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Shifting from Fossil Fuel Reliance to Green Energy Sovereignty: Ute Mountain Ute Tribe

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ABSTRACT

Self-determination has been an on-going effort for Native American people and gained much traction with the passing of The Energy Policy Act of 2005, which included the Indian Tribal Energy Development and Self-Determination Act. Congress passed this act to assist Native American tribes and Alaska Native villages with planning, development, and assistance to achieve their energy goals [1] Office of Indian Energy Policy and Programs Mission. [Online] Available: https://www.energy.gov/indianenergy/mission, accessed July 15, 2022.

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The Ute Mountain Ute Tribe (UMUT) has relied on oil and natural gas for economic support the last 70 years [2]. Burning fossil fuels, along with oil and gas development, decreases the quality of air and leads to increased greenhouse gas emissions. Subsequently, the burning of fossil fuels to produce energy is now more costly than many renewable energy sources, including solar photovoltaic (PV) systems [3].

Environmental stewardship, along with the need to maintain revenue generation, has led UMUT's efforts to achieve energy self-determinism employing PV and exploring other technology. In the past, the tribe completed a 1 megawatt PV project near Towaoc, Colorado [4], which serves as a case study on the tribe's energy goals: a future where renewables will dominate their energy landscape. This paper explores UMUT's past and on-going efforts toward energy independence and how it relates to the broader landscape of Native American energy sovereignty.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank and acknowledge Sandra Begay and Sandia National Laboratories for their efforts in furthering Native American energy initiatives and educating next generation leaders. I am grateful to have been a part of the Indian Energy internship program and have learned a lot about the much-needed energy projects happening on Native American land. The knowledge and skills I learned from Sandra are invaluable and will last a lifetime. I would also like to thank Stan Atcitty of Sandia National Laboratories for his contributions to expanding my knowledge of Indian energy projects.

I would also like to acknowledge the efforts that the Office of Indian Energy Policy and Programs and the Department of Energy put forth in assisting Native American tribes and communities develop and implement energy projects. Without the help of these two entities, many tribal communities would not have the guidance and resources to achieve their energy goals.

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ACRONYMS AND TERMS

Acronym/Term	Definition
DOE	Department of Energy
ESS	Energy storage system
kW	Kilowatt
kWh	Kilowatt hour
MW	Megawatt
MWh	Megawatt hour
IE	Office of Indian Energy
PSH	Pumped storage hydro
PV	Photovoltaic
UMUT	Ute Mountain Ute Tribe

1. INTRODUCTION AND MOTIVATION

Self-governance has been the battle tribes have faced in the past; today's battle is on the front of energy sovereignty. The passing of the Indian Tribal Energy Development and Self-Determination Act of 2005 and the creation of The Office of Indian Energy (IE), operating under the Department of Energy (DOE), has empowered Native American tribes to achieve their sovereign energy goals. The IE helps fund energy projects for Native American tribes with cost-share agreements that vary. These cost-share agreements enable tribes to pursue energy projects that would otherwise be too costly for the tribe. The goals of each tribal community vary from more simple tasks like increasing energy efficiency, to the more complex tasks such as establishing complete energy independence. Ute Mountain Ute Tribe (UMUT) wants to develop utility-scale photovoltaic (PV) systems to provide power for the entire tribe and generate revenue by selling the excess energy [5].

UMUT has a long history of dependance on oil and gas development to generate revenue, with about 70 years of leasing land to oil developers, starting in the 1950s [2]. The tribe recognizes that the best path forward is through the adoption of more environmentally friendly approaches. This can be seen in the initiatives that are outlined in the Ute Mountain Ute Climate Action Plan. This plan summarizes the approaches needed to move to more clean, renewable energy generation and outlines the steps required to preserve water integrity, air quality, and forest health, amongst other environmental initiatives [4]. One measure to increase air quality is reflected in the need for greenhouse gas reduction: adoption of PV power generation is vital to accomplish this reduction. In addition, the tribe has also realized that there are air quality issues associated with oil and gas production as harmful volatile organic compounds are released when extracting fossil fuels. It is important for the tribe to have consensus in initiatives that affect the entire tribe; therefore, their climate action plan is a crucial step for future projects and a reminder of the need for environmental protection.

The move toward renewable energy sources is also dictated by an economic consideration: the tribe must find ways to offset the revenue lost from a once-thriving oil and gas sector. Energy generation from the burning of fossil fuels has been efficient and cost effective, but the economic and environmental landscape has greatly changed in the last few decades. With the many advances in solar PV technologies, the cost of acquiring and producing power from such systems has decreased substantially in the last decade, while its efficiency has increased. The average price of utility scale PV systems (200MW), on a price per watt basis, has been reduced by about 80% from 2010 to 2020. Rooftop commercial PV systems (200kW) have seen a reduction of about 70% in the same timeframe [6]. Figure 1 shows this relationship between total installation price versus time. The vertical axis displays the price per watt of PV installations while the horizontal axis displays the year. According to Figure 1, a major cost in PV installations has historically been the cost of the PV modules, which have seen the largest price decrease, in terms of the total PV installation cost.

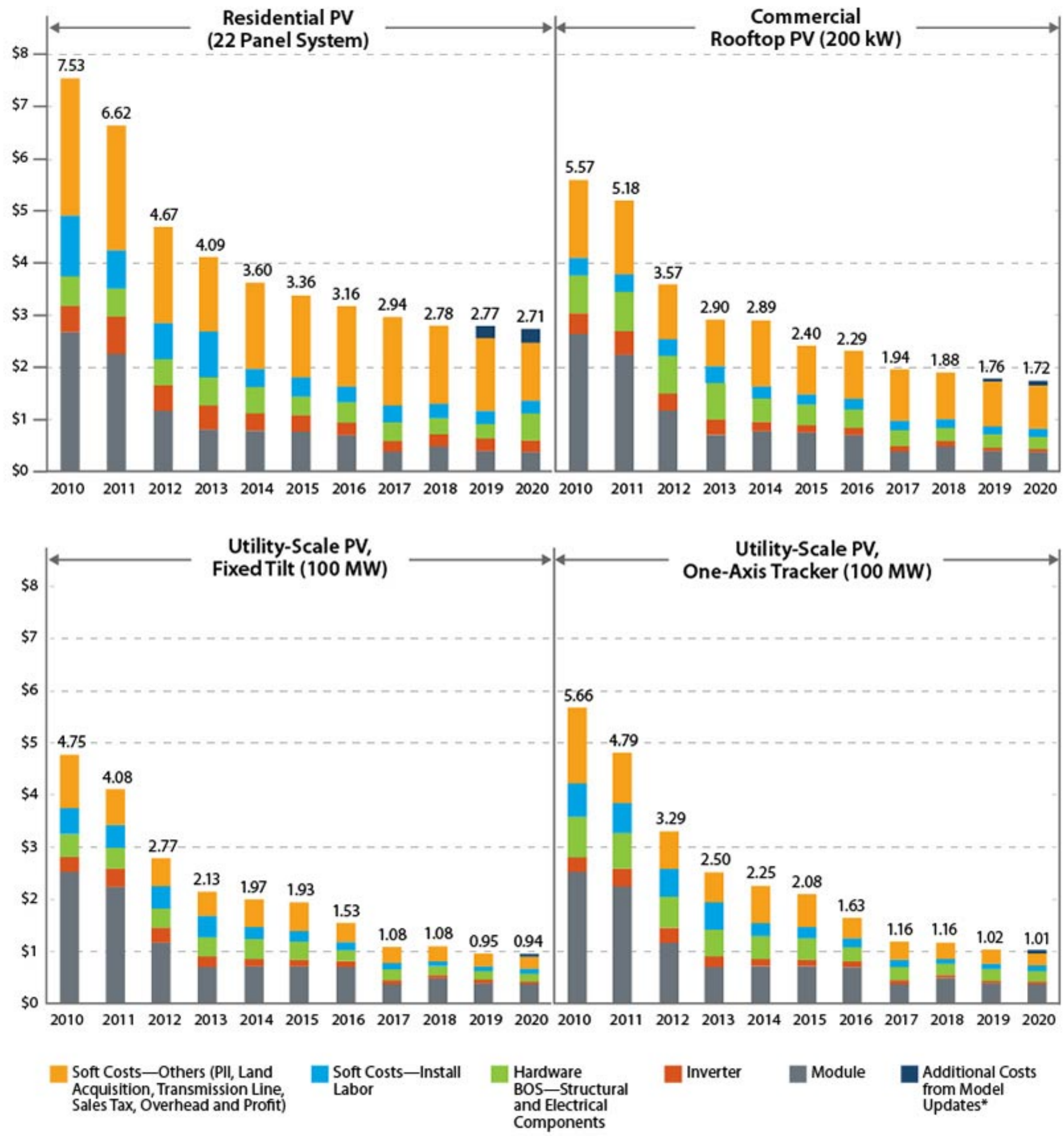

Figure 1. Solar installed system cost analysis, reprinted from National Renewable Energy Laboratory

In addition to the decreased total costs of PV, the levelized cost of energy (LCOE) for PV has also been favorable. LCOE is a measurement of the cost of energy of a system over its entire lifetime. This measurement is calculated by taking the total cost of acquiring, operating, maintaining, and fueling (not applicable to PV) a system and dividing that by the total amount of energy expected to be produced for the entire lifetime of operation [7]. This LCOE measurement is used by utility companies in evaluating proposed energy projects. Figure 2 shows the average historical LCOE for different energy generation methods [3]. The vertical axis displays the Price per megawatt hour (MWh) while the horizontal axis displays the year. According to Figure 2, the LCOE for PV was the highest for all generation methods presented in 2009 but was one of the lowest in 2020. The lower cost of PV systems and increased environmental restrictions have incentivized many coal power plant operators to shut down and move to renewables as a source of power generation [8]. Although UMUT does not operate any coal-fired power plants, the message is still the same: PV has reached a level of maturity with incomparable economic and environmental benefits.

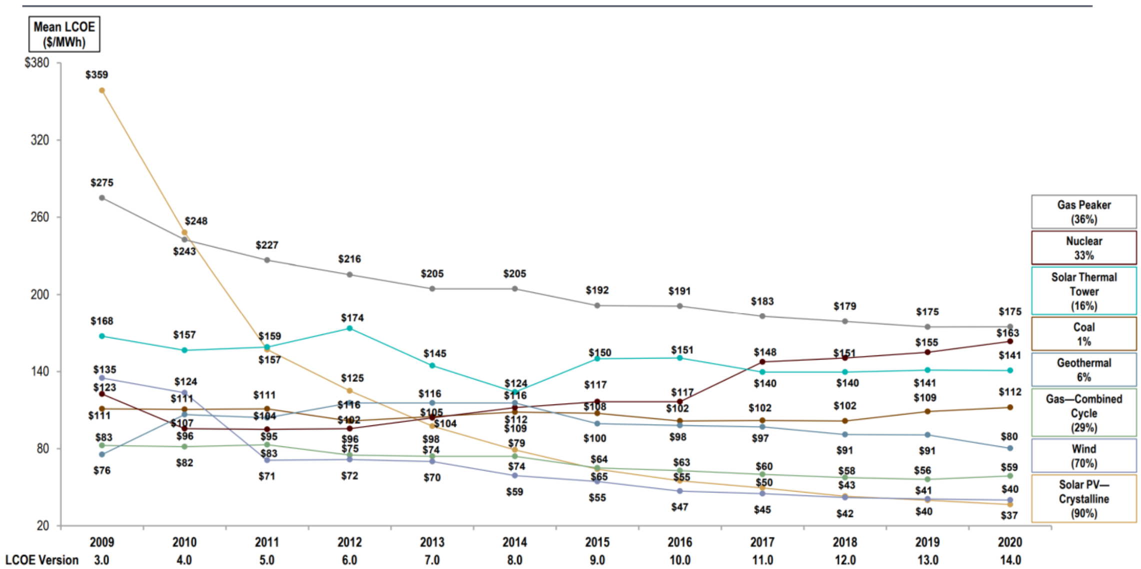

Figure 2. LCOE comparison—historical utility-scale generation comparison, reprinted from Lazard's Levelized Cost of Energy Analysis — Version 14.0

2. PAST PV INSTALLATION

UMUT's 1 MW PV system, located in Towaoc, Colorado, began with a feasibility study completed in 2014. The study determined the optimal site for the PV system, a 99-acre site formerly used for agriculture [9]. The 1 MW installation was funded with a cost share agreement with the DOE's IE. The partner and contractor for the project was GRID Alternatives who were responsible for installing and providing support for the duration of the project build. The details of the project, from March 2020 to March 2021, were documented in a final technical report to DOE [10].

The sizing of the PV system was constrained by the rules for distributed generation set by the Tri-State Generation and Transmission Association (Tri-State), an electric cooperative. Empire Electric, a member of this co-op, is the electric utility that serves the area where UMUT's PV system is located. The limit is set to a maximum of 1 MW for distributed generation. To ensure the 1 MW threshold was not violated; the sizing of the system was reduced to 999,999 kilowatt (kW) and a curtailment system was put in place and fully tested. Curtailment limits the amount of power being produced by a PV system, helping avoid utility penalties.

For the tribe to avoid behind-the-meter constraints, they purchased a part of the distribution system infrastructure, known as the NUCHU 1 circuit (Figure 3). The PV array is located on the field in Figure 3. The purchase of this circuit will enable the tribe to have full control of their electrical system, essentially creating a microgrid connecting directly to the tribe's casino if needed during the day; however, battery storage can be added to create a "true microgrid." According to the National Renewable Energy Laboratory (NREL), "A microgrid is a group of interconnected loads and distributed energy resources that acts as a single controllable entity with respect to the grid. It can connect and disconnect from the grid to operate in grid-connected or island mode" [11]. Islanding is the tern used for a microgrid that disconnects completely from the larger utility grid, enabling it to provide power to a localized community or buildings. A net metering agreement was put in place with Empire Electric to credit the power produced. The casino would pay the tribe for any power used in excess of generation and the tribe would then pay Empire Electric. The PV system was officially commissioned in March of 2020, with curtailment of 50% power generation. The curtailment was taken off and the system was allowed to operate at full potential in May 2020. Battery storage was considered but not undertaken; further evaluation is needed.

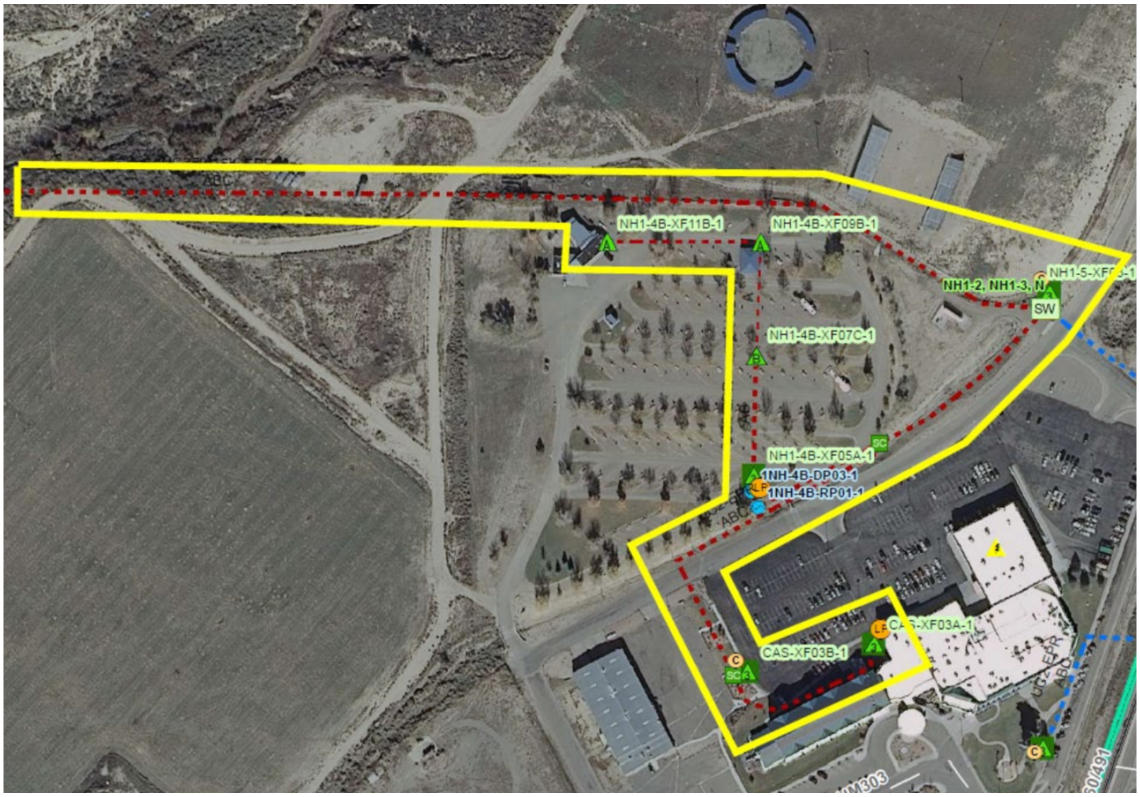

Figure 3. Nuchu 1 Circuit, reprinted from DOE Ute Mountain Ute Tribe Community-Scale Solar Project Final Technical Report

The 1 MW project showed benefits, as outlined in the final report to DOE. The value of electricity generated was $87,872 and was credited to residential and governmental bills at $51,534 and $36,337 respectively. 2,119,200 kWh of electricity was generated during this time frame, surpassing estimates by 29% despite operating the system with curtailment at 50% capacity for the first two months. Carbon emissions were offset by 960.2 metric tons due to this installation. Figure 4, which was included in the final DOE report, shows the breakdown of the project with the amount of electricity produced and the value of the electricity.

Generation and Cost Savings Verification
Towoac Community Solar Initiative: DOE Grant Cost-Share DE-IE-0000095

Project Energized on 3/5/2020; approximate 50% of capactiy due to need for Cutailment system verification test needed

Meter Reading Date	Total Generation (KWh)	Monthy Net Generation	Billed to Casino	Resident Bill Credits	Governemnt Meter Bill Credits	Empire Electric Administrative Fee	Unallocated Balance	Notes
4/1/2020	57,100.27	57,100.27		$ -	$ -			credits deferred and accumulated to future payment
5/1/2020	160,800	103,699.73		$ -	$ -			Curtailment system tested May 19, successfully; system ramped up to 100%; credits deferred and accumulated to future payment
6/1/2020	278,400	117,600.00		$ -	$ -			credits deferred and accumulated to future payment
7/1/2020	513,600	235,200.00	$ 21,567.13	$ -	$ -			Casino Bill Gross up cumulative to ***August 1***; credits deferred and accumulated to future payment
8/1/2020	676,800	163,200.00	none	$ 10,698.64	$ 10,747.96	$ 220.53	$ 100.00	First Bill Credit Implemented 8-10-20!
9/1/2020	751,200	74,400.00	$ 9,981.71	$ -	$ -	$ -	$ -	Anomoly? Inverter 1 down; Troubleshoot
10/1/2020	969,600	218,400.00		$ 2,625.00	$ 7,065.07	$ 198.64	$ -	Second Round Bill Credit implemented 10-28-20
11/1/2020	MSSING DATA		$ 9,181.54					
12/1/2020	1,384,800							
1/1/2021	1,598,400	213,600.00	$ 8,273.47	$ 6,489.00	$ 2,514.73	$ 177.81	$ -	
2/1/2021	1,792,800	194,400.00	$ 18,060.39	$ 6,180.00	$ 2,029.56	$ 88.91	$ -	Casino Bill cumulative for 2 months
3/1/2021	1,939,200	146,400.00	$ 8,172.58	$ 11,270.00	$ 6,591.75	$ 198.64	$ -	Applied Credit 3-10-21
4/1/2021	2,119,200	180,000.00		$ 6,400.00	$ 1,655.78	$ 116.80	$ -	
5/1/2021		#VALUE!		$ 7,872.00	$ 5,733.05	$ 116.80		added to correct
Totals				$ 51,534.64	$ 36,337.90	$ 1,118.13		
			Total credits	$ 87,872.54				

Figure 4. Generation and cost savings verification Towaoc Community Solar Initiative, reprinted from DOE Ute Mountain Ute Tribe Community-Scale Solar Project Final Technical Report

A benefit worth mentioning is the PV installation training that UMUT received as part of the conditions with the PV system installation contractor. Grid Alternatives trained tribal members to perform work in PV installation and maintenance, which will help ensure the tribe reaches a further level of sovereignty. This will provide them with the skill set to possibly perform future installations. Having a more educated workforce is valuable to the tribe and this knowledge can be passed down to other tribe members.

3. FUTURE ENERGY PROJECTS

The tribe's goal of having 200-300 MW total PV generation [5] will take time to realize, but completion of many smaller projects will help build the momentum needed. The distributed generation constraint of 1 MW imposed by Tri-State means the tribe is currently limiting the scope of their projects. The forming of a tribal electric utility may help overcome these constraints but requires additional financial resources and a long-term strategy [12]. One of the main strategies in forming a tribal electric utility correlates to the construction or acquisition of the required infrastructure. The purchase of existing infrastructure may make sense if the infrastructure is in good condition and can be negotiated for at a reasonable price.

A current project awaiting completion began in June 2021 with the goal of providing electricity to seven tribal facilities in White Mesa, Utah [13]. The project is a PV installation of 144 kW, allowing the tribe to meet almost 100% of the energy needs at these facilities. This project is estimated to save the tribe $22,565 per year and $676,950 over the lifetime of the PV system. A separate project began in January2022 with the goal of providing electricity to twenty tribal housing units and one Supportive Housing building located in Towaoc, Colorado [14]. The project is a PV installation of 140 kW, allowing the tribe to meet more than 82% of the energy needs at these housing units. This project is estimated to save the tribe $24,484 per year and $746,000 over the lifetime of the PV system. Each system would be able to offset 140 metric tons of carbon emissions annually.

The tribe has also considered energy storage while developing their PV systems. Energy storage systems (ESSs) are vital to the resiliency of any microgrid that is capable of islanding from the main power grid [15]. ESSs have more benefits than enabling a power system to island from the larger grid. Peak shaving is another benefit that would allow the tribe the decrease costs by reducing demand charges incurred from electric utilities. Demand charges are increased charges passed to customers for the increased demand and strain on the power grid at these peak times. For instance, when people get home from work in the evening, the power consumption rises steeply as everyone is turning on lights, preparing dinner, watching TV, etc. ESSs also allow the full capability of PV systems to be realized. When the PV system does not receive sunlight to provide power at night, ESSs can be used to supply power that was generated in the daytime. The ESS can then be charged during periods of low consumption in the daytime.

Battery storage is one method of storage the tribe has considered. Lead acid and lithium-ion are two types of batteries commonly used in battery energy storage systems, with the former being a more mature technology. Lead acid is less expensive than lithium-ion batteries for just the purchase of the battery cells but is about the same when considering the total cost of entire systems, which includes installation, balance of system, storage block, and controls and communication. According to Pacific Northwest National Laboratory, the total cost of both lithium-ion and lead acid battery storage for a 100 megawatt-hour (MWh) system with 10 hours of operating time is $356 per kWh [16]. Large scale pumped storage hydro (PSH) is another technology the tribe has expressed interest in. The cost for PSH storage is cheaper than battery storage and is priced at $266 per kWh for the same size storage previously described for lead acid and lithium-ion. For smaller scale systems, lithium ion and lead acid storage systems are still around the same cost. At smaller scale, PSH systems lose their competitiveness and are not cost-effective compared to battery storage. Approximately 93% of utility-scale energy storage is PSH [17]. Figure 5 shows the costs for different energy storage methods.

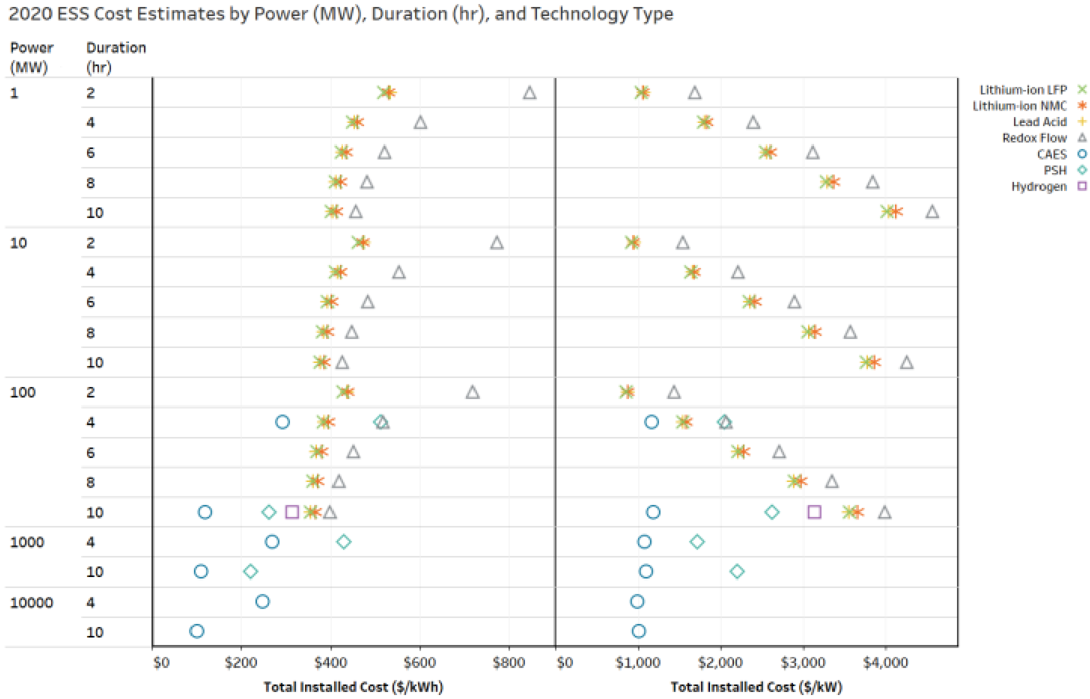

Figure 5. ES-1. Comparison of total installed ESS cost point estimates by technology, 2020 values, reprinted from Pacific Northwest National Laboratory

4. RESULTS

The 1 MW system that the tribe implemented shows the value of their investment. If the tribe's annual estimated cost savings of $157,440 could be realized for the 30-year life of the system, the total savings would amount to $3,526,624 ($4,723,200 value of electricity produced minus $1,196,576 for the tribe's cost for the installation). If a very conservative savings only amounted to $100,000 annually, the tribe would still save $1,803,420 over 30 years. Additional PV installations would have similar results and benefit the tribe greatly.

While the cost savings are appealing, reduction of carbon emissions is a step toward addressing climate change concerns. An offset of 960.2 metric tons in the first year of operation is substantial. To give an idea of what activities 1 ton of carbon(CO2) would entail, it is equivalent to taking a one-way flight from New York to Paris or producing 192 cotton T-shirts. The physical volume of 1 ton of carbon is also very substantial. Figure 6 [18] shows some activities that are 1 ton of carbon equivalents and Figure 7 [19] shows the volume of 1 ton of CO2.

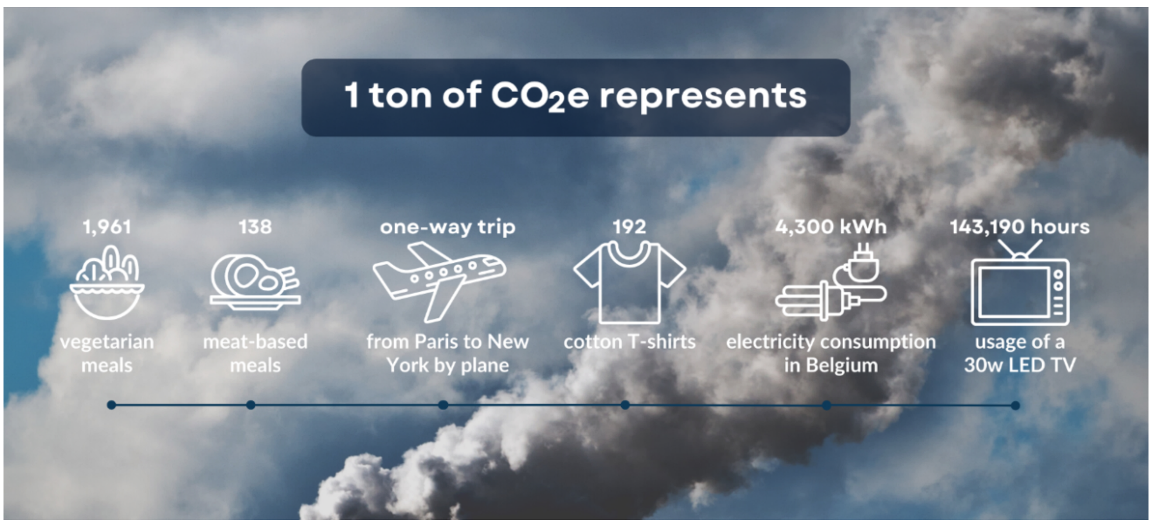

Figure 6. Everyday examples emitting roughly 1 ton of CO2, reprinted from tapioview.com

Figure 7. A One Ton Time Bomb, reprinted from carbonvisuals.com

The training on PV installation and maintenance that GRID Alternatives provided is an added benefit to the tribe. It will enable them to approach future projects with a good level of understanding perhaps leading to future project completions. At the very least, this workforce training provided tribe members with valuable technical skills and will allow them to secure gainful employment in the PV sector. These types of benefits are difficult to quantify and may be invaluable.

5. CONCLUSION

The move to renewable energy from fossil fuels is inevitable. At the current rates of consumption, it is estimated that oil will be depleted by 2052, gas in 2060, and coal in 2090 [20]. Figure 8 provides a visualization of this depletion of fossil fuels. The only way to address future energy needs is the adoption of renewables as early as possible, not when an energy crisis daunts future generations. Native American tribes have the opportunity to be leaders in this energy transition. They are the key holders of power on their lands and have the ability to dictate and implement their energy vision. Operating as sovereign nations, they can create policy that is independent of the larger United States and can create a legacy that embraces the native principles of environmental protection.

UMUT has demonstrated that Native American tribes can contribute to the protection of the environment while providing electricity and economic benefits to their constituents. They serve as an example of a tribe who is actively shifting tribal interests from fossil fuel dependency to a green economy. Many tribes have the good fortune of abundant natural resources on their lands, enabling them to create revenue and provide employment to their tribe members. Some of these resources have been fossil fuel-based and the shift from dependency on these resources to clean, renewable sources may be challenging. Many tribes are now realizing that natural resources need not to be mined and extracted from the Earth, but instead harnessed in the form of sunlight, wind, and water. Exploration of energy production using these natural, nearly infinite resources will be the new frontier giving Native American tribes the potential to lead the nation to a new, green economy.

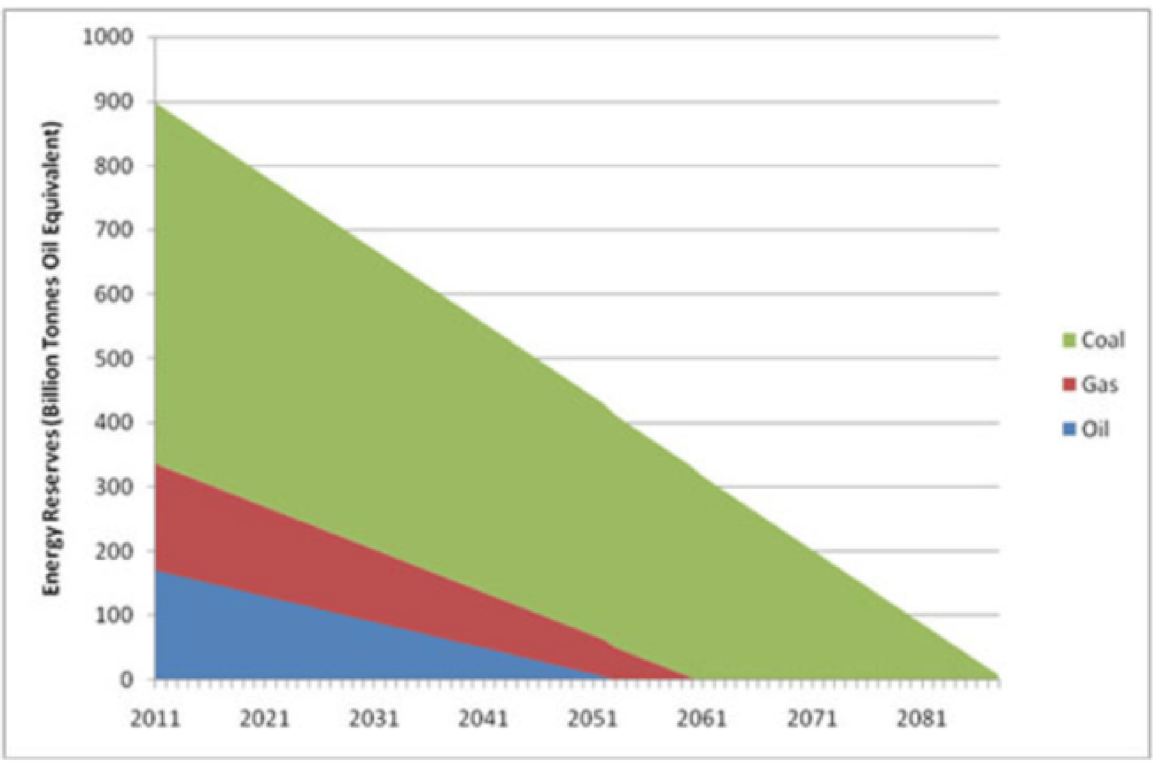

Figure 8. Energy reserves in billion tonnes of oil equivalent, reprinted from mahb.stanford.edu

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