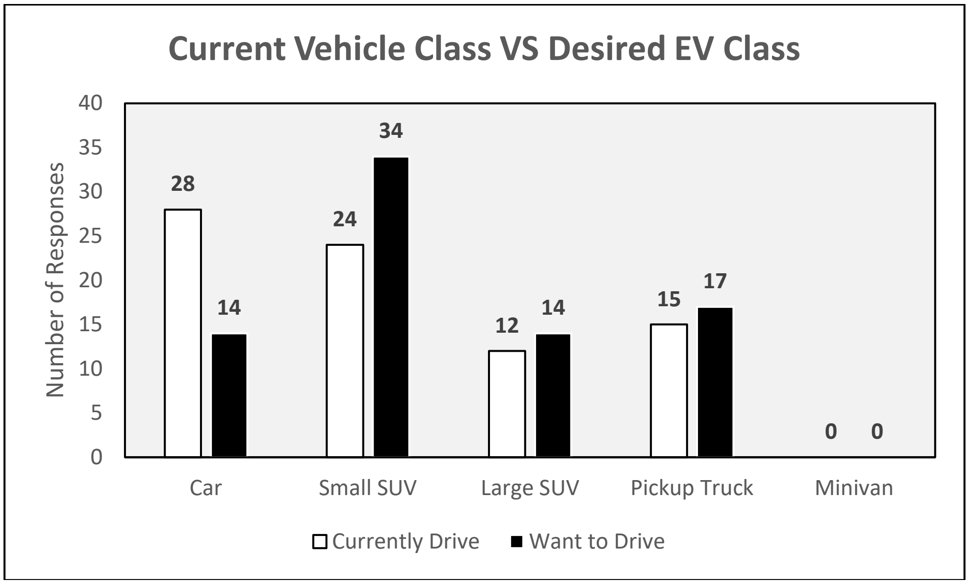

Figure 5*: Current Vehicle Class VS Desired EV Class*

3.8 Ability to Charge an Electric Vehicle at Home (Question 9):

The ability to charge an electric vehicle at home is a crucial component of electric vehicle adoption. If a respondent had to regularly rely on DC fast chargers to obtain a charge, this could increase fuel costs compared to gasoline, as fast charging costs can reach $0.50 / kWh (Motortrend: Stevens, 2023), or nearly 3.7 times the residential cost of energy. At $0.50 / kWh, the charging cost of an average electric vehicle would be $18.66 / 100 miles, which is significantly higher than the $12.04 / 100 miles of an average conventional vehicle example used in Question 11 of the survey. Therefore, the population of "*Maybe*" and "*No*" would be highly influenced by the ability to charge their electric vehicle at work. The dedicated "*No*" population received 14 (17.7%) responses, and the "*Maybe*" group received 25 (31.6%), giving a range of 17.7% – 49.4% of respondents who could be mostly dependent on the ability to charge their EV at work to save on fuel costs. If half of the "*Maybe*" results could charge at home, this would leave a population of 33.5% of employees who would be reliant on charging at work in order to avoid DC fast chargers. The results are summarized in Figure 6 below.

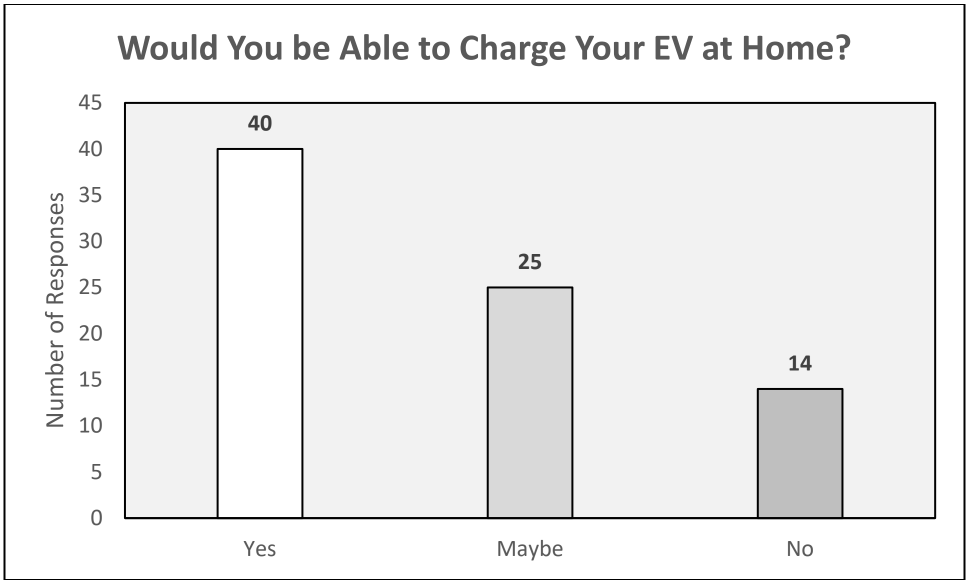

***Figure 6**: Respondent Ability to Charge Their Electric Vehicle at Home*

3.9 How Often Would You Want to Charge at Work? (Question 10):

A majority of respondents expressed that they would prefer to charge "*Daily*" at work, with 39 (49.4%) responses. The second highest group responded that they would want to charge "*Weekly*," with 35 (44.3%) responses. Only 5 (6.3%) responses indicated they would charge "*Monthly*" or "*Never*." These results indicate that there is an expectation that charging would be readily available when respondents wanted to charge, and that charging should be available to meet the needs of at least a weekly charge for each vehicle. If the responses are weighted, the average charging port could serve 1.7 vehicles. The results are summarized in Figure 7 below.

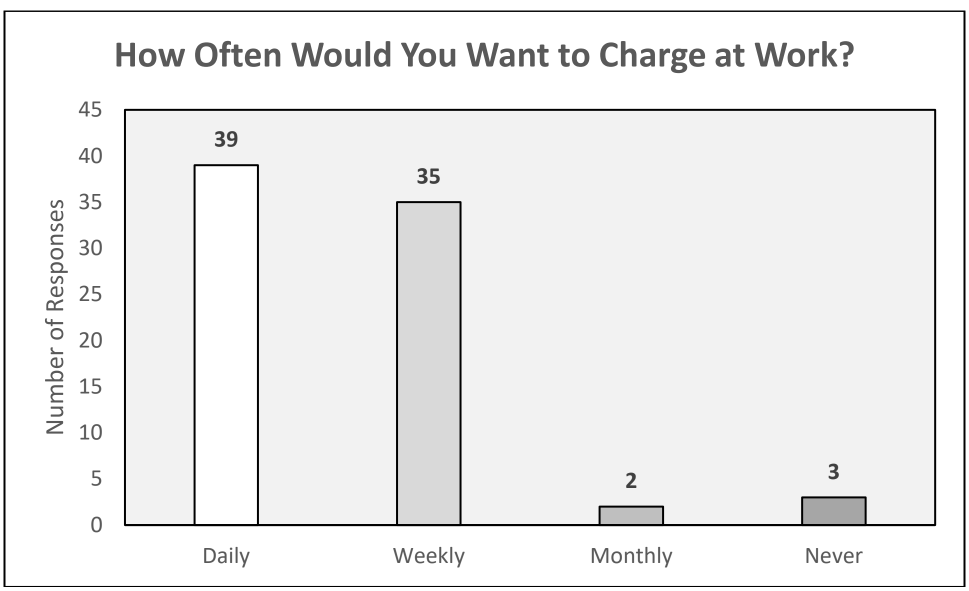

***Figure 7**: Desired Frequency of Charging at Work*

3.10 How Much Would You be Willing to Pay to Charge at Work? (Question 11):

Respondents were told in Question 11 that the cost to fuel a conventional vehicle is $12.04 / 100 miles, and that the cost to charge an electric vehicle is $5.07 / 100 miles. Figure 8 shows the distribution of responses, with $5.00 receiving the most responses (n = 34, 43.0%), which corresponds with the cost to charge an electric vehicle at home. A majority of respondents (n = 61, 77.2%) indicated they would not be willing to pay more than the residential cost of electricity to charge their vehicle. Therefore, if the Tribe wished to charge above the residential cost of electricity, this would incentivize electric vehicle drivers to instead charge at home rather than work, if that option was available, which according to the results of Question 9, could be between 49.4% – 82.3% of all electric vehicle users.

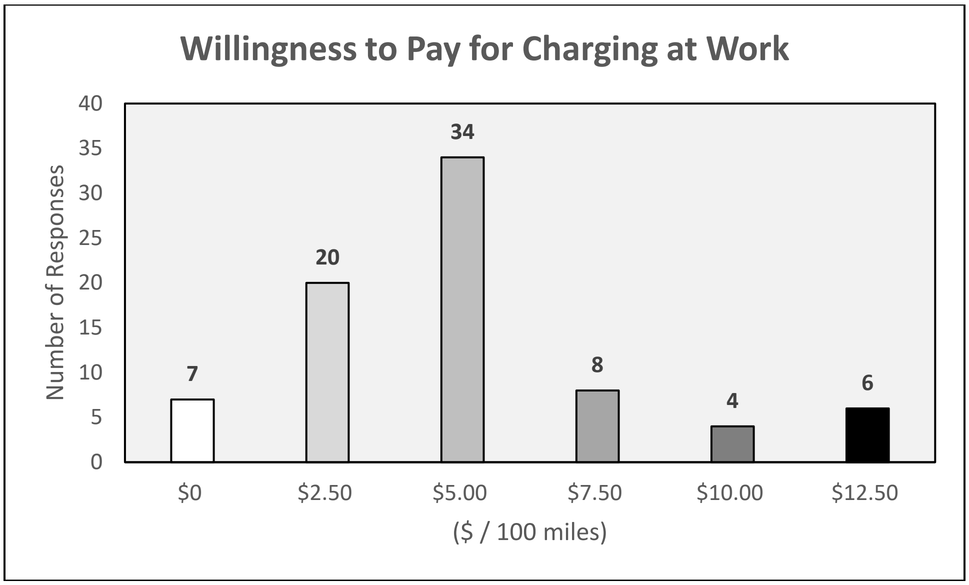

***Figure 8**: Willingness to Pay to Charge 100 Miles at Work*

4. Estimated Need for Electric Vehicle Infrastructure:

4.1 Number of Charging Ports per Electric Vehicle:

The Energy Department examined 5 sources of data to determine how many charging ports are needed per electric vehicle. Estimates for the number of Level 2 charging ports needed per electric vehicle vary by the source, but most estimates converge around the same number. The estimates provided by each source are discussed as follows.

Edison Institute Estimate:

The Edison Institute (2022) estimates that one workplace Level 2 charging port is needed for every 22 electric vehicles on the road, however this figure is in the context of all electric vehicles on the road and is not specific to just employee's vehicles. The same study projects a need for 8.25 vehicles per Level 2 charging port and 189 vehicles per public DC fast charging port.

S&P Global Estimate:

S&P Global (January 9, 2023) projects the need for 13.3 vehicles per public Level 2 charging port, and 165 electric vehicles per Level 3 charging port.

EVI-Pro Estimate:

The Alternative Fuels Data Center (2023) provides the Electric Vehicle Infrastructure Projection Tool (EVI-Pro), which can also provide useful data about the number of charging ports needed, although the tool is adapted for metropolitan areas, rather than rural areas. The Energy Department applied the results of its survey to adapt the model from the Green Bay metropolitan area. Based on the results in Question 8 (Section 3.7) for the stated preferences for buying EVs group, 17.7% of vehicles would be “*Sedans*,” 60.7% would be “*SUVs*,” 21.6% would be “*Pickups*,” and 0% would be “*Vans*.” The Energy Department assumed “*Full Support*” for Plug-in hybrid electric vehicles (PHEV), and that 66.5% of EV drivers would have home access to charging, per the midpoint result of Question 9 (Section 3.8). The results were normalized to 38,916 vehicles which represents 13.3% of Green Bay vehicles, consistent with the expected FCPC adoption rate of 13.3% with a 350 kW DC fast charger (See Section 3.6). The model recommended 3,152 public Level 2 charging ports, and an additional 2,346 workplace Level 2 charging ports, which is 7.1 Level 2 charging ports per electric vehicle. These results are shown in Figure 8. Under more conservative assumptions with the default “*Partial Support*” option for PHEVs and assuming 98% ability to charge at home, there would need to be 1,124 public Level 2 charging ports and an additional 684 workplace Level 2 charging ports, which is 21.5 Level 2 charging ports per electric vehicle.

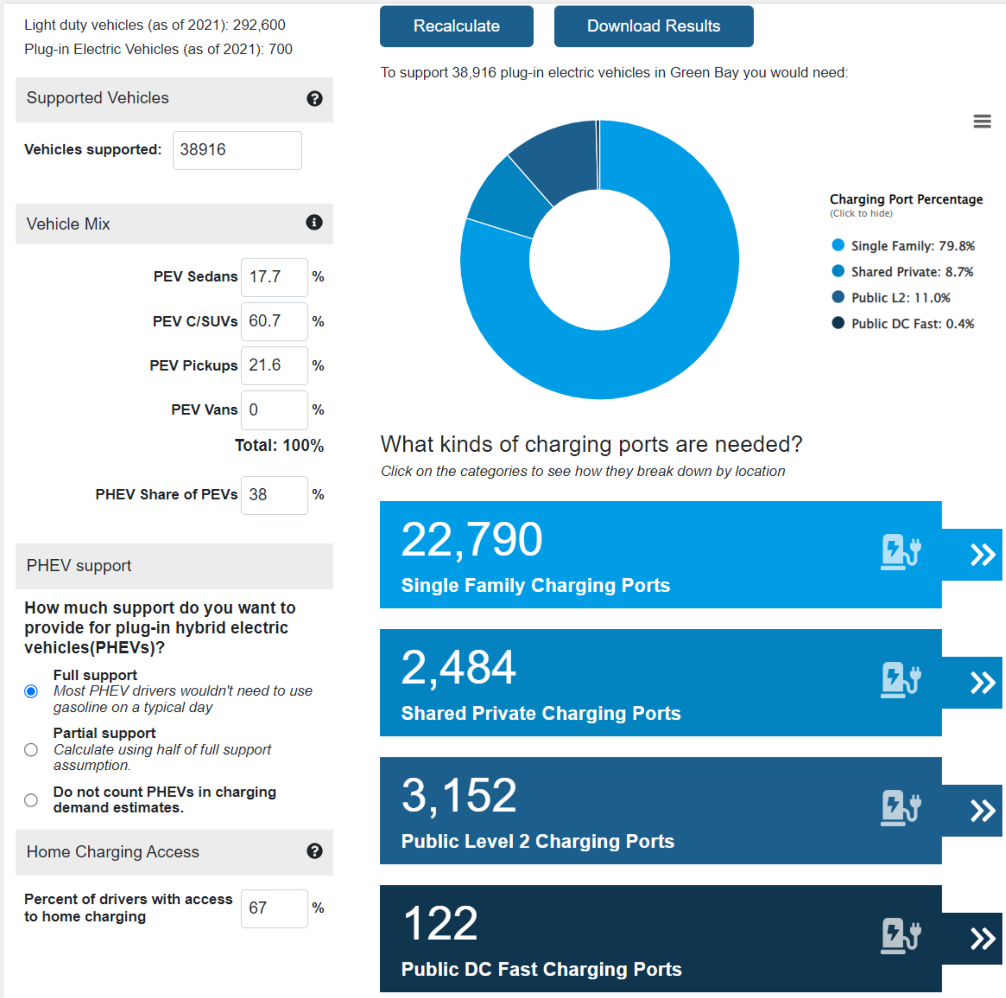

Figure 9: *Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Model Output for FCPC Survey Results (US DOE, 2023)*

FCPC Energy Survey and Power Delivery Estimates:

The results are different when considering an energy delivery perspective. When considering the vehicle class data of Survey Question 8, shown in Figure 5, the average electric vehicle would get 2.66 miles per kWh, which is presented in Table 7 below. This is very close to the fleet average miles of 2.68 miles / kWh presented in Table 3.

Table 7: *Expected Average Electric Vehicle Miles / kWh Based on Survey Question 8 Responses*

Vehicle	# Vehicles	Miles / kWh	Proportion	Weighted
Car	14	3.05	0.18	0.54
SUV	48	2.78	0.61	1.69
Truck	17	2.02	0.22	0.43
Total	**79**		**1.00**	**2.66**

The average rural vehicle travels 14,600 miles per year (US Department of Energy, 2012). The average employee travels 38.6 miles to work and back (Section 3.4), and works for 14.6 days per month when factoring in for the 4 day work week, as well as for holidays and paid time off. This accounts for 6,763 miles per year, or 46.3% of total miles driven. An Idaho National Laboratory – Plugged In (2015) report found that 32% of charging by Nissan Leaf Drivers and 39% of charging by Chevy Volt drivers who owned a home charger was performed at work, for an average of 34.5% of charging performed at work, which was mostly free in the study. While the vehicles have substantially shorter ranges than newer vehicles, this was the best data available for the percentage of workplace charging. As discussed in Section 3.8, this would represent 66.5% of drivers, and would result in 5,037 miles charged at work, which totals 1,894 kWh annually at 2.66 miles / kWh. For the 33.5% of drivers who would be reliant upon the ability to charge at work, this group is assumed to charge 80% of total miles at work (National Renewable Energy Laboratory, Blonski et al., 2021). At 80% of total miles, this would result in 11,680 miles charged at work, or 4,391 kWh annually. The weighted average electric vehicle would charge 7,265 miles or 2,731 kWh annually, which equates to 49.8% of vehicle miles traveled.

All charging at work would take place during the 175.2 working days of the average employee. This equates to 15.6 kWh charged during the average workday. For the 49.4% of employees who would charge daily, this would require approximately 2 hours to charge, however, for the 44.3% of employees who would want to charge weekly, this would require 8 hours to charge in a 10 hour workday. At maximum, a charging port could accommodate 5 vehicles per day to cover the estimated average employee work charging needs. In practice, this would not be physically possible to achieve, and thus around 2 - 4 vehicles per day could be expected to charge with rotations.

Summary of Estimates:

A summary of each study's recommendations are presented in Table 8 below. The range of values spans from 1.7 charging ports per vehicle in the FCPC Employee Survey stated preference, while the power delivery needs outlined in the previous paragraph would suggest that a maximum of 5 vehicles could be charged per day with rotation, while 2 – 4 vehicles per day would be more practical. The Edison Institute and the DOE EVI-Pro data with FCPC Survey data assumptions would suggest 8 charging ports per vehicle. Data from S&P Global and from the default DOE EVI-Pro assumptions suggest that as few as 1 Level 2 charging port would be needed for every 21.5 electric vehicles.

***Table 8**: Summary of Estimated Number of Charging Ports Needed per Electric Vehicle*

Source	# Vehicles / Level 2 Port	# Vehicles / Level 3 Port
Edison Institute	8.25	189
S&P Global	13.3	165
DOE EVI-Pro (Survey Data)	7.1	-
DOE EVI-Pro (Std Assumptions)	21.5	-
FCPC Employee Survey Preference	1.7	-
Power Delivery Needs	2 - 5	

Recommended Number of Charging Ports per Electric Vehicle:

The range of values differs because of the focus of the study. The majority of public chargers are used intermit ently when services are needed, which are representative of the figures presented by the

Edison Institute, S&P Global, and the DOE EVI-Pro Tool. These perspectives are society-focused, rather than facility-focused estimates. The range of 7.1 – 21.5 charging ports for these estimates is likely more representative for the general public, including FCP Tribal members who are not employees and citizens of local municipalities such as the City of Crandon. The Energy Department estimates the upper range consistent with the EVI-Pro Tool adapted to survey results, as well as the Edison Institute result at approximately 8 charging ports per electric vehicle. For the needs of FCPC Employees, each electric vehicle could be expected to use as many as 1 charging port per vehicle, or as few as 5 charging ports per vehicle. FCPC Employees are estimated to own 539 vehicles, PCCH Employees are estimated to own 155 vehicles, and FCPC Tribal members who are not employees living in Forest County are estimated to own 422 vehicles, for a total of 1,116 vehicles, as presented in Table 2. Employee-owned vehicles represent 62.2% of expected vehicles in the study population. With the optimal number of charging ports per employee at 1.7, weighted at 62.2%, and the optimal number of charging ports per FCPC Tribal member at around 8 charging ports per Tribal member, weighted at 37.8%, the weighted average is 4.1 charging ports per vehicle. However, as the Phase 1 results are centered on employees, the Energy Department more heavily weights employee results, as the survey results provide a reliable estimate of attitudes among employees, while attitudes of the general population are currently unknown and require further study in a Feasibility & Design study. Therefore, **the Energy Department assumes that 3 charging ports are needed for each employee vehicle**, which is nearly double the preference stated in the survey, but can still be delivered by the proposed infrastructure. The Energy Department adopts a range of 1.7 – 8 vehicles per charging port when it presents the number of charging ports needed per vehicle.

4.2 Employee Charging Needs:

As presented in Section 3.6, the Energy Department forecasted there would be an estimated 51 electric vehicles driven by employees with no DC fast charger, and 72 vehicles driven with the installation of a 350 kW DC fast charger. With an estimated 3 vehicles per charging port, FCPC would need to install 17 (6 – 29) Level 2 charging ports to meet the charging needs of FCPC employees. However, most employees work in different parts of the FCPC Government Campus that are not easily reached in different areas of the government. The Stone Lake Campus spans several miles, and several buildings do not have any sidewalks to access charging stations located in different buildings, which makes it impractical to install all electric vehicle chargers in one location. A map of the locations of main FCPC Government Buildings is shown in Figure 10.

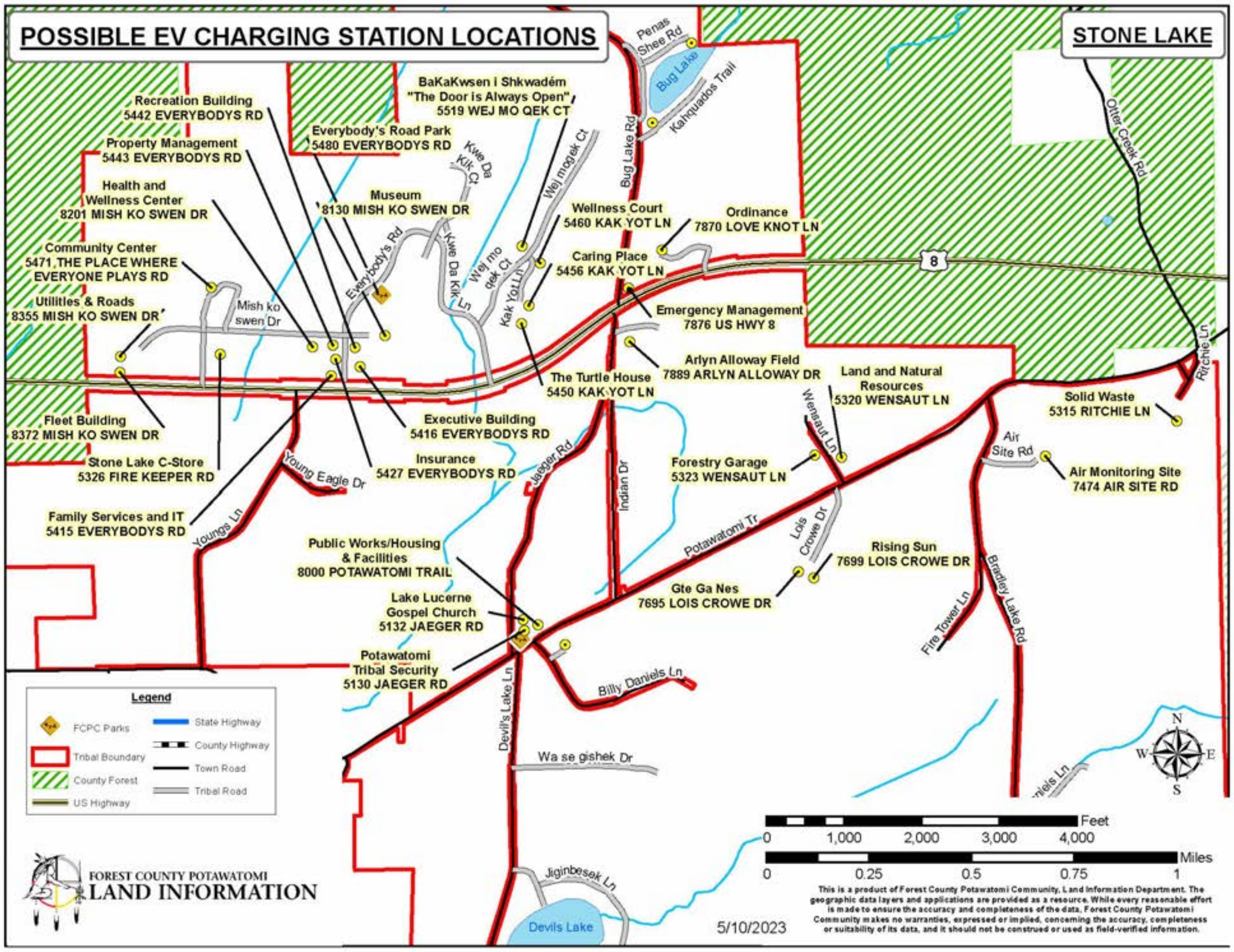

__Figure 10__: Map of the Stone Lake Government Campus Buildings

In addition to FCPC Government Employees, there would be an anticipated 15 additional electric vehicles at PCCH. Assuming 3 vehicles per charging port, PCCH would need an additional 5 (2 – 9) charging ports for its employees.

4.3 FCPC Fleet Charging Needs:

FCPC operates a fleet of 80 passenger fleet vehicles that could also utilize installed charging infrastructure. Executive Council has already approved the purchase of 4 Ford F150 Lightnings or equivalent, in addition to a planned Ford E-Transit and a Chrysler Pacifica Plugin Hybrid in the FCPC Public Transit Service, which would total 6 electric vehicles for the Tribe's electric vehicle pilot. With 7.5% electric vehicles planned in 2024, the Energy Department has conservatively set a goal to reach 25% electric vehicles by 2028.

With this goal, the Tribe would have 20 electric vehicles in service. By strategically charging FCPC fleet vehicles outside of business hours, FCPC can utilize public charging infrastructure at night to charge its fleet vehicles, where charging infrastructure is available. In order to save costs on charging and to minimize employee time spent charging, these vehicles would utilize one charging port per vehicle, rather than utilize 3 vehicles for one charging port. Therefore, 20 additional charging ports would be needed to charge the Tribe's electric vehicles.

The Energy Department does not currently collect data on the average mileage for each vehicle, which will be included in the Feasibility & Design Study, however the FCPC Fleet Maintenance Team estimates the average annual vehicle drives around 9,000 miles per year. The breakdown of the FCPC Fleet by vehicle class, alongside its estimated electric vehicle fuel consumption is shown in Table 9 below. The FCPC Fleet would average 2.41 miles / kWh. As 100% of fuel would be charged at the Level 2 chargers, this would equate to 3,734 kWh / year.

***Table 9**: Estimated Electric FCPC Fleet Vehicle Fuel Consumption*

	# Vehicles	Miles / kWh	Proportion	Weighted
Car	4	3.05	0.05	0.15
SUV	24	2.78	0.30	0.83
Minivan	22	2.43	0.28	0.67
Pickup	30	2.02	0.38	0.76
Total	**80**		**1.00**	**2.41**

4.4 FCPC Tribal Member and Visitor Charging:

With an estimated 422 additional vehicles owned by FCPC Tribal members living in Forest County, this group also represents a significant demographic to consider for charging infrastructure. The scope of the survey did not include surveying Tribal members, as there is not an email directory that can be sent to all Tribal members to take a survey. Therefore, administering a survey to Tribal members would require significantly more time to receive an adequate number of responses, which was outside the scope of the current survey effort. Due to this limitation, surveying Tribal members will be included in the Feasibility & Design Study instead.

However, with the data from employees available, the Energy Department can still project potential EV conversion based on responses from FCPC Employees. With the baseline conversion probability of 0.094, the Energy Department expects 40 electric vehicles owned by Tribal members in 2028. This would require an additional 5 electric vehicle charging ports, when only considering public charger needs (8 vehicles per charging port).

Visitor charging needs are more difficult to estimate. FCPC operates its C-Store, Community Center, and Health and Wellness Center that are used frequently by the general public. As the City of Crandon has a population of 1,713 (US Census, 2020A), and the entire county has a population of 9,179 (US Census, 2020B), there is a significantly larger potential group of visitors, in particular for the Community Center and Health and Wellness Center, which offer amenities and services that are not otherwise available without travel distances exceeding 30 miles. Again, this population was not studied, as these populations are more difficult to survey.

Finally, the FCPC Community Center also hosts large events totaling several hundred people multiple times per year. During quarterly General Council Meetings, several hundred FCPC Tribal members meet to vote on important governmental mat ers. The Community Center also hosts larger events, such as sporting events or conventions, which can at ract hundreds of visitors. The charging needs for these groups are much harder to predict, and require further study in the Feasibility & Design Study.

4.5 Potential for DC Fast Chargers:

As stated in Section 4.1, there are 165 to 189 vehicles expected for each Level 3 DC fast charger. The DOE EVI-Pro tool recommends one Level 3 fast charger for every 319 vehicles, however these fast chargers are for public spaces such as parks, community centers, or shopping centers, rather than sited at existing gas stations. In order to install a NEVI-compliant 600 kW charger with 4 ports, FCPC would need a population of 660 – 1,276 electric vehicles. The local population of FCPC Employees and Tribal members would not be large enough to support the installation of a 600 kW NEVI-compliant charger on its own, and therefore any NEVI-complaint charger would also require local residents and tourists to use the charger.

Stone Lake sits on an approved Alternative Fuel Corridor, which has an average daily traffic (ADT) of 3,900 vehicles (Wisconsin Department of Transportation, 2023). At 10% electric vehicles by 2030 (See Section 3.6), there would be an ADT of 360 vehicles, which could likely support the exitance of a NEVI-compliant charger given that this traffic is not likely composed of the same vehicles every day. The large population of tourists and seasonal home occupants in the area would likely contribute substantially to the ADT estimate. However, the broader adoption of electric vehicles remains uncertain, and the installation of a NEVI-compliant charger in Stone Lake remains risky without further study. Therefore, the Energy Department recommends that a NEVI-compliant charger in Stone Lake be included in the Feasibility & Design Study, particularly due to the possibility to enhance electric vehicle adoption by over 40%.

The Energy Department examined the potential profitability to build a 700 kW NEVI-compliant DC fast charger in Stone Lake, given current electricity prices. A 700 kW charger is more desirable in the Stone Lake area because of the larger size of vehicles in Forest County. With bat ery sizes as large as 200 kWh for the Chevy Silverado extended range, it could take over an hour to charge the vehicle by 80% with a 150 kW charger. In order to encourage electric vehicle adoption for larger vehicles that currently use the most gasoline, a charging speed of 350 kW could charge the same vehicle in less than 30 minutes. As advised by the Wisconsin Department of Transportation, the total system cost is anticipated to be $1,000,000, or $200,000 for the FCPC match. At a charging cost of $0.50 / kWh, the charger would need to have over 5% utilization just to cover its cost of energy and the installation cost, which doesn't include maintenance or repairs. This would require charging the equivalent of 20 Tesla Model 3's per day, filling up 50 kWh with each charge. The model assumes that at least one 15-minute interval during peak hours each month will trigger the full demand charge from the utility. While this may be unlikely at lower utilization rates, the economics are still expected to be unfavorable at 50% utilization (1 port at 350 kW), unless the system is curtailed to only 150 / 175 max kW, which would induce fewer electric vehicle purchases. The model output is shown in Figure 11. If the cost of charging drops to $0.35 / kWh, then the system would break even at 9% utilization, and would need to charge 30 Tesla Model 3's per day to break even. Therefore, the system profitability is highly sensitive to utilization, and the potential for utilization is currently unknown, which further warrants a Feasibility & Design Study.

Adjustable Inputs in Green

Demand Cost (kW)	
Yearly	$2.40
Summer Peak	$18.45
Non-Summer Peak	$11.99
kW Charger	700
Total / Yr	$134,453

Electric Cost (kWh)	
On Peak	$0.078
Off Peak	$0.046
% On Peak	66%

Installation Cost	
Installation Cost	$200,000
Lifespan	10
Cost / Yr	$20,000

Customer Cost per kWh
$0.50

Utilization	Tesla 3's / Day (50 kWh)	kWh / Yr	$ / kWh	Profit Margin	$ Profit / Yr	Payback Yrs
1%	3.4	61,320	$2.59	-417.1%	-$127,888	-1.6
2%	6.7	122,640	$1.33	-165.2%	-$101,324	-2.0
3%	10.1	183,960	$0.91	-81.3%	-$74,760	-2.7
4%	13.4	245,280	$0.70	-39.3%	-$48,196	-4.1
5%	16.8	306,600	$0.57	-14.1%	-$21,632	-9.2
6%	20.2	367,920	$0.49	2.7%	$4,932	40.6
7%	23.5	429,240	$0.43	14.7%	$31,496	6.4
8%	26.9	490,560	$0.38	23.7%	$58,060	3.4
9%	30.2	551,880	$0.35	30.7%	$84,624	2.4
10%	33.6	613,200	$0.32	36.3%	$111,188	1.8
15%	50.4	919,800	$0.23	53.1%	$244,008	0.8
20%	67.2	1,226,400	$0.19	61.5%	$376,828	0.5
25%	84.0	1,533,000	$0.17	66.5%	$509,648	0.4
30%	100.8	1,839,600	$0.15	69.8%	$642,468	0.3
40%	134.4	2,452,800	$0.13	74.0%	$908,108	0.2

Notes

Does not include maintenance

Does not include daily fixed charge

Does not include solar PV demand reduction

Does not include battery storage demand reduction

***Figure 11**: FCPC NEVI-Compliant 700 kW Electric Vehicle Charger Economics for Stone Lake*

PCCH is also a potential site for the installation of DC fast chargers. PCCH is a 22.1 mile, or 26 minute drive to Stone Lake, so a NEVI Compliant charger in Stone Lake would likely not overlap significantly with the Carter area. The area receives a similar amount of traffic to US Hwy 8, with an ADT of 3,000. A full-speed 150 kW DC fast charger would be a significant investment for the Carter area, particularly because it is more remote than Stone Lake, without being close to a town the size of Crandon. Therefore, a slower charger could be considered in this area. A speed around 30 – 60 kW with much lower demand charges is more ideal for PCCH. The capital investment for this speed of charger is also significantly lower, with the total installation cost estimated only around $121,612 from a quote from IngeTeam, as opposed to the cost to install 150 kW chargers, which will likely exceed $1 million.

The economics of these chargers are more favorable in comparison with the NEVI-compliant chargers. With a system cost of the 20% FCPC share of $25,960, the system could become profitable at 9% utilization with a $0.35 / kWh cost. In order to reach 9% utilization, these chargers would only need to charge about 10 Tesla Model 3's per day, which is much easier to obtain. The results are shown in Figure 12. However, this model assumes that the demand charges would be reached in one 15 minute interval once per month. PCCH runs an average load of around 430 kW, which skews higher outside peak hours, meaning that peak hour average demand is lower than this figure. With monthly peak demand charges running around 600 kW, this leaves a gap of at least 170 kW that could be used to buffer the potential for up to 71% of the demand of a 240 kW system. PCCH is also going to receive a new 245 kW solar PV system, which will add an additional average generation around 123 kW during peak hours that could fully offset any marginal demand charges. Under these circumstances, assuming that all marginal demand costs could be avoided, the system could be profitable at just 1% utilization at $0.35 / kWh. Therefore, the Energy Department recommends that four (4) 60 kW ports are installed, for a total capacity of 240 kW at PCCH.

Adjustable Inputs in Green

Demand Cost (kW)	
Yearly	$2.40
Summer Peak	$18.45
Non-Summer Peak	$11.99
kW Charger	240
Total / Yr	$46,098

Electric Cost (kWh)	
On Peak	$0.078
Off Peak	$0.046
% On Peak	66%

Installation Cost	
Installation Cost	$25,960
Lifespan	10
Cost / Yr	$2,596

Customer Cost per kWh
$0.35

Utilization	Tesla 3's / Day (50 kWh)	kWh / Yr	$ / kWh	Profit Margin	$ Profit / Yr	Payback Yrs
1%	1.2	21,024	$2.38	-580.8%	-$42,740	-0.6
2%	2.3	42,048	$1.22	-250.0%	-$36,786	-0.7
3%	3.5	63,072	$0.84	-139.7%	-$30,832	-0.8
4%	4.6	84,096	$0.65	-84.5%	-$24,878	-1.0
5%	5.8	105,120	$0.53	-51.4%	-$18,924	-1.4
6%	6.9	126,144	$0.45	-29.4%	-$12,970	-2.0
7%	8.1	147,168	$0.40	-13.6%	-$7,016	-3.7
8%	9.2	168,192	$0.36	-1.8%	-$1,061	-24.5
9%	10.4	189,216	$0.32	7.4%	$4,893	5.3
10%	11.5	210,240	$0.30	14.7%	$10,847	2.4
15%	17.3	315,360	$0.22	36.8%	$40,617	0.6
20%	23.0	420,480	$0.18	47.8%	$70,387	0.4
25%	28.8	525,600	$0.16	54.4%	$100,158	0.3
30%	34.6	630,720	$0.14	58.9%	$129,928	0.2
40%	46.1	840,960	$0.12	64.4%	$189,469	0.1

Notes
Does not include maintenance
Does not include daily fixed charge
Does not include solar PV demand reduction
Does not include battery storage demand reduction

Figure 12*: FCPC 240 kW Electric Vehicle Charger Economics for PCCH*

4.6 Estimated Charging Needs for Each FCPC Building:

As established in previous sections, there is data to support the installation of 17 Level 2 employee charging ports in the Stone Lake Government, 5 Level 2 charging ports at PCCH, 5 Level 2 charging ports for the FCP Community, and 4 Level 3 charging ports at PCCH by 2028. This does not include chargers that could be used by the broader community or for special events at FCPC. In addition, there is justification for 20 FCPC Fleet charging ports that could be used outside of normal business hours. As discussed previously, the charging locations cannot be centralized easily so that any employee can charge where they need to, so additional charging capacity is needed beyond the forecasted charging needs for 2028, and demand is only expected to grow each year with increasing electric vehicle adoption rates.

The Energy Department conducted a capacity analysis for its employees and fleet to determine which buildings could most likely benefit from installing charging infrastructure. The Energy Department used its Employee Directory to estimate which buildings each of its employees work in, and then applied the 0.91 vehicles per employee, outlined in Section 1.2, to estimate the number of vehicles in each building. The FCPC Fleet Vehicle Inventory was used to estimate where fleet vehicles are housed or operate mostly during the day. The combined result is shown in Table 10. Where the number of fleet vehicle charging ports exceeded the number of employee charging ports, the fleet vehicle number was used instead. As discussed in Section 4.3, the Energy Department set a goal to transition 25% of its fleet vehicles by 2028, and thus this factor was applied to the current number of fleet vehicles at each building.

***Table 10**: Summary of Estimated Employee and Fleet Charging Needs by Building.*

(Fleet Needs > Public Needs Highlighted in Red)

Building	# Employee Vehicles	# Employee EVs	# Employee Charging Ports Needed	# Fleet Vehicles	# Fleet EVs	Net Charging Ports Needed
PCCH (9.6% Adoption)	155	14.6	4.9 (1.8 – 8.6)			4.9 (1.8 – 8.6)
HWC	105	14.0	4.7 (1.7 – 8.2)	3	1	4.7 (1.7 – 8.2)
Exec	75	10.0	3.3 (1.2 – 5.9)			3.3 (1.2 – 5.9)
Community Center	63	8.4	2.8 (1.0 – 4.9)			2.8 (1.0 – 4.9)
Tribal Hall	44	5.9	2.0 (0.7 – 3.5)	11	3	3.0 (0.7 – 3.5)
Family Services / IT	42	5.6	1.9 (0.7 – 3.3)			1.9 (0.7 – 3.3)
Caring Place	29	3.9	1.3 (0.5 – 2.3)	11	3	3.0 (0.5 – 2.3)
LNR	26	3.5	1.1 (0.4 – 2.1)	10	3	3.0 (0.4 – 2.1)
Museum	20	2.7	0.9 (0.3 – 1.6)			0.9 (0.3 – 1.6)
Security	20	2.7	0.9 (0.3 – 1.6)	4	1	1.0 (0.3 – 1.6)
Preschool / Daycare	20	2.7	0.9 (0.3 – 1.6)			0.9 (0.3 – 1.6)
Education	18	2.4	0.8 (0.3 – 1.4)			0.8 (0.3 – 1.4)
Insurance	17	2.3	0.8 (0.3 – 1.4)			0.8 (0.3 – 1.4)
Utilities	11	1.5	0.5 (0.2 – 0.9)	5	1	1.0 (0.2 – 0.9)
Fleet	10	1.3	0.4 (0.2 – 0.8)	32	8	8.0 (0.2 – 0.8)
Farm	7	0.9	0.3 (0.1 – 0.5)	2	0	0.3 (0.1 – 0.5)
Solid Waste	5	0.7	0.2 (0.1 – 0.4)	1	0	0.2 (0.1 – 0.4)
Wellness Court	4	0.5	0.2 (0.1 – 0.3)			0.2 (0.1 – 0.3)
Traveling Times	3	0.4	0.1 (0.1 – 0.2)			0.1 (0.1 – 0.2)
Ordinance	2	0.3	0.1 (0.0 – 0.2)			0.1 (0.0 – 0.2)
Property Management	2	0.3	0.1 (0.0 – 0.2)	1	0	0.1 (0.0 – 0.2)
Emergency Management	1	0.1	0.0 (0.0 – 0.1)			0.0 (0.0 – 0.1)
Gaming Commission	1	0.1	0.0 (0.0 – 0.1)			0.0 (0.0 – 0.1)
AODA	1	0.1	0.0 (0.0 – 0.1)			0.0 (0.0 – 0.1)

4.7 Selection of Preliminary Sites:

The Energy Department looked for clusters of buildings where a single location could benefit multiple buildings to determine the estimated number of charging ports needed at each location. These locations were used to develop a project budget, but final selection will be determined after a more thorough analysis during the pre-construction Feasibility & Design Study. As per 23 CFR 680.106(b), each location selected would receive a minimum of 4 charging ports. The results of this selection are summarized in Figure 13 below (excluding PCCH), with a description of why each cluster was chosen following subsequently.

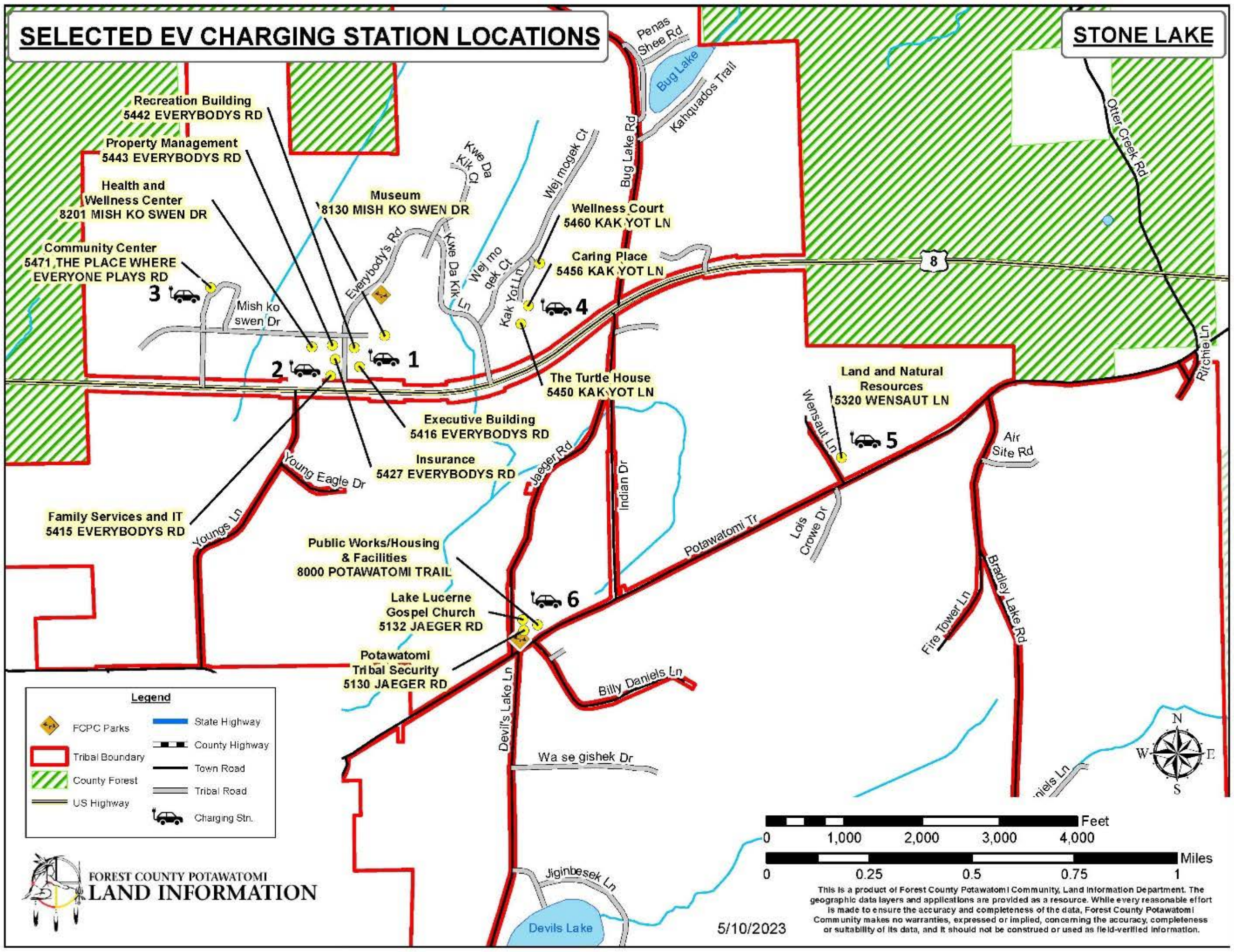

Figure 13: Preliminary EV Charging Sites Selected (Not Including PCCH)

Site 1 – Executive Building:

The Executive Building site is centrally located, and is able to provide charging infrastructure to several buildings that are within walking distance. The charging needs for FCPC Employees and the FCPC Fleet at this site are summarized as follows:

- Executive Building: 3.3 (1.2 – 8.6) Employee Charging Ports
- Family Services / IT: 1.9 (0.7 – 3.3) Employee Charging Ports
- Museum: 0.9 (0.3 – 1.6) Employee Charging Ports
- Insurance: 0.8 (0.3 – 1.4) Employee Charging Ports
- **Total Charging Ports: 6.9 (2.5 – 14.9) Employee Charging Ports**

In total, there is a need for 6.9 (2.5 – 14.9) employee charging ports in this area, with additional capacity needed for guests. The Executive Building also sees a large number of visitors, as well as the Family Services / IT building. Each of these buildings can be walked to in about 1-3 minutes from the Executive Building parking lot, which makes the location ideal for a group charging site.

This site would receive 6 Level 2 charging ports. While this site has a recommended 6.9 charging ports, additional capacity can be accessed from the Family Services / IT and Insurance buildings in the Site 2 – Health and Wellness Center site.

Site 2 – Health and Wellness Center (HWC):

The Health and Wellness Center is located just uphill of the Executive Building, which is walkable in about 3 – 5 minutes. The charging needs for FCPC Employees and the FCPC Fleet at this site are summarized as follows:

- Health and Wellness Center: 4.7 (1.8 – 8.2) Employee Charging Ports **&** 1 Fleet Vehicle
- **Total Charging Ports: 4.7 (1.8 – 8.2) Employee Charging Ports**

This site would receive 6 Level 2 charging ports. The HWC also supports a large number of employees and visitors, some of whom may have disability and would have difficulty traversing the hill to the Executive Building site. The HWC is estimated to require 4.7 (1.8 – 8.2) charging ports on its own.

Site 3 – FCPC Community Center:

The FCPC Community Center is a 110,000 ft^2 public building that features 2 large field houses, an olympic sized swimming pool with water slides, a workout gym, walking track, rock climbing wall, wood shop, and dining area. The Community Center hosts many public events, and also hosts community events with hundreds of at endees. The charging needs for FCPC Employees and the FCPC Fleet at this site are summarized as follows:

- Community Center: 2.8 (1.0 – 4.9) Employee Charging Ports
- **Total Charging Ports: 2.8 (1.0 – 4.9) Employee Charging Ports**

This site would receive 4 Level 2 charging ports. Despite only needing 2.8 employee charging ports, the large number of visitors this site receives is the reason why the Community Center was selected. This site is expected to need at least 1 or 2 additional charging ports for visitors, however this number would need to be determined by the Feasibility & Design Study. It is approximately a 10 minute walk to go from the Health and Wellness Center to the Community Center, which does not make charging convenient if visitors would need to walk that distance to access the Community Center.

Site 4 – Caring Place:

The Caring Place is an assisted living facility primarily used by FCPC Elders, who hold a special standing in the FCP Community. The building hosts an at ached housing unit with 8 apartments. The site could also be walked to from the Wellness Court, AODA, and could be accessed by local residents in the neighborhood. The charging needs for FCPC Employees and the FCPC Fleet at this site are summarized as follows:

- Caring Place: 1.3 (0.5 – 2.3) Employee Charging Ports **&** 3 Fleet Vehicles
- Wellness Court: 0.2 (0.1 – 0.3) Employee Charging Ports
- **Total Charging Ports: 1.5 (0.6 – 2.6) Employee Charging Ports – 3 Total Including Fleet Vehicles**

This site would receive 4 Level 2 charging ports. In total, the site is expected to need 1.5 employee charging ports and 3 ports for fleet vehicles. This site was selected due to the high importance of providing services to FCPC Elders. Elders receive regular services that require transports to various locations, which include pickups by the FCPC Public Transit Service. In addition, there is a regular population of visitors at this location, as well as to the Wellness Court Building, which make this location an ideal site to install chargers. The 3 fleet vehicles at this site could utilize the public charging infrastructure outside of normal business hours.

Site 5 – Land & Natural Resources (LNR) Building:

The Land & Natural Resources (LNR) Building hosts the Tribe's Energy Department, as well as the Natural Resources Department, Land Information, Forestry, Tribal Historic Preservation Office, and Capital Projects. The building frequently hosts Tribal commit ees and holds community events. The charging needs for FCPC Employees and the FCPC Fleet at this site are summarized as follows:

- Land & Natural Resources: 1.1 (0.4 – 2.1) Employee Charging Ports **&** 3 Fleet Vehicles
- **Total Charging Ports:** **1.1 (0.4 – 2.1) Employee Charging Ports – 3 Total Including Fleet Vehicles**

This site would receive 4 Level 2 charging ports. This site was selected for several reasons. As the Energy Department is the main force driving electric vehicle adoption, it is essential that the Department itself actively use and promote electric vehicles. These vehicles and infrastructure would be used for educational purposes and would set an example for the Tribe's climate mitigation efforts. The majority of the Energy Department's 4 employees are likely to drive electric vehicles in the next 5 years, as are several other environmentally minded employees in the building. The building is also expected to host 3 fleet vehicles, one of which will be operated by the Energy Department. Finally, this site is remote, and it only has walking access to the Tribe's preschool and daycare that are just up the hill, which creates a need for charging infrastructure in this remote location.

Site 6 – Tribal Hall:

Tribal Hall hosts the Public Works Division, and is currently under renovation to increase staffing capacity by at least an additional 30%. The building is also adjacent to the Security Building and to the Lake Lucerne Gospel Church, all of which can be walked to in less than 1 minute. The charging needs for FCPC Employees and the FCPC Fleet at this site are summarized as follows:

- Tribal Hall: 2.0 (0.7 – 3.5) Employee Charging Ports **&** 3 Fleet Vehicles
- Security: 0.9 (0.3 – 1.6) Employee Charging Ports **&** 1 Fleet Vehicle
- **Total Charging Ports:** **2.9 (1.0 – 5.1) Employee Charging Ports – 4 Total Including Fleet Vehicles**

This site would receive 4 Level 2 charging ports. This location was selected because of its central location to 3 isolated Tribal Government buildings. The site is expected to need 2.9 (1.0 – 5.1) charging ports, and would utilize all 4 charging ports at night for fleet vehicles. The Lake Lucerne Church could also utilize charging infrastructure when the church is in session.

Site 7 – Potawatomi Carter Casino Hotel (PCCH):

The Potawatomi Carter Casino Hotel (PCCH) hosts a 69,807 ft^2 98-room hotel, and a 79,420 ft^2 casino. The building has 2 restaurants, The Flames Sports Bar & Grill and The Springs Restaurant & Lounge. The building also has several large conference rooms that are used for local events. The building has 170 employees, and an estimated 155 vehicles used by employees. The facility receives hundreds of guests per day, and is a local tourist destination. The facility is also located on Wisconsin Hwy 32, which has an ADT of 3,000 vehicles, making the location ideal for Level 3 chargers. As described in Section 4.5, this site is ideal for 30-60 kW charging ports that would require a smaller investment from FCPC, but could still provide rapid charging for local residents and passers-by. The charging needs for PCCH employees and through traffic at this site are summarized as follows:

- <u>PCCH</u>: 4.9 (1.8 – 8.6) Employee Charging Ports **&** 4 30-60 kW DC Fast Charging Ports
- **<u>Total Charging Ports</u>: 4.9 (1.8 – 8.6) Employee Charging Ports & 4 30-60 kW DC Fast Charging Ports**

This site would receive 4 Level 2 charging ports and 4 Level 3 DC fast charging ports. These charging ports could also be accessed by users of the Potawatomi Ka Kew Se Gathering Grounds, which are used for powwows. These events also at ract several hundred at endees. The charging needs for PCCH guests were outside the scope of this current study, but do warranty further evaluation during the proposed Feasibility & Design Study. While this site is estimated to need 4.9 charging ports, the additional capacity of 4 DC fast charging ports could cover any additional employee charging needs.

Summary of Proposed Charging Infrastructure:

In total, the Energy Department found a demand for 30 Level 2 charging ports and an additional 4 Level 3 charging ports. Based on the requirements of 23 CFR 680.106(b), the proposed project scope has expanded to include 32 Level 2 Charging Ports and 4 Level 3 charging ports. These results are summarized in Table 11.

Table 11*: Summary of Proposed Charging Infrastructure to Install*

Project Site	# of Charging Ports Needed	# of Charging Ports Proposed
1 – Executive Building	(7) Level 2	(6) Level 2
2 – Health & Wellness	(5) Level 2	(6) Level 2
3 – Community Center	(3) Level 2	(4) Level 2
4 – Caring Place	(3) Level 2	(4) Level 2
5 – Land & Natural Resources	(3) Level 2	(4) Level 2
6 – Tribal Hall	(4) Level 2	(4) Level 2
7 – Potawatomi Carter Casino Hotel	(5) Level 2 & (4) Level 3	(4) Level 2 & (4) Level 3
Total	**(30) Level 2 & (4) Level 3**	**(32) Level 2 & (4) Level 3**

5. Project Budget

<u>5.1 Feasibility & Design Study:</u>

The Feasibility & Design Study will form the backbone of the project. The study will evaluate the charging needs of the FCP Community, PCCH, the Crandon Community, and those of tourists and seasonal homeowners. With a basis for future demand, the study will forecast utilization rates with and without DC fast charging infrastructure. The study will then recommend sites to consider for future implementation. These sites will undergo a techno-economic evaluation that considers the FCPC Fleet conversion, potential fee structures, infrastructure costs, NEPA / Tribal Historic Preservation Office considerations, and will provide a preliminary design and budget. This information will be used to select the final sites that will receive final design engineering with the final selected equipment, which will go out for competitive bidding. The final design will consider American With Disabilities Act (ADA) compliance, as well as the need for signage and safety considerations for future users. The full scope of the Feasibility & Design Study is included as Appendix A of this report.

The Energy Department solicited for quotes from 3 vendors to estimate the cost of the proposed Feasibility & Design Study. The 3 prices were $125,000, $192,509, and $350,000. The Energy Department chose the midpoint quote from Merjent as a basis for its cost estimate. This quote is at ached in Appendix B.

5.2 Level 2 Charger Cost:

The Energy Department solicited quotes from 2 vendors for the cost estimate for Level 2 chargers. Both vendors will be able to meet Build America Buy America (BABA) compliance within the expected project timeline. The Energy Department solicited quotes from JuiceBar and from IngeTeam for 7.7 kW dual chargers. JuiceBar quoted a price of $6,591 / dual charger, including shipping. IngeTeam quoted a price of $5,900 / dual charger with no shipping costs.

As IngeTeam does not currently have production capacity to meet BABA compliance, the Energy Department chose the JuiceBar quote, which currently meets BABA standards.

5.3 Level 3 Charger Cost:

FCPC solicited 1 quote for Level 3 chargers from IngeTeam. IngeTeam will be able to produce BABA compliant Level 3 chargers by the end of 2023, with production near Milwaukee, WI. IngeTeam quoted a price of $44,900 for dual 60 kW chargers. This quote is at ached in Appendix B.

5.4 Installation Cost:

The Energy Department consulted with its IT Division and with local electrical contractors to determine the cost of installation for Level 2 chargers. It was estimated that the installation of a dual charger would cost approximately $10,000, depending on how far of a run from the power source would be needed to connect a charger to the building electrical supply and broadband connection. The US Department of Transportation – Charging Forward (2022) Report estimates that the cost to install Level 2 chargers that are broadband connected is $11,000 for a dual charger, which is close to the estimate provided.

The costs to install a Level 3 120 kW charger are significantly higher, as DC fast chargers require significant electrical infrastructure. In conversations with manufacturers and discussing with local contractors, the cost to install a Level 3 120 kW charger is estimated at $20,000 per dual charger.

5.5 Electric Panel Upgrade Cost:

The majority of chargers are expected to be connected directly to the local utility, Wisconsin Public Service (WPS), rather than upgrade the electric panels of each building to be able to handle the increased amperage. WPS is willing to pay for additional behind the charger utility upgrade costs if a new meter is setup for each location, which would avoid electric panel upgrades.

However, at the FCPC Community Center, and at the Executive Building, the charging ports are anticipated to be connected to the main building electric supply to avoid potential demand costs. In conversations with the Tribe's electric contractors, the cost to add a 200 amp subpanel, which could supply electricity for four 32 amp 7.7 kW charging ports, is $20,000.

5.6 Maintenance Costs:

The Energy Department discussed with several contractors and manufacturers about the expected maintenance costs for chargers. The estimated cost to maintain each dual charger is $500 per year, or $2,500 for 5 years. This estimate is slightly higher than the estimated cost stated in the US Department of Transportation Charging Forward (2022) Report value of $400 / year, but is in the expected range.

The maintenance budget may be used for the purchase of a 5-year extended warranty in lieu of paying for maintenance directly. The quoted price for an extended warranty with JuiceBar is $1,920 for 5 years, and the remaining $580 could be allocated to extra-warranty fees for shipping and other expenses not covered by the warranty. The final allocation would be determined after the completion of the Feasibility & Design Study.

5.7 Operating Costs:

Operating costs were included in the cost quotes requested. JuiceBar quoted a cost of $2,880 for their ActivateEV software that processes payment and includes monitoring for the chargers. This equates to $580 per year per dual charging port. With a current electricity cost of $0.123 / kWh for many FCPC buildings and a retail electricity cost of $0.136 / kWh, this leaves a profit margin of only $0.013 / kWh to recover the cost of being able to charge customers without exceeding the residential cost of electricity. As discussed in Section 3.10, a majority of survey respondents indicated they would not be willing to pay more than the residential cost of electricity to charge at work. With a potential profit margin of $0.013 / kWh, each charging port would need to charge 44,615 kWh annually, and at 7.7 kW, the total capacity is only 67,452 kWh, which represents a 66% utilization rate. As planned, only the Community Center and PCCH would utilize existing power supplies at a lower energy cost, and the remaining 5 sites would rely on the current small commercial electric price of $0.123 / kWh. FCPC would need to charge a standardized rate, which makes the profitability of charging unfavorable. Based on the high cost to charge money for Level 2 charging, the Energy Department does not anticipate that charging money to charge will be economical, and could actually increase costs for FCPC.

However, in order to meet the requirements of 23 CFR 680.112, the Energy Department has included costs for the JuiceBar ActivateEV data plan for all Level 2 chargers. This plan would allow FCPC to charge customers as well as provide uptime and power delivery data. The plan costs $2,980 for 5 years including activation.

The cost for data on the Level 3 chargers was quoted by IngeTeam at $996 for 5 years. IngeTeam works with a third party payment processor to collect payments, and was unable to provide a quote to charge customers in the required timeframe, and therefore this cost was excluded. However, the cost to collect payments can easily be incorporated into the cost of charging, and these chargers are expected to be profitable, so the additional cost is not expected to be a problem.

5.8 Contingency:

There are a number of potential sources of cost overruns that could be encountered throughout the project. The largest source of cost uncertainty is inflation, with the current rate in May 2023 at 4.9%. Construction would not begin until nearly 2 years from the time that price quotes were obtained, and thus inflation could increase costs in excess of 5%. The Energy Department adds an additional 5% for general unexpected costs, for a total of a 10% contingency rate.

5.9 Budget Estimate:

The estimated budget to conduct the Feasibility & Design Study, as well as to install sixteen (16) Level 2 dual chargers, and two (2) Level 3 dual chargers is $796,599. The US DOT Grant request is $637,279 and the FCPC Match is $159,320. The budget is summarized in Table 12. The budget estimate represents a preliminary cost estimate. If awarded a grant by the US Department of Transportation, the Energy Department would competitively bid for all components, and the vendors discussed in this report are only used as references to estimate costs.

***Table 12**: Estimated Budget*

Item	$ / Item	Quantity	Total Cost
Feasibility & Design Study	$192,509	1	$192,509
Electric Panel Upgrade	$20,000	2	$40,000
7.7 kW Dual Charger			**$354,880**
7.7 kW Dual Charger	$6,700	16	$107,200
Installation	$10,000	16	$160,000
Maintenance (5 Yrs)	$2,500	16	$40,000
Operation (5 Yrs)	$2,980	16	$47,680
60 kW Dual Charger			**$136,792**
60 kW Dual Charger	$44,900	2	$89,800
Installation	$20,000	2	$40,000
Maintenance (5 Yrs)	$2,500	2	$5,000
Operation (5 Yrs)	$996	2	$1,992
Subtotal			**$724,181**
Contingency (10%)	$72,418	1	$72,418
Total Project			**$796,599**
US DOT Grant (80%)			**$637,279**
FCPC Match (20%)			**$159,320**

6. Environmental Impact

The environmental impact of the FCPC Electric Vehicle Charging Project was estimated using the AFLEET tool provided by the US Department of Transportation. The tool requires FCPC to estimate potential utilization for each charging port. Utilization for employee Level 2 charging was discussed in Section 4.1, and utilization for FCPC Fleet Level 2 charging was discussed in Section 4.3. Total Level 2 charging needs are summarized in Table 13. In total, the Energy Department anticipates there will be 14 "*High Utilization*" Level 2 charging ports, and 18 "*Moderate Utilization*" Level 2 charging ports.

***Table 13**: Summary of Level 2 Charging Utilization Estimates*

Building	# Ports	# Employee EVs	Employee kWh	# Fleet EVs	Fleet kWh	Total kWh	# 60 kWh Charges / Port	AFLEET Utilization
1) Executive Building	6	20.6	56,259	0	0	56,259	156	High
2) Health & Wellness	6	14.0	38,234	1	3,731	41,965	117	Moderate
3) Community Center	4	8.4	22,940	0	0	22,940	96	Moderate
4) Caring Place	4	4.4	12,016	3	11,193	23,209	97	Moderate
5) LNR	4	3.5	9,559	3	11,193	20,751	86	Moderate
6) Tribal Hall	4	8.6	23,487	4	14,924	38,410	160	High
7) PCCH Lvl 2	4	14.6	39,873	0	0	39,873	166	High

As presented in Section 4.5, 10% utilization of the 240 kW 4-port charger would charge 11.5 vehicles at 50 kWh per charge, or 9.6 vehicles at 60 kWh per charge, as required by the AFLEET model input. 10% utilization would correspond to 2.4 hours per charging port per day, or 144 kWh per day, which corresponds to 2.4 vehicles charged per port per day. Extrapolated annually, 10% utilization would correspond to 3,504 60-kWh charges per year, or 876 charges per port per year, which would be classified in AFLEET as "*High Utilization*." While the national average charging utilization for fast chargers is around 5% (Rocky Mountain Institute: Fitzgerald & Nelder, 2019). The same study suggests that utilization could reach 10% by 2024, but these rates will depend on location. It is easier to achieve a higher utilization rate with a charger that is relatively slow to charge due to the longer charging times, which makes higher utilization rates more likely with the 240 kW chargers as compared to the 600-700 kW NEVI-compliant chargers. Conservatively, the Energy Department assumes a utilization level of 5%, which would only require 1.2 vehicles charged per port per day. This corresponds to an AFLEET utilization rate of "*Moderate Utilization*."

The Energy Department used standard assumptions in the AFLEET tool. The input data is shown in Table 14 below.

***Table 14**: AFLEET Tool Data Entered*

State	WISCONSIN

	2a. Number of Chargers/Stations *(REQUIRED)*		
Charger/Station Type	**Low Utilization**	**Moderate Utilization**	**High Utilization**
Level 2 EVSE	0	18	14
DCFC EVSE	0	4	0
Hydrogen	0	0	0
Propane	0	0	0
CNG	0	0	0
LNG	0	0	0

The resulting AFLEET output is shown in Table 15. In total, the FCPC Electric Vehicle Charging Project is anticipated to reduce emissions by 233.6 tons CO_2e, 3,218.9 lbs CO, 89.2 lbs NOx, 7.7 lbs of PM2.5, 281.0 lbs of VOCs, and 1.2 lbs of SOx.

***Table 15**: AFLEET Model Output for the FCPC Electric Vehicle Charging Project*

AFV Fueling Infrastructure	GHGs (short tons)	CO (lb)	NOx (lb)	PM10 (lb)	PM2.5 (lb)	VOC (lb)	SOx (lb)	Fuel Dispensed (fuel unit)	Fuel Unit
Level 2 EVSE	160.9	2,217.5	61.4	5.3	4.7	193.6	0.9	248,000	kWh
DCFC EVSE	72.7	1,001.4	27.8	2.4	2.1	87.4	0.4	112,000	kWh
Hydrogen									kg
Propane									gal
CNG									GGE
LNG									gal
Fueling Infrastructure Total	233.6	3,218.9	89.2	7.7	6.8	281.0	1.2		

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Appendix A: Feasibility & Design Study Proposed Scope of Work

FCPC Electric Vehicle Charging Phase 1
Feasibility and Design Study Scope of Work

1. Assess Utilization Potential for Level 2 and 3 Chargers

1.1 Conduct Surveys of Potential Level 2, Level 3, and NEVI-Compliant Level 3 Charging Infrastructure

- Interpret FCPC Government Employee Survey data
- Survey FCP Community members
- Survey Potawatomi Carter Casino Hotel Employees
- Survey local Forest County residents in the Crandon and Carter areas
- Survey tourists in the Crandon and Carter areas

1.2 Determine Level 2 Charging Needs at FCPC Government Buildings and the Potawatomi Carter Casino Hotel for Employee and for Public Use:

- Assess utilization of charging infrastructure if only Level 2 chargers are installed
- Assess utilization of charging infrastructure if Level 2 charging infrastructure is built alongside a 600+ kW NEVI-complaint charging station in Stone Lake
- Determine the number of charging stations needed to meet demand by 2028 and by 2033

1.3 Determine Level 3 Charging Needs (Not NEVI-Complaint) at the Potawatomi Carter Casino Hotel:

- Determine optimal charging speed to at ract tourists or long distance drivers
- Determine the number of charging stations needed to meet demand by 2028 and by 2033

1.4 Determine Level 3 Charging Potential Utilization for a 600+ kW NEVI-Compliant Charger in Stone Lake:

- Assess utilization from FCPC Government Employees, FCP Community Members, and local residents
- Estimate induced EV adoption from installing a 600+ kW NEVI-Compliant Charger
- Estimate utilization from tourism and long distance drivers

1.5 Create a List of Recommended Sites for EV Charger Deployment Based on Future Utilization Estimates for 2028 and 2033

2. Conduct Techno-Economic Analysis to Determine the Optimal Allocation of EV Chargers

2.1 Assess Cost Saving Opportunities to Convert the FCPC Fleet of Approximately 80 Passenger Vehicles and 5 10+ Passenger Buses to Electric Vehicles:

- Estimate operational cost of current fleet through the end of life
- Estimate operational cost of replacing current fleet vehicles at current service life VS at end of life
- Update 1.5 to include any additional EV charging infrastructure needed for FCPC fleet vehicles

2.2 Analyze Fee Structure of Level 2 and 3 Chargers
- Examine potential payment processing fees compared to utilization rates
- Examine energy costs of charging, including energy use charges and marginal increases in building demand charges
- Examine the cost of a subscription system in lieu of a cost-per time or energy use
- Examine the cost of offering free charging

2.3 Assess Infrastructure Costs to Install Level 2 Charging Infrastructure
- Determine cost to install pedestals and to run conduit
- Determine cost to install broadband infrastructure
- Determine if an electric panel upgrade is needed to supply service to proposed and future infrastructure needs
- Determine alternative cost to directly connect EV chargers to WPS instead of connecting the chargers to the host building

2.4 Assess Infrastructure Costs to Install Level 3 Charging Infrastructure
- Determine cost to install chargers, transformers, and conduit needed to operate chargers
- Determine cost to install broadband infrastructure
- Determine cost to install a bat ery that could offset 100% of demand at 1%, 3%, 5%, and 10% utilization

2.5 Assess Maintenance Costs of Level 2 and 3 Charging Infrastructure
- Determine failure frequencies for common problems
- Determine industry rates for fixing common problems
- Assess the benefit of having trained staff on site at FCPC VS hiring a contractor

2.6 Conduct Techno-Economic Analysis
- Determine optimal allocation of resources to maximize utilization, while minimizing costs
- Examine dynamic load management technologies to minimize demand charges
- Examine bat ery systems to offset up to 100% of the load at 1%, 3%, 5%, and 10% utilization (Priority for Level 3 Chargers)
- Determine profitability scenarios for all Level 3 chargers

2.7 Propose Final List of Sites Recommended for Installation by 2028 and in 2033
- Consult with the FCPC Energy Department to modify and approve proposed list before design begins

2.8 Analyze Siting Constraints for Selected Infrastructure
- Examine feasibility of siting the recommended number of chargers at each location
- Consult with FCPC Facilities and Potawatomi Carter Casino Hotel facilities about feasible locations to site proposed infrastructure
- Examine NEPA, environmental, and Tribal Historic Preservation constraints for proposed siting areas

2.9 Select Final Sites for Design of Level 2 and Level 3 (Non-NEVI Compliant) Chargers
- Compile a list of final sites to complete for design work

- Select fee structure and payment options for each charger

3. Complete Design for Selected Sites

3.1 Examine Safety and Accessibility of Proposed Infrastructure

- Examine traffic access to infrastructure sites
- Examine safe charging best practices to implement
- Examine accessible language requirements and the inclusion of traditional Potawatomi language signs
- Examine Americans With Disabilities (ADA) requirements and recommend the number of ADA compliant chargers
- Examine National Roadway Safety Strategy (NRSS) design considerations to avoid accidental injury or death

3.2 Design Electrical and Broadband Infrastructure Siting

- Develop a scope of work to connect EV chargers to the host building or directly to WPS
- Develop scope of work for any electrical upgrades necessary for FCPC or WPS
- Develop scope of work to connect each charger to the local broadband network via a hard wire connection
- Design system to meet 2033 system sizing for future upgrades

3.3 Design Chargers for Durability & Climate Resilience

- Design for possible shelters to protect EV chargers from sunlight, rain, snow, ice, and extreme weather events that could worsen due to climate change
- Design chargers for protection from accidental vehicle collisions that could damage the equipment
- Design chargers for resilience according to the Federal Flood Risk Mitigation Standard

3.4 Design Parking Lot Modifications and Signage

- Re-Design parking lots to accommodate new parking space paint and markings
- Develop signage at charging sites, as well as along FCPC roadways directing users to EV charging sites. Signage should consider the inclusion of traditional Potawatomi language signs

3.5 Integrate Fee Structure Into Design Plans

- Install any required metering if the free-charging option is selected
- Propose final payment software needs and costs

3.6 Develop Final Scope of Work and Site Plans

- Develop full list of materials and estimated cost for final design
- Develop CAD or other engineering drawings for site plans, including parking space modifications and placement of signage
- Submit a final bid package for site plans

FOREST COUNTY POTAWATOMI
ENERGY

FCPC Tribal Member Home Decarbonization Plan Excerpt

February 2023

Section 1: Project Goals

The Forest County Potawatomi Community (FCPC or Tribe) has developed a number of energy projects aimed at increasing renewable energy development and energy efficiency for the Tribal Government, as well as Tribal businesses, but progress on Tribal member homes has been limited.

1.1 – Carbon Neutral via 100% Renewable Energy:

The tribal government has had a long time goal of reaching carbon neutrality via 100% renewable energy. This goal has guided every energy project at the Tribe, from its construction of the 2 MW biodigester, to the construction of over 1.9 MW of solar PV, energy efficiency at the Wgema campus and the FCPC Community Center, and many additional projects.

Despite the Tribe's goal, the Tribal membership had previously not been surveyed. In order to determine Tribal member attitudes and needs in regards to energy, in the spring of 2022, the FCPC Energy Department conducted the FCPC Energy Future Survey. The survey asked Tribal members about their attitudes towards renewable energy, electric vehicles, energy efficiency, and cost preferences. The survey received 97 responses in total, and represented the FCPC geographic distribution of Tribal members well. Results indicated that 69.1% (59.9% - 78.3%) of Tribal members would like a carbon neutrality goal by 2050 or sooner, while 25.8% of respondents were unsure, and 5.2% did not want a goal, which is shown in **Figure 1**. The FCPC Energy Department interpreted the large share of answers of "Not Sure" to result from the abstract concept of understanding carbon neutrality.

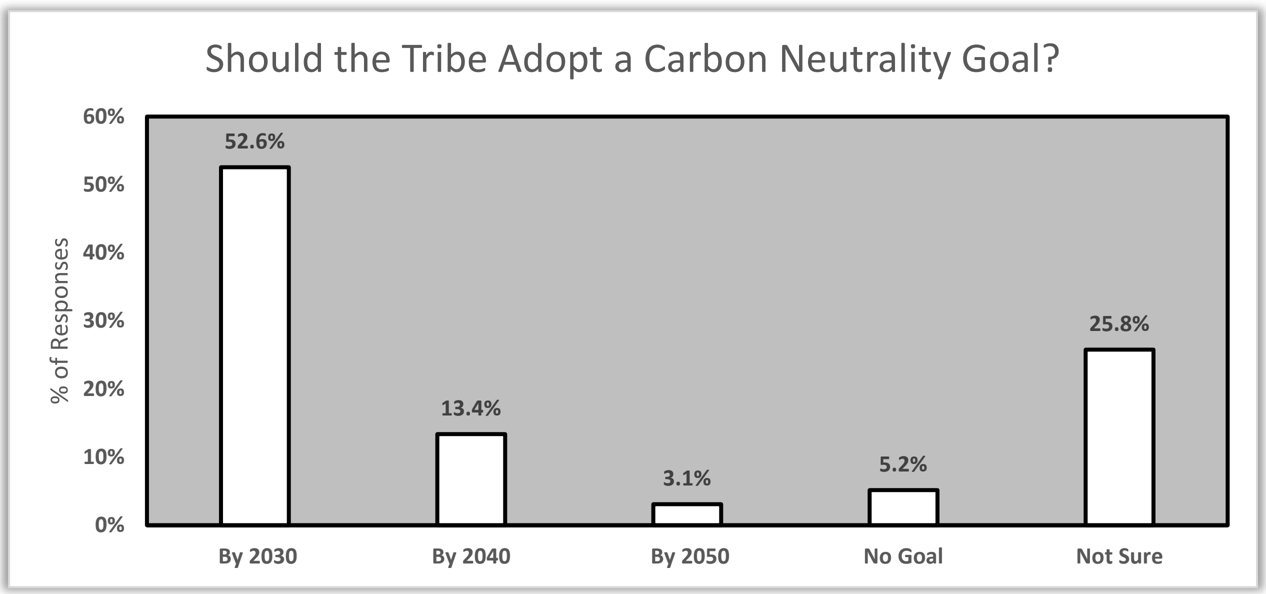

Figure 1: *Margin of Error (95% Confidence) for Any Carbon Neutral Goal: 9.2%*

When asked about renewable energy specifically, the results were much more certain, with 96.9% (93.5% - 100%, 95% Confidence Interval) of Tribal members indicating that the Tribe should develop renewable energy to protect mother earth, shown in **Figure 2**. Based on these results, the FCPC Energy Department sets the goal:

Project Goal 1: Develop renewable energy

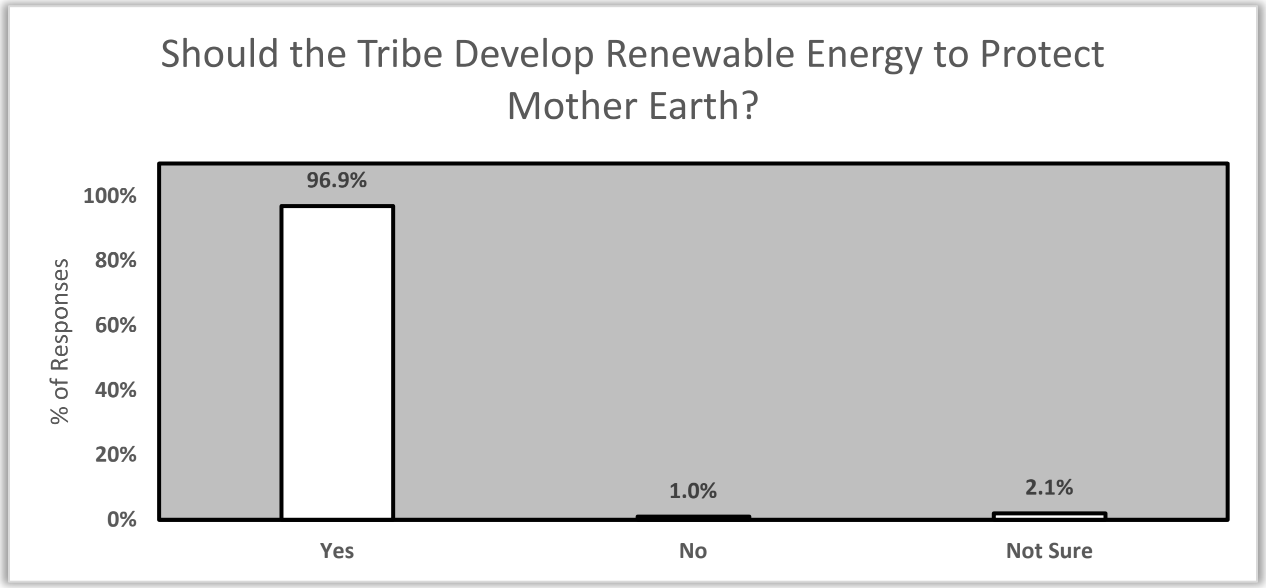

Figure 2*: Margin of Error (95% Confidence) for Development of Renewable Energy: 3.4%*

1.2 – Increase Energy Independence:

The survey also indicated that the Tribe should try to achieve energy independence, with 90.6% (84.8% - 96.4%) of respondents indicating that the Tribe should strive to achieve energy independence, shown in **Figure 3**. Based on this result, the FCPC Energy Department sets the goal:

Project Goal 2: Increase energy independence

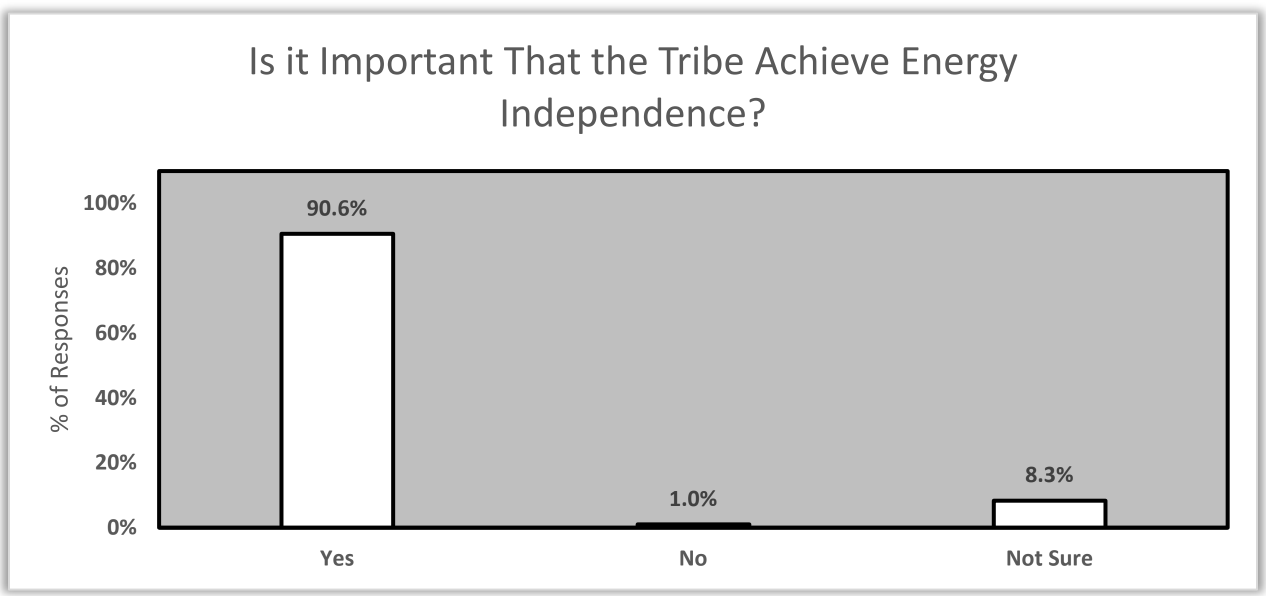

Figure 3*: Margin of Error (95% Confidence) for Achieving Energy Independence: 5.8%*

1.3: Increase Resilience to Outages:
The need for energy independence is also evidenced by the result that 81.4% (73.7% - 89.1%) of respondents indicated that power outages affect their lives as either an inconvenience or as a major disruption, which is shown in **Figure 4**. A total of 21.6% of respondents indicated that power outages are a major disruption, and in the depth of winter in rural Tribal lands, these outages could be life threatening without backup power. Based on this result, the FCPC Energy Department sets the goal:

Project Goal 3: Increase resilience to outages

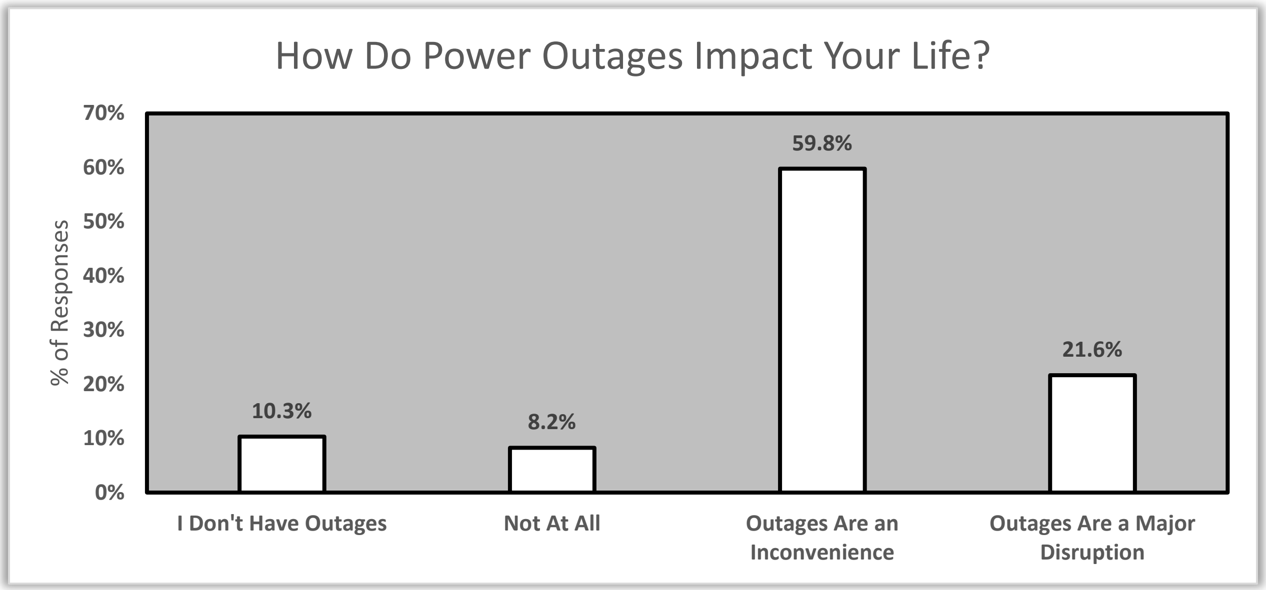

Figure 4*: Margin of Error (95% Confidence) for Power Outages Impacting the Respondent's Life: 7.7%*

1.4 – Save Money:

Finally, when respondents were asked when they support renewable energy development, a majority of respondents indicated they support renewable energy if costs stay the same, or are lower, with 71.1% (62.1% - 80.1%) of the results received. The results are shown in **Figure 5**. Based on this result, the FCPC Energy Department sets the goal:

Project Goal 4: Save money

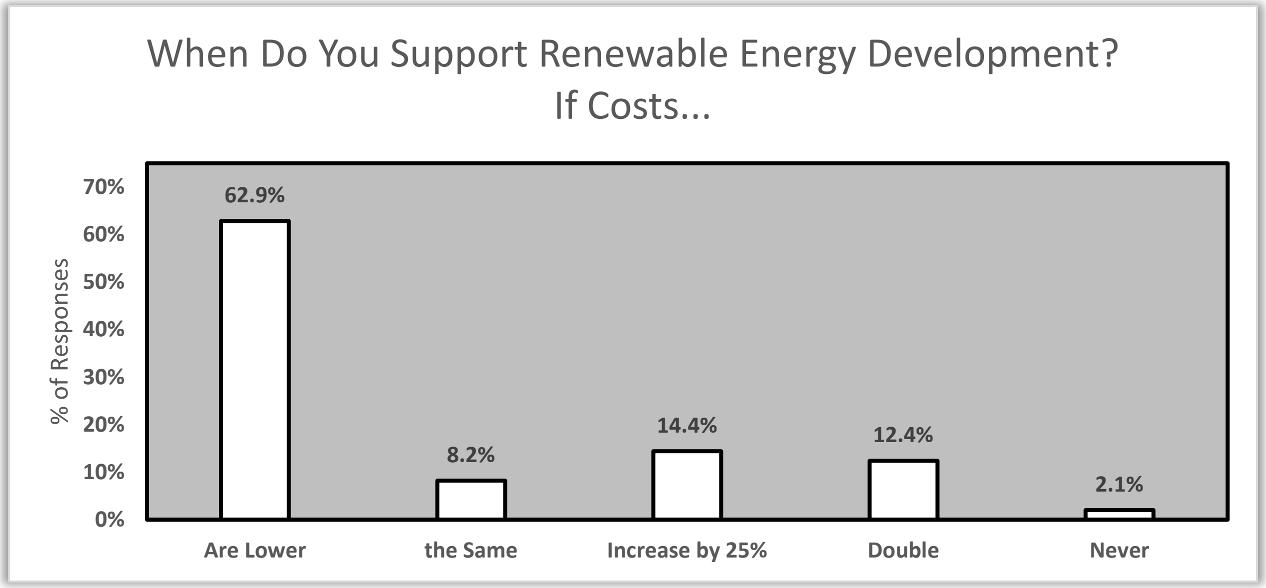

Figure 5*: Margin of Error (95% Confidence) for Costs Staying the Same or Lower: 9.0%*

1.5 – Summary of Project Goals:

The main goals of the Project are to:
1. Develop Renewable Energy
2. Increase Energy Independence
3. Increase Resilience to Outages
4. Save Money

Section 2: Load Analysis

2.1 – Period of Analysis:

The FCPC Energy Department is considering energy projects with lifespans between 20 to 30 years, which is typical for wind, solar, energy efficiency, or other energy technologies. The earliest date FCPC could start to perform on a grant award is 2024, however, any project involving Tribal member homes will likely take multiple years to execute. Therefore, a three (3) year time horizon was chosen for project installation, between 2024 and 2026. The average base start year is therefore 2025. Project benefits will begin to accrue 1 year after installation, which makes the start year 2026. FCPC chooses a period of analysis of 25 years for the accumulation of benefits, and therefore the final benefit year is 2050.

2.2 – Energy Use Analysis:

Energy use data was obtained from the baseline energy consumption collected under the DOE First Steps Toward Developing Renewable Energy and Energy Efficiency on Tribal Lands grant award, DE-IE0000065. The FCPC Energy Department conducted energy audits on 117 Tribal member homes and provided baseline energy reports for each of these homes. Full 24-month datasets were available for 91 homes for electricity, 70 homes for propane, and 20 homes for natural gas. There are 51 homes out of 238 that use natural gas, and thus the Gas / Propane data was weighted at 21.4% natural gas, and 78.6% propane. Based on these results, the average household uses 11,107 kWh of electricity, or 37.9 MMBtu, 1,007 therms, or 100.7 MMBtu, 854.7 gallons of propane, or 102.8 MMBtu. The weighted average of natural gas and propane is 102.3 MMBtu.

Fuel use for vehicles was estimated based on survey results and available data on US households. There are an estimated 1.83 vehicles per household in Wisconsin (Paulus, N., February 23, 2022). FCPC Tribal members were asked about mileage driven in the FCPC Energy Future Survey, and the weighted average result was 37.0 miles per person, which is shown in **Figure 6**. This totals to 13,505 miles driven per year. Assuming a Light-duty average fuel economy of 24.0 miles per gallon (US EIA, 2022), this results in 563 gallons of gasoline per car per year. Assuming there are an average of 1.83 vehicles per household, this results in 1,030 gallons of gasoline per household per year, which totals 123.8 MMBtu / Year.

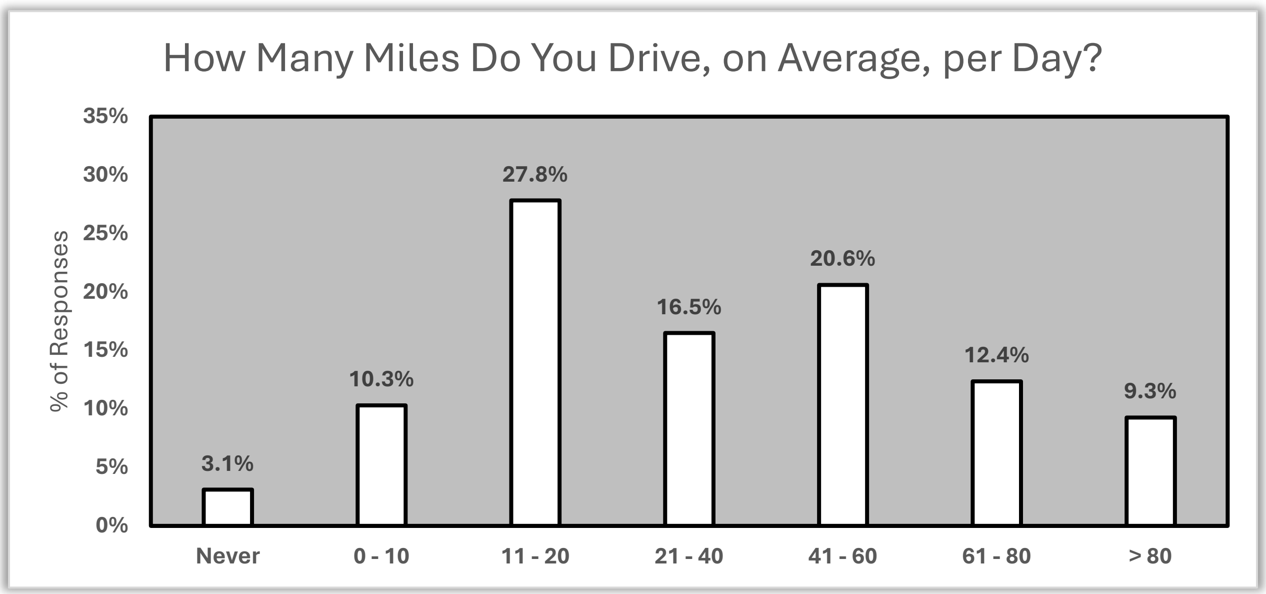

Figure 6*: Average Miles Driven Per Day: 37.0. Note: Average miles based on midpoint of bin size*

The results for the average home energy use are shown in **Figure 7**. Gasoline accounts for 46.9% of all energy use, followed by natural gas or propane, with 38.7% of energy use, and then electricity, with 37.9% of energy use.

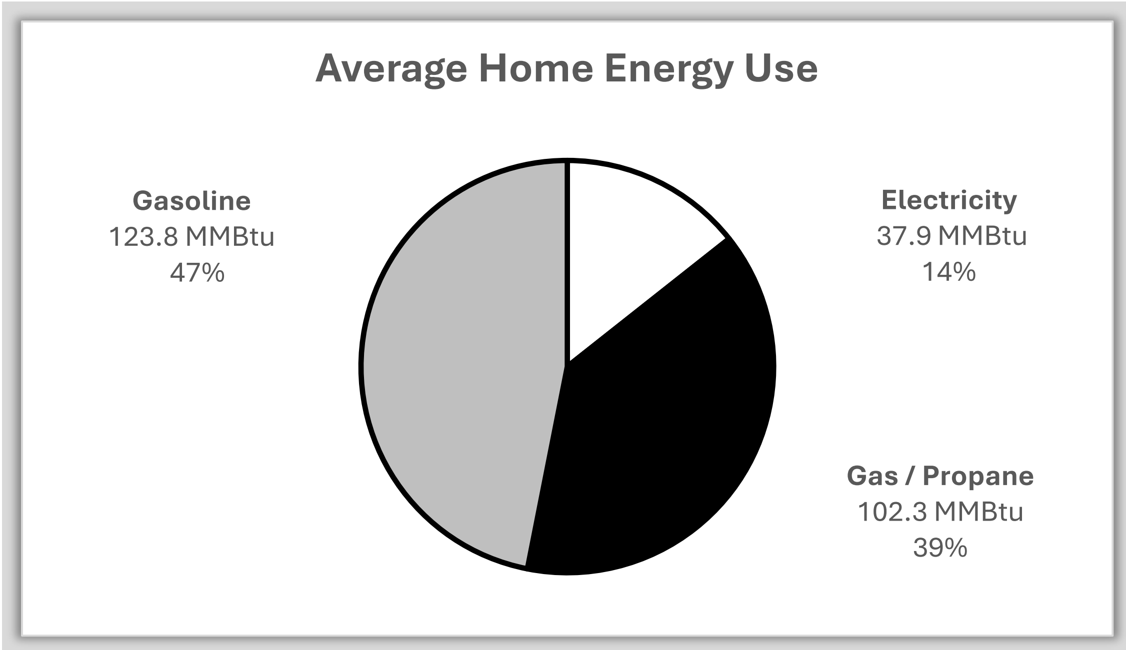

Figure 7*: Average home energy use*

2.3 – Cost Analysis:

Based on Goal #4, cost is an important factor for any energy project at FCPC. The local utility, Wisconsin Public Service (WPS) has set fixed rates for electricity, and thus these rates are not variable. The newly raised electricity rate is 13.6 cents / kWh (WPS, 2023), or $39.86 / MMBtu. Based on these results, the average homeowner will pay $1,511 for electricity per year, which is 26.2% of all homeowner energy costs. The 5-year average cost of residential natural gas in Wisconsin is $1.04 / therm (US EIA, 2023A), or $10.40 / MMBtu. The average cost of residential propane in Wisconsin is $1.76 / gallon, or $19.21 / MMBtu (US EIA, 2023B). The average homeowner will pay $1,404 / year for heating, which is 24.4% of all homeowner energy costs. The 5-year average cost of gasoline in the midwest is $2.76 / gallon, or $22.96 / MMBtu (US EIA, 2023C). The average homeowner will pay $2,843 / year for gasoline, which is 49.4% of all homeowner energy costs. These results are summarized in **Figure 8**.

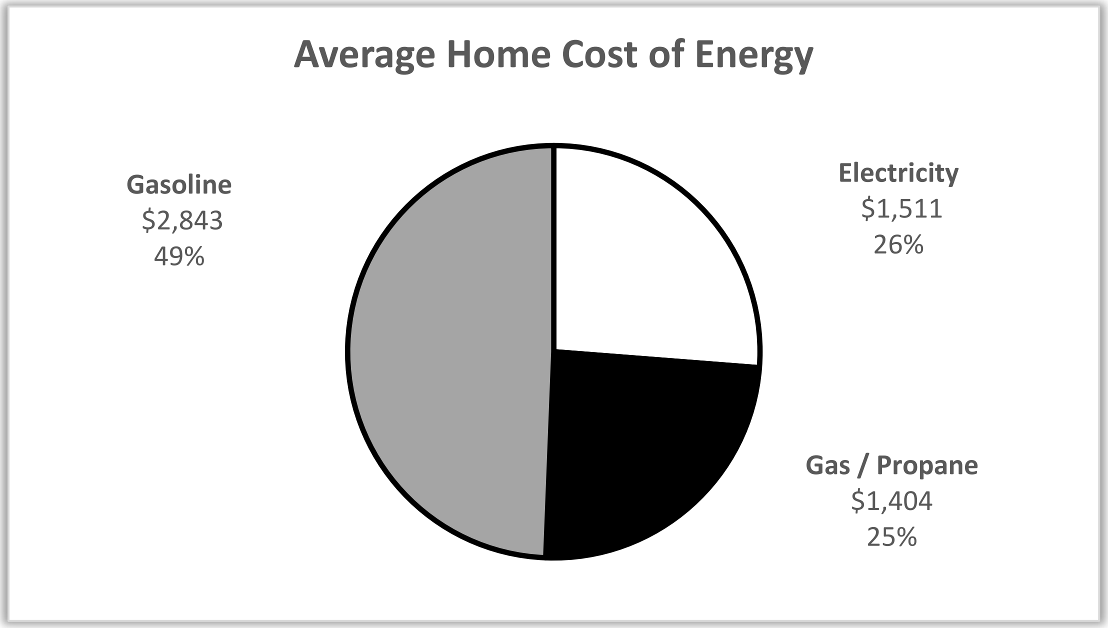

Figure 8*: Average home cost of energy*

2.4 – Carbon Footprint Analysis:

Based on Goal #1 Develop renewable energy, the carbon footprint of energy is an important factor for any energy project. Emissions depend on the fuel source, and assumptions of the carbon footprint of energy are outlined below.

Electricity Emissions:

WPS has a goal to reduce its emissions by 80% of 2005 levels by 2030, and to be carbon neutral by 2050 (WEC Energy Group, 2021). In 2021, WPS stated electricity emissions of 1,367 kg CO2e / MWh (WPS, 2023), or 620.0 kg CO2e / MWh, which is listed in **Figure 9** below as a 45% reduction in emissions from the 2005 base year. While **Figure 9** shows the emissions for all of the WEC Energy Group, WPS is a subset of the whole organization’s electricity service, and has a higher 2021 greenhouse gas intensity compared to WEC as a whole, with only 480 kg CO2e / MWh.

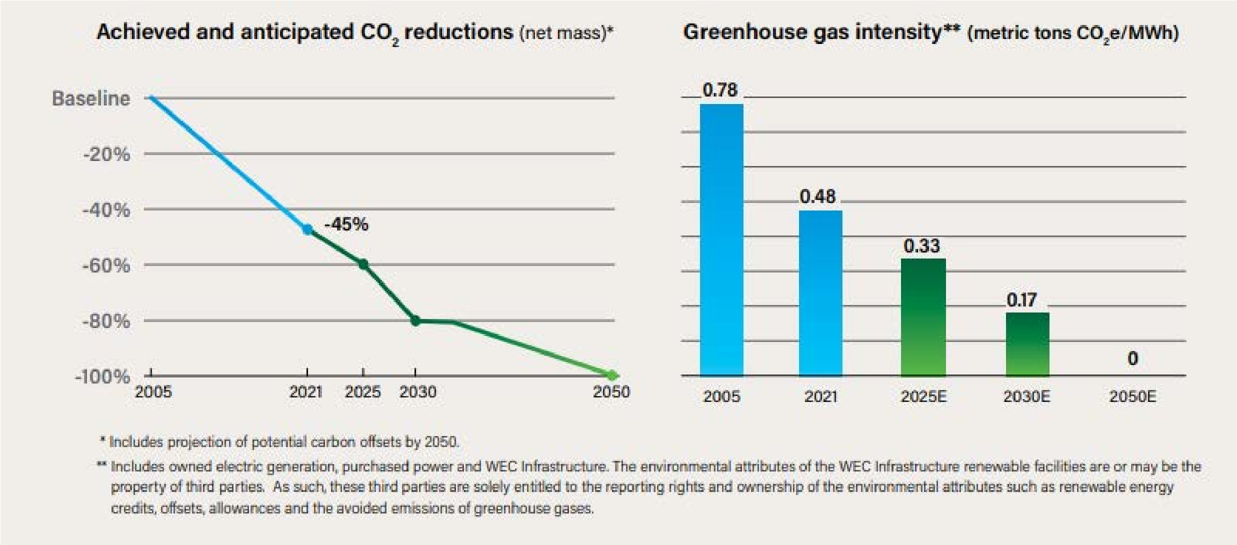

Figure 9*: Carbon emissions reduction goals of WEC Energy Group. Figure adapted from the WEC Energy Group Corporate Social Responsibility Report (2021).*

The FCPC Energy Department modeled the emissions reduction per year relative to the WPS emissions intensity, rather than for all of WEC. In the 4 years between 2021 and 2025, emissions are set to reduce from 45% to 60%, which is a 27.3% relative reduction over 4 years, or 6.8% per year, resulting in a 2025 emission level of 450.9 kg CO2e / MWh. In the 5 years between 2025 and 2030, emissions are set to decrease from 60% to 80%, which is a 50% relative reduction over 5 years, or 10% per year, resulting in a 2030 emission level of 225.5 kg CO2e / MWh. In the 20 years between 2030 and 2050, emissions are scheduled to reduce from 80% to 0%, which results in a relative reduction of 5% per year, ending in 0 kg CO2e / MWh in 2050. The results of the electricity carbon model are shown in **Table 1** below.

Table 1*: Modeled WPS electricity emissions intensity to 2050.*

Year	kg CO2e / MWh
2021	620.0
2022	577.7
2023	535.5
2024	493.2
2025	450.9
2026	405.8
2027	360.7
2028	315.7
2029	270.6
2030	225.5
2031	214.2
2032	203.0
2033	191.7
2034	180.4

2035	169.1
2036	157.9
2037	146.6
2038	135.3
2039	124.0
2040	112.8
2041	101.5
2042	90.2
2043	78.9
2044	67.6
2045	56.4
2046	45.1
2047	33.8
2048	22.5
2049	11.3
2050	0.0

Averaged over the 25 year period of analysis stated in **Section 2.1** between 2026 and 2050, the emissions intensity of electricity is 148.8 kg CO2e / MWh.

Natural Gas Emissions:

Natural gas emissions are listed by the US EIA (2023D) at 54.87 kg CO2e per thousand cubic feet. This converts to 5.29 kg CO2e / therm at 10.37 therms per thousand cubic feet.

Propane Emissions:

Propane emissions are listed by the US EIA (2023D) at 5.75 kg CO2e per gallon.

Gasoline Emissions:

Gasoline emissions are listed by the US EIA (2023D) at 8.10 kg CO2e per gallon of finished motor gasoline.

Carbon Footprint of Energy for the Average Tribal Member Home:

Based on the emissions factors outlined above, the average home energy carbon footprint of a Tribal household is 14,999 kg CO2e / yr, which is shown in **Figure 10**. Gasoline makes up the largest share of the carbon footprint of energy, with 55.6% of the carbon footprint, followed by Gas / Propane, with 33.4%, and then electricity, with 11.0%.

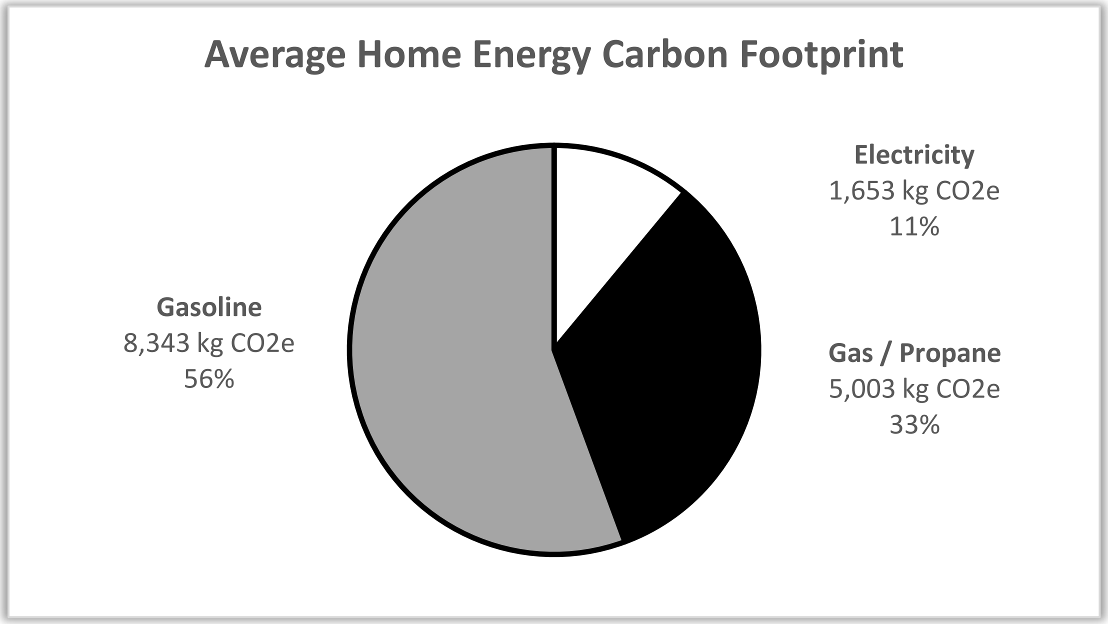

Figure 10*: Average Home Energy Carbon Footprint*

Section 3: Identification and Selection of Options

3.1 – Option Alignment With Project Goals:

Based on the results presented in Section 2, it is clear that gasoline represents the largest source of energy use and cost for Tribal members. While heating is the second largest source of energy consumption, it is approximately an equal source of cost to electricity for families that use propane for heating. In total, the average household is expected to spend $5,758 per year, or $480 per month, which is a significant cost burden for Tribal families.

While FCPC has goals to 1) *Develop renewable energy*, to 2) *Increase energy independence*, and to 3) *Increase resilience to outages*, any options considered must all be sensitive to goal 4) *Save money*.

As discussed in Section 2.4, by switching energy use to electricity, these loads will eventually be powered mostly by renewable energy, which advances Goal 1, but may not advance the remaining goals. However, any electrification options to reduce energy use, cost, and carbon emissions will be considered for the project.

3.2 – Identification of Options:

There are many energy saving and distributed energy technologies that can accomplish one or more project goals. These options include:

1. Off grid solar PV
2. Off grid wind

3. On grid solar PV
4. On grid wind
5. Wood heat
6. Wood combined heat and power
7. Solar hot water
8. Ground source heat pumps
9. Air source heat pumps
10. Appliance electrification
11. Weatherization
12. Vehicle electrification

3.3 – Elimination of Costly Options:

Off-grid solar or wind systems provide renewable electricity and could support full energy independence for electricity, heating, and transportation. FCPC has extensive experience with on-grid solar PV systems, and these systems have generally performed slightly below the cost of grid energy. Off grid systems, however, require higher rated capacities than building loads to account for the variability of renewable generation. In addition, these systems require the use of energy storage systems, all of which are considerably more expensive than grid energy. Therefore, 1) *Off grid solar PV* and 2) *Off grid wind* are eliminated due to cost.

Wood is renewable, and the Tribe owns over 10,000 acres of forest land that could potentially be used for wood harvesting, which would support the Tribe's energy independence. However, the use of 5) *Wood Heat* for heat or 6) *Combined Heat and Power* is currently more expensive ($22.66 / MMBtu; Home Advisor, 2023) than propane heat ($15.94 / MMBtu), or natural gas heat ($10.95 / MMBtu). While combined heat and power could potentially lower energy costs for electricity, previous feasibility studies for biomass have all concluded that biomass would result in increased costs for the Tribe. Therefore, these options are eliminated due to cost. A summary of these costs is presented in **Table 2**.

Table 2*: Summary of costs for different heating options*

Fuel	Unit	MMBtu / Unit	$ / Unit	$ / MMBtu	Efficiency	Adjusted $ / MMBtu
Electric (GSHP)	MWh	3.412	$136.00	$39.86	350%	$11.39
Electric (ASHP)	MWh	3.412	$136.00	$39.86	250%	$15.94
Electric (Resistance)	MWh	3.412	$136.00	$39.86	100%	$39.86
Propane	Gallon	0.091	$1.76	$19.21	95%	$20.22
Natural Gas	Therm	0.100	$1.04	$10.40	95%	$10.95
Wood	Cord	20.000	$362.50	$18.13	80%	$22.66

Finally, 7) *Solar hot water* has been shown to be more expensive than solar PV with an electric water heater (SolarReviews.com, September 7, 2022). Costs for solar PV systems have dropped considerably in the last 10 years, and have made the economics of solar hot water less favorable. Therefore, this option is eliminated due to being more expensive than solar PV.

3.4 – Elimination Due to Social Acceptance:

FCPC has only two options for distributed electricity generation, which are 3) *On grid solar and* 4) *On grid wind*. With 11,107 kWh of energy in a home, and assuming system sizing can accommodate at least 50% of home energy use without sellback to the utility, a wind turbine would need to be sized at 3-4 m2 if mounted at 80 ft, as shown in **Figure 9** below, which would produce around 5,500 kWh per year. However, many FCPC homes are closely surrounded by forest with canopy heights of 60 to 70 ft. This would mean a wind turbine would need to be mounted at least 100 ft to reach the recommended rotor height of 30 ft above any obstacle within 300 ft (NREL, 2007). Even higher heights may be required, as many of the homes border National Forest, which may prohibit wind turbines close to tree canopies.

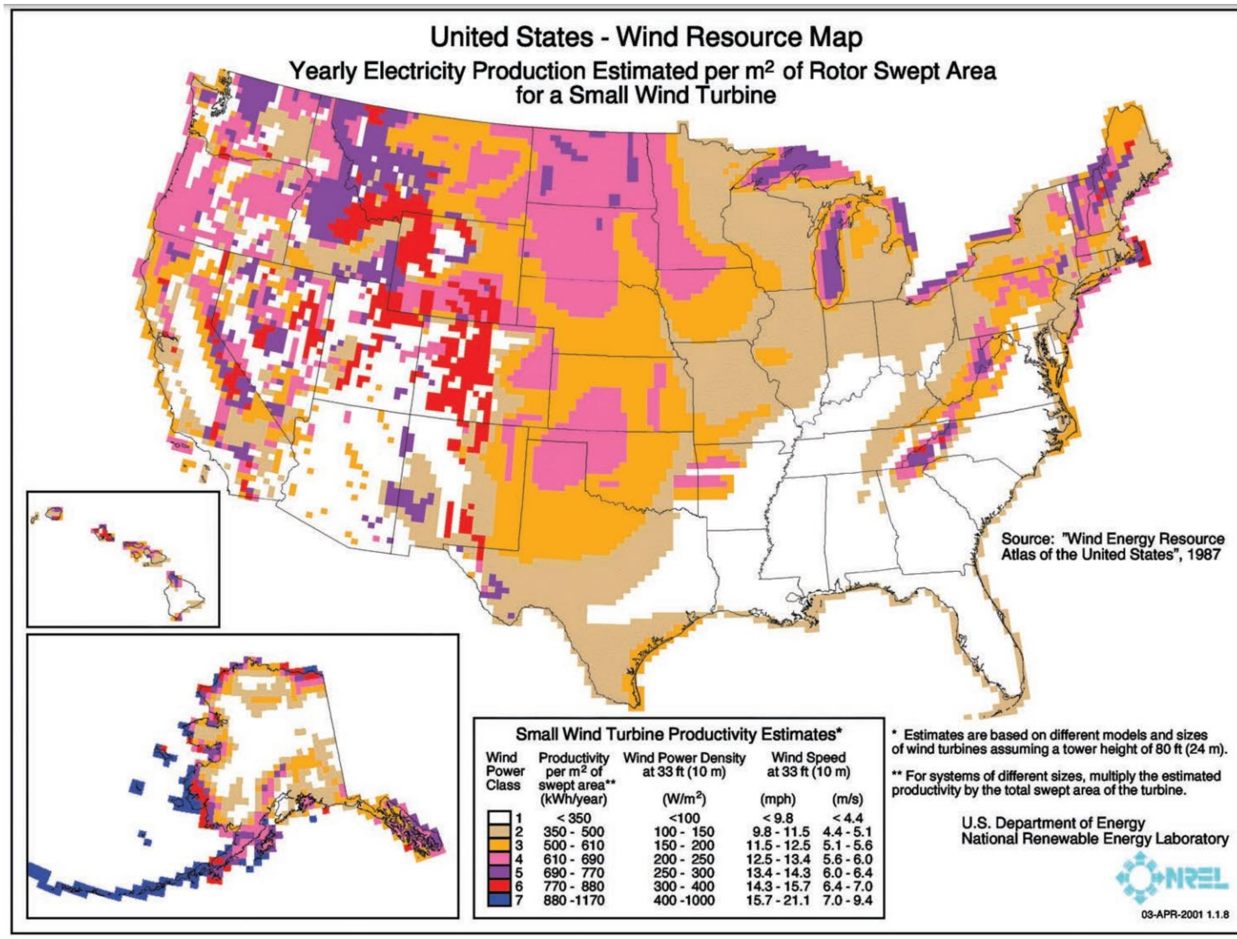

Figure 11*: Small wind resource availability from NREL (1987). Wind Energy Resource Atlas of the United States.*

With a cost of $3,000 to $5,000 per kW, and a higher capacity factor than solar, wind could be cost competitive or even cheaper than solar. Even if larger heights are required, they would boost energy production and lower the overall cost of energy (NREL, 2007). However, the greatest obstacle to wind energy deployment is social acceptance. In the FCPC Energy Future Survey, only 22.7% of respondents indicated they would support a wind turbine located less than a quarter mile from their home, which is shown in **Figure 12**. While the question did not differentiate between small wind and utility scale wind, there was still a strong preference to live further away from wind turbines. Therefore, 4) *On grid wind* is eliminated as an option due to the likely potential for social resistance in the community.

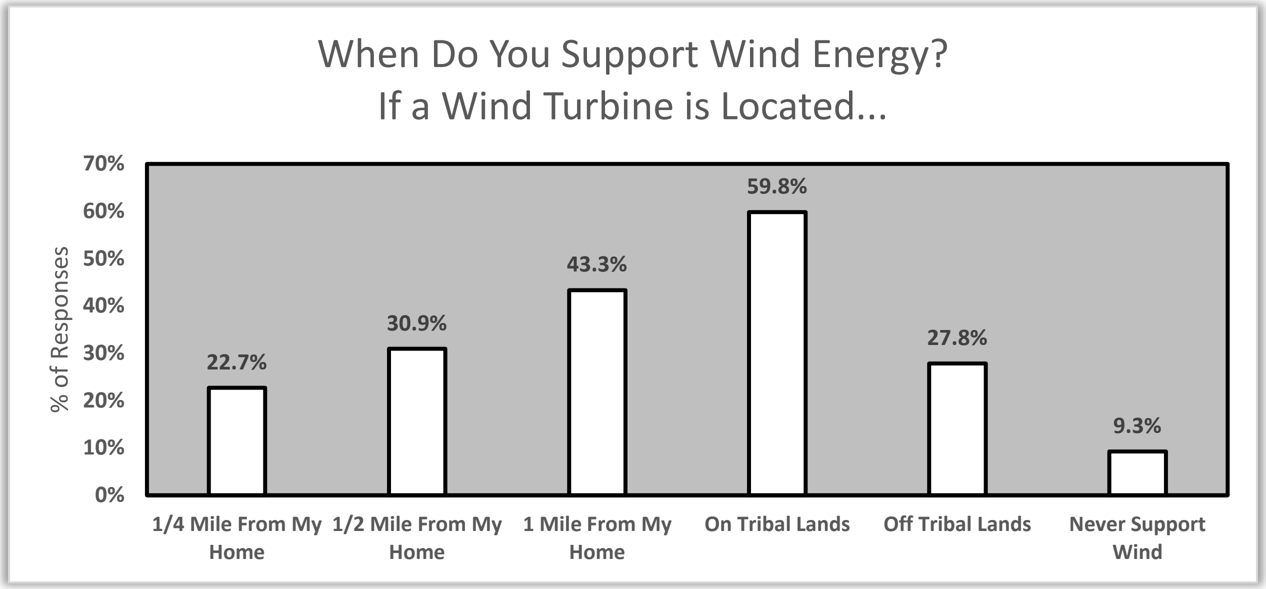

Figure 12*: Margin of Error (95% Confidence) for turbine located 1 Mile From My Home: 9.9%*

<u>3.5 – Elimination Due to Lack of Data</u>:

As shown in Table 1, both 8) *Ground source heat pumps* and 9) *Air source heat pumps* have a lower energy cost than propane, but not natural gas. This means that fuel switching from propane to a heat pump could lower energy costs, if the capital cost of the equipment is not prohibitively expensive such that the payback period is too long. Ground source heat pumps commonly have a coefficient of performance (COP) of 3 – 5, and many air source heat pumps have a COP of 2 – 3 (PickHVAC.com, 2022). As discussed in Section 3.1, fuel switching to electricity can support renewable energy development.

However, the engineering feasibility study conducted for the FCPC Community Center grant #DE-IE0000119 considered a geothermal heat pump option. This option was not pursued because the glacial till under the community center made drilling costs expensive, as large boulders are present that would increase costs. The estimated payback of this system was over 50 years, and longer than the life of some of the components. While the same glacial till is present under all Tribal member homes, to date, the Tribe has not attempted to install a pilot ground source heat pump on Tribal lands. Due to the concerns about underlying geology, 8) *Ground source heat pumps* are eliminated from consideration until FCPC can conduct a further assessment of its underlying geology and pilot the technology on Tribal lands.

Air source heat pumps are not as efficient as ground source heat pumps, but are considerably easier to install, and also have a smaller up front cost. Air source heat pumps can save around 21% on energy costs at a COP of 2.5, and can utilize renewable energy from the grid. When coupled with the replacement of a central air unit, a heat pump may add only $1,000 - $3,000 of extra cost. In December of 2022, FCPC piloted 4 air source heat pumps, with a unit cost of about $6,200. Data is still being collected to gauge electricity consumption and winter performance. Until FCPC has more data about the performance of air source heat pumps, the option is eliminated from consideration.

3.6 – Prioritization of Options:

After eliminating options, the following options still remain:

3) On grid solar PV
10) Appliance electrification
11) Weatherization
12) Vehicle electrification

These options can be prioritized based on the cost effectiveness of carbon reduction, which is shown in **Table 3**. The highest cost per kg CO2e fuels represent the best opportunities for both carbon reduction and cost savings. Efficiency estimates for gasoline cars and electric cars are based on midpoint efficiencies listed on FuelEconomy.gov (2023A). The highest cost is for Gasoline cars, at $1.62 spent for each kg CO2e emitted. Electric cars cost 36% less compared to gasoline cars, assuming that all charging is done at home. As gasoline is also the largest source of energy, cost, and emissions, 10) *Vehicle electrification* is the best way to save money and reduce carbon emissions at the same time.

***Table 3**: Cost effectiveness of carbon reduction*

Fuel	Unit	MMBtu / Unit	Efficiency	Adjusted $ / MMBtu	kg CO2e / MMBtu	$ / kg CO2e
Propane	Gallon	0.091	95%	$20.22	62.9	$0.32
Natural Gas	Therm	0.100	95%	$10.95	52.9	$0.21
Electric	MWh	3.412	100%	$39.86	43.6	$0.91
Gasoline Car	Gallon	0.120	21%	$109.33	67.5	$1.62
Electric Car	MWh	3.412	89%	$45.03	43.6	$1.03

The next best option is to reduce the cost of electricity, which costs $0.91 per kg CO2e. Option 3) *On grid solar PV* has been proven to lower electricity costs on Tribal lands, and is the most effective way to reduce electricity costs.

Option 10) *Appliance electrification* does not appear to be a good option alone, as electric heat that could be used for space heating, water heating, dryers, or stoves is more expensive ($0.91 / kg CO2e) compared to both propane ($0.32 / kg CO2e) and natural gas ($0.21 / kg CO2e). An air source heat pump with a COP of 2.5 would still result in $0.36 / kg CO2e, which is still higher than propane. A ground source heat pump with a COP of 3.5 would result in $0.26 / kg CO2e, which is cheaper than propane, but not natural gas. While efficiency rates outside of space heating will not be as high, appliance electrification will still need to either become cheaper, or have a lower carbon footprint to be a good option. Coupling 10) *Appliance electrification* with 3) *On grid solar PV* could both lower energy costs and lower the carbon footprint of electricity, which could then make this a good option.

Finally, Option 11) Weatherization is a good option to reduce energy use, cost, and the carbon footprint of the average home. Typically, these efforts save 18% on heating bills and 7% on electricity bills (US DOE 2018). An 18% reduction in the propane use of a typical home would result in $270 of cost savings. With an average cost of $4,396 to weatherize 6 homes on Tribal lands in 2022, weatherization would have a 16 year payback in propane fueled homes, which is consistent with the DOE – EERE study payback.

<u>3.7 – Selection of Options</u>:

After reviewing the evidence presented, the FCPC Energy Department decided to pursue an All the Above strategy for the remaining options. The best option for energy use, cost, and carbon is 12) Vehicle Electrification. S&P Global (May 25, 2022) predicted that electric vehicles will reach price parity with gasoline vehicles in 2022 or 2023, meaning that the cost of electric vehicles will be the same as for gasoline vehicles. In the FCPC Energy Future Survey, respondents were asked about their willingness to purchase electric vehicles, and 74.2% (65.5% - 82.9%) of respondents indicated a willingness to purchase an electric vehicle, shown in **Figure 13**. In total, 51.6% of respondents indicated they either wouldn't ever buy an electric vehicle, or would wait until charging stations were as common as gas stations. With the Bipartisan Infrastructure Law (BIL) set to create an EV charging network and the economics of electric vehicles becoming cheaper than gasoline vehicles in the near future, the FCPC Energy Department expects a substantial amount of electric vehicles to be purchased by 2030. Incentives offered from the Inflation Reduction Act (IRA) will make some electric vehicle purchases more financially viable. These purchases could further be incentivized by reducing the cost of energy with solar PV, such that electric vehicles are cheaper to own than gasoline cars, and could even offset car payments for new or used electric vehicles. Furthermore, while fuel switching to electricity (43.6 kg CO_2e / MMBtu) saves carbon compared to gasoline (67.5 kg CO_2e / MMBtu), adding solar PV could reduce emissions potentially down to zero.

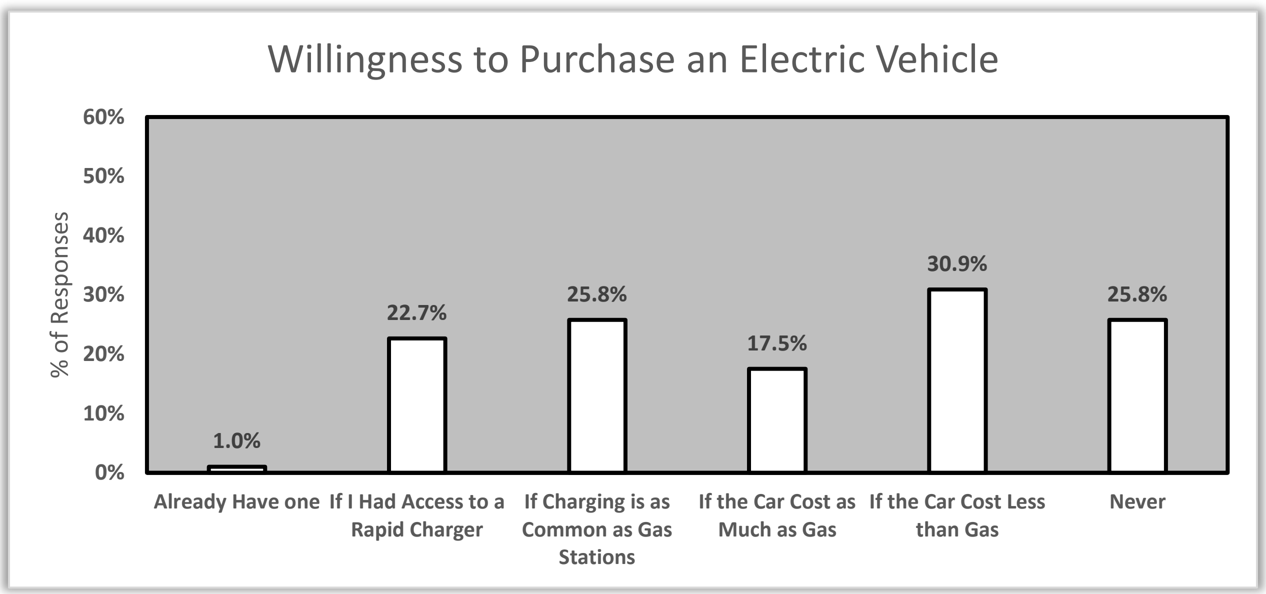

***Figure 13**: Margin of Error (95% Confidence) for willingness to buy an EV: 8.7%*

Option 10) *Appliance electrification* will also become a more attractive option if appliances are electrified. Federal and state incentives are available for home electrification, which can offset some of the cost to switch appliances.

In addition to 3) *On grid solar PV*, 10) *Appliance electrification*, and 12) *Vehicle electrification*, the Tribe is also actively pursuing 11) *Weatherization* on Tribal member homes using energy audits performed under the DOE First Steps Toward Developing Renewable Energy and Energy Efficiency on Tribal Lands grant award, DE-IE0000065. The Tribe has received funding from the state run energy efficiency program, Focus On Energy to weatherize 6 homes in 2022, and the Tribe has plans to weatherize 10-20 more homes in 2023. However, homes on propane are not eligible for the weatherization program, and thus the Tribe will seek alternative sources of funding to weatherize homes on propane, which stand to receive the greatest benefits from weatherization.

3.8 Option Scope:

Due to eligibility limitations of the Clean Energy Technology Deployment on Tribal Lands 2022 FOA, the final project will only utilize solar PV technology. However, based on survey results that around 50% of Tribal members may be willing to purchase an electric vehicle with favorable economics, the FCPC Energy Department will seek to size solar PV arrays to meet anticipated electric vehicle loads for 50% of all homes selected to receive a solar PV array. Similarly, where practical, the FCPC Energy Department will also size loads to meet appliance electrification loads, however these are anticipated to be much smaller compared to an electric vehicle.

Weatherization will not be pursued during this project, but weatherization efforts are ongoing on FCPC Tribal lands. Furthermore, as weatherization will not substantially affect building electricity loads, these projects can be pursued in parallel with each other, and complement each other well.

Section 4: Solar Resource Modeling

4.1 – Solar Radiation Modeling:

In the summer of 2022, FCPC was awarded funding from Focus On Energy (FOE), the state run energy efficiency program. The Tribe secured funding to install 35 ground-mount solar arrays, that had to be installed by December 15th, 2022. The FCPC Energy Department contracted with a solar contractor to install the solar arrays. The FCPC Energy Department was responsible for signing up Tribal members for the program, selecting the sites for the solar arrays, and for contracting.

After discussions with the contractor about project feasibility, the FCPC Energy Department requested for solar resource mapping on all Tribal member home lots. The FCPC Land Information Department then used Lidar data to develop a solar resource model from solar radiation data. The results for the 4 main sections of FCPC Tribal lands in Forest County are shown in **Figures 14 – 17**. The FCPC Land Information Department then vetted each plot to determine if there was sufficient space for a 7 kW solar array at a summer solar resource near 6,000 watts / m^2. The FCPC Land Information Department found that there were 97 high quality sites with estimated shading at 15% or below, and 37 additional sites with higher shading, between 15% - 25%. This analysis did not factor in roof-mounted arrays, as the project did not have sufficient time to vet the roof integrity of homes. Thus, there will be additional homes that could hold a roof mount that are not included in this list. In total, there are 134 homes on Tribal lands that are suitable to receive a ground-mounted solar PV array.

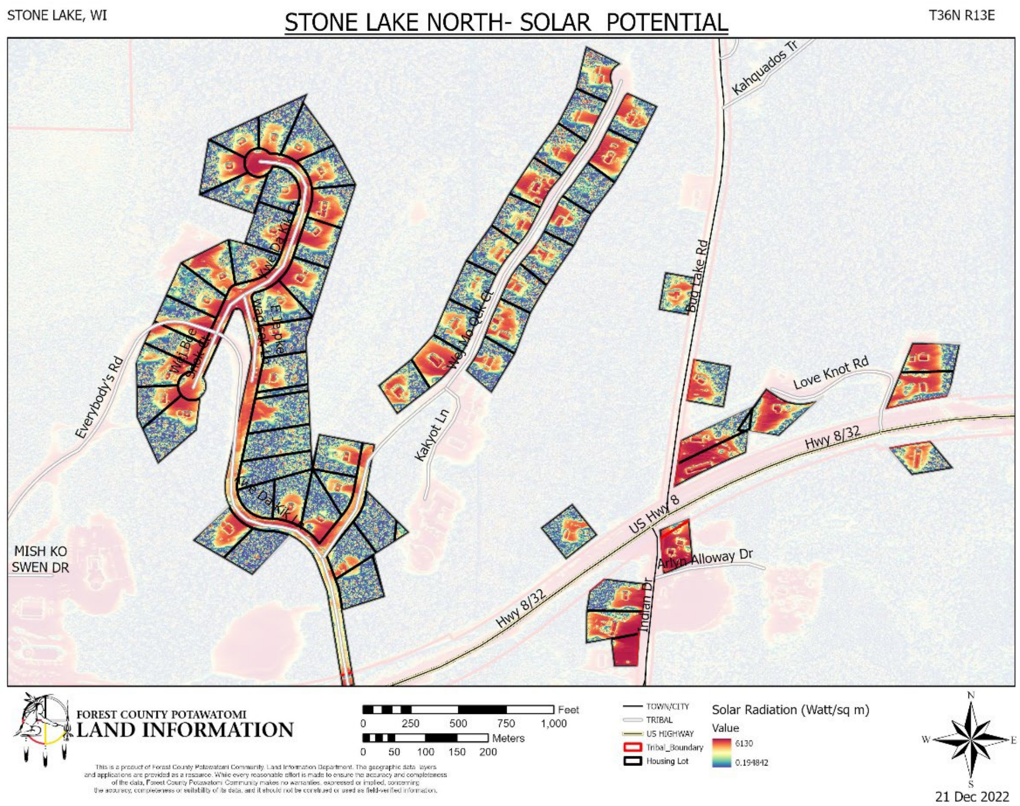

***Figure 14**: Stone Lake North solar resource*

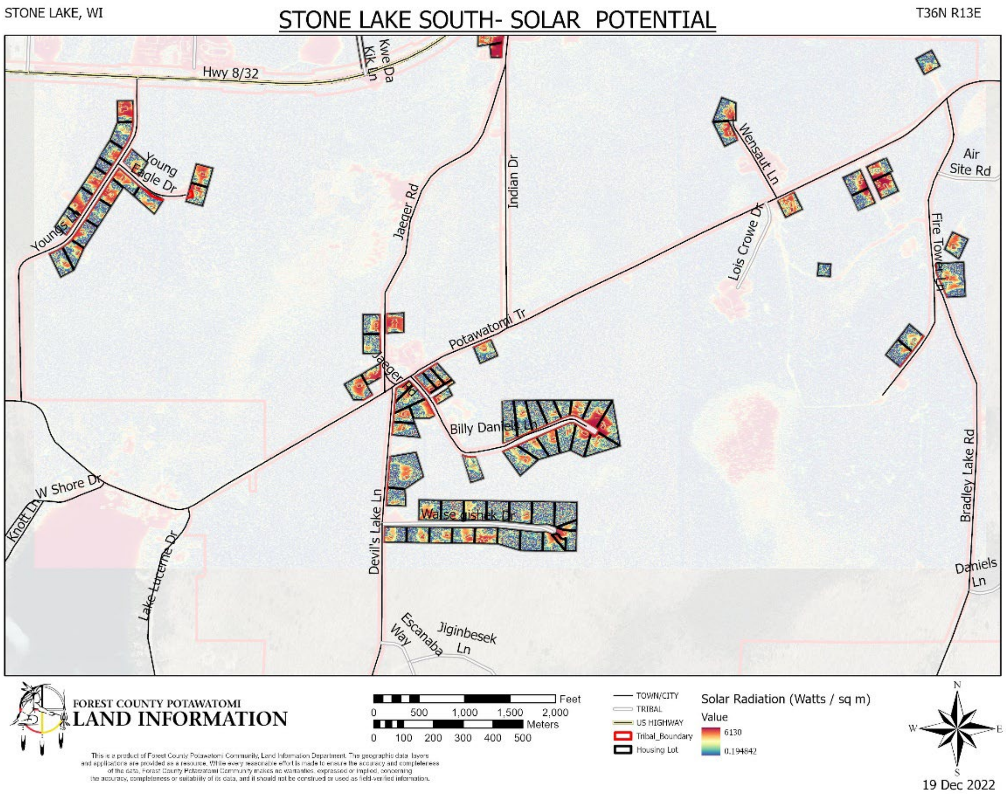

***Figure 15**: Stone Lake South solar resource*

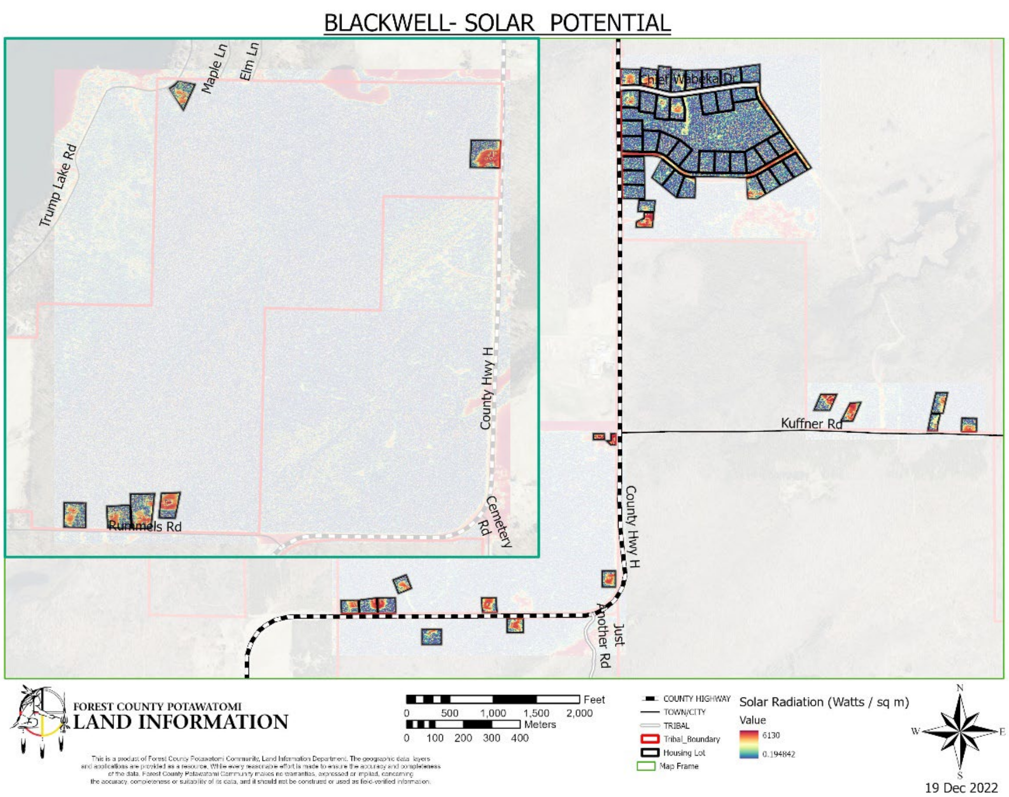

***Figure 16**: Blackwell solar resource*

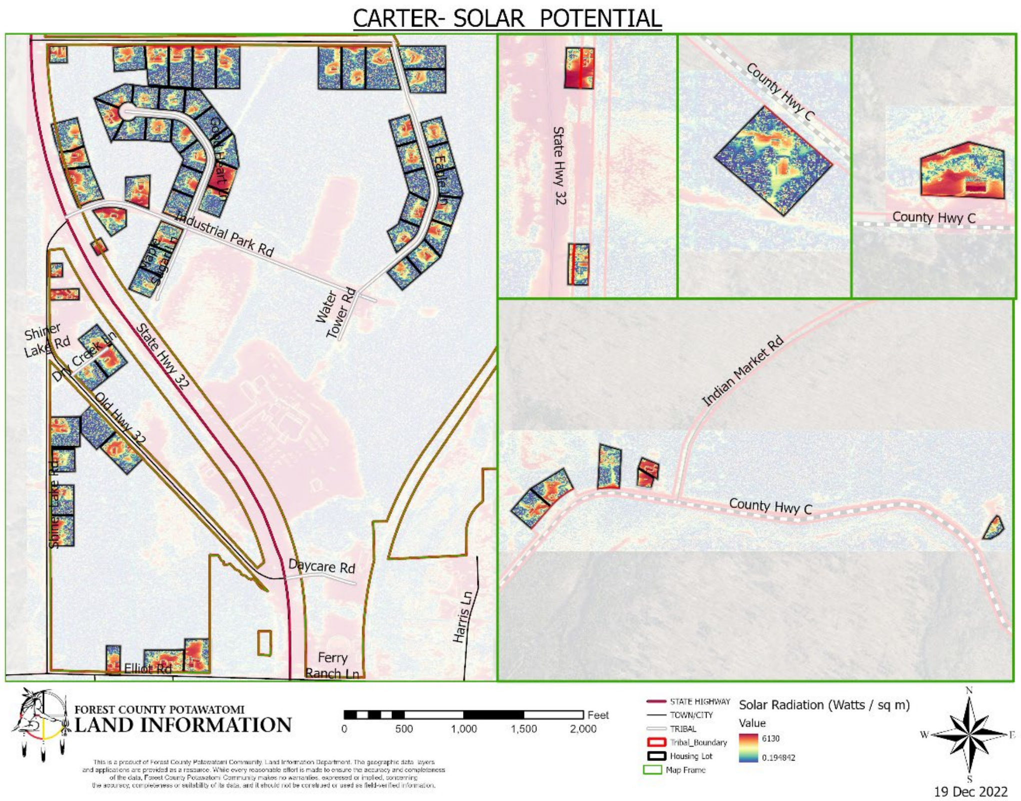

***Figure 17**: Carter Solar Resource*

Upon receiving the list of eligible homes, the FCPC Energy Department then developed an Application for Financial Assistance. The application covered eligibility requirements, and listed a number of requirements to participate, such that the participant must agree to the FOE program terms and conditions, agree to a location suitable on their property, sign a contract with the contractor allow the contractor to enter their home, among other requirements. The Application for Financial Assistance was then distributed to the 97 homes that had shading at 15% or less, which was the maximum cutoff for the FOE program funding. The FCPC Energy Department received all 35 applications, and applicants were vetted based on application order, with elders prioritized first.

The 35 homes then received an environmental and cultural review. These reviews were intended to ensure that no sensitive areas would be disturbed during the installation of a solar PV array. In general, the homes were all located in forested areas that had to be logged prior to the construction of the home, so the ground has already been highly disturbed, and no significant concerns were found with any of the 35 reviews conducted.

Ultimately, the project was canceled, as the timeline to receive Legal and Executive Council approval for the Application for Financial Assistance and contracts pushed the project signup into September, and the building window closed in November. The project also ran into budget constraints, as the contractor could not secure materials within the allocated budget and within the tight construction timeline. Therefore, all 35 applicants were notified that the program was canceled for 2022, and that the FCPC Energy Department would seek alternative funding, which is the purpose for the Tribe's DOE application.

Based on all the work already performed, the FCPC Energy Department is nearly ready to begin construction on 35 homes. If more homes receive solar, then the FCPC Energy Department would open up a second round of the Application for Financial Assistance to sign up additional households.

4.2 – Definition of Standard Systems:

With the solar resource modeling completed, the FCPC Energy Department could then develop a model for expected solar PV generation. The FCPC Energy Department used the NREL PV Watts Calculator (2023) to calculate estimated solar generation. Solar arrays will be installed on roofs as well as on ground mount arrays. The two arrays are anticipated to have different generation characteristics, both because of tilt and because of technology. The roof mount arrays will use standard solar modules, but the ground mount arrays will utilize bifacial technology, which allows the solar PV array to generate electricity from the back of the module as well as the front. This increases solar generation and allows the arrays to generate electricity even when the front is covered with snow. Studies indicate that bifacial panels can increase yield by 7% compared to monofacial panels (Rodriguez-Gallegos et al., 2020), and the NREL PV Watts calculator estimates that a 10 kW 30 degree tilt bifacial array in the Crandon, WI zip code 54520 will generate 13,842 kWh per year compared to 12,978 kWh per year for a monofacial system. This represents a 864 kWh increase, which is 6.7%.

The FCPC Energy Department used standard systems to model system losses. The standard system reflects the best available conditions, with a 180 degree azimuth, no tree shading, and no snow shading. However, not every system will be mounted at a 180 degree azimuth, most of the homes have trees, and every array will be affected by snow. The nearest available weather station in Rhinelander, WI indicates that the annual average snowfall is 81.6 inches per year (NOAA, 2022), which represents a substantial snow burden.

The FCPC Energy Department expects the average roof mount to be around 30 degrees of tilt, as the area receives more snow than most of the rest of the United States and has a higher pitched roof to shed snow.

The standard roof mount system is defined as:

- 10 kW monofacial modules
- 30 degrees tilt
- 180 degrees azimuth

Solar production for the 10 kW roof mount, per the NREL PVWatts Calculator, is estimated as follows in **Table 4**.

***Table 4**: Expected generation for 10 kW roof mount array*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
kWh	668	917	1,290	1,315	1,381	1,308	1,437	1,350	1,195	884	642	591	12,978

The FCPC Energy Department selected a higher tilt configuration to shed snow more rapidly. The 32 degree tilt of the Tribe's 810 kW solar array in Carter still suffers from substantial snow losses. After performing a review of the snow loss literature, the FCPC Energy Department based its snow angle on Heidari et al. (2015), which performed snow loss modeling in the Upper Peninsula of Michigan at different tilt angles. The study found that a tilt angle of 45 degrees resulted in an annual production loss of 5%, compared to 10% at a tilt angle of 30 degrees. Based on this study, the tilt angle was selected at 45 degrees. A higher tilt also favors winter production, as the sun angle is lower and the higher angle is closer to perpendicular in the winter. This results in losses during the higher yielding summer months, but allows homeowners to have a greater energy utilization in winter months, because homes will utilize net metering on a monthly basis. With monthly net metering, any sellback to the utility will only be credited at $0.018 / kWh compared to the retail rate of $0.136 / kWh. Therefore, the Tribe has a strong economic incentive to minimize sellback to the utility, and homeowner economics will be more favorable if a solar array can offset a greater amount of total energy instead of maximizing only summer production.

The standard ground mount system is defined as:

- 10 kW bifacial modules
- 45 degrees tilt
- 180 degrees azimuth

Solar production for the 10 kW ground mount, per the NREL PVWatts Calculator, is estimated as follows in **Table 5**.

Table 5*: Expected generation for a 10 kW ground mount array*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
kWh	787	1,057	1,445	1,395	1,324	1,242	1,378	1,331	1,232	955	722	689	13,557

<u>4.3 – Tree Shade Analysis</u>:

As many homes on Tribal lands are adjacent to approximately 70 ft tree canopies, shade is the most significant constraint for solar PV generation. Tree shading analysis was performed in Helioscope, which has a 3D modeling feature for shade analysis. The FCPC Energy Department performed shading analysis on 7 of the 35 homes selected before the FOE-funded project was canceled. In a review of these homes, the 97 homes that were identified as low or moderate shade by the FCPC Land Information Department would have a shade loss of 15% or lower, after adjusting for deciduous tree shading. Eligible homes can be roughly categorized into 3 main categories, 1) *Low Shade*, 2) *Moderate Shade*, and 3) *High Shade*. Results will be presented for each of the shade categories.

<u>Low Shade</u>:

The typical low shade house is located in an open field with relatively little tree cover. The system illustrated in **Figure 18** shows a shade loss of 6.2%. Sites with low shade are present in approximately 25% of the eligible homes.

Figure 18*: Shade loss analysis for a low shade home. Analysis performed in Helioscope.*

<u>Moderate Shade</u>:

The typical moderate shade house has an open field, but is surrounded by a canopy of trees with heights up to 70 ft. The system illustrated in **Figure 19** shows a shade loss of 16.1%. Sites with moderate shade are present in approximately 50% of eligible homes.

Figure 19*: Shade loss analysis for a moderate shade home. Analysis performed in Helioscope.*

<u>High Shade</u>:

The typical high shade house has an open field, but is surrounded on all sides by a canopy of trees with heights up to 70 ft. The system illustrated in **Figure 20** shows a shade loss of 22.4%. Sites with high shade are present in approximately 25% of eligible homes. These homes were excluded from the FOE project because they did not meet the 15% shading cutoff.

***Figure 20**: Shade loss analysis for a high shade home. Analysis performed in Helioscope.*

<u>Selection of Typical Home</u>:

In a review of all available sites, the FCPC Energy Department selected the 2) *Moderate Shade* home as a typical home for shading analysis calculations. Note that while there is a 10 ft tall building in front of the array, the shade losses result almost entirely from the 70 ft tree canopy surrounding the array. The majority of potential homes have significant shading at some point in the day. The base shading losses for this home are shown in **Table 6**. Note, the shading percentage does not reflect total shading losses, as the solar resource is higher in the summer and lower in the winter.

***Table 6**: Shade loss percentage for the moderate shade home*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg
Tree Loss (%)	57.3	77.3	85.1	90.8	89.3	90.2	90.3	90.6	90	80.7	69.1	48.6	80.0

The FCPC Energy Department then adjusted the shading from a 16.7% loss to a 15.0% loss. The shade loss was normalized based on an expected 10% difference in the shading for each home type, such that a typical 1) *Low Shade* home would have 5% shade loss, a 2) *Moderate Shade* home would have a 15% shade loss, and a 3) *High Shade* home would have a 25% shade loss. In roughly equal proportions, the typical home would therefore have a shade loss of 15%. This is of course a subjective decision, and final shade loss will likely vary by +/- 5%. The proportion of shade loss was adjusted to meet a 15% loss by dividing the shade loss in **Table 7** by 15/16.7, or 0.898. The 15% adjusted shade loss is shown in **Table 7**.

***Table 7**: Shade loss percentage for the moderate shade home, normalized to 15% shade loss*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg
Tree Loss (%)	61.6	79.6	86.6	91.7	90.4	91.2	91.3	91.6	91.0	82.7	72.2	53.8	82.0

Adjustment for Deciduous Trees:

Finally, while Helioscope has an option for trees, the program does not factor in additional sunlight from deciduous trees when the leaves have fallen. Trees in northern Wisconsin have no leaves on them between November to April. For these months, the Solar Pathfinder Manual (2016) recommends that tree shading losses be cut in half for the non-bearing months. The deciduous adjustment was only made for January, February, March, November, and December, and was capped at a total loss percent of 91.7%. The final results for shading on a typical home are shown in **Table 8**.

***Table 8**: Shade loss percentage for the moderate shade home at 15% shade loss, and adjusted for deciduous tree shade*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg
Tree Loss (%)	80.8	89.8	91.7	91.7	90.4	91.2	91.3	91.6	91.0	82.7	86.1	76.9	87.9

In total, anticipated tree shade loss for a typical home is modeled to be 11% of total production.

4.4 – Snow Shade Analysis:

Snow shade losses were modeled after Heidari et al. (2015), which performed snow loss modeling in the Upper Peninsula of Michigan at different tilt angles. The study found that a tilt angle of 45 degrees resulted in an annual production loss of 5%, compared to 10% at a tilt angle of 30 degrees. While FCPC currently lacks comprehensive access to its solar PV production data, the ballasted roof mount arrays generally sit under snow cover for close to the entire winter season, however these arrays sit at a tilt of only about 10 degrees, and have no place to shed snow. In Heidari et al. (2015), systems called “obstructed” had yearly energy losses around 30%, which are similar to ballasted roof mounts. The study area however received a 5 year average snowfall of 181 inches, which is more than double the 81 inches that FCPC receives per year. In order to conservatively model snow loss, the FCPC Energy Department assumes slightly lower the annual snow loss figures than presented by Heidari et al. (2015) at 9.8% for the 30 degree tilt standard roof mount system, presented in **Table 9**, and at 4.4% for the 45 degree tilt standard ground mount system, presented in **Table 10**. These results are estimated based on snowfall to reach the annualized loss percentages, as the study does not state monthly loss values.

***Table 9**: Modeled snow loss for the 10 kW standard roof mount system*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg Gen
Snow Loss (%)	40	30	15	10	0	0	0	0	0	5	20	40	9.8

***Table 10**: Modeled snow loss for the 10 kW standard ground mount system.*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg Gen
Snow Loss (%)	20	15	10	0	0	0	0	0	0	0	5	15	4.4

<u>4.5 – Azimuth Loss</u>:

While the FCPC Energy Department would prefer to mount every solar array at a 180 degree azimuth, it is unrealistic to assume that this will actually happen. Azimuth angle may need to be adjusted to avoid tree shading, or to form better with a landscape. For roof mounted arrays, the azimuth angle is fixed, and usually does not face a perfect 180 degrees. In addition, the final location of each ground mounted array must be decided on with the homeowner, who will want to prioritize aesthetics and may want the array in a less than optimal location. The FCPC Energy Department will prioritize arrays that are within 45 degrees of due south to optimize generation, particularly in winter months. Azimuth losses were estimated for array generation at either 135 degree azimuth (SE), or a 225 degree azimuth (SW) in equal proportions. The FCPC Energy Department will not select an azimuth greater than 90 degrees from 180, as these orientations significantly reduce solar production.

Solar PV production for the standard 10 kW roof mount system is shown in **Table 11** below. Note that negative loss values represent higher generation compared to a 180 degree azimuth. Total modeled loss for the standard 10 kW roof mount system is 6.5%.

***Table 11**: Azimuth loss for the standard 10 kW roof mount system*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total Gen
180 deg	668	917	1,290	1,315	1,381	1,308	1,437	1,350	1,195	884	642	591	12,978
225 deg	554	812	1,190	1,269	1,345	1,319	1,424	1,304	1,127	799	541	478	12,162
135 deg	554	779	1,189	1,249	1,396	1,303	1,430	1,321	1,096	768	538	483	12,106
Avg	**554**	**796**	**1,190**	**1,259**	**1,371**	**1,311**	**1,427**	**1,313**	**1,112**	**784**	**540**	**481**	**12,134**
% Loss	**17.1**	**13.2**	**7.8**	**4.3**	**0.8**	**-0.2**	**0.7**	**2.8**	**7.0**	**11.4**	**16.0**	**18.7**	**6.5**

Solar PV production for the standard 10 kW ground mount system is shown in **Table 12** below. Note that negative loss values represent higher generation compared to a 180 degree azimuth. Total modeled loss for the standard 10 kW ground mount system is 5.4%.

***Table 12**: Azimuth loss for the standard 10 kW ground mount system*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total Gen
180 deg	787	1,057	1,445	1,395	1,324	1,242	1,378	1,331	1,232	955	722	689	13,557
225 deg	653	941	1,374	1,385	1,344	1,315	1,420	1,330	1,170	840	586	562	12,920
135 deg	656	898	1,356	1,361	1,401	1,293	1,431	1,338	1,117	794	584	574	12,803

Avg	**655**	**920**	**1,365**	**1,373**	**1,373**	**1,304**	**1,426**	**1,334**	**1,144**	**817**	**585**	**568**	**12,862**
% Loss	**16.8**	**13.0**	**5.5**	**1.6**	**-3.7**	**-5.0**	**-3.4**	**-0.2**	**7.2**	**14.5**	**19.0**	**17.6**	**5.4**

<u>4.6 – Total System Losses</u>:

Total system losses for the standard 10 kW roof mount system are estimated to be 23.8%, which is shown in **Table 13**.

***Table 13**: Summary of total system losses for the standard 10 kW roof mount system*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total Gen
Azimuth	17.1	13.2	7.8	4.3	0.8	-0.2	0.7	2.8	7.0	11.4	16.0	18.7	6.5
Snow	40.0	30.0	15.0	10.0	0.0	0.0	0.0	0.0	0.0	5.0	20.0	40.0	9.8
Tree	19.2	10.2	8.3	8.3	9.6	8.8	8.7	8.4	9.0	17.3	13.9	23.1	12.1
Tot. Loss	**59.8**	**45.5**	**28.1**	**21.0**	**10.3**	**8.6**	**9.3**	**11.0**	**15.3**	**30.4**	**42.1**	**62.5**	**23.8**
Base Gen (kWh)	668	917	1,290	1,315	1,381	1,308	1,437	1,350	1,195	884	642	591	12,978
Adj. Gen (kWh)	**269**	**500**	**928**	**1,039**	**1,239**	**1,196**	**1,303**	**1,202**	**1,012**	**615**	**372**	**222**	**9,895**

Total system losses for the standard 10 kW ground mount system are estimated to be 18.6%, which is shown in **Table 14**.

***Table 14**: Summary of total system losses for the standard 10 kW ground mount system*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total Gen
Azimuth	16.8	13.0	5.5	1.6	-3.7	-5.0	-3.4	-0.2	7.2	14.5	19.0	17.6	5.4
Snow	20.0	15.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	15.0	4.4
Tree	19.2	10.2	8.3	8.3	9.6	8.8	8.7	8.4	9.0	17.3	13.9	23.1	12.1
Tot. Loss	**46.2**	**33.6**	**22.0**	**9.7**	**6.3**	**4.2**	**5.6**	**8.2**	**15.5**	**29.3**	**33.7**	**46.1**	**18.6**
Base Gen (kWh)	787	1,057	1,445	1,395	1,324	1,242	1,378	1,331	1,232	955	722	689	13,557
Adj. Gen (kWh)	**423**	**702**	**1,127**	**1,260**	**1,241**	**1,189**	**1,301**	**1,221**	**1,041**	**675**	**479**	**371**	**11,030**

Section 5: System Sizing

<u>5.1 – Average Home Electricity Use</u>:

Data was cleaned from the DOE First Steps grant baseline energy usage, such that only fully occupied homes with a full 24 months of electricity use were included in the final baseline dataset. Of the 117 homes that were audited, 91 homes had a full 24 months of data available. The results are shown in **Figure 21**. Average home electricity use is 926 kWh per month, or 11,107 kWh per year. The highest energy use month was December, with 1,141 kWh, and the lowest energy use month was April, with 857 kWh. At the 84th percentile, average home electricity use is 1,459 kWh per month, or 17,509 kWh per year. At the 16th percentile, average home electricity use is 392 kWh per month, or 4,705 kWh per year. Energy use peaks in mid-summer and mid-winter. The summer peak in electricity use is likely due to air conditioning, while the winter peak is likely due to electric heating. Given the variation in energy use, solar array size is going to vary considerably based on which home is receiving a solar array.

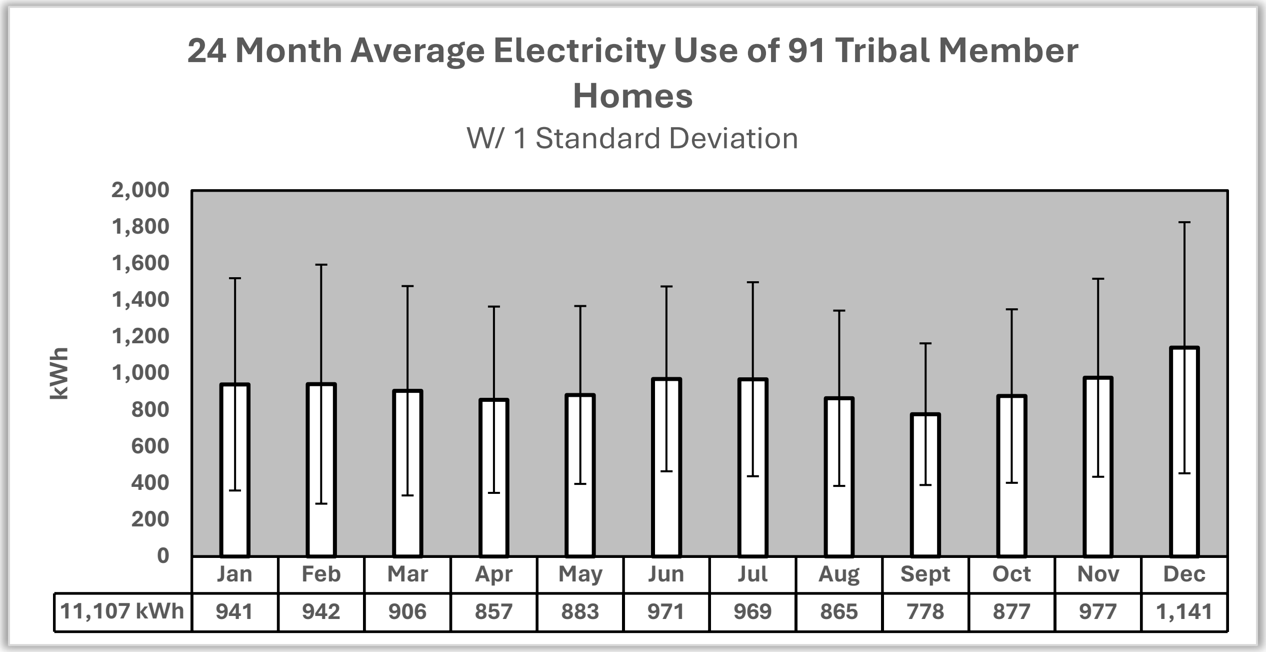

***Figure 21**: 24 month average electricity use of 91 tribal member homes*

<u>5.2 – Average Electric Vehicle Electricity Use</u>:

Electric vehicle electricity use is based on the average mileage traveled per day, and the efficiency of the electric vehicle. As presented in Section 2.2, the average miles traveled by the average Tribal member is 37.0 miles per day, or 13,505 miles per year.

Average fuel economy of an electric vehicle is more difficult to estimate. While Tesla currently dominates the landscape of electric vehicles, during the period of analysis between 2026 and 2050, the landscape for electric vehicle options is going to look considerably different than it does now. In order to estimate the average fuel economy of an electric vehicle, the FCPC Energy Department visited FuelEconomy.gov, and filtered all vehicle models with all electric engines for the model year 2023 (FuelEconomy.gov, 2023B). The fuel economy of multiple trims was averaged for each vehicle model. The FCPC Energy Department then took the average of each vehicle model for each vehicle class. There were no all electric minivans listed, so the fuel economy of the plug-in hybrid Chrysler Pacifica was used as a substitute, which is the only plug-in hybrid minivan. Similarly, there were only 2 trucks listed as all electric. The proportion of vehicles is based on a survey of new car sales in Wisconsin between June 2021 and May 2022 performed by iSeeCars.com (2023). Based on this analysis, the average vehicle mileage is 2.68 miles / kWh, which is shown in **Table 15**.

Table 15: *Estimated of average electric vehicle fuel economy*

Vehicle	# Models	Miles / kWh	Proportion	Weighted
Car	18	3.05	0.278	0.85
SUV	14	2.78	0.473	1.31
Minivan	1	2.43	0.036	0.09
Truck	2	2.02	0.213	0.43
Total	35		1.00	**2.68**

Based on this result, the average electric vehicle will use 5,039 kWh per year. However, the total electric use of an electric vehicle will not all be charged at home. NREL (2021) recommends that a value of 80% be used for home charging, and thus the anticipated load is 4,031 kWh per year, or 11.04 kWh per day.

5.3 – System Sizing:

System sizing was performed for homes without electric vehicles and for homes with electric vehicles. Combined with the standard system types, this results in 4 different array types:

1. Roof Mount – No EV
2. Roof Mount – With EV
3. Ground Mount – No EV
4. Ground Mount – With EV

The FCPC Energy Department set a goal to minimize sellback to 2.5% or less of the average energy use of a home. Different system sizes were explored based on the manipulation of the standard 10 kW roof and ground mount systems to optimize solar PV generation and utilization. The FCPC Energy Department settled on 2 average system sizes, one for a home without an electric vehicle, and a second size for a home with an electric vehicle. Ultimately, the FCPC Energy Department decided on a size of 7.25 kW for the average home without an EV, and 10.25 kW for a home with an EV, which is a 3 kW upgrade. The system sizes are presented below.

7.25 kW Roof Mount – No EV:

The 7.25 kW roof mount array will generate 7,174 kWh in the first year, and will sell back 21 kWh, or 0.3%. This will offset 64.4% of the average home's electricity use of 11,107 kWh, and 64.6% including sellback. The results are shown in **Figure 22**.

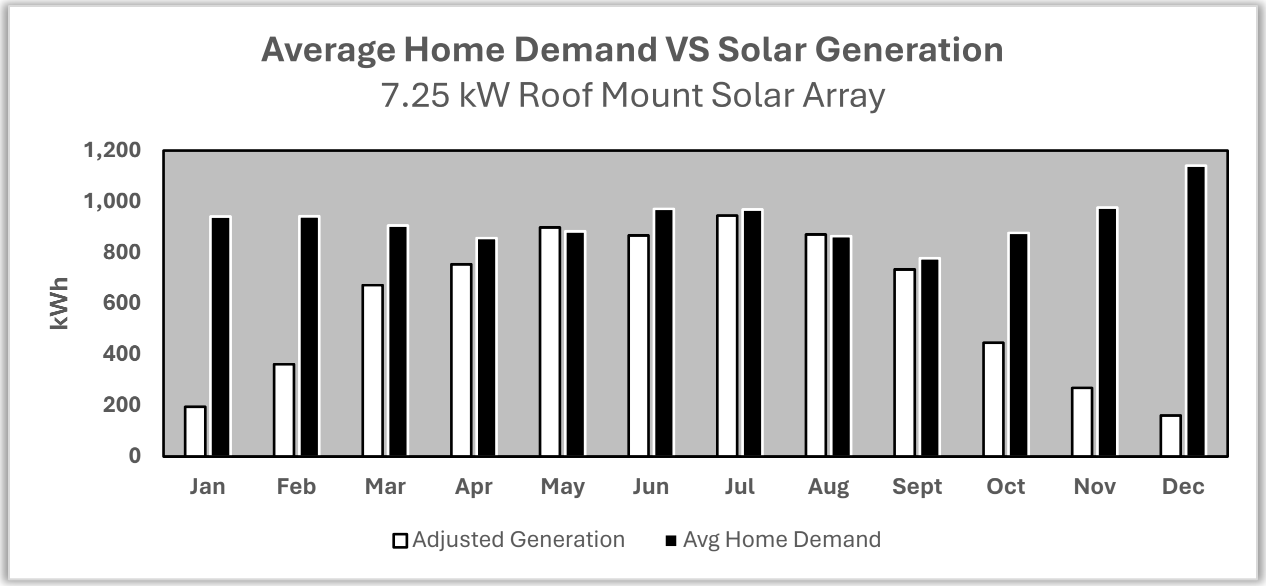

Figure 22*: 7.25 kW roof mount system generation vs home demand*

<u>10.25 kW Roof Mount – With EV</u>:

The 10.25 kW roof mount array will generate 10,142 kWh in the first year, and will sell back 93 kWh, or 0.9%. This will offset 64.4% of the average home's electricity use plus EV use of 15,138 kWh, and 67.0% including sellback. The results are shown in **Figure 23**.

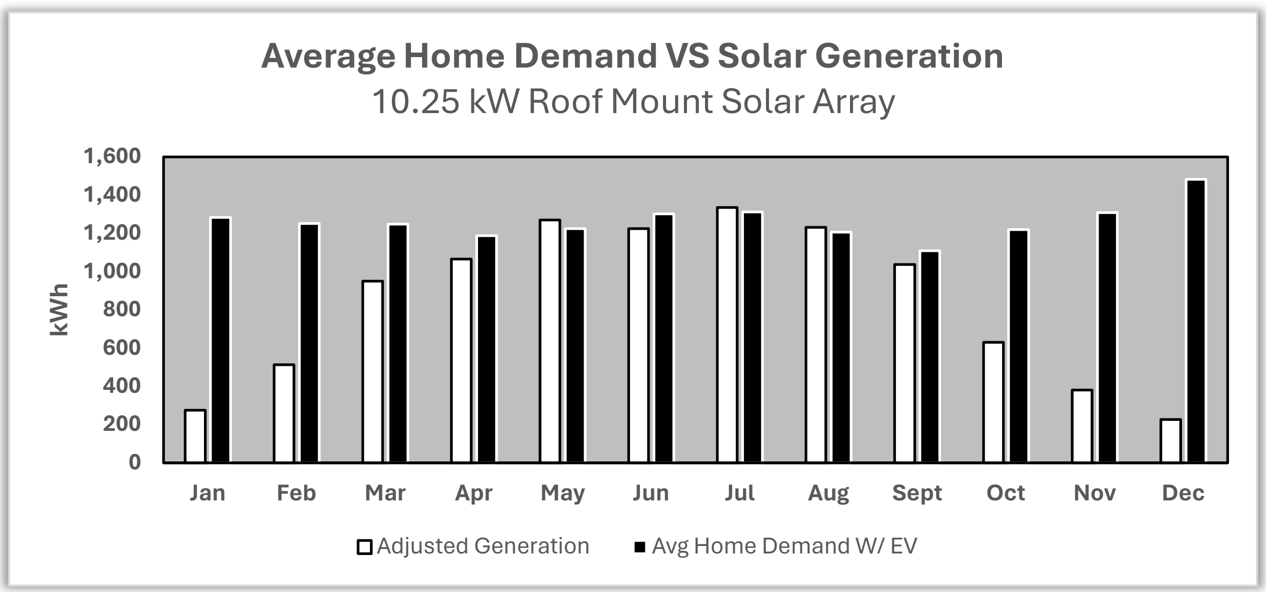

Figure 23*: 10.25 kW roof mount system generation vs home demand*

<u>7.25 kW Ground Mount – No EV</u>:

The 7.25 kW ground mount array will generate 7,997 kWh in the first year, and will sell back 93 kWh, or 1.2%. This will offset 71.3% of the average home's electricity use of 11,107 kWh, and 72.0% including sellback. The results are shown in **Figure 24**.

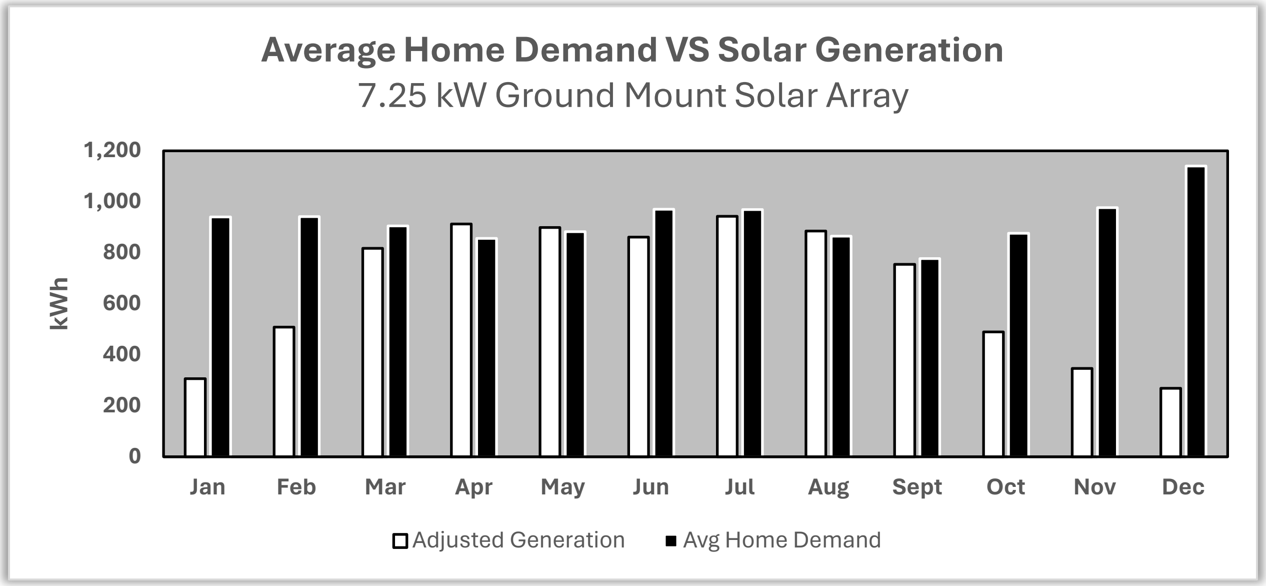

Figure 24*: 7.25 kW ground mount system generation vs home demand*

<u>10.25 kW Ground Mount – With EV</u>:

The 10.25 kW ground mount array will generate 11,306 kWh in the first year, and will sell back 216 kWh, or 1.9%. This will offset 73.9% of the average home's electricity use plus EV use of 15,138 kWh, and 74.7% including sellback. The results are shown in **Figure 25**.

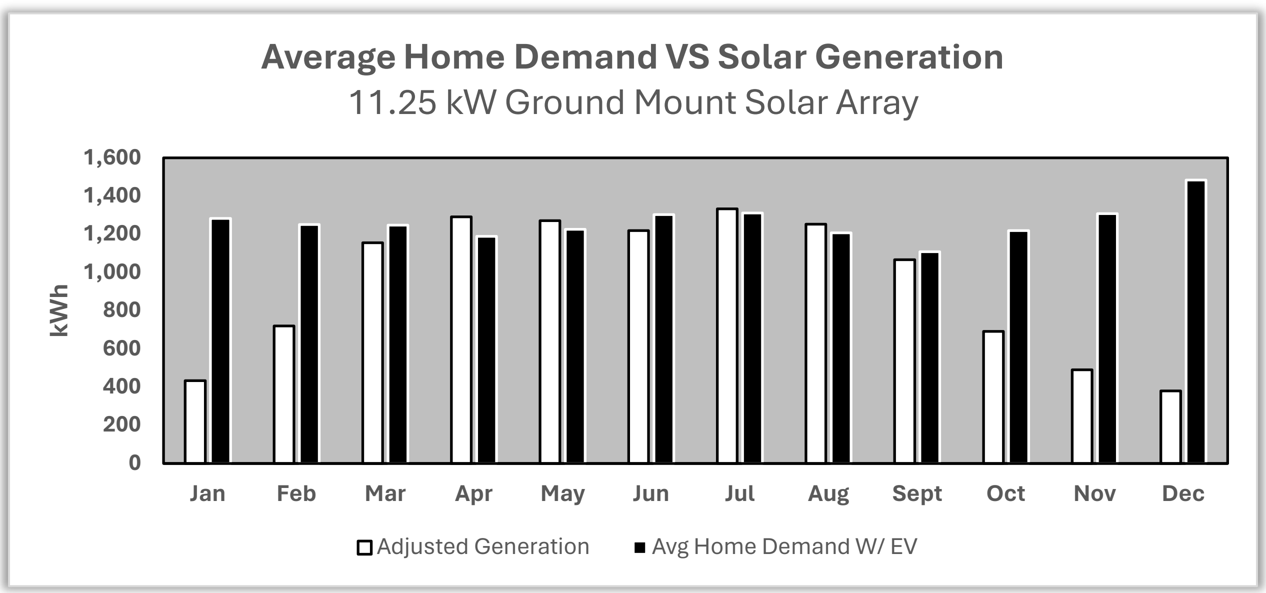

Figure 25*: 10.25 kW ground mount system generation vs home demand*

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Study for:

FCPC Potawatomi Bingo Casino and Potawatomi Hotel Level 3 Energy Audit Project

Forest County Potawatomi Community

1721 West Canal Street City, Milwaukee, WI, 53233

Michaels No.: FD424AAN

Prepared by: Ayush Gupta & Chuck Hanson

Contents

Executive Summary

This report includes the results of an ASHRAE level III energy audit study for the Forest County Community dba Potawatomi Bingo Casino Hotel. The primary purpose of the study was to develop a list of energy efficiency measures (EEMs) and heat decarbonization measures (HDMs) for the facility, in preparation for the two EPA grants. This report shows our findings and discusses the measures that were identified during the study.

Table 1. Measure Summary Table

EEM Measure Package

Number	EEM Name	Total Cost[1]	Total Savings	Payback	2025 to 2030 Cumulative kg CO2 Offset	2025 to 2030 Cost of Carbon Offset ($/kg CO2)	2025 to 2050 Cumulative kg CO2 Offset	2025 to 2050 Cost of Carbon Offset ($/kg CO2)
1	Retrofit LED Lighting Fixtures in Mechanical Spaces	$101,000	$7,256	13.9	122,676	$0.82	179,949	$0.56
2	Optimize DCV Controls for Major Restaurants	$23,000	$13,691	1.7	535,271	$0.04	2,231,694	$0.01
3	Add Unoccupied Setbacks for Major Restaurants and Kitchens	$37,000	$34,583	1.1	1,132,925	$0.03	4,026,035	$0.01
4	Install Efficient Air Distribution System in Gaming Space	$6,476,000	$563,610	11.5	16,309,574	$0.40	56,131,001	$0.12
5	Upgrade Server Rooms UPS's and Cooling Units	$1,823,000	$58,977	30.9	1,134,603	$1.61	2,332,240	$0.78
6	Install Heat Recovery Loop to Toilet, General and Vapor Exhausts	$938,000	$27,670	33.9	1,513,765	$0.62	7,686,163	$0.12
7	Optimize Kettle and Dishwashing Unit Steam Operation	$1,420,000	$9,476	149.9	390,597	$3.64	1,692,588	$0.84
8	Consolidate Kitchen Hood Exhaust Operation	$77,000	$7,064	10.9	284,053	$0.27	1,209,356	$0.06
	Total	**$10,895,000**	**$722,327**	**15.1**	**21,423,465**	**$0.51**	**75,489,027**	**$0.14**

[1]Total cost includes design fee

HDM Measure Package

Number	HDM Name	Total Cost[1,2]	Total Savings	Payback	2025 to 2030 Cumulative kg CO2 Offset	2025 to 2030 Cost of Carbon Offset ($/kg CO2)	2025 to 2050 Cumulative kg CO2 Offset	2025 to 2050 Cost of Carbon Offset ($/kg CO2)
1	Install Solar Thermal Hot Water System	$23,598,000	$115,051	205.1	4,825,692	$4.89	21,077,156	$1.12
2	Install Heat Recovery Chillers	$33,870,000	$323,413	104.7	14,168,765	$2.39	63,925,942	$0.53
3	Electrify Kitchen Appliances	$14,624,000	$72,215	202.5	5,018,578	$2.91	27,910,731	$0.52
4	Install a Solar PV Array on Parking Garage	$6,340,000	$151,280	41.9	2,399,886	$2.64	4,933,099	$1.29
	Total	**$78,432,000**	**$661,958**	**118.5**	**26,412,921**	**$2.97**	**117,846,927**	**$0.67**

[1]Total cost includes design fee
[2]Grant not included in total

Figure 1 compares the building's current energy consumption to the estimated consumption after recommended measures have been implemented.

Figure 1. Energy Consumption Comparison

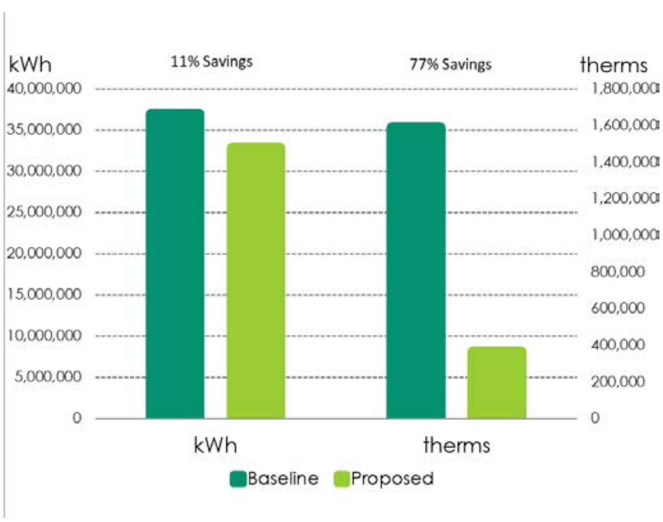


Table 2. Proposed Measures Results Summary

	kWh	Therms	kg CO2*
Baseline (2023)	36,906,943	1,589,092	22,597,016
Proposed Package	32,704,879	274,984	1,454,667
Percent Reduction	**11%**	**83%**	**94%**

*Baseline for CO2 emissions are from 2023 and proposed emissions are from 2050.

Table 3. Measure Package Selected for Implementation

EEM Measure Package

Number	EEM Name	Total Cost[1]	Total Savings	Payback	2025 to 2030 Cumulative kg CO2 Offset	2025 to 2030 Cost of Carbon Offset ($/kg CO2)	2025 to 2050 Cumulative kg CO2 Offset	2025 to 2050 Cost of Carbon Offset ($/kg CO2)
1	Retrofit LED Lighting Fixtures in Mechanical Spaces	$101,000	$7,256	13.9	122,676	$0.82	179,949	$0.56
2	Optimize DCV Controls for Major Restaurants	$23,000	$13,691	1.7	535,271	$0.04	2,231,694	$0.01
3	Add Unoccupied Setbacks for Major Restaurants and Kitchens	$37,000	$34,583	1.1	1,132,925	$0.03	4,026,035	$0.01
5	Upgrade Server Rooms UPS's and Cooling Units	$1,823,000	$58,977	30.9	1,134,603	$1.61	2,332,240	$0.78
6	Install Heat Recovery Loop to Toilet, General and Vapor Exhausts	$938,000	$27,670	33.9	1,513,765	$0.62	7,686,163	$0.12
8	Consolidate Kitchen Hood Exhaust Operation	$77,000	$7,064	10.9	284,053	$0.27	1,209,356	$0.06
	Total	**$2,999,000**	**$149,241**	**20.1**	**4,723,294**	**$0.63**	**17,665,438**	**$0.17**

[1]Total cost includes design fee

HDM Measure Package

Number	HDM Name	Total Cost[1,2]	Total Savings	Payback	2025 to 2030 Cumulative kg CO2 Offset	2025 to 2030 Cost of Carbon Offset ($/kg CO2)	2025 to 2050 Cumulative kg CO2 Offset	2025 to 2050 Cost of Carbon Offset ($/kg CO2)
2	Install Heat Recovery Chillers	$33,870,000	$323,413	104.7	14,168,765	$2.39	63,925,942	$0.53
3	Electrify Kitchen Appliances	$14,624,000	$72,215	202.5	5,018,578	$2.91	27,910,731	$0.52
4	Install a Solar PV Array on Parking Garage	$6,340,000	$151,280	41.9	2,399,886	$2.64	4,933,099	$1.29
	Total	**$54,834,000**	**$546,907**	**100.3**	**21,587,229**	**$2.54**	**96,769,771**	**$0.57**

[1]Total cost includes design fee
[2]Grant not included in total

Disclaimer: The purpose of this study is to identify energy and/or maintenance saving measures and quantify their cost effectiveness. This investigative study does not include comprehensive functional testing of equipment and components and therefore, some deficiencies have likely gone unnoticed. Some of these unnoticed deficiencies may be discovered during implementation or testing of the projects recommended in this report. Such deficiencies should be remedied at Forest County Community dba Potawatomi Bingo Casino's expense, particularly if they substantially affect energy savings. Any use of information in this report by Forest County Community dba Potawatomi Bingo Casino, its agents, or any third parties is the sole responsibility of those parties. Michaels Energy accepts no responsibility, duty of care, or liability for any use by those parties for loss or damages of any kind because of decisions made or actions taken or not taken, based on this document.

1 Introduction

Identification Page

Owner	Forest County Community dba Potawatomi Bingo Casino Hotel
Address	1721 West Canal Street
City	Milwaukee State WI Zip 53233
Contact Person	Jerry Hauber
Title	Energy Manager
Telephone	715.889.6043
Telephone	1.800.729.7244

Energy Suppliers

Electricity	WE Energies
Natural Gas	WE Energies

Energy Analyst and Technical Support Personnel

Firm Name	Michaels Energy
Analyst's Name	Bob Ford
Support Person	Ayush Gupta
Support Person	Chuck Hanson
Telephone	872.444.4597

Firm Name	HGA
Analyst's Name	Russell Knudson
Support Person	Michael Barnett
Telephone	608.554.5331

2 Building Description

2.1 Occupancy Patterns

The Potawatomi Casino sees 12,000 to 15,000 people each day, Monday-Thursday, and 18,000 to 20,000 people each day, Friday-Sunday. The Potawatomi Hotel usually has a 90 percent occupancy every night, as per the facility management team.

2.2 Heating Plant

The heating system consists of five natural gas boilers that also operate with variable primary flow. The design system temperatures of this system are roughly 180/160°F. Originally, the boilers did not have stack gas heat recovery and the boiler exhaust gases were vented to the exterior of the building without any heat recovery. As part of the ASHRAE level II audit in March 2023, a boiler economizer was recommended to be installed so that it would capture some of the heat from the exhaust gases and pre-heat the incoming hot water for the casino's domestic hot water system which is in the same mechanical room.

The hotel has a snow melt system that is tied to the central heating system and operates to maintain the valet areas as well as the entrance to the casino. The snowmelt pumps are enabled for the season and run continuously until the end of the season. Due to implementation of the ASHRAE level II audit in March 2023, this system will be controlled based on predicted weather forecasts.

The hotel's heating loop is separated from the building's main heating loop by plate and frame heat exchangers. The heating loop in the hotel uses treated water.

There are two steam boilers that serve the level 1 kitchen kettles and two dishwashers throughout the day in a lead-lag configuration.

2.3 Cooling Plant

The central chilled water plant consists of (8) 700-ton water-cooled centrifugal chillers that operate above 52°F external temperature. Two air-cooled chillers, 500-ton and 350-ton capacity, operate between 52°F and 17°F, and finally, a 100-ton dry cooler operates to serve the load below 17°F. The chiller plant operates with a variable primary flow of 30% ethylene glycol, that is balanced between two plants by 10 chilled water pumps, depending on the needs of the building and the outside air conditions. All cooling equipment is controlled via a Trane control system that is also integrated into the central building automation system (BAS).

Currently, the system appears to maintain a constant 42°F chilled water supply temperature set point year-round. This system also appears to maintain a differential pressure set point of 14 PSI throughout both the heating and cooling season as well. As part of the ASHRAE level II audit in March 2023, a chilled water supply temperature reset was recommended to be installed on this system which will reset the chilled water temperature set point as high as 50ºF. Magnetic bearing chillers will be installed as part of the implementation process of this level II audit.

The three centrifugal chillers that were installed in 2000 in the old East chiller plant are close to the end of their useful life.

The hotel's cooling loop is separated from the building's main cooling loop and uses treated water.

2.4 Air Handling Equipment

There are roughly 55 RTUs and 30 AHUs in the building that bring primary air, make-up air, and ventilation to the casino, hotel, back-of-house operations, and all other operations like retail and kitchens. See table-9 in Appendix C for the list of air handling equipment will be impacted by the measures discussed in this study. Also see table-11 for observations or deficiencies in this equipment list, that could affect the impact of these measures.

2.5 Domestic Hot Water

The domestic hot water is served from the central boiler system through double-wall heat exchangers and storage tanks located throughout the facility. The domestic hot water system for the casino is in the same mechanical room as the boiler system.

2.6 Lighting

Most of the building lighting fixtures in the hotel and casino have been upgraded to LED fixtures. The building has four major mechanical spaces that have fluorescent lamp fixtures (T8s/T12s). A small portion of the hotel guest rooms have 23-Watt CFL bulbs instead of LEDs.

3 Building Energy Use and Fuel Cost Information

3.1 Building Energy Use and Fuel Cost Information

In this section, we provide a breakdown of your fuel usage and how that fuel is being used throughout the year.

Table 4, 3, and 4 show the current facility energy use (electricity and natural gas) and costs on a monthly and annual basis. They include the following:

- Energy use and cost for 2023[1]
- Fuel cost and energy intensity for each fuel type

As of 2023, your facility's emissions associated with energy use are equivalent to 22.59 MKg of carbon dioxide (CO2e) each year.

Table 4. Electric Energy Use and Cost

Month	Total kWh	Demand kW	Load Factor	Total Cost
January	2,811,321	4,103	92%	**$ 249,078**
February	2,603,021	4,282	90%	**$ 242,444**
March	2,859,204	4,153	93%	**$ 254,304**
April	2,821,459	4,773	82%	**$ 263,434**
May	2,892,268	5,120	76%	**$ 274,684**
June	3,030,926	5,025	84%	**$ 322,915**
July	3,461,545	5,894	79%	**$ 365,014**
August	3,618,820	6,852	71%	**$ 405,381**
September	3,570,435	5,847	85%	**$ 374,501**
October	3,251,405	5,309	82%	**$ 302,013**
November	3,197,853	4,854	92%	**$ 286,540**
December	2,788,686	4,557	82%	**$ 245,672**
Total	**36,906,943**			**$ 3,585,980**

[1] Due to the data provided from the customer, December energy use and cost have been taken from 2022 utility usage.

Table 5. Gas Energy Use and Cost

Month	Total Therms		Total Cost
January	177,157	$	**163,972**
February	154,097	$	**132,753**
March	155,507	$	**130,655**
April	124,070	$	**51,535**
May	105,011	$	**40,444**
June	89,132	$	**35,299**
July	97,455	$	**38,893**
August	102,009	$	**38,346**
September	110,846	$	**39,195**
October	129,485	$	**48,717**
November	159,441	$	**76,892**
December	184,882	$	**172,515**
Total	**1,589,092**	**$**	**969,216**

Table 6. Energy Use Intensity

Energy Use Metrics			
Electric Average Cost	$	0.10	$ / kWh
Electric Energy Intensity		27.8	kWh / ft^2
Gas Average Cost	$	0.61	$ / therm
Gas Fuel Intensity		1.2	therm / ft^2

3.2 Historical Energy Use

The facility's historical energy use profiles below are used to determine general trends in energy consumption.

Figure 2. Annual Electric Use Profile

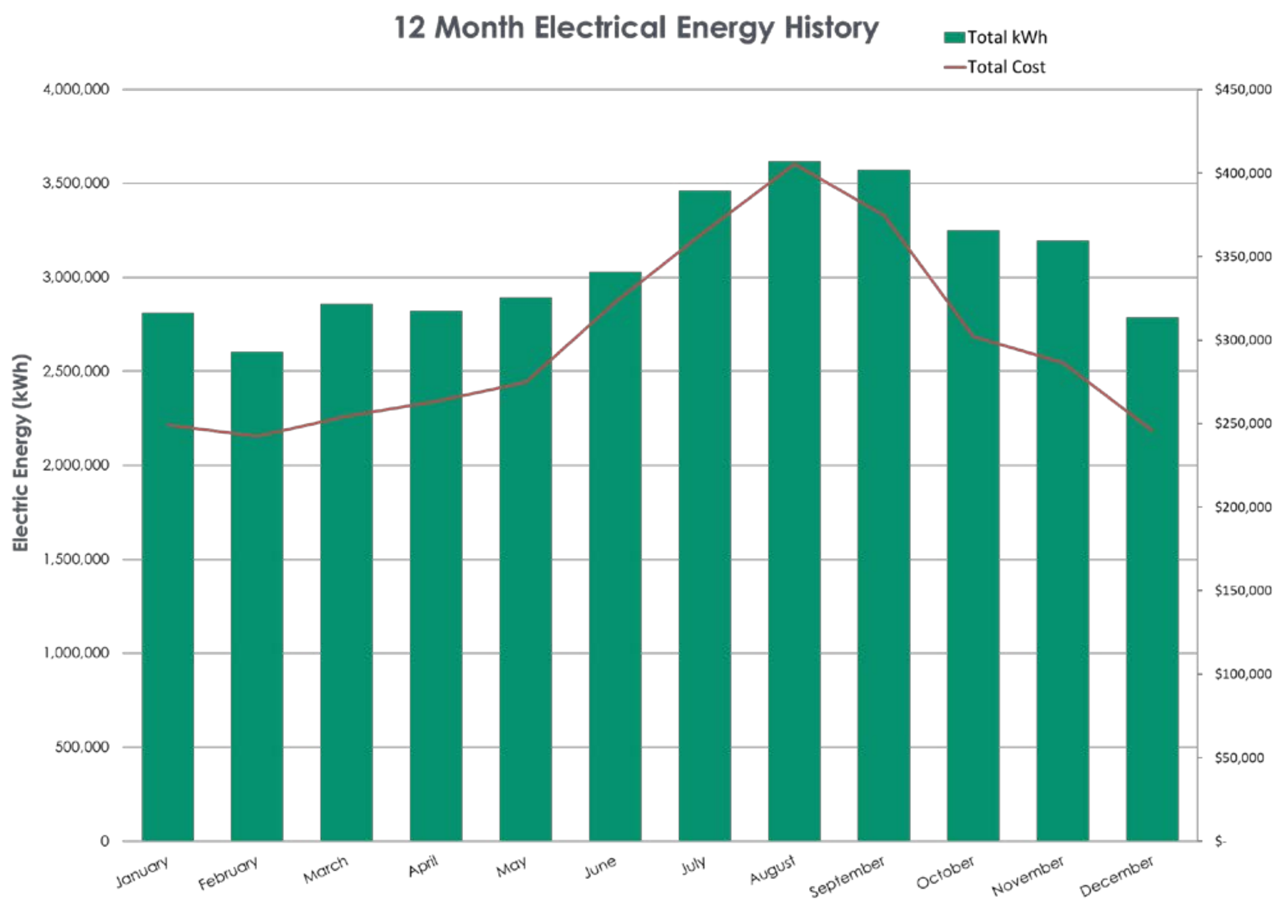


Figure 3. Annual Electric Demand Profile

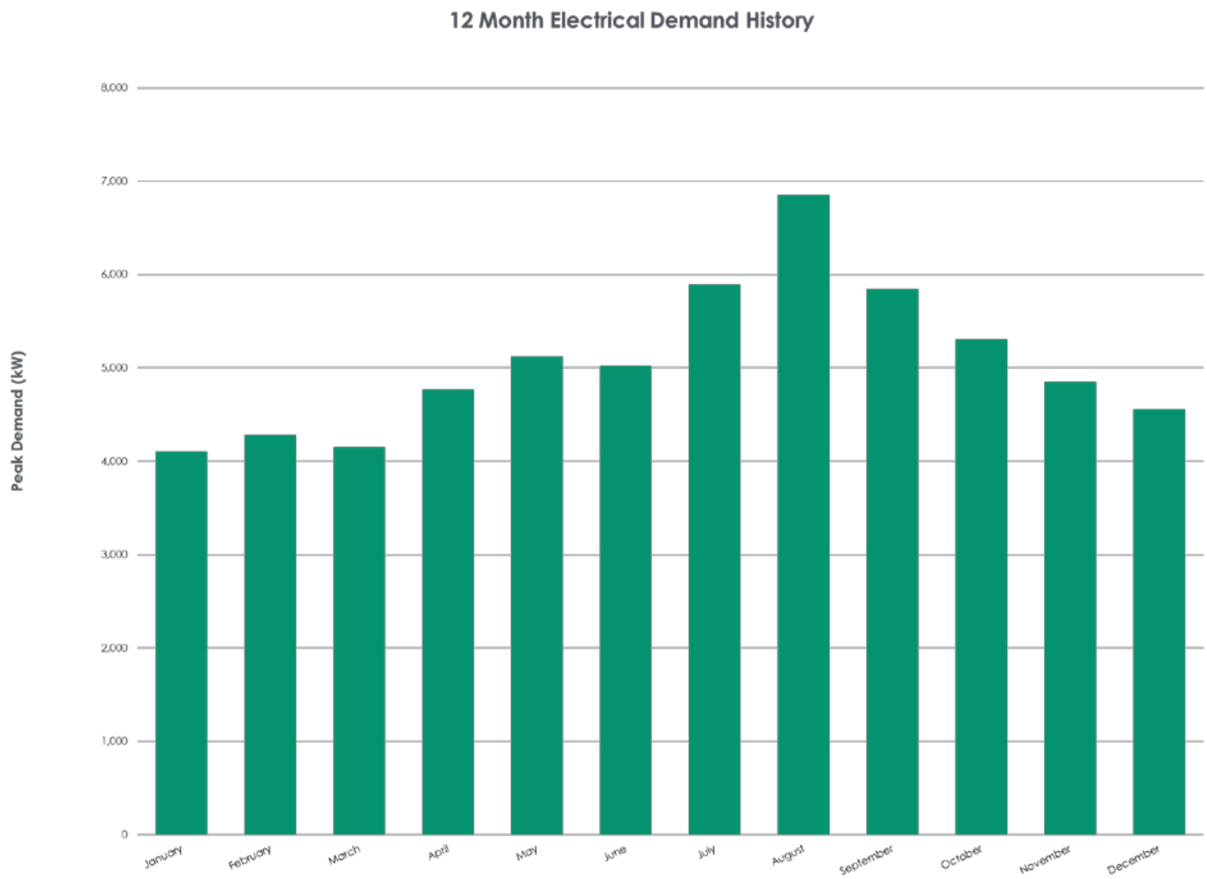
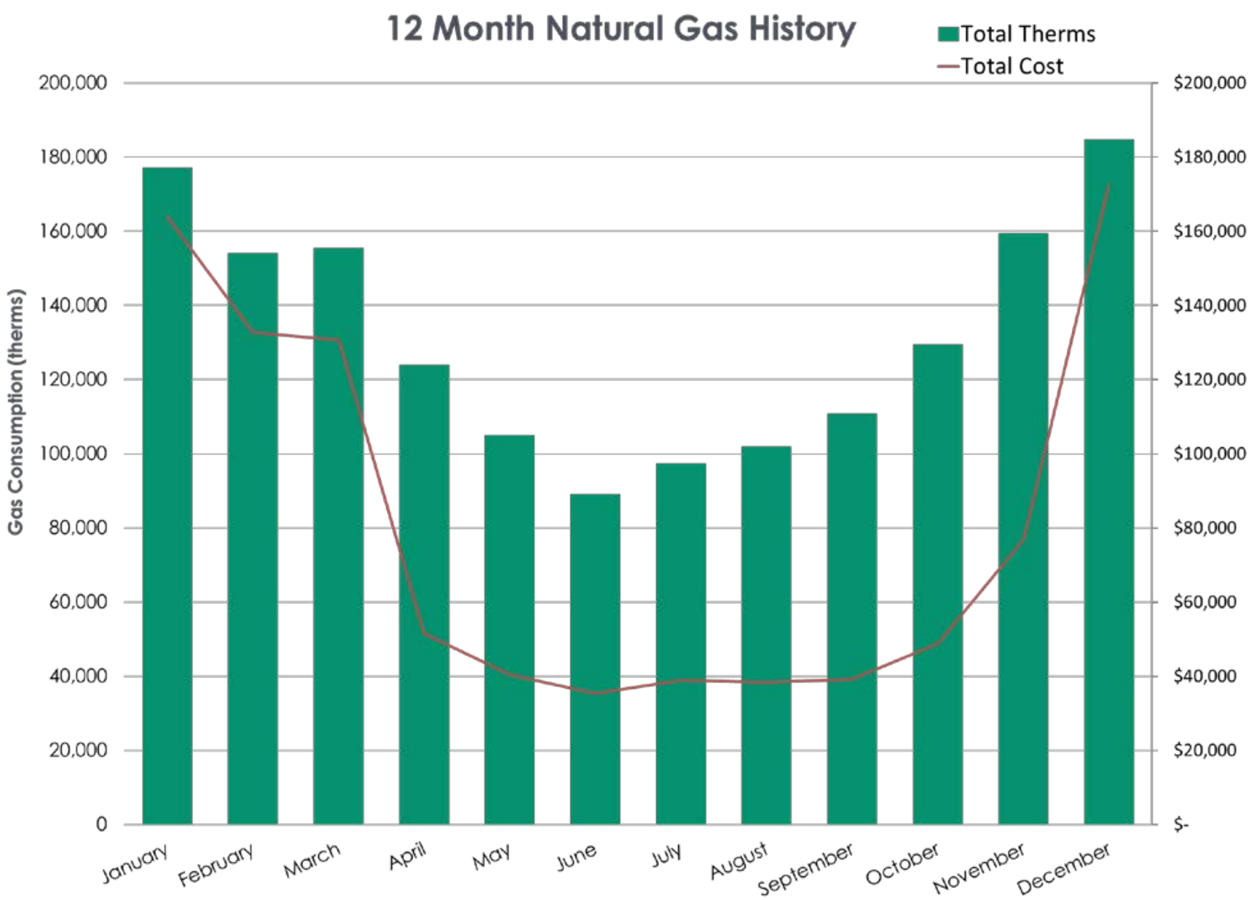


Figure 4. Annual Natural Gas Profile



3.3 End Use of Energy

The estimated end use of energy by major energy using system is presented in Table 7 and 8 and in Figure 5 and Figure 6. This information is used in determining the areas of primary emphasis for energy conservation activities, and in estimating the savings from the implementation of building and system modifications.

Table 7. End Use of Electricity

Electricity	kWh	Annual Cost	% of Electrical Energy Use
Fans	8,330,650	$ 809,429	23%
Casino Gaming	8,234,400	$ 800,077	22%
Miscellaneous	6,607,892	$ 642,041	18%
Air Conditioning	5,831,000	$ 566,556	16%
Lighting	4,712,414	$ 457,871	13%
Pumps	3,190,587	$ 310,006	9%
Totals	**36,906,943**	**$ 3,585,980**	**100%**

Figure 5. Electrical End Use

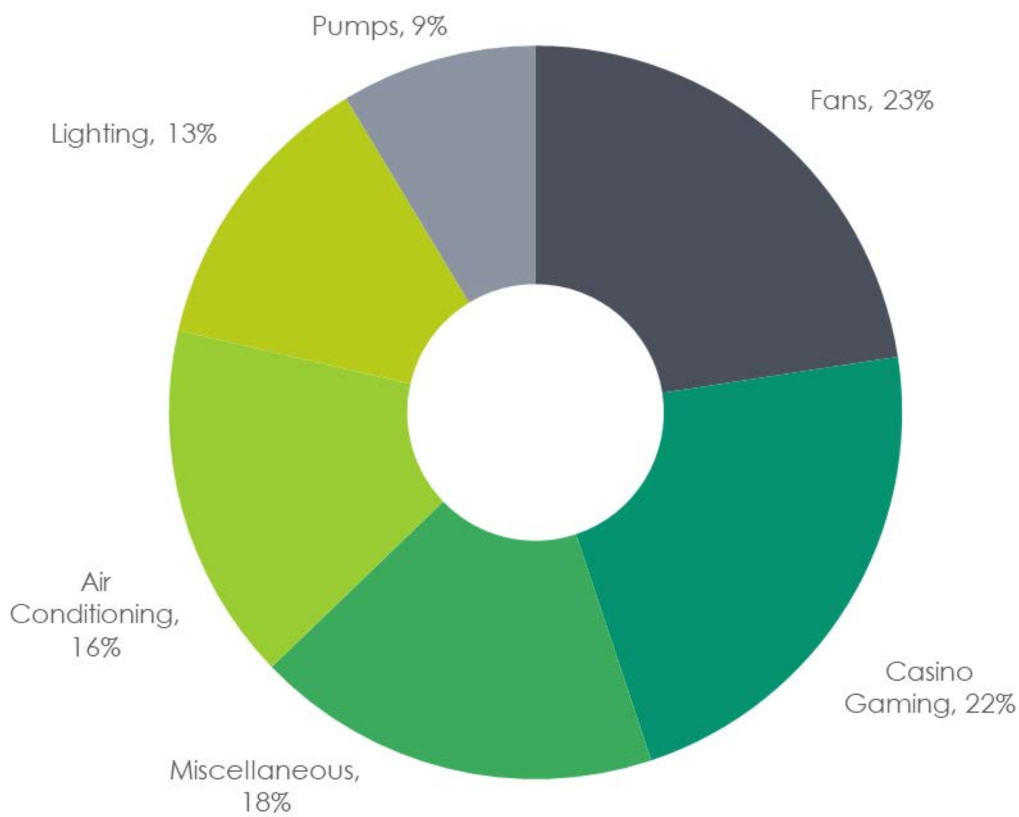
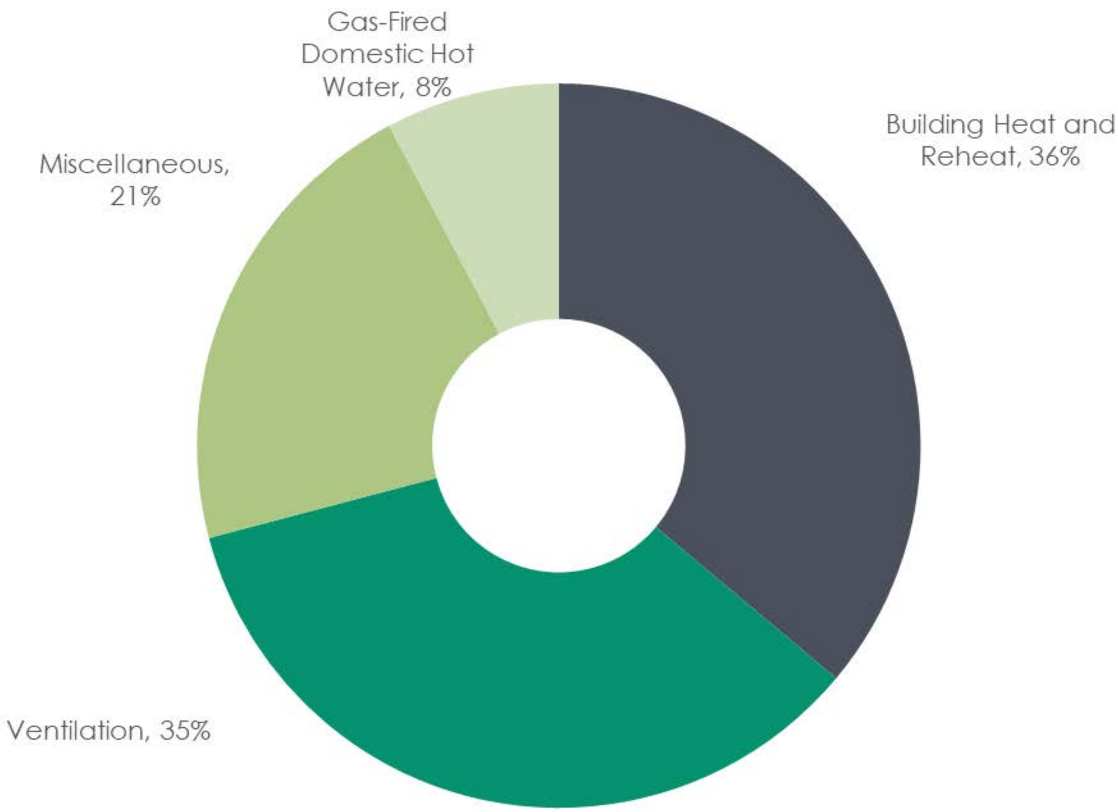


Table 8. End Use of Fossil Fuel

Fossil Fuel	Therms	Annual Cost	% of Fossil Fuel Energy Use
Building Heat and Reheat	573,595	$ 349,846	36%
Ventilation	553,020	$ 337,297	35%
Miscellaneous	338,967	$ 206,742	21%
Gas-Fired Domestic Hot Water	123,511	$ 75,331	8%
Totals	**1,589,092**	**$ 969,216**	**100%**

Figure 6. Fossil Fuel End Use



4 Analysis Methods

4.1 Estimating Methodologies

Energy Estimating

The energy saving estimates are based on information gathered from available plans, equipment name plate data, mechanical schedules, observations during the on-site visit, energy management system (EMS) graphics and trended data, and information provided by building operators and other stakeholders.

The baseline scenario (or reference case) for our calculations draws on actual building operating conditions as observed during our December 2023 site visit and from subsequent data collected from the energy management system. Baseline energy usage was provided from 2023 (see previous section). So as to not overstate energy savings, the baseline energy usage was adjusted to account for the planned implementation of measures recommended as part of the ASHRAE level II audit completed by Michaels Energy in March 2023. These measures are:

- Operate Snowmelt based on weather forecast
- Cycle hot water coil pump based on mixed air temperature
- Implement chilled water supply temperature reset
- Implement ultralow temperature heating
- Install boiler economizer to preheat domestic hot water
- Install magnetic bearing chiller to improve part load efficiency
- Install event center occupancy sensors and implement scheduling

Energy savings consider the interactions that exist between items. Energy efficiency measures are assumed to be implemented in order unless otherwise noted.

Energy savings were calculated using an energy model built using OpenStudio and spreadsheet calculations that employ industry standard practices and are grounded in established engineering principles. Solar PV energy production was modeled using HelioScope. All calculations account for local weather data, hourly variation in equipment energy use, and buildings operations. Our calculation methodologies meet or exceed the calculations standards for an ASHRAE Level III Energy Audit. Opinions of energy savings were made based on Michaels Energy's experience and qualifications and represent our best judgment as experienced and qualified energy professionals.

When applicable, marginal fuel rates are used. Savings are "taken off the top" to provide accurate dollar savings estimates. The last energy purchased is subtracted first. When applicable, seasonal, on and off peak, and demand rates are used with an estimated savings allocation to each. For other tariffs, the recent twelve-month average fuel costs are used for each fuel type. Fuel costs do not include fixed monthly charges such as a monthly customer charge. Taxes, if applicable, are included in the rates.

Greenhouse Gas Emissions Reduction Estimation Methodology

The carbon dioxide emissions have been calculated for natural gas and electricity based on current equipment usage and calculate energy savings. Yearly emissions factors are applied to the annual energy savings to determine pounds of carbon dioxide equivalent emissions each year. Emission reductions are provided on an annual basis; a cumulative basis from 2025-2030; and a cumulative basis from 2025-2050.

Annual carbon dioxide emissions values for the casino are collected from information and forecasts provided by We Energies and the methodology outlined in the plan (PCAP) from February 2024. Natural gas emissions are assumed to be constant per therm consumed, using factors provided by the US Energy Information Administration.

The methodology assumes that We Energies will achieve their carbon neutral goals stated in the WEC Energy Group parent company Corporate Sustainability Report. We assume that We Energies will reach net zero emissions by 2050, and thus carbon emissions reductions decline each year until they reach 0 kg CO2e/MWh in 2050. 2023 baseline emissions reductions are modeled based on relative reduction goals from 2021 to 2050.

In 2021, WEC stated electricity emissions of We Energies as 982 lbs. CO2e/MWh (We Energies, 2023), or 445 kg CO2e/MWh. In the 4 years between 2021 and 2025, emissions are set to reduce from 445 kg to 2025 emission level of 324 kg CO2e/MWh. In the 5 years between 2025 and 2030, emissions are set to decrease from 324 kg CO2e/MWh to a 2030 emission level of 162 kg CO2e/MWh. In the 20 years between 2030 and 2050, emissions are scheduled to reduce from 162 kg CO2e/MWh to 2050 emission level of 0 kg CO2e/MWh.

Emissions factors for electricity data and avoided electricity costs are mapped from the Electric Tariffs & Emissions Factors file. This file contains a list of electric tariffs and electric costs by year, for each active tariff. Emissions factors are published to the We Energies[2] website directly.

Cost Estimating

The implementation cost estimates are based on information gathered from available plans, observations during the on-site visit, information provided by building operators, and all other stakeholders. All costs were estimates provided by HGA using methods as appropriate. Opinions of probable construction cost were made based on HGA's experience and qualifications and represent their best judgment as experienced and qualified design professionals.

Material Costs are based on either recent vendor quotes for similar products or values listed in standard estimating guides and product catalogs. HGA worked with various vendors and consultants as part of the price estimating process. For example, computer room air conditioning equipment pricing was provided from the current Potawatomi Liebert sales

[2] https://www.we-energies.com/environment/epa-greenhouse-gas-reporting

representative, CDP. Kitchen equipment pricing was provided by the current Potawatomi kitchen consultant, Rippe and Associates.

Labor Costs are based on prevailing wage rates for local contractors. Wage rates for self-installed projects (if applicable) were provided by the owner or the labor was a sunk cost and therefore, not included.

Design cost estimates should be considered preliminary. The actual cost may vary depending on the total size of the implementation project and the specific scope of services desired. In some cases, projects are broken into small segments to illustrate the economic feasibility of certain specific technologies or portions of a broader technology classification. It should be noted that implementing only small portions of a larger energy efficiency project will increase cost for those small portions, possibly by a substantial amount.

Although every effort has been made to include cost contingencies, neither Michaels Energy or HGA have control over the operation of the building, the cost of labor, material, equipment, or services furnished by others. Accordingly, Michaels Energy and HGA do not guarantee that energy savings, proposals, bids, or actual costs will not vary from those contained in this report.

4.2 Economic Analysis Methods

Three indicators are used to present the economic attractiveness of each measure:

Simple Payback Period is equal to the initial cost divided by the estimated annual savings. The simple payback period is the approximate time required to recoup the initial investment.

Net Present Value is equal to the present value of all future savings over the useful life of the modification minus the initial investment. In many cases, only incremental first cost is used. In this case, the first cost of the base project is $0. If maintenance costs are estimated to be similar for all options, they are excluded from the analysis. Future costs are adjusted for escalation and time value of money. An EEM is cost effective if the Life Cycle Savings is greater than zero. In the case of mutually exclusive EEMs, assuming analysis periods are equal, the option with the greater Life Cycle Savings is the most cost effective.

Savings to Investment Ratio compares the lifetime savings of a project to the initial investment. This ratio is used to compare several projects, and the project with the higher value will have the higher return per dollar invested.

Adjusted Internal Rate of Return is a form of internal rate of return that assumes all returns are reinvested at a company's cost of capital. It compares profitability and measures the net present value of future cash flows.

- The general inflation rate, discount rate, and energy cost escalation factors used are taken from Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2021, Department of Energy, 2021[3].

[3] https://nvlpubs.nist.gov/nistpubs/ir/2021/NIST.IR.85-3273-36.pdf

- A real discount rate of 5.0% is used to discount future cash flows to the present. The real discount rate and all other costs exclude general inflation. The analysis results would be the same if general inflation were included in everything.

5 Energy Efficiency Measures (EEMs) and Heat Decarbonization Measures (HDMs)

Our investigation of your facility yielded the following opportunities for improvement. Throughout this section, we identify the opportunity, benefits to this facility, and the estimated cost and savings per measure.

Each EEM includes a description of the existing system, piece of equipment or operating procedure followed by a detailed description of the proposed retrofit, replacement, installation, or operating procedure.

The financial analysis of all EEMs includes both life cycle savings and simple payback. Each EMI was studied to determine its technical feasibility and to estimate its initial cost and effect on long-term maintenance, operating costs, and energy costs. The recommendations conform to local and state building codes.

There are significant interactions between the energy efficiency measures (EEMs) and the heat decarbonization measures (HDMs) proposed in this report. These measures are not stand-alone and will need to be implemented together. True savings are dependent on these interactions and can be realized if the measures are implemented together.

EEM 1 – Retrofit LED Fixtures in Mechanical Spaces

Annual Savings Summary		
Electricity	105,886	kWh
Peak kW	12.1	kW
Winter kW	12.1	kW
kW-Months	145	kW-month
Gas	(999)	therm
Savings	**$7,256**	

Financial Summary *	
Estimated Implementation Cost	$101,000
Grant Funding Request	$0
Simple Payback (years)	13.9
Savings to Investment Ratio (SIR)	1.1
Modified Internal Rate of Return (MIRR)	8%
Net Present Value	**$14,835**

*These metrics use a 20 year measure life and a 20 year analysis period where applicable

Current Conditions:

The building has four major mechanical spaces that have fluorescent lamp fixtures (T8s/T12s):

1. Old (East) chiller plant
2. 3rd floor West plant for chillers and boilers
3. Hotel HX room
4. Hotel hot water room

A small portion of the hotel guest rooms also have 23-Watt CFL bulbs (model TCP 33123SP 2700k 82CRI) instead of LEDs.

Proposed Changes:

It is recommended to retrofit all T8 and T12 lighting fixtures in the mechanical rooms and any CFL lamps in the hotel rooms with LED lighting fixtures in accordance with the most recent version of ENERGY STAR specifications.

Energy Savings:

Retrofitting fluorescent fixtures with LED fixtures saves electricity by reducing the lighting power density (kWh/sq-ft) and extending the useful lifetime of the lamps which saves lifecycle and repair costs. There is also an opportunity to impact peak demand savings during the summer.

Lighting lamps emit waste heat which interacts with the HVAC systems in the form of cooling loads. LED lamps will waste less heat than T8/T12 lamps which will make the space call for more heat from the central hot water system when in heating mode. This accounts for the Therms penalty. When the space is in cooling mode, the reduction in waste heat from LED lamps will reduce the cooling load which will result in reduced electric load on the central cooling system.

The back-of-house (BOH) operations area may have fluorescent or metal halide fixtures as well. As and when more data is available, the energy savings from this measure would increase.

EEM 2 – Optimize DCV Controls for Major Restaurants

Annual Savings Summary		
Electricity	26,441	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	15,650	therm
Savings	**$13,691**	

Financial Summary *	
Estimated Implementation Cost	$23,000
Grant Funding Request	$0
Simple Payback (years)	1.7
Savings to Investment Ratio (SIR)	9.5
Modified Internal Rate of Return (MIRR)	21%
Net Present Value	**$195,576**

*These metrics use a 20 year measure life and a 20 year analysis period where applicable

Current Conditions:

There are four major restaurants in the casino hotel – Rock and Brews, Ruyi, Canal Street Cafe, and Street Eatz. The dining areas for these restaurants are served by their respective rooftop units (RTUs) that have CO2 return duct detectors.

Proposed Changes:

It is recommended to implement a demand-controlled ventilation (DCV) sequence for the RTUs that serve these major restaurants in the building. These units already have CO2 detectors in their return ducts and would only need to be programmed to control the outdoor intake and bring fresh air in based on the CO2 levels in the space.

Energy Savings:

DCV implementation for these major restaurants will reduce how much outside air is needed to condition and maintain space temperature setpoints, while maintaining minimum ventilation needed based on occupancy.

EEM 3 – Add Unoccupied Setbacks for Major Restaurants and Kitchens

Annual Savings Summary		
Electricity	265,977	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	23,476	therm
Savings	**$34,583**	

Financial Summary *	
Estimated Implementation Cost	$37,000
Grant Funding Request	$0
Simple Payback (years)	1.1
Savings to Investment Ratio (SIR)	14.9
Modified Internal Rate of Return (MIRR)	23%
Net Present Value	**$515,112**

*These metrics use a 25 year measure life and a 20 year analysis period where applicable

Current Conditions:

All restaurants in the building are served by AHUs/RTUs that serve the dining area and regular cooking area for temperature control, while the MAUs serve the kitchen cooking areas with hood exhaust fans. These units run 24 hours a day, 7 days a week for both the dining and kitchen areas. Several of these units' fan VFDs have been commanded to run at constant speeds in manual override, and the remaining fans are either controlled by supply air temperature setpoint or supply air static pressure setpoint. During low occupancy, these units run at a minimum VFD speed.

Proposed Changes:

It is recommended to implement schedules for the AHUs/RTUs in the dining areas. Depending on the restaurant's schedule, these AHUs can be turned off for a few hours at night with a setback temperature setpoint. For this measure, we are only using the AHUs/RTUs and not the MAUs.

Occupancy sensors should be installed in each kitchen and restaurant to detect occupancy without manual monitoring. These units are already on the facility's latest building automation system (Ecostruxture Building Operations) and would need to be programmed to schedule the AHUs to be turned off when unoccupied with space temperature setbacks.

List of restaurant dining areas/kitchens used –

1. Canal Street Dining - Hotel
2. Dream Dance Steakhouse - Casino
3. Rock & Brews Restaurant – Casino
4. Pastry Kitchen - Hotel
5. Banquet Kitchen - Hotel

Energy Savings:

Scheduling the AHUs for these restaurants and kitchens account for reduced fan use at night and reduced heating/cooling load due to a wider unoccupied temperature set-point dead-band range.

Other Considerations:

The Buffet/Marketplace and RuYi restaurant cooking area are served by one RTU which is mostly running at 100% supply fan speed to condition the space. The Marketplace food court has four different smaller kitchens which have their own operating times. Considering that this area is open 24 hours a day, 7 days a week, it is assumed that occupancy sensors and an unoccupied schedule are not a suitable measure for this space.

Street Eatz is a fast-food restaurant on the third floor that is served by RTU-9. Since RTU-9 conditions other spaces that need temperature control 24 hours a day, 7 days a week, it is assumed that occupancy sensors and an unoccupied schedule are not a suitable measure for this space.

There are other bars and lounges that can be put on an unoccupied schedule with a setback. As more data is available for these lounges, the savings potential for this measure will increase.

EEM 4 – Install Efficient Air Distribution System in Gaming Space

Annual Savings Summary		
Electricity	4,379,350	kWh
Peak kW	171.6	kW
Winter kW	366.9	kW
kW-Months	3,622	kW-month
Gas	312,681	therm
Savings	**$563,610**	

Financial Summary *	
Estimated Implementation Cost	$6,476,000
Grant Funding Request	$0
Simple Payback (years)	11.5
Savings to Investment Ratio (SIR)	1.4
Modified Internal Rate of Return (MIRR)	9%
Net Present Value	**$2,521,919**

*These metrics use a 30 year measure life and a 20 year analysis period where applicable

Current Conditions:

The existing air distribution system for the casino provides filtration and ventilation, and satisfies the cooling loads by recirculating air through the AHUs and RTUs down to the gaming floors through long ductwork, high MERV HEPA filters, UV filtration chambers, and approximately 6 inches of W.C. total pressure. This system works as a hybrid displacement ventilation system for the gaming floors to effectively move conditioned and purified air through the occupant level in space. The constant volume nature of the system allows for even and predictable airflow in the comfort zone for casino occupants.

Proposed Changes:

It is recommended to install local fan-powered boxes (FPBs) on the gaming floors (with return register filters) as a one-to-one replacement of the variable air volume (VAV) boxes and constant air volume (CAV) boxes of respective AHUs/RTUs. These FPBs will move air locally at the occupant level using the existing hybrid displacement infrastructure while taking the required air from the primary AHU/RTU for ventilation, cooling, or sanitization needs.

The first level is served by roughly 45 VAV boxes in the space, with another 5 RTUs that are recirculating nearly constant air volume into the space. These terminal units date back to the original installation. The same number of boxes are on the second gaming level and can be upgraded too. All these boxes are currently set at a constant air volume set point as observed via the building automation system (BAS).

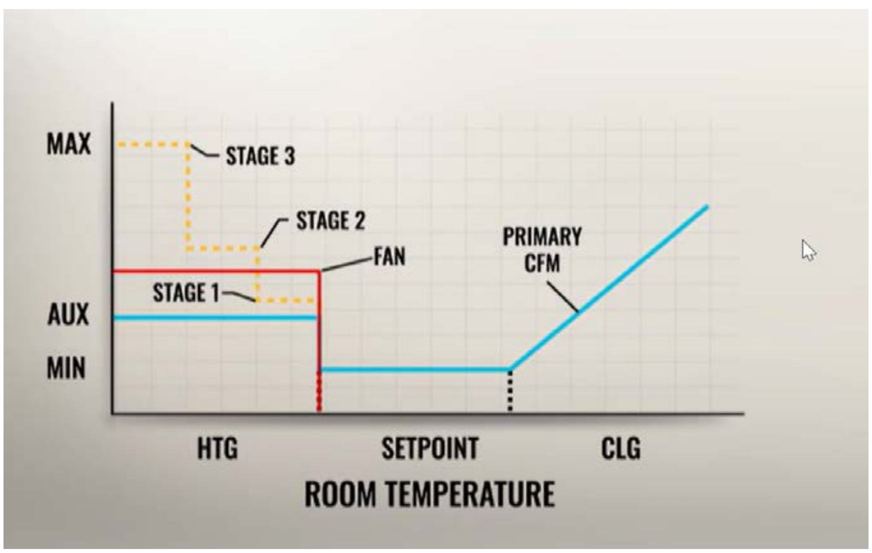
Based on the current terminal unit airflow requirements, all the existing terminal units can be replaced by fan-powered boxes without any additional cooling or heating elements. These fan-powered boxes will be controlled by zone thermos-stats and CO2 readings.

Figure 7: Nailor Industries Parallel Flow Fan Powered Box

Design Considerations:

- Sheet metal: Take the existing terminal units out and install the fan-powered boxes. Structural support would be installed, wherever needed, for the fan side of the box. Return registers with serviceable air filters should be installed in areas that are easily accessible for maintenance.
- Electrical: Provide power and installation for the fan, electrical damper actuator, and zone level controller.
- Mechanical: Install mixing damper controls to mix return air with primary air from the AHUs. The AHU or RTU discharge air temperature set point should be reset based on the critical zone's cooling demand. The existing VAVs should already have dampers with actuation, flow sensors, and supply temperature sensors that can be reused. For existing constant volume boxes, flow control actuation and sensors may need to be installed. These boxes should be selected with sound attenuation installation options to avoid noise-issues near casino occupants. Conduits, network cables for controllers, and data jacks for thermostats will be run through raceways or cable trays.
- OA ventilation: Space CO2 sensors and AHU return duct CO2 sensors should control outdoor air CFM to ventilate the spaces via primary air. Air volumes would typically be reduced to either the minimum of general/equipment exhaust or the ASHRAE 62.1 minimum ventilation required per square foot.
- Controls: One temperature sensor per zone (already exists) to control discharge temperature and CFM. Return air humidity sensors should be used to monitor moisture in the space and reset discharge air temperature if dehumidification is required.
- Model options: Multiple manufacturers have fan-powered variable volume boxes with sound attenuation options.

Figure 8: Parallel Fan Powered Box Sequence (Source: Krueger HVAC)



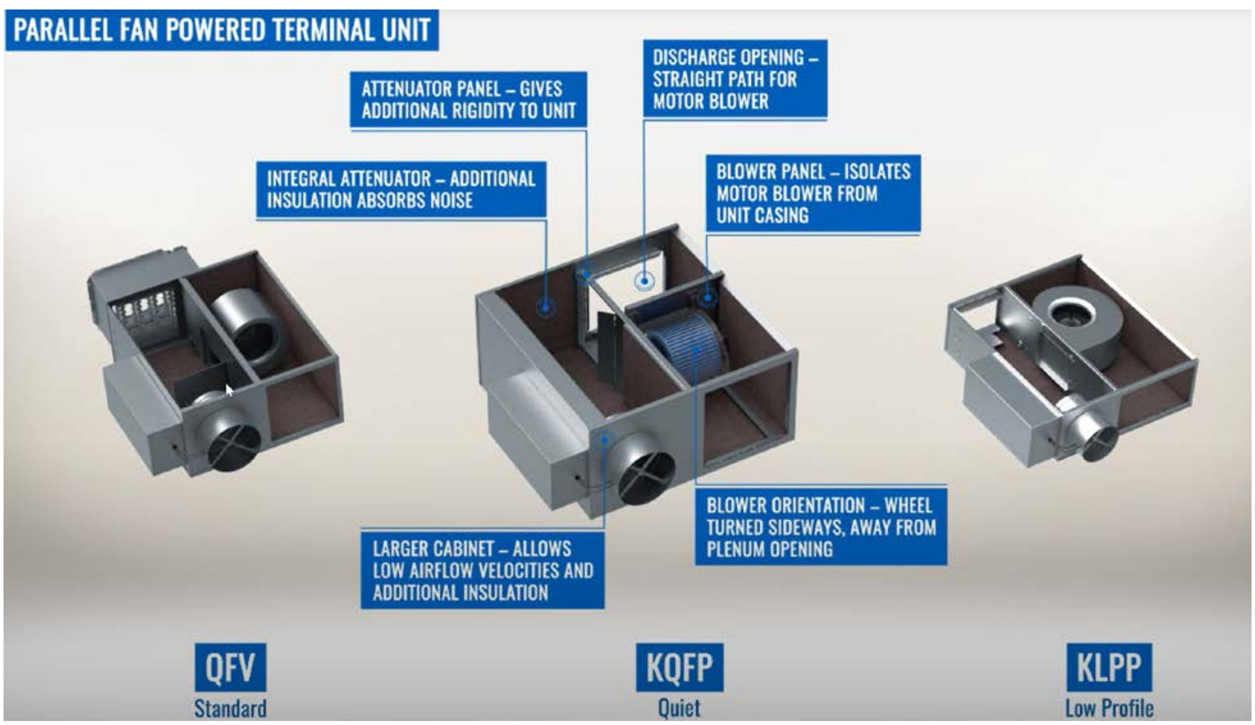
Energy Savings:

The fan-powered boxes will move conditioned air locally at the gaming floors to provide comfort at the occupant level, instead of taking that air through the primary AHU/RTU ductwork. This will reduce the amount of total pressure drop in the air distribution system and provide fan energy savings for the primary AHUs and RTUs. The ventilation and sanitization needs would be served by the primary AHU/RTU discharge air based on the zone CO2 and relative humidity sensors.

The FPB locally recovers the return/plenum air to maintain the zone temperature set point, instead of sending it back to the AHU/RTU where it is cooled and reheated again, based on the zone's demand. By decoupling the zones, the amount of subcooling and reheating is reduced while still maintaining the desired occupancy comfort. This will result in a large reduction of both the cooling and heating load.

This system provides a pathway to decouple the ventilation and sanitization function from the heating/cooling needs for the casino space with proven energy savings, better maintainability, and ease of expansion for future growth, while posing minimal disruption to the gaming operation and occupant comfort level.

Figure 9: Parallel FPB Design



EEM 5 – Upgrade Server Rooms UPSs and Cooling Units

Annual Savings Summary		
Electricity	778,191	kWh
Peak kW	88.8	kW
Winter kW	88.8	kW
kW-Months	1,066	kW-month
Gas	-	therm
Savings	**$58,977**	

Financial Summary *	
Estimated Implementation Cost	$1,823,000
Grant Funding Request	$0
Simple Payback (years)	30.9
Savings to Investment Ratio (SIR)	0.5
Modified Internal Rate of Return (MIRR)	4%
Net Present Value	**-$881,444**

*These metrics use a 20 year measure life and a 20 year analysis period where applicable

Current Conditions:

There are fourteen computer room air conditioning (CRAC) units with matching air-cooled condensing units serving multiple data center and surveillance equipment rooms in the casino. There are four CRACs, H1, H2, H3, and H4, serving the IT and surveillance rooms in the hotel. These units are ten years old. The other twelve CRACs are over fifteen years old.

The current UPS system in the Casino is over 15 years old; older units typically have poor efficiency, 80% or lower, when partially loaded.

Proposed Changes:

It is recommended to upgrade the four CRACs, H1, H2, H3, and H4, with variable frequency drives (VFDs) and associated controls. A similar option for these four units would be to install plug fans with electronically commutated motors (ECMs). Plug fans are pre-assembled fans and motors that can replace the existing fans and motors. We also propose installing VFDs on two fan coil units (FCUs) in the hotel electrical room.

The other ten CRACs are over fifteen years old and replacing them with high-efficiency CRACs that are equipped with ECMs or VFDs is recommended.

It is also recommended to upgrade the current UPS systems to UPS systems with efficiency ratings of approximately 96%, even at low load factors.

Energy Savings:

Upgrading the UPS units from 80% efficiency to units with 96% efficiency will save electricity in operating these units at their design IT loads or lower. Older UPSs usually have poor efficiencies at partial load.

Integrating variable speed into the CRAC units H1, H2, H3, and H4 plus two FCUs would allow matching air flow, and fan power input, to the demand from the rooms. Reducing fan and UPS power will save additional energy by reducing the cooling loads on the CRAC units.

Other Considerations:

The CRACs in the server rooms seem oversized for the load requirements in these rooms. The IT loads should be analyzed to right-size the equipment before replacing the existing CRAC units.

EEM 6 – Install Heat Recovery Coils for Toilet, General, and Vapor Exhausts

Annual Savings Summary		
Electricity	(339,210)	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	63,275	therm
Savings	**$27,670**	

Financial Summary *	
Estimated Implementation Cost	$938,000
Grant Funding Request	$0
Simple Payback (years)	33.9
Savings to Investment Ratio (SIR)	0.5
Modified Internal Rate of Return (MIRR)	4%
Net Present Value	**-$496,254**

*These metrics use a 30 year measure life and a 20 year analysis period where applicable

Current Conditions:

Based on the mechanical equipment schedules available from 2007 onwards, there are over 50 exhaust fans in the building used for toilets, general areas, vapor/dishwashers, and other operations that do not have grease in their exhaust air.

The toilet and general exhaust fans run at constant speed, while the kitchen vapor exhausts run based on the demand from their respective kitchen.

Proposed Changes:

It is recommended to install a run-around coil loop from every toilet, general, or vapor/dishwashing exhaust fan to the nearest AHU/RTU/MAU to capture waste heat from their exhaust air and preheat the supply air from the nearby AHU, hence reducing the load from the central boiler system.

For this study, all toilet and general exhaust fans have been assumed to work 24 hours a day, 7 days a week. The kitchen rack ovens and dishwashing exhausts have been assumed to operate normal kitchen operating hours.

Energy Savings:

This measure reduces the heating demand from the boiler system in the building, as it transfers heat from the exhaust air stream to the supply air stream.

Other Considerations:

Since, there was limited data available from the 1999-2000 casino build, we can expect that adding the exhaust fans from that part of the building to this estimate will increase the heat recovery potential and result in higher natural gas savings. To account for these savings, it has been assumed that the 1999-2000 build had the same number of toilet exhausts as the 2007 expansion project.

EEM 7 – Optimize Kettle and Dishwashing Unit Steam Operation

Annual Savings Summary		
Electricity	-	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	12,306	therm
Savings	**$9,476**	

Financial Summary *	
Estimated Implementation Cost	$1,420,000
Grant Funding Request	$0
Simple Payback (years)	149.9
Savings to Investment Ratio (SIR)	0.1
Modified Internal Rate of Return (MIRR)	-4%
Net Present Value	**-$1,268,722**

*These metrics use a 25 year measure life and a 20 year analysis period where applicable

Current Conditions:

There are two steam boilers that operate in lead-lag sequence to provide steam to a few large kettles in the level-1 kitchen and to two dishwashers. At least one steam boiler runs all the time. Also, almost all steam equipment is at the end of its useful life and is due for replacement.

Proposed Changes:

It is recommended to upgrade these steam kettles and dishwashers, to high efficiency alternatives with self-contained or integral burners/boilers. The goal is to reduce dependency on the central steam boilers and provide more modular kitchen expansion instead of running steam pipes throughout the building.

If an electric dishwasher is used instead of a gas-fired one, the annual Therms savings would increase. This would increase the electric usage for the kitchen and is subject to the kitchen's electrical infrastructure. For costing assumptions, the kitchen consultant priced an EUCCW series electrical dishwasher.

Energy Savings:

The energy savings for this measure come from avoided distribution losses from supplying steam from the steam boilers to the kitchens, and from the increased efficiency of the point of use gas-burners/boilers as compared to the existing steam boilers.

This measure will provide a scope for the lean future expansion of the kitchen operations in the casino and hotel without having to run new steam pipes through the building.

EEM 8 – Consolidate Kitchen Hood Exhausts Operation

Annual Savings Summary		
Electricity	6,487	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	8,651	therm
Savings	**$7,064**	

Financial Summary *	
Estimated Implementation Cost	$77,000
Grant Funding Request	$0
Simple Payback (years)	10.9
Savings to Investment Ratio (SIR)	1.5
Modified Internal Rate of Return (MIRR)	10%
Net Present Value	**$35,778**

*These metrics use a 30 year measure life and a 20 year analysis period where applicable

Current Conditions:

There are five hood exhaust fans operating in the banquet kitchen that run on variable speed when operational and at minimum speed when not operational. The kitchen is served by make-up air units (MAU), H1 and AHU-H11 that run 24 hours a day, 7 days a week. The MAU speed shadows the hoods speed while AHU-H11 controls space temperature in the kitchen.

Proposed Changes:

It is recommended to consolidate the operations for the banquet kitchen hoods (H13, H14, H16, H17 and H18) to reduce the run time of the smaller hoods and assimilate that exhaust into the larger hoods, while maintaining overall negative pressure in the space as before.

The goal of this measure is to reduce the run time of the smaller hoods as that exhaust would be consolidated into the larger fans' operation. During exhaust demand, the smaller hood exhaust fans (HEFs) would run at a lower speed unless in peak demand, where they are needed to run at high speeds. During non-operational times at night, the smaller HEFs will be turned off.

Energy Savings:

Reduced runtime will translate into less airflow that needs to be conditioned. Additionally, fan reduction will save electrical energy and reduce motor maintenance costs.

Other Considerations:

The total exhaust capacity of the five hoods is 28,790 CFM while the MAU supply air capacity is 17,090 CFM. There is enough capacity among the bigger exhaust fans (EFs) to keep the hood exhaust area in a negative pressure differential to its surroundings during low demand times, but this needs to be measured and verified with static differential pressure readings for both baseline and proposed cases.

HDM 1 – Install Solar Thermal Hot Water System

Annual Savings Summary		
Electricity	(49,932)	kWh
Peak kW	(5.7)	kW
Winter kW	(5.7)	kW
kW-Months	(68)	kW-month
Gas	154,332	therm
Savings	**$115,051**	

Financial Summary *	
Estimated Implementation Cost	$23,598,000
Grant Funding Request	$0
Simple Payback (years)	205.1
Savings to Investment Ratio (SIR)	0.1
Modified Internal Rate of Return (MIRR)	-5%
Net Present Value	**-$21,761,231**

*These metrics use a 30 year measure life and a 20 year analysis period where applicable

Current Conditions:

The campus currently operates five gas-fired boilers, producing up to 180°F hot water for distribution. This system's loads include heating coils in air handling units, reheat coils at air terminal units, the snowmelt system, make-up air units, as well as domestic hot water. The hotel heating loop is mechanically separated via heat exchangers from the main building loop. This allows for both independent operation and for submetering requirements.

Proposed Changes:

It is recommended to install a ground-mounted solar thermal hot water system on site that would use a base array of 1,500 solar collectors with an inlet hot water temperature of around 120°F from the utility plant[4]. A tilt angle of 15 degrees from horizontal was used for evaluation.

The 1,500 collectors will fit in a site a little larger than the size of the west digester site (Site-A as marked in Figure 10 below). This system is integrated into the main heating loop via a heat exchanger, with a 24-hour thermal storage tank designed to store excess heat produced during peak solar irradiance hours to serve the heating load overnight, and hot water pumps to run water through the closed solar panel loop. This system could be scalable up to an array of 2,500 solar collectors, with thermal storage needing to be expanded as well.

Figure 10: Solar Site Layout

[4] A combination of ground-mounted and canopy-mounted solar thermal system would need to be evaluated for cost purposes if the site cannot accommodate the needed ground-mounted collector count.

The site area layout above assumes a typical evacuated tube collector. It is expected that the total gross area of the collectors (135,000 ft²) would be equal whether the collector type is evacuated tube or flat plate collector. Typically, the lifecycle of a solar thermal field is more than 30 years.

Footprint Inside the Building:

There are two locations in the boiler room that could accommodate the heat exchanger(s). One is about 24' x 16', and the second is 10' x 24'. Both locations would allow easy coupling of the existing heat exchanger that served the former digester loop.

Energy Savings:

The solar thermal system will offset roughly 150,000 Therms of heat from the heating system in the building, directly offsetting natural gas usage. The solar thermal system collects heat from the sun to heat the water circulating through it, which in turn, gets added to the central heating system. The cost before any incentives is roughly $24,000,000. The energy savings offset is about 10% of the total annual natural gas consumption. In addition to this existing site, this system can be further scaled to roughly offset 16% of the natural gas consumption. The system would also allow any new structures to be designed with a low temperature heating system and a return water of less than 100˚F into the system for better overall efficiency. This would need a pumping system to circulate the building return hot water through the collectors while it collects solar energy during the day, with some pumping penalty. Savings were calculated assuming (2) 30-HP pumps operating with a lead-lag sequence dusk to dawn.

Applicable Rebates:

Solar thermal is a qualifying energy property under the Inflation Reduction Act (IRA) and may be eligible for additional local utility incentives.

Other Considerations:

The water quality of this thermal system would be identical to the closed loop hydronic system that exists in the building right now. For maintenance, the heat exchanger would need to be flushed every five years. Cleaning the collectors brings a small percentage of efficiency gain that is required on an as-needed basis when peak collector efficiency is measured to be under design conditions. To run this system year-round through extreme weather conditions, glycol would need to be added to the water with regular testing and maintenance.

In times of high solar irradiance, the system can store excess heat in a 24-hour storage tank. If the system size is further increased, a larger storage tank and heat dissipation means would need to be implemented. It has been reported that piping infrastructure exists from the previous digester plant project. The condition of this piping should be investigated to determine compatibility with and reuse for a solar thermal project of this scale.

HDM 2 - Install Heat Recovery Chillers

Annual Savings Summary		
Electricity	(761,204)	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	481,367	therm
Savings	**$323,413**	

Financial Summary *	
Estimated Implementation Cost	$33,870,000
Grant Funding Request	$0
Simple Payback (years)	104.7
Savings to Investment Ratio (SIR)	0.2
Modified Internal Rate of Return (MIRR)	-2%
Net Present Value	**-$28,706,789**

*These metrics use a 25 year measure life and a 20 year analysis period where applicable

Current Conditions:

The facility currently operates five gas-fired boilers, producing up to 180°F hot water for distribution. This system's loads include heating coils in air handling units, reheat coils at air terminal units, snowmelt system, make-up air units, as well as domestic hot water.

Currently, the chilled water system appears to maintain a supply setpoint of 42°F. After implementing the chilled water supply temperature reset from the level II energy audit, this set-point will go as high as 50˚F based on outside air temperatures. During cooling-only operation, the chillers remove heat from the building and dissipate it through water-cooled or air-cooled towers.

Given the operation of this type of hotel/casino facility, there is always going to be process cooling loads. It is estimated that on average the casino is operating 3,000 slot machines, has roughly 30-45 tons of process chilled water loads, and roughly 6,000 people in the facility at any given time throughout the day.

Proposed Changes:

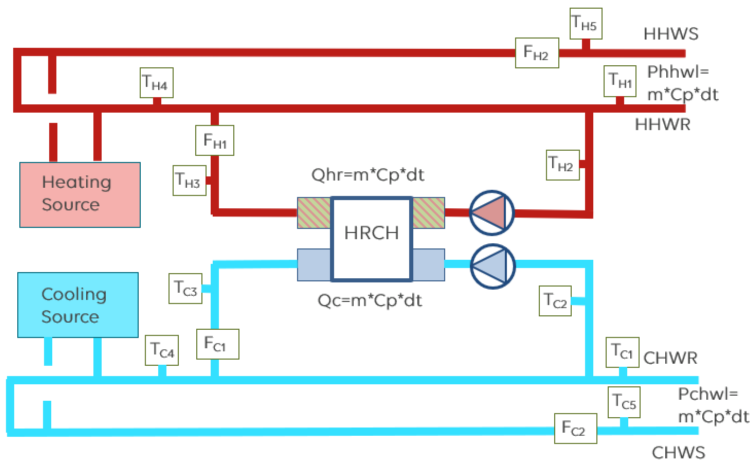
The heat dissipated from the chiller system can be recovered into the hot water system through a heat recovery chiller system. Such a system would transfer energy that would otherwise be rejected to the environment into the building heating system. This process is most effective when the hot water loop return water temperature is less than 100°F.

This system depends on the cooling demand for the chiller and simultaneous need for hot water. Hence, the heat recovery mode of the chiller should be sized to serve the unavoidable process cooling loads like heat load from gaming slot machines, people in the space, lighting thermal interactions, server rooms, etc. in the building. Keeping this in mind, a heat recovery chiller system of up to 600-tons capacity has been evaluated.

To reduce the building hot water return temperature to less than 100˚F, heating coils in the facility would need to be re-sized to provide enough heating capacity with the lower hot water supply temperature. This re-sizing of coils is an enabler for an effective heat recovery chiller system and to approach 100°F return hot water temperature in the heating system. It will also allow for future expansion of the system as new emerging technologies enable less environmental impacting fuel sources to be utilized.

Figure 10 below shows a schematic representation of how the HRCH interacts with both the heating and cooling systems. The HRCH condenser would be tied into the cooling tower system, allowing the HRCH to act as a cooling-only chiller for redundancy.

Figure 11. Schematic for Heat Recovery Chiller Interactions



The domestic hot water system for the casino and hotel will have to be partially decoupled from the central hot water system. The low temperature hot water system can be used to preheat domestic hot water, with a separate system used to boost the temperature up to the DHW distribution temperature of 140°F.

Energy Savings:

Recovering the heat that would have been dissipated from the water-cooled or air-cooled chillers through their cooling fans and putting it back into the hot water system reduces how much heat the boilers need to produce, in turn offsetting the natural gas consumption.

Other Considerations:

As mentioned, the savings from this measure are dependent on the unavoidable cooling loads and the simultaneous heating loads in the building. If the efficient air-distribution measure is not implemented, then the unrealized cooling and heating energy savings from that measure would cause a higher simultaneous cooling and heating load for the casino floors which will increase the size of the heat recovery chillers that can be installed on site.

Re-sizing heating coils in all AHUs/RTUs and terminal units poses disruption to the casino and hotel operations. The heat recovery chiller system can be implemented in phases to reduce this disruption.

An 80% system efficiency factor has been assumed based on the current boiler configuration when converting metered natural gas data to the heating output.

Additional technologies or system types can be incorporated into the facility in the future to supplement the heat recovery chiller system. This includes air source heat pumps and waste-water heat recovery systems which are both rapidly advancing and improving.

Integrating a geothermal system was considered as part of this study to expand the potential for heat recovery during times when there is little cooling load in the building. This was dropped once we learned more about the land surrounding the building. Since there are environmental impacts associated with any drilling or boring activity, a geothermal well field is not feasible and not recommended for this site. Additional information has been provided about this in the later section of the report after all the measures.

Applicable Rebates:

Based on the information currently available, heat recovery does not appear to be an eligible technology under the IRA.

HDM 3 – Electrify Kitchen Appliances

Annual Savings Summary		
Electricity	(1,855,934)	kWh
Peak kW	-	kW
Winter kW	-	kW
kW-Months	-	kW-month
Gas	243,369	therm
Savings	**$72,215**	

Financial Summary *	
Estimated Implementation Cost	$14,624,000
Grant Funding Request	$0
Simple Payback (years)	202.5
Savings to Investment Ratio (SIR)	0.1
Modified Internal Rate of Return (MIRR)	-5%
Net Present Value	**-$13,471,106**

*These metrics use a 30 year measure life and a 20 year analysis period where applicable

Current Conditions:

There are five major restaurant kitchens in the casino, an additional three in-house kitchens (pastry, banquet, and main) and four cafes/bars that have steam and gas-based appliances.

The casino sees 12,000 to 15,000 people in a day during weekdays and 18,000 to 20,000 people on the weekends and holidays. That can amount to a peak of 2,000 to 3,000 people an hour on a weekday and 5,000 to 6,000 people an hour on a weekend. This many people eating everyday amounts to a considerable use of natural gas in the kitchens throughout the day.

Proposed Changes:

It is recommended to upgrade the gas-fired equipment in all the kitchens with electric alternatives to reduce the onsite consumption of CO2 emitting equipment. The goal is to address and reduce natural gas loads outside of the boiler system and HVAC consumption.

There are major appliances that are needed for each restaurant and the capacity of people they serve every day. Each restaurant should be able serve 200 to 400 people in an hour.

Below is a list of kitchens evaluated for this measure–

1. Canal Street Café – Hotel
2. Dream Dance Steakhouse - Casino
3. Potawatomi Marketplace – Casino food court
4. Rock & Brews Restaurant – Casino
5. RuYi-Authentic Asian Cuisine – Casino
6. Street Eatz - Casino
7. Bar 360 - Casino
8. Eleven Hundred Bar & Lounge - Casino
9. The Curve - Casino
10. Cream City Coffee Co. - Casino
11. Pastry kitchen
12. Banquet (catering) kitchen
13. Main kitchen (a.k.a. employee dining kitchen)

Although not included in this calculation, we also propose upgrading the banquet and pastry kitchen gas-fired MAU heaters with either the building's central hot water heating coils or with air source heat pumps with supplemental preheat.

Carbon Offsets:

Switching fuel from natural gas to electricity will directly offset the carbon emissions associated with natural gas combustion. There will be an electric usage penalty and associated carbon emissions, but the net effect will be positive carbon offset at installation. Moreover, if the grid becomes more carbon-free, the carbon offset from fuel-switching will increase.

Electrifying the kitchen operations will not just help in carbon-offset goals at the current capacity but also provide the ability to scale with future expansion plans.

Other Considerations:

Based on the customer's feedback, the level-1 kitchen kettles, and dishwashers, that are served by the steam boilers, have been included in this measure's energy savings and cost estimate later on. If the EEM – 7 for upgrading the steam kettles and dishwashers is implemented, then their savings potential would be removed from the impact of this electrification measure.

HDM 4 – Install a Solar PV Canopy on Center Parking Garage

Annual Savings Summary*		
Electricity	1,646,012	kWh
Peak kW	103.3	kW
Winter kW	819.3	kW
kW-Months	6,968	kW-month
Gas	-	therm
Savings	**$151,280**	

Financial Summary *	
Estimated Implementation Cost	$6,340,000
Grant Funding Request	$0
Simple Payback (years)	41.9
Savings to Investment Ratio (SIR)	0.4
Modified Internal Rate of Return (MIRR)	3%
Net Present Value	**-$3,924,852**

*These metrics use a 25 year measure life and a 20 year analysis period where applicable

Current Conditions:

There are three separate parking structures all built at different times and designed by different firms. Out of these, the center and east garages are post-tensioned (PT) construction. The center garage has the most structural capacity because it was designed around 2009 for 30psf snow load prior to the IBC updates. The building is put on a utility tariff with $0 compensation for exported energy (CGS NP).

Proposed Changes:

It is recommended to add a solar PV canopy at the center parking garage with additional capacity on the south side of the structure with a total capacity of 1 MW. These savings are based on a HelioScope model assuming 1,827 JAM 540W PV modules on a fixed rack tilt of 3 degrees (see Appendix A for design details and model results). This system will have steel canopies built on top of the parking structure, which involves detailed engineering and construction. Design, procurement, fabrication, and installation of such a system are more complex than a traditional ground-mount or rooftop solar array system, which is why the costs would be higher in this case (see Appendix B).

In addition to the canopies, there is space on the south side of the parking garage structure that can be used to install 45-degree angled solar PV arrays with total capacity of 382 kW. This system is based on the design proposed by Telamon Energy using a Hanwha Q Cells Q.Peak 480W PV module. The cost of this additional system has been included in Appendix B.

Energy Savings:

The annual production of this solar PV system on the garage will be 1.134 GWh, offsetting the electric bill by that same amount and the associated carbon emissions from the grid.

Other Considerations:

Further analysis is needed to evaluate how much more the annual energy potential increases with an exoskeleton structure. An exoskeleton concept can be expensive and cumbersome as compared to a conventional canopy for solar PV.

The utility (WE Energies) has other tariffs that compensate exported energy at wholesale rates. There are a few options available to get slightly better wholesale rates.

5.1 Additional Measures Considered

In addition to the measures identified and evaluated in detail above, there is another group of measures that were considered. Although these measures are cost effective and feasible in other facilities, preliminary analysis has shown that they do not yield an equitable payback or are not feasible for this facility.

5.1.1 Energy Efficiency Measures

Relocate Existing Solar Array

Current Conditions:

The existing solar array installation that serves the casino does not get compensated for any excess production export back to the grid, with the current utility tariff.

Proposed Changes:

It is recommended that the economics will be best if the PV system is moved onto the main building and never exported back to the grid. As part of this study, a cost associated with relocating the AC disconnects and electric panel is provided, while replacing the old inverters with new ones. This would cost $234,400 (see figure-25 for cost estimate in Appendix B). Alternatively, this system could be retrofitted with 300kW-AC inverters and moved to the WE Energies net metered tariff, while remaining on the parking garage meter.

5.1.2 Heat Decarbonization Measures

Install Geothermal Wells with Heat Recovery Chiller System

Proposed Changes:

A geothermal well field was evaluated and ultimately deemed infeasible for this site. Such a system would integrate with the heat recovery chiller system to extract heat from the ground when the building cooling loads are low, and the centrifugal chillers are not needed to provide cooling (roughly below 45°F outdoor air temperature).

Energy Savings:

The savings from this measure would have come from reduced load on the boiler system for HVAC heating, hence offsetting carbon emissions. These savings are dependent on the heating loads in the building. If the solar thermal hot water system measure is not implemented, then the unrealized heating energy savings from that measure would cause a higher heating load on the boiler system. This will increase the potential of ground-source heat recovery to 630,000 Therms annually.

6 Summary of Results

The following tables summarize the economic and energy impacts of all the energy efficiency measures (EEMs) and heat decarbonization measures (HDMs).

Table 9. Summary of EEM and HDM Analysis & Recommendations

EEM Measure Package

Number	EEM Name	Total Cost[1]	Total Savings	Payback	2025 to 2030 Cumulative kg CO2 Offset	2025 to 2030 Cost of Carbon Offset ($/kg CO2)	2025 to 2050 Cumulative kg CO2 Offset	2025 to 2050 Cost of Carbon Offset ($/kg CO2)
1	Retrofit LED Lighting Fixtures in Mechanical Spaces	$101,000	$7,256	13.9	122,676	$0.82	179,949	$0.56
2	Optimize DCV Controls for Major Restaurants	$23,000	$13,691	1.7	535,271	$0.04	2,231,694	$0.01
3	Add Unoccupied Setbacks for Major Restaurants and Kitchens	$37,000	$34,583	1.1	1,132,925	$0.03	4,026,035	$0.01
4	Install Efficient Air Distribution System in Gaming Space	$6,476,000	$563,610	11.5	16,309,574	$0.40	56,131,001	$0.12
5	Upgrade Server Rooms UPS's and Cooling Units	$1,823,000	$58,977	30.9	1,134,603	$1.61	2,332,240	$0.78
6	Install Heat Recovery Loop to Toilet, General and Vapor Exhausts	$938,000	$27,670	33.9	1,513,765	$0.62	7,686,163	$0.12
7	Optimize Kettle and Dishwashing Unit Steam Operation	$1,420,000	$9,476	149.9	390,597	$3.64	1,692,588	$0.84
8	Consolidate Kitchen Hood Exhaust Operation	$77,000	$7,064	10.9	284,053	$0.27	1,209,356	$0.06
	Total	**$10,895,000**	**$722,327**	**15.1**	**21,423,465**	**$0.51**	**75,489,027**	**$0.14**

[1]Total cost includes design fee

HDM Measure Package

Number	HDM Name	Total Cost[1,2]	Total Savings	Payback	2025 to 2030 Cumulative kg CO2 Offset	2025 to 2030 Cost of Carbon Offset ($/kg CO2)	2025 to 2050 Cumulative kg CO2 Offset	2025 to 2050 Cost of Carbon Offset ($/kg CO2)
1	Install Solar Thermal Hot Water System	$23,598,000	$115,051	205.1	4,825,692	$4.89	21,077,156	$1.12
2	Install Heat Recovery Chillers	$33,870,000	$323,413	104.7	14,168,765	$2.39	63,925,942	$0.53
3	Electrify Kitchen Appliances	$14,624,000	$72,215	202.5	5,018,578	$2.91	27,910,731	$0.52
4	Install a Solar PV Array on Parking Garage	$6,340,000	$151,280	41.9	2,399,886	$2.64	4,933,099	$1.29
	Total	**$78,432,000**	**$661,958**	**118.5**	**26,412,921**	**$2.97**	**117,846,927**	**$0.67**

[1]Total cost includes design fee
[2]Grant not included in total

Table 10. EEMs and HDMs Energy Savings Summary

Energy Efficiency Measures (EEMs) Package

EEM	EEM Name	Elec. Demand (kW, July)	Elec. Demand (kW, Jan)	Elec. Demand (kW-month)	Elec. Energy (kWh/yr)	Natural Gas (Therm/yr)	Bill Savings ($/yr)	Payback Period (years)
1	Retrofit LED Lighting Fixtures in Mechanical Spaces	12.1	12.1	145.0	105,886	-999	$7,256	13.9
2	Optimize DCV Controls for Major Restaurants	0.0	0.0	0.0	26,441	15,650	$13,691	1.7
3	Add Unoccupied Setbacks for Major Restaurants and Kitchens	0.0	0.0	0.0	265,977	23,476	$34,583	1.1
4	Install Efficient Air Distribution System in Gaming Space	171.6	366.9	3621.9	4,379,350	312,681	$563,610	11.5
5	Upgrade Server Rooms UPS's and Cooling Units	88.8	88.8	1066.0	778,191	0	$58,977	30.9
6	Install Heat Recovery Loop to Toilet, General and Vapor Exhausts	0.0	0.0	0.0	-339,210	63,275	$27,670	33.9
7	Optimize Kettle and Dishwashing Unit Steam Operation	0.0	0.0	0.0	0	12,306	$9,476	149.9
8	Consolidate Kitchen Hood Exhaust Operation	0.0	0.0	0.0	6,487	8,651	$7,064	10.9
	Total	**272.5**	**467.9**	**4,833**	**5,223,123**	**435,039**	**722,327**	**15.1**

Heat Decarbonization Measures (HDMs) Package

HDM	HDM Name	Elec. Demand (kW, July)	Elec. Demand (kW, Jan)	Elec. Demand (kW-month)	Elec. Energy (kWh/yr)	Natural Gas (Therm/yr)	Bill Savings ($/yr)	Payback Period (years)
1	Install Solar Thermal Hot Water System	-5.7	-5.7	-68.4	-49,932	154,332	$115,051	205.1
2	Install Heat Recovery Chillers	0.0	0.0	0	-761,204	481,367	$323,413	104.7
3	Electrify Kitchen Appliances	0.0	0.0	0	-1,855,934	243,369	$72,215	202.5
4	Install a Solar PV Array on Parking Garage	103.3	819.3	6,968	1,646,012	0	$151,280	41.9
	Total	**97.6**	**813.6**	**6,899**	**-1,021,058**	**879,068**	**$661,958**	**118.5**

	Elec. Demand (kW, July)	Elec. Demand (kW, Jan)	Elec. Demand (kW-month)	Elec. Energy (kWh/yr)	Natural Gas (Therm/yr)	kWh/SF	Therm/SF
Baseline Year	5894.0	4103.0	60,769	36,906,943	1,589,092	27.8	1.2
Proposed Year	5621.5	3635.1	55,936	31,683,820	1,154,053	23.9	0.9

Appendix A Detailed System Data

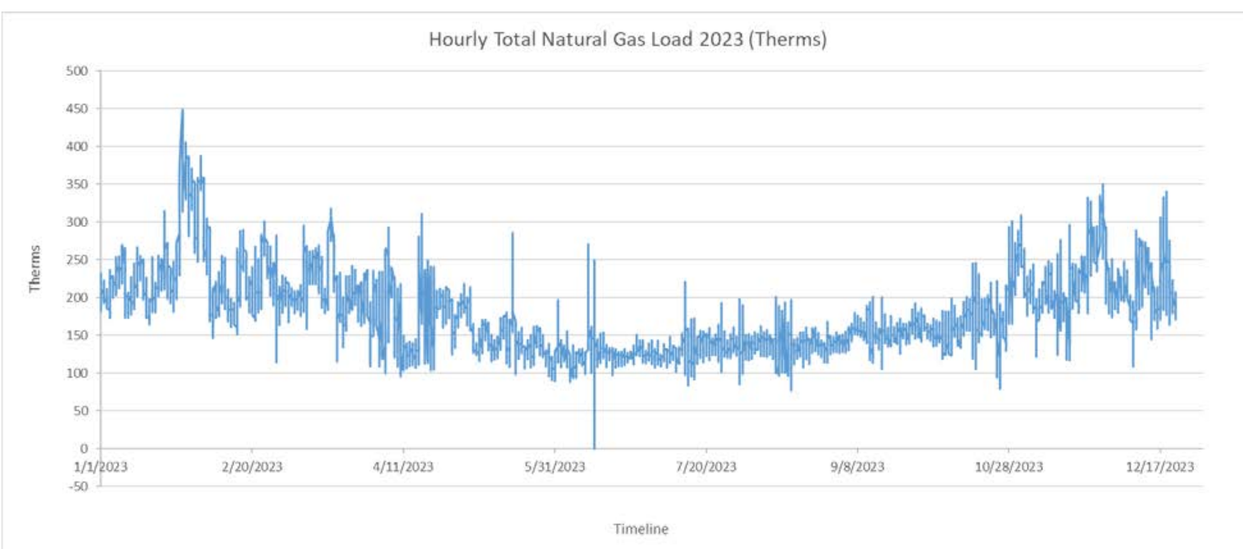
The Potawatomi Hotel and Casino is located at 172 West Canal Street in Milwaukee, WI. The building is split into the approximately one-million-square-foot casino and an attached 500,000-square-foot hotel with five hundred total rooms. Originally constructed in 2000, the building had a major expansion in 2007, 2013-2014, and then 2017-2018. The casino and hotel operate 24 hours a day, 365 days a year without exception. There are, on average, 15,000 guests in the casino during a weekday and 20,000 guests during a weekend. The casino has over 3,000 slot machines, multiple restaurants, and several rooms for hosting events of multiple sizes.

Most of the casino is conditioned with variable volume air handling units with hot water preheat and reheats, as well as glycol chilled water for cooling. Newer units have heat wheels that are used for heat recovery. The air filtration equipment includes MERV 13 filters on the return air, MERV 10 filters on the outside air, and MERV 16 filters on the mixed air. There are also photocatalytic oxidation air cleaners, carbon filters, and UV lamps as needed throughout the equipment. The hotel is isolated from the main heating and cooling loops via plate and frame heat exchangers. The hotel rooms are served by four-pipe fan coil units supported by two makeup air units with heat recovery serving fresh air throughout the hotel.

Most of the building equipment is on a Schneider Electric building automation system with a Tridium front end. The casino is currently converting some of the older controllers to the newest hardware which is on a separate front end.

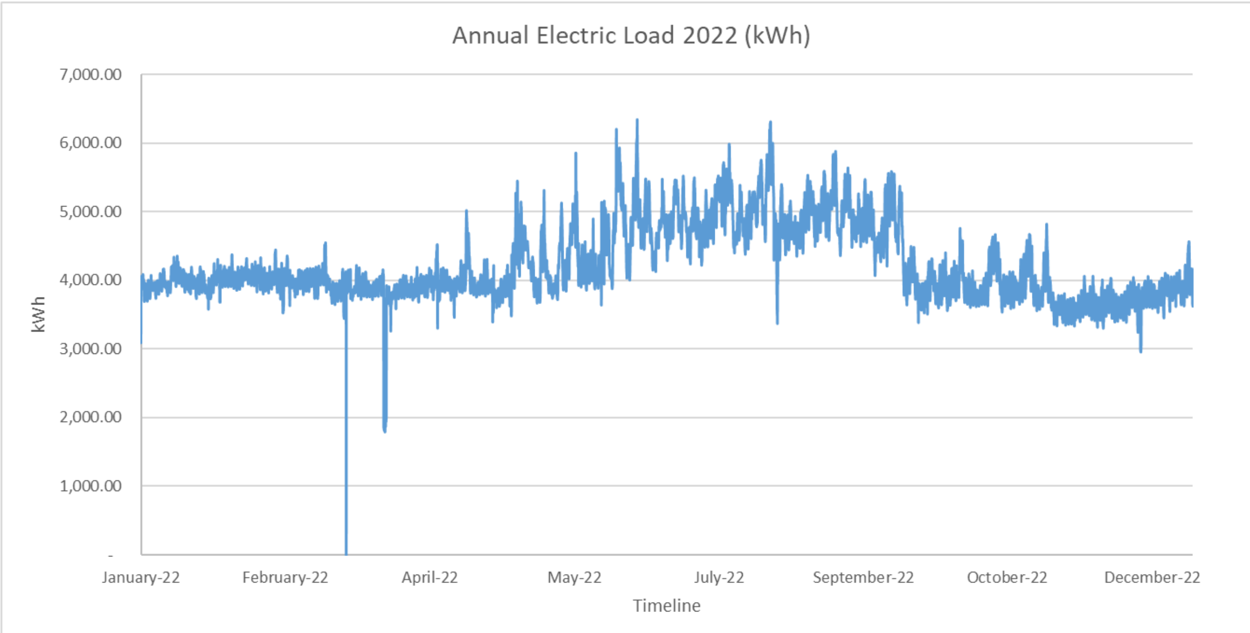
Below is the total combined hourly load profile for all natural gas loads (HVAC heating, domestic water heating, and miscellaneous gas loads).

Figure 12. Natural Gas Load 2023 (Therms)



Below is the total combines hourly load profile for all electric loads (motors, fans, cooling, gaming machines, lighting, and miscellaneous plug loads).

Figure 13. Annual Electric Load 2022 (kWh)[5]



[5] Electric load Interval data available for 2022 from customer

Appendix B Cost Data

Figure 14. LED Lighting Retrofit Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for Retrofit LED Lighting Fixtures in Mech Spaces

HGA

3/13/2024

HGA Comm. #: 1174-003-00

	Mechanical Spaces	
Direct Construction Costs	**%**	**Cost**
Equipment and Labor		
Bulb Replacement	95%	$76,800
General Requirements		
General Requirements	5%	$3,840
Total Direct Construction Cost		$80,640
Construction Contingency	5%	$4,032
Design Contingency	0%	$0
Sub Total		$84,672
Phasing Premium	0%	$0
Sub Total		$84,672
Soft Costs: Architectural / Engineering Fees	0%	$0
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0
Soft Costs: Commissioning	0.20%	$169
General Conditions	3%	$2,540
Building Permit	0%	$0
Contractor Fee, Bond & Insurances	5%	$7,620
		$95,002
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$5,700
Total Construction Cost Incl. Escal.		$100,702

Figure 15. DCV Controls Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for DCV Controls for Major Restaurants

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Major Restaurants %	Cost
Equipment and Labor		
BAS Programming	46%	$7,600
Duct CO2 Sensor Replacement	49%	$8,000
General Requirements		
General Requirements	5%	$780
Total Direct Construction Cost		$16,380
Construction Contingency	5%	$819
Design Contingency	0%	$0
Sub Total		$17,199
Phasing Premium	0%	$0
Sub Total		$17,199
Soft Costs: Architectural / Engineering Fees	12%	$2,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0
Soft Costs: Commissioning	0.20%	$34
General Conditions	3%	$516
Building Permit	0%	$0
Contractor Fee, Bond & Insurances	5%	$1,548
		$21,297
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$1,278
Total Construction Cost Incl. Escal.		$22,575

Figure 16. Restaurant Dining Scheduling Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for Unoccupied Setback for Major Restaurants and Kitchen

HGA

3/13/2024

HGA Comm. #: 1174-003-00

	Major Restaurants and Kitchens	
Direct Construction Costs	**%**	**Cost**
Equipment and Labor		
Installing and Programming Occupancy Sensors	48%	$10,000
General Requirements		
General Requirements	5%	$1,000
Total Direct Construction Cost		$20,999
Construction Contingency	5%	$1,050
Design Contingency	0%	$0
Sub Total		$22,049
Phasing Premium	0%	$0
Sub Total		$22,049
Soft Costs: Architectural / Engineering Fees	36%	$8,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	9%	$2,000
Soft Costs: Commissioning	0.20%	$44
General Conditions	3%	$661
Building Permit	0%	$0
Contractor Fee, Bond & Insurances	5%	$1,984
		$34,739
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$2,084
Total Construction Cost Incl. Escal.		$36,823

Figure 17. Gaming Space HVAC Improvement Cost Estimate

Potawatomi Casino
Milwaukeem WI
Cost Estimate for HVAC Air System Improvements

HGA

Updated: 2/19/2024

HGA Comm. #: 1174-003-00

	Decoupled Air Change / Fan Powered Mixing @ Casino Gaming Floors		
Direct Construction Costs	%	$/SF	265,672
Services			
Conveying	0%	$0	$0
Plumbing	0%	$0	$0
HVAC	72%	$8	$2,112,092
Fire Protection	0%	$0	$0
Electrical	23%	$3	$664,180
General Requirements			
General Requirements	5%	$1	$138,814
Total Direct Construction Cost		$11	$2,915,086
Construction Contingency	20%	$2	$583,017
Design Contingency	15%	$2	$437,263
Sub Total		$15	$3,935,366
Phasing Premium	15%	$2	$590,305
Sub Total		$17	$4,525,671
Soft Costs: Architectural / Engineering Fees	8%	$1	$362,054
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0	$0
Soft Costs: Commissioning	1%	$0	$45,257
General Conditions	15%	$3	$678,851
Building Permit	2%	$0	$90,513
Contractor Fee, Bond & Insurances	9%	$2	$407,310
		$23	$6,109,656
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$1	$366,579
Total Construction Cost Incl. Escal.		$24	$6,476,235

Figure 18. UPS and CRAC Upgrades Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for UPS Replacment and CRAC VFD Retrofit

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	IT/Data/Surveillance	
	%	Cost
Equipment and Labor		
VFDs	3%	$56,000
UPS Units (w/LIB & 1 Flywheel)	21%	$390,000
CRAC Units (Air-cooled, no economizing)	68%	$1,260,000
Labor & BAS Control Integration	0%	$52,800
General Requirements		
General Requirements	5%	$87,940
Total Direct Construction Cost		**$1,846,740**
Construction Contingency	5%	$92,337
Design Contingency	0%	$0
Sub Total		**$1,939,077**
Phasing Premium	0%	$0
Sub Total		**$1,939,077**
Soft Costs: Architectural / Engineering Fees	0%	$8,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0
Soft Costs: Commissioning	0.20%	$3,878
General Conditions	3%	$58,172
Building Permit	0%	$0
Contractor Fee, Bond & Insurances	5%	$174,517
		$2,183,644
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$131,019
Total Construction Cost Incl. Escal.		**$2,314,663**

Figure 19. Toilet and General Exhaust Heat Recovery Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for Heat Recovery Loop Toilet, General and Vapor Exhaust

HGA

3/13/2024

HGA Comm. #: 1174-003-00

		Toilet, General and Dishwasher Exhaust	
Direct Construction Costs		%	Cost
Equipment and Labor			
Coil Loops, Distribution Systems & Installation		95%	$380,000
General Requirements			
General Requirements		5%	$19,000
Total Direct Construction Cost			$399,000
Construction Contingency		5%	$19,950
Design Contingency		15%	$59,850
	Sub Total		$478,800
Phasing Premium		10%	$47,880
	Sub Total		$526,680
Soft Costs: Architectural / Engineering Fees		4%	$20,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)		0%	$0
Soft Costs: Commissioning		0.20%	$1,053
General Conditions		15%	$79,002
Building Permit		2%	$10,534
Contractor Fee, Bond & Insurances		5%	$47,401
			$684,670
Constr. Escal. (Mid-Point of Construction 2-13-27)		6%	$41,080
Total Construction Cost Incl. Escal.			$725,750

Figure 20. Kettle and Dishwasher Upgrade Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for Kettle and Dishwashing Steam

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Kitchen %	Kitchen Cost
Equipment and Labor		
Kettle Upgrades	42%	$400,000
Dishwashing Upgrades	42%	$400,000
Piping Connections	10%	$96,500
General Requirements		
General Requirements	5%	$44,825
Total Direct Construction Cost		$941,325
Construction Contingency	5%	$47,066
Design Contingency	5%	$47,066
Sub Total		$1,035,458
Phasing Premium	0%	$0
Sub Total		$1,035,458
Soft Costs: Architectural / Engineering Fees	2%	$16,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	2%	$16,000
Soft Costs: Commissioning	0.20%	$2,071
General Conditions	15%	$155,319
Building Permit	2%	$20,709
Contractor Fee, Bond & Insurances	5%	$93,191
		$1,338,747
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$80,325
Total Construction Cost Incl. Escal.		$1,419,072

Figure 21. Kitchen Hood Exhaust Consolidation Cost Estimate

Potawatomi Casino

Milwaukee WI

Cost Estimate to Consolidate Kitchen Hood Exhaust

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

		Kitchen	
		%	Cost
Equipment and Labor			
Exhaust Ductwork Modifications & Upsized Exhaust Fan		90%	$45,000
BAS Programming		10%	$4,800
General Requirements			
General Requirements		0%	$240
Total Direct Construction Cost			$50,040
Construction Contingency		5%	$2,502
Design Contingency		5%	$2,502
	Sub Total		$55,044
Phasing Premium		0%	$0
	Sub Total		$55,044
Soft Costs: Architectural / Engineering Fees		15%	$8,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)		3%	$1,600
Soft Costs: Commissioning		0.20%	$110
General Conditions		3%	$1,651
Building Permit		2%	$1,101
Contractor Fee, Bond & Insurances		5%	$4,954
Total Construction Cost			$72,460
Constr. Escal. (Mid-Point of Construction 2-13-27)		6%	$4,348
Total Construction Cost Incl. Escal.			$76,808

Figure 22: Solar Thermal HW System Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for Solar Thermal System

HGA

Updated: 3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Area 1 Solar Thermal Hot Water		
	%	$/SF Collector Area	48,000
Equipment and Labor			
Collector, Storage and HX Pricing	81%	$309	$14,850,000
Underground Piping	11%	$43	$2,049,412
Racking	3%	$10	$478,196
	0%	$0	$0
	0%	$0	$0
General Requirements			
General Requirements	5%	$18	$868,880
Total Direct Construction Cost		$380	$18,246,488
Construction Contingency	5%	$19	$912,324
Design Contingency	0%	$0	$0
Sub Total		$399	$19,158,813
Phasing Premium	0%	$0	$0
Sub Total		$399	$19,158,813
Soft Costs: Architectural / Engineering Fees	2%	$8	$383,176
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0	$0
Soft Costs: Commissioning	0.20%	$1	$38,318
General Conditions	3%	$12	$574,764
Building Permit	2%	$8	$383,176
Contractor Fee, Bond & Insurances	5%	$36	$1,724,293
		$464	$22,262,540
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$28	$1,335,752
Total Construction Cost Incl. Escal.		$492	$23,598,293

Figure 23. Heat Recovery Chiller Plant Cost Estimate

Potawatomi Casino
Milwaukeem WI
Cost Estimate for Heat Recovery Chiller Plant

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Heat Recovery Chiller Plant	
	%	Cost
Services		
Stage 1 Equipment	13%	$3,561,000
Stage 1 Labor	10%	$2,712,000
Stage 2 Equipment	5%	$1,312,500
Stage 2 Labor	68%	$19,210,000
Victaulic Seal Replacement	1%	$250,000
General Requirements		
General Requirements	5%	$1,352,275
Total Direct Construction Cost		**$28,397,775**
Construction Contingency	2%	$567,956
Design Contingency	2%	$567,956
Sub Total		**$29,533,686**
Phasing Premium	0.3%	$80,000
Sub Total		**$29,613,686**
Soft Costs: Architectural / Engineering Fees	0.1%	$40,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0
Soft Costs: Commissioning	0.2%	$59,227
General Conditions	2%	$592,274
Building Permit	0.5%	$148,068
Contractor Fee, Bond & Insurances	5%	$1,480,684
		$31,933,940
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$1,916,036
Total Construction Cost Incl. Escal.		**$33,849,976**

Figure 24. Kitchen Electrification Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate to Electrify Kitchen Appliances

HGA

3/20/2024

HGA Comm. #: 1174-003-00

	Kitchen	
Direct Construction Costs	%	Cost
Equipment and Labor		
Kitchen Equipment	77%	$7,896,500
Electrical Infrastruture Upgrades	18%	$1,860,000
General Requirements		
General Requirements	5%	$487,825
Total Direct Construction Cost		$10,244,325
Construction Contingency	2%	$204,887
Design Contingency	8%	$819,546
Sub Total		$11,268,758
Phasing Premium	6%	$676,125
Sub Total		$11,944,883
Soft Costs: Architectural / Engineering Fees	0%	$16,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$16,000
Soft Costs: Commissioning	0.20%	$23,890
General Conditions	10%	$1,194,488
Building Permit	1%	$119,449
Contractor Fee, Bond & Insurances	4%	$477,795
		$13,792,505
Constr. Escal. (Mid-Point of Construction 2-13-27)	4%	$827,550
Total Construction Cost Incl. Escal.		$14,620,055

Figure 25. Parking Garage Canopy Solar PV Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate to Center Parking Garage Solar PV Canopy

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Solar Array %	Solar Array Cost
Equipment and Labor		
Material & Final Engineering Est.	38%	$1,514,752
Mechanical Installation Est.	32%	$1,244,160
Freight Est.	1%	$28,000
Module Cost	8%	$332,500
All the DC Wiring and wiring labor	12%	$475,000
Inverters	2%	$95,000
AC Combiner Panel	1%	$20,000
Utility Disconnect	0%	$15,000
Materials and Labor from Utility Disconnect	1%	$30,000
General Requirements		
General Requirements	5%	$187,721
Total Direct Construction Cost		$3,942,133
Construction Contingency	5%	$197,107
Design Contingency	0%	$0
Sub Total		$4,139,239
Phasing Premium	0%	$0
Sub Total		$4,139,239
Soft Costs: Architectural / Engineering Fees	1%	$30,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	0%	$0
Soft Costs: Commissioning	0.20%	$8,278
General Conditions	2%	$82,785
Building Permit	2%	$82,785
Contractor Fee, Bond & Insurances	1%	$41,392
		$4,384,480
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$263,069
Total Construction Cost Incl. Escal.		$4,647,548

Figure 26. South of Parking Garage Solar PV Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate for 45°Solar Grandstand South of Parking Garage

HGA

3/19/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Solar Array	
	%	Cost
Equipment and Labor		
Engineering	5%	$72,778
Permits, Bonding & Interconnection	0%	$3,656
Mobilization, Travel, Conditions	3%	$51,652
Modules	12%	$186,792
Inverters	3%	$42,750
Racking	30%	$469,563
AC Equipment	4%	$62,497
Materials	1%	$17,500
DC Installation	30%	$469,563
AC Installation	12%	$187,825
Total Direct Construction Cost		$1,564,575
Construction Contingency	0%	$0
Design Contingency	0%	$0
Sub Total		$1,564,575
Phasing Premium	0%	$0
Sub Total		$1,564,575
Soft Costs: Commissioning	0.20%	$14,087
		$1,578,662
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$94,720
Total Construction Cost Incl. Escal.		$1,673,382

Figure 27. Existing Solar PV Array Relocation Cost Estimate

Potawatomi Casino
Milwaukee WI
Cost Estimate to Relocate Existing Solar Array

HGA

3/13/2024

HGA Comm. #: 1174-003-00

Direct Construction Costs

	Solar Array	
	%	Cost
Equipment and Labor		
(2) sets (4) 600 kcm + (1) #1/0 grd copper wire @ 287'. 4" conduit	37%	$54,000
Relocate and reuse existing 800A disconnnect from garage	1%	$2,000
Demolition of equipment: inverter, wire, terminations	7%	$10,000
(5) 100kW inverters + labor	36%	$53,500
New Eaton 800A breaker and installation into substation	14%	$21,080
General Requirements		
General Requirements	5%	$7,029
Total Direct Construction Cost		**$147,609**
Construction Contingency	5%	$7,380
Design Contingency	5%	$7,380
Sub Total		**$162,370**
Phasing Premium	2%	$3,247
Sub Total		**$165,617**
Soft Costs: Architectural / Engineering Fees	10%	$16,000
Soft Costs: Other Consultant Fees (Lighting, Kitchen, Acoustic, Security & I.T.)	10%	$16,000
Soft Costs: Commissioning	0.20%	$331
General Conditions	3%	$4,969
Building Permit	2%	$3,312
Contractor Fee, Bond & Insurances	5%	$14,906
		$221,135
Constr. Escal. (Mid-Point of Construction 2-13-27)	6%	$13,268
Total Construction Cost Incl. Escal.		**$234,403**

Appendix C Equipment List

Table 11. Air Handling Unit Summary

Air Handling Unit Summary									
Building	**Unit**	**Serves**	**Supply Airflow (cfm)**	**Supply Fan Power (hp)**	**Return Fan Power (hp)**	**Preheat Coil**	**Cooling Coil**	**Reheat Coil**	**Humidifier**
Casino/Hotel	AHU-H3	L1 Dining	11,300	25.0	10.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	AHU-H5	L1 Kitchen	14,000	25.0	10.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	AHU-H6	L3 Meeting Rooms (East)	26,420	60.0	25.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	AHU-H7	L3 Meeting Rooms (North)	26,770	75.0	30.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	AHU-H8	L1 Grand Hallway, L3 Connection	26,250	60.0	30.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	AHU-15 (H11)	Banquet Kitchen	27,410	(2) 25.0	(2) 10.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	AHU-16 (H12)	Pastry Kitchen	10,510	16.0	7.5	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	AHU-19 (Ex 5)	Dream Dance	9,000	15.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	AHU-20 (Ex 6)	1C7 Gaming	12,000	20.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	MAU H1	Banquet Kitchen	17,090	(2) 20.0	N/A	N/A	N/A	Furnace	N/A
Casino/Hotel	MAU H2	Pastry Kitchen	4,925	5.0	N/A	N/A	N/A	Furnace	N/A
Casino/Hotel	MAU-03	Main Kitchen	4,925	5.0	N/A	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-H01	Hotel Floor 2-17	32,340	(4) 20.0	30.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-H02	Hotel Guest Rooms	10,600	(4) 10.0	10.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-1	Southwest Casino	TBD	TBD	TBD	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-2	Southeast Casino	TBD	TBD	TBD	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-3	Northwest Casino	TBD	TBD	TBD	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-5	Gaming Area 1A (Skylodge and Bingo)	TBD	TBD	TBD	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-6	Gaming Area 1B (Bingo - West to Center)	TBD	TBD	TBD	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-10 (EX 35)	Rock & Brew (West)	15,125	25.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-22	2nd Floor-C4, C6, C7; 3rd Floor-C6, C7	25,000	40.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-25 (Ex 11)	1st Floor Section C6, C7	12,000	20.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-26 (EX 12)	Buffet/Ruyi	22,000	30.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-27 (EX 17)	EDR	15,000	25.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-29 (Ex 29)	Section 3C8	20,000	30.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-34 (EX 19)	Rock & Brew (East)	8,000	15.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-35 (Ex 18)	Walkway between Gaming 3 and 4	20,000	30.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-36 (Ex 25)	Gaming area 4	15,000	20.0	N/A	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-37 (Ex 20)	Gaming area 3 (Room 3446)	25,000	40.0	N/A	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-38	VIP, Tribal Room and Streat Eats	TBD	TBD	TBD	N/A	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-41 (Ex 1)	1C4 Gaming	40,000	75.0	40.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-42 (Ex 2)	1C5 Gaming	40,000	75.0	40.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-44 (Ex 3)	Gaming and 360	40,000	75.0	40.0	Hot Water	Chilled Water	N/A	N/A
Casino/Hotel	RTU-45 (Ex 4)	1C5 and 1C8 Gaming	30,000	50.0	30.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-46 (Ex 7)	1C8 Gaming	20,000	40.0	20.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-48 (Ex 8)	1C8 Gaming	40,000	75.0	40.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	RTU-49 (Ex 9)	1C7 Gaming	30,000	50.0	30.0	Hot Water	Chilled Water	Hot Water	N/A
Casino/Hotel	CRAC H1	IT/AV	12,000	7.5	N/A	N/A	DX	Electric	Infrared
Casino/Hotel	CRAC H2	SURV	8,600	10.0	N/A	N/A	DX	Electric	Infrared
Casino/Hotel	CRAC H3	IT/AV	12,600	7.5	N/A	N/A	Chilled Water	Electric	Infrared
Casino/Hotel	CRAC H4	SURV	8,200	7.5	N/A	N/A	Chilled Water	Electric	Infrared

Table 12. List of Equipment with Measure Involvement

	Heat Recovery Option 2	Restaurants & Kitchen Schedule	DCV for Restruanant AHUS	Liebert and UPS upgrades	Air Distribution Public Spaces	Boiler Economizers	Ultra Low Temperature Heating	Full Replacement	Modify Heating Coil	Modify Cooling Coil	Fan Wall	Controls Upgrade	Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
	X							X					CH-1	CH-Chiller	3rd FL Casino / Hotel	3301	Old Chiller Room	Trane	CVHF077FA1EO3UT2807V7E8R1C0000000J00F0000010003A(	425000	1999
	X							X					CH-2	CH-Chiller	3rd FL Casino / Hotel	3301	Old Chiller Room	Trane	CVHF077FA1EO3UT2807V7EBR1C0000000J0OF0000010003A	425000	1999
	X							X					CH-3	CH-Chiller	3rd FL Casino / Hotel	3301	Old Chiller Room	Trane	CVHF077FA1EO3UT2807V7E8R1C0000000JOOF0000010003A	425000	1999
Key													CH-4	CH-Chiller	3rd FL Casino / Hotel	3601	Chiller Room	Trane	CVHF770	425000	9/21/2007
Level II Audit Measures													CH-5	CH-Chiller	3rd FL Casino / Hotel	3601	Chiller Room	Trane	CVHE770	425000	9/21/2007
EEMs													CH-6	CH-Chiller	3rd FL Casino / Hotel	3601	Chiller Room	Trane	CVHF770	425000	9/21/2007
HDMs													CH-7	CH-Chiller	3rd FL Casino / Hotel	3601	Chiller Room	Trane	CVHF770	425000	9/21/2007
How impacted?													CH-8	CH-Chiller	3rd FL Casino / Hotel	3601	Chiller Room	Trane	CVHF760	425000	10/12/2018
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
													CT-1A	Cooling Tower	Mechanical Roof Plan NEW			BAC	1-33568-2	925000	2000
													CT-1B	Cooling Tower	Mechanical Roof Plan NEW			BAC	1-33568-2	925000	2000
													CT-2A	Cooling Tower	Mechanical Roof Plan NEW			BAC	Not Accessible	925000	2000
													CT-2B	Cooling Tower	Mechanical Roof Plan NEW			BAC	Not Accessible	925000	2000
													CT-3A	Cooling Tower	Mechanical Roof Plan NEW			EVAPCO	Not Accessible	925000	2007
													CT-3B	Cooling Tower	Mechanical Roof Plan NEW			EVAPCO	Not Accessible	925000	2007
													CT-4A	Cooling Tower	Mechanical Roof Plan NEW			EVAPCO	Not Accessible	925000	2007
													CT-4B	Cooling Tower	Mechanical Roof Plan NEW			EVAPCO	Not Accessible	925000	2007
													CT-4C	Cooling Tower	Mechanical Roof Plan NEW			EVAPCO	Not Accessible	925000	2007
													Lakos Side Stream Filtration	Cooling Tower	Mechanical Roof Plan NEW					83000	2000
													Side Stream Filtration	Cooling Tower	Mechanical Roof Plan NEW			Bell and Gossett		83000	2007
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
	X				X				X			X	RTU-1	RTU - Roof Top Unit	Mechanical Roof Plan NEW			HAAKON		2100000	1999
	X								X				RTU-14	RTU - Roof Top Unit	Mechanical Roof Plan NEW			HAAKON	PVS-18	2100000	2006
	X				X				X			X	RTU-2	RTU - Roof Top Unit	Mechanical Roof Plan NEW			HAAKON	PENTPAK	2100000	1999
	X				X				X			X	RTU-22	RTU - Roof Top Unit	Mechanical Roof Plan NEW			Trane	TSCB050U0D00000000CC0UA279.0	2100000	2007
	X								X				RTU-25	RTU - Roof Top Unit	Mechanical Roof Plan NEW			Trane	TSCB025U0D00000000CC00A222.8	1560000	2007
	X	X							X			X	RTU-26	RTU - Roof Top Unit	Mechanical Roof Plan NEW			Trane	TSCB050UOD00000000CC00A262.5	2100000	2007
	X	X							X			X	RTU-27	RTU - Roof Top Unit	Mechanical Roof Plan NEW			Trane	NOT LEGIBLE	1068000	2007
	X				X				X			X	RTU-3	RTU - Roof Top Unit	Mechanical Roof Plan NEW			HAAKON	PENTRAK	2100000	1999
	X								X				RTU-4	RTU - Roof Top Unit	Mechanical Roof Plan NEW			HAAKON	PENTPAK	1560000	1999
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
	x						X		X	X		X	MAU-1	MAU - Makeup Air Unit	Mechanical Roof Plan NEW			TRANE	TSCB0303D00006000CC00A242.8	960000	2007
	x						X		X	X		X	MAU-2	MAU - Makeup Air Unit	Mechanical Roof Plan NEW			Trane	TSCB025U0D00000000CC00A242.8	960000	2007
	x						X		X	X		X	MAU-3	MAU - Makeup Air Unit	Mechanical Roof Plan NEW			TRANE	TSCB066U0D00000000CC00A309.0	960000	2007
	x						X		X	X		X	MAU-4	MAU - Makeup Air Unit	Mechanical Roof Plan NEW			Trane	TSCB035U0D00000000CC00A275.5	960000	2007
	x						X		X	X		X	MAU-5	MAU - Makeup Air Unit	Mechanical Roof Plan NEW			Trane	TSCB021U0D00000000CC00A255.0	960000	2007
	x						X		X	X		X	MAU-6	MAU - Makeup Air Unit	Mechanical Roof Plan NEW			Trane	TSCB021U0D00000000CC00A266.0	960000	2007
	x						X		X	X		X	MAU-7	MAU - Makeup Air Unit	2nd FL Casino / Hotel	2806	Air Handler Room	Trane	MCCB035UA0COUA	960000	2007
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
													RTU-P01	RTU- Roof Top Unit	Second			Trane	YHC120A4RYAOTO8	130000	2007
													RTU-P02	RTU- Roof Top Unit	Second			Trane	YHC074F4RMA1N68	130000	2007
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
	X								X				FCU-09	FCU-Fan Coil Unit	1st FL Casino / Hotel	1748	Open Shell Space	Trane	LPCAAD8D1FORCM	42600	2007
	X								X				FCU-20	FCU-Fan Coil Unit	1st FL Casino / Hotel	1639	BOH Corridor Employee Check-In	Trane	BCH036A	42600	2007
	X								X				FCU-36	FCU-Fan Coil Unit	3rd FL Casino / Hotel	3701	Skywalk	Trane	BCHC090A1BOA2AN3D	42600	2007
	X								X				FCU-37	FCU-Fan Coil Unit	3rd FL Casino / Hotel	3701	Skywalk	Trane	BCHC090A1BOOA2AN3D	42600	2007
	X								X				FCU-38	FCU-Fan Coil Unit	3rd FL Casino / Hotel	3701	Skywalk	Trane	BCHC090A1BOO2AN3D	42600	2007
	X								X				FCU-39	FCU-Fan Coil Unit	3rd FL Casino / Hotel	3701	Skywalk	Trane	BCHC090A1BOA2AN3D	42600	2007
	X								X				FCU-40	FCU-Fan Coil Unit	3rd FL Casino / Hotel	3701	Skywalk	Trane	BCHC090A1BOA2AN3D	42600	2007
	X								X				FCU-1H-10	FCU-Fan Coil Unit	1st FL Casino / Hotel	133	Hotel Trash Room	Zehnder Rittling	FBHP-710	42600	2014
	X								X				FCU-1H-7	FCU-Fan Coil Unit	1st FL Casino / Hotel	134	Hotel Water Room	Zehnder Rittling	FBHP-710	42600	2014
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
													CWP-1	Pumps	3rd FL Casino / Hotel	3301	Old Chiller Room	Taco	FA2524....		Aug-99
													CWP-2	Pumps	3rd FL Casino / Hotel	3301	Old Chiller Room	Taco	TA2524B2P1B2L0		Aug-99
													CWP-3	Pumps	3rd FL Casino / Hotel	3301	Old Chiller Room	Taco	TA2524B2P1B2L0		Aug-99
													CWP-4	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CWP-5	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CWP-6	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett	Not Accessible		2007
													CWP-7	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CWP-8	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007

	Heat Recovery Option 2	Restaurants & Kitchen Schedule	DCV for Restruanant AHUS	Liebert and UPS upgrades	Air Distribution Public Spaces	Boiler Economizers	Ultra Low Temperature Heating	Full Replacement	Modify Heating Coil	Modify Cooling Coil	Fan Wall	Controls Upgrade	Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
													CHWP-1	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-10	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-2	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-3	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-4	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-5	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-6	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-7	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2007
													CHWP-8	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	Bell and Gossett			2016
													CHWP-9	Pumps	3rd FL Casino / Hotel	3601	Chiller Room	BELL AND GOSSETT			2016
													Name	Asset Category	Floor	Room Number	Room Name				
													HWP-1	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gosset			2007
													HWP-2	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	Not Accessible		2007
													HWP-3	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	Not Accessible		2007
													HWP-4	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	Not Accessible		2007
													HWP-5	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	N/A		2007
													HWP-6	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	N/A		2007
													HWP-7	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	N/A		2007
													HWP-8	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	N/A		2007
													HWP-9	Pumps	3rd FL Casino / Hotel	3602	Boiler Room	Bell and Gossett	N/A		2007
													Name	Asset Category	Floor	Room Number	Room Name				
													Steam Boiler Pump-1	Boiler	3rd FL Casino / Hotel	3602	Boiler Room	Grundfos	A96610884-P10744323	615000	2007
													Steam Boiler Pump-2	Boiler	3rd FL Casino / Hotel	3602	Boiler Room	Grundfos	A96610884-P10744322	615000	2007
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
						X						X	B-1	Boiler	3rd FL Casino / Hotel	3602		Bryan	RW2100-W-FDG-LX	615000	2007
						X						X	B-2	Boiler	3rd FL Casino / Hotel	3602		Bryan	RW2100-W-FDG-LX	615000	2007
						X						X	B-3	Boiler	3rd FL Casino / Hotel	3602		Bryan	RW2100-W-FDG-LX	615000	2007
						X						X	B-4	Boiler	3rd FL Casino / Hotel	3602		Bryan	RW2100-W-FD-(B0)	615000	2013
						X						X	B-5	Boiler	3rd FL Casino / Hotel	3602		Bryan	RV800-W-FDG	615000	1999
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
				X								X	CRU-1A	CU-Liebert	2nd FL Casino / Hotel	2404	Surveilance	Liebert	VH114AUAAEI	93000	2008
				X								X	CRU-1B	CU-Liebert	2nd FL Casino / Hotel	2404	Surveilance	Liebert	VH114AUAAEI	93000	2008
				X								X	CRU-4A	CU-Liebert	2nd FL Casino / Hotel	2706	Surveilance	Liebert	VH125AUAAEI	93000	2008
				X								X	CRU-4B	CU-Liebert	2nd FL Casino / Hotel	2706	Surveilance	Liebert	VH125AUAAEI	93000	2008
				X								X	CRU-5A	CU-Liebert	2nd FL Casino / Hotel	2812	Surveillance Equipment	Liebert	VH125AUAAEI	93000	2008
				X								X	CRU-5B	CU-Liebert	2nd FL Casino / Hotel	2812	Surveillance Equipment	Liebert	VH125AUAAEI	93000	2008
				X								X	CRAC-1	CU-Liebert	3rd FL Casino / Hotel	3110	Surveilance Room	Liebert	BF067A-AAEI	93000	2003
				X								X	CRAC-2	CU-Liebert	3rd FL Casino / Hotel	3110	Surveilance Room	Liebert	BF067A-AAEI	93000	2003
				X								X	CRAC-2A	CU-Liebert	2nd FL Casino / Hotel	2508	Surveilance Equipment	Liebert	MMD24E-XHEDG	93000	2008
				X								X	CRAC-2B	CU-Liebert	2nd FL Casino / Hotel	2508	Surveilance Equipment	Liebert	MMD24E-XHEDG	93000	2008
				X								X	CRAC-H1	CU-Liebert	2nd FL Casino / Hotel	221	Hotel Mechanical Room	Liebert	VS077AUA0EI549A	266000	2013
				X								X	CRAC-H2	CU-Liebert	2nd FL Casino / Hotel	226	East Mechanical Room	Liebert	VS053AUA0EI550A	266000	2013
				X								X	CRAC-H3	CU-Liebert	2nd FL Casino / Hotel	221	Hotel Mechanical Room	Liebert	CW084UCSA2S549	266000	2013
				X								X	CRAC-H4	CU-Liebert	2nd FL Casino / Hotel	226	East Mechanical Room	Liebert	CW060UCSA2A549	266000	2013
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
	X	X	X						X	X	O	X	AHU-19	AHU- Air Handling Unit	2nd FL Casino / Hotel	2806	Air Handler Room	Trane	MCCB021UA0COUA	648000	2007
	X				X				X	X	O	X	AHU-20	AHU- Air Handling Unit	2nd FL Casino / Hotel	2806	Air Handler Room	Trane	MCCB025UA0COUA	648000	2007
	X								X	X	O		AHU-21	AHU- Air Handling Unit	2nd FL Casino / Hotel	2802	Air Handler Room	Trane	MCCB030UA0COUA	648000	2007
	X								X	X	O		AHU-23	AHU- Air Handling Unit	3rd FL Casino / Hotel	3601	Chiller Room	Trane	N/A	408000	2007
	X								X	X	O		AHU-30	AHU- Air Handling Unit	Lower Level - Valet	402	Air Handler Room	Trane	MCCB030UA0COUA	648000	2008
	X								X	X	O		AHU-31	AHU- Air Handling Unit	Lower Level - Valet	0501A	Air Handler Room	Trane	MCCB030UA0COUB	648000	2007
	X								X	X	O		AHU-32	AHU- Air Handling Unit	Lower Level - Valet	701	Air Handler Room	Trane	MCCB030UA0COUB	648000	2007
	X								X	X	O		AHU-33	AHU- Air Handling Unit	Lower Level - Valet	801	Air Handler Room	Trane	MCCB030UACOUA	648000	2007
	X								X	X	O		AHU-39	AHU- Air Handling Unit	2nd FL Casino / Hotel	2802	Air Handler Room	Trane	CSAA021UAF00	648000	2007
	X								X	X	O		AHU-7	AHU- Air Handling Unit	3rd FL Casino / Hotel	3303	Air Handler Room	Trane	Not Accessible	648000	2000
													Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
				X								X	AC-01	AC-Liebert	First	P131	Surveillance Room	Liebert	DME037E-PH3	75000	2007
				X								X	AC-02	AC-Liebert	First	P136	Surveillance Equipment Room	Liebert	DMW027E-PH3	75000	2000
				X								X	AC-03	AC-Liebert	First	P137	Elevator Equipment	Liebert	MMD36KAHEDA	75000	2007

	Heat Recovery Option 2	Restaurants & Kitchen Schedule	DCV for Restruanant AHUS	Liebert and UPS upgrades	Air Distribution Public Spaces	Boiler Economizers	Ultra Low Temperature Heating	Full Replacement	Modify Heating Coil	Modify Cooling Coil	Fan Wall	Controls Upgrade	Name	Asset Category	Floor	Room Number	Room Name	Manufacturer	Model	Cost	Manufacture Date
				X								X	AC-04	AC-Liebert	First			Liebert	MMD36KAHEDA	75000	2007
				X								X	AC-05	AC-Liebert	First	P129	Electrical Room / UPS	Liebert	MCD69W3AH4	75000	2007
				X								X	AC-06	AC-Liebert	First	P136	Surveillance Equipment Room	Liebert	DME027E-PH3	75000	2000
				X								X	AC-07	AC-Liebert	First	P131	Surveillance Room	Liebert	DME037E-PH3	75000	2007
				X								X	AC-08	AC-Liebert	First	P131	Surveillance Room	Liebert	DME03E-PH3	75000	2007
				X								X	AC-09	AC-Liebert	First	P136	Surveillance Equipment Room	Liebert	DME027E-PH3	75000	2000
				X								X	AC-13 (8)	AC-Liebert	Third	P301	Surveillance	Liebert	MMD20G3PHE7GS74	75000	2014
				x								X	AC-7	AC-Liebert	Third	P301	Surveillance	Liebert	MCD38W3AH7	75000	2014
				X								X	IF-01	AC-Liebert	First	P131	Surveillance Room	GREENHECK	SQ-120-A	75000	2007

Table 13 below includes a summary of observations and deficiencies noticed while going through the new BAS for the facility. The air handlers and rooftop units included in this list are the ones that will be impacted as part of the implementation of the measures in this report. These issues include loss of communication with zone temperature, humidity, and CO2 sensors, airflow sensors being out of calibration, damper actuators having controls issues, among others. These issues either operate the unit inefficiently or cause the onsite BAS team to put manual overrides to prevent alarms and shutdowns. For the building to get the required conditioned and purified air, and the energy efficiency measures to provide the intended energy savings, these issues would need to be fixed.

Table 13. Common Deficiencies Noticed from BAS

Corrective Action Report	
Issue	**Unit**
Zone sensor communication failure	AHU-20 (Ex 6)
	RTU-42 (Ex 2)
	RTU-44 (Ex 3)
	RTU-45 (Ex 4)
	RTU-46 (Ex 7)
	RTU-48 (Ex 8)
	RTU-49 (Ex 9)
Sensor failure or out of calibration	AHU-H3
	AHU-H5
	AHU-H8
	AHU-20 (Ex 6)
	RTU-H01
	RTU-1
	RTU-2
	RTU-3
	RTU-22
	RTU-29 (Ex 29)
	RTU-35 (Ex 18)
	RTU-36 (Ex 25)
	RTU-41 (Ex 1)
Damper control issues	RTU-6
	RTU-10 (EX 35)
	RTU-34 (EX 19)
	RTU-37 (Ex 20)
	RTU-38
Discharge temperature control improvement	AHU-H7
	RTU-H01
	RTU-44 (Ex 3)
Heating or cooling valve needs checked	RTU-6
	RTU-44 (Ex 3)
	RTU-48 (Ex 8)

Appendix D Emissions Data

Figure 28. Carbon Emissions Timeline

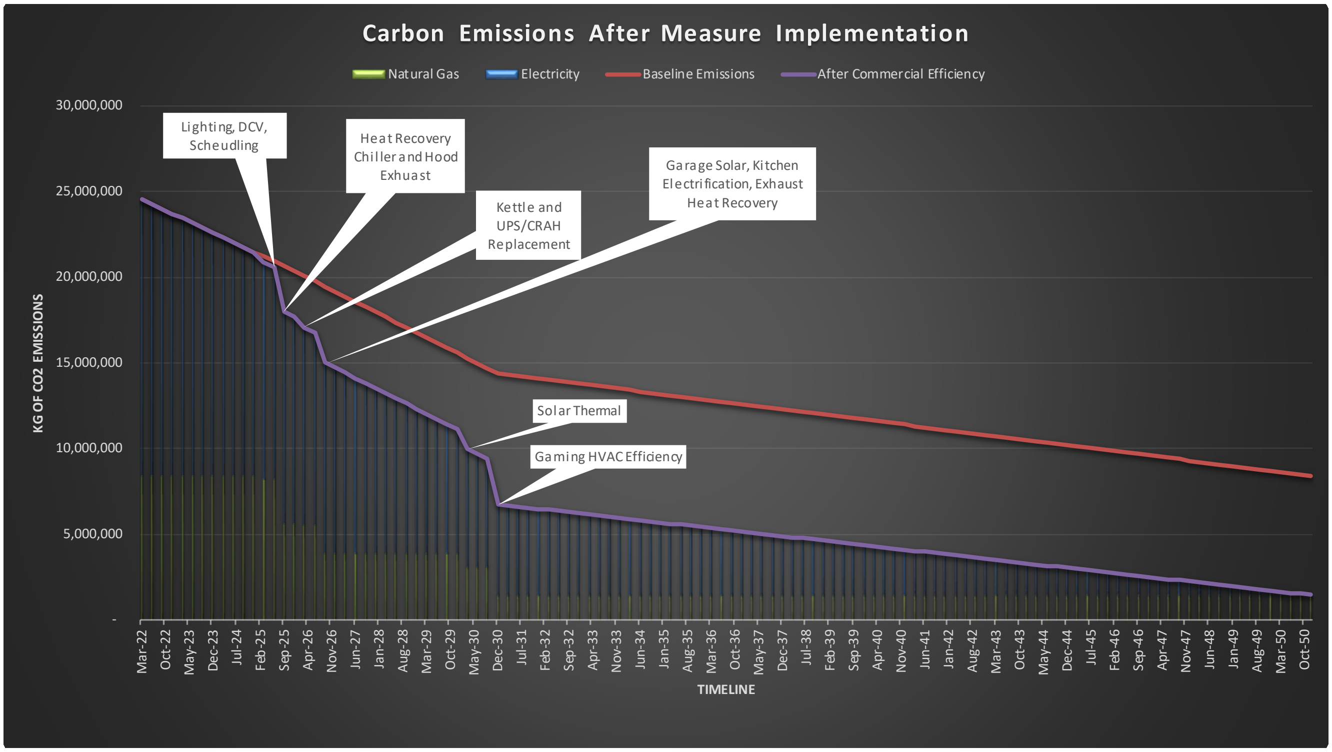


Figure 29. Energy Use Timeline

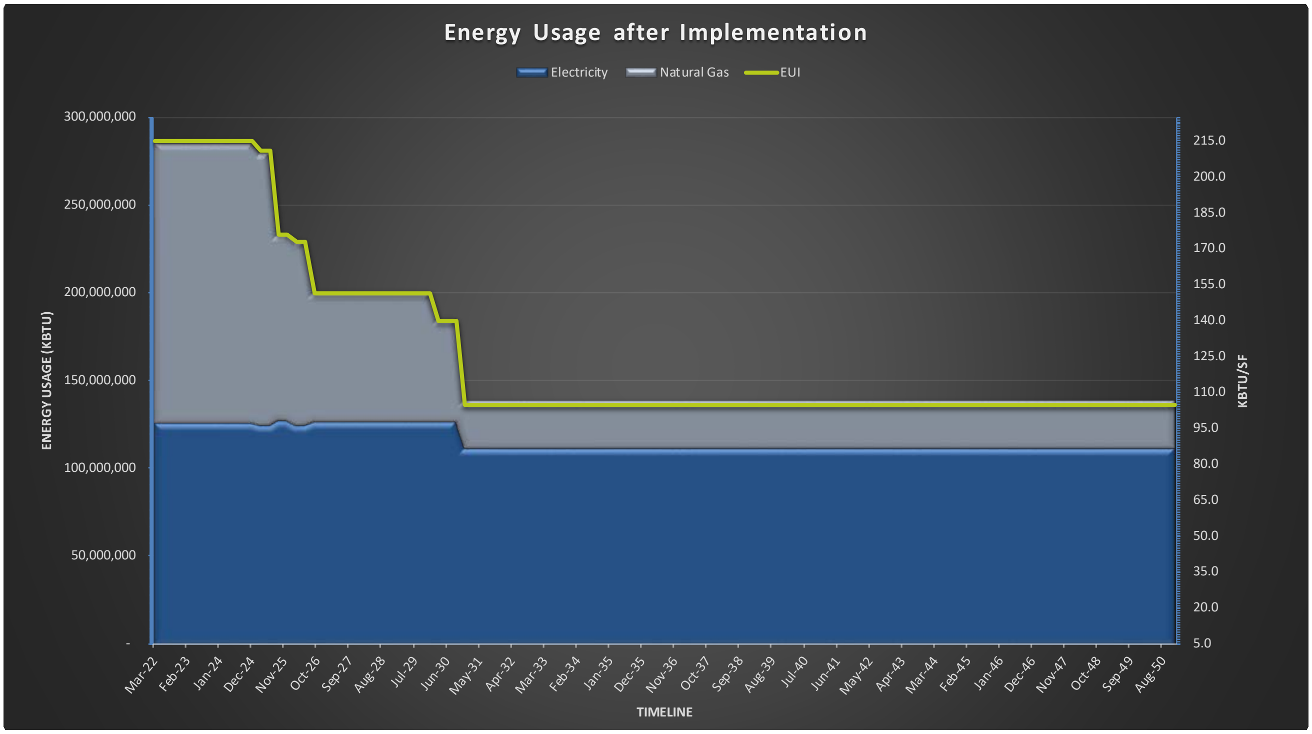


Table 14. Measures Emissions Summary

Energy Saving Strategy	Cumulative** CO2 (kg)	Average Annual N2O (lbs)	Average Annual CH4 (lbs)	Cumulative CO2e (metric tons)
Obtain Specifications for Implementation:				
Retrofit LED Lighting Fixtures in Mechanical Spaces	179,949	80	(0)	180
Optimize DCV Controls for Major Restaurants	2,231,694	20	3	2,232
Add Unoccupied Setbacks for Major Restaurants and Kitchens	4,026,035	203	5	4,026
Install Efficient Air Distribution System in Gaming Space	56,131,001	3,335	69	56,131
Upgrade Server Rooms UPS's and Cooling Units	2,332,240	591	0	2,332
Install Heat Recovery Loop to Toilet, General and Vapor Exhausts	7,686,163	(256)	14	7,686
Optimize Kettle and Dishwashing Unit Steam Operation	1,692,588	0	3	1,693
Consolidate Kitchen Hood Exhaust Operation	1,209,356	5	2	1,209
Install Solar Thermal Hot Water System	21,077,156	(35)	34	21,077
Install Heat Recovery Chillers	63,925,942	(568)	106	63,926
Electrify Kitchen Appliances	27,910,731	(1,405)	54	27,911
Install a Solar PV Array on Parking Garage	4,933,099	1,251	0	4,933
Total for all measures above recommended for implementation or study:	**193,335,954**	**3,223**	**290**	**193,336**
Additional Opportunities:				

* Further study required, † Incremental cost used, TBD = to be determined

** Calculated from 2025 to 2050.

Table 15. Annual Measures Emissions

	Baseline Forecast KG CO2	Solar Thermal Offset KG CO2	Heat Recovery Chiller Offset KG CO2	Kitchen Electrification Offset KG CO2	Solar PV Garage Canopy Offset KG CO2	LED Retrofit KG CO2	DCV Controls for Restaurants KG CO2	Unoccupied Setbacks for Restaurants KG CO2	Efficient HVAC System in Gaming Space KG CO2	Upgrade UPS's and Cooling Units KG CO2	Heat Recovery Loop for Exhausts KG CO2	Optimize Kettle and Dishwashing Operation KG CO2	Consolidate Kitchen Hood Exhaust KG CO2	Net Emissions KG CO2
2021	24,829,886													24,829,886
2022	23,713,451													23,713,451
2023	22,597,016													22,597,016
2024	21,480,581													21,480,581
2025	20,364,146	800,238	2,299,803	686,099	533,308	29,023	91,354	210,365	3,072,990	252,134	224,818	65,100	47,868	12,051,048
2026	19,168,361	801,855	2,324,466	746,231	479,977	25,592	90,497	201,747	2,931,099	226,921	235,809	65,100	47,657	10,991,410
2027	17,972,576	803,473	2,349,129	806,364	426,646	22,161	89,640	193,130	2,789,208	201,707	246,799	65,100	47,447	9,931,772
2028	16,776,791	805,091	2,373,792	866,496	373,316	18,731	88,783	184,512	2,647,317	176,494	257,789	65,100	47,237	8,872,134
2029	15,581,006	806,709	2,398,455	926,628	319,985	15,300	87,927	175,894	2,505,426	151,280	268,780	65,100	47,027	7,812,496
2030	14,385,221	808,326	2,423,118	986,760	266,654	11,869	87,070	167,277	2,363,535	126,067	279,770	65,100	46,817	6,752,858
Cumulative 2025 - 2030		**4,825,692**	**14,168,765**	**5,018,578**	**2,399,886**	**122,676**	**535,271**	**1,132,925**	**16,309,574**	**1,134,603**	**1,513,765**	**390,597**	**284,053**	
2031	14,086,275	808,731	2,429,284	1,001,793	253,321	11,012	86,856	165,122	2,328,062	119,764	282,518	65,100	46,764	6,487,948
2032	13,787,329	809,135	2,435,450	1,016,827	239,989	10,154	86,642	162,968	2,292,590	113,460	285,265	65,100	46,712	6,223,038
2033	13,488,383	809,540	2,441,616	1,031,860	226,656	9,296	86,427	160,814	2,257,117	107,157	288,013	65,100	46,659	5,958,129
2034	13,189,436	809,944	2,447,781	1,046,893	213,323	8,439	86,213	158,659	2,221,644	100,854	290,761	65,100	46,607	5,693,219
2035	12,890,490	810,349	2,453,947	1,061,926	199,990	7,581	85,999	156,505	2,186,171	94,550	293,508	65,100	46,554	5,428,310
2036	12,591,544	810,753	2,460,113	1,076,959	186,658	6,723	85,785	154,350	2,150,699	88,247	296,256	65,100	46,502	5,163,400
2037	12,292,598	811,158	2,466,279	1,091,992	173,325	5,866	85,571	152,196	2,115,226	81,944	299,003	65,100	46,449	4,898,491
2038	11,993,652	811,562	2,472,444	1,107,025	159,992	5,008	85,357	150,042	2,079,753	75,640	301,751	65,100	46,396	4,633,581
2039	11,694,705	811,967	2,478,610	1,122,058	146,660	4,150	85,142	147,887	2,044,280	69,337	304,499	65,100	46,344	4,368,672
2040	11,395,759	812,371	2,484,776	1,137,091	133,327	3,292	84,928	145,733	2,008,808	63,034	307,246	65,100	46,291	4,103,762
2041	11,096,813	812,775	2,490,942	1,152,124	119,994	2,435	84,714	143,578	1,973,335	56,730	309,994	65,100	46,239	3,838,853
2042	10,797,867	813,180	2,497,107	1,167,157	106,662	1,577	84,500	141,424	1,937,862	50,427	312,741	65,100	46,186	3,573,943
2043	10,498,920	813,584	2,503,273	1,182,190	93,329	719	84,286	139,269	1,902,389	44,123	315,489	65,100	46,134	3,309,034
2044	10,199,974	813,989	2,509,439	1,197,223	79,996	(138)	84,072	137,115	1,866,917	37,820	318,237	65,100	46,081	3,044,124
2045	9,901,028	814,393	2,515,605	1,212,256	66,663	(996)	83,857	134,961	1,831,444	31,517	320,984	65,100	46,029	2,779,215
2046	9,602,082	814,798	2,521,770	1,227,290	53,331	(1,854)	83,643	132,806	1,795,971	25,213	323,732	65,100	45,976	2,514,305
2047	9,303,135	815,202	2,527,936	1,242,323	39,998	(2,711)	83,429	130,652	1,760,499	18,910	326,479	65,100	45,924	2,249,396
2048	9,004,189	815,607	2,534,102	1,257,356	26,665	(3,569)	83,215	128,497	1,725,026	12,607	329,227	65,100	45,871	1,984,486
2049	8,705,243	816,011	2,540,268	1,272,389	13,333	(4,427)	83,001	126,343	1,689,553	6,303	331,975	65,100	45,819	1,719,577
2050	8,406,297	816,415	2,546,433	1,287,422	-	(5,284)	82,787	124,189	1,654,080	-	334,722	65,100	45,766	1,454,667
Cumulative 2025 - 2050		**21,077,156**	**63,925,942**	**27,910,731**	**4,933,099**	**179,949**	**2,231,694**	**4,026,035**	**56,131,001**	**2,332,240**	**7,686,163**	**1,692,588**	**1,209,356**	

Potawatomi Carter Hotel Casino Brief of Recommended Measures

618 WI-32, Wabeno, WI 54566

POTAWATOMI
CASINO | HOTEL™
CARTER

GRUMMAN|BUTKUS
ENERGY EFFICIENCY CONSULTANTS
AND SUSTAINABLE DESIGN ENGINEERS

RECOMMENDED CAPITAL MEASURES AT POTAWATOMI CARTER CASINO

Over the course of the fall and winter of 2023, Potawatomi Carter Casino and Hotel worked with engineering firm Grumman Butkus Associates to identify capital measures that will reduce energy consumption at the Potawatomi Carter Casino. Below is a brief discussion of the measures that are being recommended for implementation. Summary table is below. For a complete list of measures evaluated and considered, refer to the full report.

SUMMARY OF MEASURES RECOMMENDED

EEM	Description	kWh/yr Savings	Therm/Yr Savings	Utility Cost Savings	Carbon Emission Reduction (Tons CO_2E)	Capital Cost	Payback (yrs)
1	Rebuild RTU 1 and 2 with Variable Exhaust and Reduced Supply Flow	525,000	53,400	$96,000	736	$1,400,000	14.5
2	RTU-3 Modification – Variable Exhaust Flow and Variable Supply Flow	32,600	5,000	$11,300	56	$490,000	43
3	Schedule RTU-6 VAVs	8,600	1,900	$1,800	18	$5,000	2.8
4	Control Flames Makeup Based on Exhaust Hood Status	10,700	2,000	$2,000	20	$10,000	5
5	Occupancy Sensor Control for RTU-7	12,900	1,100	$1,500	17	$10,000	6.7
6	Install ground-source heat pump system to support loads served by RTUs-1,2,3,6,&7.	271,857	19,679	$30,335	492	$5,925,000	195
	TOTAL	861,657	83,079	$142,955	1,339	$7,840,000	43

NOTES:

Grumman/Butkus Associates does not guarantee that proposals, bids, or actual construction costs, incentives and stated energy savings will not vary from costs and average contained within.

The estimated useful life of all proposed measures is 20 years.

REBUILD RTU 1 AND 2 WITH VARIABLE EXHAUST AND REDUCED SUPPLY FLOW

Background

RTU-1,2 serve the Carter casino, VIP room, and Flames restaurant dining area. The casino used to allow smoking but the elimination of smoking and the space not always being at peak occupancy provides opportunities for improving energy efficiency.

The casino is not always fully occupied and during periods of lower occupancy the outside airflow and associated exhaust could be reduced to save energy. Measuring the CO_2 levels in the space is an effective way to determine occupancy and air quality and can be utilized for modulating ventilation. The RTUs have more than enough supply airflow to satisfy the heating/cooling load in the space. The original sizing was likely based on the ventilation requirements when smoking was in the space.

This measure and associated savings assumes smoking will continue to not be allowed in the casino and that the International Mechanical Code can be utilized for ventilation design in lieu of Wisconsin code. The Wisconsin code includes a requirement of 2 cfm per square foot of exhaust for casinos which in our opinion is unreasonably high for a non-smoking casino and results in a much higher outside airflow requirement than that required by the International Mechanical Code, which is utilized by the majority of the country.

The EEM is “reversible” and if smoking or other changes occurred the system could be returned to operate at full flow, as it does now, which would eliminate the energy savings.

Assumptions for Energy Savings

New equipment sizing is based on the original design occupancy of 2,500 people. All EEM 1 energy saving calculations are based on the actual hourly head count data provided in 2011 which had a maximum occupancy of 1,678 people. The current occupancy is less and therefore the energy savings will be greater than that calculated until occupancy returns to previous levels.

Energy savings calculations assume the VIP room RCx measures listed in the retrocommissioning report have been completed. If these RCx measures weren’t completed the savings for these measures will be greater.

Occupant Comfort and Indoor Air Quality

This measure includes a reduction in ventilation and exhaust airflows which could technically reduce air quality from the existing conditions but the air quality will still be in compliance with the International Mechanical Code and ASHRAE guidelines and therefore no impact to occupant comfort is expected.

Recommended Action

Provide VFDs on both the supply and exhaust fans. Modulate ventilation and exhaust flow. Operate the supply fan at a reduced flow continuously.

Implementation

Provide new VFDs for the exhaust fans in RTU-1 and RTU-2. The fan motors are inverter duty and therefore do not require replacement. Provide controls which allow VFDs to be modulated by the BMS.

Modify existing outside air inlet damper (this is the damper at the outside air inlet, not the face/bypass damper which controls whether air flows through or bypasses heat recovery) and return face/bypass dampers (the dampers which control whether flow goes through heat recovery and out exhaust or returns to supply fan) and all associated controls so that the dampers can be modulated by the BMS instead of being 2-position.

Provide a total of 6 space CO2 sensors. One sensor shall be located in the Flames Restaurant seating area and one shall be in the VIP room. The casino shall include two sensors in the area served by RTU-1 and two sensors in the area served by RTU-2.

Provide Demand Controlled Ventilation (DCV) controls which reduce outside and exhaust airflow when space CO2 is below setpoint.

Provide new VFDs for the supply fans in RTU-1 and RTU-2. The fan motors are inverter duty and therefore do not require replacement. Provide controls which allow VFDs to be modulated by BMS.

Perform test of existing RTU flows. After verifying existing flows, perform test and balance on supply air side of the system including both the RTUs and the downstream ductwork. Replace/fix any volume dampers which aren't operational. Decrease supply fan speed and balance grilles serving entry (these are served by RC-3,4) to original design flows and balance remaining grilles/diffusers to achieve a total supply flow of 25,000 cfm for each of the units. Confirm minimum flow requirements of furnace and cooling systems and increase minimum flow value as required to ensure heating and cooling operate properly. Perform the remaining test and balance work listed in the previous measure associated with determining exhaust fan speed and damper curves at this new reduced supply flow.

To ensure persistence of this measure, the units could be fully rebuilt utilizing the existing housings which would improve maintainability. If the units are rebuilt the following components should be replaced: all dampers, supply fans, exhaust fans, furnace, entire DX cooling system, and all sensors. The following components may remain and be reused: flat plate heat exchanger and filter racks. The hot gas reheat coil and any remaining piping for the hot gas reheat system shall be removed.

Energy Savings

Energy savings are provided by reducing the amount of heating and cooling required for conditioning the outside air and by reducing the amount of exhaust fan energy. Savings assume RTU-1 EF runs even when the VIP is unoccupied which reduces savings but improves ventilation distribution.

Estimated Energy Savings

Electricity Demand Savings (kW)	Electricity Energy Savings (kWh/yr)	Natural Energy Savings (therm/yr)	Utility Cost Savings ($/yr)	Investment Economics	
				Estimated Capital Cost ($)	Simple Payback (yrs)
186	525,000	53,400	$96,000	$1,400,000	14.5

O&M Impact

The new VFDs will require maintenance but this should be more than outweighed by the reduced wear and tear on the exhaust fans due to operating at reduced speed and the soft start capability of a VFD. Once fully rebuilt, as discussed above, the estimated remaining useful life of the RTUs would be 20 years.

EEM 2: RTU-3 MODIFICATIONS – VARIABLE EXHAUST FLOW

Recommended Action

Provide variable frequency drive (VFD) for the exhaust fan and modify existing dampers to provide modulating controls. Reduce exhaust and outside airflow when less ventilation is required.

Either EEM 2a or 2b should be selected and the energy savings and capital cost listed for each option is comprehensive and not additive with the other EEM 2 option.

Background

RTU-3 serves the bingo hall which used to allow smoking but the elimination of smoking and the space not always being at peak occupancy (if occupied at all) would allow the outside and exhaust airflows to be reduced significantly while still maintaining occupant comfort and health. The exhaust flow can be reduced by adding a VFD to the exhaust fan and reducing exhaust fan speed when less exhaust flow is required. The outside airflow can be reduced by adding modulating controls to the outside air inlet damper and the return face/bypass dampers and modulating the dampers to decrease outside airflow and increase return airflow.

This measure is "reversible" and if smoking or other changes occur the system could be returned to operate at full flow as it does now which would eliminate the energy savings. Staff have indicated that it's possible that the area served by RTU-3 will be converted into a smoking casino area with slot machines and therefore only easily "reversible" measures have been proposed, unlike the replacement options included for RTU-1,2.

Implementation

Provide new VFD for the exhaust fan in RTU-3. The fan motor is inverter duty and therefore does not require replacement. Provide controls which allow VFD to be modulated by the BMS.

Modify existing outside air inlet damper (this is the damper at the outside air inlet, not the face/bypass damper which controls whether air flows through or bypasses heat recovery) and return face/bypass damper (the dampers which control whether flow goes through heat recovery and out exhaust or returns to supply fan) and all associated controls so that the dampers can be modulated by the BMS instead of being 2-position.

Provide a CO2 sensor in the space or return duct.

Provide Demand Controlled Ventilation (DCV) controls which reduce outside and exhaust airflow when space CO2 is below setpoint. Supply flow will remain constant. See Scope of Work document for a more detailed sequence of operation.

Energy Savings

Energy savings are provided by reducing the amount of heating and cooling required for conditioning the outside air and by reducing the amount of exhaust fan energy. Energy savings calculations assume the VIP room RCx measures listed in the retrocommissioning report have been completed. If these RCx measures weren't completed the savings for these measures will be greater.

Estimated Energy Savings

Electricity Demand Savings (kW)	Electricity Energy Savings (kWh/yr)	Natural Energy Savings (therm/yr)	Utility Cost Savings ($/yr)	Investment Economics	
				Estimated Capital Cost ($)	Simple Payback (yrs)
33	32,600	5,100	$11,300	$490,000	43

Indoor Air Quality and Occupancy Comfort Impact

Although indoor air quality will technically be reduced due to a reduction in outside airflow, no impact to occupancy comfort is expected because the space will still be provided with ventilation levels which are in compliance with industry standard and ASHRAE requirements.

O&M Impact

The new VFD will require maintenance but this should be more than outweighed by the reduced wear and tear on the exhaust fan due to operating at reduced speed and the soft start capability of a VFD. Once fully rebuilt, as discussed above, the estimated remaining useful life of the RTU would be 20 years.

EEM 3: SCHEDULE RTU-6 VAVS

Recommended Action

Schedule VAV boxes serving areas which aren't occupied continuously utilizing time of day scheduling.

Background

RTU-6 serves the administrative and back of the house areas. Some of these areas can be occupied at any time which prevents the RTU from being able to be turned off entirely, but there are some VAVs serving areas which aren't occupied at night and scheduling these and allowing them to close fully will save energy.

Implementation

Discuss the hours of operation of the various spaces served by RTU-6 with the space occupants. Provide unoccupied controls for the VAVs serving areas which can be scheduled and when unoccupied the VAV box shall have a minimum flow setpoint of 0 cfm. Provide unoccupied space temperature setpoints. If the space is beyond the unoccupied heating or cooling setpoint the VAV box should open to normal, occupied flow setpoints to provide heating or cooling.

Even greater energy efficiency could be achieved by using occupancy sensors which set the VAV to standby mode when the space is unoccupied. Standby mode would utilize occupied or standby space temperature setpoints but unoccupied minimum flow setpoint. Occupancy sensors haven't been included in the energy savings or capital cost because they typically only have an attractive payback in large rooms and spaces served by RTU-6 are typically relatively small.

Energy Savings

Energy savings is provided by a reduction in fan power, outside air conditioning, space conditioning, and reheat energy. Energy savings are included for outside air conditioning based on current controls which utilize a constant minimum percentage of outside air and would be less if compensation/controls were provided which increased outside air percentage at lower supply flows to provide a constant outside airflow.

The estimated energy savings assume 30% of the VAV box flow is serving areas which can be scheduled and these spaces are still occupied 16 hours per day, 7 days a week. Actual savings achieved will vary depending on quantity of VAVs that can be scheduled and actual scheduled utilized but the assumptions are likely producing conservative results.

Estimated Energy Savings

Electricity Demand Savings (kW)	Electricity Energy Savings (kWh/yr)	Natural Energy Savings (therm/yr)	Utility Cost Savings ($/yr)	Investment Economics	
				Estimated Capital Cost ($)	Simple Payback (yrs)
0	8,600	1,900	$1,800	$5,000	2.8

O&M Impact

This measure adds additional control complexity and requires staff to update schedules/controls if space use changes in the future, but the reduction in fan speed will reduce wear and tear on the supply fan.

EEM 4: CONTROL FLAMES MAKEUP BASED ON EXHAUST HOOD STATUS

Recommended Action

Provide controls which reduce the minimum flow setpoints for the VAVs providing makeup air for the Flames kitchen when the kitchen hood is not active.

Background

VAV-6-5 and VAV-6-7 provide makeup air for the Flames kitchen hoods. When the hood exhaust is off the makeup flow isn't required and the VAVs could be controlled to much lower flow setpoints.

Implementation

Provide monitoring of kitchen exhaust fan (EF-1,2) via the BMS, either based on motor status or on the "command" being provided by the manual switch used to turn the fans on/off. Whenever both exhaust fans are off, reduce the minimum flow setpoint for VAV-6-5 and VAV-6-7 to a reduced, unoccupied setpoint of 555 cfm each.

It's assumed that the kitchen may be occupied when the hood is not in use and therefore the minimum flow setpoint when the hood is not in use is greater than 0 to ensure adequate ventilation is still provided.

Energy Savings

Estimated energy savings are based on current minimum flow setpoints which are much lower than the original design values and a new total unoccupied flow setpoint of 1,005 cfm.

Estimated savings are based on the hood operating 10AM-11PM Sun-Thur and 10AM-12:30AM Fri-Sat. Savings will vary depending on actual hours of hood operation.

Estimated energy savings assume other RTU-6 VAVs have already been scheduled as recommended in separate EEM and savings for this measure would be higher if that EEM was not completed.

Estimated Energy Savings

Electricity Demand Savings (kW)	Electricity Energy Savings (kWh/yr)	Natural Energy Savings (therm/yr)	Utility Cost Savings ($/yr)	Investment Economics	
				Estimated Capital Cost ($)	Simple Payback (yrs)
0	10,700	2,000	$2,000	$10,000	5.0

O&M Impact

This measure adds additional control complexity, but the reduction in fan speed will reduce wear and tear on the supply fan.

EEM 5: OCCUPANCY SENSOR CONTROL FOR RTU-7

Recommended Action

Provide occupancy sensors in the areas served by RTU-7 and allow RTU to cycle off when area is unoccupied.

Background

RTU-7 serves VAVs in Willow Conference area. The retrocommissioning study recommends utilizing timeclock controls to shut down RTU-7 during the middle of the night but there are many times when the area is unoccupied outside of those hours and utilizing occupancy sensors to determine when the space is actually occupied would allow RTU-7 to be shut down during other unoccupied hours.

Implementation

Provide occupancy sensors in regularly occupied areas such as the conference rooms and corridors; sensors should not be necessary in storage areas. During occupied timeclock hours, when no occupancy sensors have detected occupancy in over an hour, put RTU-7 into standby mode until an occupancy detection occurs. During standby operation RTU shall be controlled the same as it is during timeclock unoccupied mode (fan cycles based on demand and minimum outside air damper position is 0%) except it should be cycled on based on occupied space temperature setpoints.

Additional savings could be achieved by providing standby space temperature setpoints in lieu of using occupied setpoints and this may be necessary if existing deadbands aren't large enough. Standby setpoints are typically just a degree or two wider than occupied setpoints to prevent spaces from getting too far away typical temperatures.

If desired the occupancy sensors being utilized for HVAC control could also be used for lighting control as well which would provide additional energy savings if the lights aren't already controlled by occupancy sensors, or the capital cost of implementing this measure could be reduced if the HVAC system can be tied into existing occupancy sensors that serve the lighting.

Energy Savings

Energy savings are provided by a reduction in fan energy and reheat. No energy savings are included for a reduction in conditioning of outside airflow because RTU-7 currently has a minimum outside air damper position setpoint of 0%. The damper should have a higher setpoint during occupied hours to ensure adequate ventilation is being provided to the occupants and if the setpoint is increased it would increase savings for this measure. The estimated savings don't include any savings for setback.

The calculated energy savings for this measure are additive with those for the RCx measure which adds timeclock unoccupancy controls for RTU-7. If that measure wasn't completed the savings for this measure would be higher. This measure assumes the space is scheduled unoccupied 2AM-6AM every night and that the space is in standby mode 60% of all remaining hours.

Estimated Energy Savings

Electricity Demand Savings (kW)	Electricity Energy Savings (kWh/yr)	Natural Energy Savings (therm/yr)	Utility Cost Savings ($/yr)	Investment Economics	
				Estimated Capital Cost ($)	Simple Payback (yrs)
0	12,900	1,100	$1,500	$10,000	6.7

O&M Impact

This measure will reduce runtime for RTU-7 which should reduce wear and tear on the RTU. The measure will increase the quantity of starts and stops for the fan but the fan already has a VFD so this is shouldn't cause significant wear. The occupancy sensors will require some additional maintenance but overall the savings in RTU wear and tear are expected to exceed and additional maintenance costs elsewhere.

EEM 6: INSTALL GROUND-SOURCE HEAT PUMP SYSTEM TO SUPPORT LOADS SERVED BY RTUS-1,2,3,6,&7.

Recommended Action

Eliminate R-22 DX Cooling throughout most of the building. Utilize ground-source heat pump technology.

Background

RTU 1, 2, and 3 commonly have issues with DX compressors. Multiple units must be replaced each year. Furthermore, the control capability of these units, once downsized in EEM 1 discussed above, may become problematic.

For these reasons, PCH would like to explore the use of chilled water and hot water to manage the major loads in the building. Smaller loads (RTUs A-H) could be added to this system as they reach end of life.

These units all utilize R-22 refrigerant. So, in addition to reducing energy consumption, phasing out these units will result in a reduction of Greenhouse Gases caused by refrigerant leak.

Implementation

Install a ground-source heat pump system to serve RTUs 1,2,3,6, and 7. RTUs 1,2,3, could be retrofitted with hot and cold water coils. RTU-7 could be replaced with a new unit that utilizes hot and cold water coils. RTU-6 system would likely benefit from being replaced with an Energy Recovery Ventilator System with Fan Coil Units. All of these units would be served by a central 6-pipe water-to-water heat pump unit.

Throughout the year, the cooling load is higher than the heating load (unbalanced). So, it is recommended to explore the latest geothermal technology, which utilizes convection-based heat exchange with an underground flowing aquifer. This technology would avoid any potential complications with a change in earth temperature over time.

A test well must be drilled and studied. The cost of a test well is approximately $50,000. Initial preliminary investigation was unable to determine whether aquifer flow at the casino is adequate to support the typical well production, but, worst case, it would likely be feasible with more wells. To be conservative, GBA has estimated twice the number of wells may be required compared to a typical installation. Depending on the performance of a test well, the project cost may be reduced.

Alternative Option: Air-Cooled Chiller and High-Efficiency Boilers, instead of geothermal

Alternatively, a contractor has provided an option to retrofit RTUs 1,2,3 as discussed above, then replace RTU 6 &7, install air-cooled chillers, and install high efficiency boilers. This is estimated to cost $4,500,000 to $5,000,000. The energy savings from this option would be about 100,000 kWh/yr, and 2,000 therms/yr. This would reduce utility costs by about $7,000 per year and reduce carbon emissions by about 180 Tons per year.

Without test well data, it is difficult to determine the incremental cost between this option and the geothermal option. Initial estimates though indicate that the geothermal option may not have a high incremental cost, if any, relative to the chiller option, especially after incentives (30%) are available through the DOE Infrastructure Recovery Act.

Energy Savings

The water-water heat pump selected has an average heating COP of 8 and a cooling EER of 25. For a good portion for the shoulder months, any heating required in the office spaces could be provided by the heat on the casino floor. As a result, the natural gas load in the building would be reduced dramatically.

Estimated Energy Savings

Electricity Demand Savings (kW)	Electricity Energy Savings (kWh/yr)	Natural Energy Savings (therm/yr)	Utility Cost Savings ($/yr)	Investment Economics	
				Estimated Capital Cost ($)	Simple Payback (yrs)
45	119,936	70,679	$62,360	$5,925,000	70

O&M Impact

This measure will greatly reduce O&M costs. As discussed above, there is a significant cost associated with replacing DX coils. These units are end-of-life.

Outside the geothermal wells, the VAVs and Reheat Coils replacement for RTU-6 are also a good portion of the cost. These units were installed in 2005 so also seem to be end-of-life.

RTU 6 and RTU7 are not end of life (about 10 years old).