

One Megawatt Solar Array for Grand Canyon West

LAND AREA FOR ARRAY: 3.7 ACRES

PROJECT BUDGET: \$3,690,000

DEPARTMENT OF ENERGY GRANT: \$2,430,000
(DE-IE0000128)

TRIBAL MATCH: \$1,260,000 FROM VARIOUS
SOURCES INCLUDING FREEPORT MCMORAN

Prepared for: Department of Energy, Office of Indian Energy
Prepared by: Hualapai Tribal Utility Authority and Planning Dept.
November 13, 2023, Denver DOE Conference

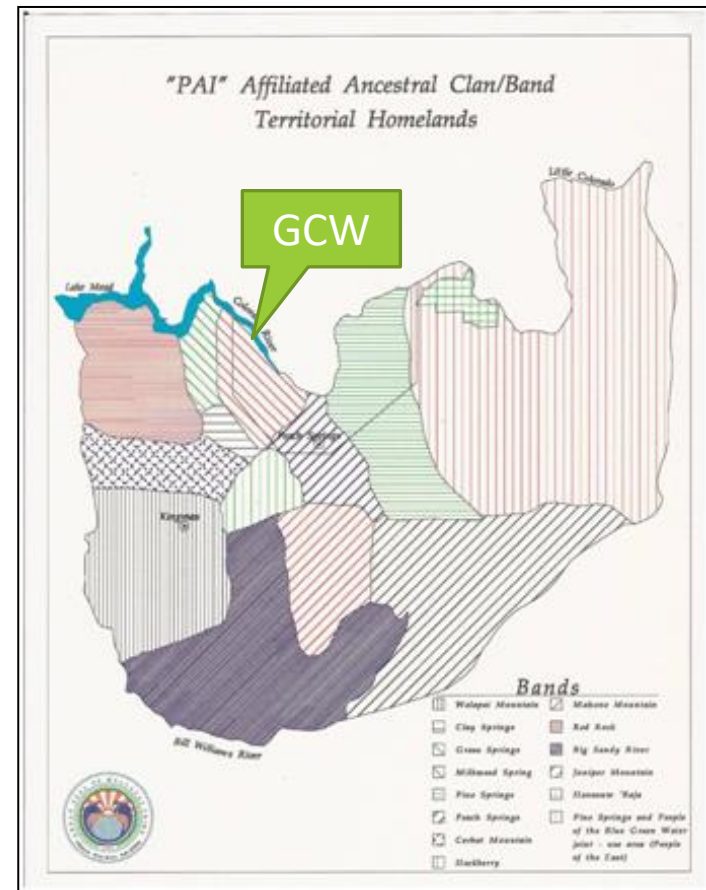
Introduction to Hualapai

The People of the Tall Pines, 2,396 enrolled members as of August 21, 2023 with 1,247 living on the Reservation.

Reservation comprises approximately one million acres established by Executive Order in 1883.

Traditionally, Hualapai inhabited an area up to seven million acres, with archeological evidence dating to 600 AD.

The homeland stretched from the Grand Canyon southward to the Bill Williams and Santa Maria Rivers and from the Black Mountains eastward to the San Francisco Peaks located near what is today Flagstaff, Arizona.



Hualapai Population

Population

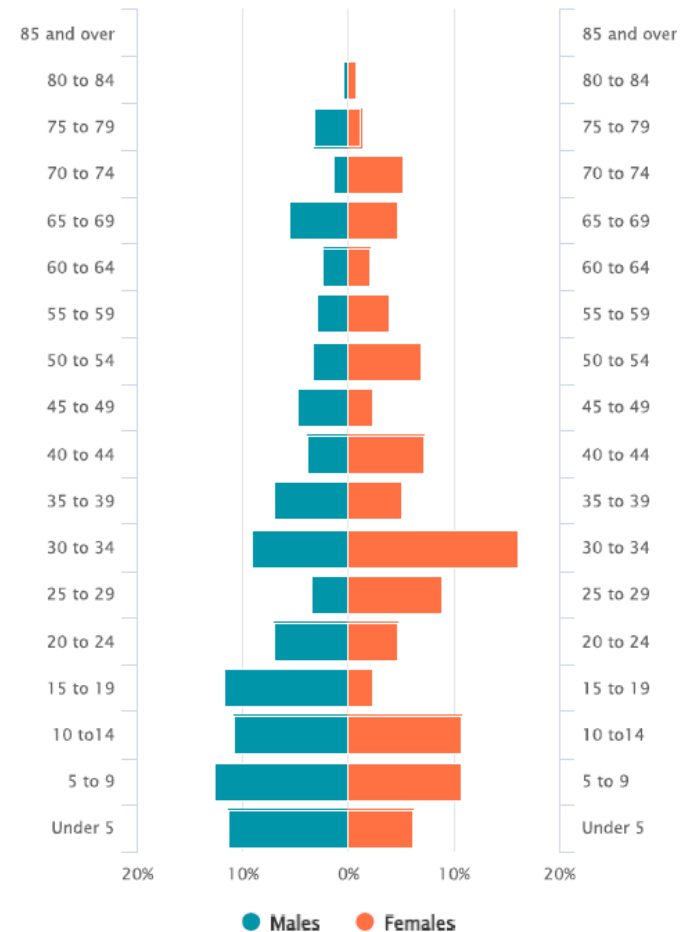
- Median age is 30.1 years
- 513 households
- Average household size is 3.15 persons
- 27% of adults do not have a high school diploma

Employment & Poverty

- Sectors include arts & entertainment, education, transportation, and government
- Labor participation is 43% for those 16 years of age and older.
- Unemployment rate = 20.4% (pre-Pandemic)
- Median Annual Income = \$37,679
- Poverty rate = 35.3%

Housing

- 578 dwelling units (513 occupied)
- \$60,300 median home value (91% SFDUs)
- 73% of homes have internet subscription



Source: 2020 Census and
2016-2020 American Community Survey

Grand Canyon Resort Corporation Profile

Founded in 1988 with operations in Peach Springs and Grand Canyon West to administer several enterprises employing 350 full and part-time employees as follows:

Grand Canyon West - Skywalk & Western Town

Hualapai River Runners & Pontoons

Hualapai Lodge & Diamond Creek Restaurant

Walapai Market and Fuel Station

Approximately 5,000 tourists take the rafting trip each year with most staying at the Hualapai Lodge in Peach Springs the night before.

Visitation to Grand Canyon West averaged some 1,000,000 persons per year from 2015 thru 2019. Visitation for the first 9 months of 2022 is 555,000 as the tourist industry recovers from the Pandemic.



Project Summary

In 2014, the tribal council formed the Hualapai Tribal Utility Authority to bring electricity to GCW, via a new 69 KV line from an off-reservation utility. Currently, diesel generators provide electric service.

The micro-grid's generators, also commissioned in 2014, have an extremely high operating cost and are prone to go offline for scheduled repairs which become more frequent after 20,000 hours of use. As development at GCW intensified, on-site generators have become impractical. After the numerous delays and setbacks of connecting to the grid, the Tribe began exploring a solar option.

The goal of the project is to improve the resilience of the non-grid-connected electrical generation system at GCW to withstand short-term disruptions and rising energy costs by installing a 885-kW solar PV and 750-kW/2,145-kWhr battery storage system.* The system will be capable of providing some 1,600 MWhrs per year (25 year lifetime average) or about 50% of the annual energy needed at GCW to supplement the existing diesel generator energized micro-grid, saving approximately \$450,000 per year and over \$11 million dollars over the 25-year life of the system. These dollar values will likely increase as the price of diesel rises over the next decade.

** Solon upgraded the battery pack from 1,500 kWhr to 2,145 kWhr and replaced the mono-facial modules with bi-facial units reducing array's size while maintaining output*

Project Approach and Objectives

The Tribe’s Technical Contact will:

1. oversee the procurement of a qualified construction company to install the solar array.
2. ensure that all permits are completed and that the project stays in compliance with the grant scope of work as well with all tribal and federal environmental regulations.
3. ensure that progress on the project is completed as scheduled and that all reporting related to this project is complete and submitted in a timely manner.
4. have an assistant who will be responsible for tracking the energy produced by the array as well as ensuring the system is operational.

Amended Statement of Project Objectives submitted to DOE (Federal Fiscal Year)														
Milestone	3Q 2021	4Q 2021	1Q 2022	2Q 2022	3Q 2022	4Q 2022	1Q 2023	2Q 2023	3Q 2023	4Q 2023	1Q 2024	2Q 2024	3Q 2024	4Q 2024
Pre-Construction	Blue													
Site Characterization		Green												
Preliminary Design		Yellow	Yellow											
Engineering			Orange	Orange	Orange									
Procurement					Pink	Pink								
Construction							Red	Red						
Commissioning									Purple	Purple				
Monitoring											Cyan	Cyan	Cyan	Cyan
Closeout														Black

Project Background - Conception through Initial Site Selection

Spring of 2019: HTUA requests staff to look into developing a solar project at Grand Canyon West to help power the micro-grid, save on diesel fuel costs and reduce emissions.

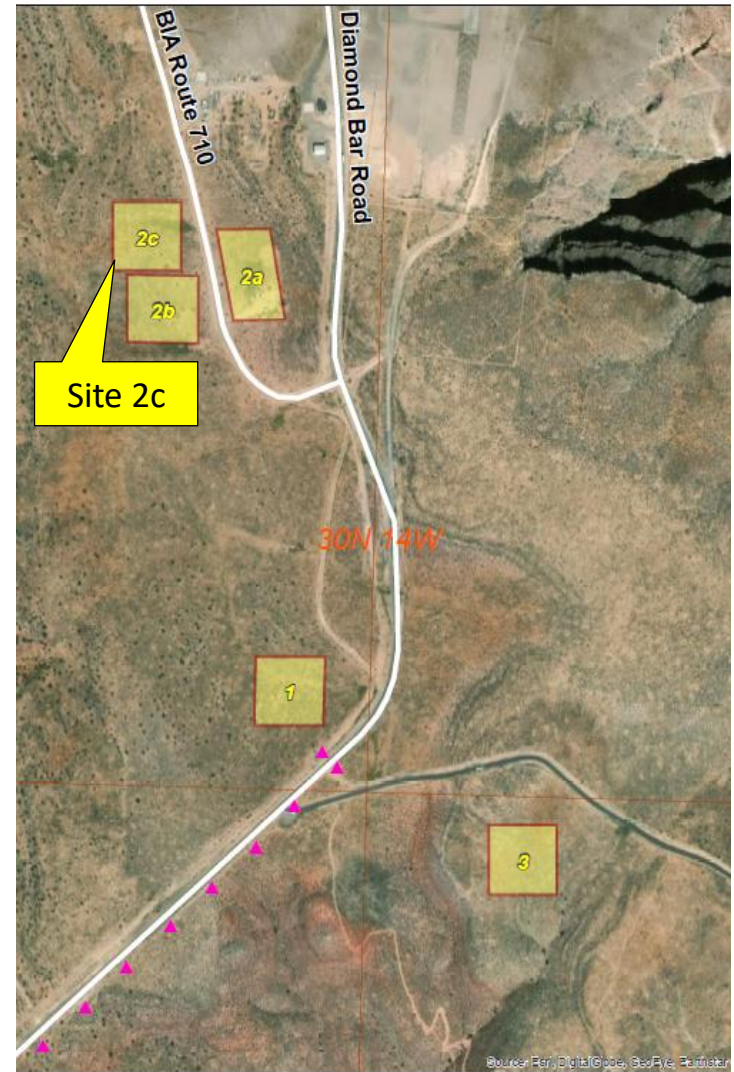
Summer of 2019: HTUA requested proposals from vendors to construct a 2 MW solar array at Grand Canyon West to cover 100% of micro-grid's output.

October 2019: Discussion with tribal council on the cost of the project led to a reduction in scope to a 1 MW solar array to offset 50% of micro-grid's energy needs. HTUA issues addendum Nos. 5 & 6 with Solon's proposal considered the most responsive & responsible.

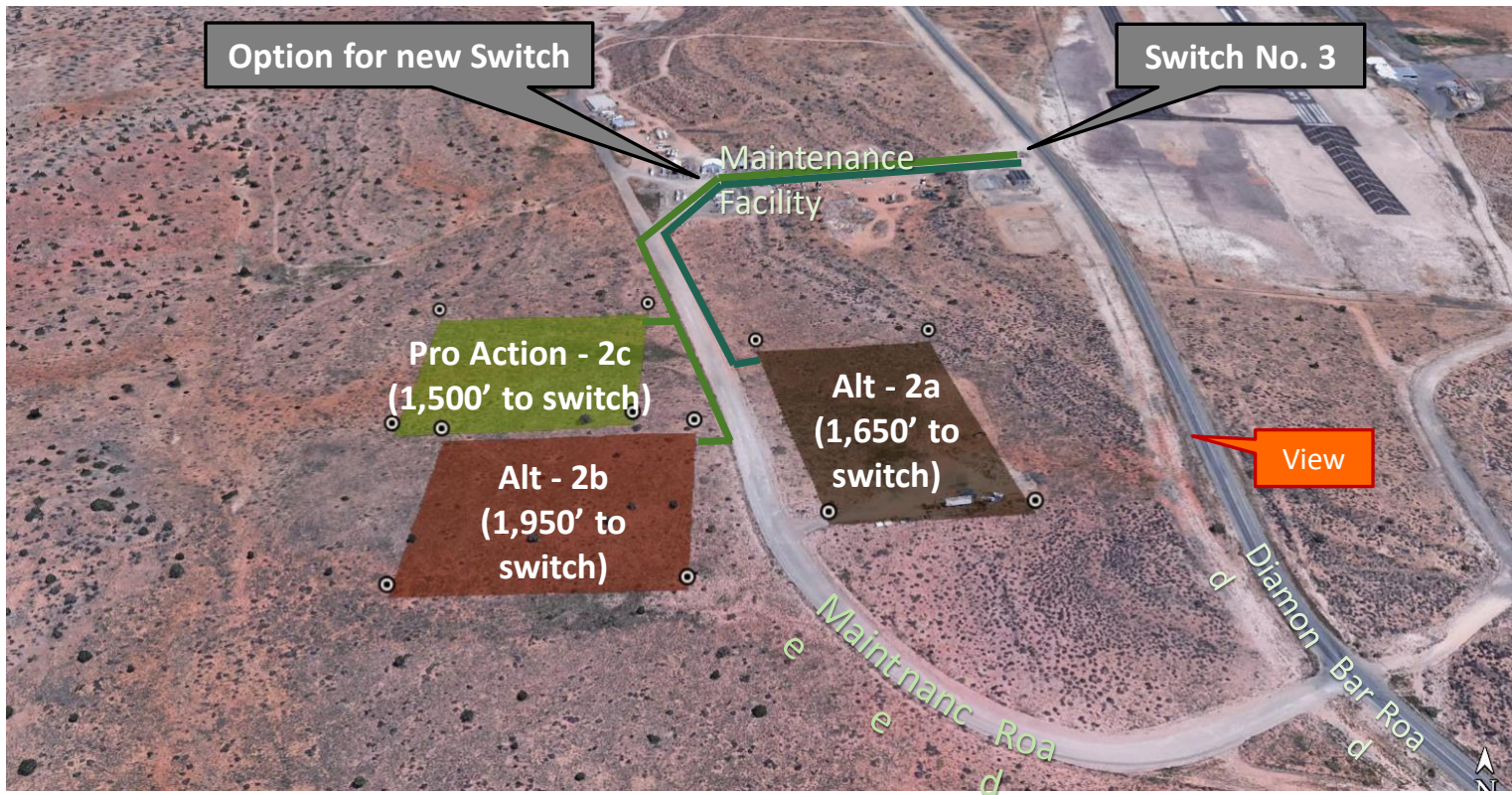
February 2020: Hualapai applies to DOE for a grant to fund a 1 MW solar array with lithium battery bank.

May 2020: DOE notifies tribe of successful application and begins negotiations on \$2.7 million award w/ tribe contributing \$1.35 million (50/50 match).

Summer of 2020: Planning begins work on EA with input from IDT, TERC, HTUA, GCRC, FAA and DOE. Public survey and radio interview done in November 2020 to discuss preferred location of solar array.



Solar Array Alternate Site Nos. 2a, 2b & 2c (Proposed Action)



Alternative Site No. 2c (Proposed Action) as seen from Diamond Bar Road



Project Background Thru Environmental Assessment Approval

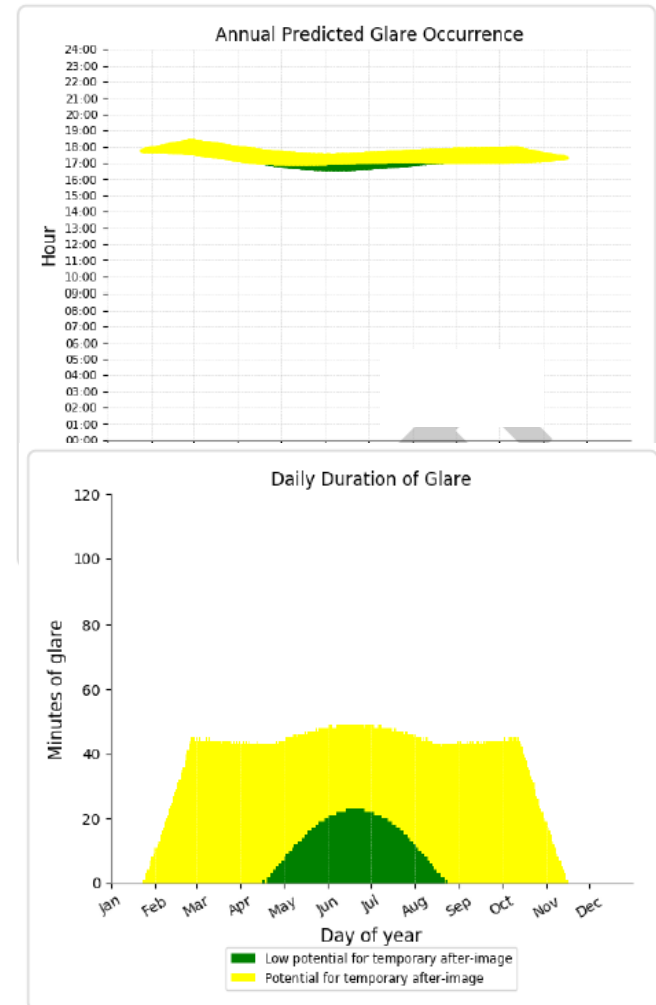
November 2020: Tribe requests reduction in cost share and receives approval from DOE for 10% match (\$270,000) on December 29th.

December 2020: TERC reviews community surveys and preliminary glare analysis and recommends Site No. 2c as the Proposed Action in the draft EA. Site location adds \$400,000 to project cost to extend 20.8 KV electrical line to nearest micro-grid switch.

February 2021: Draft EA distributed to IDT, TERC, HTUA, GCRC and tribal council for review and input.

April 27, 2021: Tribal Council recommends Site No. 2c which allows for future expansion for a 100% solar power solution at GCW.

May 19, 2021: TERC approves EA with FONSI signed in June. General Permit pending council review upon completion of contract negotiations between vendor and HTUA.



Project Status Since Approval of Environmental Assessment

July 2021: HTUA solicits third-party cost estimate which projects \$2,705,983 to construct the fence line project.

August 2021: DOE's contracting officer approves Solon as the competitively selected vendor and approves the NEPA review performed by the tribe.

September 2021: Solon requests a price increase due to rise in aluminum, steel and copper prices bringing the cost to \$2,967,589 (\$3,190,158 with TERO tax and bonding). Price is still lower than bids received by other vendors in 2019.

October 2021: HTUA's estimate for off-site work to connect array to micro-grid increases from \$400,000 to \$500,000 (25% increase) based on Solon's cost increases.

Summer to Early Fall 2021: Contract with Solon reviewed and revised by HTUA Board and attorney at four meetings between June 22 and October 14 to address questions of tribal sovereignty.

November 6, 2021: Tribal council approves contract with Solon.

May 9, 2022: Tribal council approves battery upgrade and use of screw mounts increasing contract value to \$3,277,558.

Payback-Fuel Savings and Maintenance

Solar array will supply 48% of the energy requirements for the GCW micro-grid and reduce other operating costs by 20%. (Labor-Service Contract)

CURRENT GCW Generator Operating Costs					Projected Yearly Savings	
		2018	2019	Average		
1. Diesel - Red Dye	Fuel	\$1,048,751	\$808,243	\$928,497	\$445,679	48%
2. Grid Generator Service Agreement	Maint.	\$106,140	\$113,464	\$109,802	Note 1	20%
3. Grid generators - Labor Parts	Maint.	\$228,000	\$203,000	\$215,500	Note 1	20%
	Total	\$1,382,891	\$1,124,707	\$1,253,799	\$445,679	Annual Savings

Note 1: Reduction in diesel generation Maint. costs offset by solar Maint. cost.

Hualapai Tribe will recover its \$1,260,000 investment in approximately 35 months*

** Increasing diesel prices will likely reduce the pay back period to less than 24 months*

Sharing Technical Knowledge between Tribes



Sandia National Labs Field Trip on 6/16/2023



Can you spot the solar array from Diamond Bar Road ?

Technical Considerations Summary

1. Grand Canyon West is completely “Off Grid”
2. No third-party utility provider - no third-party power lines
3. Hualapai operates/maintains its own on site generation and Micro-grid
4. Prior to Solar integration - GCW primary source of electricity was 3 - 750KW Caterpillar diesel generators
5. The power produced by existing generators and now the PV panels and Tesla battery Mega Pack is distributed to most GCW loads via GCW’s existing 20.8 KV micro-grid
6. Some electrical loads at GCW not connected to micro-grid continue to be served by independent, stand-alone diesel generators however plans are underway to connect these loads to the micro-grid which will improve the project’s economics and improve grid resilience

Technical Considerations Summary

The resulting system is at the forefront of today's deployed Solar technology in Indian Country and non-Indian Country as well

- ❖ All electric Assets are owned and operated solely by the Hualapai Tribe thru its own Utility - HTUA
- ❖ All electric assets at GCW are not connected the traditional utility grid
- ❖ GCW distributes power to end use customers thru its own 20.8 KV underground micro-grid
- ❖ The Hualapai Tribe independently managed all engineering procurement and construction for the entire project. Including the RFP for retaining the third party Solar contractor

Technical Considerations - Primary Infrastructure Additions

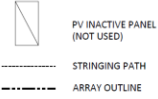
1. Anchoring of Solar panels / fence into shallow bedrock
2. Construction and/or installation of:
 - i. Solar panels and racking system
 - ii. Concrete pads/conduits/fence
 - iii. Tesla Battery Mega Pack with system site controller
 - iv. Step-Up Transformer, ground detection, electrical switchgear
3. Extension of existing 20.8 KV micro-grid
4. New fiber optic communications path between existing generators and battery/solar system. It is important to note that the Solar system is remote from the main generator yard and as such HTUA had to cause the extension of the fiber network to facilitate constant communications(24X7X365) between the Solar and Diesel site
5. Upgrade/change out existing generator “EPIC” controls

Technical Considerations - Operational/Maintenance

1. Tesla Mega Pack and controller provide “grid forming functions.” voltage regulation and frequency control
2. Typical solar installations rely on the solid grid to provide “grid forming functions.”
3. Existing diesel generators follow the Mega Pack’s “lead” but revert back to “grid forming” if the battery system is unavailable due to:
 - i. Lack of solar irradiation or battery charge falls to less than 20% of rating
 - ii. Loss of communications path
 - iii. Micro-grid interruption
4. Creation and monitoring of a generation dispatch model and optimization of integrated system
5. HTUA created a generation manager to ensure proper operation and maintenance

GENERAL NOTES:

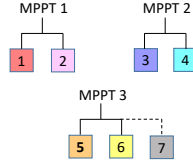
- INVERTERS AND AC COMBINER PANELS MAY NOT BE DRAWN TO SCALE. THEY ARE SHOWN FOR DIAGRAMMATIC PURPOSES ONLY.
- SEE THREE LINE DIAGRAM: PV SUBARRAY SHEET(S) FOR DETAILED STRINGING DIAGRAM.
- THIS DIAGRAM DOES NOT REFLECT THE WIRING METHOD THAT WILL BE USED. THIS DIAGRAM IS FOR DESCRIPTIVE PURPOSES ONLY. PLEASE REFER TO PV SUBARRAY THREE LINES FOR DETAILED WIRING DESCRIPTION.



SYSTEM DESCRIPTION

PROJECT SUMMARY											
ARRAY	TILT	AZIMUTH	PANEL BOARD	INVERTER	INVERTER TYPE	ACTIVE MODS	STRINGS	MODS / STRING	WWR	KWDC	DC/AC RATIO
A	26	180	PNL-01	INV-01	A	126	7	18	60	68.04	1.13
				INV-02	B	168	6	18	60	58.32	0.97
				INV-03	A	126	7	18	60	68.04	1.13
				INV-04	B	168	6	18	60	58.32	0.97
				INV-05	A	126	7	18	60	68.04	1.13
				INV-06	A	126	7	18	60	68.04	1.13
				INV-07	A	126	7	18	60	68.04	1.13
			PNL-02	INV-08	A	126	7	18	60	68.04	1.13
				INV-09	A	126	7	18	60	68.04	1.13
				INV-10	B	168	6	18	60	58.32	0.97
				INV-11	D	168	6	18	60	58.32	0.97
				INV-12	B	168	6	18	60	58.32	0.97
				INV-13	B	168	6	18	60	58.32	0.97
				INV-14	B	168	6	18	60	58.32	0.97
Totals					1638	91	140	684.32	1.05		

String Association with Inverter MPPTs



Solar Project Summary

Component	Count	Description
Modules	1,638	Boviet Bi-Facial 540W (144 Cells)
Inverters	14	CPS 60KW (6 to 7 strings per Inv)
Strings	91	2 to 3 Strings per MPPT
Modules/String	18	36 to 54 modules per MPPT
KWDC	885	
KWAC	840	

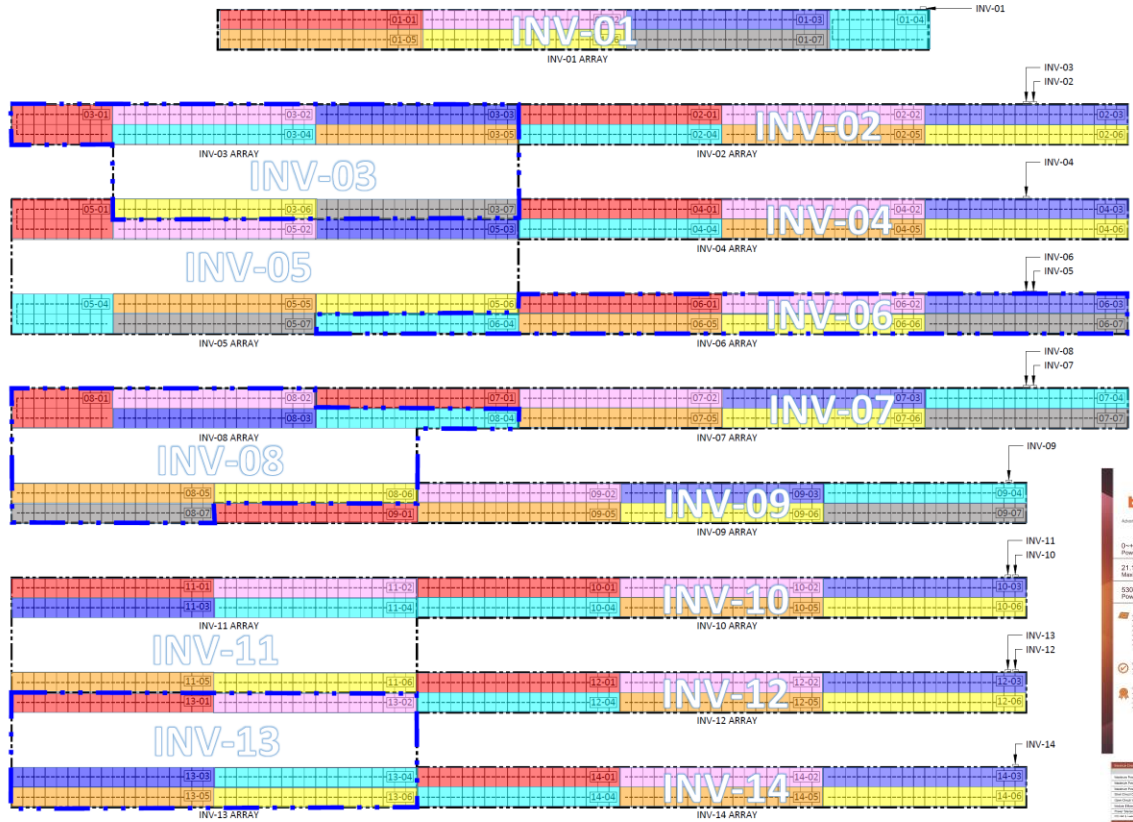
CPPI 50/60KW, 1000Vdc String Inverters for North America

Key Features:

- 100% DC input efficiency
- 100% AC output efficiency
- MPPT efficiency > 99%
- Wide input voltage range
- High power density
- Low temperature rise
- Easy installation and maintenance
- Wide operating temperature range
- High reliability
- Low maintenance
- Wide operating temperature range
- High reliability
- Low maintenance

1 INVERTER SPECIFICATION SHEETS

Model	Power (kW)	DC Voltage (V)	AC Voltage (V)	Efficiency (%)
CPPI-50-1000V	50	1000	240	99.0
CPPI-60-1000V	60	1000	240	99.0



BOVIET
Advancing the Power of the Sun

144 Cell Mono 530-550W
ENVIRONMENTAL (E)P (C)

9-10% Power Tolerance
21.1% Maximum Efficiency
530-550W Power Output Range

144 Cell Mono 530-550W
ENVIRONMENTAL (E)P (C)

144 Cell Mono 530-550W
ENVIRONMENTAL (E)P (C)



PHOTO: M. HARRIS/ISTOCK #1017
TUCSON, AZ 85747-0000
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FAX: 520.887.0000

HUALAPAI - GRAND CANYON WEST
884.52 KW-DC, 840 KW-AC PHOTOVOLTAIC, 770KW, 2145KWWH BESS PROJECT
5001 DIAMOND BAR RD PEACH SPRINGS, AZ 86434

PROJECT SC21-028
INITIAL DATE 06/22
ENGINEER FA 06/22
DRAFTER FA 06/22
CHECKER JMI
SHEET # E2.1

Technical Considerations Site



Relatively Flat Site—Soil Depth 2 feet over granite bedrock

Technical Considerations

Anchoring of Solar Panel Racks and Fence into Bedrock



Large Screw Anchors are Twisted into Pre-drilled Holes

Technical Considerations

Anchoring of Solar Panel Racks and Fence into Bedrock



Drill Rig



Anchor Screw Device

Technical Considerations Solar Panels and Racking System



Racks Attached to Driven Screws – Solar Panels Attached

Technical Considerations

Tesla Mega Pack and interconnection point to existing Micro Grid



Mega pack delivery and main connection to existing Micro grid

Technical Considerations Tesla Mega Pack

MEGAPACK



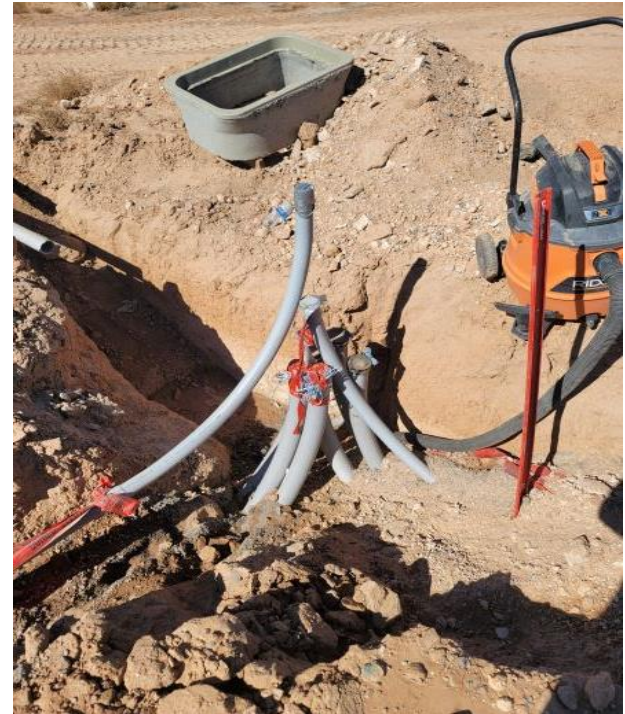
Representative Picture of Tesla Mega Pack-Batteries

Technical Considerations Micro Grid Extension



**Rock Hammer Attachment -- Trench Excavation for
20.8 kv micro grid extension and fiber optic line extension**

Technical Considerations Micro Grid Extension



4 conduit runs - 3 for Power and 1 for Fiber Optic

Hualapai Grand Canyon West Generation Sources

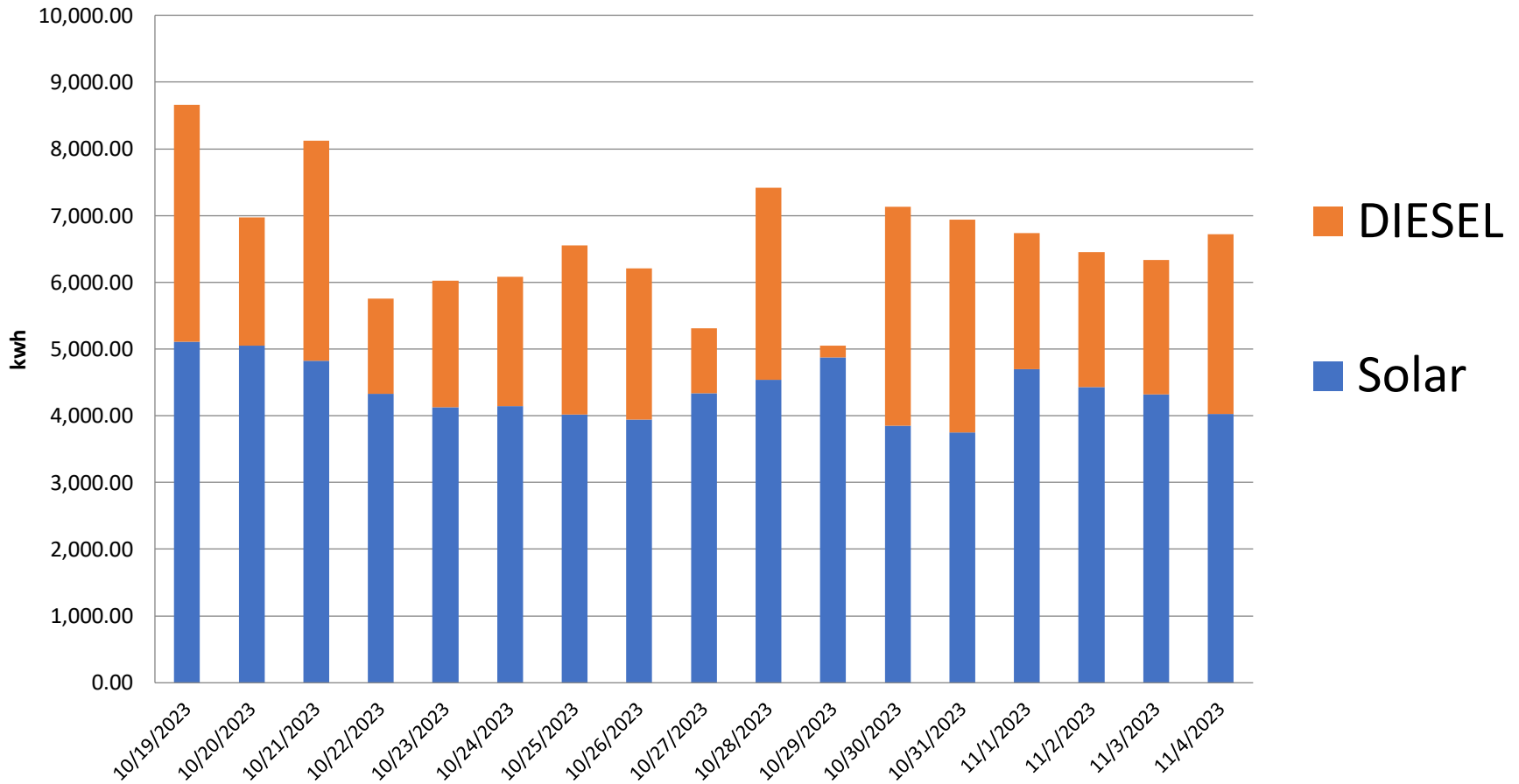
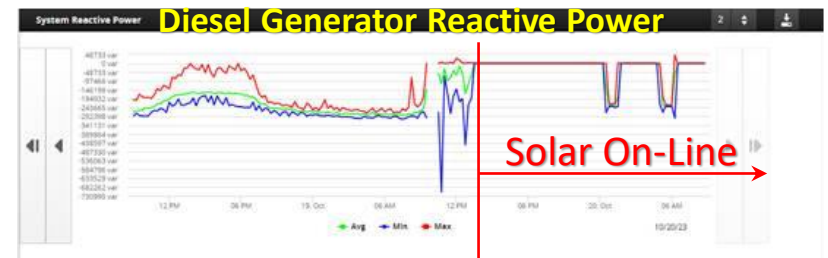
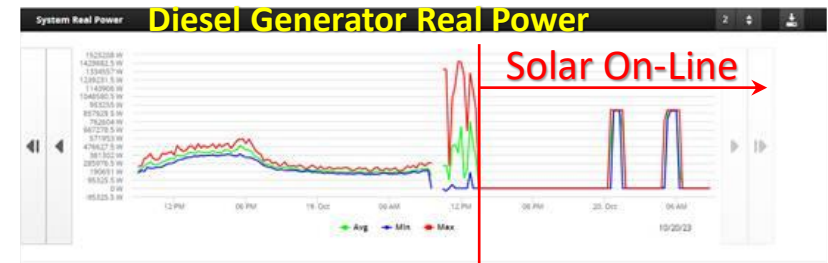
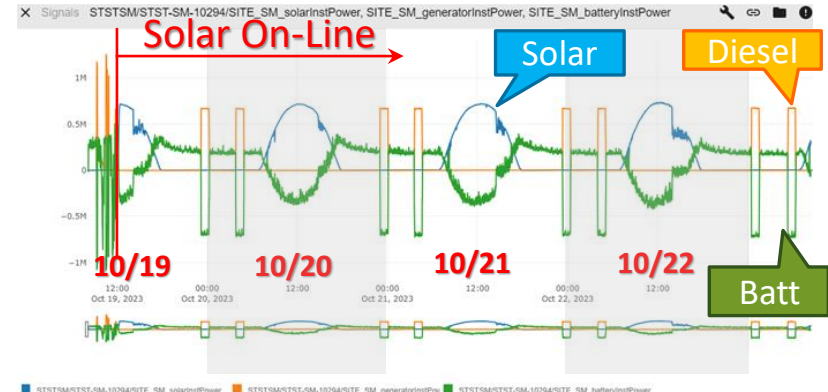


Table & Graphs Showing Generation Sources

Since Operational Date

Solar has produced 60% of the energy requirements at GCW!!!!

Date	Solar	%	Diesel	%	Total
10/19/2023	5,109	59%	3,547	41%	8,656
10/20/2023	5,051	72%	1,917	28%	6,968
10/21/2023	4,827	59%	3,294	41%	8,121
10/22/2023	4,328	75%	1,427	25%	5,755
10/23/2023	4,126	68%	1,898	32%	6,024
10/24/2023	4,141	68%	1,940	32%	6,081
10/25/2023	4,017	61%	2,536	39%	6,553
10/26/2023	3,943	64%	2,262	36%	6,205
10/27/2023	4,339	82%	967	18%	5,306
10/28/2023	4,536	61%	2,879	39%	7,415
10/29/2023	4,878	97%	174	3%	5,052
10/30/2023	3,847	54%	3,285	46%	7,132
10/31/2023	3,748	54%	3,187	46%	6,935
11/1/2023	4,699	70%	2,037	30%	6,736
11/2/2023	4,433	69%	2,017	31%	6,450
11/3/2023	4,320	68%	2,011	32%	6,331
11/4/2023	4,023	60%	2,697	40%	6,720
Total	74,365	66%	38,076	34%	112,441



Summary - Next Steps – Major Take Aways

- Work on optimizing system minimize fuel consumption
 - Verify system performance over 1 year period –DOE requirement
 - Document system operation including general operating instruction
-

- Battery resolved a significant technical problem – battery absorbs costly excessive VAR produced by micro-grid
- With proper support from Tribal Council, other Tribes can duplicate this success.
- Retain qualified personnel, HTUA Generation Manager is 4 year degreed electric utility and communications engineer
- Be sure to adequately budget for the replacement of the main battery. Battery needs to be changed out in 10 to 12 years

Questions /Contact Information



Thank You for Your Time!