Yurok Tribe

Energy Paths for the Yurok People

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Final Report

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Executive Summary

The Yurok Tribe has been working for more than two decades to bring adequate, cost-effective energy services to their Tribal members. With the completion of the electric line extension to Wautec, they are well on their way to an effective and sustainable energy future. However, there is still much work to be done; many Tribal households in the Upper Reservation are still without reliable, affordable electric power. Now the Tribe needs to determine the next steps to realize their energy vision.

The **Yurok Tribe Energy Vision Statement** now reads:

> *"To make sure all Tribal members living within the Yurok Ancestral Territory have access to reliable, affordable, modern, cost-effective energy services. In addition, the Tribe seeks an energy program that promotes energy self-sufficiency, environmental sustainability, use of local renewable resources, job creation and economic opportunity for Tribal members."*

This Yurok Tribe energy strategic planning study examined electricity usage, costs and infrastructure, as well as electricity needs on the Reservation. It also assessed the Tribe's energy resources. Equipped with this information, the project team conducted an energy options analysis that examined different project opportunities and identified key projects that are both feasible to implement and will help the Tribe reach its stated Energy Vision.

A key finding of the energy needs assessment is that there are still numerous households (likely over 100) in the Upper Reservation and adjacent lands that are without grid electric power, and it is likely that most of them will remain disconnected from the grid because of their remoteness. To provide these community members with reliable, affordable, modern energy services their homes will need to be electrified via a robust off-grid energy services program that installs and maintains off-grid energy systems. This is the key need that is explored and addressed in this plan.

The approach taken is to establish a new business entity, a Tribal Energy Authority or Utility, that will operate a Tribal Energy Program. This entity will seek grant funding to deploy on-grid solar PV systems to provide electricity to Tribal facilities. They will charge for the electricity provided and the revenues generated will then support the ongoing maintenance of the on-grid systems and the salary of Energy Program staff person. In addition, the funds will be used to support the ongoing maintenance of a fleet of off-grid energy systems. The Tribal Energy Program will seek grant support to install a large number (50 to 100 in the first phase) of off-grid energy systems. Off-grid customers will pay a monthly fee for these systems, and that monthly fee along with net revenues from the On-grid Solar Program will support the long-term maintenance of the off-grid systems. Under the preferred funding scenario, customer fees will be just a little higher (~20%) than what PG&E's on-grid residential customers currently pay for electricity. The Energy Strategic Plan identifies a number of potential funding sources that could be used to support both the On-grid and Off-grid Energy Programs.

This plan also promotes continued efforts to reduce electricity consumption through the implementation of energy efficiency measures in existing facilities and the enforcement of a strong energy efficient building code for all new construction on the Reservation. The Tribe is encouraged to continue to take advantage of existing energy efficiency programs offered by the electric utility companies that provide electricity services on the Reservation (Pacific Power, PG&E and the Redwood Coast Energy Authority).

Finally, the plan promotes added resilience at critical Tribal facilities on the Reservation by recommending that battery energy storage systems and microgrid controls be coupled with rooftop solar PV systems to create cutting edge microgrid facilities that can provide critical power services to Tribal facilities when the main electric grid is shutdown.

If implemented, *Energy Paths for the Yurok People*, the Yurok Tribe's Energy Strategic Plan, will help the Tribe reach its stated Energy Vision. This plan will:

- Help make sure that all Tribal members living within the Yurok Ancestral Territory have access to reliable, affordable, modern, cost-effective energy services.
- Increase the Tribe's energy self-sufficiency and energy self-reliance.
- Increase the resilience of critical Tribal government facilities so that critical services will be available to the Tribal community during times of disaster and hardship.
- Decrease the Tribes environmental footprint by reducing their greenhouse gas emissions.
- Make efficient use of the Tribes indigenous renewable power resources.
- Create jobs and economic opportunity on the Reservation for Tribal members.

Energy Paths for the Yurok People lays out a set of project opportunities, highlights key opportunities, and then packages these key opportunities together in order to accomplish the Tribe's broader Energy Vision. It identifies potential funding sources and lays out an implementation plan and schedule for moving the Yurok Tribe Energy Program forward. The plan, if executed successfully, would result in the installation of approximately 360 kW of solar PV on Tribal facilities and another 170 kW to 285 kW of off-grid solar PV at a total installed cost of approximately $3M. The program would be financially self-sustaining and would provide clean, reliable, affordable, cost-effective, modern energy services to a large number of Tribal community residents who currently due not have access to such services. This would go a long way toward achieving the Tribe's Energy Vision.

Project Overview

Yurok Tribe Background

The Yurok Tribe is the largest Tribe in California, with over 6,000 enrolled members, about 1,200 of whom live on the Reservation. The Yurok Reservation's currently extends one mile on each side from the mouth of the Klamath River and upriver for a distance of 44 miles. The Yurok Reservation has a total area of about 56,000 acres. Tribal landholdings on the reservation are mixed in a "checkerboard" pattern with non-Tribal fee lands. A large portion of the Reservation lands are held by non-Tribal owners, though the Tribe is working to acquire privately held lands both on the Reservation and in their wider Ancestral Lands. Tribal plots are typically small, ranging from 20 to 200 acres each.

Residents of the Reservation live in small village clusters and remote homesteads. A few of the most isolated homes are accessible only via the river or on foot. Over 40% of the Upper Yurok reservation has no access to basic telephone or electricity services. The Yurok Tribe is also the poorest California Tribe, with poverty rates averaging 80%. Problems including lack of land for economic development and community facilities, inadequate telecommunications and electrical infrastructure, and a grossly substandard transportation system inhibit chances for economic growth, access to health care, educational opportunities and job opportunities.

However, the Yurok Tribe employs roughly 400 staff in approximately 16 departments, and they are working hard to increase their capacity for self-governance and cultural preservation and to bring a bright future to the Yurok Tribe and its people. The Tribe was first recognized by the federal government in 1993 and is governed by a nine-member elected council that includes a chair, vice-chair, and seven district representatives. The Tribe's major initiatives include: The Hoopa-Yurok Settlement Act, dam removal, natural resources protection, sustainable economic development enterprises and land acquisition.

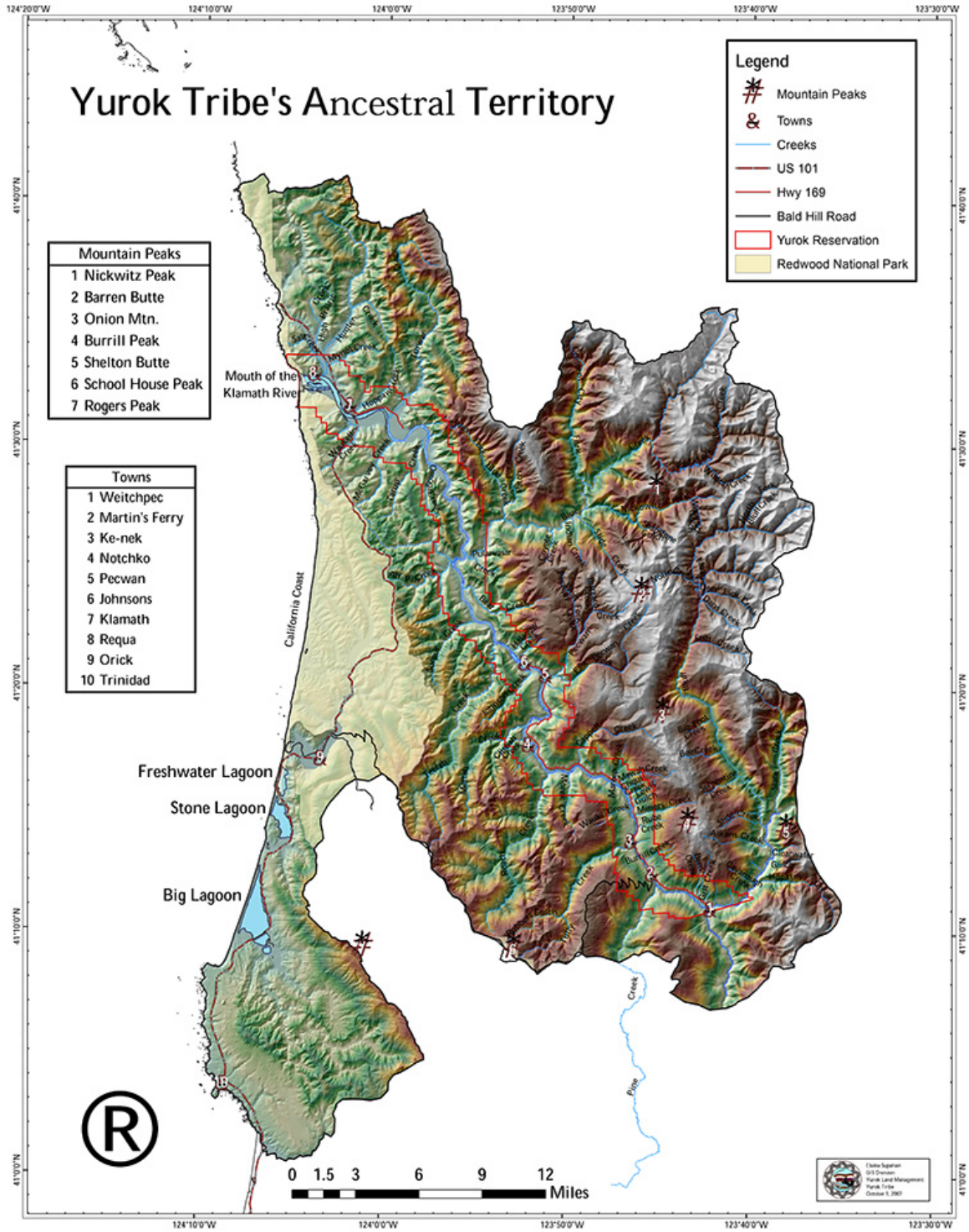

Figure 1: Map of Yurok reservation and ancestral territory

Geography and Energy

The Yurok Tribe has substantial need to develop its energy resources and infrastructure. Because of the remote location of the Reservation in a deep canyon along the Klamath River, grid electricity is still unavailable to a substantial portion of the Reservation's residents. This causes hardship for Tribal members and severely thwarts economic development. While the Tribal Government has been working for many years to provide basic energy services to Tribal members on the Reservation and they just recently completed an electrical line extension to the Village of Wautec, many Tribe members living in the Upper Reservation still have inadequate access to electric power, disproportionately low household income, and disproportionately high household energy costs.

A key characteristic of the Yurok Reservation is also that it is divided into two distinct geographic regions. The Lower Reservation is located in Del Norte County and includes the mouth of the Klamath River, the Klamath Tribal Office and the Klamath town site. This is where the main Tribal Government office is located and where the largest concentration of Tribal services and Tribal facilities are located. The Upper Reservation is in Humboldt County and includes the town of Weitchpec, the Weitchpec Tribal Office, and various Upper Reservation village sites, including Tully Creek, McKinnon Hill, and Wautec.

These two distinct regions of the Reservation straddle two counties (Humboldt and Del Norte) and two investor owned electric utility service territories (Pacific Gas and Electric Company in Humboldt County and Pacific Power in Del Norte County). In addition, these two sections of the Reservation are rather isolated from each other. While there is only about 15 miles between the Klamath Tribal Office near the mouth of the Klamath in Del Norte County and the Village of Wautec in the Upper Reservation in Humboldt County, there are no roads that directly connect these geographic areas. The fastest way to travel between them is by boat. Traveling by road is a circuitous 76-mile journey over Bald Hills Road. Approximately 3 miles of this is dirt and in the winter time the road is occasionally unpassable due to snow.

This bifurcation in the Yurok Reservation also has important implications with regard to energy supply and services. These two geographic areas are served by two distinct electrical distribution systems – one owned by PG&E and the other owned by Pacific Power. Figure 2 shows the location of the Reservation and its relationship to county and electric utility service territory boundaries and electrical transmission system infrastructure.

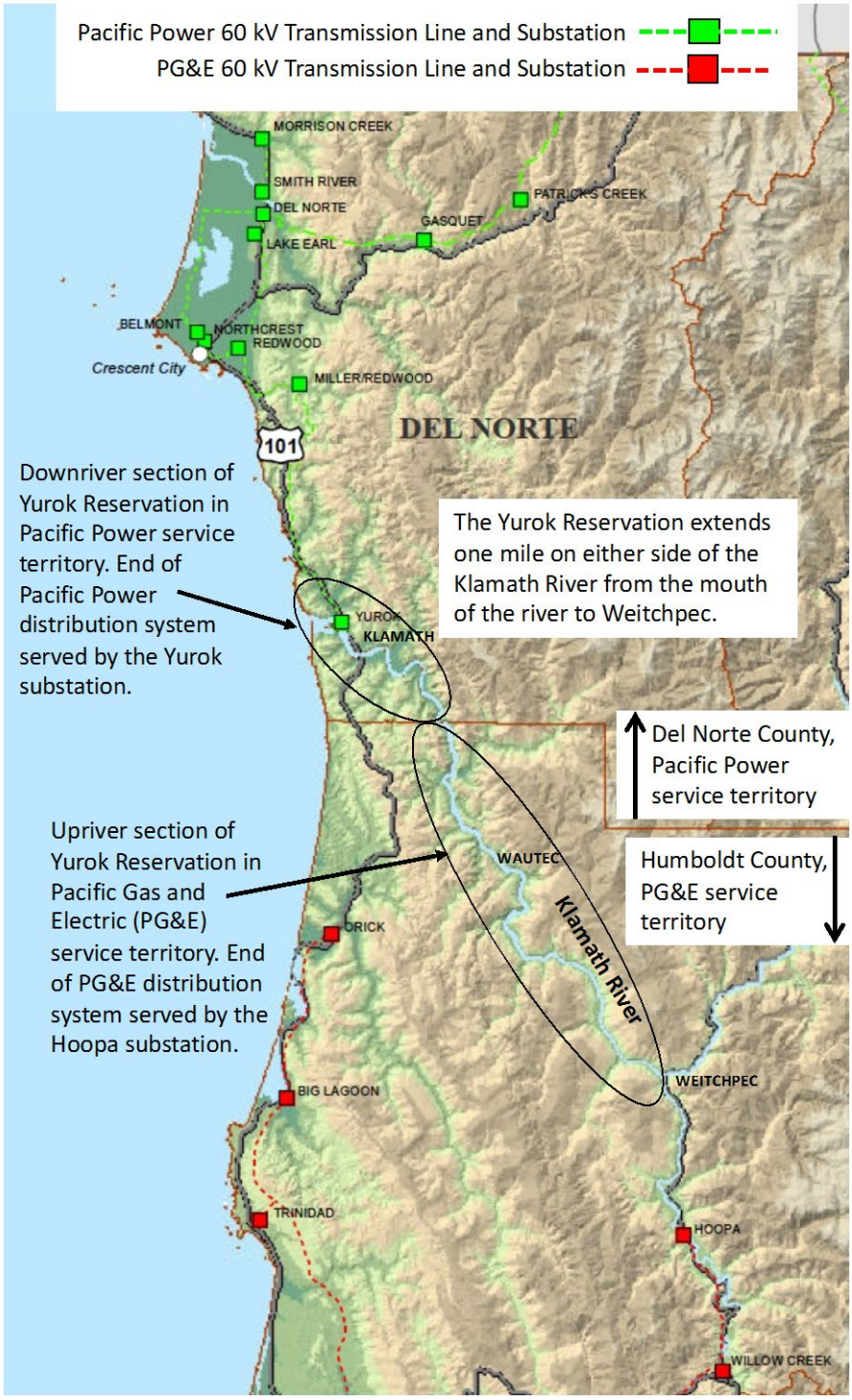

Figure 2: Yurok Reservation location in relation to county and electric service territory boundaries (adapted from California Transmission Lines and Substations map, California Energy Commission)

This bifurcation of the Yurok Reservation across two counties and two electric utility service territories poses numerous challenges to providing adequate and consistent energy services to all residents. For example:

- These areas are remote and at the end of the line in both utility service territories. This means customers in these regions are typically the first to lose service and the last to get service restored after an outage. They are also the most expensive to serve.
- Because of their remote location, some residents in these areas still do not receive electrical service. Even after over 20 years of effort to extend the power lines and some areas just becoming electrified in 2018, it is still expected that many remote residences will never receive grid power.
- Securing electricity services on the Reservation is more complicated because there are two different entities to deal with for energy efficiency programs, interconnection services, net metering programs, etc.
- PG&E is one of the largest IOUs in CA, whereas Pacific Power serves only a very small portion of California's electricity customers. Because of this, programs and regulations are not consistent. In addition, the development and/or availability of programs and services is sometimes delayed in Pacific Power's service territory. For example, for many years rebates were available for rooftop solar electric systems installed in PG&E territory while no such rebates were available in Pacific Power territory.
- A Tribal electricity generation project in one IOU service territory cannot serve retail electrical loads in the other service territory, for example through a program like aggregate net metering or similar tariff.

Yurok Strategic Energy Plan - Purpose and Need

The Yurok Tribe has been working for more than two decades to bring adequate, cost-effective energy services to their Tribal members. With the recent completion of the electric line extension to Wautec the Tribe has much to celebrate. However, there is still much work to be done; many Tribal households in the Upper Reservation are still without reliable, affordable electric power. The Tribe needed to determine the next steps required to realize their energy vision.

To assist them in this quest the Yurok Tribe Planning Department partnered with the Schatz Energy Research Center at Humboldt State University to develop an updated, comprehensive Yurok Tribe Strategic Energy Plan called *Energy Paths for the Yurok People.*

Yurok Tribal Energy Vision Statement

In 2003, the Yurok Tribe drafted an Energy Vision Statement. The Energy Vision Statement was addressed again in 2007 in the Tribal Utility Feasibility Study. Then in 2019, at a Tribal Council Working Session held to discuss the Yurok Tribe Strategic Energy Plan, the Tribal Council decided to update the vision statement to address the needs of all Yurok Tribe members, not just those residing on the Reservation. The updated **Yurok Tribe Energy Vision Statement** now reads:

"To make sure all Tribal members living within the Yurok ancestral territory have access to reliable, affordable, modern, cost-effective energy services. In addition, the Tribe seeks an energy program that promotes energy self-sufficiency, environmental sustainability, use of local renewable resources, and job creation and economic opportunity for Tribal members."

This vision statement guided the development of the Yurok Tribe Energy Strategic Plan, *Energy Paths for the Yurok People*.

Planning Approach

The approach taken in crafting the *Energy Paths for the Yurok People* Energy Strategic Plan was to:

1. Gather and review past electrical energy activities and planning work already completed by or for the Yurok Tribe.
2. Assess the current electrical energy situation (based on past and current work) on the Reservation.
3. Review the Yurok Tribe Energy Vision statement.
4. Assess the energy resource and energy program opportunities available to the Tribe and identify those that appear most feasible, economically viable, and able to advance the Tribe's Energy Vision.
5. Solicit input from the Tribal community.
6. Craft a plan that includes an implementation strategy and a prioritized list of energy projects that can advance the Tribe's Energy Vision.

Objectives

The objectives of this project were to produce a Yurok Tribe Strategic Energy Action Plan that includes an implementation strategy and a prioritized list of energy projects. The Plan will be used as a strategic guide for the Yurok Tribe in order to increase energy efficiency, develop local renewable energy generation potential, reduce energy costs, and meet energy needs on the Yurok Reservation.

Description of Activities Performed

The following set of tasks were carried out in fulfillment of the Energy Paths for the Yurok People strategic planning project:

1) Review past Yurok Tribe energy projects and studies
2) Analyze current electricity load
3) Assess demand reduction opportunities
4) Assess energy resource development opportunities
5) Engage the Tribal community
6) Analyze energy options
7) Develop Yurok Strategic Energy Action Plan.

The following sections of the report describe the activities performed and the results obtained.

Task 1.1 Review of Previous Work

The Yurok Tribe, with assistance from external partners, has been exploring how to better meet their energy needs for over twenty years. Much of this previous work was reviewed and considered in the development of this strategic plan. The majority of the past work focused on local renewable energy resource assessments and feasibility assessments for specific projects. This included many assessments of hydroelectric potential, as well as assessments of wind, biomass and solar potential. In a few cases energy efficiency upgrade opportunities for Tribal buildings were evaluated. The objectives of the previous studies generally targeted three areas: 1) increasing energy access, 2) generating revenue or meeting local loads via renewable energy generation, and 3) reducing energy costs by reducing demand. Another topic considered has been the formation of a Tribal utility and the various forms that might take. Appendix A - Previous Energy Studies includes a listing of the previous energy studies that were reviewed.

Energy Access

The objective to increase energy access has been focused on delivering electric service to those who do not have it, mainly in the Upper Reservation. The two approaches considered and pursued have included: 1) efforts to extend the existing electric utility grid to unelectrified areas, and 2) developing off-grid resources to serve unelectrified areas. While some studies recommended the development of off-grid resources, the approach that largely won out was to extend the electric grid. As discussed elsewhere, the electric utility grid was finally extended all the way to the Village of Wautec in August of 2018. However, many households remain unelectrified in the Upper Reservation and the development of off-grid resources is still considered the preferred approach for many of these remote residences because of the excessive cost to extend the power lines over long distances. The Yurok Tribe Planning Department has been directed to assess who will remain without electricity following the completion of the grid extension to Wautec. Estimates are that approximately 128 residences on, or adjoining the reservation, will still be without grid power after the Wautec power line extension project is completed. Of that number, possibly 1/3 are tribal members.

Renewable Generation

With several large creeks running through the Yurok reservation, the bulk of previous studies on renewable energy opportunities explored establishing small-scale (<2 MW) hydro power installations for either exporting utility-scale power or for providing power for Yurok facilities and unelectrified communities. The most detailed study was conducted for Pecwan and Kepel Creeks, with potential project capacities ranging from 50 kW to 1.5 MW. Small installations on Minor Creek and a development supporting up to 1.8 MW on Pine Creek were also investigated, though the economic assessments of these projects were less robust. Potential projects on Pecwan and Kepel Creeks were identified as preferred locations by the Yurok Tribe Environmental and Fisheries Programs because projects on these creeks could be located above natural barriers to fish passage, thereby ensuring that these potential small hydro projects would not adversely impact anadromous fisheries on the Reservation. Development of a 1.5 MW hydropower system on Pecwan Creek was found to be one of the most attractive opportunities. However, the significant distribution system infrastructure upgrades required to export power made the economic viability of this project marginal (at best), and therefore risky.

One study also looked into wind power opportunities on the Yurok reservation. The study investigated a single site atop McKinnon Hill, which was selected based on wind energy potential maps prepared by the National Renewable Energy Laboratory. Anecdotally many Upper Reservation residents also confirmed that McKinnon Hill was one of the windiest spots on the Reservation. One year of wind measurements at the site demonstrated an insufficient resource to support utility-scale power, but enough to provide stand-alone facility-level power at a nearby telecommunications facility if paired with battery storage and possibly a small solar PV system to supplement power production in the less windy summer months.

Previous studies have examined the opportunities for solar electric power on the Reservation, especially in the Upper Reservation. It is noted that the Yurok Tribe maintains and operates a remote automated weather station at Notchko in the Upper Reservation. Data from this site was evaluated in previous studies and was found to be consistent with solar resource data collected or modeled in the nearby Humboldt Bay area, as well as an inland site to the south of Humboldt Bay called Butler Valley. Unsurprisingly, the data showed that the inland sites (both Notchko and Butler Valley) show greater solar resource in the summer months of June through September when fog is more common on the coast. In any event, all previous work shows that there is a substantial solar resource on the Reservation with plenty of potential for development.

Biomass power was considered in a couple of the previous studies. A 2003 biomass study by TSS Consultants determined that there was potentially enough renewable biomass resource to support about 700 kW of generation in the Upper Reservation. Follow up work conducted as part of the Tribal Utility Feasibility Study found that local biomass resources could likely support at least about 400 kW of generation. TSS Consultants assessed the viability of a small 35 kW unit and estimated the break-even power cost from such a unit would be about $0.30/kWh. However, they noted that at the time no small biomass power plants were commercially available in that size range. While they noted larger sized plants in the 100-200 kW range were

available, experience has shown that biomass electrical power plants smaller than at least a few MW's can be challenging to operate over the long-term in a practical and cost-effective manner.

Energy Efficiency

Energy efficiency upgrades were identified as a priority in the 2003 Yurok Strategic Energy Plan. Subsequent studies conducted both household and Tribal facility efficiency assessments. Both the Weitchpec and Klamath tribal offices eventually implemented some efficiency upgrades.

Tribal Utility

A Tribal utility typically takes the form of a conventional utility that owns and operates the electrical distribution system, generates or purchases power on the wholesale market, and sells retail power to its customers. Less conventional forms might include a Tribal utility that focuses on providing other energy services that might be lacking. This could include providing power to off-grid residents, providing energy efficiency services, or developing distributed generation.

Previous studies have recommended and/or considered the establishment of a Yurok Tribal Utility. A prior Yurok Strategic Energy Plan, completed in 2003, recommended that the Tribe form a Tribal utility to control all energy developments on the Reservation. The Tribal utility would focus on developing power for profit and also on extending the distribution system to serve Tribal members on the Reservation.

However, in 2005 Winzler and Kelly Consulting Engineers concluded that a creating a Tribal Utility that fit the model of a traditional electric utility was not feasible for the Yurok Tribe. Winzler and Kelly examined a model where the Tribe would own and maintain the electric grid infrastructure, would purchase wholesale electric power and deliver it to customers on the reservation, and would perform billing and other customer service functions traditionally provided by the local investor-owned utility. Winzler and Kelly determined that the traditional electric utility model was not viable because the Tribe's electricity customer base was not sufficient to support such an enterprise. One key revenue generating opportunity that Winzler and Kelly investigated was the possibility that the Tribe could purchase cheap electric power from the Pacific Northwest (i.e. from BPA and WAPA) and wheel this power for sale in the California electricity market. Unfortunately, this opportunity proved to be impractical for the Tribe. Power wheeling would have required a high voltage transmission line be built through the Upper Reservation that would connect the Pacific Power and Pacific Gas and Electric service territories, and apparently this was not deemed achievable[1]. Instead, low voltage distribution lines were extended as far as the Village of Wautec.

Following this conclusion, the Yurok Tribe decided to take a step back and re-evaluate their options for creating a non-traditional Tribal utility that would focus on renewable energy and

[1] This appeared to be the conclusion of the Winzler & Kelly team as cited in the Tribal Utility Feasibility Study prepared by the Schatz Energy Research Center in 2011. However, no written record of this decision was ever obtained.

energy efficiency services. It was thought that this approach might prove feasible and may better serve the Tribe's needs at that time. The Tribal Utility Feasibility Study completed in June 2007 examined these opportunities. This included an inventory of renewable energy resources on the Reservation (solar, wind, biomass and hydro), as well as an assessment of opportunities to provide off-grid energy services to remote residences and energy efficiency services to all homes and businesses. This study also considered opportunities to generate revenue from renewable energy projects. Potential funding sources were identified and a plan to incorporate energy services into the existing Tribal Public Utility District (which currently provides water supply services to many residences) was presented.

Task 1.2 Load Analysis

Estimates of average energy use and costs were developed using a variety of Tribal and public data. The Yurok Tribe provided the research team with the locations of all Tribal facilities, as well as a year of energy use data for these facilities. Residential estimates were based around counts of Tribal residences pulled from Tribal GIS resources, aggregate residential consumption data for Del Norte County, and aggregate electricity billing data for the majority of grid-connected residences in the Upper Reservation.

Annually, the Reservation uses 9.8 GWh of electricity, with over 80% of this consumption occurring in Lower Reservation communities (Klamath, Klamath Glen, Hunter Creek, Requa, and Resighini) served by Pacific Power. The Lower Reservation residential electricity usage is estimated to average about 32 kWh/day at an average cost of $0.11/kWh. Tribal facilities pay slightly more for power, with an average rate of $0.16/kWh. Upper Reservation communities (Weitchpec, Upper and Lower Kepel, McKinnon Hill, Tulley Creek, Wautec, and other areas) account for the other 20%. Upper Reservation communities are served by Pacific Gas and Electric. The average residential usage is approximately 14 kWh/day[2], with an average rate of $0.22/kWh for residences, and $0.17/kWh for tribal facilities.

For Tribal facilities, electricity costs are the Tribes largest building energy cost. Annual electricity costs for all Tribal facilities in 2017 was approximately $400,000 per year. Heating and back-up generator fuel costs were only about $51,000 per year. No information was collected regarding transportation fuel consumption and costs. This is suggested for future study. Figure 3 shows the breakdown of building energy costs across the highest cost Tribal facilities. In 2017, five facilities accounted for almost 60% of total building energy costs. Tribal facilities account for an estimated 30% of the total electrical energy costs on the Reservation.[3]

[2] This average usage was originally estimated to be 22.5 kWh/day based on average consumption data for the entire Hoopa zip code. However, aggregate data were obtained from PG&E during the course of the project that were specific to the upriver section of the Yurok Reservation and these data indicated an average usage of 13.8 kWh/day.

[3] Note that this includes a few off-Reservation Tribal facilities, such as the Worthington School site in Eureka and the Food Distribution Center in Crescent City.

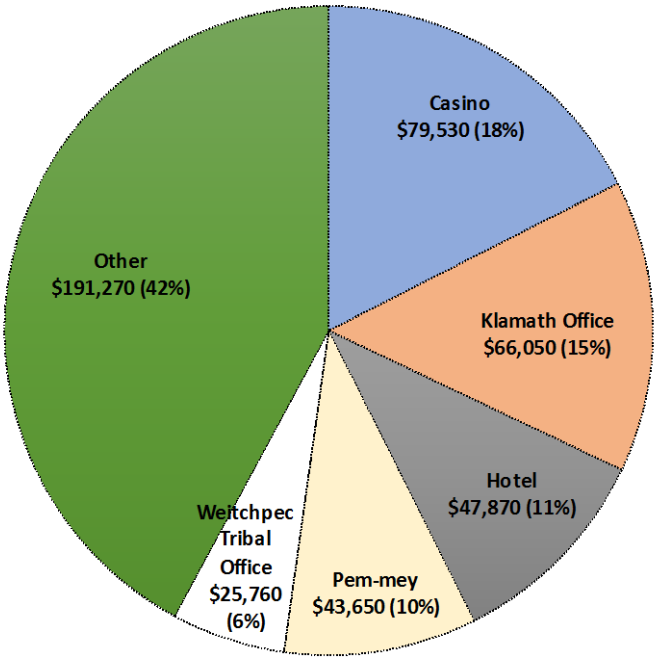

Figure 3: Tribal facilities with highest annual energy cost (five facilities account for almost 60% of annual energy costs)

There is currently no natural gas service on the Yurok reservation, so some of the electricity use is utilized for heating, along with other alternative fuels. Within the Klamath area 38% of households use electricity for heating fuel, 29% use wood, 19% use propane, and 15% use fuel oil or kerosene. Within the Upper Reservation in the Weitchpec/Hoopa zip code 62% of households use wood, 17% use electricity, 10% use fuel oil or kerosene, and 8% use propane.

Additional information regarding the load analysis can be found in Appendix B - Energy Use Assessment.

Task 1.3 Demand Reduction Assessment

The objective of the demand reduction analysis was to identify opportunities where the Tribe can reduce energy consumption in Tribal facilities and residences on the Reservation. The basic approach was to identify the high use facilities and then conduct a benchmarking analysis for these facilities. According to the U.S. Department of Energy, benchmarking is the practice of comparing the measured performance of a building to its peers with the goal of informing and motivating performance improvement. The performance metric used for the comparison is the energy use intensity, or EUI. The EUI is defined as the annual energy consumption for the facility divided by the floor area. The facility EUI's were compared with other similar buildings using the U.S. Environmental Protection Agency's ENERGY STAR Portfolio Manager® tool. While we acknowledge that comparing buildings based on their EUIs is a simplistic approach, we suggest it as an easy way to identify outlier buildings that deserve further examination.

We identified high cost, high use Tribal facilities as those where annual energy costs were greater than $10,000 per year. Only facilities located on the Reservation were evaluated. Both electricity and propane energy consumption were considered. Table 1 shows the results of the benchmarking exercise. The site EUI is compared with the National Median EUI for buildings in the same primary property type (e.g., hotel, office, casino, convenience store with gas station). A site EUI higher than the national median means that the building's energy consumption per unit of area is higher than the national median for that property type, and therefore less energy efficient.

Table 1: Benchmark Comparison of High Energy Cost Facility Energy Use Intensities

Facility	Location	Year Built	Fuels	Site EUI (GJ/m2)	National Median EUI (GJ/m2)	Difference (%)	Area (m2)	Area (ft2)
Casino	Klamath	2014	electricity	0.56	0.45	24%	3,323	35,750
Hotel	Klamath	2014	electricity	0.98	0.87	13%	1,094	11,770
Klamath Office	Klamath	2002	electricity & propane	0.89	0.66	35%	2,694	28,983
Pem-mey Gas Station/ Convenience Store	Klamath	2005	electricity	3.32	2.4	38%	325	3,496
Pec-tah Gas Station/ Convenience Store	Weitchpec		electricity	1.58	2.4	-34%	424	4,562
Weitchpec Tribal Office	Weitchpec	1999	electricity & propane	1.22	0.6	103%	513	5,519

EUIs are affected by a building's business activity and climate, as well as its energy efficiency characteristics. The climate in Klamath is mild, with average monthly temperatures ranging from a low of about 37°F to a high of about 67°F. Average monthly temperatures in Weitchpec span a wider temperature range, with a monthly low of 36°F to monthly high of 92°F. Energy efficient buildings located in mild to moderate climates are expected to have EUIs that are lower than the national medians. However, most of the Tribal facilities have EUIs greater than the corresponding national medians. We suggest that this deserves further examination.

Note that the Yurok Tribe adopted a Building and Construction Ordinance in March of 2014 that specifies that all construction projects on the Yurok Reservation will meet or exceed the California Building Code, which includes one of the most advanced energy efficiency standards in the country. That means that any buildings constructed after this date should be built to meet a very high standard of energy efficiency.

The best current opportunities available the Yurok Tribe for electricity demand reduction are to participate in existing energy efficiency programs offered by the two electric utilities that serve the Reservation (PG&E and Pacific Power). As part of the demand reduction assessment task, SERC engaged with energy efficiency program representatives from these electric utilities and determined what programs are currently available and how these program might best be

accessed to serve Tribal needs. SERC then facilitated calls between utility representatives and the Yurok Tribe.

Additional information about the high use / high cost facilities, as well as current energy efficiency program offerings and how they relate to current Yurok Tribe needs can be found in Appendix C - Demand Reduction and Utility Program Offerings.

Task 1.4 Resource Assessment

There are many renewable energy and energy savings opportunities available to the Yurok Tribe. This includes solar, small hydro, wind, biomass and energy efficiency opportunities for both on-grid and off-grid applications. Table 2 outlines many of these opportunities and compares them according to various metrics.

Table 2: Resource assessment matrix

Project Metric			Project / Resource Type				
			Solar	Wind	Small Hydro[4]	Biomass	Energy Efficiency
Project Cost Range	Off-Grid	Residential	$6-7/W	$8-10/W	$6/W - $12/W	TBD	TBD
		Tribal Facility			N/A (no suitable sites)		
	On-Grid	Residential	$3.00/W - $3.50/W	N/A (no suitable sites)	$6/W - $12/W		
		Tribal Facility			N/A (no suitable sites)		
		Community Scale	$3/W		$6/W - $16/W		N/A (facility level only)
Potential System Size Range	Off-Grid	Residential	1 kW - 5 kW	1 kW - 15 kW	0.10 kW - 2 kW	N/A (not suitable)	N/A (facility level only)
		Tribal Facility	5 kW - 20 kW		5 kW - 20 kW	25 kW – 150 kW	
	On-Grid	Residential	1 kW - 5 kW		0.10 kW - 2 kW	N/A (not suitable)	
		Tribal Facility	5 kW - 100 kW		5 kW - 100 kW	25 kW – 150 kW	
		Community Scale	100 kW - 1 MW	N/A (not viable)	500 kW - 2 MW	150 kW – 2 MW	
Total Production Potential Estimate	Capacity		3,300 kW	10 kW[5]	2,015 kW[8]	150 kW	
	Annual Production (kWh)		3,861,000	9,600	14,120,000	1,000,000	1,600,000
	Annual Cost Savings ($)		710,700	7,200	1,059,900	200,000	215,000
	Annual GHG Reduced (lbs. CO2)		5,290,000	37,000	2,971,400	200,000	2,010,000

[4] Small Hydro refers to any hydroelectric system smaller than 30 MW. Anything larger than 30 MW is not considered renewable by the CA Energy Commission. The systems examined for the Yurok Tribe were generally 1.5 MW or smaller and do not involve the damming or impoundment of water (referred to as "run-of-the-river"). Many of the systems considered are very small residential scale systems, which are referred to as microhydro.

[5] Based on the *Wind and Hydro Energy Feasibility Study*, June 2011.

Table 2 Continued

Project Metric	Project / Resource Type				
	Solar	Wind	Small Hydro	Biomass	Energy Efficiency
Near-term suitable locations identified	Klamath, Tulley Creek, Wautec	McKinnon Hill	Pecwan, Kepel	Wautec	Site assessments required
Likelihood of additional suitable locations	Very high	Low, telecom sites may be suitable	Low, residential applications more likely, off grid sites especially important as compliment to solar PV	Low, need for a broad flat area for fuel supply, handling, processing and production of multiple products	Very high, most all Tribal facilities and residences have at least some energy efficiency opportunities
Project Deployment Time	6 months - 1 year	6 months - 1 year	6 months - 1 year for small hydro; 2-3 years for 2 MW community scale system	2-3 years due to complex nature of biomass fuel supply, technologies, market assessment for products, labor requirements, etc.	6 months - 1 year
Degree of Local/Tribal Control[6]	Panels and inverters tribally owned, distribution infrastructure owned by utility for NEM systems. Opportunity for microgrids offers greater resilience. Complete tribal control of off-grid installations.	Complete tribal control of off-grid installations.	Hydro generation system tribally owned, distribution infrastructure owned by utility for NEM systems. Complete tribal control of off-grid installations.	Tribal control of biomass facilities; tribal control of biomass supply chain would depend on location of forestry activities. Imported biomass residue may fall outside of tribal control.	Completely under tribal control.

[6] In all cases if a system is financed or installed under a third-party ownership model then that will change the degree of Tribal control

Table 2 Continued

Project Metric			Project / Resource Type				
			Solar	Wind	Small Hydro	Biomass	Energy Efficiency
Suitable power categories	*Off-Grid*	*Residential*	Offset gasoline generator, paired w/ hydro or back-up generator for winter production	N/A (no suitable sites)	Offset gasoline generator, can be paired w/ solar especially where flows are low in summer	N/A (not suitable for off-grid applications, power only available when biomass is being processed, power is a byproduct not a main product)	Absolutely required in order to reduce the load and the cost of an off-grid renewable energy system, efficiency is typically much cheaper than generation
		Tribal Facility	Minimal applications for off-grid Tribal facility, offset gasoline generator, paired w/ back-up generator for winter production	Provide primary power for telecommunications station, could be paired with solar or back-up generator	N/A (no suitable sites)		
	On-Grid	*Residential*	Net metering	N/A (no suitable sites)	Net metering	N/A (not suitable for residential sites)	Can reliably reduce energy costs, typically cheaper than generation options
		Tribal Facility	Net metering		Net metering	Net metering when power is available	
		Community Scale	Aggregate net metering		Aggregate net metering for modest sized system, wholesale power generation for larger scale (i.e., 1-2 MW)	Aggregate net metering when power is available	N/A (facility level only)

Table 2 Continued

Project Metric	Project / Resource Type				
	Solar	Wind	Small Hydro	Biomass	Energy Efficiency
Environmental Effects	Minimal impacts, though some tree clearing could be required in some locations. Reduces GHG emissions for both on-grid systems and off-grid systems that displace gasoline generators.	Depending on the site, some tree clearing could be required or could pose viewshed impacts for cultural sites. May pose impacts to birds and bats. Reduces GHG emissions for off-grid systems that displace gasoline / diesel generators.	Most recent environmental assessment is preliminary and currently dated. Siting and design specifics should eliminate impacts to fish (especially anadromous species) and other aquatic species. Reasonable creek flows must be maintained and this may require ceasing operations during dry parts of the year. Reduces GHG emissions for both on-grid systems and off-grid systems that displace gasoline generators.	Biomass supply chain could aid in fire risk reduction activities. Biomass power plant would generate emissions.	Offset energy usage, reducing associated greenhouse gas emissions. Reduces need for additional capacity as new users are added to grid, mitigating the future impact of accommodating new customers. Reduces the required size of off-grid systems.

Table 2 Continued

Project Metric		Project / Resource Type				
		Solar	Wind	Small Hydro	Biomass	Energy Efficiency
Potential Tribal Needs Met	*Economic Development*	Energy savings can bolster tribal and residential budgets. Maintenance of solar systems will necessitate new jobs and skills training. Development, installation and maintenance of standardized off-grid systems would create job opportunities for Tribal business.	Off-grid site installation could save generator fuel costs.	Early economic forecasts estimate a small profit in later years if the project. System operation and maintenance will create new jobs and skills training.	This energy generation technology is not typically cost effective unless there are additional products and values derived. For example, utilizing biomass residues to reduce fire hazards and create local jobs are additional benefits. Selling additional by-products such as biochar, briquettes or firewood can also help improve the economic results.	Efficiency improvements are generally highly cost effective and can deliver significant savings for comparatively small investments.
	Energy Security / Resilience	Provide electricity to unconnected homes, backup power to key facilities during blackout if battery storage and stand-alone power options are included.	Could be combined with solar PV &/or back-up generator to reliably power telecommunications sites.	Provide electricity to unconnected homes, backup power to key facilities during blackout if battery storage and stand-alone power options are included.	Power production is likely to be intermittent and not to be relied upon for on-demand needs.	Can offset energy demand growth and keep ensure current level of service
	Energy Cost Stability	Reduce reliance on fossil fuels for off-grid generators and grid electricity	Reduce reliance on fossil fuels for off-grid generators	Reduce reliance on fossil fuels for off-grid generators and grid electricity		Reduce reliance on fossil fuels for off-grid generators and grid electricity

Key details of each energy resource opportunity are described below, but several broad conclusions can be drawn from this resource assessment:

- Energy projects in the Klamath region will see the greatest greenhouse gas emissions reductions, as Pacific Power has a much higher greenhouse gas energy intensity than Pacific Gas & Electric.
- Efficiency upgrades and energy-focused building code updates generally provide cost-effective savings.
- Solar power projects and energy efficiency initiatives can be implemented most broadly, with options both in the Upper and Lower Reservation.
- Wind and biomass have limited identified opportunities.
- Hydropower is most likely suited to microhydro applications for off-grid residences.

Solar

Solar PV power is broadly available at both the residential and tribal facility level, with potential options for community-scale installations. SERC broadly estimates an on-grid rooftop solar capacity of about 3.3 MW, based on:

- The number of residences and Tribal facilities on the reservation
- An 80% Solar Feasibility Factor to account for houses where shading and architecture preclude array installation
- Typical residential array size estimates from NREL (NREL 2019[7]), and a representative array size from preliminary array designs for tribal facilities

This estimate notably does not include community-scale projects (> 100 kW), although such projects are possible. For example, an 800 kW installation on available Klamath land was briefly investigated, although the area is targeted for other development. Parking canopy PV arrays were also considered for Klamath and could range from 500 to 1,000 kW. Note that community-scale projects of this size would require aggregation of a large number of Tribal facilities to take advantage of aggregate net metering, and this could prove challenging as all properties have to be contiguous, under the same ownership or lease agreement, and under the same electric account name.

The most economically promising projects are those that achieve energy cost reductions at the retail rate using net metering. These require no wholesale power contracting, can work at any scale up to the total annual consumption of the facility or facilities in the case of aggregate net metering, and offset energy costs at the higher retail rate. However, systems under 1 MW are preferred because they tend to incur lower interconnection costs.

An on-grid solar installation could also be combined with energy storage (and perhaps other forms of generation), along with smart controls to create a microgrid that can operate in parallel with the grid during normal operations and in island mode when disconnected from the grid in the case of a regional or widespread power outage. While these expanded systems will add

[7] NREL (National Renewable Energy Laboratory). 2019. *2019 Annual Technology Baseline*. Golden, CO: National Renewable Energy Laboratory. https://atb.nrel.gov/electricity/2019.

cost, they can also add resiliency for critical services and can potentially provide other benefits, such as the ability to store power when it is cheap and discharge it when the price is high.

Off-grid solar is also an important resource that can potentially serve many of the off-grid households that may never be connected to the main electric grid. It is estimated that there are 100 to 200 off-grid homes on the Upper Reservation and surrounding Yurok Ancestral Lands. This could represent the potential for another 200 to 1,000 kW of off-grid capacity.

Wind

In 2011 the Schatz Center conducted a *Wind and Hydro Energy Feasibility Study* for the Yurok Tribe. This study, in part based on NREL wind resource maps, determined the McKinnon Hill was likely one of the few potential sites on the Reservation that might support a large, utility-scale wind project. A 50-meter meteorological tower was installed on McKinnon Hill and wind speed data were collected for a full year. The analysis that followed determined the site was not viable for a utility-scale installation as the wind speeds were not strong enough. However, the study did find that the McKinnon Hill site could support a smaller turbine, with the goal of providing power to a Tribal telecommunications facility also located at the site.

Currently the telecommunications station is powered by a battery bank that is charged via a diesel genset. A small wind turbine could reduce the genset operating times, saving fuel costs and emissions. Alternately, a wind turbine could be installed in conjunction with a solar array, with the solar array providing summer power when wind speeds are weakest, and heavier winds supplementing the reduced solar resource in the winter months. The use of a small wind turbine in this type of application might also be suitable for the Tribe's other remote telecommunications stations at Miners Creek and Wiregrass Ridge. However, it should be noted that these sites have not been evaluated for wind power suitability. At least one year of wind speed data would be recommended for this purpose.

Small Hydro

Numerous previous studies identified creeks on the Reservation that might be suitable for small hydroelectric installations. The culmination of this work was the *Wind and Hydro Energy Feasibility Study*. This study identified Pecwan and Kepel Creeks as the best candidates and went on to install stream gauging stations and collect stream flow data for a period of approximately 18 months. The detailed resource and economic analyses that were conducted for the study indicated that Pecwan Creek had the greatest potential, and identified a 1.5 MW system as optimal. Although it appeared the 1.5 MW system could be economically viable, it was marginal at best and would likely be a risky investment. The main cost that deterred the project's viability was the need to upgrade the distribution lines all the way back to the Hoopa substation 30 miles away. This type of distribution system upgrade would likely be required for any generator of this size located in the Upper Reservation.

For this reason, only smaller micro-hydro systems that are sized to meet local demand are likely to be feasible at this time. These could be deployed as net metered systems for on-grid applications, or as stand-alone systems for off-grid applications. Below we consider hybrid

systems of micro-hydro and solar power for off-grid applications. These two resources complement each other because there tends to be an abundance of sun in the summertime when creek flows have significantly subsided, whereas creek flows are strong in the winter when the solar resource is at a minimum. As described below, it was estimated that there may be potential for up to about 100 off-grid homes that could be powered, at least in part, by off-grid micro-hydro systems.

Any consideration of hydro project development should be done in consultation with other Tribal departments, namely Fisheries and YTEP, in order to mitigate environmental and cultural impacts and concerns.

Biomass

Biomass has been determined to be a potential renewable energy resource on the Yurok Reservation. The TSS Consultants study and subsequent *Utility Feasibility Study* identified sufficient biomass resources to fuel a small biomass power plant. However, biomass power, especially at a small scale (less than a few MW's) is typically more expensive and significantly more challenging to operate than other renewable power options. For these reasons, biomass power is not recommended as a preferred energy resource. However, if other benefits associated with biomass utilization, such as job creation and a need to utilize biomass waste from forest management practices, are instead the drivers for a project, then this energy resource might warrant further examination.

When considered solely as a means of electricity production biomass is not a cost-effective solution. The fuel can be problematic: biomass will vary in size, moisture, and energy content, which will affect the generation potential and limit the equipment that can be used. Unlike other renewable resources, biomass fuel must be harvested, which requires coordination with forest management stakeholders or other sources, and can limit available fuel based on those stakeholder's needs. Material collection and delivery to a central location increase operational costs relative to other means of power production. Biomass fuel is frequently collected in remote locations, and being less energy dense than other fuels, more trucks are needed to transport the same amount of energy as traditional fuels.

Small-scale biomass generators are also more complicated to operate than the other renewable systems explored in this plan. An operational biomass generator requires active labor to operate and handle fuel, whereas other renewable systems only require maintenance labor. Moving parts and exposure to high heat will increase the maintenance load. Fuel supplies will need to be stored on-site, increasing the facility footprint. Emissions and generator noise is another concern absent from other renewable systems.

As an energy resource, biomass is most effective as a corollary to existing forest management activity. Forest management and wildfire fuel reduction necessarily create some amount of available woody material, often containing branches, tree tops, and low-quality wood not suitable for board timber or poles. Using the excess low-quality material for a value-added byproduct can be more cost-effective than disposing of the material as waste.

However, electricity is not the only value-added biomass byproduct. Some byproducts will require simple processing, such as wood chips and mulch. Other byproducts require more intensive processing solutions, such as biochar (a valuable soil amendment) or briquettes for stove heating. With the difficulties and relatively high costs of biomass energy, the most economically viable biomass utilization solutions may involve creating additional byproducts as well as electricity, or even instead of electricity. If the fuel supply characteristics vary enough, taking advantage of multiple product pathways may be the only way to fully utilize all biomass.

Depending on the site and resource availability, different products can be produced simultaneously via an integrated biomass utilization system, or piecemeal within separate systems. The system configuration will ultimately depend on the available fuel, demand for various byproducts, and site limitations. The most economically viable solution may be to generate biomass electricity solely to power byproduct processing equipment, or it may be more viable to produce both byproducts and grid electricity. Electricity can be produced via direct combustion (i.e. wood chips heating a boiler) or through gasification. Each product pathway requires different machinery and a biomass fuel with a certain range of characteristics. For small sized biomass fueled electricity generators (less than about 500 kWe) gasification is typically the only option, and even with gasification there are very few equipment options. It also should be noted that gasification is typically more efficient, and in order to make direct combustion approaches viable there typically must be a large need for waste heat.

Regardless of the specific technology, biomass utilization sites will require: electric service, access to water, a chipper, screener, or grinder to control fuel size, a loader and fuel handler, some means of handling the byproduct, and biomass fuel storage. Dryers may also be required, depending on the moisture content of the fuel, and waste heat utilization may be needed to keep an operation efficient and cost-effective. The best potential project sites also need easy road access, little required site transformation, and no land ownership obstacles.

Energy Efficiency

Energy efficiency opportunities are typically the most economical and environmentally favorable energy project options, and the greatest energy efficiency opportunities are often associated with the biggest energy users. As part of this planning study the energy consumption for all Tribal facilities was evaluated and the highest cost facilities were identified. In addition, the energy use intensity[8] for high cost facilities was calculated and compared to comparable buildings, a practice referred to as energy benchmarking (see Table 1).

The facilities with the highest annual electricity costs included the following:

1. Redwood Hotel and Casino, Klamath
2. Klamath Tribal Office, Klamath
3. Pem-mey Fuel Mart, Klamath
4. Food Distribution Center, Crescent City
5. Klamath Head Start, Klamath
6. Weitchpec Tribal Office, Weitchpec

[8] Energy use intensity is the total energy used by a facility divided by its floor area.

7. Worthington School Site, Eureka
8. Pec-tah Fuel Mart, Weitchpec

Task 1.5 Infrastructure Assessment

Both of the electrical power substations serving the Yurok reservation are at the end of the transmission line for their respective utilities - the Yurok substation in Klamath for Pacific Power and the Hoopa substation for PG&E. The capacity of these substations and the distribution circuits they serve is important in terms of both the amount of load they can serve, and the amount of distributed generation they can support without significant upgrades. If there is planned/expected load growth, the utility will typically upgrade the circuit and rate-base[9] the cost. The exception to this can be if there is a need for upgrades that will benefit only one customer, then that customer may need to pay for all or a portion of the costs.

When interconnecting distributed generation, like rooftop solar PV, to the distribution system, who incurs the cost of any required distribution system upgrades will depend on the tariff under which the interconnection occurs and the utility service territory that the project is in. For net metered[10] (NEM) projects in PG&E's service territory under 1-MW of capacity, distribution system upgrades are rate-based. For non-NEM projects and projects 1-MW and above, all upgrade costs are incurred by the interconnection customer. In Pacific Power's service territory, all upgrade costs are incurred by the interconnection customer regardless of the size of the system or the interconnection tariff. When interconnecting distributed generation, it is important to know which category you fall into. In addition, it is important to note that interconnecting larger systems will increase the chance that upgrades will be necessary.

One guideline that can be followed to minimize the chance of incurring system upgrade costs is to size the distributed generator to be no bigger than the minimum load on the circuit it is interconnecting to. Information about the minimum load on a circuit can typically be obtained from the distribution utility. In Pacific Power's territory you can pay $300 for a Pre-Application Report where you specify the size of the system and where you want to interconnect it. They will then provide you with information about the circuit, including what the minimum load is. In PG&E's territory you can also purchase a Pre-Application Report. Alternatively, you can examine their PVRAM map and/or their Integration Capacity Analysis (ICA) Map to obtain related information about the size of the system you can likely install without significant upgrades. As part of this planning exercise, these approaches were used to evaluate potential project opportunities for the Yurok Tribe.

The Yurok substation is located only about one-mile north of the town of Klamath where the majority of the electrical load is. The distribution circuit feeding the area is a 12.5 kV circuit.

[9] Rate-basing means that the cost of the upgrades will be distributed across the entire rate base of the utility so that all customers share in the cost.
[10] Net metering refers to customers who install on-site generation, like solar PV, supply some of their load directly and send excess power back to the utility grid. The offset load and excess power returned to the grid are both valued at the retail value of the electricity, though certain charges cannot be credited.

According to Pacific Power's Pre-Application report the Tribe should be able to interconnect cumulative PV generation of up to about 450 kW in the Klamath area without the need for substantial upgrades.

For potential distributed generation projects in the Upper Reservation, the following information was compiled. From the Hoopa substation, a 12 kV 3-phase, 3-wire distribution feeder runs along highway 96 to connect to Weitchpec. Over the last 15 years, line extensions from Weitchpec have connected other communities on the reservation:

- 2003: Line extended (12 kV 3-phase, 3-wire) to the Martins Ferry Bridge, over the Klamath River, and into the Tulley Creek community
- 2005: Line extended (1-phase, 2-wire) up Mitchell Road
- 2008: Line extension (1-phase, 2-wire) from Martins Ferry Bridge to Notchko began
- 2011: Line extension (1-phase, 2-wire) from Weitchpec to Lake Prairie community
- 2018: Line extended (1-phase, 2-wire) to Wautec

Smaller, 1-phase distribution lines will limit the amount of distributed generation capacity that can be supported without upgrades. PG&E's PVRAM map provided an estimate of the distributed generation capacity the current grid can support:

- Weitchpec: 230 kW
- Tulley Creek: 180 kW
- Wautec: 125 kW (Note that this is not a PVRAM estimate; it is based solely on voltage drop concerns and is likely an overestimate. If the minimum daytime load is the limiting factor, the maximum capacity is likely to be much lower and might only be 25-50% of this amount.)

Another issue with the remote circuits that connect to the Yurok Reservation is that they have significant reliability issues. Electric utility customers are often the first to lose power in these areas and the last to get power restored, and this is anticipated to worsen in PG&E's territory with the recent implementation of Public Safety Power Shutoffs[11]. Based on PG&E's reliability reports, the Hoopa circuit has ranked consistently low on reliability - for 2017 it was ranked 11th worst for frequency of power outages and 7th worst for time spent without power. While the Pacific Power reliability reports do not include information on the Klamath circuit, nearby circuits - Patricks Creek along Highway 199 and Pine Grove serving Crescent City - were ranked as some of the worst performing circuits in 2017 and 2016, respectively. Additionally, Yurok staff report that power outages are not uncommon in these areas.

Task 1.6 Community Engagement

The project team engaged with the Yurok Tribal Council on two occasions. The first was a Council Meeting in Klamath on March 20, 2019. Jim Zoellick and Peter Lehman from the Schatz Center joined Gino O'Rourke and Kathleen Fischer of the Yurok Tribe Planning Department in attending that meeting and presenting to the Tribal Council. The project team provided the Council a status update on the project and presented them with some near-term

[11] Public Safety Power Shutoffs are when the utility shuts off the power in large geographic areas due to excessively high fire danger and the threat of power lines igniting a fire.

projects opportunities for installing solar PV on Tribal facilities. Following the meeting the Tribe decided to move forward with securing a grant and installing a solar PV system on the Tulley Creek Transportation Building. That system is already installed and operational.

The second meeting with Council was a Working Session. It took place on November 12, 2019 in Tulley Creek. Jim Zoellick and Ian Guerrero from the Schatz Center joined Gino O'Rourke and Sophia Lay from the Yurok Tribe Planning Department in attending that meeting and presenting to the Tribal Council. This Working Session included a review and update of the Yurok Tribal Energy Vision statement, a review and discussion of the Energy Options Analysis matrix, as well as discussion about various project opportunities and the technical and economic viability of these various options. The feedback from Council assisted the project team in finalizing the Yurok Tribe Strategic Plan.

Community outreach to share information about the Yurok Tribe Strategic Plan was conducted by Gino O'Rourke. Gino put together a poster based on the presentation delivered to Council at the November 12th Working Session and then attended the Fall Feast celebrations and shared the poster with community members. Following the Fall Feast celebration in McKinleyville Gino reported the following "The community outreach went good. There was more than 100 people in attendance. Everyone I talked to was excited about the plan and really liked it."

Task 1.7 Energy Options Analysis

Energy Needs Assessment

An energy needs assessment was not formally conducted as part of this strategic planning exercise. Nonetheless, previous needs assessments were reviewed and a sense of the current energy needs of the Yurok Tribe were ascertained through communications with Tribal staff and Tribal Council, as well as via a review of the energy and Yurok Tribe demographic data that were compiled as a part of this planning project. The key needs and potential Tribal responses are identified below:

- Provide access to electricity to many of the remote residences in the Upper Reservation who are not currently and likely will never be connected to the utility distribution grid. A program to address this is laid out in the strategic energy plan.
- Provide reliable electricity services, especially to critical facilities. Because of the remote location of the Yurok Reservation it is more susceptible to electrical power outages, and when the power goes out it is typically out for longer periods. This situation is expected to worsen with Public Safety Power Shutoffs. This can be addressed with the installation of microgrids for critical facilities.
- Provide cost effective energy services. Many residents on the Reservation are low income and therefore pay a greater share of their income for energy. By implementing energy efficiency upgrades and net metered renewable energy systems the Tribe can help residents lower their energy costs.

- Promote Tribal self-sufficiency. The more the Tribe can decrease the amount of energy they use (through efficiency upgrades) and decrease the amount of energy they need to purchase from external sources (by installing local distributed generation that serves facility loads via net metering), the more self-sufficient the Tribe will become from an energy perspective.
- Promote environmental sustainability. By reducing energy consumption and increasing the use of low and zero carbon energy sources, like solar, wind and hydro, the Tribe can reduce its carbon footprint and thereby reduce its contribution to global climate change, the most serious environmental danger of our time.
- Promote job creation and economic opportunity for Tribal members. The Tribe can create energy related job opportunities by creating a Tribal Energy Program that develops, installs, operates and maintains local energy projects for the benefit of the greater Tribal community. This will require local labor and there will be opportunities for Tribal members to become trained energy technicians.

Energy Options Rubric

In order to evaluate and screen the various energy resource options identified during the Resource Assessment exercise, an Energy Options Rubric was developed. Each energy resource type was then evaluated using the rubric. Each resource option was assessed according to the criteria shown in Table 3.

Table 3: Evaluation Criteria

Evaluation Criteria	Description of Criteria	Weight
Technical Feasibility	This assesses both technology issues, as well as programmatic and implementation issues. If a technology is more complicated or difficult to implement, even though it is technically well-proven, that will lower its score in terms of technical feasibility.	2
Economic Feasibility	This rates the economic feasibility. Is this project likely to be an economic success? Will revenues at least equal costs? Will there be excess revenues? Can the project be funded? Will it be economically self-sustaining?	2
Promotes Tribal Vision	This rates the ability of the project to further the Tribal Energy Vision.	1
Creates On-Reservation Jobs	This rates the ability of the project to create local jobs that Tribe members would likely have access to.	1
Promotes Tribal Sovereignty	This rating is based on the projects ability to further Tribal sovereignty. Will it make the Tribe more self-sufficient or resilient.	1
Risk Level	This rates the risk level for the project. How much chance is there that the project could fail (could be due to technical challenges, programmatic challenges, economic challenges, etc.)?	2

Each resource option, or project type, was evaluated based on these criteria and assigned a score from 1 to 5. For all criteria a score of 5 means the project scored as well as it could, and a score of 1 means it scored very poorly. Projects that were highly technically or economically feasible would receive a 5. Projects that would do a very good job promoting the Tribal Energy Vision, creating on-Reservation jobs, or promoting Tribal sovereignty could score 5 in those categories. And a project that had a very low risk level would score a 5 in that category.

Each of the criteria were also assigned a weight. Then each project type was scored according to the criteria, the scores were weighted and summed, and a final score was determined. The highest score possible was a score of 45 if a project scored 5's in every criterion category. Results of the evaluation exercise are given in Tables 4 and 5. Table 4 briefly describes each project type and provides the final qualitative ranking. Table 5 shows the actual numeric scores for each project. In addition, Appendix D – Energy Options Analysis Criteria and Ranking provides additional details about each project type and why it was scored the way it was.

Table 4: Project Types and Overall Ranking

Project Type	Locations	Description	Overall Ranking
On-grid Solar Electric	Klamath, Tulley Creek, Wautec, Worthington School	Roof-top solar arrays, net metered systems, offset retail electricity costs for Tribal facilities	**High**
Energy Efficiency	Tribal facilities and residences, up-river and down-river	Many energy efficiency improvements for buildings are cost-effective. Utilize existing programs.	**High**
Microgrids	Tulley Creek Tribal office complex, Klamath Tribal Office, Weitchpec Tribal Office	Battery storage and controls are combined with solar electric systems	**High/Med**
Off-grid Solar Electric and Microhydro	Up-river area, off-grid homes that are too far from the grid to be connected	Standardized/containerized systems, solar+battery+genset or solar/hydro+battery	**Med/High**
Wind	McKinnon Hill and perhaps other remote rigetop telecom sites	Small wind systems for individual telecom sites, might compliment or replace solar	**Med**
Biomass	Up-river area	A biomass utilization program, make use of biomass waste material	**Med/Low**
Medium-scale hydro	Pecwan Creek, Ke'Pel Creek	~1.5 MW system on Pecwan Creek, would require major upgrades to power lines	**Med/Low**

Table 5: Numeric Scoring by Project Type

	Evaluation Criteria							
	Technical Feasibility (weight=2)	*Economic Feasibility (weight=2)*	*Promotes Tribal Vision (weight=1)*	*Creates on-Reservation Jobs (weight=1)*	*Promotes Tribal Sovereignty (weight=1)*	*Risk Level (weight=2)*	*Overall Ranking*	*Overall Ranking*
On-grid Solar Electric	5	5	5	4	5	5	**44**	**High**
Energy Efficiency	5	5	5	1	5	5	**41**	**High**
Microgrids	5	3	5	3	5	3	**35**	**High/Med**
Off-grid Solar Electric and Microhydro	3	3	5	5	5	2	**31**	**Med/High**
Wind	3	3	3	3	3	3	**27**	**Med**
Biomass	1	1	4	5	5	1	**20**	**Med/Low**
Medium-scale hydro	3	1	3	3	3	1	**19**	**Med/Low**

Note: Each project type was scored on a level of 1 to 5 for each criterion, where 1 = low and 5 = high. Scores were then weighted according to the criterion weights shown and a total score for each project type was determined.

Energy Project Opportunities

The following list of energy project opportunities were developed based on the results of the Energy Options Analysis. These project opportunities have been determined to have:

- high to medium technical feasibility,
- high to medium economic feasibility,
- high promotion of the Tribal energy vision,
- high promotion of Tribal sovereignty, and (in most cases)
- low to medium risk.

Grid-connected Solar

Grid-connected solar projects were examined for locations in Tulley Creek, Wautec, and Klamath (shown in Figure 4), as well as some off-Reservation locations. These proposed projects would operate under net metering agreements, offsetting the retail cost of a customer's energy use. This approach provides the greatest economic benefit. Initial project designs were based on simulations using the National Renewable Energy Laboratory's System Advisor Model (SAM). This model uses estimated system sizes, array configurations, and regional weather data to estimate system performance. Installed system costs were estimated assuming a cost of $3/W of installed DC capacity. This is consistent with what the Tribe recently paid for a 28 kW PV system installed on the new Transportation Building located in Tulley Creek. Operations and maintenance costs were estimated at $15/kW of capacity per year based on NREL's 2019 technology baseline[11] for similarly sized grid-connected solar systems. These systems are expected to last at least 25 years, with some equipment being replaced during that period.

To be eligible for net metering, systems must be sized no larger than to offset the annual consumption for the facilities they serve. In addition, facilities can be aggregated as long as they are on contiguous properties owned or leased by the customer named on the electric bill. Only one generation account can serve each aggregation, but multiple aggregations are possible. Net metering and aggregate net metering are available from both Pacific Power and PG&E.

The recent system installed on the Tulley Creek Transportation Building was installed by GRID Alternatives, and they are highly recommended as a potential partner for future projects. They are cost competitive, a non-profit organization, have a Tribal Program, and have worked with many Tribes across the country. In addition, their business model includes opportunities to train Tribal members in the installation and maintenance of solar PV systems. This could offer the Yurok Tribe a great opportunity to build their own staff of trained PV system technicians.

Table 6 lists the rooftop solar PV projects that have been examined as part of this strategic plan. Below, most of the proposed projects are briefly discussed. In all cases design estimates are preliminary and additional work would be required before the project could move forward. Determining a specific array capacity will require a more detailed roof survey with accurate dimensions and roof obstructions, as well as an assessment of electric service panel capacity and other facility details. A firm cost estimate will also need to be obtained.

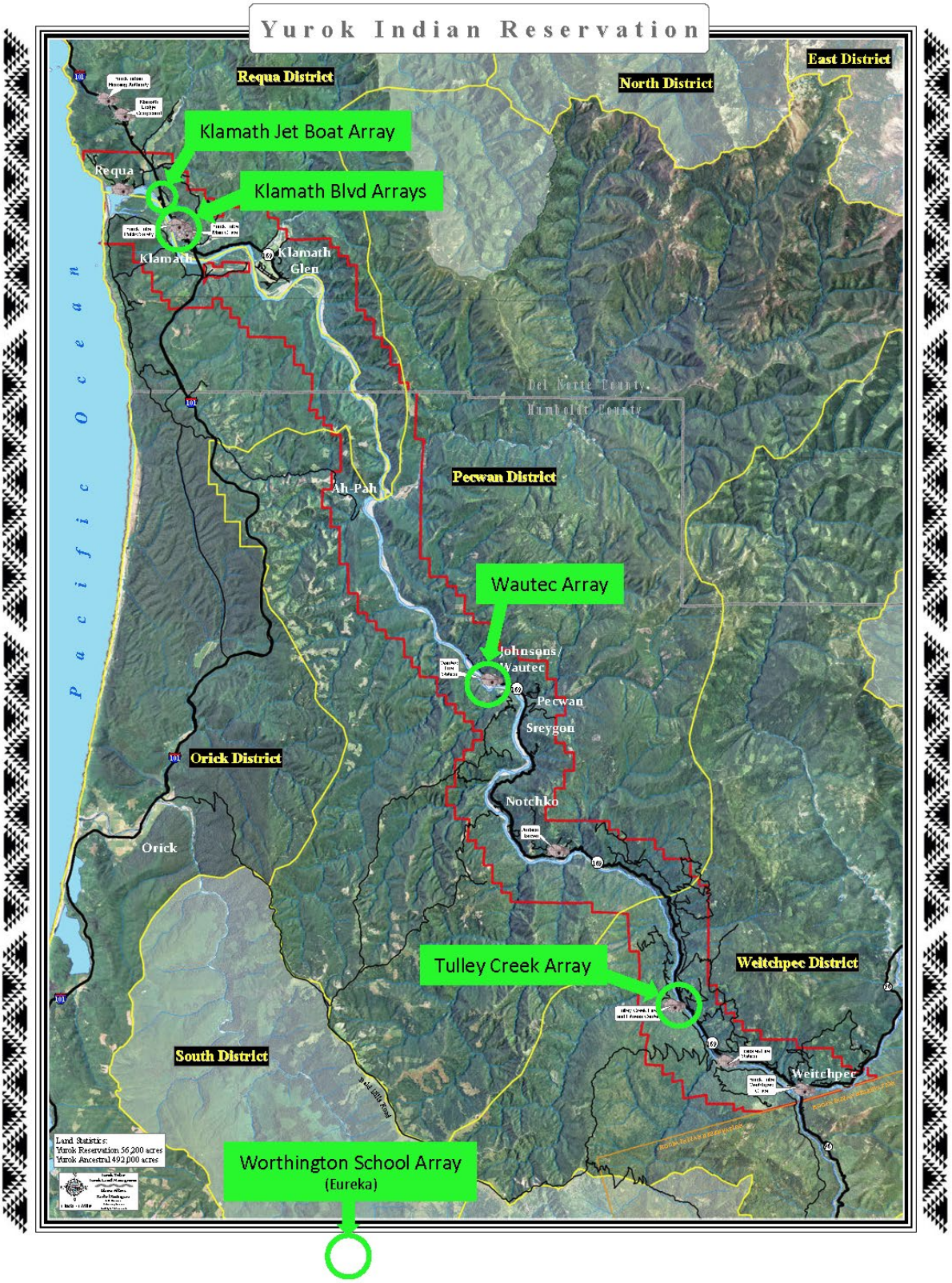

Figure 4: Proposed on-grid PV array locations for Tribal facilities

Table 6: Proposed on-grid rooftop PV systems on Tribal facilities

Region	System Location	Size (kW_DC)	Annual Energy (kWh)	Estimated Installed Cost	Generator Account	Service arragement	% load met by generation	Annual net revenutes (cost savings - O&M costs)	25 year revenue	Annual GHG Emission Reductions (MT CO2e)	25 year GHG emission reductions (MT CO2e)
Blue Lake	Mad River Brewery	120 (Max)	148,500	$360,000						14.2	354
Eureka	Worthington School	50	70,237	$150,000	Worthington School	No aggregation, Worthington school only	98	$12,180	$304,500	6.7	168
Up-river	Tulley Creek Transportation Building	28	28,200	$85,400	Tulley Creek Transportation Building	Aggregation of Transportation Building, Transfer stations 1&2	102	$7,032	$175,800	2.7	67
Up-river	Tulley Creek Fire Station	24	30,600	$72,000	Tulley Creek Fire Station	Aggregation of Fire Station and Ke-Nek Building	96	$5,650	$141,250	2.9	73
Up-river	Wautec	34	46,000	$102,000	Wautec Firehouse	Aggregation of Wautec Firehouse, Mor-ek Won Community Center, Head Start and Early Head Start @ McKinnon Hill	117	$7,506	$187,650	4.1	103
Down-river	Klamath Tribal Office	109	141,684	$347,000	New service	Aggregation of Tribal Office, Justice Center, Old Cannery	45	$14,980	$374,500	56.0	1,399
Down-river	Klamath Hotel	80	103,604	$260,000	New service	Aggregation of temp service for hotel/casino, Hotel waste water, Bates bilding, Bates building 2, Bates building Old Market	93	$11,520	$288,000	40.9	1,023
Down-river	Klamath Casino	85	111,198	$255,000	Klamath Casino	No aggregation, Klamath Casino only	20	$11,700	$292,500	43.9	1,098
Down-river	Klamath Visitor Center	22	29,100	$66,000	Klamath Visitor Center	Visitor Center Load Only	95	$3,068	$76,700	11.5	287
Down-river	Pem-mey fuel mart	40	52,900	$140,000	New service	Aggregatioin of Pem-mey fuel mart, YEDC Office 1&2, Old Police Station, Knowledge Park	15	$5,760	$144,000	20.9	522
Down-river	Jet Boat Tours	10	13,225	$30,000	Jet Boat Tours	No aggregation Jet Boat Tours only	102	$1,676	$41,900	5.2	131
All Projects		**482**		**$1,867,400**				**$81,072**	**$2,026,800**	209.1	5,226

Tulley Creek Campus

The Tulley Creek Tribal Facility Campus includes: the Transportation Program Building - Tulley Creek, the Ke-nek Administration Building, and the Tulley Creek Fire Station. These facilities provide critical services to the Tribal community in the Upper Reservation. According to PG&E's PVRAM map the electrical distribution system at the Tulley Creek campus should be able support up to approximately 175 kW of interconnected solar PV. An approximate satellite view of the proposed PV array placement in Tulley Creek is provided in Figure 5.

A possible avenue for future development of this project could be the incorporation of the existing array into a community-scale microgrid for Tulley Creek. This would require additional equipment - chiefly energy storage, as well as a management system to control the microgrid. A microgrid would also require a utility interconnection agreement to define how the microgrid would interact with the grid at large. This is discussed further below.

Figure 5: Proposed location of Tulley Creek PV arrays.

Transportation Building

This project has already been installed, with 28 kW of solar panels on the southern roof of the Transportation Building in Tulley Creek (see Figure 6). The installed cost of the system just barely exceeded $3/W. This system is projected to generate 28,200 kWh/year and save approximately $7,000 in annual energy costs.

Figure 6: Rooftop PV system on Tulley Creek Transportation Building

Firehouse

This project would install up to 24 kW of solar panels on the SE facing roof of the Tulley Creek Firehouse. Simulations estimate that this array could produce over 30,000 kWh per year, saving approximately $5,500 per year on energy costs. With an installation cost of $72,000, approximately $3,200 in inverter replacement costs required every 10 years and $360 in annual operation and maintenance, the total net present system value is estimated at $141,000. This facility is planned to be aggregated with the Ke-nek Building at Tulley Creek as part of an aggregate net metering arrangement.

Wautec

This project would install 34 kW of solar PV capacity in the Wautec community. The SW facing portion of the firehouse roof would hold a 20 kW array, and the remaining 14 kW would be installed facing SW on the small field in front of the fire house. The estimated installation cost is $102,000. Initial simulations calculate that this system could produce 46,000 kWh per year and save approximately $7,500 per year in energy costs. This facility is planned to be aggregated with the Morek Won Community Center, the Head Start facility and the Early Head Start facility,

all in McKinnon Hill. Parcel ownership has been reviewed and there are contiguous properties between the Wautec Fire Station and the McKinnon Hill facilities. An approximate satellite view of the proposed PV array placement in Wautec is provided in Figure 7.

Figure 7: Proposed location of Wautec PV arrays

Klamath

Below are six proposed PV systems for Klamath totaling about 350 kW. It is expected that this level of PV capacity can be installed in Klamath without serious need for distribution system upgrades. This is based on the Pre-Application Report that was obtained from Pacific Power for the Klamath area. This report indicated that up to 450 kW of PV could be installed without significant upgrades. However, full interconnection applications will need to be submitted for these proposed systems, interconnection study evaluations will be performed as necessary, and a final determination will be given regarding the need for any upgrades. An approximate satellite view of the proposed PV array placement in Klamath is provided in Figure 8.

Redwood Hotel

This project would install 80 kW of panels on the SW-facing portion of the Redwood Hotel roof, initially estimated to cost $260,000. The array is projected to produce 103,000 kWh/year (approximately 93% of the aggregated load), saving about $11,500 per year. The PV array on this facility is planned to be connected via a new electric service. This generating account is then planned to be aggregated with multiple accounts as part of an aggregate net metering arrangement (accounts include: temporary service for hotel/casino, hotel waste water, Bates bldg., Bates bldg. #2 and Bates bldg. Old Market).

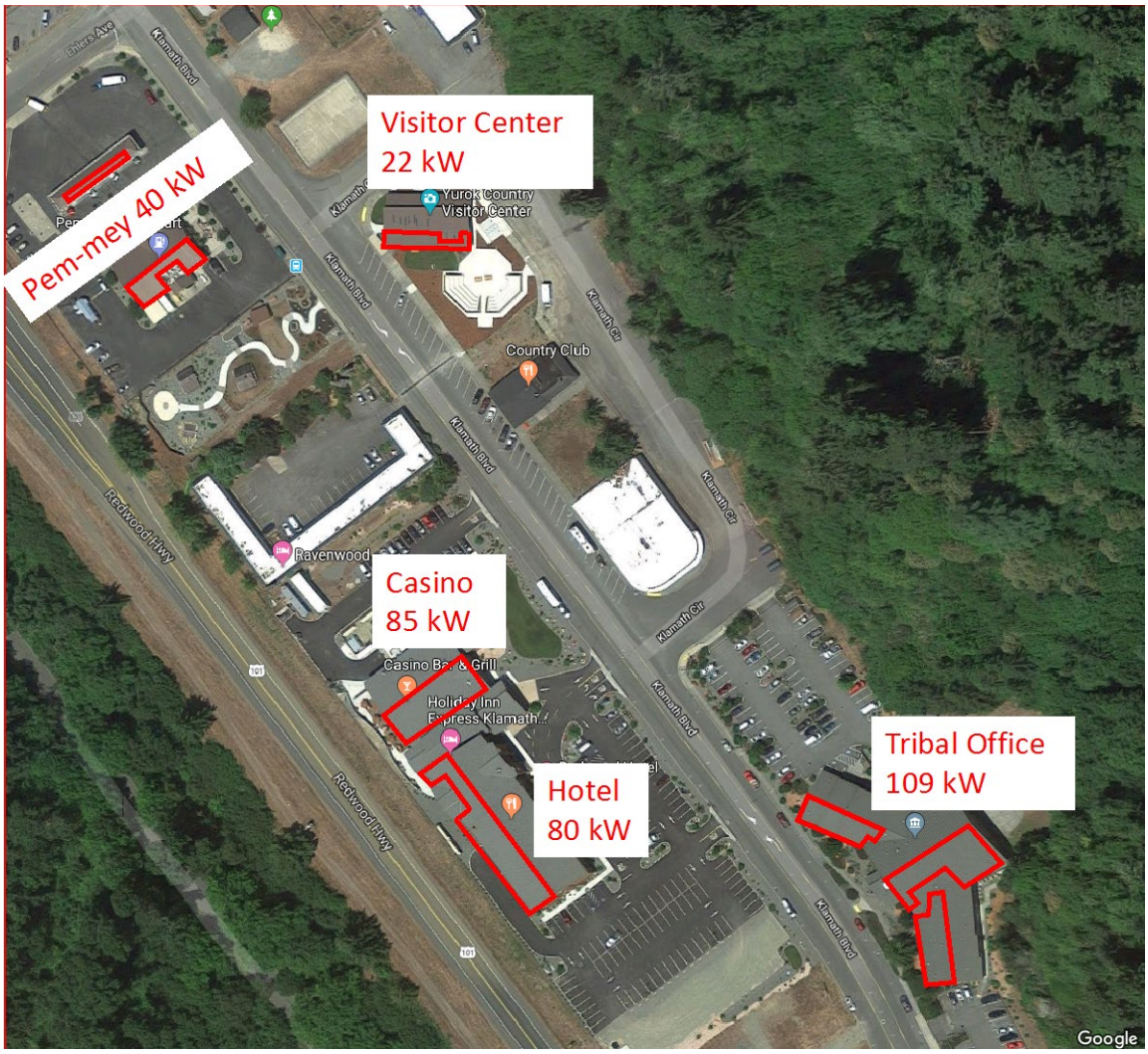

Figure 8: Proposed location of Klamath PV arrays

Redwood Casino

This project would install 85 kW of panels on the SE-facing portion of the casino roof, initially estimated to cost $255,000. The array is projected to produce 112,000 kWh/year (approximately 20% of the casino load), saving nearly $12,000 per year.

Klamath Tribal Office

This project would install 109 kW of panels on the SE, SW and W-facing portions of the Klamath Tribal Office roof, initially estimated to cost $347,000. The PV array on this facility is planned to be connected via a new electric service. The array is projected to produce 141,000 kWh/year (approximately 45% of the aggregated load), saving about $15,000 per year. This generating account is planned to be aggregated with multiple accounts, including the Justice Center and the Old Cannery.

Pem-mey Fuel Mart

This project would install 40 kW of panels on the SE-facing portion of the Pem-mey roof, initially estimated to cost $140,000. The array is projected to produce about 53,000 kWh/year (approximately 15% of the aggregated load), saving about $5,700 per month. This generator would be interconnected via a new service and would be aggregated with the YEDC Office #1 and #2, the Old Police Station, and the Knowledge Park load accounts.

Klamath Visitor Center

This project would install 22 kW of panels on the south facing portion of the Visitor Center roof, initially estimated to cost $66,000. The array is projected to produce about 29,000 kWh/year (approximately 95% of the Visitor Center load), saving about $3,000 per year.

Worthington School

This project would install 50 kW of panels on the south-facing portion of the school roof and is estimated to cost $150,000. The array is projected to produce 70,000 kWh/year (approximately 98% of the school facility load) and save approximately $12,000 per year. An approximate satellite view of the proposed PV array placement at Worthington School is provided in Figure 9.

Figure 9: Proposed location of Worthington School PV arrays.

Microgrids

According to the US Department of Energy, a microgrid is "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode."

Microgrids typically include energy storage and smart controls, in addition to onsite generation such as rooftop PV. During normal operation, when the utility grid is operational, the microgrid runs in grid-connected mode in parallel with the main grid. In this case the system can function as a typical net metered system, generating energy savings for the facility.

However, the main purpose of a microgrid is to be able to provide resilience to critical facilities. In the event of a grid outage, the microgrid can disconnect from the main grid, go into island mode, and form its own grid. This can allow the facilities to run for extended periods of time without grid power. The length of time a facility can run depends on the size of the battery, its state of charge, the loads it is subjected to, and any generation that might be contributing to the load.

Tulley Creek Campus

With the solar PV system that has already been installed on the Tulley Creek Transportation Building and the additional PV array that is planned for the Fire Station, these systems can form the basis for a microgrid system. In order to develop a microgrid system, battery energy storage and microgrid controls would need to be added. In addition, it would be best to reconfigure the electrical service for these facilities so they are all served from one utility meter. This would also allow a propane generator to provide back-up power when needed to all three facilities. This is discussed further below.

Additional Microgrid Opportunities

Additional Tribal facilities that have been identified as candidates for microgrid installations include:

- Klamath Tribal Office
- Weitchpec Tribal Office
- Morek Won Community Center

Off-Grid Solar and Solar/Micro-Hydro Hybrid Systems

In order to serve the Yurok Tribal members who live in remote locations that are unlikely to ever become grid connected, multiple options for off-grid energy systems were considered. SERC developed cost estimates for off-grid solar plus storage systems which could be used alongside backup generators when the solar resource is not adequate. PV systems were sized to meet loads in the winter months when the solar resource is minimal. Back-up generators were added to cover the worst solar periods and ensure battery health is maintained. In addition, a preliminary analysis for the feasibility of using micro-hydro systems in conjunction with off-grid solar plus storage systems was conducted. In this case, the solar systems could be downsized due to the availability of the hydro resource during the winter months.

It is unclear exactly how many off-grid homes there are on the Upper Reservation. Estimates appear to range between about 100 and perhaps as many as 200 off-grid homes, though the larger estimate includes homes that are off the Reservation yet within the Ancestral Territory. The total number also varies depending on whether the residents are Tribal members or not, and also whether or not the houses are occupied. Additional survey work will need to be done if exact numbers are desired for planning purposes. Figure 10 below provides a map that shows on- and off-grid homes both on and off the Reservation.

One important note is that energy efficiency is extremely important for cost effective off-grid energy services. Efficiency measures decrease energy demands and thereby decrease the required size of off-grid energy systems. This is by far the most cost-effective approach. It is almost never cheaper to simply increase the size of the solar generator. It is recommended that as part of an off-grid energy services program off-grid residents be educated and encouraged to utilize the most energy efficient appliances possible. In fact, the program could consider helping finance these efficient products rather than installing a larger off-grid energy system.

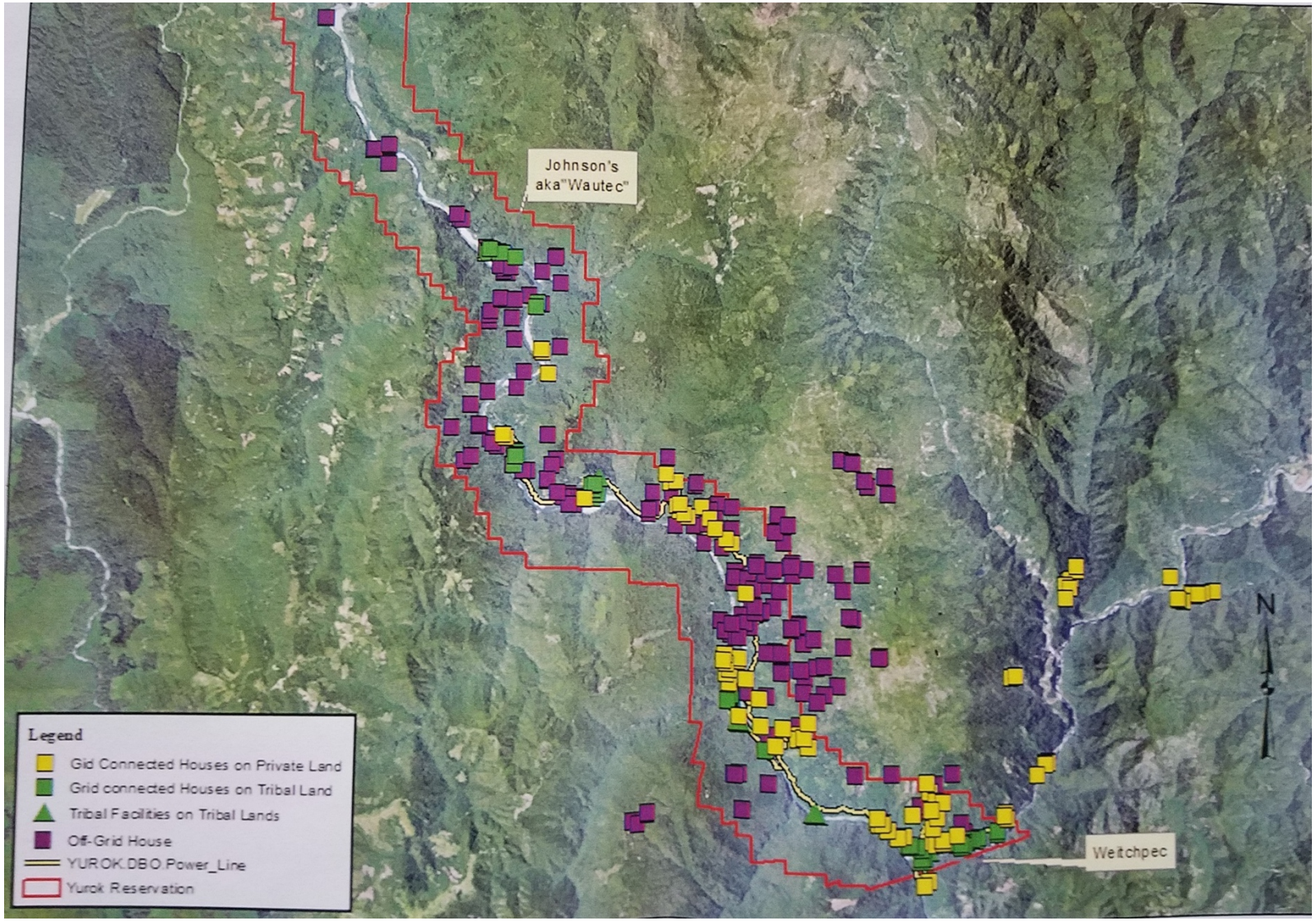

Figure 10: Upper Reservation map showing on-grid and off-grid homes

Off-Grid Solar

The solar resource available is substantial and could likely provide power to many, if not all of the off-grid homes on the Upper Reservation. However, designing custom systems for each home would be both very time consuming, and likely cost prohibitive. To this end, SERC determined the best option would be to develop standardized, palletized systems which could be fabricated in a warehouse and then transported to off-grid sites and installed with much less effort and cost than a custom system. The system would be placed on level ground and anchored in place. Conductors would then be laid in a trench leading to the home's electrical service panel and the system would be interconnected. Prior to interconnection, required electrical work would be performed to bring the home up to electrical code standards to ensure safe and reliable operation.

Standardized systems would help keep costs down by lowering the cost of production, maintenance, replacement, and system installation. For these reasons SERC developed preliminarily designs for three different solar plus storage and backup generator systems which could be deployed in a palletized form. Figure 11 shows a sample of what a system might look like; this is one version of a standardized system that the Navajo Tribal Utility Authority has deployed for off-grid homes.

Figure 11: Example of a standardized, palletized PV system. Source: Navajo Tribal Utility Authority

Three systems were chosen to provide different options at different costs, thereby allowing flexibility for the various needs of different Tribal members. System sizes were designed at 1.5-kW, 10-kW, and 15-kW, and are expected to provide approximately 5 kWh/day, 10 kWh/day, and 15 kWh/day, respectively, of electrical power to meet residential loads. The average energy usage for an on-grid home in the Upper Reservation region is approximately 14 kWh/day. With the targeted installation of energy efficiency measures this load should be able to be reduced to 10 kWh/day or less, allowing these solar electric systems to provide sufficient energy for daily needs.

The installed system costs were estimated to be $13,000 for the 1.5-kW system, $18,000 for the 3-kW system, and $26,000 for the 5-kW system. These estimations include all of the needed hardware to build a functioning palletized system, as well as estimates of production and installation costs. An itemized list of component costs is included in Appendix E – Itemized Cost for Off-Grid Solar Standardized Systems. These systems are expected to last at least 25 years, with some components being replaced over that time period.

Off-Grid Micro-Hydro

It is important to note that the micro-hydro systems considered in this section do not involve dams or impoundments, and therefore will not impair fish passage. These systems pull water from a stream channel at one location and can return it downstream in another location. Any effort to implement micro-hydro systems would need to be explored in conjunction with other relevant departments, such as the Yurok Fisheries Department and the Yurok Tribe Environmental Program.

The study of off-grid hydro was carried out for eleven regions in the Upper Reservation using topographical maps provided by the Yurok Tribe Planning Department. This analysis included the areas of Ah-Pah, Alemeda Road, Bald Hills, Mareep and Mawah Creek, Mckinnon Hill, Miners Creek, Sregon, Surpur Creek, Tulley Creek and Rube Creek, Wautec and Weitchpec.

In each of these regions SERC identified the named streams as listed in the *Tribal Utility Feasibility Study* (SERC 2007). Only the named streams were considered. SERC applied criteria to determine which homes had the potential for a micro-hydropower system. The potential hydraulic head for each home was assessed based on the topography shown in the maps provided. SERC then applied a limit on the allowed distance between candidate homes and a hypothetical intake location on the streams of interest. This allowed the team to screen out homes that were too far from streams and/or could not attain adequate elevation head based on potential stream intake locations. Homes that failed these criteria screened out of the process and were deemed to be impractical to serve from both a cost and a technical perspective.

A total of 214 off-grid homes were screened. During this screening process SERC looked at two different sets of criteria to determine what percentage of off-grid homes could be served by micro-hydro systems. Initially, SERC applied constraints of 300 feet of distance from the house to the stream, with the requirement that there be 100 feet of hydraulic head. In this situation it

was found that approximately 20 homes had some level of feasibility for micro-hydro installation. Following this result another set of criteria were considered. While still requiring 100 feet of hydraulic head, the allowed head loss was increased to 20%, and this increased the possible distance between the home and the stream to 1000 feet. With these criteria, approximately 100 of the off-grid homes displayed some level of feasibility.

If micro-hydro systems are to be considered as part of the Yurok Tribe's Off-grid Energy Program, there will need to be considerably more feasibility and planning work done to assess their suitability. While the results presented above provide a rough estimate of the potential for off-grid micro-hydro systems on the Yurok Reservation, there is much more work that would need to be done to accurately determine how many residences could utilize micro-hydro power. More detailed studies would need to be conducted to better determine site specific criteria, including elevation head, distance and flow rate. It is recommended that the twenty Tier 1 homes within 300 feet of potential micro-hydro intake sites be prioritized for further evaluation. It is also important to note that several of the residences considered in this analysis are in clusters near a common stream. This could be problematic if too many homes were to draw water from a common stream and adversely impact flows, even if only for a portion of the stream reach.

To determine if micro-hydro systems are a suitable addition to the Off-grid Energy Program, a cost analysis would need to be performed as well. An example cost of a representative micro-hydro system is given in Appendix F – Example Residential Micro-hyrdo Cost Estimate. This example system is sized appropriately for what is expected to be needed in the Yurok Off-grid Energy Program. The vendor represented was recommended to SERC and is local to Humboldt County (located in Redway). They also live off-grid with a hybrid PV-microhydro system that powers their home and business, so they know what they are talking about. If the Tribe were considering micro-hydro systems for their off-grid program, we recommend the Tribe reach out to this vendor and engage them in a discussion. Having a local vendor who can supply equipment and provide recommendations and guidance would be very valuable to the Tribe.

Efficiency

Both Pacific Power and PG&E offer numerous programs to help customers adopt energy efficient equipment. These programs can offer free energy audits, assistance with installation contractors, and financial incentives. Table 7 provides a listing and brief description of the different energy efficiency programs currently offered by each utility; this information will likely need to be updated as programs change and new incentives develop.

Table 7: Utility-provided energy efficiency programs

Utility	***Sector***	***Program***	***Summary***
Pacific Power	Commercial	Evergreen Efficiency	Pacific Power's third-party contractor; provides free assessments to evaluate potential lighting and refrigeration upgrades.
		Custom Analysis Program	Provides custom energy services
		Energy Management Program	Assesses facilities with higher than expected energy use, diagnose problems, identify low cost solutions, and provide a $0.02/kWh incentive.
		Watt Smart Business	Provides energy assessments and incentives for qualified upgrades
	Residential	Watt Smart Energy Efficiency Starter Kit	Free kit providing LED light bulbs and low-flow water saving fixtures for residential customers
		Energy Efficient Incentives	Provides economic incentives to encourage the installation of energy efficient equipment
		Weatherization Services	Provides insulation, lighting, and water saving fixtures free to income-qualifying households
PG&E	Commercial	Energy Watch Partnership / Direct Install Program	Administered by RCEA. Provides free audit, works with contractors, verifies installations, and procures rebates.
		On-Bill Financing Program	Interest-free loan program for eligible upgrades; repaid directly through energy savings.
	Residential	Energy Savings Assistance Program	Provides energy upgrade services to income-qualifying customers
		California Alternative Rates for Energy	Provides reduced rates for income-eligible customers
		Moderate Income Direct Install	Provides free installation of approved upgrades, energy and water conservation tips, and referrals to other programs for income-qualifying households.
		Medical Baseline Allowance Program	Provides reduced rates for income-eligible customers with in-home medical appliances
		Energy Upgrade California ® Home Upgrade	Provides home evaluations to determine best upgrades, and can provide up to $5,500 in rebates. Collaborative effort between PG&E and RCEA.

The Tribe has already taken advantage of some of these programs. Through RCEA, tribal buildings within the PG&E service territory have been audited, and in most cases, energy-efficient lighting has been installed. Through Pacific Power's Watt Smart Business program, the four largest energy users (Redwood Hotel/Casino, the Yurok Tribal Office, Head Start, and the food distribution building) have had energy assessments, with lighting upgrades already completed for the Tribal Office.

Appendix G – Status of Energy Efficiency Upgrades has complete listings of the planned and completed energy efficiency upgrades on Tribal buildings, as well as the expected savings for each upgrade. With the given incentives, the upgrades are projected to pay for themselves in less than 2.5 years. On the residential side, the Tribe has made significant outreach efforts to educate members about PG&E's Energy Savings Assistance Program, mailing letters to all residents, posting flyers, and using the Tribe's Facebook page.

As mentioned in the Resource Assessment, adopting energy efficient building codes is one of the most cost-effective means of reducing energy costs. To this end, the Tribe has adopted the California Building Code, including the Title 24 Energy Code, requiring strict energy efficient construction standards. Though this is a critical first step, enforcement is required to fully realize the energy savings of the building code. Building plans must be checked for code compliance, building inspections must confirm that construction has rigorously followed the plan and code specifications, and building commissioning must verify that systems are working as expected post-construction. We encourage the Tribe to pursue these energy code enforcement activities for all new construction on the Reservation.

Task 1.8 Strategic Energy Action Plan

As a culmination of project activities a strategic energy action plan, called *Energy Paths for the Yurok People*, was prepared. The strategic plan largely summarized the work performed in this project, set a context for the planning work, articulated the Yurok Tribe's Energy Vision, assessed the Tribe's energy needs and opportunities, and outlined a plan to enable the Tribe to realize their Energy Vision.

The results of the Energy Options Analysis informed the development of a Yurok Tribe Energy Program. To characterize the Program, a set of Tribal Energy Program activities were proposed, options for a Tribal Energy business model were explored, Tribal Energy Program workforce needs were evaluated, and possible funding opportunities and implementation pathways presented. The proposed Yurok Tribe Energy Program is presented below.

Yurok Tribe Energy Program

The Yurok Tribe has a strong and vibrant Energy Vision, many opportunities they can pursue to further their vision, and a committed and competent team that can lead their efforts. To date all of the energy project work that has been conducted by the Tribe has fallen under their Planning Department. Now that they have completed the line extension all the way to Wautec they can look to the next chapter. If they are to step up their level of energy project activities in an effort

to realize the rest of their Energy Vision, then it is recommended that they begin to establish a formal Energy Program. Below is a suggested framework for an Energy Program, an outline of key activities to be carried out in the near-term, a discussion about possible business models for the Tribe's Energy Program, a discussion about the necessary work force needed to carry out Energy Program activities, a review of potential funding opportunities, and a funding implementation plan and schedule that can allow the Tribe to take the next steps in establishing and Energy Program and moving closer to a realization of their Energy Vision.

Tribal Energy Program Activities

Below are a set of key Energy Program activities that are recommended for the Tribe to engage in during the next few years.

On-Grid Solar Electric via Net Metering

The Tribe should develop an on-grid solar electric program that seeks to fund the purchase and installation of solar electric systems on Tribal facilities. Potential projects were outlined in Table 6. If all of these projects are installed the total cost is anticipated to be about $1.9M. These systems will operate under a net metering model and provide electrical power to Tribal facilities. The power will be valued at the retail cost of energy. If these projects can be grant funded, either in part or in full via available funding sources, then there can be substantial net revenues generated from these projects. The annual cost savings will be substantial and will allow for coverage of modest operation and maintenance costs. These recurring costs can include basic maintenance, troubleshooting and repairs, equipment replacement at end of life (for example, inverters only last about half as long as solar panels), array cleaning, tree trimming, etc.

The net revenues from these projects should be pooled and used to fund other aspects of the Energy Program. In order to do this, the Tribe will need to form an entity that can charge for the power produced by these on-grid systems. Business models to accomplish this are discussed below. Net revenues can be used to support Energy Program staff (also discussed below) and to fund and support other energy projects that serve to forward the Tribe's Energy Vision.

Off-Grid Energy Services Program

As discussed above, there is a need for an off-grid solar (and perhaps micro-hydro) program to provide electric services to the many off-grid residents who live in the Upper Reservation. In an earlier section of this plan we discussed standardized systems that could be deployed. It is recommended that grant funding be sought to plan such a program and to then purchase and install the systems. SERC estimates the cost to install 100 systems ranging in size from 1.5 kW to 5 kW will cost approximately $1.7 M (see Table 8)[12].

One of the most critical aspects to the success of an off-grid program is to make sure that a robust and effective maintenance program is in place to care for and maintain the installed systems. Batteries will need to be tended to multiple times per year and then replaced

[12] This cost will vary depending on the number of 1.5-kW, 3-kW and 5-kW systems installed.

approximately every five years. Inverters and charge controllers will need to be replaced every 10 years or so, as will backup generators. The cost to maintain these systems is not cheap, and it will require trained technical staff. SERC estimates that the annual cost to maintain these 100 systems will be about $98,000 (see Table 8). It is anticipated that the cost to maintain these systems will be too much for the off-grid customers to pay for, as many of them survive on very meager annual incomes. Therefore, a funding model that combines revenues from the On-Grid Solar Electric Program with fees collected from off-grid residents receiving these energy services is recommended. This combined program is discussed below.

Combined On-Grid / Off-Grid Program

SERC conducted an economic analysis to assess the annual costs and revenues associated with both the On-Grid Solar Electric Program and the Off-Grid Energy Services Program. Assuming all of the on-grid PV systems outlined in Table 6 are installed, it is estimated that annual net revenues would amount to about $81,000. This accounts for annual O&M costs associated with these systems. As noted above, Table 8 shows the cost to maintain 100 off-grid PV systems is expected to be about $98,000. In addition, it is anticipated that there will need to be at least one full-time staff person to run the Energy Program at a cost of approximately $60,000 per year. That means that approximately $158,000 per year will be needed to support the off-grid energy program and Energy Program staff person. This means that the Off-Grid Energy Services Program will need to generate approximately $77,000 per year to break even. SERC estimates that by charging off-grid customers a monthly fee ranging from $50 to $150, depending on the size of their solar array, that the off-grid program could generate about $99,000 per year in revenues. Note that the $50 to $150 per month fee for off-grid customers would be equivalent to about $0.33/kWh; for comparison PG&E's on-grid residential rates are currently about $0.27/kWh[13].

It should also be noted that the number of 1.5 kW, 3 kW and 5 kW systems that would be installed was assumed to be 50, 35 and 15, respectively. This was a rather arbitrary assumption and the number of each size system installed could vary substantially. However, even when adjusting the number of each sized systems across the full range (0 to 100 systems of each size), the revenues and costs generally balance out. Numerous combinations of 1.5 kW, 3 kW and 5 kW PV systems, that totaled 100 PV systems in all, were examined and the costs and revenues were compared. In all cases it appears that revenues will outstrip costs by nearly $20,000 per year or more. Table H-1 in Appendix H – On-grid/Off-grid Program Economics with Varied Numbers of Off-grid PV System Sizes presents the results of this analysis.

If costs started outstripping revenues, then the off-grid service fees might need to be increased. It is unclear what fee level will be acceptable in this market. However, planning staff presented comparable preliminary cost numbers to a large group of Upper Reservation community members at a recent community gathering and people's responses were generally favorable, with comments such as, "Yeah, I'd pay that much a month for a system. Where can I sign up."

[13] PG&E – RCEA Joint Rate Comparison, rates current as of July 1, 2019. Sources: https://www.pge.com/pge_global/common/pdfs/customer-service/other-services/alternative-energy-providers/community-choice-aggregation/rcea_rateclasscomparison.pdf

Table 8: Off-Grid Energy Program Costs and Revenues

	Off-grid Option #1	Off-grid Option #2	Off-grid Option #3	Total
Load supported	5 kWh/day	10 kWh/day	15 kWh/day	
System Size	1.5-kW	3-kW	5-kW	
Number of Systems	50	35	15	**100**
Total installed kW	75	105	75	**255**
Installed cost/system	12,800	18,200	26,100	
Estimated Installed Cost	$639,200	$635,500	$391,800.00	**$1,666,500**
Maintenance (hrs/yr)	500	350	150	**1,000**
Annual Equipment Replacement Costs (per system)	$630	$1,140	$1,740	
Annual Equipment Replacement Costs (whole program)	$31,500	$39,900	$26,100	**$97,500**
25 Year O&M Costs				$2,437,500
Customer monthly fees (per system)	$50	$100	$150	
Customer rate ($/kWh)	$0.333	$0.333	$0.333	
Customer revenues (annual)	$30,000	$42,000	$27,000	**$99,000**

Full time staff position, $24/hour + benefits ($/yr)	**$60,000**

Annual revenues	**$180,100**	**Net revenue from on-grid NEM PV systems ($81,100) + off-grid PV customer generated revenues ($99,000)**
Annual costs	**$157,500**	**Total annual equipment replace costs for the off-grid program ($97,500) + the full-time salaried position ($60,000)**

Microgrid Resilience for Critical Tribal Facilities

Key Tribal facilities that have been identified as good prospective microgrid sites include: Tulley Creek Compound (Transportation Bldg., Fire Station, Ke-nek Bldg.), Klamath Tribal Office, Weitchpec Tribal Office, and Morek Won Community Center. Tulley Creek has been identified by Tribal staff as the preferred first site for a microgrid installation. The Transportation Building at Tulley Creek recently received a 28 kW PV system, and there are plans for the installation of a 24 kW PV array on the Fire Station roof. There are also plans to install a backup propane generator at Tulley Creek that could support all three buildings on the property. Currently the three buildings are on three separate electrical services fed off of two separate transformers at different locations on the property. In order to provide backup power to all three buildings from one propane generator the electrical distribution system will need to be reconfigured. It is recommended that if a propane generator is installed, that the planning and design for the propane generator consider the future installation of a microgrid and make sure that the designs are compatible (i.e., you don't want to have to reconfigure things and dig new trenches for the microgrid if you don't have to). This is often referred to as a no regrets policy, where you plan for future expansion and add in low-cost conduit stubouts and extra conduit, thereby making it easy to come back later and add more components, like battery storage and switch gear.

SERC estimates the cost to install a microgrid at Tulley Creek to be about $1.1M. This cost estimate includes enough battery storage for about two days of back-up power in the dead of winter. Design engineering, procurement of equipment, PG&E interconnection costs, electrical and civil site work, and construction management costs are included. A rough itemized cost estimate is provided in Appendix I – Tulley Creek Microgrid Concept. Note that it may be possible to reduce the microgrid cost if the battery storage capacity were decreased and/or if the microgrid controls were simplified.

Also included in Appendix I – Tulley Creek Microgrid Concept are site drawings showing both the existing configuration for the electrical services that feed the site, as well as a proposed configuration for the future microgrid system. A simple 1-line electrical diagram for the proposed configuration is also included. Note that although the PG&E distribution system in Tulley Creek is 3-phase, the three electrical services that serve the Tulley Creek facilities are all 1-phase, 120/240V. Because most commercial-scale battery energy storage systems operate at 3-phase, 480V, it is suggested that the electric service at the Tulley Creek site be reconfigured to be served by a 3-phase, 120/240V high leg delta transformer. That will allow for a 3-phase, 480V transformer to easily serve the battery storage system on the site.

Microgrids for the other Tribal facilities will have to be custom designed for each site. Depending on the size of the required systems and many other details, the costs could be substantially different. Nonetheless, the proposed Tulley Creek system can act as an example of what might be expected at other sites.

Energy Efficiency Services Program

In terms of the Tribal Energy Program, it is recommended that the Tribe continue to take advantage of existing energy efficiency programs and services offered by Pacific Power, PG&E, and the Redwood Coast Energy Authority. The project team does not think it makes sense for the Tribe to try to create their own energy efficiency services program. That said, it does make sense for Yurok Tribe Energy Program staff to be trained and familiar with energy efficiency technologies and programs, and to stay current on these topics. It is vitally important for the Tribe to have a knowledgeable staff person who can interface with the utilities on these energy efficiency programs and who can help the Tribe make wise decisions about which opportunities to pursue.

Yurok Tribe Energy Code

In addition to retrofitting existing buildings with energy efficiency upgrades, it is important for the Tribe to ensure that all new buildings constructed on the Reservation are built to be as energy efficient as possible. The Yurok Tribe's Building and Construction Ordinance (http://www.yuroktribe.org/documents/building_ord.pdf) specifies that all construction projects on the Reservation must meet or exceed the California Building Code. The CA Building Code is probably the most energy efficient building code in the United States, so if the Yurok Tribe successfully enforces this code it will be ensuring that all buildings constructed on the Reservation meet a very high efficiency standard. However, code enforcement is often the Achilles' heel of building code implementation. This is especially a problem for small municipalities, and it is anticipated that it could be a challenge for the Yurok Tribe's Planning and Community Development Department. Successful enforcement of energy efficient building code provisions typically requires the following:

1. An enforcement program must identify and penalize projects that subvert the proper permitting process, otherwise people will decide they don't need to follow it.
2. At the time a permit is applied for the energy code calculations must be checked and verified that they meet the current energy code requirements. This requires staff with adequate energy code compliance skills.
3. During construction the building must be inspected to confirm that it is being built to specification. The proper equipment and materials must be utilized and must be properly installed.
4. Once the building construction is complete there must be adequate commissioning to ensure that the installed equipment is properly adjusted and tuned so that it can operate at its optimum performance level.

If all of these steps are followed the Tribe can ensure that all new construction on the Reservation is meeting energy efficiency goals and objectives.

Coordinate Energy Plan with Other Plans, Policies and Programs

The Yurok Tribe Energy Plan should be coordinated with other Tribal planning documents, policies and programs so that the plans support each other and are not at cross purposes. If there are conflicts with the planning document, these issues should be brought to the Tribal Council's attention and decisions should be made to resolve planning document conflicts.

The Yurok Tribe planning documents, policies and programs listed in Table 9 are anticipated to interact with the Yurok Tribe Energy Plan; possible relationships or interactions with the Energy Plan are noted.

Table 9: Suggested Interactions between Yurok Tribe Energy Plan and other Tribal Documents

Yurok Tribe Department, Plan or Policy	***Suggested Interactions with Energy Plan***
Yurok Housing Authority (YHA), Housing Weatherization Policy and Procedures	Ensure that current policy promotes weatherization and installation of energy efficiency measures to the best degree possible. Make sure all eligible residents are encouraged and supported as needed to participate in available energy efficiency programs, such as PG&E's Energy Savings Assistance Program.
Yurok Economic Development Council (YEDC) programs and policies	Work with YEDC to ensure that any new projects incorporate a sustainable energy element to them if possible. Pursue net zero energy construction if possible. Explore opportunities for economic development and job creation associated with energy projects.
Yurok Tribe Forestry Department, Forest Management Plan	Coordinate with thinning projects and shaded fuel break projects in relation to potential biomass energy and biomass utilization opportunities.
Yurok Tribe Environmental Program (YTEP)	Ensure that the following areas are coordinated between YTEP policies and programs and the Energy Plan: GHG emissions reduction, air quality, hazardous waste, hydrology.
Yurok Tribe Fisheries Department	Ensure that any hydro-electric project opportunities are fully vetted with the Fisheries Department. Seek guidance from Fisheries regarding where projects should and should not be located, how much water can be extracted and where, where water should be returned to the channel, and any mitigations that might be necessary to ensure there are no adverse impacts to fisheries or aquatic ecosystems.

Measurement and Verification Plan

To ensure success, the Energy Plan must be tracked and evaluated over time. This requires the development of a set of quantifiable goals that can be used to measure the Tribe's success in attaining their Energy Vision. In addition, the parameters necessary for measuring success must be determined and a way to collect the required data must be identified. Data collection systems and/or processes must be put in place and data collection activities begun. A periodic evaluation interval should be decided upon. The data should then be processed, parameters calculated, and attainment of goals measured on a periodic basis.

Potential measurable goals could involve the following metrics:

- Number of off-grid homes with renewable energy power systems
- Percentage of Tribal facility electric load provided by net metered PV systems
- Total cost of energy for Tribal facilities
- Percentage of critical Tribal facilities with backup power and/or microgrids

- Energy use intensities of Tribal facilities and comparison to benchmark buildings
- Number of energy jobs created and filled by Tribal members
- Greenhouse gas emissions associated with Tribal facility energy use

It is suggested that the activity of determining what goals should be tracked to measure plan success and what data is needed to track these goals should be a follow on activity that the Tribal Planning staff conduct with the Tribal Council and perhaps the broader the Tribal community.

As the Tribal Energy Plan is modified over time, the Measurement and Verification plan will have to be updated as well. In addition, there may be opportunities for adaptive management, where the data collected and evaluated can inform future Energy Program activities. For example, if a particular program is designed to achieve certain goals and those goals are not being met, then information may be collected to help explain why goals are not being met and this information may generate ideas for program modifications that can improve future results.

Tribal Energy Business Model

As discussed earlier in this plan, a key element critical to the success of the proposed program will be the ability to generate revenues associated with the energy cost savings that result from net metered solar PV systems or energy efficiency measures. The Yurok Tribal Government will not be able to charge for the energy generated by a solar array or the energy saved by an energy efficiency device. Even if they borrow money to finance a project, they cannot charge a fee for the energy in order to pay off the loan.

The success of this Energy Program will require an entity that can charge customers for the energy generated or saved by installed projects. Since the Tribal Government cannot charge for these energy services, another entity separate from the Tribal Government must be created that can collect revenues. This could be a separate Tribal Energy Authority or a separate Tribal Utility or Tribal business. It is suggested that the Tribe devote some staff time to research this issue. It is also recommended that the Tribe consult with their legal counsel on this matter, and perhaps secure external expertise to provide assistance in determining what the best business structure will be to allow the Tribe to reach its goals. Below is a list of possible business structures that can be explored. Also, many other tribes have been faced with this same issue and have devised ways ways to address it. The Yurok Tribe can learn from these other tribal efforts. It is recommended that staff research what other tribes have done. Below is a list of categories under which possible structures could be formed. Appendix J – Tribal Energy Business Model Options Matrix includes a chart that briefly discusses each of these categories and their characteristics.

- Tribal Government Entities
- Tribal Corporations
- State-law Entities
- Joint Venture Entities

The following information resources provide information on many of these options.

- Tribal Utility Authority Handbook
- Tribal Business Structure Handbook
- Tribal Energy Resource Agreements
- Tribal Authority Process - Case Studies
- Northwest Tribal Energy Reference Guide

Tribal Energy Program Workforce

Workforce Needs

It is suggested that the Yurok Energy Program be established using a phased approach. This is described below under the Funding Opportunities section, Funding Implementation Plan. The first phase of the program would establish an On-Grid Solar PV Program and an Off-Grid Energy Services Program. Revenues from the On-Grid program would, in part, support the Off-Grid Program. In addition, revenues from the On-Grid program would support one full-time position for an Energy Program Manager.

Energy Program Manager Work Tasks

Once the first phase of the Energy Program is fully operational with approximately 100 off-grid systems and 10 on-grid systems, it is anticipated that the Energy Program Manager will spend approximately half their time maintaining the off-grid systems. The rest of their time will be spent on other Energy Program activities. Below is a list of activities that are anticipated to be carried out by the full-time Energy Program Manager.

- Maintain energy systems (site visits, battery maintenance, cleaning of PV arrays, shading analysis and brush/tree pruning, basic troubleshooting and repairs, equipment replacement, etc.)
- Participate in design and installation of new energy systems
- Provide assistance and information to energy program customers and other members of the Tribal community
- Conduct energy outreach and education activities in the Tribal community
- Pursue additional funding and write grants
- Administer and manage contracts
- Pursue energy efficiency opportunities for Tribal facilities
- Track the progress of the implementation of the Yurok Energy Plan, conduct measurement and verification activities
- Exhibit good customer service skills, respond to customer requests

Meeting Staff Training Needs

It is likely that the Energy Program Manager and other staff will need specific training to gain the skills needed for the job. One opportunity the Tribe should consider is to develop a partnership with GRID Alternatives. They installed the Solar PV system at the Tulley Creek Transportation Building. They have a Tribal program, and a component of their program is training, especially

of Tribal members. If one or more staff could be involved in an official training program with GRID Alternatives during the installation of both on-grid and off-grid systems on the Yurok Reservation, this would be a tremendous training opportunity.

At least one Yurok Tribe program has already successfully carried out a construction training program. Learnings from that experience would be valuable to those starting the Energy Program. TERO and the Planning Department established a construction training program and Tribal community members were trained during construction of the Ke-nek building at Tulley Creek. This was a highly successful project and training opportunity.

Another training option would be to send someone to a training institute, such as Solar Energy International. As mentioned below, there are specific funding sources for staff training and capacity building.

Funding Opportunities and Implementation Pathways

To support the development of a Yurok Tribe Energy Program funding is needed in three key areas:

1. **Energy Program Planning** – this includes additional planning to support more detailed development of the programs and opportunities outlined in this plan, as well as business expertise and legal support for developing an appropriate Tribal business structure for the Yurok Tribal Energy Program.
2. **Capacity Building** – this includes training and technical support for Tribal staff who will be involved in establishing and operating the Yurok Tribe Energy Program.
3. **Infrastructure Development** - this funding will support the design, procurement and installation of the on-grid and off-grid energy systems outlined in this plan.

SERC and Yurok Planning Department staff have compiled several key opportunities for funding the activities considered in above. In particular, pathways have been strategized for the implementation of the Combined On-grid/Off-grid Energy Program. Note that the implementation strategies presented below are based on past funding solicitations, and solicitations may change from one cycle to the next. The funding opportunities will need to be evaluated as they become available and adjustments may need to be made if funding levels, solicitation requirements or other details change.

Possible Funding Pathways for Yurok Tribe Energy Program- Combined On-Grid / Off-Grid Program

Phase 1 - Feasibility and Planning

***BIA* Tribal Energy Development Capacity (TEDC)**

The U.S. Department of the Interior BIA TEDC program is designed to further the development of Tribal management and technical capacity, with the goal of maximizing the economic impact of the available energy resources. There are no maximum individual award amounts; however, the funding is limited to an overall maximum for each funding cycle. The TEDC program allows

project types that would fit well for establishing an On-grid/Off-grid Energy Program as described above. In particular, the TEDC program allows for feasibility studies, which can look at both technical and regulatory issues. Beyond feasibility, TEDC projects can include the development of necessary regulation and legal frameworks that would likely be faced during this type of program development.

BIA Energy and Mineral Development Program (EMDP)
The BIA EMDP helps tribes evaluate their energy resources. Projects may include performing initial resource exploration, defining potential targets for development, performing market analysis to establish production/demand for a given commodity, performing economic evaluations and feasibility analyses of resources. This grant could be used to further explore energy project options identified in this planning document. Good candidates for further study include:

- Standardized system design and procurement analysis, program feasibility, and program design for the Off-grid Energy Services Program,
- Feasibility and economic assessment of off-grid micro-hydro opportunities and comparison to off-grid solar only systems,
- Detailed design and cost estimate for a Tulley Creek microgrid project.

California Energy Commission (CEC) Tribal Program
Another possible avenue for funding during the planning phase could be the CEC Tribal Program. Although no solicitation has been released, Yurok Tribe staff have been informed that the program intends to offer funding to assist Tribal energy planning efforts.

Phase 2 - Energy Program Implementation

As described in the Energy Project Opportunities section of this plan, the total cost to build the proposed on-grid solar PV systems is estimated to be $1,867,000. However, because this report did not consider the possible revenues from a rooftop system on the Mad River Brewery, the following calculations do not include the cost or revenue for possible systems at that location.

Preferred Option: USDA RUS High Cost of Energy Grant
The *USDA* RUS High Cost of Energy Grant has a maximum award of $3,000,000, and is meant to assist regions where the average cost of energy exceeds 275% of the national average. Eligible projects include both on-grid and off-grid development. The net-metered systems described in the Energy Projects Opportunities section of this report would not, on their own, qualify for this grant because these grid-connected facilities are not paying 275% of the national average cost of electricity. However, there is potential that if the cost savings from these projects were used to fund the ongoing expenses of a Combined On-grid/Off-grid Energy Program as described in the Yurok Energy Program Activities section above, these systems could then qualify.

The estimated total cost to build the on-grid systems without considering the Mad River Brewery is about $1,507,000, which provides a cost savings of approximately $81,000 per year. If the Tribe were awarded the full $3,000,000 from the USDA grant, this would leave enough money to build between 57 and 115 off-grid systems, depending on their size (57 5-kW systems or 82

3-kW systems or 115 1.5-kW systems, or other possible combinations of these three standardized systems). Taking into account the off-grid customer fees and the on-grid cost savings, it is estimated that the revenues generated could support one full-time Energy Program staff position and a maintenance program for the all off-grid systems, with some modest amount of revenue left over as a cushion or to fund other program activities. Off-grid customer fees under this scenario would be $50/month, $100/month and $150/month for the 1.5-kW, 3-kW and 5-kW off-grid PV systems, respectively. The estimated cost of electricity to the off-grid customers would be $0.33/kWh, fairly comparable to current charges from PG&E for on-grid residential customers, which as stated above currently averages about $0.27/kWh.

Secondary Option: DOE Energy Infrastructure Deployment on Tribal Land in Combination with USDA RUS High Cost of Energy Grant

Another option for funding the Combined On-grid/Off-grid Energy Program would be to fund the initiation of the program using the DOE Energy Infrastructure Deployment on Tribal Land grant. The key issue with this pathway is that due to required loan payments the on-grid systems would not generate net revenues for the first ten years of the project, so the off-grid customers would need to pay higher monthly fees in order for the project to be sustainable. Also, additional grant funds would be needed to fund the off-grid systems.

The DOE grant has a maximum award of $2,000,000 and requires a 1:1 match. In order to achieve a cash flow balance between annual savings and annual costs for the on-grid systems, the eight on-grid systems shown in Table 10 were chosen. Total installed cost for these systems is estimated at $1,094,400. This would require a DOE grant of $547,200 and an equivalent amount of match funds. Assuming the match funds were obtained as a low interest (3%) loan with a 10-year term, the annual loan payments would be just over $63,000 per year. This loan payment would be offset by the expected savings from these systems of $63,000 per year, so for the first 10 years these on-grid projects would be cash flow neutral. After the first 10 years there would be an annual savings of approximately $63,000 per year. Note that this amount may drop slightly due to degradation of the solar panels over time, but this impact is expected to be minimal (typically less than 1% per year).

Table 10: On-grid solar PV projects for secondary funding option

Region	System Location	Size (kW_DC)	Annual Energy (kWh)	Estimated Installed Cost	Generator Account	Service arragement	% load met by generation	Annual net revenues (cost savings - O&M costs)	25 year revenue	Annual GHG Emission Reductions (MT CO2e)	25 year GHG emission reductions (MT CO2e)
Eureka	Worthington School	50	70,237	$150,000	Worthington School	No aggregation, Worthington school only	98	$12,180	$304,500	6.7	168
Up-river	Tulley Creek Transportation Building	28	28,200	$85,400	Tulley Creek Transportation Building	Aggregation of Transportation Building, Transfer stations 1&2	102	$7,032	$175,800	2.7	67
Up-river	Tulley Creek Fire Station	24	30,600	$72,000	Tulley Creek Fire Station	Aggregation of Fire Station and Ke-Nek Building	96	$5,650	$141,250	2.9	73
Up-river	Wautec	34	46,000	$102,000	Wautec Firehouse	Aggregation of Wautec Firehouse, Mor-ek Won Community Center, Head Start and Early Head Start @ McKinnon Hill	117	$7,506	$187,650	4.1	103
Down-river	Klamath Hotel	80	103,604	$260,000	New service	Aggregation of temp service for hotel/casino, Hotel waste water, Bates bilding, Bates building 2, Bates building Old Market	93	$11,520	$288,000	40.9	1,023
Down-river	Klamath Casino	85	111,198	$255,000	Klamath Casino	No aggregation, Klamath Casino only	20	$11,700	$292,500	43.9	1,098
Down-river	Pem-mey fuel mart	40	52,900	$140,000	New service	Aggregatioin of Pem-mey fuel mart, YEDC Office 1&2, Old Police Station, Knowledge Park	15	$5,760	$144,000	20.9	522
Down-river	Jet Boat Tours	10	13,225	$30,000	Jet Boat Tours	No aggregation Jet Boat Tours only	102	$1,676	$41,900	5.2	131
All Projects		**351**		**$1,094,400**				**$63,024**	**$1,575,600**	127.4	3,186

In order to fund the off-grid systems another grant would have to be identified, and without the revenues from the on-grid systems the monthly fees to off-grid customers would have to be increased. SERC assumed grant funds could be identified to install 50 off-grid systems and determined the size of the grant that would be needed, as well as the fees that would need to be charged to pay for a part-time staff person and on-going maintenance costs of the off-grid systems. The required size of the grant would depend on how many of each standardized system were installed and would range from $640,000 (for 50 1.5-kW systems) to $1.3M (for 50 5-kW systems). The staff position needed to support this downsized program is expected to be a 50% full-time equivalent position at $30,000 per year. The necessary cost to the off-grid customers to cover this 50%-time staff position and the annual maintenance costs for the off-grid systems was determined to be $110/mo., $150/mo. and $200/mo. for the 1.5-kW, 3-kW and 5-kW systems, respectively. This works out to be a cost of electricity to the off-grid customers of $0.73/kWh, $0.50/kWh and $0.44/kWh, again for the 1.5-kW, 3-kW and 5-kW systems, respectively. These costs to the off-grid customers may not be viable.

One other option might be to fund the installation of fewer systems while using part of the grant funding for on-going operation and maintenance costs. This would not be allowable under the USDA High Cost of Energy grant program rules since funds cannot be used for operating costs, and it is anticipated that most grants would have this stipulation. However, if it were possible then the following grant amounts could support 25 off-grid systems plus 10 years of O&M costs assuming the off-grid customers paid monthly fees of $50/mo., $100/mo. and $150/mo. for the 1.5-kW, 3-kW, and 5-kW systems, respectively:

- (25) 1.5 kW systems = $627k grant
- (25) 3-kW systems = $739k grant
- (25) 5-kW systems = $938k grant

Relevant Grant Funding Opportunities for the Yurok Tribe Energy Program

A number of potential grant funding sources have been identified that could potentially fund parts of the Yurok Tribe Energy Program. Some of these funding sources have been discussed above. Table 11 provides a summary of the funding sources identified, the expected range of possible funding amounts, match requirements and other relevant information. Figure 12 provides a proposed funding implementation schedule for the preferred option presented above.

Table 11: Grant Funding Opportunities

Organization	Opportunity	Funding Information / Eligible Costs	Amount	Match Requirements
DOE Office of Indian Energy	Energy Infrastructure Deployment on Tribal Lands	Projects which funding can be used for include, installation of energy generating systems and/or energy efficiency measures for Tribal Buildings, deployment of community-scale energy generating systems and energy storage on Tribal Lands, installation of energy systems for autonomous operation (independent of the traditional centralized electric power grid) to power a single or multiple essential tribal facilities during emergency situations or for tribal community resilience, and deployment of energy infrastructure and integrated energy systems to electrify Tribal Buildings.	$50,000-$2,000,000	Minimum 50% for the total allowable costs of the project.
USDA	RUS High Energy Cost	The grant funds may be used to acquire, construct, or improve energy generation, transmission, or distribution facilities serving communities where the average annual residential expenditure for home energy exceeds 275% of the national average. Eligible projects also include on-grid and off-grid renewable energy projects and the implementation of energy efficiency and energy conservation projects for eligible communities. Projects cannot be for the primary benefit of a single household or business. Grant funds may not be used for the preparation of the grant application, operating costs, or for the purchase of any equipment, structures, or real estate not directly associated with the provision of community energy services.	$100,000-$3,000,000	None, but match funds do increase the likelihood of being funded.
USDA	Rural Energy for America Program Renewable Energy and Energy Efficiency Grants	The program provides grant funding to agricultural producers and rural small businesses for renewable energy systems or to make energy efficiency improvements. This grant is not available to Tribal governments.	$2,500-$500,000 (grants)	Must provide 75% of project costs.

Table 11: Funding Opportunities (continued)

Organization	Opportunity	Funding Information / Eligible Costs	Amount	Match Requirements
USDA	Rural Energy for America Program Energy Audit and Renewable Energy Development Assistance Grants	Provides grants for energy audits and renewable energy development assistance to rural small businesses. Tribal governments are eligible. Funds can be used for salaries related directly to the project, travel expenses, office supplies, administrative expenses and project related equipment operating expenses. These funds could potentially be used to support an Energy Program staff position and program expenses for the first few years of the program, as needed. This opportunity would need to be further explored with the USDA REAP program.	Max $100,000	None
U.S. Department of Commerce	Economic Development Assistance Program	EDA provides strategic investments on a competitive merit basis to support economic development, foster job creation, and attract private investment in economically distressed areas of the United States. EDA funds will support construction, non-construction, technical assistance, and revolving loan fund projects. Grants and cooperative agreements made under these programs are designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	$100,000-$3,000,000	Dependent on regional financial metrics compared to the national average. Between 50-80 percent.
U.S. Department of the Interior Bureau of Indian Affairs	Energy and Mineral Development Program (EMDP)	The goal of the EMDP is to assist tribes by helping to expand tribal knowledge of energy and mineral resources on their lands and to bring tribal energy and mineral projects to the point where the economic benefits can be realized from the targeted resource in an economically efficient and environmentally sound manner. Projects may include performing initial resource exploration, defining potential targets for development, performing market analysis to establish production/demand for a given commodity, perform economic evaluation and analysis of the resources.	Typical award sizes up to ~$100,000	None

Table 11: Funding Opportunities (continued)

Organization	Opportunity	Funding Information / Eligible Costs	Amount	Match Requirements
U.S. Department of the Interior Bureau of Indian Affairs	Tribal Energy Development Capacity (TEDC)	The goal is to develop the Tribal management capacity, and technical capacity to develop or enhance their business and regulatory environment needed to maximize the economic impact of energy resource development. The energy project(s) for which the applicant seeks to build tribal energy development capacity can be, existing or planned, tribally owned or privately owned. Projects may include utility feasibility studies, establishing tribal business charters under federal, state, or tribal law with a focus on energy resource development, adopting a secured transactions code.	No min/max requirements on projects.	None
Federal Emergency Management Agency (FEMA)	Pre-Disaster Mitigation Grant	This program is designed to assist state, tribal, territorial and local governments in reducing overall risk to the population and structures from future hazard events, while also reducing the reliance on federal funding from future disasters. The projects that can be funded under this program are fairly broad, and should be screened against the full solicitation. This funding source would be suitable for funding microgrid projects that provide resilience in times of disaster and natural hazards.	$10,000,000 max	Between 10%-25% total project costs
California Energy Commission (CEC)	Electric Program Investment Charge (EPIC)	Meant to support investment in clean energy technologies that provide benefits to the electricity ratepayers in PG&E, SDG&E, and SCE utility territories. Funds must be used for on-grid projects in PG&E territory. Projects need to have a research component and funds typically cannot be used for routine energy projects that are already proven to be technologically feasible and cost-effective, such as rooftop solar projects. The research component of these projects can introduce a fair amount of risk. These funds are not expected to be a good fit for the PV projects suggested above for on-grid development.	Minimum and maximum award amounts will be specific to various EPIC solicitations.	0%-20% requirement.

Organization	Opportunity	Funding Information / Eligible Costs	Amount	Match Requirements
State of California	Tribal Nation Grant Fund	If eligible, the Yurok Tribe could apply for funding from the State of California Tribal Nation Grant Fund. The stated funding priorities for the Tribal Nation Grant Fund are "facilitating tribal self-governance and improving the quality of life of tribal people throughout the state, prioritizing projects and programs that promote effective self-governance, self-determined communities, and economic development."	$400,000 (in 2019)	None
Wells Fargo/Grid Alternatives	Tribal Solar Accelerator Fund (TSAF)	Aims to catalyze the growth of solar energy and expand solar job opportunities in tribal communities across the United States. For awarded tribes, TSAF provides technical assistance on solar project development and renewable energy strategy, installation of solar PV systems, workforce development, and community outreach.	$250,000 max	None
Charitable Foundation of the Energy Bar Association	Cornerstone Project	CFEBA supports charitable projects that have an energy-related purpose and are focused on improving lives worldwide	Projects have ranged from $2,500-$150,000	Not required, but encouraged.

Yurok Tribe Energy Program Primary Funding Implementation Plan		2020				2021				2022				2023				2024	
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Grant	*Activity*																		
BIA EMDP	**Program planning** Business model and program development Off-grid system design, detailed cost and feasibility analysis Detailed microgrid design for FEMA grant																		
BIA TEDC	**Tribal staff capacity building**																		
USDA RUS High Energy Cost Grant	**Combined On-grid Solar PV and Off-grid Energy Services Program implementation** System procurement, installation, commissioning																		
FEMA Hazard Mitigation Grant	**Microgrid project implementation** Tulley Creek, Klamath, Weitchpec System procurement, installation & commissioning																		
Energy Efficiency Programs	**Energy efficiency audits and project implementation**																		

Figure 12: Proposed funding implementation schedule for preferred funding option

Conclusion, Recommendations and Lessons Learned

The Yurok Tribe Strategic Energy Plan, *Energy Paths for the Yurok People*, assesses the current state of energy for the Yurok People, identifies needs and resources, identifies project opportunities, and then screens these opportunities based on a set of criteria. The screening criteria are rooted in the Tribe's Energy Vision statement. Finally, a set of preferred projects are identified that are both feasible and, if implemented, will help the Tribe realize it's Energy Vision. These key project opportunities are then packaged together to create a Yurok Tribe Energy Program.

The foundational concept of this program is that an On-grid Solar PV Program is recommended to serve Tribal facilities both on and off the Reservation. If the installation of these PV systems is grant funded, then these systems can be used to generate net revenues over their 25 year lives. These net revenues can then be used to help support an Off-grid Energy Services Program. The plan lays out a combination of both on-grid and off-grid solar PV installations that is economically viable over the long-term. However, this plan does rely on 100% grant funding for the installation of these systems. If substantial match funds are required, then the economic viability of the program suffers. It still might be possible, but it faces much greater risk.

A set of funding sources are identified and a funding implementation plan is proposed. The plan, if executed successfully, would result in the installation of approximately 360 kW of solar PV on Tribal facilities and another 170 to 285 kW of off-grid solar PV at a total installed cost of $3M. The program would be financially self-sustaining and would provide clean, reliable, affordable, cost-effective, modern energy services to a large number of Tribal community residents who currently due not have access to these energy services. This would go a long way toward achieving the Tribe's Energy Vision.

To move this plan forward, the following recommended actions are put forth:

- Pursue funding from BIA EMDP and TEDC programs (or similar sources) to fund further planning and feasibility for the Yurok Tribe Energy Program. Activities carried out under this funding should include: business model development, Energy Program development, legal assistance, development of standardized off-grid energy systems, detailed cost and feasibility analysis for the Energy Program. In addition, TEDC funding should support capacity building and training for Tribal staff who will be involved with the development and execution of the Yurok Tribe Energy Program.
- Establish a Tribal Energy Authority as a separate business entity from the Tribal government. The Tribal Energy Authority's purview will be to implement the Yurok Tribe Energy Program.
- Pursue funding from the USDA RUS High Energy Cost Grant to fund the implementation of the Combined On-grid Solar PV and Off-grid Energy Services Program. This funding would support procurement, installation and commissioning of these systems.
- Pursue BIA EMDP funding (or similar planning and feasibility funding) to develop a detailed microgrid design for Tulley Creek and perhaps additional critical Tribal facilities.

- Pursue FEMA Hazard Mitigation Grant funds to support the procurement, installation and commissioning of microgrids at critical Tribal facilities.
- Continue to pursue energy efficiency opportunities for existing Tribal facilities utilizing existing energy efficiency programs and services offered by Pacific Power, PG&E and the Redwood Coast Energy Authority.
- Pursue a USDA Rural Energy for America Program Renewable Energy Development Assistance Grant to fund an Energy Program staff position. Once the Tribal Energy Authority is established, on-grid systems are in place and annual revenues are being generated, this staff position will be funded by these annual revenues. However, this USDA grant (or something similar) could fund the startup of this position prior to the revenue generation expected from the On-grid Solar PV Program.
- Continue to engage with Tribal leadership and the Tribal community throughout this process. Continue to build support and solicit input for the Yurok Tribe Energy Program.
- Develop a measurement and verification plan to track the progress of the Yurok Energy Plan and to assess the ability to meet the stated Yurok Tribe Energy Vision.
- Consider the investigation of other Tribal energy need beyond the electricity sector. This should include:
    - Heating fuels (propane, wood)
    - Transportation fuels
    - Electrification and the future role of electricity in the heating and transportation sectors.

A key lesson learned during this planning project is the value of prioritizing planning activities. While this project took a comprehensive, big picture planning perspective, it was decided from the start that priority should be placed on identifying highly feasible project opportunities that could be implemented in the near-term. The project team did not want another quality planning study that would simply sit on a shelf. This priority paid dividends: before the planning project was completed numerous projects that were identified in the early planning stages were already successfully implemented. This included multiple energy efficiency upgrades at Tribal facilities, as well as the installation of a PV array on the roof of the new Transportation Building in Tulley Creek. These early successes generated momentum and the Yurok Tribe is now poised to move additional projects forward.

Appendix A - Previous Energy Studies

Bibliography

Anderson, G., Ortiz, A. and Tingleff, B., Small-Scale Hydropower for the Yurok Nation, Humboldt State University, Engineering 492 Capstone Design Project, May, 2007.

Birch, M., Leichtfuss, C., and Walker, N., Yurok Tribe Grid-Connected Hydropower System Design, Humboldt State University, Engineering 492 Capstone Design Project, May, 2007.

Engel, R. and Zoellick, J., Tribal Utility Feasibility Study, USDOE Tribal Energy Program, DE-FG36-03GO13117, June 2007.

Engel, R. and Zoellick, J., Human Capacity Building in Energy Efficiency and Renewable Energy System Maintenance for the Yurok Tribe, USDOE Tribal Energy Program, DE-FG36-05GO15166, July 2007.

Engel, R., Garcia, R., Sheppard, C. and Zoellick, J., Wind and Hydro Feasibility Study, USDOE Tribal Energy Program, DE-FG36-07GO17078, June 2011.

Engel, R., Post-Installation Inspection Report on Energy Efficiency Measures Performed at the Yurok Tribe's Weitchpec Office, October 2011.

Engel, R., Post-Installation Inspection Report on Energy Efficiency Measures Performed at the Yurok Tribe's Klamath Office, January 2012.

Fulwiler, J., Hailey, P., Walton, L., and Zielke, E., Yurok Village Hydroelectric Project, Humboldt State University, Engineering 492 Capstone Design Project, May, 2007.

Greacen, Christopher E. Community Context and Technology Options in the Yurok Tribal Electrification Project. Thesis for M.S. in Energy and Resources. University of California, Berkeley. May 1997.

Greenwood, Charles S. Miners Creek Hydroelectric Feasibility Study. Greenwood Engineering. January 18, 2004.

Hill, Roger, Mike Thomas, Ben Rinehart, and Randy Manion. Phase I Report on Renewable Energy Options for the Yurok Indian Reservation. Sandia National Laboratories/Idaho National Engineering and Environmental Laboratory/Western Area Power Administration. June 2000.

Humboldt Engineering and Construction, Inc. Final Report: Yurok Power Project. March 2000.

Ludington, Milt. "Engineering Report: Ke'pel Creek Hydroelectric Potential." September 26, 2001.

TSS Consultants. Preliminary Feasibility Study for a Biomass Utilization Project on the Yurok Reservation. March 31, 2003.

Yurok Tribe Strategic Energy Plan. Facilitated by the Council of Energy Resource Tribes. December 17-19, 2003.

Table A-1: List of previous Yurok Tribe energy studies

Date	Title	General Energy Planning	Hydro	Wind	Biomass	Solar	Efficiency
May-1997	Community Context and Technology Options in the Yurok Tribal Electrification Project		X (Pecwan, Achelth)				
Mar-2000	Final Report: Yurok Power Project		X (Pecwan, Cappell)				
Jun-2000	Phase I Report on Renewable Energy Options for the Yurok Indian Reservation	X	X (many upriver creeks considered)			X	
Sep-2001	Ke'pel Creek Study		X (Ke'pel)				
Mar-2003	Preliminary Feasibility Study for a Biomass Utilization Project on the Yurok Reservation				X		
Dec-2003	Yurok Tribe Strategic Energy Plan	X					
Jan-2004	Miners Creek Hydroelectric Feasibility Study		X (Miners)				
May-2007	Small-Scale Hydropower for the Yurok Nation (student project)		X (Pine, Tully)				
May-2007	Yurok Tribe Grid-Connected Hydropower System Design (student project)		X (Miners, Tully, Pine)				
May-2007	Yurok Village Hydroelectric Project (student project)		X (Pecwan, Cappell, Roach, Johnson)				
Jun-2007	Tribal Utility Feasibility Study	X	X	X	X	X	X
Jul-2007	Human Capacity Building in Energy Efficiency and Renewable Energy System Maintenance for the Yurok Tribe	X				X	X
Jun-2011	Wind and Hydro Feasibility Study		X (Ke'Pel, Pecwan)	X (McKinnon Hill)			
Oct-2011	Post-Installation Inspection Report on Energy Efficiency Measures Performed at the Yurok Tribe's Weitchpec Office						X
Jan-2012	Post-Installation Inspection Report on Energy Efficiency Measures Performed at the Yurok Tribe's Klamath Office						X

Appendix B - Energy Use Assessment

Informational resources

For the energy use assessment, we collected and utilized the following information:

- One year of energy consumption and cost data for all Tribal facilities (provided by the Yurok Tribe).
- Locations of all Tribal facilities.
- Count of the number of Tribal residences within various geographic regions of the Reservation based on the Yurok Tribe GIS map available on the Yurok Tribe's website.
- Aggregate residential consumption data[14] and US Census data for the Hoopa zip code 95546, which include all grid-connected residences in the Weitchpec/upriver region of the Reservation. This was used to estimate an average electricity consumption associated with residences in the upriver section of the Reservation of 22.5 kWh/day[15].
- Aggregate residential consumption data[16] and US Census data for Del Norte County. This was used to estimate an average electricity consumption associated with residences in the Klamath section of the Reservation of 32.6 kWh/day.
- Electricity billing data for a small sample of residences in the Weitchpec region of the Reservation.

Energy use assessment findings

Table B-1 shows the total annual electricity consumption and costs for Tribal facilities and residences on the Reservation. Data for Tribal facilities are from actual facility bills for the year 2017. Consumption data for residences are based on average consumption data for the region (Hoopa zip code for the upriver section and Del Norte County for the downriver section). Residential electricity costs are based on current residential baseline rates without the CARE discount. The number of facilities identified in each region is based on data from the Yurok Tribe GIS map available on the Yurok Tribe's website.

As shown, the majority of Tribal facilities and residences are located in the downriver section near the Klamath town site. For this reason, the vast majority of electricity consumption and costs are centered in the Klamath area. Approximately 90% of the electricity usage and costs for Tribal facilities are in Klamath, 80% of residential usage is in Klamath, and 60% of residential electricity costs are in Klamath.

[14] From PG&E Energy Data Request Program – Public Data Sets (https://pge-energydatarequest.com/public_datasets)

[15] Note that aggregate data for residential electricity consumption in the upriver section of the Reservation was obtained later in the project and showed the average consumption to be only 13.8 kWh/day. This information was used for subsequent analyses.

[16] From the California Energy Commission's Energy Consumption Database (http://ecdms.energy.ca.gov/)

Table B-1. Electricity use and costs for upriver and downriver sections of the Yurok Reservation in 2017

	Downriver (Pacific Power)		Upriver (PG&E)		Total	
	Tribal Facilities	*Residences	Tribal Facilities	*Residences	Tribal Facilities	*Residences
# Facilities/Accounts	45	519	12	229	57	748
Total Annual Cost ($)	$ 349,400	$ 679,300	$ 57,800	$ 413,700	$ 407,200	$ 1,093,000
Total Annual Consumption (kWh)	2,173,300	6,175,600	336,200	1,880,700	2,509,500	8,056,300
Ave. Electricity Cost ($/kWh)	$ 0.16	0.11	$ 0.17	0.22	$ 0.16	0.14
Ave. Annual Cost - per Facility ($)	$ 7,770	$ 1,300	$ 4,800	1,800	$ 7,140	$ 1,460
Ave. Annual Consumption - per Facility (kWh)	48,300	11,900	28,020	8,210	44,030	10,770
Additional facilities in the region that are not represented include:						
Non-residential facilities	29		19		48	
Mobile home / RV parks	12		0		12	

Note that 4 accounts listed as Tribal facilities are located off the Reservation and ancestral lands. This includes a food distribution center in Crescent City, fisheries modulars in Willow Creek, and a Yurok Tribe office/Head Start site at Worthington School in Eureka.
*Residential electricity consumption levels are estimated based on 2017 regional averages; costs are based on 2018 residential rates.

Heating fuel usage and costs were also collected for Tribal facilities. Only five facilities utilize propane fuel, with a total annual cost of about $31,000 across all facilities. In addition, gasoline and diesel fuels are used for back-up or stand-alone generators at five facilities. Total annual cost for generator fuels is about $15,800. Propane, gasoline and diesel fuel costs for Tribal facilities pale in comparison to electricity costs. No heating fuel or generator fuel consumption or cost data were available for the residential sector.

Table B-2 lists the Tribal facilities with the highest annual energy cost. Facilities with costs exceeding $2,000 per year are listed in rank order. The facilities listed in Table B-2 make up more than 90% of annual energy costs for Tribal facilities. Key high energy users include the new hotel and casino in Klamath, the Klamath Tribal Office, the Pem-mey fuel mart in Klamath, and the Weitchpec Tribal Office. These five facilities account for almost 60% of all Tribal facility energy costs.

Table B-3 lists the cumulative electricity consumption for Tribal facilities and residences in each of 22 Community Areas. The Community Area designation corresponds to the Community Area identifiers specified in the Yurok Tribe GIS map. Tribal facility data are based on actual billing data for 2017 and residential data are based on average residential usage for the region and the estimated number of residences in the Community Area. The counts of residences come from the Yurok GIS map.

As shown, the downriver region (Klamath, Klamath Glen, Hunter Creek, Requa and Resighini) account for 80% of the total electricity usage on the Reservation. The upriver section makes up the other 20%, with the Weitchpec, Lower and Upper Kepel, McKinnon Hill, Tulley Creek, and Wautec Community Areas accounting for the majority of usage. The rest of the usage is spread in very small amounts between the remaining numerous Community Areas. The total cumulative electricity consumption on the Reservation is estimated to be approximately 10.4 GWh per year.

Table B-2. Annual energy use and cost for high cost Tribal facilities

	Facility Location	Facility/Account Name	Annual Electricity Usage (kWh)	Annual Cost	Heating/ Generator Fuel Annual Cost
Downriver (Pacific Power Service Territory)					
>$10,000/yr	Hotel/Casino Complex (YEDC)	Casino	523,549	$ 79,529	
	Klamath Town Site	Klamath Office	282,480	$ 44,056	$ 21,998
	Hotel/Casino Complex (YEDC)	Hotel	308,618	$ 47,869	
	Klamath Town Site (YEDC)	Pem-mey	308,880	$ 43,653	
	Stand Alone System - Crescent City	Food Distribution 190 Nelson LN	117,011	$ 18,094	
	Stand Alone System - Klamath	Head Start	110,440	$ 17,984	
>$5,000/yr	Jet Boat Tours Area (YEDC)	Riverside Rv. 1	48,250	$ 8,748	
	Northern Klamath Office Compound	YTEP	42,191	$ 7,348	
	Klamath Town Site	Justice Center	43,827	$ 7,260	
	Requa Area	PJ Murphy PUD Pump	37,894	$ 6,699	
	Klamath Town Site (YEDC)	Village Rv 7	37,080	$ 6,485	
	Hotel/Casino Complex (YEDC)	Waste Water Treatment	32,960	$ 5,888	
	Klamath Town Site	Visitor Center 101	29,083	$ 5,870	
	Requa (YEDC)	Requa	20,160	$ 3,520	$ 2,044
>$2,000/yr	Hunter Creek Area	Watershed. 40 Hunter Creek Rd.	24,386	$ 4,390	
	Requa Area	End of Klamath Rd. Pump House	18,680	$ 4,274	
	Northern Klamath Office Compound	15900 US HWY N # 4 Klamath	18,715	$ 3,171	
	Bates Building Complex (YEDC)	Bates Building	3,492	$ 2,722	
	Hotel/Casino Complex (YEDC)	Temp Service for Hotel/Casino	12,252	$ 2,260	
	Jet Boat Tours Area (YEDC)	Riverside Rv. 2	12,848	$ 2,158	
	Klamath Town Site	Police Station	11,521	$ 2,128	
	Klamath Town Site (YEDC)	Redwood RV (Cats RV)	12,285	$ 2,071	
	Jet Boat Tours Area (YEDC)	Jet Boat Tours	10,596	$ 2,062	
Upriver (PG&E Service Territory)					
>$10,000/yr	Weitchpec	Weitchpec Tribal Office*	72,700	$ 17,920	$ 7,844
	Eureka	Worthington Site. 4100 Erie St.	71,418	$ 13,022	
	Weitchpec	Pec-tah Fuel Mart	104,596	$ 11,532	
>$5,000/yr	Tulley Creek	Tulley Creek Firehouse	19,907	$ 3,381	$ 4,480
	Mor-ek Won	Mor-ek Won Community Center	14,182	$ 2,407	$ 4,642
	Mor-ek Won	Head Start	12,635	$ 2,215	$ 3,215
>$2,000/yr	Mor-ek Won	Early Head Start	7,702	$ 1,387	$ 1,668

*The Weitchpec Tribal office has a net metered rooftop solar electric system rated at 18 kW_{DC} that produces approximately 23,000 kWh/yr. The annual electricity consumption and cost shown in Table B is for the electricity purchased from PG&E. The site electrical load is the sum of what was purchased plus what was generated on site.

Table B-3. Estimated annual electricity use by Community Area

Downriver (Pacific Power Service Territory)			
Community Area	**Facility Name**	**Annual Electricity Usage (kWh)**	**% Annual Usage**
Hunter Creek	(2) Tribal facilities	27,344	
	Estimate for (92) residences in aggregate	1,094,708	
	Total for Hunter Creek Area	**1,122,052**	**11%**
Klamath	(33) Tribal facilities	1,925,889	
	Estimate for (152) residences in aggregate	1,808,648	
	Total for Klamath Area	**3,734,537**	**36%**
Klamath Glen	(1) Tribal facilities	1,829	
	Estimate for (203) residences in aggregate	2,415,497	
	Total for Klamath Glen Area	**2,417,326**	**23%**
Requa	(8) Tribal facilities	101,258	
	Estimate for (66) residences in aggregate	785,334	
	Total for Requa Area	**886,592**	**9%**
Resighini	Estimate for (6) residences in aggregate	71,394	
	Total for Resighini Area	**71,394**	**1%**

Upriver (PG&E Service Territory)			
Community Area	**Facility Name**	**Annual Electricity Usage (kWh)**	**% Annual Usage**
Bald Hills	Estimate for (3) residences in aggregate	24,638	
	Total for Bald Hills Area	**24,638**	**0.2%**
Johnsons	Estimate for (6) residences in aggregate	49,275	
	Total for Johnsons Area	**49,275**	**0.5%**
Lake Prairie	Estimate for (11) residences in aggregate	90,338	
	Total for Lake Prairie Area	**90,338**	**0.9%**
Lower Kep'el	Estimate for (32) residences in aggregate	262,800	
	Total for Lower Kep'el Area	**262,800**	**2.5%**
McKinnon Hill	(3) Tribal facilities	34,519	
	Estimate for (24) residences in aggregate	197,100	
	Total for McKinnon Hill Area	**231,619**	**2.2%**
Mitchell Road	Estimate for (8) residences in aggregate	65,700	
	Total for Mitchell Road Area	**65,700**	**0.6%**
New Village	Estimate for (14) residences in aggregate	114,975	
	Total for New Village Area	**114,975**	**1.1%**
Notchko	Estimate for (12) residences in aggregate	98,550	
	Total for Notchko Area	**98,550**	**1.0%**
Old Village	Estimate for (4) residences in aggregate	32,850	
	Total for Old Village Area	**32,850**	**0.3%**
Pecwan	Estimate for (6) residences in aggregate	49,275	
	Total for Pecwan Area	**49,275**	**0.5%**
Ross Ranch	Estimate for (1) residences in aggregate	8,213	
	Total for Ross Ranch Area	**8,213**	**0.1%**
Rube Ranch	Estimate for (2) residences in aggregate	16,425	
	Total for Rube Ranch Area	**16,425**	**0.2%**
Sregon	Estimate for (6) residences in aggregate	49,275	
	Total for Sregon Area	**49,275**	**0.5%**
Tulley Creek	(2) Tribal facilities	29,388	
	Estimate for (23) residences in aggregate	188,888	
	Total for Tulley Creek Area	**218,275**	**2.1%**
Upper Kep'el	Estimate for (29) residences in aggregate	238,163	
	Total for Upper Kep'el Area	**238,163**	**2.3%**
Weitchpec	(4) Tribal facilities	186,867	
	Estimate for (29) residences in aggregate	238,163	
	Total for Weitchpec Area	**425,030**	**4.1%**
Wautec	Estimate for (19) residences in aggregate	156,038	
	Total for Wautec Area	**156,038**	**1.5%**

Appendix C - Demand Reduction and Utility Program Offerings

Brief Assessments of High Use/Cost Facilities

Redwood Casino and Hotel, Klamath

These buildings were completed in 2014 and were built to meet the California Building Code. These buildings are all electric. We would expect these buildings to score high in terms of energy efficiency, but they don't. Sometimes a new building is designed to be energy efficient, but poor construction practices and/or a lack of effective commissioning of building systems causes the building to significantly underperform. We suggest follow-up energy assessments be performed on these two buildings to evaluate their performance and determine if there are good opportunities for retro-commissioning[17] fixes. To accomplish this, we suggest that these facilities participate in Pacific Power's Energy Management Program.

Klamath Tribal Office, Klamath

The Klamath office was built in 2002, and a walk-through audit of the facility was completed in 2006 by Schatz Energy Research Center staff. The walk-through audit identified that the energy use for the building was higher than expected. Issues with the building shell and the heating, ventilating and air conditioning systems were identified and a retro-commissioning process was recommended. Many of the recommendations in the audit were implemented and verified in 2011. Nonetheless, we suggest that this facility also participate in Pacific Power's Energy Management Program. However, one complication is that the Klamath Tribal Office uses propane fired furnaces for heating. Since propane service is not provided by Pacific Power, they will likely not be allowed to assess issues with the heating system as part of their Energy Management Program. In addition, we recommend that opportunities for additional energy efficiency upgrades for this facility be considered where appropriate.

Pem-mey Fuel Mart, Klamath

The Pem-mey Fuel Mart was constructed in 2005 and is an all-electric facility. According to Pacific Power representatives, the exterior canopy lights and most of the interior lights have been upgraded to LEDs. Nonetheless, there may be additional energy efficiency upgrade opportunities. This facility might also be a good candidate for the Energy Management Program. We suggest that the Tribe work with Pacific Power to determine which of their energy efficiency programs best fits the needs of this facility.

Pec-tah Fuel Mart, Weitchpec

The Pec-tah Fuel Mart is a small country store that was built decades ago. It has two gasoline pumps and has been classified in **Error! Reference source not found.** as a gas station/convenience store. However, it is quite different from a typical modern gas station/convenience store, which has many more fuel pumps and dramatically more exterior lighting. This likely explains why the EUI for the Pec-tah Fuel Mart is lower than that for the national median facility. A brief walkthrough and discussion with staff of the Pec-tah Fuel Mart indicates that it has old, inefficient T12 fluorescent lighting, utilizes electric resistance space heaters, and likely uses older refrigeration units that could be upgraded to more energy efficient equipment. We suggest that the Tribe work

[17] Retro-commissioning is an in-depth analysis of an existing buildings energy-related systems with a focus on troubleshooting and fixing identified problems.

with Pacific Gas and Electric to determine which of their energy efficiency programs would be most appropriate for this facility. We anticipate that there is a good opportunity to upgrade the facility's lighting, as well as perhaps new refrigeration equipment. A mini-split heat pump system that could provide both energy efficient heating and cooling might be preferable to replace the electric resistance space heating. However, this may not be cost effective since a new air conditioning unit was just recently installed.

Weitchpec Tribal Office, Weitchpec

The Weitchpec Tribal Office was built in 1999. A walk-through energy audit of the facility was completed in 2006 by Schatz Energy Research Center staff. A roof-top solar electric system was installed in 2011. Many of the energy efficiency recommendations from the walk-through audit were also implemented and verified in 2011. We suggest the Tribe work with Pacific Gas and Electric to determine which of their energy efficiency programs would be most appropriate for this facility. Ideally a facility audit could be combined with an audit of the Pec-tah Fuel Mart.

Energy Efficiency Programs - Pacific Gas and Electric Company

Tribal Facilities

Following a review of PG&E's energy efficiency program offerings and discussions with PG&E representatives, it was determined that the best energy efficiency program opportunities in PG&E's service territory for Tribal facilities is likely the Energy Watch Partnership/Direct Install Program. This program is administered locally by the Redwood Coast Energy Authority (707-269-1700). This program is a best fit because it is suited to varied, smaller facilities, such the Tribe's facilities. It also has higher incentives, provides a free energy audit, and is a one-stop shop full-service program. If the Tribe were to participate in this program for one or more Tribal facilities, the Redwood Coast Energy Authority would support the Tribe through the whole process, starting with the energy audit, working through the evaluation of opportunities, working with a third party installation contractor, overseeing/managing the installation contractor, verifying proper measure installation, securing rebates and completing all required paperwork. This program will mainly cover lighting and refrigeration upgrades.

The Tribe will also be eligible to participate in PG&E's On-Bill Financing Program. This zero percent interest loan program can allow the Tribe to install eligible upgrades at no cost. The loan payments are set equal to the monthly energy bill savings. Once the loan is paid off in five years or less, then the Tribe will start to see the energy cost savings each month.

Residential Properties

PG&E and RCEA offer energy efficiency program services for home owners and renters. For income-qualified households, free services are available through the Energy Savings Assistance Program. The Tribe is already working with Lori Leiva, Principal Program Manager for the Energy Savings Assistance Program at PG&E (415-973-3034). Because the third party contractors who can provide the services are located out of the area, it will make sense for the Tribe to work with Lori to aggregate a group of customers who all want the energy upgrade services. Once all the customers are signed up and deemed eligible, it can be arranged to have a contractor come to the area and deliver services to all the homes at one time. The Tribe is planning to hold a community meeting to inform the community about this opportunity and to encourage people to sign up for the services. It is likely that Lori will try to be present at that meeting to answer questions and help facilitate the process. Lori will also support the Tribe in trying to make sure that all income-eligible residents get signed up for the CARE Program (for reduced electric rates) and for the Medical Baseline Allowance

Program (for reduced rates if residents have a medical appliance that they need to operate in their home, like an oxygen machine).

PG&E and RCEA also offer energy efficiency services for all residential customers regardless of income. This includes the Energy Upgrade California® Home Upgrade program that evaluates all of the systems in the home to determine which upgrades can reduce energy use and improve the comfort of the home. This program offers up to $5,500 in rebates. In addition, homeowners can be eligible for low-interest financing programs to cover upgrade costs.

Energy Efficiency Programs - Pacific Power

Tribal Facilities

Following a review of Pacific Power's energy efficiency program offerings and discussions with Pacific Power representatives, it was determined that there are multiple Pacific Power programs that could be well-suited for Tribal facilities. For various Tribal facilities in the Klamath area it is recommended that the Tribe utilize Pacific Power's third party contractor Evergreen Efficiency (contact is Craig Muedeking, 541-450-1856). Evergreen Efficiency has already participated in delivering energy upgrade services to the Klamath Tribal Office and the Pem-mey Fuel Mart, and they can perform additional free energy assessments of Tribal facilities to evaluate them for possible lighting and refrigeration upgrades. If more custom services are needed, facilities can be referred to Pacific Power's Custom Analysis Program (contact is Hallie Gallinger at Pacific Power, 503-813-5215).

Also, for facilities such as the Redwood Hotel and Casino, Pem-mey Fuel Mart, and perhaps the Tribal office, where energy use intensity values are higher than expected and facilities already have taken advantage of most energy efficiency opportunities, it is recommended that these facilities participate in Pacific Power's Energy Management Program (contact is Hallie Gallinger). This program will assess these facilities in an effort to diagnose why energy use is high and what can be done to remedy that. Evaluation services are free and an evaluation report will be prepared that will describe the Tribe's options for fixing identified problems. Low or no-cost options will be identified and a $0.02/kWh incentive is available to help offset potential costs.

Residential Properties

In Pacific Power's service territory, energy efficiency program opportunities for residential customers include a free energy efficiency starter kit (includes four LED light bulbs and low-flow water saving devices), incentives for the purchase of energy efficiency equipment, and income-qualifying weatherization services. The free weatherization services are available to income-qualifying homeowners and renters living in single-family homes, mobile homes or apartments. A variety of measures can be installed to save energy. These include insulation, energy-efficient showerheads, compact fluorescent light bulbs and more. All of these measures are designed to lower bills, while keeping the home comfortable. Services are available through the Del Norte Senior Center, 707-464-9013.

Nov.16, 2018: PG&E Energy Efficiency Call

Participants: Jim, Rich – (SERC), Gino O'Rourke (Yurok Tribe), Michelle Brasuell (PG&E)

- We are at the end of the year and PG&E's energy efficiency programs are sunsetting, they are currently waiting for approval of new measures/programs for 2019 and beyond, we will not know until after the first of the year what the new offerings are
- After the start of the new year it will make sense to work with PG&E to have assessments done for key Yurok Tribe facilities in PG&E territory and see what the opportunities are
- Because the Tribes facilities are mostly modest in size and there are a variety of facilities it makes the most sense to participate in the Redwood Coast Energy Watch program (this is also known as the Direct Install Program), PG&E's other main program is their Deemed Rebate Program
- Redwood Coast Energy Watch Program
    - The Direct Install program is likely the best fit because it has higher incentives, provides a free energy audit of facilities, and is a one-stop shop full-service of program, the administrator will support the Tribe through the whole process starting with the energy audit, evaluation of opportunities, working with a third party installation contractor, overseeing/managing the installation contractor, and verifying proper measure installation
    - This program is administered by the Redwood Coast Energy Authority in Eureka
    - Approved 3rd party contractors actually provide the direct install services, the Sierra Business Council used to cover our area, but they no longer do, PG&E can try to get the Tribe looped in with another approved contractor from out of the area (make referral, see if out of area contractor will be willing to travel here, to make it worth their while it would be best to group a number of facilities together so they could assess them all in one trip
    - The audits would mainly cover lighting and refrigeration
    - The audits are free of charge
    - They identify opportunities, recommend measures and identify incentives
    - They provide a full economic analysis
  - If the Tribe participates in the Direct Install Program and agrees to have measures installed, they can participate in the On-bill Financing Program
    - On-bill financing offers 0% interest financing
    - Can make eligible upgrades at no cost to customer (loan payments are set equal to monthly energy bill savings, once loan is paid off in five years or less then customer starts seeing energy cost savings)
    - Loans of $5k to $100k (business) or up to $250k (government agency), up to 5 year repayment period (business) or 10 year (government agency)
  - PG&E can offer a rate analysis for all Yurok Tribe accounts to see if any facilities would do better (lower cost) on a different rate option, Michelle said she will do this and send a report to Gino

- Michelle can provide SERC with billing information for Tribal facilities, Tribe simply needs to fill out a 3rd party authorization form to release the data

Contact Information:

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Customer Relationship Manager/Business Energy Solutions
Pacific Gas and Electric Company
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Nov.16, 2018: Pacific Power Conference Call

Participants: Jim, Rich – (SERC), Monte (PacifiCorp), Hallie (PacifiCorp), Craig (Evergreen Efficiency), Eric Anderson (PacifiCorp), Ethan Clifford (3rd party contractor)

Call Participants Roles

Name	Company	Role	Topic Area
Monte Mendenhall	Pacific Power	Regional Business Manager	Billing and customer services, liaison with Tribes
Ethan Clifford	(contractor)	Third party contractor, Energy Resources Integration, Senior Engineer	Custom Analysis Projects
Eric Anderson	Pacific Power	Renewable energy programs	Renewable Energy Programs - NEM, interconnection, solar on multifamily housing, generation installation.
Craig Muedeking	Evergreen Efficiency	Third party contractor	Standard upgrades/incentives, lighting and HVAC for commercial buildings
Hallie Gallinger	Pacific Power	Energy Engineer for EE services	Custom Analysis and Energy Management programs

1 **Which energy efficiency programs are best suited to the Yurok Tribe's facilities.**

- No Charge for any *site assessment* associated with Pacific Power's programs.
- For the newer facilities where use is high but lighting is already high efficiency LED and/or buildings have been built to recent CA energy code (hotel, casino, Pem-mey, Tribal office), the Energy Management Program (see below) would be a good fit to try to determine why use is high and what can be done about it, this work would be coordinated by Hallie Gallinger

  Hallie Gallinger
  Energy Efficiency Project Manager
  Pacific Power
  503-813-5215
  Hallie.gallinger@Pacificorp.com
  https://www.pacificpower.net/bus/se/california/ca.html
  https://www.pacificpower.net/bus/se/california/em.html
  Custom energy efficiency projects and energy management

- For smaller facilities there can be a walk-through audit to assess lighting upgrade opportunities, heating/cooling, etc., this would be done by Pacific Power's third-party contractor Evergreen Efficiency (Craig Muedeking)

  Craig Muedeking
  Evergreen Efficiency
  Energy Specialist
  (541) 450-1856
  Craig.Muedeking@evergreen-efficiency.com

https://www.pacificpower.net/bus/se/california/il.html
Typical measure incentives for HVAC/Lighting

- If the typical measure incentives or energy management program are not appropriate and a facility/project needs more custom assistance, then it can be directed to the Custom Analysis program. This would go through Hallie as mentioned above and might involve Ethan Clifford as a third party contractor.

2 **Many of the Tribe's facilities are clustered in geographic areas (Klamath Town Site, Northern Klamath Office Compound, Bates Bldg Complex, etc.) -- How can these clusters best be served?**

- ***(Hallie):*** For smaller facilities: Start with a lighting assessment, if tribe has relationship with vendor, use them. PP will provide a fixture count and use a lighting tool to recommend fixtures for installation and available incentive estimates. They can also look at heating/cooling options.
- Assessment is free of charge.
- ***(Craig):*** Could easily conduct a walkthrough of facilities provided on the EUI comparison spreadsheet.
  - **Requires:** letter authorizing access from the Tribe to do so.

3 **Would a retrocommissioning program potentially be appropriate for the identified high EUI facilities (like the hotel/casino where is seems odd that the EUIs are so high)? (*Craig*)**

- Pacific Power reps agree that the EUI's for the casino, hotel and Pem-mey fuel mart seem high and they suggest an assessment via the Energy Management Program with follow-up retrocommissioning work might help bring the usage down
- Not much in Typical EE Upgrades/Incentives because it's a new facility, built in 2014 to CA Energy Code.
- They have not yet done an assessment of the hotel or casino for energy management opportunities
- Retrocommissioning assessment of cooling, lighting, etc. might help explain
- No cost to the tribe for energy analysis & site assessment

Energy Management Program Inter-workings (Hallie)

- General application (Link)
- ***Ethan*** schedules time with tribal member would is most knowledgeable about facilities (facility manager, perhaps Gino, etc) - who can assist them with questions
- Site assessments, Site work would be great to schedule on the same day - optimize time
- Analysis report provided to tribe - with costs and offered/qualifying incentives
- If tribe wants to move forward and more analysis is needed - PP will conduct that data logging/further analyses.
- All this would need to be done before the contract is signed.
- Incentive (2 cent/kWh saved) - 6 month implementation schedule.
- PP returns to verify the energy savings, as compared to the baseline.

4 **Is it true that the Klamath office has had a recent LED lighting upgrade? (*Craig*)**

- Craig was involved with the Tribal Headquarters and Pem-mey upgrade projects:
  - Tribal office: Replacing 4ft. fluorescents with LEDs
  - Pem-mey Fuel Mart Upgrades:

- LEDs on Canopy and most interior lights
- Still a few exterior lights that may need replacing
- Maybe opportunity for refrigeration, evaporator motors, or controls, etc..

5 **Are there programs that cover water pumping (wastewater treatment, water supply)?**
- Not discussed
- This might fit under one of the existing programs or perhaps would fit under the custom program, this can be a follow-up question for Hallie if further information is desired

6 **Do you know if Pacific Power will be offering the CPUC approved Energy Savings Assistance Program anytime soon for income qualified residential customers (http://www.cpuc.ca.gov/esap/)?**
- **(*Hallie*)**: Believes there is a low income residential programs for CA
- Tribe would work with agencies in service territory to provide weatherization services
- Hallie will send us several links to offerings on website
- **Del Norte Senior Center** manages financing for weatherization programs in Del Norte County (funding, monte believes, is state based) - **Free Services** - get on waiting list

  Low Income Assistance/Weatherization
  https://www.pacificpower.net/res/fa.html

7 **Does Pacific Power offer On Bill Financing?**
- No, not yet; this is projected for later 2019 or 2020

8 **Is it possible to get aggregate kWh data for residences in the Klamath area?**
- Ran out of time and did not address this question in call, can follow up with email if desired

9 **We are also exploring opportunities for distributed generation projects (rooftop or community solar arrays). Is there any information available regarding the capacity of distribution circuits to host DERs? *(Eric)***
- Pacific Power does not provide information about the potential DER hosting capacity of the distribution system like PG&E does with the PVRAM map
- To get this type of information there are two options:
  - Request a pre-application interconnection report (FERC process), transmission services does a screening and generates a report, provides information about the circuit (minimum load, existing generation, etc.), this report requires a $300 fee, there are no costs provided regarding required upgrades, this might make sense for larger projects (like ≥1MW scale)
  - If the system is smaller and will be interconnected as a NEM system a interconnection request can be submitted through the PowerClerk website, takes up to 30 days to get response, will provide information about any needed upgrades and what the cost will be, no fee is required for the basic application, however, if a more detailed study is required (like for a larger or more complicated system) then there is a $3,000 fee

10 **For interconnection of modest sized distributed generators (10's of kW up to 1-2 MW) to the distribution system under net energy metering or aggregate net energy metering, what is the process? Is there a "fast track" process for small/simple systems? Is there a distribution interconnection handbook? (*Eric*)** -

- No distribution/interconnection handbook available, some differences with PG&E
- Pacific Power does not follow Rule 21
- PP is still on "old school" net metering, kWh is credited back at full retail value
- However, they do allow aggregation, just like PG&E, and there is a contiguous property constraint. Max generation size is 1 MW
- Greater than 1 MW: Multiple projects could allocate meters to different generation sites
    - Yes, you can have more than 1 generating account but **can't** have more than 1 MW of cumulative generating capacity in one aggregation unit (AGU)
    - An individual meter can only participate in 1 AGU

11 **Would this be similar to interconnection with Pacific Gas and Electric? Does it follow the Rule 21 process?**

PP does NOT follow rule 21, they have an exemption because they serve so few customers in California, interconnection upgrade costs are borne by the generating customer not the ratepayers

- Small facility = typically no upgrade costs
- Larger system that requires a transformer upgrade or some other distribution system upgrade, generating customer pays for upgrade (this is not the case in PG&E territory for NEM customers)

12 **A heads up from Eric A about the SOMA program which PP will offer possbily by early 2019 (*Eric A*):**

- Are there any low-income apartments/multi-family housing? - Eric
- **SOMA** program is great: very generous solar incentive for multi-family, low income housing, 1 solar facility is implemented and then virtual net metering occurs
- Incentive is about ~$3/Watt
- $$$ is set aside and there are not that many facilities so there should be ample opportunity
- Not fully baked yet, but early 2019 - would be a great option for the tribe.
- 51% of generation **Must** go to tenants, all else can go to general load needs: incentive is higher for the generation to tenant compared to other "general load"

- **Would small residential communities on their own meters still qualify (for example, a Yurok Housing Authority housing development where there are multiple single family residences, all income qualified, all owned by Tribe, all clustered together?**
    - Independent metering is not disqualifying, but there are restrictions around it being a "recognized low-income facility"
    - We would need to explore the program structure more.

- Center for Sustainable Energy is administering this program, they should be able to provide more information, Eric can provide a contact person if needed

13 **Are there programs that can determine if current tariff schedule tribe is on is most optimal?**

- Rate analysis - PP conducts a rate analysis on an annual basis for customers and notifies customers if a better rate option exists.

14 **Should the tribe fill out the general application to start process for energy efficinecy services? What do we put under "description of project" on the application? Do we need to fill out separate applications for each facility?**

- **Response:** For Energy management and Custom Analysis we must fill out the form online - have tribe fill out one general application: input "multiple sites" - application is more of framework

Appendix D – Energy Options Analysis Criteria and Ranking

Table D-1: Energy options analysis criteria descriptions

			Evaluation Criteria						
Project Type	*Locations*	*Description*	*Technical Feasibility*	*Economic Feasibility*	*Promotes Tribal Vision*	*Creates on-Reservation jobs*	*Promotes Tribal sovereignty*	*Risk level*	*Comments*
On-grid Solar Electric	Klamath, Tulley Creek, Wautec, Worthington School	Roof-top or parking canopy solar arrays, net metered systems, offset retail electricity costs for Tribal facilities, target facilities with highest $/kWh rates	High	High	High	High/Med	High	Low	These projects can pay for themselves over time. Grant funding sources are available for up front costs. Cost savings can go toward long-term maintenance and can fund other energy program activities. Patrnership with GRID Alternatives can lead to job skill training opportunities.
Microgrids	Tulley Creek Tribal office complex, Klamath Tribal Office, Weitchpec Tribal Office	Battery storage and controls are combined with solar electric systems to provide the ability to island when the main grid goes down.	High	Med	High	Med	High	Med	Microgrids can provide resilience to critical facilities, providing back-up power when the main grid is de-energized. If a back-up generator already exists it can be relegated to deep back-up. Batteries and controls can also offer more optimized economic performance of solar electric system during normal daily operation when the main grid is functioning.
Off-grid Solar Electric and Microhydro	Up-river area, off-grid homes that are too far from the grid to be connected	Standardized/containerized systems, solar+battery+genset or solar/hydro+battery	Med	Med	High	High	High	Med/High	The concept if to create a Tribal energy authority that would provided these services, including procurerment and installation of these systems, as well as on-going maintenance. Residents would pay a nominal fee to support the program. Additional funds for operation and maintence would come from other sources.
Energy Efficiency	Tribal facilities and residences, up-river and down-river	Many energy efficiency improvements for buildings are cost-effective. Existing programs offer technical assistance and funding opportunities.	High	High	High	Low	High	Low	Existing programs exist that the Tribe can take advantage of. These include income-eligible programs for residents, such as the state-funded Energy Savings Assistance Program in PG&E territory and the federally-funded Weatherization Assistance Program in Pacific Power territory. Both PG&E and Pacific Power also have programs to serve commercial customers, including Tribal facilities. PG&E also has an on-bill financing program that can result in no-costs to the Tribe for a qualifying energy efficiency project. Finally, the Redwood Coast Energy Authority, under contract to PG&E, can provide local services.

Table D-1 Continued

			Evaluation Criteria						
Project Type	*Locations*	*Description*	*Technical Feasibility*	*Economic Feasibility*	*Promotes Tribal Vision*	*Creates on-Reservation jobs*	*Promotes Tribal sovereignty*	*Risk level*	*Comments*
Biomass	Up-river area	A biomass utilization program would aim to make use of biomass waste material generated during forest management activities and/or fuel-reduction efforts. Value-added products that can possibly be produced from suitable biomass waste includes: electricity, biochar, briquettes, etc.	Low	Low	High/Med	High	High	High	Biomass projects are extremely challenging and often fail. There are few to no technologies available that have been consistently proven to be practical, reliable, and cost-effective. A biomass project should not be seen as an energy generation project. If there is a desire to utilize biomass waste and a program can be conceived to do this, it is possible for one of the products to be the generation of electricity or the production of a biomass fuel, such as a briquitte or torrefied pellet. However, the production of energy products can seldom be done cost effectively using biomass. It may be possible to utilize waste biomass, create local jobs, and generate some revenue to support the program. If this is the goal, and not cost effective energy production, then a biomass project might be successful, though still likely challenging.
Medium-scale hydro	Pecwan Creek, Ke'Pel Creek	The Wind and Hydro Feasibility Study (2011) demonstrated that a viable hydroelectric resource (up to about 1.5 MW in capacity) exists in the upper reaches of Pecwan Creek above natural barriers to anadromous fish.	Med	Low	Med	Med	Med	High	Building a run-of-the-river hydroelectric project would be challenging even if all risk parameters were favorable. However, this project would require an substantial upgrade of the power lines all the way back to the Hoopa substation. This would add substantial cost to the project, perhaps doubling the capital cost, and would make the economic feasibility challenging at best.
Wind	McKinnon Hill and perhaps other remote rigetop telecom sites		Med	Med	Med	Med	Med	Med	More work would need to be done for specific sites to determine if there is a sufficient wind resource and to design and cost out a system. Work was done for the McKinnon Hill telecom site and is presented in the Wind and Hydro Energy Feasibility Study (2011).

Appendix E – Itemized Cost for Off-Grid Solar Standardized Systems

Table E-1: Off-grid solar PV itemized costs

Off Grid Solar + Generator System Itemized Costs						
System Component	System Size KW (DC)	Estimated Component Cost	$/W	Assumed Component Life (yrs)	Number of times replacement needed over 25 years*	Replacement costs over 25 years
Modules	1.5	$1,500	$1.00	25	0.2	$300
	3	$3,000	$1.00	25	0.15	$450
	5	$5,000	$1.00	25	0.1	$500
Charge Controller	1.5	$143		8	2	$286
	3	$478		8	2	$956
	5	$528		8	2	$1,056
Batteries	1.5	$2,190		4	5	$10,950
	3	$4,380		4	5	$21,900
	5	$6,570		4	5	$32,850
Inverter\Charger	1.5	$800		8	2	$1,600
	3	$1,100		8	2	$2,200
	5	$1,700		8	2	$3,400
Racking and Pallet Hardware	1.5	$1,100		25	0	$0
	3	$1,600		25	0	$0
	5	$2,100		25	0	$0
Backup Generator	1.5	$2,550		13	1	$2,550
	3	$3,100		13	1	$3,100
	5	$5,720		13	1	$5,720
Installation Labor + BOS hardware**	1.5	$4,500				
	3	$4,500				
	5	$4,500				
Total Cost	1.5	**$12,783**	**$8.52**			**$15,686**
	3	**$18,158**	**$6.05**			**$28,606**
	5	**$26,118**	**$5.22**			**$43,526**

Notes:

*PV module replacements are for incidents where a module needs to be replaced due to a premature failure, such as being struck by a rock and shattering the glass cover.

** Installation labor costs assumes 2 people for 2 days at 8 hrs/day and $125/hr, BOS hardware estimated at $1000.

Appendix F – Example Residential Micro-hyrdo Cost Estimate

HYDRO INDUCTION POWER

MICRO HYDRO SYSTEMS

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EXAMPLES

The most popular AC/DC System:

* Hydro: HV1200 w/ 4 Nozzles
* Gross Head: 180' / Net Head: 166'
* Pipe: Utility, 2" Poly
* Pipe Length: 900'
* Transmission Line: 1000'
* Measured Flow: 10 - 40 gpm
* Power: 500W @ 30gpm

System Costs:

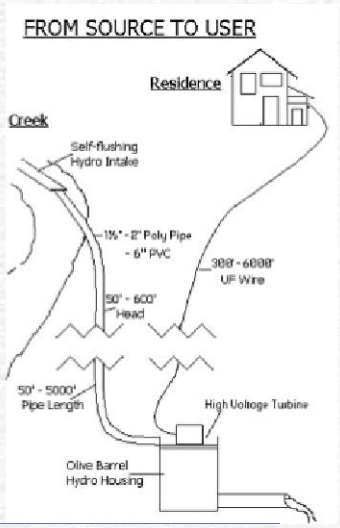
* Intake: $300
* Pipe: $450
* Manifold w/ Gate Valves and Pressure Gauge: $150
* Wire 12/3 UF: $500
* Hydro Housing (Olive Barrel): $125
* Hydro HV 1200 w/ 4 Nozzles: $3.600
* DC Shunt Regulation: $400
* Installation: +/- 8 Hours
* TOTAL COST: $5.525 + Installation

Formulas:

Power (W) = Net Head (ft) x Actual Flow (gpm) / 10

Net Head = Gross Head - (Head Loss x Pipe Length / 100)

Head Loss: see Head Loss Chart



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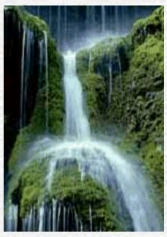

Appendix G – Status of Energy Efficiency Upgrades

Table G-1: Lighting efficiency upgrade project overview - Interior

Site	Project Pathway	Estimated Upgrade Cost	Available Incentive	Net Cost	Estimated Savings/Yr (kWh)	Estimated Savings/Yr ($)	Simple Payback (Yrs)	Estimated # of Lamps to be Replaced	Notes
Pek-Tah Fuel Mart	RHC	$ 847.41	$ 847.41	$ -	4,600.57	$ 460.06	0.00	102	Lighting Upgrades Completed
Weitchpec Tribal Office	RHC	$ 1,610.46	$ 1,610.46	$ -	6,572.51	$ 788.70	0.00	212	Lighting Upgrades Completed
Weitchpec Fire Station	RHC	$ 504.05	$ 484.15	$ 19.90	2,005.04	$ 360.91	0.06	58	Lighting Upgrades Completed
Tulley Creek Fire House	RHC	$ 874.97	$ 874.97	$ -	4,335.80	$ 737.09	0.00	98	Lighting Upgrades Completed
Kepel Early Head Start	RHC	$ 415.24	$ 203.91	$ 211.33	1,251.56	$ 225.28	0.94	56	Lighting Upgrades Completed
Morek-Won Community Center	RHC	$ 678.45	$ 305.75	$ 372.70	1,290.66	$ 232.32	1.60	78	Lighting Upgrades Completed
Wautec Fire House	RHC	$ 504.05	$ 484.15	$ 19.90	2,005.04	$ 441.11	0.05	58	Lighting Upgrades Completed
Klamath Tribal Office	Watt-Smart	$ 9,000.00	$ 6,000.00	$ 3,000.00		$ 1,200.00	2.50		Lighting Upgrades Completed (Rough estimates, but close)
Worthington Building	On-Bill	$ 18,887.50	$ 4,272.63	$ 14,614.87	15,451.00	$ 2,781.18	5.25	457	Lighting Upgrades, (Determine funding source/ Contract review)
		$ 33,322.13	**$ 15,083.43**	**$ 18,238.70**	**37,512.17**	**$ 7,226.64**	**2.52**	**1119**	

Table G-2: Lighting efficiency upgrade project overview - Exterior

Audit #	Site	Building Type	Project Pathway	Estimated Upgrade Cost	Available EW Incentive	Net Cost	Estimated Savings/Yr (kWh)	Estimated Savings/Yr ($)	Simple Payback (Yrs)	Notes
6014	*Pek-Tah* Fuel Mart - Exteriors	RTS	Contractor	$ 605.78	$ 98.40	$ 507.38	624.00	$ 118.56	4.3	All exterior fixtures
6015	Weitchpec Tribal Office - Exteriors	OFS	Contractor	$ 4,340.14	$ 913.82	$ 3,426.32	5,720.00	$ 1,430.00	2.4	All exterior fixtures
6017	Weitchpec Fire Station - Exteriors	MLI	Contractor	$ 2,943.37	$ 1,136.85	$ 1,806.52	7,116.00	$ 1,280.88	1.4	All exterior fixtures
6016	Wautec Fire House - Exteriors	MLI	Contractor	$ 1,318.61	$ 505.78	$ 812.83	3,166.00	$ 573.68	1.4	All exterior fixtures
	Totals for all contractor projects			**$ 9,207.90**	**$ 2,654.85**	**$ 6,553.05**	**16,626.00**	**$ 3,403.12**	**1.93**	

Appendix H – On-grid/Off-grid Program Economics with Varied Numbers of Off-grid PV System Sizes

Table H-1: Program economics with varied numbers of off-grid PV system sizes

Number of each system					
1.5-kW (5 kWh/day)	3-kW (10 kWh/day)	5-kW (15 kWh/day)	Annual Revenues	Annual Costs	Net Revenues
0	0	100	$261,100	$234,000	$27,100
0	100	0	$201,100	$174,000	$27,100
100	0	0	$141,100	$123,000	$18,100
30	30	40	$207,100	$182,700	$24,400
50	25	25	$186,100	$163,500	$22,600
25	25	50	$216,100	$191,250	$24,850

Appendix I – Tulley Creek Microgrid Concept

Table I-1: Tulley Creek microgrid battery sizing and cost estimate

Load: Based on interval data, representative high load, low solar day in mid-winter		
	300	kWh (net load minus solar resource, actual load is 350 kWh))
	330	kWh (added 10% for safety margin)
Recommended Battery Size		
	330	kWh needed for one day of storage (based on evaluation of interval data for site load and expected PV generation potential with 52 kW PV)
	2	desired days of storage
	660	kWh (assuming 2 days of storage)
	189%	This is 190% of the total load (350 kWh) on the max load day
	36	kW peak demand (per interval data)
	52	kW solar (expected installed solar capacity)
	100	kW battery energy storage system (BESS) (this is inverter capacity for BESS)
	700	kWh (7 hrs of storage based on rated capacity)
Cost Estimate		
$	480,000	Li-ion battery energy storage system
$	100,000	microgrid controls
$	110,000	PG&E interconnection
$	100,000	BOS (switchgear, wire, conduit, breakers, protection relays, etc.)
$	200,000	engineering, construction mgt & integration, commissioning, etc.
$	75,000	BESS and switchgear installation
$	50,000	site work
$	**1,115,000**	**Total**

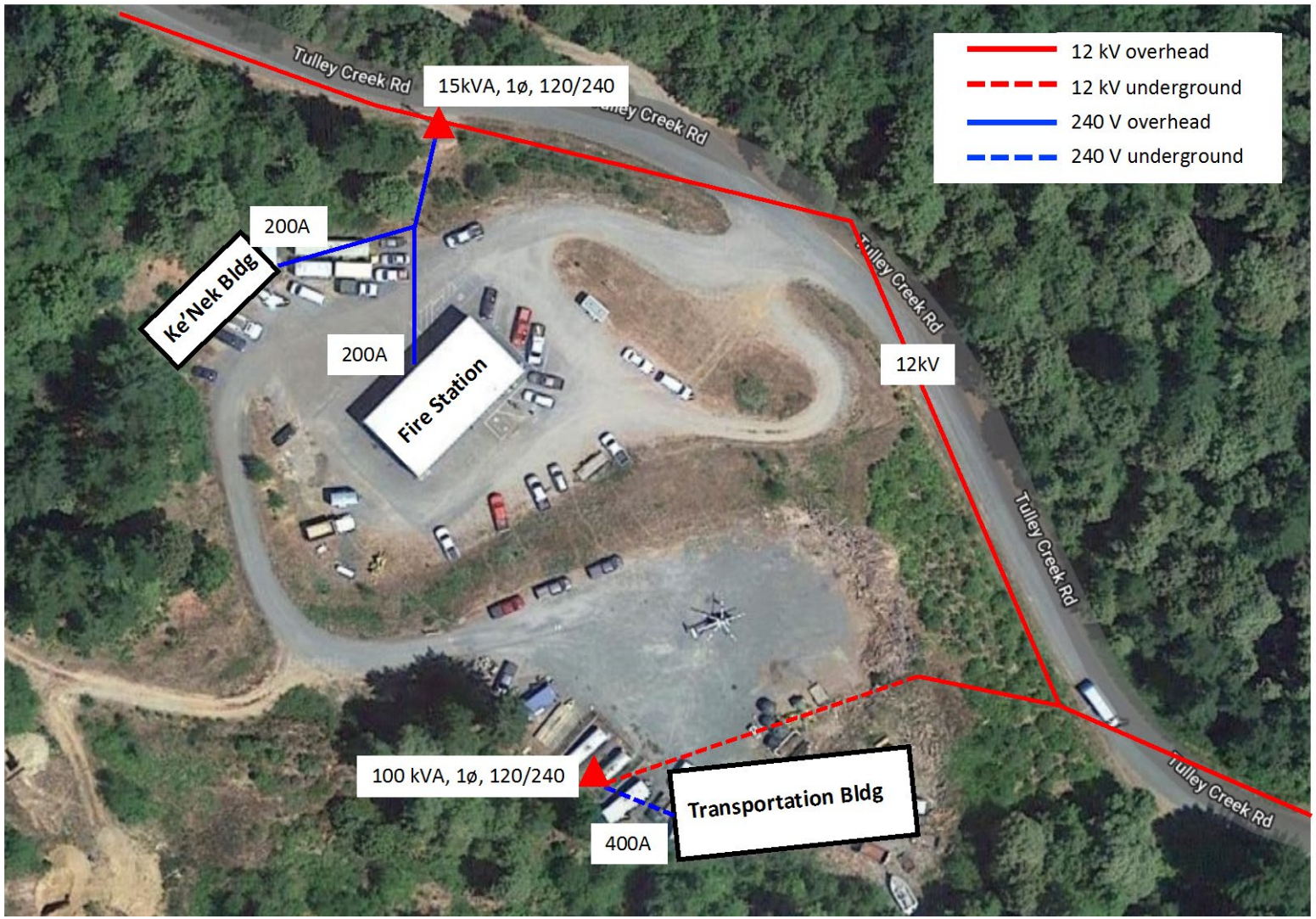

Figure I-1: Tulley Creek existing electrical distribution circuit

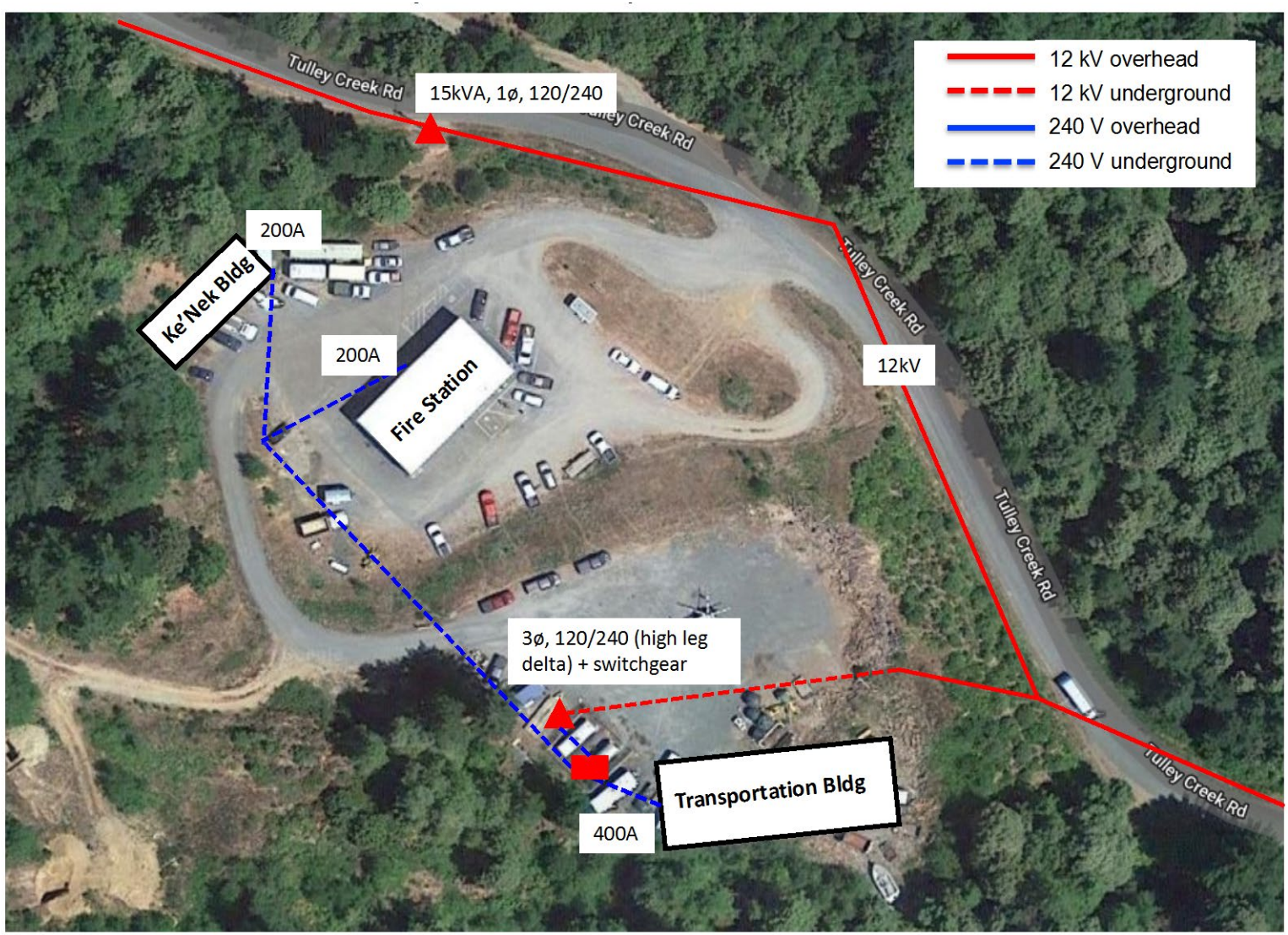

Figure I-2: Tulley Creek proposed electrical distribution circuit

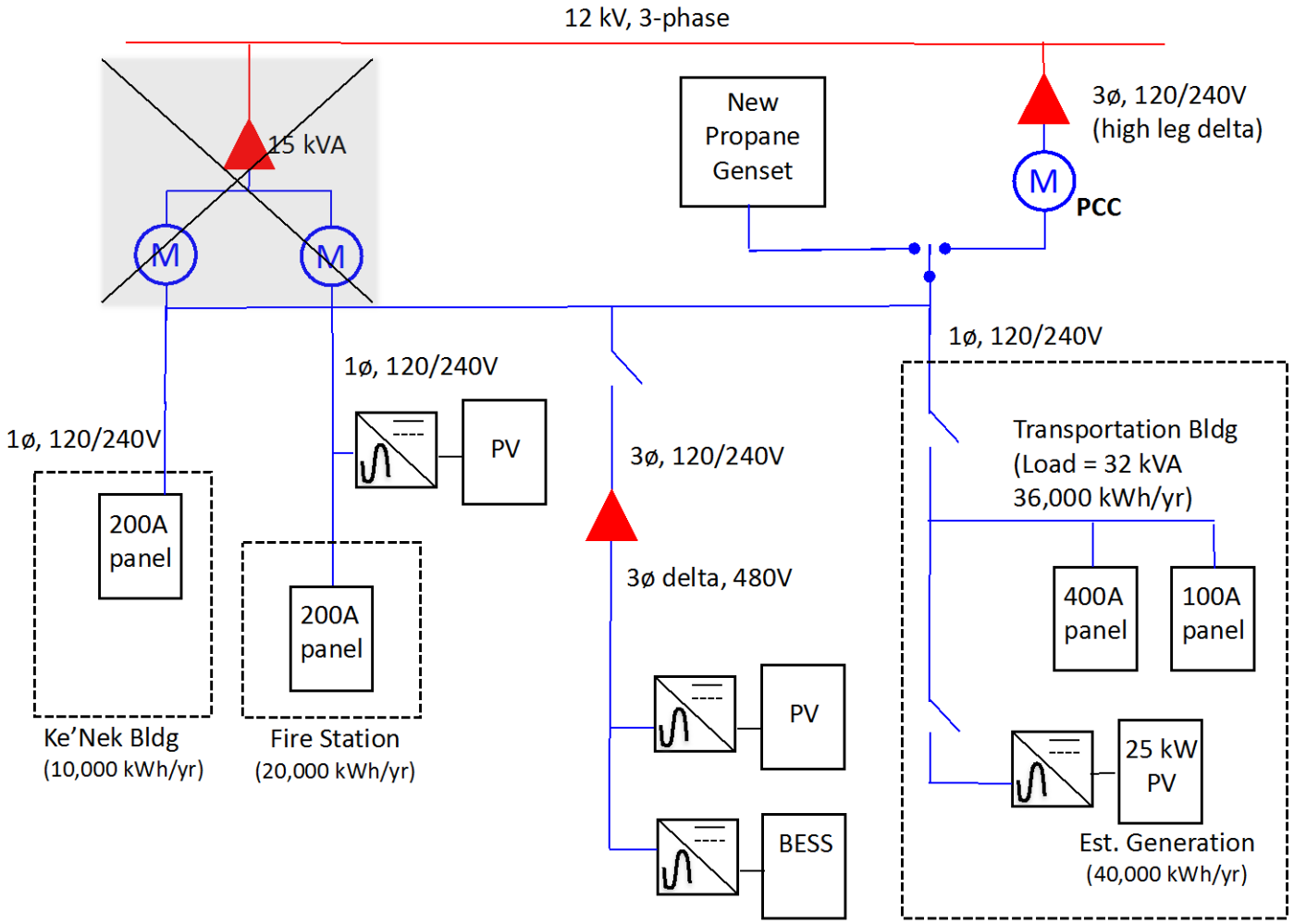

Figure I-3: Tulley Creek proposed microgrid circuit

Appendix J – Tribal Energy Business Model Options Matrix

Table J-1: Tribal Business Models

TYPE OF ENTITY	LAW GOVERNING FORMATION	SOVEREIGN IMMUNITY	LEGAL LIABILITY	FEDERAL TAX TREATMENT	FINANCING
Tribal Instrumentality and unincorporated entity	Tribal law, constitution, code, resolution or ordinance	Can share the same attributes of immunity as tribal government; immunity can be waived by tribe; waiver must be in accordance with tribal law	Tribal assets may not be segregated from entity; Tribal government may be liable for debts and obligations of tribal enterprise	Not subject to federal income tax (regardless of location of business activities) if the entity is not separate from the tribe.	Equity financing not possible, may qualify for tax-exempt financing if IRS requirements met; may be eligible for government guaranteed loans
Tribal Political Subdivision	Created under Tribal law through a special purpose ordinance or resolution to exercise one or more sovereign powers delegated by the tribe	Shares same attributes of immunity as tribal government; immunity can be waived by tribe	Whether tribal government is liable for debts and obligations of its political subdivisions would be determined under tribal law.	IRS practice has been to treat political subdivisions the same as the tribe—so long as they qualify as such by having been delegated substantial governmental powers	Can be both borrower and issuer of tax-exempt financing for facilities or operations that meet the essential governmental functions test; may be eligible for government guaranteed loans; can issue clean renewable energy bonds (CREBS)

Table J-1 (continued)

TYPE OF ENTITY	LAW GOVERNING FORMATION	SOVEREIGN IMMUNITY	LEGAL LIABILITY	FEDERAL TAX TREATMENT	FINANCING
Tribally Chartered Corporation	Tribal law, constitution, code, resolution or ordinance	A corporation that operates independent from the tribal government may not share the immunity of the tribe (multi factor test).	A wholly owned tribal corporation should make clear in its organizing documents that the tribal shareholder is not liable for debts of the corporation except to the extent of its contributed capital or the shares it owns.	Tax treatment is uncertain. In, 2001, the IRS and the Treasury Department agreed to resolve the uncertainty by issuing guidance but have not yet done so. For this reason, many tribal advisors have ceased creating new tribal law corporations.	It is not clear whether tribal law corporations can issue tax exempt bonds. Government guaranteed loans, taxable bond issuances, private placements, commercial bank financing available.
Section 17 Corporation	Federal charter issued under the Indian Reorganization Act	Corporate charter can confer the same privileges and immunity as tribe; waivers of sovereign immunity pursuant to the "sue and be sue clause" in the corporate charter should be limited to a waiver of only the corporation's sovereign immunity and such waiver should be restricted in scope to transactions of the corporation and limited to claims against the assets of the corporation and not the tribe itself	Assets and liabilities of the corporation are segregated from tribal government assets; Tribal government can pledge assets or property to the corporation; tribal government is not liable for debts or obligations of the corporation	Not subject to federal income tax regardless of location of business activities	Section 17 Corporation can pledge assets and property of the corporation; is eligible for government guaranteed loans; can issue tax exempt bonds for "essential governmental services" and can issue clean renewable energy bonds; joint ventures or equity partnerships possible through a LLC subsidiary chartered under a Section 17 corporation.

Table J-1 (continued)

TYPE OF ENTITY	LAW GOVERNING FORMATION	SOVEREIGN IMMUNITY	LEGAL LIABILITY	FEDERAL TAX TREATMENT	FINANCING
State Law Corporation	Created under state law for-profit or nonprofit purposes	Need to look at state law to determine power to sue and sued	Assets and liabilities of the corporation are segregated from tribal government assets; Tribal government can pledge assets or property to the corporation; tribal government is not liable for debts or obligations of the corporation	IRS has taken position that a state chartered tribal corporation does not share the same tax status as the tribe and it therefore taxable.	Does not qualify as an issuer of tax-exempt bonds or clean renewable energy bonds.
State Chartered Limited Liability Company	Created under state law	A single member LLC owned by a tribe would likely be considered a separate legal entity for purpose of legal process and thus not likely to be viewed as sharing the tribe's immunity from suit.	Has advantage of limited liability like a corporation; Tribe is not liable for debts or liabilities of LLC.	Taxed like a partnership or other "flow through" entity. IRS has not ruled on treatment of tribal single member LLC, in the absence of a rule, tribal advisors believe that a tribal government owned-LLC should be treated as a division of tribal government of tax purposes.	Does not qualify as an issuer of tax-exempt bonds or clean renewable energy bonds.