The Iowa Tribe of Kansas and Nebraska: Advancing Clean, Resilient, and Sovereign Energy

Summary Report of Communities LEAP Activities

December 2024

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Notice

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Contents

Introduction to Communities LEAP

Communities LEAP

- The U.S. Department of Energy's Communities LEAP (Local Energy Action Program) pilot supports community-driven action plans for clean energy-related economic development.
- This opportunity is open to low-income, energy-burdened communities that experience environmental justice challenges and/or direct economic impacts from reducing reliance on fossil fuels.
- Communities LEAP reflects the Biden-Harris Administration's commitments to:
    - Combat climate change through community-led transitions toward a more equitable and sustainable future
    - Deliver 40% of the overall benefits of federal climate, clean energy, affordable and sustainable housing, clean water, and other investments to communities that have been historically marginalized, underserved, and overburdened by pollution.

The Iowa Tribe of Kansas and Nebraska

ITKN Background

- The Iowa Tribe of Kansas and Nebraska (ITKN) is a sovereign nation and federally recognized Tribe located along the Missouri River on the border of northeast Kansas and southeastern Nebraska.
- 800+ people (Tribal citizens and non-Tribal residents) live on the ITKN Reservation, as well as more than 500 people who visit or work on the reservation on a daily basis.
- The ITKN has faced many energy challenges including rising service costs and frequent power outages that impact resident well-being and business activities on Tribal lands.
- Power service issues are made more challenging by the remoteness of the reservation, which is 20 miles from the nearest town.

ITKN Vision and Goals

Long-term energy goals for the ITKN are centered around achieving energy sovereignty. Priority actions include:

- Establishing a **Tribal Utility Authority** (TUA) to promote social welfare and community development.
- Deploying **renewable community microgrids** with ground-mount solar arrays and sustainable energy storage systems.

Community Coalition

- **David Tam –** CEO, Grey Snow Management Solutions, an Iowa Tribe of Kansas and Nebraska company
- **Peter Gregory –** CEO, Grey Snow Sovereign Solutions, a Grey Snow Management Solutions company
- **Jason Pockrus –** Grants and Contracts Administrator, Iowa Tribe of Kansas and Nebraska

Grey Snow Management Solutions, named after the Iowa Tribe of Kansas and Nebraska, who self describe as Baxoje – Ba meaning "snow" and Xoje describing "ashes or ash-colored" – is the tribe's economic development enterprise created to manage, build, support, and enhance tribal sovereignty, and provide expert services for government and commercial clients nationwide.

Communities LEAP Scope and Technical Activities

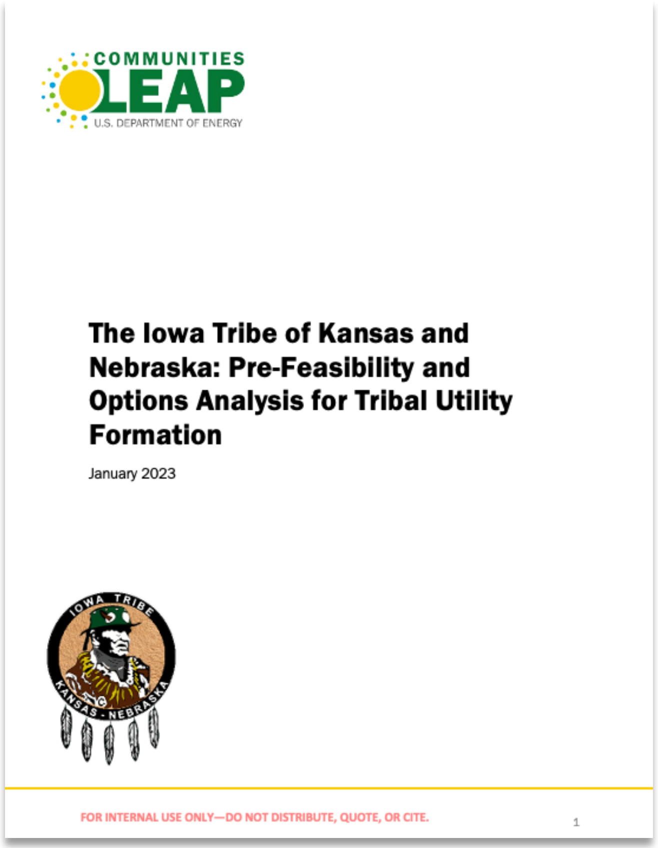
Community-Led Technical Assistance

- From **August 2022 to March 2024**, Communities LEAP collaborated with the ITKN community coalition to meet a long-term goal of providing reliable, resilient, efficient, secure, sustainable, and sovereign energy to the local community.
- Technical assistance **goals** and **objectives** included:
  1. Evaluating the costs and benefits of possible legal pathways, regulatory options, and estimated timelines to establish an ITKN-directed **TUA.**
  2. Developing technical analyses to support planning and implementation of **clean energy microgrids** on the reservation, including:
     a. **Technical** and **economic performance modeling** to determine the optimal configuration of renewable energy, conventional generation, and energy storage technologies needed to meet Tribal energy goals.
     b. Impact assessment of microgrid deployment on **social burden** and provision of **critical services** during outages.

Advancing Energy Sovereignty

Pre-Feasibility and Options Analysis for Tribal Utility Formation

- As part of Communities LEAP technical assistance, Schaff Martin Consulting prepared a **pre-feasibility assessment** for the ITKN that discusses key regulatory, technical, and economic considerations to establish and operate a **TUA.**
- This report also provides information on alternative governance and policy measures that might fall within the rights and jurisdiction of the ITKN to exercise **regulatory authorities over existing third-party utility service.**
- Information provided in the pre-feasibility report is **based on publicly-available records and reasonable assumptions.**
  - Assumptions and considerations contained within the report **should be fully investigated through further research** and analysis.



Tribal Utility Formation Pre-Feasibility Analysis – Prepared for the Iowa Tribe of Kansas and Nebraska by Schaff Martin Consulting

Tribal Regulatory Jurisdiction

- Tribes generally retain **jurisdiction over "retail" electricity transactions** (depicted in figure at right).
- Under principles of federal Indian law, "behind the meter" energy projects (and other utility activities not considered "interstate commerce") on trust and other Indian lands are subject to Tribal law.
- **Tribal governments may take regulatory jurisdiction** over retail electric power service, **depending on where activities take place on the reservation.**
- In the absence of specific Tribal regulations over electric power service, utilities generally abide by state regulations on Tribal reservations, including but not limited to the application of state-approved electricity rates to reservation residents and other service parameters.

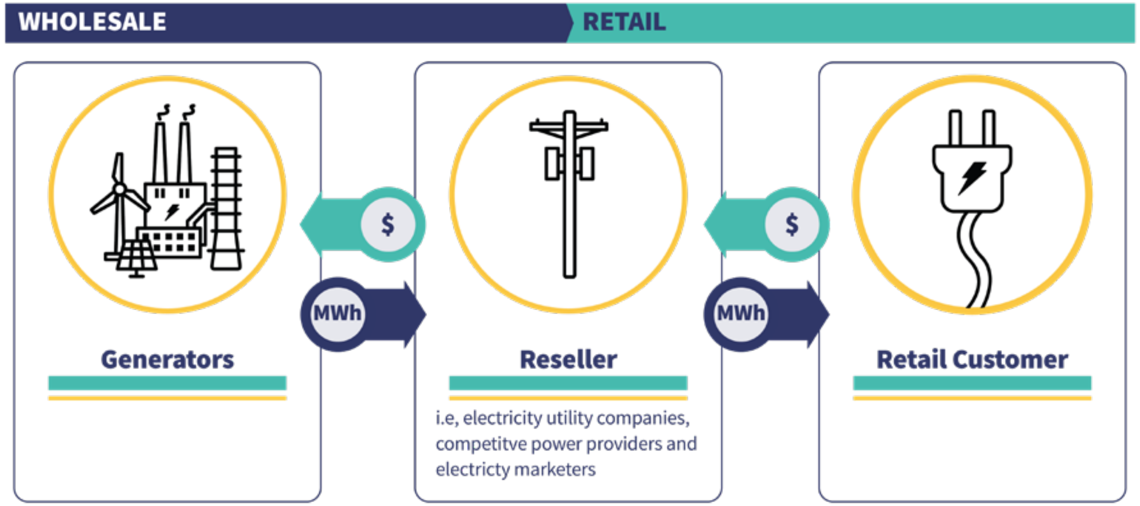


Figure from the Federal Energy Regulatory Commission illustrating wholesale versus retail electricity transactions.

Example Actions Identified to Advance Energy Sovereignty and Self-Governance

Exert Regulatory Authority Over Third-Party Utility Service

Tribes have several mechanisms to get third-party utility service providers to meet Tribal needs, including:

- Setting **policies** and **goals for energy use** on the reservation (e.g., carbon limits, renewable portfolio standards, net metering).
- Legislating **electricity codes** and standards.
- Negotiating a **franchise agreement** for service on Tribal lands.
- Establishing a **Tribal utility commission** or other oversight body.
- Requiring that a Tribal member be informed of utility activities and/or **participate in utility board meetings.**
- Establishing service with a **new utility provider** (and facilitating infrastructure acquisition, as needed).

Establish A Tribal Utility Authority

Tribes can also choose to **form their own electric utilities**, rather than working with a third-party providers. Tribally owned utilities that are governed and managed under Tribal law can perform a number of functions for the Tribe, including:

- **Purchasing** or **generating** electricity and **distributing it to Tribal customers.**
- Installing **solar panels**, **wind turbines**, or other utility-scale or distributed **energy resources.**
- **Managing energy programs** and goals (e.g., energy efficiency, distribution of energy fuels, issuing grants).

Install Distributed Energy Resources

Tribal-owned generation, such as **rooftop or community solar**, as well as **distributed energy storage** can also help to support energy sovereignty goals, **reduce energy costs**, improve **reliability**, increase **resilience**, and **reduce harmful energy emissions**. Tribes can choose to deploy on or off-site generation as a standalone activity, or in complement to regulatory and policy actions.

Working with Existing Utility Providers

Considerations might include:

- Appointing a **Tribal liaison** to engage and negotiate with third-party utility providers.
- Participating in third-party utility **governance structures**, such as elected leadership boards.
- Considering the benefits and potential risks of new laws and **obtain appropriate stakeholder input** prior to enacting.
  - For example, providing a copy of draft codes and ordinances to third-party utilities for advance comment might support good-faith negotiation and avoid onerous legal processes.

Why Establish a Tribal Utility Authority?

In addition to advancing **energy sovereignty** and **self-governance**, Tribal utilities can also be designed to:

- Improve **reliability** and **resilience** of energy services.
- Reduce energy **costs** for Tribal members.
- Develop local **jobs** and **economic opportunities.**
- Accelerate **renewable energy development** on Tribal lands.
- Operate and **administer Tribally owned energy projects.**

Establishing a Tribal Utility Authority

Phase 1: Planning and Oversight	
✓	Identify and document Tribal goals and priorities for utility service.
✓	Review energy and non-energy rights of way on Tribal lands.
✓	Review and understand the jurisdictional issues and any applicable laws (Tribal and non-Tribal) related to utility service.
✓	Decide who or what entity will have the responsibility for utility administration, operations, and maintenance. For example, delegating to Tribal staff, establishing a Tribal department, implementing through a Tribal corporation.
✓	Draft Tribal laws that will govern electric utility matters and establish any Tribal utility entities. Ensure that Tribal courts have jurisdiction over utility disputes.
✓	Take necessary and appropriate procedures to obtain necessary approvals to begin implementation of the new laws and coordinate with affected parties.
✓	Establish utility entities with appropriate start-up budgets, personnel, and directives.
✓	Explore additional funding sources to undertake necessary technical studies, equipment and infrastructure, and long-term administration, operation, and maintenance.

Establishing a Tribal Utility Authority

Phase 2: Conduct Pre-Feasibility Studies	
✓	Determine which electric loads and consumers will be served by the Tribal utility.
✓	Collect and evaluate load data, including aggregate and time-series or seasonal demand, and consumer characteristics.
✓	Evaluate power supply options to meet electricity demand, including self-generation and wholesale electricity purchases.
✓	Determine the best options for delivery of power, considering technical or legal constraints, as well as cost of service.
✓	Conduct detailed engineering studies of the distribution network, if necessary.
✓	Estimate utility service rates for customers and compare to existing service.
✓	Develop a utility business plan and operations strategy.
✓	Determine if contracts will be needed for construction, interconnection, transmission and distribution, maintenance, and other needed services, or if the Tribe will perform these functions itself.

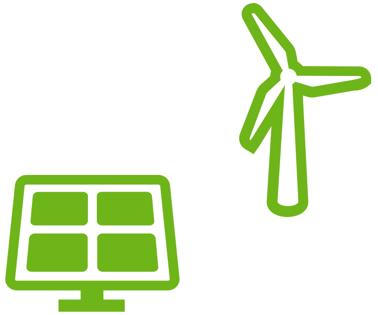
Establishing a Tribal Utility Authority

Phase 3: Tribal Utility Formation	
✓	Ensure start-up operational funds are in place and that the Tribal utility is in compliance with Tribal law.
✓	Hire and onboard utility management.
✓	Formalize utility goals and business plans.
✓	Draft internal guidelines and processes.
✓	Establish banking, insurance, and other essential relationships.
✓	Develop and approve financing approaches.
✓	Establish a date for utility service start-up.
✓	Ensure ongoing and accessible public communication, for example, through a website or social media.
✓	Determine a metering regime and order appropriate software and hardware (including control technology and regulating equipment), as needed.

Establishing a Tribal Utility Authority

Phase 3: Tribal Utility Formation (Cont.)	
✓	Establish GIS and other record-keeping protocols for utility facilities.
✓	Contract for reliable power supply through power purchase agreements or by installing self-generation.
✓	Negotiate wholesale transmission supply.
✓	Negotiate and acquire (or condemn or build) necessary distribution infrastructure.
✓	Set and communicate rates for service.
✓	Develop other helpful utility relationships, such as with local and national utility groups.
✓	Construct and implement projects.
✓	Test equipment and utility administrative systems.
✓	Flip the switch!

Tribal Utility Power Supply Options



On-Site Generation

Tribal utilities can consider installing utility-scale or distributed clean energy generation to meet Tribal energy needs or contracting with third-party producers to deploy Tribal-serving generation. Clean energy options, such as solar photovoltaics (PV), wind, community microgrids, and energy storage might present cost-effective options for resilient, sovereign power.

Figure from the Federal Energy Regulatory Commission (FERC)

Organized Wholesale Electricity Markets

Utilities that are members of wholesale power markets can purchase power from generators within the market. Transporting power over high-voltage transmission networks and lower-voltage distribution networks might incur additional fees (tariffs). Tariff rates are discussed further in subsequent slides.

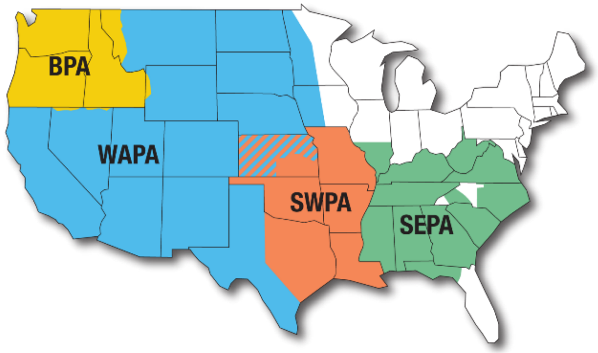


Figure from the Western Area Power Administration

U.S. DOE Power Marketing Administrations

Four federal Power Marketing Administrations (PMAs) operate electric systems and sell the electrical output of federally owned and operated hydroelectric dams in 34 states. Some PMAs have specific power allocations for Tribes.

Cost of Service Components

Estimating Tribal **utility rates** and **comparing to the existing cost of service** can help to determine if a new Tribal utility will be cost effective for customers. When determining whether a Tribal electric utility could result in lower rates and **potential cost-savings for consumers**, the following **cost components** of an electric utility service must be **carefully estimated**, researched, and compared to the existing or alternative service providers.

Table 1. Example Energy Cost of Service Components

Cost Component	Could Include
Wholesale Power and Transmission	• Wholesale power market rate for purchased power (e.g., from a regional transmission organization [RTO], independent system operator [ISO], or a federal PMA) • Levelized cost of self-generation • Transmission access tariffs • Power scheduling services.
Distribution	• Tariffs to transmit power over existing distribution network • Cost to finance the purchase the whole or part of the distribution system • Cost to build new infrastructure or serve new loads • Maintenance costs for poles, equipment, and wires.
Operation and Administration	• Personnel • Equipment • Subcontracts • Education and training • Metering and billing • Legal • Contingency funds • Other ongoing operational and business costs.
Start-Up Costs	• Planning and pre-feasibility processes • Legal and regulatory • Initial capitalization • Potential stranded costs • Other initial expenses.

Estimating Tribal Utility Rates

- **Wholesale Power Purchase and Delivery:** Some RTOs and ISOs make **monthly average wholesale electricity rates** or other data available on their websites. **Transmission access tariffs** and other delivery service costs will **depend on the network** and associated providers.

- **Self-Generation Costs:** Estimated costs for **installing new generation assets** (such as wind or solar) can use **levelized cost of electricity** as a reference point, although **actual costs will vary** project-to-project.

- **Distribution Costs:** Estimates will depend on **wheeling tariffs** and/or financial terms to acquire or build out the distribution network.

- **Operation and Administration:** Varies utility to utility, as will start-up costs, based on utility business planning and expenses. The **American Public Power Association** (APPA) provides some information on mean weighted **average operation and maintenance expenses** for small utilities across the nation.

Wholesale Power Purchase Price Variability

- **Wholesale power rates** for RTO and ISO markets **will vary** based on the season, fuel prices, peak versus off-peak, day-ahead versus real-time pricing, and transmission congestion, among other factors.
- **Monthly averages** for wholesale power prices might be informative for planning, but **do not capture the full complexity** of real-time or actualized costs.
- Prospective Tribal utility organizations can **review historical data from RTOs/ISOs** to understand price ranges in their region.

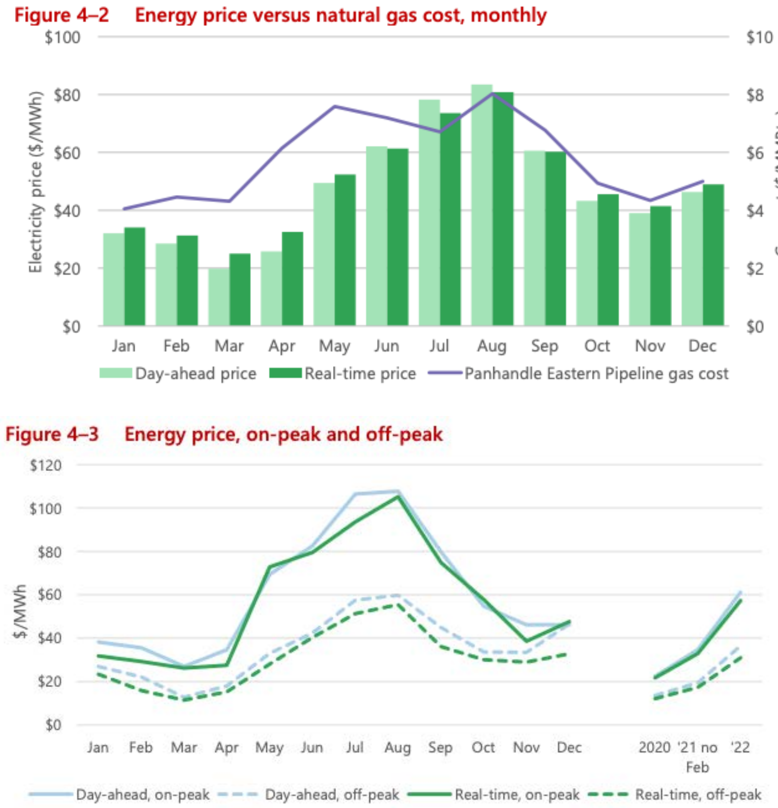


Figure 2. Day-ahead and real-time energy pricing in the Southwest Power Pool (2022).
Figures sourced from the Southwest Power Pool 2022 [Annual State of the Market Report](#).

Levelized Cost of Energy for New Energy Generation Resources

- **Levelized cost of energy** (LCOE) and **levelized cost of storage** (LCOS) provide simple metrics that encompass capital costs, operations and maintenance (O&M), performance, and fuel costs of energy generation and storage resources.
- These metrics also represent the **average revenue per unit** of electricity **needed to break even** on the cost of building and/or operating these assets over their respective life cycles.
- The U.S. **Energy Information Administration** (EIA) Annual Energy Outlook and the **National Renewable Energy Laboratory** (NREL) Annual Technology Baseline provide **updated annual estimates** of LCOE and LCOS for emerging and market-ready energy technologies.
- LCOE values provided by the EIA and NREL are **estimates based on market and technology averages** – publicly-available **performance and financial modeling tools** such as the System Advisor Model (SAM) and Renewable Energy Integration and Optimization (REopt®) tool can be used to **develop project-specific LCOE estimates** and inform more detailed planning.

Table 1b. Estimated unweighted levelized cost of electricity (LCOE) and levelized cost of storage (LCOS) for new resources entering service in 2027 (2021 dollars per megawatthour)

Plant type	Capacity factor (percent)	Levelized capital cost	Levelized fixed O&M[a]	Levelized variable cost	Levelized transmission cost	Total system LCOE or LCOS	Levelized tax credit[b]	Total LCOE or LCOS including tax credit
Dispatchable technologies								
Ultra-supercritical coal	85%	$52.11	$5.71	$23.67	$1.12	$82.61	*NA*	$82.61
Combined cycle	87%	$9.36	$1.68	$27.77	$1.14	$39.94	*NA*	$39.94
Advanced nuclear	90%	$60.71	$16.15	$10.30	$1.08	$88.24	-$6.52	$81.71
Geothermal	90%	$22.04	$15.18	$1.21	$1.40	$39.82	-$2.20	$37.62
Biomass	83%	$40.80	$18.10	$30.07	$1.19	$90.17	*NA*	$90.17
Resource-constrained technologies								
Wind, onshore	41%	$29.90	$7.70	$0.00	$2.63	$40.23	*NA*	$40.23
Wind, offshore	44%	$103.77	$30.17	$0.00	$2.57	$136.51	-$31.13	$105.38
Solar, standalone[c]	29%	$26.60	$6.38	$0.00	$3.52	$36.49	-$2.66	$33.83
Solar, hybrid[c,d]	28%	$34.98	$13.92	$0.00	$3.63	$52.53	-$3.50	$49.03
Hydroelectric[d]	54%	$46.58	$11.48	$4.13	$2.08	$64.27	*NA*	$64.27
Capacity resource technologies								
Combustion turbine	10%	$53.78	$8.37	$45.83	$9.89	$117.86	*NA*	$117.86
Battery storage	10%	$64.03	$29.64	$24.83	$10.05	$128.55	*NA*	$128.55

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022*

[a] O&M = operations and maintenance

[b] The tax credit component is based on targeted federal tax credits such as the Production Tax Credit (PTC) or Investment Tax Credit (ITC) available for some technologies. It reflects tax credits available only for plants entering service in 2027 and the substantial phaseout of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA*, or *not available*. The results are based on a regional model, and state or local incentives are not included in LCOE and LCOS calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[c] Technology is assumed to be photovoltaic (PV) with single-axis tracking. The solar hybrid system is a single-axis PV system coupled with a four-hour battery storage system. Costs are expressed in terms of net AC (alternating current) power available to the grid for the installed capacity.

[d] As modeled, we assume that hydroelectric and hybrid solar PV generating assets have seasonal and diurnal storage, respectively, so that they can be dispatched within a season or a day, but overall operation is limited by resource availablility by site and season for hydroelectric and by daytime for hybrid solar PV.

Figure 3. Estimated levelized cost of energy and levelized cost of storage for new energy resources. Table from the U.S. Energy Information Administration Annual Energy Outlook

Sample Cost of Rate Components for a Small Utility

- Evaluating the **potential cost of utility service** and operations is an important step to determining if a Tribal utility will be able to provide **cost-savings to consumers** in their service area.
- Depending on the resources available within the utility service area, renewable energy resources such as solar PV and wind might offer cost-effective self-generation options and might be eligible to offset costs through power sales back to the grid.

Cost of Rate Component	Sample Average $/kWh
Power Generation and/or Purchase Costs[1]	$ 0.049
Capital Cost for Wholesale Distribution and Acquisition of Distribution Infrastructure	Unknown/Context-Specific
Transmission to Local Substation or Other Wholesale Market Costs[2]	$ 0.010
Operation, Maintenance, and Administration[3]	$ 0.019
Wholesale Distribution	Unknown/Context-Specific
Start-Up Financing	Unknown/Context-Specific
Total Estimated Sample Costs per kWh	**$ 0.078**

1. Based on Southwest Power Pool actual average wholesale rates in 2021.
2. Assuming power is not generated locally.
3. Estimated based on weighted average total operation and maintenance expenses for small utilities in 2019, as reported by APPA.

If distribution and start-up financing costs were known, **how would this amount compare to what consumers currently pay for electricity service?**

Key Takeaways

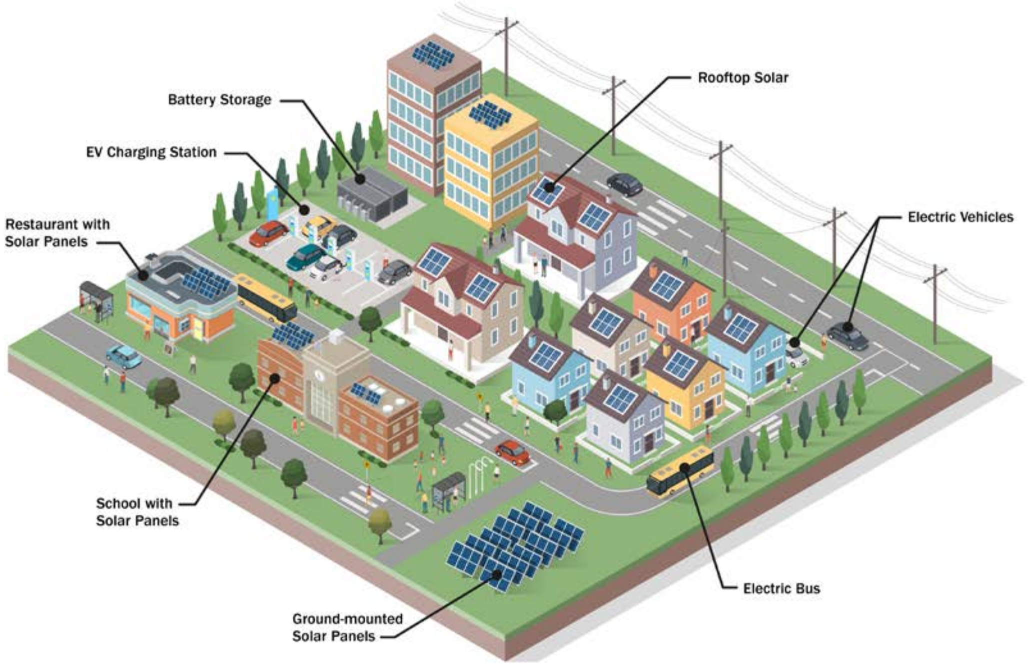
- Regulating electricity and other energy services on Tribal lands is an important component of **Tribal sovereignty.**
- Tribes have several options, including regulatory and policy actions, at their disposal to **enhance oversight of third-party utility service** and advance Tribal energy goals.
- Developing an **independent Tribal Utility Authority** can be a long and complex process – advance planning and robust strategy development can support this process.
- Deploying **clean energy technologies** on Tribal lands can also help to **reduce energy costs**, improve **resilience** and **reliability**, and advance energy sovereignty of Tribal nations.

Clean and Resilient Microgrids

Advancing Clean and Resilient Power with Microgrids

A **microgrid** is a coordinated energy and electrical distribution system with **dispatchable resources** capable of both **grid-interactive** and **autonomous operation** that:

- Encompasses **load** and **generation**, including multiple distributed energy resources (DER) — from traditional diesel gensets to renewable energy and storage (can't be just energy storage).
- Able to **disconnect** and **parallel** with the local utility (not emergency back-up generation).
- Intentionally "**islands**" as part of a planned operation and may include sophisticated monitoring and controls—including load, generation, and stored energy management.



Microgrids are small-scale electrical grids that can enable local sources of energy, like rooftop solar and battery storage, to keep electricity on in a community even when outages, storms, or other disruptions shut down the larger grid.

Community Benefits

Microgrids can be designed to provide a number of benefits to communities, including:

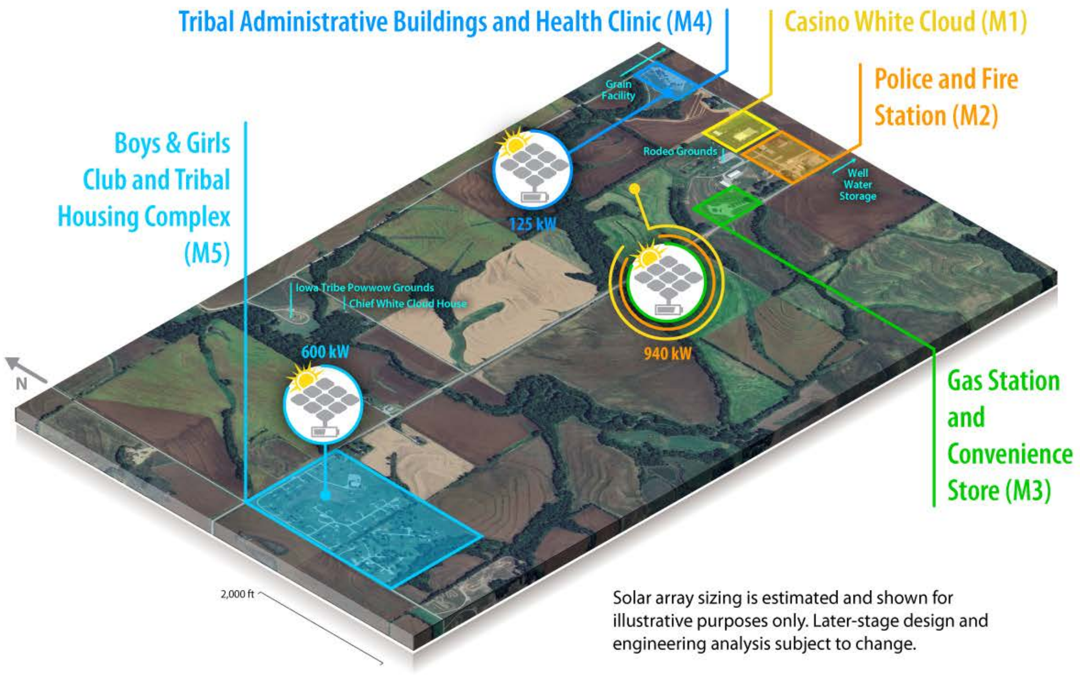
- Increasing power system resilience to outages and disruptions.
- Increasing the share of clean and renewable energy consumed by a community.
- Providing power to essential loads during extended grid outages.
- Decreasing greenhouse gas emissions.
- Improving overall system reliability and power quality.
- Advancing self-determination and sovereignty.

Technical and Economic Modeling

Determining Microgrid Configurations

- Facilities on the ITKN reservation include a **casino**, **gas station**, **daycare center**, **police department**, **fire department**, a Tribally owned and operated **medical clinic**, **administrative offices**, **wellness center**, **Boys & Girls Club**, and numerous **residences.**
- Placement of **existing power infrastructure** and estimated costs for new construction (e.g., trenching, line development) led ITKN to consider **five independent microgrids** to serve these facilities.

Proposed Microgrid Configurations



Off-reservation social services (not powered by proposed microgrids):
Cell tower • Airport • FM Radio Transmission • Hospital • Grocery Store • Housing

On-reservation social services and critical facilities powered by proposed microgrids:

Casino White Cloud Microgrid (M1)
Casino White Cloud • Casino White Cloud RV Grounds • Casino White Cloud Shop

Police and Fire Station Microgrid (M2)
Flakey Mills - Lab Facility • Iowa Tribal Fire Department
Rutana Tires and Automotive Services • Iowa Tribal Museum • United Tribes
Heavy Machine Shop • Agriculture and Heavy Equipment Storage
Tribal Multipurpose Building - Police Department, Tribal Court, Senior Citizens Program, and Fish and Wildlife Department

Gas Station and Convenience Store Microgrid (M3)
Casino White Cloud Cabins • Grandview Oil Gas Station and Convenience Store

Tribal Administrative Buildings and Health Clinic Microgrid (M4)
Tribal Administration Building • George Ogden Community Building
White Cloud Health Center • Fitness Center at White Cloud Health Center
Emergency Storm Siren

Boys & Girls Club and Tribal Housing Complex Microgrid (M5)
Boys & Girls Club • Tribal Housing Complex - 47 residences

Additional on-reservation social services (not powered by proposed microgrids):
Rodeo Grounds • Iowa Tribe Powwow Grounds • Well Water Storage
Chief White Cloud House • Grain Facility

Figure 4. Proposed configurations for five clean energy microgrids (M1-M5) for the ITKN. Microgrids 1-5 were designed to modulate the impact of potential power outages by maintaining continuous service for critical services and buildings on the reservation.

Microgrid Optimization Modeling

Microgrid **optimization** and **simulation tools** can be used to determine the **optimal sizing**, **configuration**, and **dispatch** of microgrid system components, including solar PV, wind, energy storage, combined heat and power, and back-up generation, to support **economic**, **resilience**, and/or **emissions reductions** goals. Optimization tools can support **early-stage** technical and economic **planning** for microgrid deployment and help to determine if projects options are **financially viable** and meet **community goals**.

HOMER Pro

STANDALONE MICROGRIDS

REopt

HOMER® is a suite of commercial software tools that can be used to model **hybrid** and **grid-connected microgrid systems**. Originally developed by NREL, the HOMER modeling suite is now developed and maintained by UL Solutions and can be accessed via a **paid subscription.**

NREL's REopt® is a **publicly available** microgrid modeling tool, available via a user-friendly **web platform** – more advanced modeling capabilities can be accessed through the **application programming interface** and **Julia package**.

Microgrid Optimization Modeling

- Multiple analysis iterations were conducted using the **HOMER** microgrid optimization and modeling software to:
  - Determine **approximate solar PV and battery capacity** needed to serve all facilities connected to the microgrids.
  - Estimate **performance metrics**, including solar PV production, energy purchase and export from the grid, generator fuel consumption, and other key metrics.

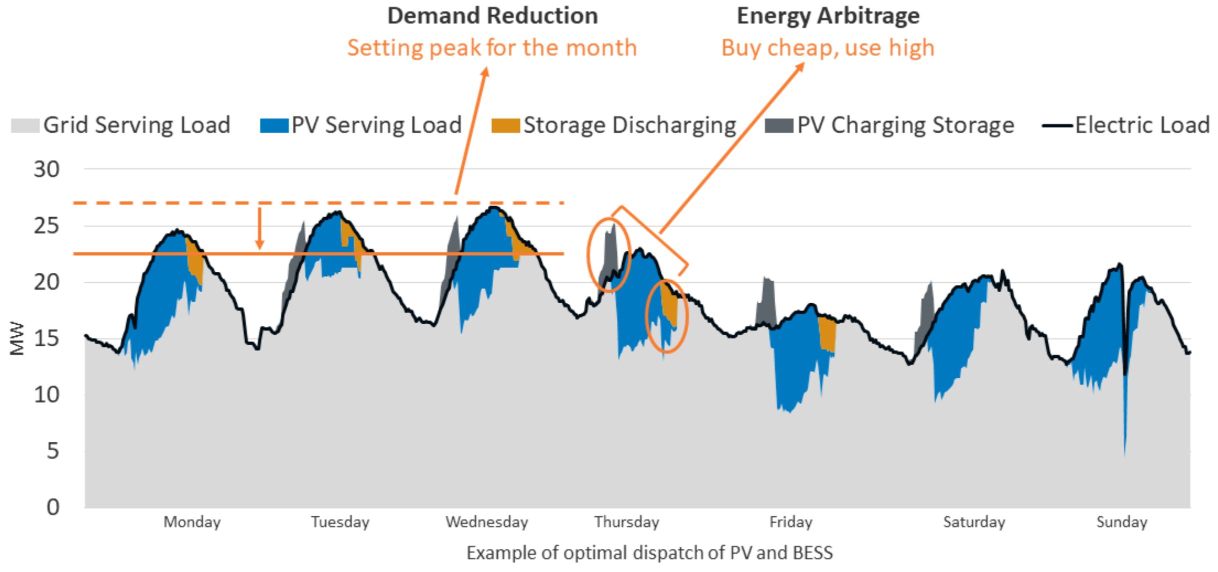


Figure 5. Example of modeled optimal dispatch for solar PV and battery energy storage

Community Data Collection

Input	Data Collected
Solar Resource Data	• Hourly average global horizontal irradiance (GHI) for the ITKN reservation was retrieved from NREL's National Solar Radiation Database.
Electricity Consumption	• Representative monthly utility bills (spanning 2017–2022) were collected for businesses, facilities, and houses on the reservation. • Total annual consumption (kWh) and average daily consumption (kWh) for business and facility loads were imported to HOMER to create synthetic hourly interval data for the analysis. • Electricity consumption profiles from NREL's ResStock™ for single family residences in Brown County, Kansas were scaled to match seasonal profiles derived from monthly utility bill data.

Electricity Outages	• Electricity consumption for all loads was adjusted by +5% to account for electricity that would have been purchased if not for grid outages.
	• HOMER was used to simulate microgrid dispatch during random grid outages. Analysts assume conservative values for outage simulation, including:
	  • Mean outage frequency = 50 outages per year
	  • Average repair time = 7 hours.

Electricity Tariffs	• Service, demand, and energy charges, as well as energy buyback rates, for different tariff classes were retrieved from the local utility and utility bill data.
Generator Fuel Use	• Rated power (kW) and fuel use (gallons per hour) were obtained for existing back-up generators serving the casino and health clinic.

Microgrid Technical Results

Table 4. Estimated Energy Production and Installed Capacity for Microgrid Generation and Storage Components

Microgrid	Annual Consumption (kWh)	Annual PV Production (kWh/year)	PV Capacity (kW_{dc}/kW_{ac})*	PV Array Type	Battery Capacity (kW/kWh)	Diesel Generator Capacity (kW)
M1 – Casino**	1,720,000	1,045,000	700/600	1-Axis Tracking	300/1,200	500
M2 - Police and Fire Station	220,000	210,000	140/125	1-Axis Tracking	50/100	75
M3 - Gas Station and Convenience Store	155,000	145,000	100/80	1-Axis Tracking	50/100	45
M4 – Tribal Administrative Buildings and Health Clinic	170,000	155,000	125/100	Fixed Tilt	50/100	75
M5 - Boys & Girls Club and Tribal Housing Complex	760,000	740,000	600/600***	Fixed Tilt	300/600	500

* kW_{dc}: PV array capacity, kW_{ac}: PV inverter capacity
**PV capacity for M1 constrained by 200 kW export limit. For the other microgrids, the PV is sized so that annual PV production roughly matches annual consumption.
***AC and DC power ratings are equivalent for this (notional) PV system, as the coalition partners requested that the model utilize a 1:1 inverter load ratio to accommodate economic and equipment specifications.

Microgrid Technical Results – Discussion

- For **M2**, **M3**, and **M4** the solar PV arrays were sized to "**net zero**" the anticipated electricity consumption (i.e., so that annual production is roughly equal to the annual consumption of the load being served).
- For **M1**, the **200-kW export constraint** prevents net metering of electricity consumption with solar PV production.
  - Proposed solar PV capacity of **700 kW$_{dc}$ is the maximum size** prior to which a significant portion of the production of incremental additional PV capacity would be wasted.
- For **M5**, the 200-kW export constraint results in maximum solar PV capacity less than what is needed for annual solar production to equal annual consumption of the buildings being served.
  - Proposed solar PV capacity of **600 kW$_{dc}$** is the maximum size prior to which a significant portion of the production from incremental additional PV capacity would be wasted.

Microgrid Technical Results – Discussion

- For all microgrids, batteries were sized to **cover short outages** (approximately 3-5 hours) without the need to turn on a diesel generator in the event of a blackout.
- In the HOMER algorithm, the **battery is only dispatched during power** outages and is consequently underutilized. **Peak shaving** and **load shifting** could help to further improve the economics of the energy storage system.

Project Cost and Investment Mobilization

- Capital and operating costs for microgrid configurations were estimated using HOMER optimization models.
- Detailed financial and cash flow analyses were performed outside of HOMER to evaluate project economics over time and determine the appropriate combination of various investment streams, accounting for incentives such as the investment tax credit and potential federal grant resources.
- State and utility-level financial incentives (e.g., net energy metering programs) for project investment were limited in this circumstance.
- Federal investment incentives, low-interest financing, and grant funding can help to ensure that projects break even or that they do not increase energy costs for consumers.

Key Takeaways

- Clean energy microgrids with battery energy storage and back-up generators can help to increase energy resilience, reliability, and Tribal sovereignty for the ITKN.
- Federal incentives, including grants, tax credits, and low-interest financing, can help to support cost-effective project development for Tribes in areas with limited state and utility incentive programs.

Social Burden Evaluation

Equitable Resilience Planning

Several free, publicly available tools are available to support the measurement of equity and resilience value of existing and planned infrastructure investment alternatives.

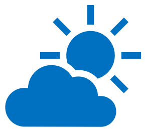
ReNCAT was developed by Sandia National Laboratories as a **free**, **publicly available** optimization software that identifies portfolios of microgrids, line hardening, and load shedding alternatives, that are co-optimized for cost and equitable resilience benefits.

Sandia National Laboratories' QGIS Social Burden Calculator is a **free, open-source, publicly available** plugin to the open-source QGIS software. Via a user-friendly graphical user interface, users can easily calculate and map out different social burden scenarios.

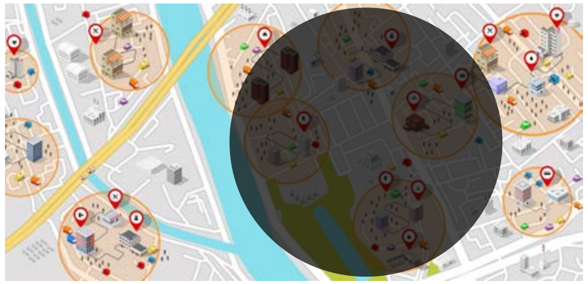
How to Integrate Equitable Resilience into Microgrid Planning and Scenario Analysis?

Social Burden is a measure of: **equity** in service availability vs baseline capacity;
resilience to disruption in service access.

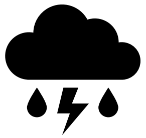
$$Social\ Burden = Effort/Ability \cong \frac{Effort\ to\ Obtain\ Service_{people,services}}{Service\ Levels_{facilities,services} \times Baseline\ Capacity_{people}}$$



"Blue Sky" Scenario: Grid Powered, All Available Facilities "ONLINE"



"Black Sky" Scenario: Grid Outage, Some/All Facilities "OFFLINE"



Calculating the Resilience Value of Microgrid Alternatives

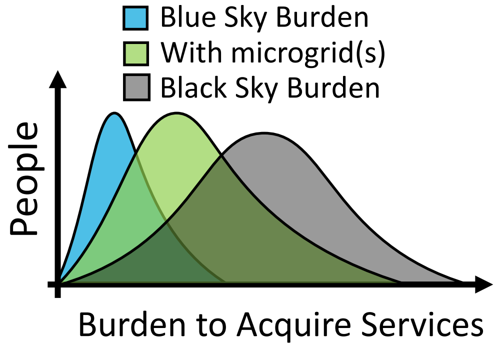
- The Social Burden differential (*"Black Sky" minus "Blue Sky" Burden*) measures the social impact a given outage will have on a community.
  - Smaller differentials indicate the community is more resilient to the outage (less impacted); larger differentials indicate the community is less resilient (more impacted).
- A microgrid can modulate the impact of the outage by maintaining service at facilities that provide critical services to the community.
  - This can be quantified directly for different outage scenarios and microgrid configurations.

"Blue Sky" Scenario: Grid Powered, All Available Facilities ONLINE

Social Burden at its lowest; power system adds no burden.

"Black Sky" Scenario: Grid Outage, Some/All Facilities OFFLINE

Social Burden highest; power system increases burden through service reduction.



Increased Social Burden during outage is modulated by microgrids.

Identifying Critical Services: On-Reservation Facilities

- Critical services and the manner in which they are accessed by ITKN residents were identified in collaboration with community partners.
- Figure 6 shows the spatial distribution of on-reservation services and critical facilities included in the social burden evaluation (broken out by microgrid service area) included in the Social Burden Evaluation.

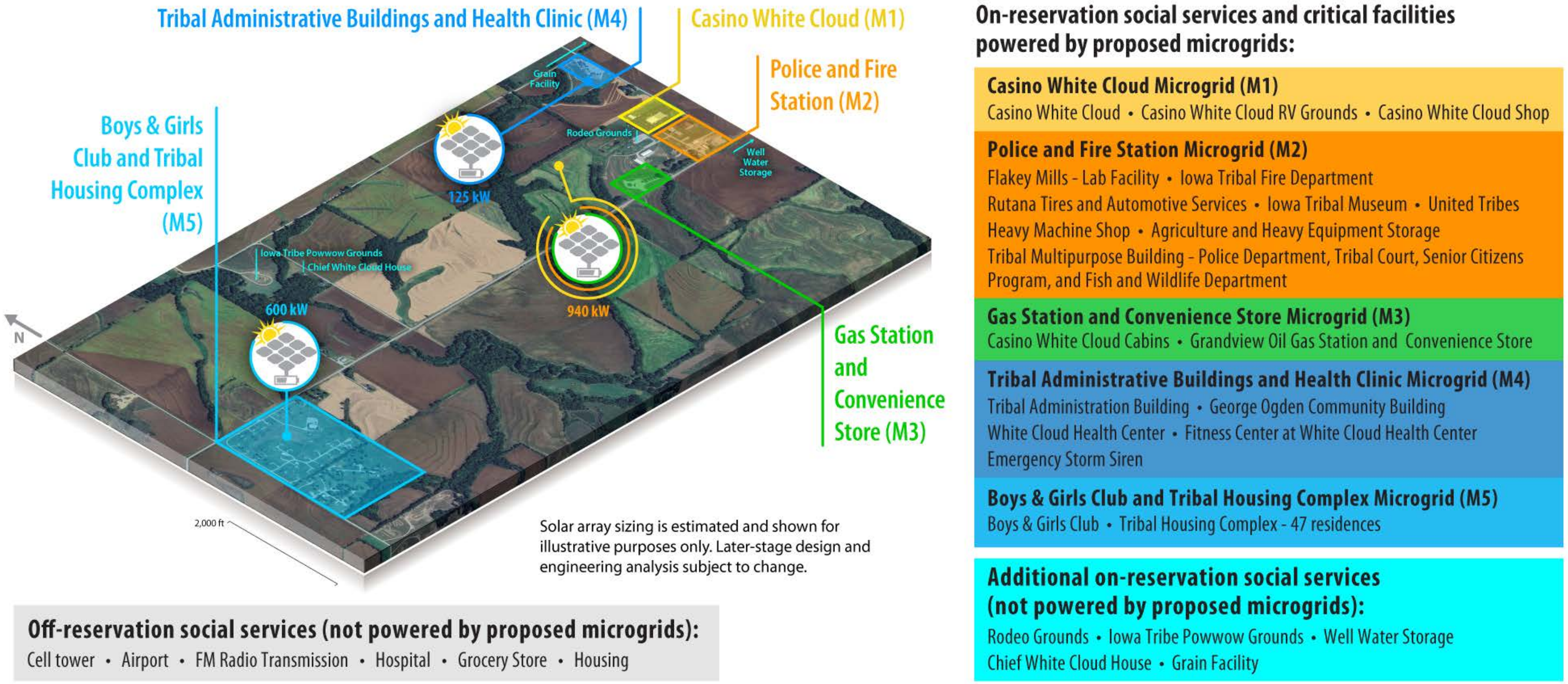


Figure 6. Proposed configurations for five clean energy microgrids (M1-M5) for the ITKN

Identifying Critical Services: On-Reservation Facilities Cont.

- Microgrids 1-5 were designed to modulate the impact of potential power outages by maintaining continuous service for critical services and buildings on the reservation.
- Available social services (both on- and off- reservation) were evaluated to determine the impact of the proposed microgrids (M1-M4) on community resilience and relative social burden.
- Microgrid serving the Boys & Girls Club and Tribal Housing Complex (M5) was also evaluated separately due to its geographic separation from M1-M4.

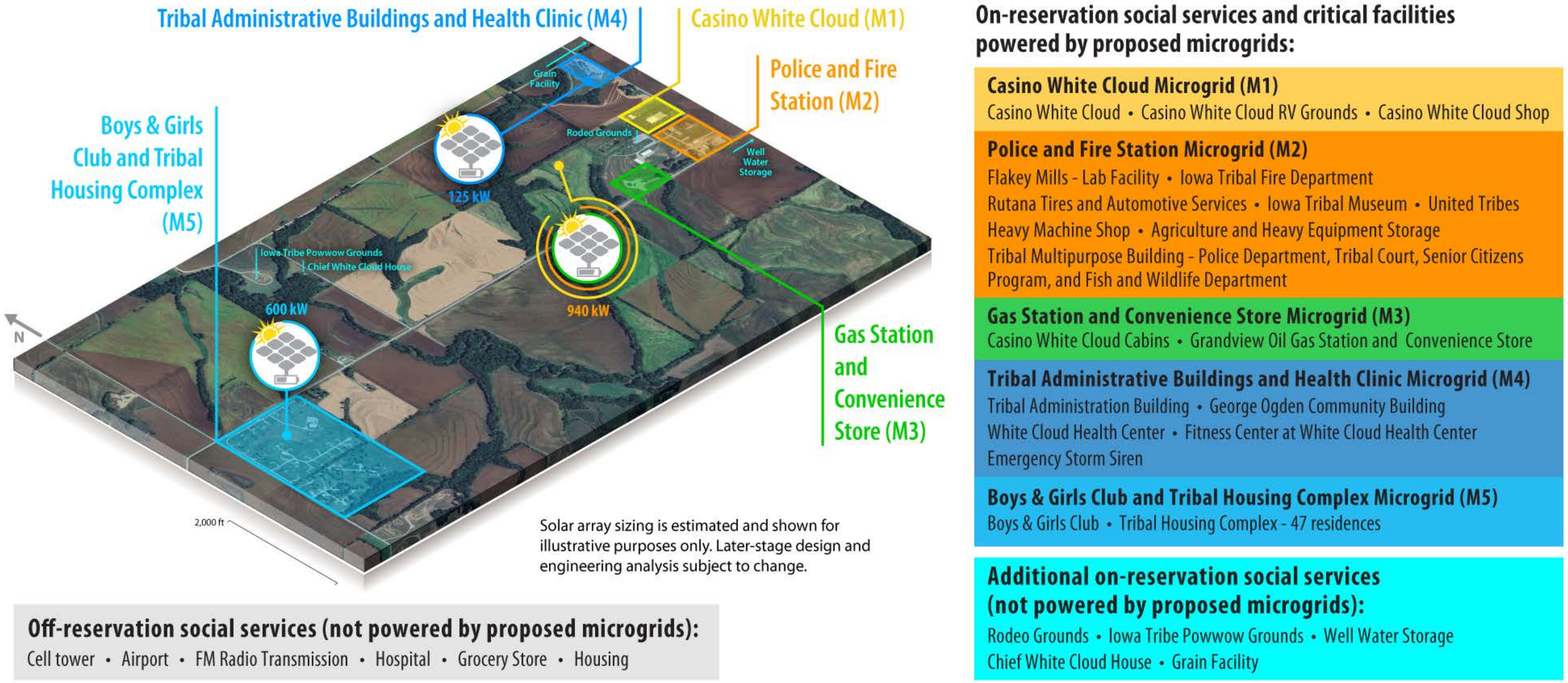


Figure 6. Proposed configurations for five clean energy microgrids (M1-M5) for the ITKN

Identifying Critical Services: Off-Reservation Facilities

Table 5. Off-Reservation Services and Critical Facilities Included in the Social Burden Evaluation

Type of Service	Number of Services Available	Average Distance from the ITKN Reservation (Miles)
Cell Tower	11	11
Airport	2	9
FM Radio Transmission	2	11
Hospital	1	32
Grocery Store	1	10
Housing	1	0.1

Selecting Equity Criterion

- Differences in people's experiences during grid power outages, and the severity of the impacts they experience as a result, depend not only on their proximity to critical services but also on their **ability** to expend time, energy, and money to obtain the services.
  - The ITKN study area was divided into census block groups and median household income was used to study the on-reservation differences in Social Burden during different scenarios.

$$\textit{Social Burden} = \textit{Effort}/\textit{Ability} \cong \frac{\textit{Effort to Obtain Service}_{people,services}}{\textit{Service Levels}_{facilities,services} \times \textit{Baseline Capacity}_{people}}$$

Scenario Definition

To calculate the impact of power outages on social burden, and the impact deployment of a microgrid might have on community resilience (vis a vis improved service availability), three power outage scenarios were compared.

1. **"Blue Sky" (Baseline) Scenario:**
   - Maximum service availability and lowest possible burden; grid provides steady power across its entire service territory; on the ITKN reservation, all existing facilities are fully powered; all existing facilities provide services at their usual (maximum) levels.
2. **"Black Sky" Scenario:**
   - Worst-case scenario; grid outage not mitigated by any additional resilience measures other than those currently deployed; produces the least service availability and highest possible social burden. All facilities, except those powered by existing reliable backup generators, are offline (not powered). Facilities outside of the reservation boundary remain powered and provide services at their usual (maximum) levels.
3. **"Microgrid" (Mitigation) Scenarios:**
   - A grid outage is mitigated by the deployment of a theoretical microgrid which provides stand-alone power to those facilities which fall within its footprint. All facilities powered by the microgrid remain powered (online) in the Microgrid Scenario. Powered facilities provide services at their usual (maximum) levels. Any facilities falling outside of the microgrid footprint are unpowered (offline). Facilities outside of the reservation boundary remain powered and provide services at their usual (maximum) levels.

Results: “Blue Sky” Social Burden

- Per-capita Social Burden distribution under “Blue Sky” scenario are shown at right.
  - The grid provides power to the entire service territory, including the ITKN reservation.
  - All on-reservation and off-reservation facilities are powered and provide services as usual.
  - The power system introduces no additional burden on top of what exists as a function of infrastructure availability and the population’s ability to expend time, resources, and money obtaining critical services.
  - Burden is at its lowest.

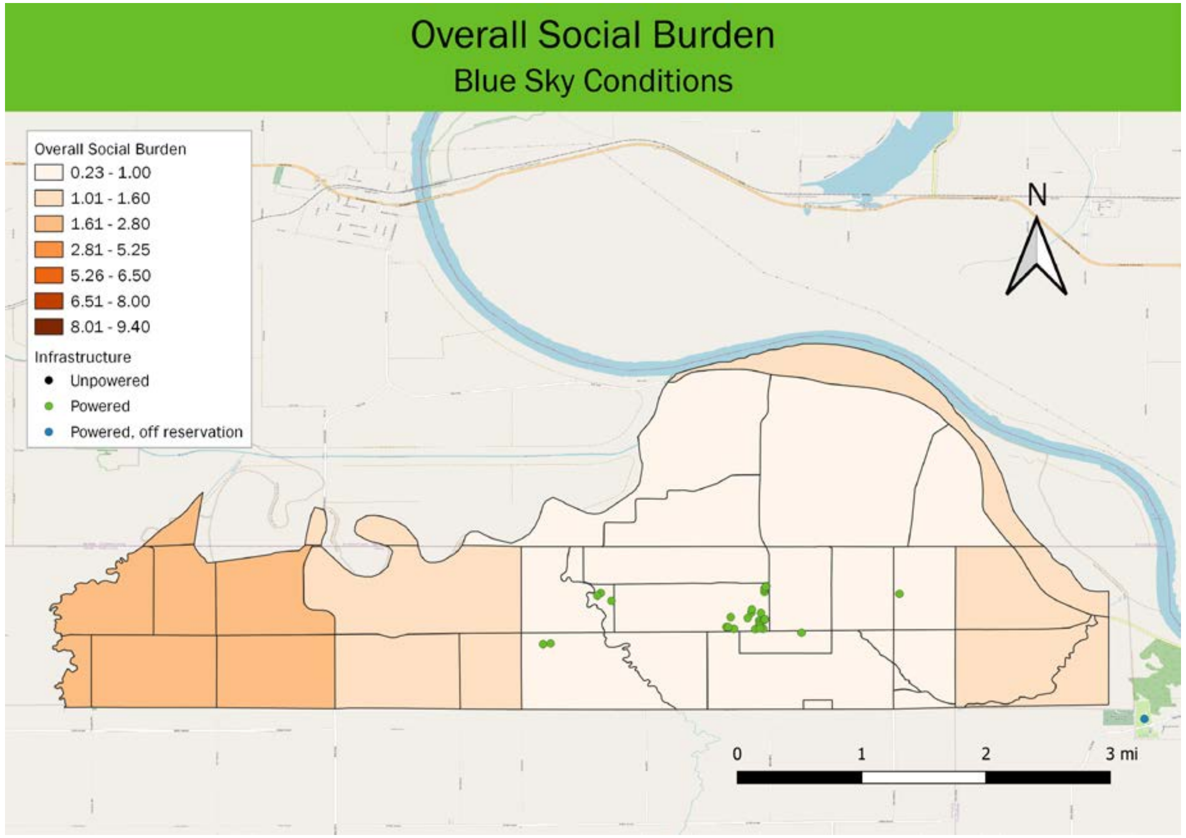


Figure 7. Per capita Social Burden distribution under Blue Sky scenario

Results: “Black Sky” Social Burden

- Per-capita Social Burden distribution under “Black Sky” scenario is shown at right.
  - An outage impacts power provision to the ITKN reservation.
  - All on-reservation facilities, aside from those with independent backup power (i.e., Casino, Well) are without power and off-line.
  - Offline facilities do not provide services.
  - Facilities with backup power and facilities outside of the reservation remain online and continue to provide services as usual.
  - Burden is at its highest.

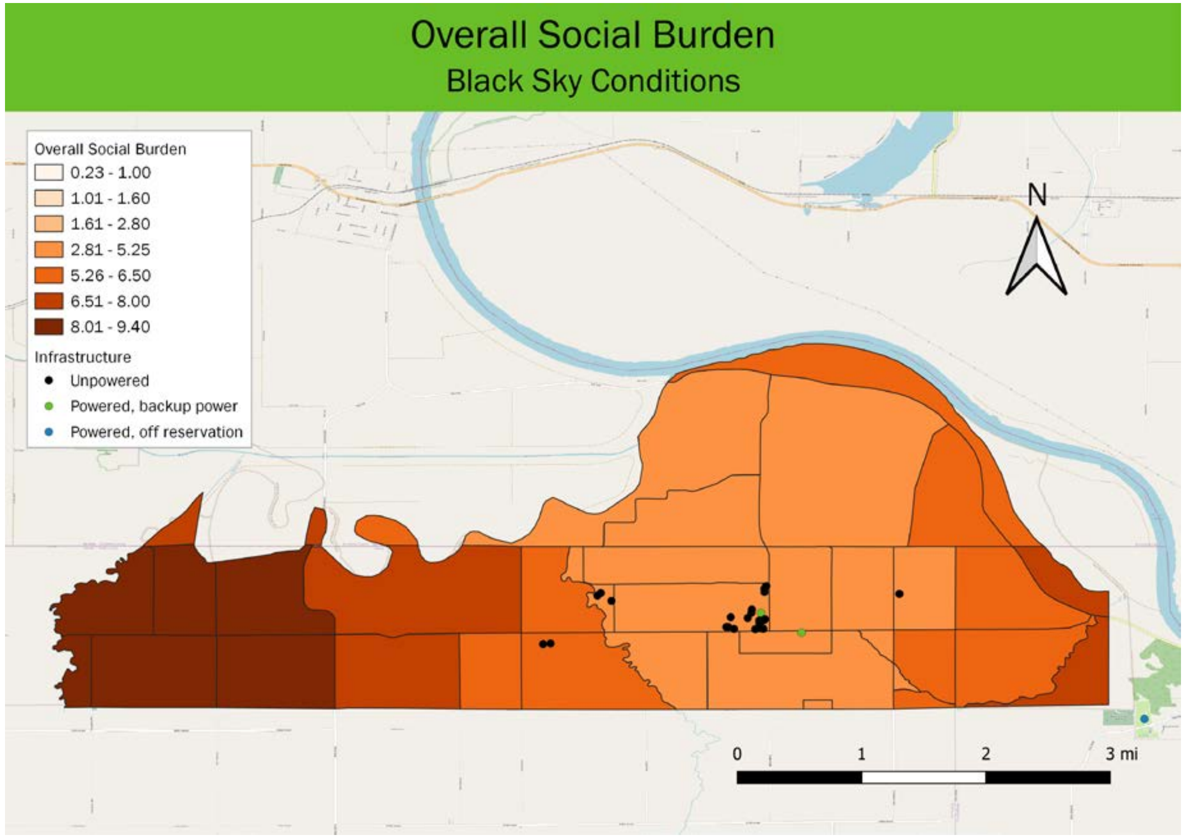


Figure 8. Per capita Social Burden distribution under Black Sky scenario

Results: “Casino Cluster Microgrid” (M1-M4) Social Burden

- Per-capita Social Burden distribution under “Microgrid” scenario shown at right.
  - Same outage as in the “Black Sky” scenario is experienced, however, the hypothetical microgrid is activated.
  - The microgrid provides power to those facilities which fall within its footprint.
    - Microgrid-powered facilities remain online and continue to provide their complete (“Blue Sky”) level of service.
  - Facilities powered by existing backup resources (e.g., Casino, Well) and those located outside of the reservation remain online and continue to provide their complete level of service.
  - Facilities on the reservation that fall outside of the microgrid footprint are offline and do not provide services.

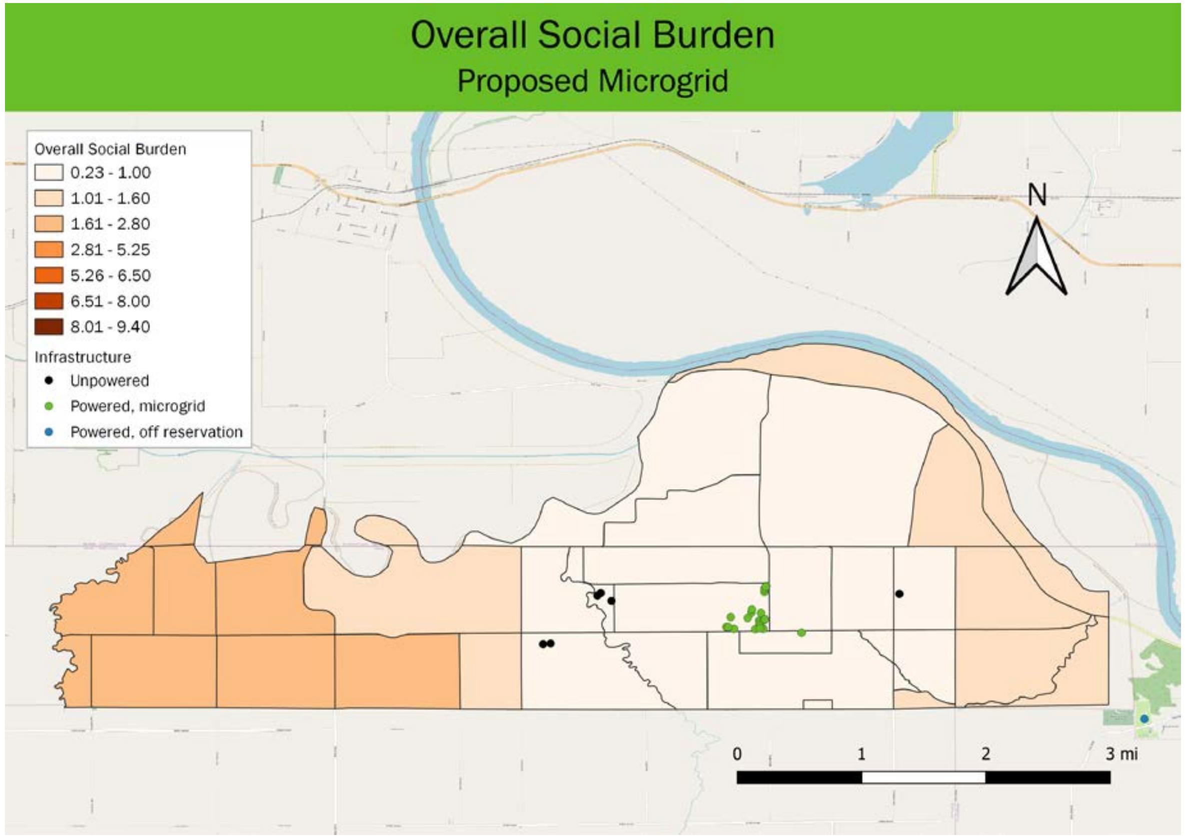


Figure 9. Per capita Social Burden distribution under Microgrid scenario

Results: "Housing Microgrid" (M5) Social Burden

- Per-capita Social Burden distribution under "Housing Microgrid" scenario only is shown at right.
- Burden values are relatively close to Black Sky conditions, but there is some improvement in the center of the reservation.
- Casino backup generator power and well battery are included.
- Because this scenario powers an incomplete set of critical services, burden is higher than under the Casino Cluster Microgrid scenario.

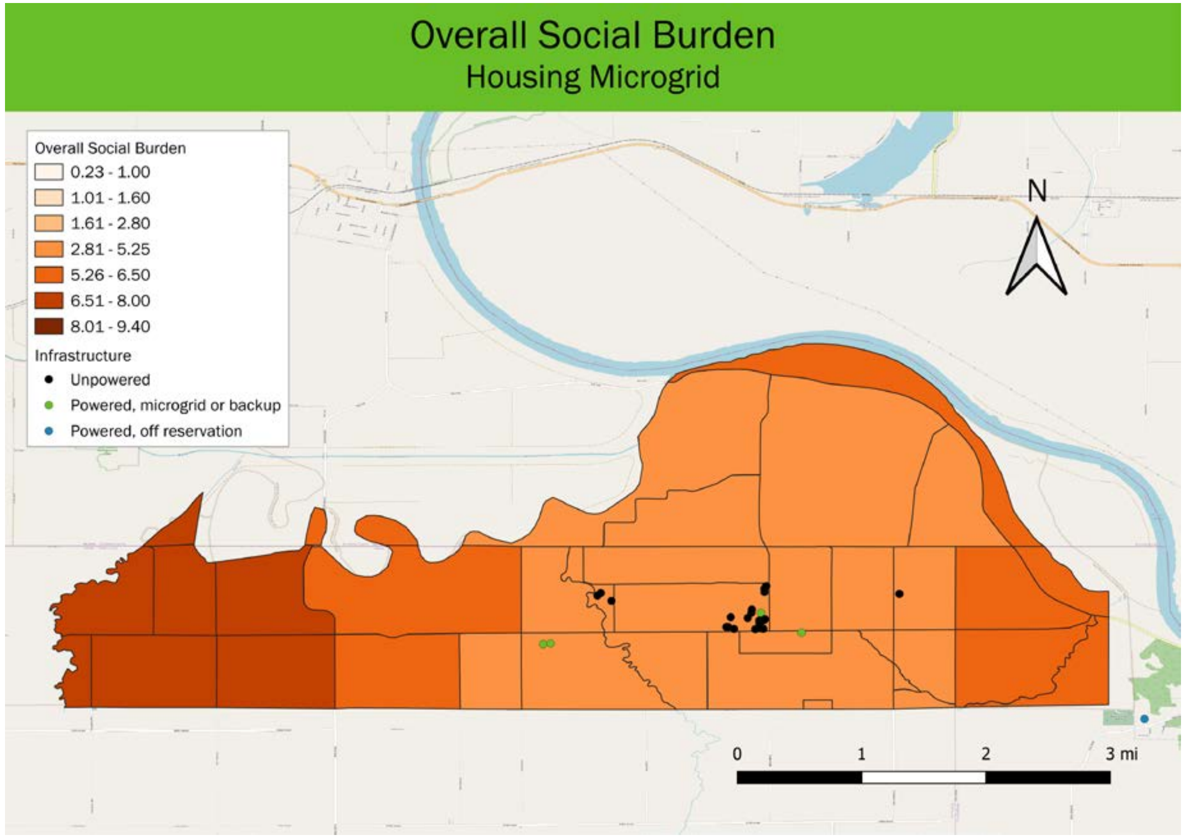


Figure 10. Per capita Social Burden distribution under Housing Microgrid scenario

Results: "Both Microgrids" Social Burden (M1-M5)

- The combined per-capita Social Burden distribution, under both microgrids in operation, is shown at right.
- This scenario maps closely to the "Blue Sky" scenario, though the actual burden values are marginally higher, as full power to all facilities is still not achieved.

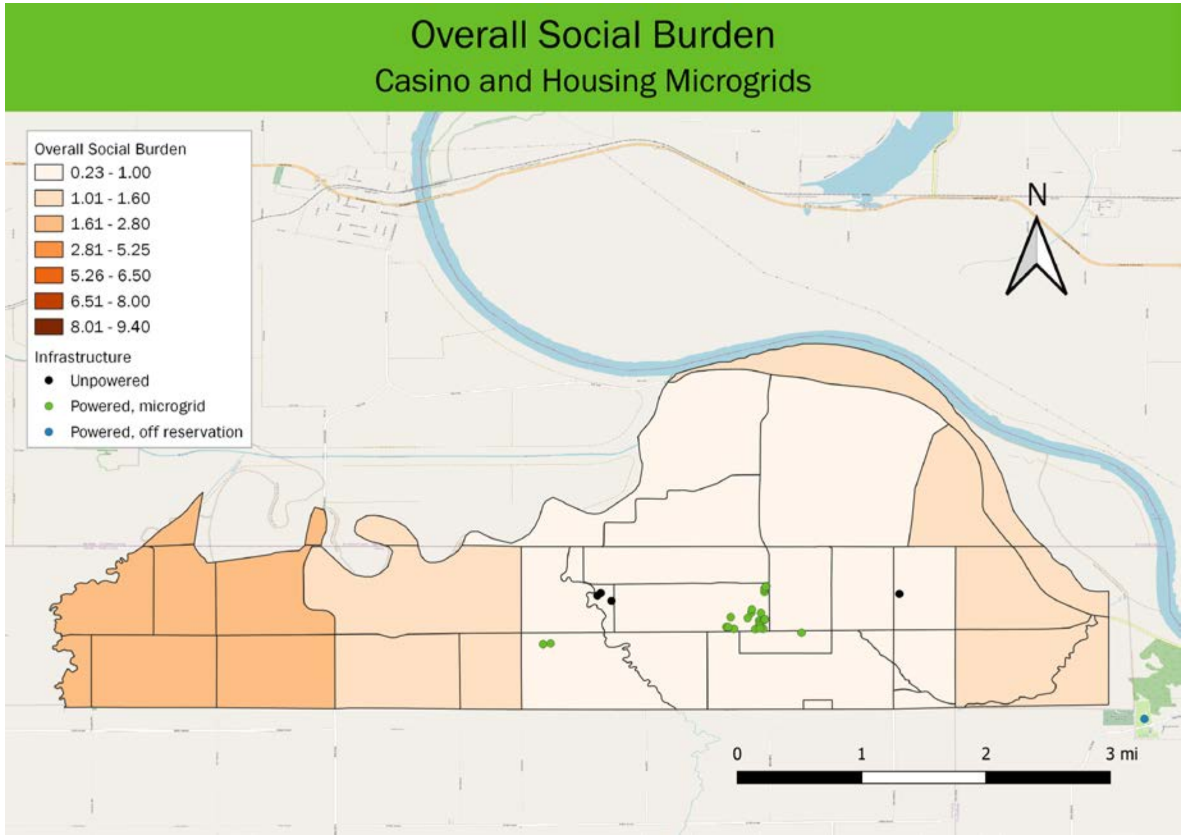


Figure 11. Per capita Social Burden distribution under All Microgrids scenario

Results: Summary

- Figure 12 shows cumulative overall Social Burden across the ITKN reservation is plotted under the Blue Sky, Black Sky, Casino Cluster Microgrid, Housing Microgrid, and Both Microgrids outage scenarios.
  - Note that the Social Burden values displayed in this figure are summed across all population groups and across all service types.

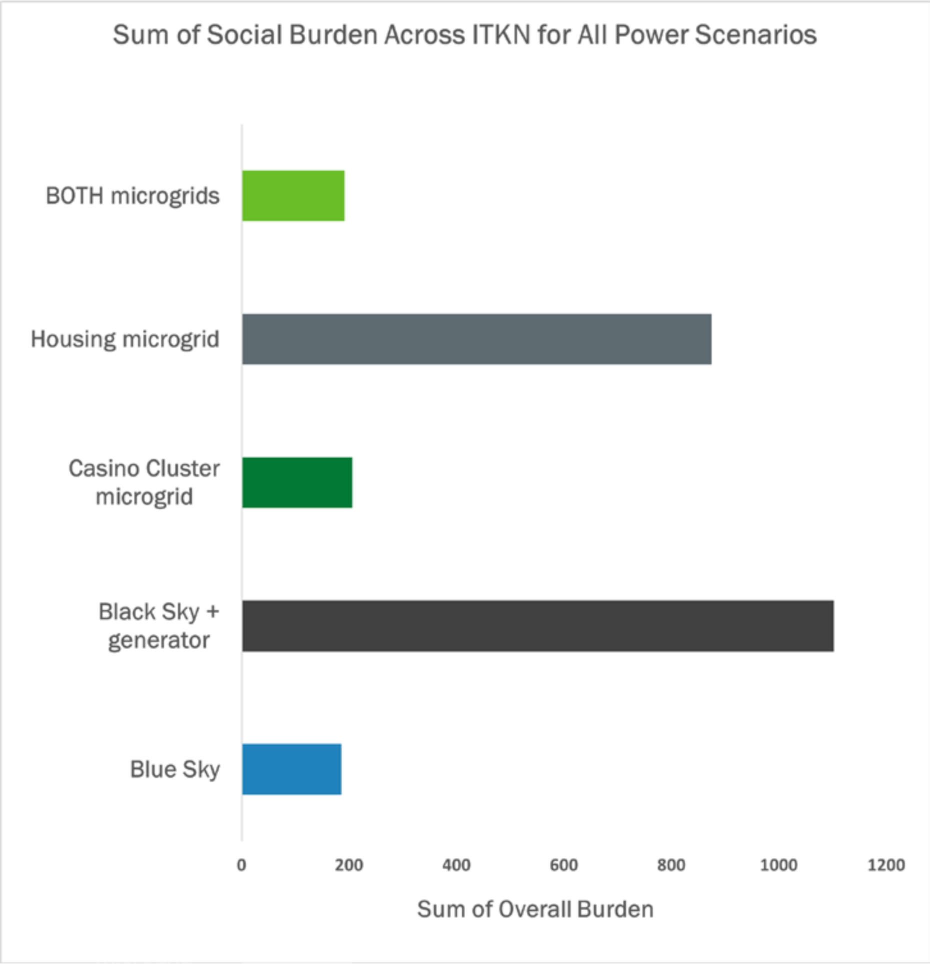


Figure 12. Sum of Social Burden for all power scenarios

Key Takeaways

- The proposed Casino Cluster Microgrid scenario and the Both Microgrids scenario would each nearly completely mitigate on-reservation power outages, in terms of critical service provision.
- The ITKN on-reservation population relies heavily on off-reservation resources for certain critical services; these resources are not within the jurisdiction of the Tribe.
- Resources considered for inclusion in microgrids focused primarily on community resources that would provide critical services to a large number of residents; some housing developments were also considered.

Model Transfer Training

Community Coalition Training on Microgrid Modeling

In November 2023, the ITKN community coalition and other collaborators visited NREL's Golden, Colorado campus and SolarTAC facilities for **a week of hands-on training** to learn how to use publicly and commercially available **microgrid modeling tools**, including:

- **Resilient Node Cluster Analysis Tool (ReNCAT)** to analyze urban, suburban, rural, and Tribal areas to determine optimal placement of microgrids and line hardening to ensure utility services are equitably available, specifically during grid outages.
- **Quantum Geographic Information System (QGIS) Social Burden plugin** to evaluate how microgrid deployment can reduce overall social burden, relative to a business-as-usual case.
- **Renewable Energy Integration & Optimization (REopt)** to optimize planning of generation, storage, and controllable loads to maximize the value of integrated distributed energy systems for buildings, campuses, and microgrids.
- **Hybrid Optimization of Multiple Energy Resources (HOMER)** to optimize microgrid design for communities ranging from Village power and island utilities to grid-connected buildings.

Representatives from Grey Snow Green Energy, SolarTAC, SunSource, and 10Power participated in hands-on microgrid modeling training, led by Communities LEAP technical assistance providers, NREL and Sandia National Laboratories.
Photo by Werner Slocum, NREL

Next Steps

Next Steps After Communities LEAP

ITKN aims to focus on the following areas to reinforce its energy independence, contribute to environmental sustainability, and promote economic prosperity for the Tribe and the wider Indigenous community.

- **Implement the outcomes from technical assessments** by focusing on the practical execution of recommended energy projects, particularly the deployment of microgrid technologies and renewable energy systems by leveraging the technical assistance provided through Communities LEAP.
- **Formalize energy policies** through the development and implementation of policies and regulations that increase energy sovereignty. This may involve the establishment of a TUA to manage energy resources more effectively and independently.
- **Expand ITKN's workforce** to build knowledge in renewable energy technologies and microgrid systems through training programs and partnerships with institutions like NREL and Sandia National Laboratories.
- **Create economic development through sustainable energy technologies** that reduce energy costs, enhance the reliability of power supply, and stimulate economic growth within the community.
- **Actively participate in and support inter-Tribal exchanges** to share clean energy technology insights, knowledge, and learnings gained from the ITKN energy sovereignty journey. With the support of Grey Snow Green Energy, ITKN will also utilize the microgrid modeling and analysis tools and skills gained during the Communities LEAP initiative to support other Tribes in achieving their energy goals and foster economic development through inter-Tribal trade. This highlights ITKN's dedication to using their journey as a blueprint for empowering other Tribes, fostering a network of Indigenous communities united in their quest for energy independence.

Thank You

www.energy.gov/communitiesLEAP

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Cover Photo by Werner Slocum, NREL

Appendix

Detailed HOMER Modeling Results

The table below summarizes the results of the HOMER modeling. M1 results are shown assuming both 1200 and 600 kWh of battery storage.

Microgrid	M1	M2	M3	M4	M5
PV Capacity (kW)	700	140	100	125	600
PV Inverter Capacity (kW)	600	125	80	100	
Generator Capacity (kW)	500	75	45	75	
Battery Storage Capacity (kWh)	1200	100	100	100	600
Battery Converter Capacity (kW)	300	50	50	50	
Annual Fuel Use (gal/year)	2,692	306	160	226	1,434
Annual Excess Elec. (kWh/year)	39,978	3,717	2,429	2,559	74,521
Generator Run Time (Hours/year)	233	236	184	212	196
Annual Production – Generator (kWh/year)	34,595	3,658	1,965	2,534	16,194
Annual Production – PV (kWh/year)	1,045,330	209,066	147,287	154,143	739,896
Battery Autonomy (hours of average load)	4.9	2.4	4.5	4.1	5.5
Battery Annual Energy Throughput (kWh/year)	32,333	3,078	2,798	2,944	16,186
Energy Purchased from Grid (kWh/year)	964,986	93,638	65,482	74,795	404,872
Energy Sold to Grid (kWh/year)	277,587	81,543	57,327	58,577	321,497
Annual Sum of Monthly Peak Loads (kW)	2,924				2,062

Modeling Inputs and Assumptions

Estimated Electricity Consumption for Microgrids

Microgrid	Unit	M1	M2	M3	M4	M5
Label		Casino	Police and Fire Station	Gas Station and Convenience Store	Tribal Administrative Buildings and Health Clinic	Boys & Girls Club and Tribal Housing Complex
Total Annual Consumption – From Utility Bills	kWh	1,638,836	210,060	147,098	161,549	
Total Annual Consumption – Adjusted for Analysis*	kWh	1,720,778	220,563	154,452	169,626	761,564**
Average Daily Consumption	kWh	4,717	604	423	465	2,086
Average Load	kW	196	25	18	19	87
Max Hourly Load	kW	327	58	40	44	286
Load factor (Average/Peak)		0.60	0.43	0.45	0.43	0.30

*Utility bill electricity consumption increased by 5% to account for outages

**61,640 kWh/year for the Boys & Girls Club and 699,924 kWh/year for the 47 residences.

Load Profile Data and Assumptions

Microgrid	Load Data and Assumptions
M1 – Casino	Profile used was provided by a previous analysis conducted by the Tribe.
M2 – Police and Fire Station, M3 – Gas Station and Convenience Store, and M4 – Tribal Administrative Complex and Health Clinic	An aggregate initial load profile was created for all buildings to be served by microgrids M2, M3, and M4, assuming predominantly daytime use. This aggregate profile was re-scaled for each individual microgrid to match the consumption of facilities served.
M5 – Boys and Girls Club and Tribal Housing Complex	The M5 load profile is the sum of two “sub-profiles.” One sub-profile was created for the Boys & Girls Club, assuming primarily daytime and early evening use. The sub-profile for residential buildings was based upon monthly diurnal electricity consumption profiles for single-family residences in Brown County, Kansas from the NREL ResStock tool.

Microgrid load profiles were scaled to match monthly consumption data from utility bills. Load profiles were then fed into the HOMER modeling routine that takes daily profiles and creates synthetic interval data by adding daily and hourly “noise” to reflect non-uniformity.