TOHONO O'ODHAM UTILITY AUTHORITY

SOLAR EDUCATION AND CASE STUDY

April 2019

Memorandum

To: Chairman of the Tohono O'odham Nation
Tohono O'odham Legislative Council Commerce Committee
Tohono O'odham Legislative Council

From: TOUA Management Board

Subject: Tohono O'odham Utility Authority (TOUA) Renewable Energy, Education and Case Study Report

Overview

Section 4 of the Tohono O'odham Utility Authority Second Restated Plan of Operation (Plan of Operation) sets forth six purposes for which TOUA was established. We would like to emphasize three (3) purposes which have specific relevance in the TOUA Board's evaluation of renewable energy:

Purpose No. 1 – "To plan for, provide and furnish utility services to all areas within the Tohono O'odham Nation, where such services are determined to be feasible and economic."

Purpose No. 3 – "To acquire, construct, operate, maintain, promote and expand utility systems furnishing electric, gas, water, sewer and telephone services within the Tohono O'odham Nation."

Purpose No. 5 – "To provide utility service to the Tohono O'odham at the lowest possible cost consistent ·with prudent fiscal responsibility."

The TOUA Board's immediate objective with respect to renewable energy is three-fold:

1) To thoroughly research and evaluate suitable renewable energy options;
2) To identify current and future partnership opportunities for local and utility-scale renewable energy projects; and
3) To inform and educate TOUA's customers and tribal leadership regarding renewable energy opportunities and challenges.

Background

In March 2018, the TOUA Management Board (Board) set about to further educate ourselves on renewable energy with an emphasis on solar and available alternative considerations.

TOUA contracted with K. R. Saline & Associates, an electrical engineering and electric utility consulting firm, to assist in the evaluation of other Arizona utility-operated renewable energy

programs, the level of solar knowledge and interest of TOUA customers, and the recent experiences of current TOUA solar customers.

During the past twelve months the Board and TOUA management have been engaged in the following activities:

- Met with representatives of APS, SRP, NTUA and GRICUA to learn about their renewable energy projects.
- Consulted with KR Saline to conduct a customer survey designed to gain information on customers current level of knowledge on solar and their willingness to participate in a future solar project.
- Collect and analyze data on current customer solar systems to understand what benefit the customer is receiving from their solar system.

The accompanying KR Saline report, titled "TOUA Solar Education and Case Study" presents the findings from our information and data collection activities.

Findings and Conclusions

The Board's review of reports and our own deliberations leads to the following conclusions:

- Community scale and rooftop solar projects would produce energy at a cost that exceeds TOUA's current wholesale power supply cost.
    - Without the economies of scale of large projects, the cost of solar energy projects does not meet the prudent responsibility requirements of Section 4(A) (5) of the Second Restated Plan of Operation.
    - Customers may not be willing to pay more for solar generated energy to gain the environmental, social and reliability benefits.
    - To justify the higher cost of solar energy non-monetary factors, such as environmental, social and reliability benefits, have to be considered in justifying the higher cost of solar energy.

- TOUA needs to proactively develop and communicate a basic solar education program and establish a TOUA point of contact where customers can get renewable energy questions answered.

- Renewable energy projects must have a clear purpose and objective that will provide benefits for our customers and TOUA.
    - This could be accomplished by reducing purchase power cost and/or improving system reliability.

- Grant opportunities should be explored as a means to reduce the financial impact, making projects more economically feasible.

- Any renewable energy project should be owned and/or maintained by TOUA.
  - The case studies revealed that in most instances customers were not monitoring or maintaining their solar systems. One solar system support structure collapsed and the solar system was inoperative for a long period of time. Another customer did not know if the solar system was producing energy.
  - To ensure the customer is getting a benefit from a solar system it must be properly maintained and monitored.

- Investigate partnership opportunities with Nation, Districts/Communities and TOKA.
  - Roof top solar on all new homes (maintenance agreements, rebates, etc.).
  - Older homes may not support a rooftop solar system without expensive modifications to the roofs. Since many of the homes on the reservation are owned by the tribe who would pay for the required improvements and what process would need to be followed to get approval for such installations.

- .Community solar would be the preferred option for a project.
  - Community solar provides some economies of scale in purchasing solar panels, while allowing customers who want to buy or lease solar panels and receive a credit on their electric bill, based on the amount of the energy produced by the solar panel(s) purchased or leased.
  - Community solar is a better option for older homes.
  - TOUA should pursue grants to increase the feasibility of a community solar project.

- When addressing system reliability issues, micro grids should be one of the options considered.
  - Customers see solar energy as a solution to perceived electric distribution system reliability issues. Yet, in the 2010 National Renewable Energy Laboratory Workshop “Strategic Energy Planning Session Summary” report participants ranked **cost** as the highest emerging energy issue and **reliability** was ranked as the lowest emerging energy issue.

- Rooftop solar and micro grids can address some reliability concerns if they include battery storage. However, battery storage systems are normally only designed to provide up to four hours of energy.
- Micro grids with battery storage could also be considered for reducing system peak demand, which would provide savings in purchased power peak demand charges.
- Micro grids, for reliability purposes, will be a duplication of infrastructure and power supply resources that will result in retail rate increases.

- Utility Scale Solar projects present many challenges and are not being considered a priority alternative for TOUA at this time. Some concerns and challenges for utility scale projects include:
  - Perceived to create jobs. This is true only during construction of the solar project (six months). NTUA's Kayenta -I solar project only provides two (2) long term jobs.
  - Requires large amounts of land adjacent to a transmission line and land rights have to be in place in order to respond to Requests For Proposals (RFPs) in a timely manner.
  - Tribal economic benefits are limited to land lease fees and taxes.
  - Requires a private partnership to benefit from tax incentives or the formation of a taxable entity by TOUA.
  - Project funding is beyond TOUA's ability to finance.
  - Private partnership arrangements raise sovereign immunity issues.
  - Requires long term Purchase Power Agreement for the sale of the energy being generated.
  - Transmission cost to get the power to the market can make a project non-competitive in a RFP response.

- TOUA should continue to communicate and meet with neighboring utilities (SRP, APS, TEP etc.) to stay abreast with their future plans for solar and other renewable energy needs and to evaluate partnering opportunities that would be beneficial for TOUA's customers and the Nation.
- TOUA and the Nation should anticipate that renewable energy facilities, including solar panels, are subject to damage and end of useful life considerations requiring the development of responsible disposal and recycling standards.

- Energy conservation and energy efficiency could be a tool for customers to reduce their electric bills with shorter payback time periods than renewable energy projects.
    - In the 2010 National Renewable Energy Laboratory Workshop "Strategic Energy Planning Session Summary" it states that "Reducing the need for energy is often the most cost-effective energy solution."
    - TOUA should provide customer education on energy efficiency and conservation.

Next steps for TOUA

- Offer solar education for customers designed to:
    - Identify the truths verses myths of solar energy
    - Explain the difference between solar behind the meter and community solar
    - Explain the different financing options and return on investment.
    - What to expect from investing in solar energy
        - Payback on the investment
        - Monitoring energy production
        - Maintenance concerns, costs and options
- Commission consultant to develop project concepts and budgets for the following types of projects:
    - Community solar project located near TOUA headquarters.
    - Village level template for Micro Grid projects to provide peak demand reduction benefits and improve system reliability for the village.
    - Framework for a utility scale project identifying potential size, land requirements, suitable locations and potential third party investors.

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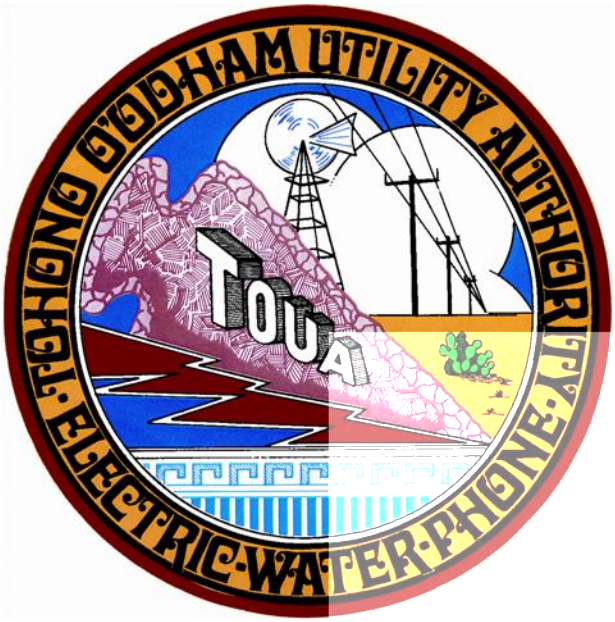

TOUA SOLAR EDUCATION AND CASE STUDY

Prepared for the

Tohono O'odham Utility Authority

April 2019

Conducted by

K.R. Saline & Associates, PLC

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Table of Contents

Index of Tables and Figures 4
Executive Summary 5
Study Scope 7
Tohono O'odham Utility Authority 7
Current Renewable Energy Programs 8
Energy Opportunities 9
Learning from Our Past 11
1978 Gunsight Photovoltaic Installation "The World's First Solar-Powered Village" 11
San Lucy Farm Solar Project 12
ASARCO Mission Mine Complex 13
Lessons Learned 14
Learning from Other Arizona Utilities 17
Navajo Tribal Utility Authority 17
Salt River Project 18
Arizona Public Service Company 18
Gila River Indian Community Utility Authority 19
Insights from Arizona Utilities 20
Learning with TOUA Customers 21
Developing & Administering the Survey 21
Results of the Solar Customer Survey 21
Customer Feedback 22
Observations 22
Learning from Existing Solar Customers 25
Residential Solar Customers 25
Pisinemo District 25
Gu Achi District 26
San Xavier District 28
Commercial Solar Customers 28
San Xavier District Administration Building 29
Santa Rosa Health Center 31
Lessons Learned from Existing Solar Customers 33
Conclusion 35

Index of Tables and Figures

Table 1 - 2017 TOUA Average Power Cost $/MWh....9
Table 2 - Lazard Levelized Cost of Energy Analysis, November 2018 10
Table 3 – Net Metered Solar Production data for the Pisinemo Residential Customers....26
Table 4 – Net Metered Solar Production data for the Santa Rosa Day School Residential Customers....27

Figure 1 - District Map of the Tohono O'odham Nation....8
Figure 2 - Arizona DNI Resource Range. Source: NREL 9
Figure 3 – Announcement of Solar Power in Gunsight. Source: https://oodhamrunner.com....11
Figure 4 - Gunsight / Schuchuli Project Site....12
Figure 5 - Asarco Mission Mine Complex Site Analysis. Source: http://itepsrv1.itep.nau.edu 14
Figure 6 - Avalon Solar 1 & II, Sahuarita, AZ - Source: TEP.COM....14
Figure 7 - Pisinemo NIFA Grant Funded Solar Installations – Source: https://www.usda.gov....25
Figure 8 - Typical Santa Rosa Residential Customer Household Electric Use 27
Figure 9 - Aerial Image of Residential Solar near the Santa Rosa Day School....28
Figure 10 - Aerial View of Solar Canopy at San Xavier Admin Bldg....29
Figure 11 - Solar Production Data for San Xavier Admin Bldg....30
Figure 12 - Monthly Customer Usage Before, During, and After Installation of Solar Canopy 30
Figure 13 - Aerial Image of Santa Rosa health Center's Ground-Mounted Solar....31
Figure 14 - Solar Production Data for Santa Rosa Health Center....32
Figure 15 - Monthly Customer Usage before, During, and After Installed Solar....32

Executive Summary

The Tohono O'odham Utility Authority (TOUA) is examining opportunities for investment in solar renewable energy resources. TOUA contracted with K. R. Saline & Associates to assist in the evaluation of other Arizona utility-operated renewable energy programs, the level of solar knowledge and interest of TOUA customers, and the recent experiences of current TOUA solar customers.

The Study began by evaluating past solar project development efforts made by the Tohono O'odham Nation to gain insight on how to best manage future TOUA solar efforts. It is evident that the past has contributed to the current understanding and expectations surrounding solar that persist on the reservation today. For instance, the Gunsight solar project from 1978 is still mentioned by TOUA customers. Recent unsuccessful solar projects highlight the importance of due diligence, stakeholder collaboration, communication, and overall project leadership. Current customer understanding of the basics of solar photovoltaic technology and TOUA programs also reveal a need for additional education.

Peer discussions with other Arizona utilities opened the door to invaluable contacts and support that will benefit TOUA in their future renewable energy investments. Neighboring utilities presented working examples of utility scale solar model that can provide new revenues for utility operations, and a community solar model that minimizes investment risk while providing clean energy and education for the community. All projects emphasized the importance of site selection and community involvement and stressed the significance of defining a project's overall objectives.

TOUA delivered a customer survey designed to collect customer understanding, expectations, and interest in solar. The survey experience proved to be a worthwhile process of customer engagement and an opportunity to receive feedback. The general impressions heard is that more education is needed on the basics of solar power and the cost and benefit realities of solar investments. By-in-large, TOUA customers are primarily incentivized to want solar based on the expectation that installing solar would save them money; however, a strong desire for environmental stewardship was also exhibited in the survey results. Overall, customers demonstrated a balanced desire for either customer-owned or community-sized solar investments driven by either an appeal for control over a personal system or the affordability of a community project.

Lastly, a case study was conducted to examine the existing TOUA customer-owned solar installations on TOUA-operated distribution system. Except for one residential customer, existing solar customers have been beneficiaries of grant-financed solar projects. While customers hold an expectation that they are saving money through the solar facilities attached to their property, customers generally lack the knowledge of how the system operates, is maintained and what the net impact to their utility bill is.

The results of the Study prove the need for additional customer education and collaboration, but also confirms that TOUA's customer base would be supportive of further solar investments. Based on the information collected, the following are outlined as key observations to consider when planning future solar projects:

- Clearly define the purpose of a solar project whether it be for reliability, revenue creation, or a community education. Defining the purpose of the project will help distinguish the type of system, level of investment, business vehicle, and site requirements needed for project success.
- Customers need a basic understanding of how solar systems work, how they are financed, the maintenance requirements, and overall bill impacts of TOUA's distributed generation policies.
- Communicating on a regular basis with the community about a project's purpose and life cycle is important to manage customer expectations and impressions of solar in general.

- Careful due diligence and planning for alternatives prior to a project launch can insure TOUA's readiness to respond quickly to new opportunities and/or unforeseen conflicts.
- Developing awareness for changes in the comparable value of distributed generation resources, market demand, and available deliverability options can limit risk and provide a robust and healthy investment in solar.

The scope of this study is keeping with TOUA's responsibilities as outlined in the Second Plan of operation approved by Resolution No. 91-175 of the Tohono O'odham Legislative Council. Per the Plan of Operation, TOUA is expressly called upon to educate the Tohono O'odham peoples in the proper, efficient and economical use of all utilities. This effort is also consistent with the Tohono O'odham Nation's Core Values and Vision for the future which seeks to "empower our Nation and our people with the knowledge of best practices."

Study Scope

The introduction of investment tax credits, with the Energy Policy Act of 2005, provided new incentives for residential and commercial renewable energy systems. In the past ten (10) years, the electric utility industry has experienced an increasingly rapid shift away from carbon-based fuels and toward the adoption of renewable and distributed energy resources. Heightened scrutiny of climate and environmental impacts of traditional generating units, abundant and inexpensive natural gas supplies, and a rapid decline in photovoltaic and wind technology costs has contributed to the current utility energy resource portfolio decision making. This paradigm shift has introduced more opportunities for Indian Tribes to participate in the procurement of renewable energy now more than ever before.

The Tohono O'odham Utility Authority (TOUA), located in the desert southwest of Arizona, is investigating the opportunities that exist for renewable solar energy systems. TOUA contracted with K. R. Saline & Associates, an electric utility consulting firm in Mesa, Arizona, to assist in a case study evaluating:

1. The history of solar projects for the Tohono O'odham Nation
2. Other Arizona Utilities & Tribal Authorities with Solar Programs and/or Installed Solar Systems
3. TOUA Customer expectations and knowledge of solar energy,
4. TOUA Customer's experience who currently have solar systems installed

The scope of this study directly relates to TOUA's responsibilities as outlined in the Second Plan of operation approved by Resolution No. 91-175 of the Tohono O'odham Legislative Council. Per the Plan of Operation, TOUA is expressly called upon to educate the Tohono O'odham peoples in the proper, efficient and economical use of all utilities. This effort is also consistent with the Tohono O'odham Nation's Core Values and Vision for the future which seeks to "empower our Nation and our people with the knowledge of best practices."

Tohono O'odham Utility Authority

The Tohono O'odham Utility Authority is a tribal enterprise, originally established in 1970 as the Papago Tribal Utility Authority by the Papago Tribal Council as one of the first tribally-owned and operated electric utilities in the country. Prior to the Tohono O'odham Nation's (TON or Nation) development of TOUA, only four villages had electric service, leaving 27 villages without power. The electric cooperative providing service at the time was not interested in supplying power to the outlying villages. The original utility charter authorized TOUA to provide electric and water service to the reservation. The first service provided by the electric operations was an act of self-determination: wheeling power from an investor owned utility (IOU) to a mining operation on the reservation. Later, TOUA purchased the on-reservation electric system of the electric cooperative and has since expanded. Today, TOUA provides electric, water/wastewater, telephone, cellular, propane, and internet services to over 3,000 customers throughout the Tohono O'odham Nation. The TOUA headquarters is located 1.5 miles west of Sells, Arizona with approximately 100 employees. Employees operate and maintain over 600 miles of distribution line that are connected through five substations ranging in size from 40 MVA to 5 MVA. TOUA's service territory includes the main reservation and the San Xavier District. TOUA does not provide service to the non-contiguous areas of the San Lucy District and Florence Village. Providing reliable service across a vast rural delivery area is TOUA's top priority.

Figure 1 - District Map of the Tohono O'odham Nation

Current Renewable Energy Programs

Discussions regarding the incorporation of solar generation in the Nation's resource planning appears to have taken hold in 2009 when the Nation was first investigating modern grid-scale solar options and the availability of federal energy grants opportunities were increasing. At a September 1, 2009 Economic Development Bonds meeting, it was reported that 5 or 6 Tohono Districts had already included solar energy in their economic development plans and the Asarco Mission Mine Tailing Site had been identified as a potential project site. In January 2010, the Nation partnered with the National Renewable Energy Lab to conduct a Strategic Energy Planning workshop. Workshop participants highlighted the assistance Districts could provide via the contribution of lands and community support, while the Nation should be providing long range planning and overall support. Participants also viewed the community college and federal agencies as important partners. Meanwhile, costs, availability of lands, and lack of a project champion were key roadblocks identified at that time. On April 5, 2011, a representative from the San Lucy District and a representative from the Planning and Economic Development Department participated in a Department of Energy roundtable on Tribal Energy to discuss the current status of DOE tribal energy programs and policies. As a result of the upswell in solar energy interest, on May of 2011, the TOUA Board approved the "Distributed Generation Procedures and Guidelines Manual" (DG Manual). The DG Manual establishes the requirements and procedures that customers must follow to apply to install a distributed generation resource (wind, solar, etc.) behind their meter. Subsequently, on September 19, 2013 the TOUA Board adopted their Schedule DG, "Distributed Generation" rate Tariff which remains in effect.

Pursuant to the terms of Schedule DG, retail customers are limited to distributed generation projects "with capacity rating of less than 700 kW AC and rated to produce an amount of electricity less than or equal to the amount of electricity the Customer for whom the DG is installed is reasonably expected to consume and where the Customer desires to export power." Any excess power that is generated and not consumed by the customer, is purchased by TOUA at the prevailing monthly avoided cost of generation. The avoided cost of generation is TOUA's monthly wholesale purchase power cost divided by the total kilowatt-hours purchased. Presently there are eleven (11) residential customers and two (2) commercial customers under the Distributed Generation program.

Energy Opportunities

Tohono O'odham Nation covers nearly 2.9 million acres in southern Arizona and is comprised of three separate reservations: what were formerly called the Papago Reservation, the Gila Bend Reservation, and the San Xavier Reservation. According to reports by the National Renewable Energy Laboratory, some of the highest solar energy production index numbers in the country are found in this region.

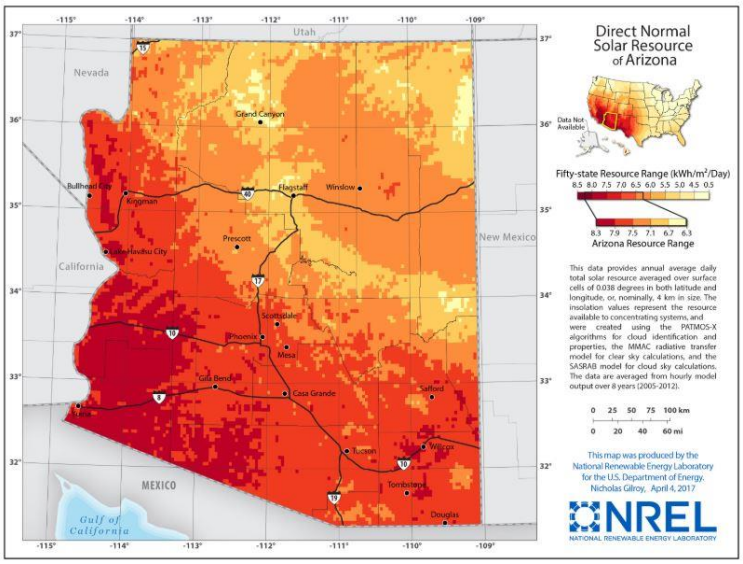


Figure 2 - Arizona DNI Resource Range. Source: NREL

At the start of this study, TOUA's current wholesale and retail power costs were reviewed. In 2017, 9.3 % of the Nations needs were met by low-cost hydroelectric Federal Preference Power purchased from the Western Area Power Administration, 69.2% was served by wholesale power contracts with Arizona Investor Owned Utilities, and 21.6% was served under retail rate tariffs. Based on effective rates during 2017, the Nation's average energy costs were $57.66 per megawatt-hour.

TOUA'S 2017 Average Energy Costs $/Megawatt-Hour		Percent of Power Requirements Met
Hydro Federal Preference Power	$23.18	9.3%
AZ IOU Wholesale	$59.06	69.2%
Retail	$132.00	21.6%
2017 Average	$57.66	

Table 1 - 2017 TOUA Average Power Cost $/MWh

Referring to *Table 2 – Lazard Levelized Cost of Energy* on the next page, the levelized cost of energy of utility-scale solar is competitive with current TOUA wholesale and retail power costs and has the possibility of being competitive with TOUA's federal hydroelectric preference power. Without the economies of scale of the larger projects, community scale and rooftop projects still exceed TOUA's wholesale power supply

costs. However, community scale project costs may be further reduced using federal grants opportunities as part of the projects financing. Through smart investments and careful planning, opportunities exist today to reduce TOUA's wholesale purchased power costs. Similarly, costs to serve TOUA's retail loads may be further mitigated through taking advantage of the current solar programs offered by the local retail service providers.

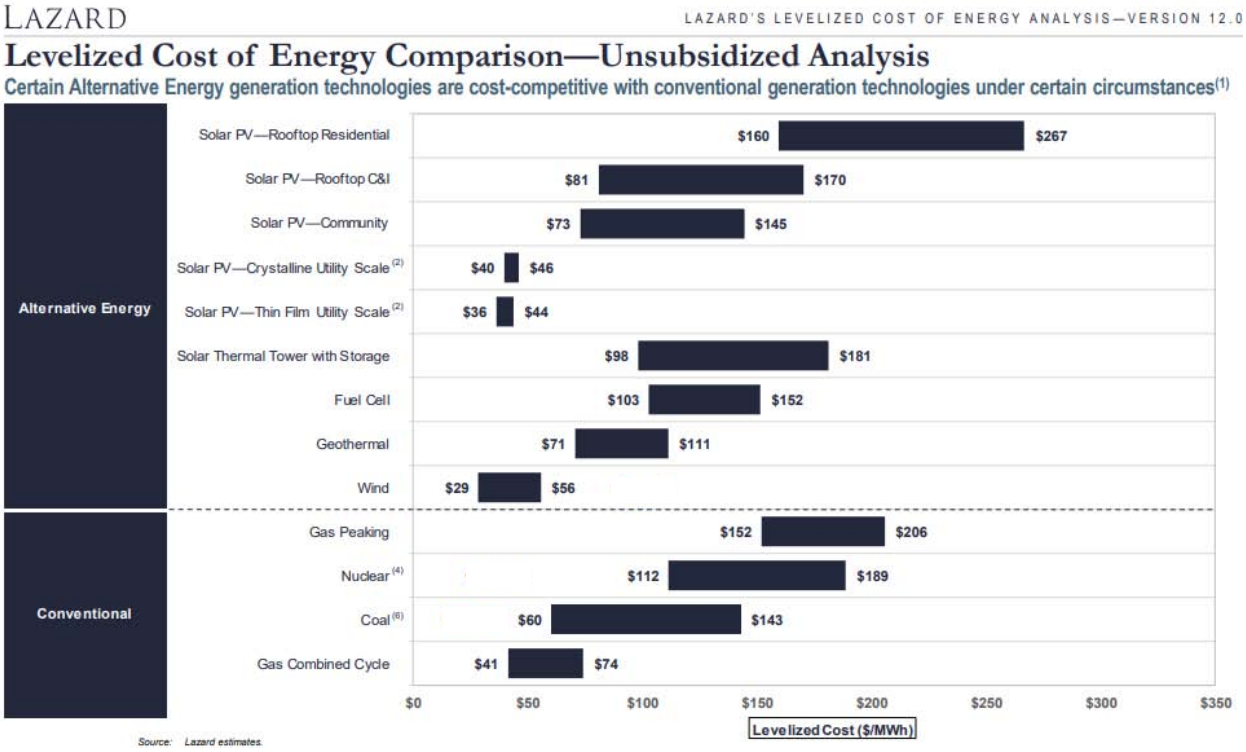


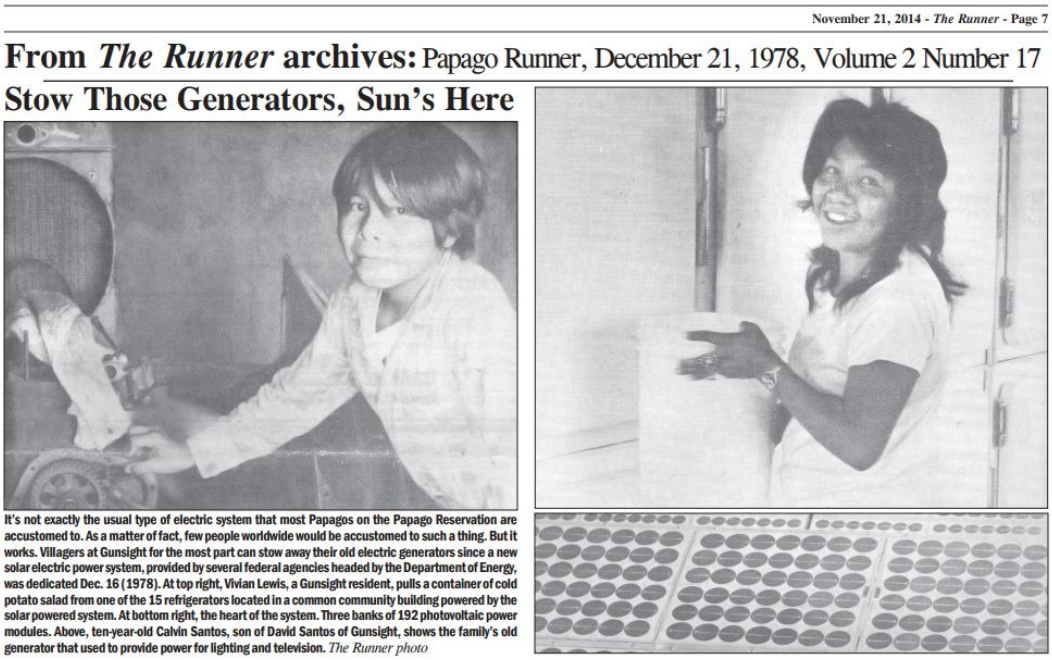
Table 2 - Lazard Levelized Cost of Energy Analysis, November 2018

Source: https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

Learning from Our Past

For the Tohono O'odham, solar energy addresses core values of sovereignty and environmental stewardship. As a result, solar energy has been a part of community planning and development for the last thirty years. During this study it became evident that past efforts are contributing to the current understanding and expectations of TOUA customers and tribal leaders. Reviewing past efforts can provide insight to previous difficulties and may impart lessons learned that will aid in the successful delivery of future solar projects that TOUA considers and can assist TOUA in better managing customer expectations. Building on their past experiences the TOUA may discover opportunities in solar development that not only address their values but provide economics that can compete with existing power costs and improve the reliability of their electric grid.

1978 Gunsight Photovoltaic Installation "The World's First Solar-Powered Village"



November 21, 2014 - *The Runner* - Page 7

From *The Runner* archives: Papago Runner, December 21, 1978, Volume 2 Number 17

Stow Those Generators, Sun's Here

It's not exactly the usual type of electric system that most Papagos on the Papago Reservation are accustomed to. As a matter of fact, few people worldwide would be accustomed to such a thing. But it works. Villagers at Gunsight for the most part can stow away their old electric generators since a new solar electric power system, provided by several federal agencies headed by the Department of Energy, was dedicated Dec. 16 (1978). At top right, Vivian Lewis, a Gunsight resident, pulls a container of cold potato salad from one of the 15 refrigerators located in a common community building powered by the solar powered system. At bottom right, the heart of the system. Three banks of 192 photovoltaic power modules. Above, ten-year-old Calvin Santos, son of David Santos of Gunsight, shows the family's old generator that used to provide power for lighting and television. *The Runner photo*

Figure 3 – Announcement of Solar Power in Gunsight. Source: https://oodhamrunner.com

It was an electrifying day in the Tohono O'odham village of Schuchuli (Gunsight) on December 16, 1978. That was the day the new solar power system was activated, bringing power to the remote settlement about 110 miles west of Tucson. NASA furnished the system built to REA specifications, and the U.S. Department of Energy and Indian Health Services provided project financing. Federal officials declared it the "World's first solar electric village." Since the federal government was also interested in the deeper implications of the project, an anthropologist from Arizona State University was assigned to conduct a year-long study to see how electricity affected the villagers' lives.

The project was an array of 192-volt photovoltaic modules said to be DC power, or without the use of an inverter to AC which limited the appliances that could be used to run off DC and included batteries. This 3.5 kW PV system powered water pumps, lights, refrigerators, and sewing and washing machines for the village's 95 residents until the early 1980's when Schuchuli was connected to the grid. At this time, the panels were adapted to a new system designed to serve a new water system. In 1984 a sixth string of panels

were added to increase PV capacity. In 1990 the system would be transferred to TOUA ownership and operational control and would subsequently be retired due to the ongoing maintenance expense and technology obsolescence.

Figure 4 - Gunsight / Schuchuli Project Site

The project is still talked about today among TOUA customers and the reasons surrounding the projects demise are debated among customers who are vaguely aware of the project's history. Numerous customers made mention of this project during the first customer survey day and highlighted that it was no longer in operation and implied they hoped future solar efforts did not have the same result as Gunsight.

San Lucy Farm Solar Project

Around 2010 the San Lucy Farm Solar Project was being considered for economic development on Tohono O'odham trust lands adjacent to the Western Area Power Administration 's Electrical District No. 5 (ED5) Palo Verde Hub Project (ED5-PVH). Funding for the project would have come from Western's Transmission Infrastructure Program (TIP) and would have relied directly on the additional transmission capacity created by ED5-PVH.

The first phase of the San Lucy Farms Project (the Project) was anticipated to produce approximately 20 MW at an estimated cost of $61,145,000 for the 100-acre facility. In addition to transmission access, the site is ideally located to take advantage of some of the highest daily sunlight volumes in the United States. The Tohono O'odham Nation began feasibility analysis in 2010 for the Project and, after consulting with Western staff, issued a Request for Proposals (RFP) from technology vendors interested in working with the tribe. The key objective of the RFP was to compare and select proven solar photovoltaic electricity generation technologies capable of a 20-megawatt utility grade facility and to provide production guarantees and maintenance programs that would secure needed financing. After reviewing proposals from

over 20 companies from across the United States, in April of 2010 the Tohono O'odham Nation entered into an agreement with NASDAQ-listed SunPower Corporation of Richmond, California.

For the next few years, the Tohono O'odham Nation worked closely with Western and other U.S. Department of Energy staff to understand the ED5-PVH Project and the opportunities provided by the TIP program to expand the capacity of the existing Western transmission line. Western staff met with the Tohono O'odham Nation Legislative Council (the Nation's elected legislative body), participated in site visits, met with project staff, and included the Tohono O'odham Nation in training, consultation sessions and special meetings to explain Western's contracting authority, processes, and procedures.

As a result, the Tohono O'odham Nation prepared a draft Power Purchase Agreement for Western. At the time Western was hoping to secure the U.S. Navy as an off-taker of the projects production. Western facilitated discussions between TOUA and the Tohono O'odham Nation project staff to explore opportunities and efficiencies under TOUA's existing contracts with Western. Western provided critical and valuable assistance, education, and support to the Tohono O'odham Nation for the San Lucy Farms Solar Project.

The San Lucy Farms Solar Project was eventually canceled by the Nation due to the proposed cost of transmission and the lack of clearly identified off-taker.

ASARCO Mission Mine Complex

Located on Tohono O'odham Nation (TON) land, the ASARCO Mission Mine is an open-pit copper mine that covers 29 square miles. At the request of the TON, in 2011, the Environmental Protection Agency (EPA) prepared a renewable energy assessment to evaluate renewable energy development opportunities for a portion of the mine tailings area. The tailings area located on lands within the San Xavier District of the TON was leased to ASARCO by the Nation for mining-related activities. Of the 1,400 acres evaluated, roughly 1,100 acres are flat areas and 300 acres are made up of the mine tailings embankment, providing approximately 130 acres for project development.

The study concluded that the ASARCO Mission Mine tailings embankment could accommodate an 8-megawatt utility-scale solar energy project. TON passed a resolution accepting the 2011 EPA Feasibility Study. The local utility, Tucson Electric Power, worked with the TON on a solar project on top of the tailings area. An environmental impact statement (EIS) was completed and submitted to the Bureau of Land Management (BLM) as part of the Arizona Restoration Design Energy Project. The BLM released a draft EIS in 2012.

The project was eventually canceled due to the TON taking too long to set up an organizational structure for a third-party project. Building on the 2011 assessment, ASARCO, Tucson Electric Power and Clenera, LLC moved forward with plans to redevelop a nearby area off reservation for a utility-scale solar array. The project, called the Avalon Solar Facility, is a 56-megawatt (MW) single-axis tracking solar power photovoltaic (PV) facility and is sited on approximately 500-acres of disturbed land in Pima County, Arizona. At the time of the construction the project was estimated to create up to 300 jobs and produce $4 million in property tax revenue for Pima County. After signing a 20-year lease with the original project, TEP expanded the original 35-megawatt site by an additional 21-megawatts which was completed in 2016.

Figure 5 - Asarco Mission Mine Complex Site Analysis. Source: http://itepsrv1.itep.nau.edu

Figure 6 - Avalon Solar 1 & II, Sahuarita, AZ - Source: TEP.COM

Lessons Learned

Evaluating earlier solar projects provides critical insight that should aid TOUA in the future. The Gunsight Solar Project in 1978, reveals how a successful project can remain a bench mark in the memories of community members for decades after the project. Conversely, a poorly maintained project or a project that is operated for a limited period can leave a negative impression with TOUA customers. TOUA should provide routine status updates on a projects development and lifecycle to avoid customer confusion or

misinformation. The Gunsight solar project also highlights the inherent risk that comes with any technology investment. Technological obsolescence will likely occur at some point during its operating lifetime. TOUA should be cognizant of changing technology and look to invest in proven technologies that have a higher likelihood to remain competitive for the near term.

While the San Lucy Village is not within the TOUA service territory, the San Lucy Farm Solar Project provides lessons on the importance of collaboration with federal partners, neighboring utilities and other Tribal entities. This project emphasizes that proper site analysis and selection is critical to economically deliver a project's power output. In addition, each project should have a project champion to see a project through, because the potential for conflicts in planning timelines may arise if parallel efforts are relying on another planned project (i.e. transmission capacity) alternatives should be planned beforehand so the project does not lose momentum. TOUA should look to collaborate with other tribal interests but take the lead on project development to insure the project timeline. It is recommended TOUA develop a general sense of awareness of changes in the marketable value of different energy resources, market demand, and available deliverability options before and throughout the life of any project.

Lastly, the ASARCO Mine Solar Project highlights the importance for the Tohono O'odham Nation to have a timely procurement processes and the readiness to move projects forward to keep partnerships alive. Obtaining site control and ensuring the appropriate business models are available preceding a project will help ensure project success. The ASARCO project also underlines the potential opportunity cost of not being prepared in these areas. TOUA should work closely with the Nation's Legislative Council, Economic Development and District offices to identify potential sites and any roadblocks that may prevent project deployment. TOUA should also consider a review of the Tribal Code and Plan of Operation to ensure it is appropriately updated to accommodate modern day renewable energy investments.

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Learning from Other Arizona Utilities

In an effort to learn from the other utilities in Arizona, TOUA invited Arizona Public Service Company (APS), Salt River Project (SRP), Tucson Electric Power (TEP), the Navajo Tribal Utility Authority (NTUA), and the Gila River Indian Community Utility Authority (GRICUA) to present on renewable energy, which took place at the Desert Diamond Casino on July 20, 2018. In advance of that meeting, TOUA requested the participating utilities address the following:

1. Brief overview of current solar/renewable projects and activities
2. What drives your company's position on the development of solar/renewable projects?
3. Method of financing projects and return on investment
4. What benefit do the solar/renewable projects provide to your customers?
5. How is any benefit funneled to your customers?
6. What is your company's future plan for solar/renewables?
7. How can TOUA or the Tribe find out about future opportunities to participate in an RFP process for future projects?

Provided below is a synopsis of each presentation given:

Navajo Tribal Utility Authority

NTUA's primary driver for developing large-scale renewable resources has been to create new income streams to help fund utility needs, job opportunities for community members, resource diversification and economic development. Secondary to this is the development of a small solar program intended to provide immediate power to the Nation's estimated 11,000 un-connected houses.

Completed in 2017, NTUA's first large-scale project is a 27.3 MW photovoltaic project known as *Kayenta I*. Construction financing was provided through the National Rural Utilities Cooperative Finance Corp with permanent financing through Rural Utilities Service. During construction the Navajo workforce was paid $5.2 million and about 241 Navajo employees received over 4,700 hours of specialized training in solar utility construction. The $5.2 million is expected to have $15.6 million economic impact (3x multiplier) for the Nation. The construction also generated $3,017,055 in taxes (5% sales tax) paid to the Navajo Nation and first-year sales tax is expected to exceed $211,852. After construction was completed, the project only provides 2 long-term jobs.

To complete the Kayenta project, NTUA formed a for-profit company to capture Investment Tax Credits and signed a two-year Energy and Environmental Attribute contract with SRP for renewable energy credits (RECs) that cover construction loan repayment. As part of the lease agreement, the NTUA will run power lines to 92 Navajo residences which previously had been without electricity. In August 2018 NTUA broke ground on a second identical project, *Kayenta II*, located at the same site. *Kayenta II* is expected to have similar benefits as the first phase with slightly lower sales taxes but higher construction wages and approximately 3,000 additional hours of training.

In June 2018 NTUA created the first majority Navajo owned 100 MW facility operating outside the Navajo Nation, which led to a power purchase agreement (PPA) partnership with Sacramento Municipal Utility District (SMUD). The Project Developer is an affiliate of NTUA Generation, Inc., which is a wholly owned subsidiary of the NTUA. The PPA is being offered as a 30-year fixed contract at a rate of $29.67 per MWh with the environmental attributes going to SMUD to meet their portfolio goals. The Project is owned 51:49% between the project developer and SMUD to capture and pass along tax benefits.

The NTUA is looking at additional projects including a 100-150 MW project near Cameron. The project would be developed like the Kayenta projects and add additional benefits to the local community with additional benefits in the form of communication and water services to the local area. The project is targeted to be online by mid-2020.

The NTUA also operates and maintains the largest off-grid residential solar fleet in the country. The fleet includes: 220 hybrid wind/solar units located throughout the service territory to provide off-grid service to un-connected homes. Seven different systems are available with varying levels of production up to 4 kWh per day. Customers pay a fixed monthly price and NTUA provides the maintenance.

NTUA recommends starting the process now to use full ITC credits, recommends RUS loads, and believes Savings/Revenues can be used to subsidize retail rates.

Salt River Project

Salt River Project is not regulated by the state but complies with the state's 15% renewables by 2025 renewable portfolio standard. SRP has since moved to a carbon-based plan aimed at reducing CO2 lbs./MWh by 40% by 2043. SRP reports seeing an increase in demand by large commercial customers for "Additive" renewable resources, i.e. new renewable projects that cab be operated and credited specifically to the customer. SRP reported challenges related to solar projects including the project's distance from load and related siting issues, as well as wheeling-related impacts. SRP's last request for proposal (RFP) was for 100 MW of renewable energy to be online by December 31, 2020 and resulted in 74 proposals from 28 different entities. SRP also reported increased demand in residential batteries.

Recent projects include:

- Copper Crossing Solar PV: Developer Iberdrola Renewables – PPA for 20 MW for 25 years
  - SunPower Monocrystalline panels – single axis tracking
  - Florence AZ – September 1, 2011 Commercial Operation
- Queen Creek Solar PV: Developer Juwi – PPA for 19 MW for 20 years
  - Polycrystalline Panels – single axis tracking
  - Queen Creek AZ – October 3, 2012 Commercial Operation
- Sandstone Solar PV: Developer Spower -PPA for 45 MW for 21 years
  - Polycrystalline panels – single axis tracking
  - Florence, AZ – December 30, 2015 Commercial Operation
- Pinal Center Energy Center: Developer NextEra – PPA for 20 MW + 10MW energy storage for 20 years
  - First Solar Thin-Film panels – lithium-ion batteries
  - Coolidge, AZ – April 23, 2018 Commercial Operation

Arizona Public Service Company

APS is a regulated utility and must comply with the state's Renewable Energy Standard requiring 15% of renewable resources by 2025. For operational benefits, APS is looking at Intermediate-scale batteries to be installed at various points on feeder (200-300 kW batteries) to handle back-flow/ancillary services instead of use of capacitors. APS is also testing batteries at end of feeder and next to substation that can be programmed in advance to dispatch in a manner that will provide demand-side management benefits.

APS current owns and operates the following:

- 37 MW Microgrid project to serve load Pocket
- Utility Scale Plants 10 sites totaling 210 MW

- Commercial Scale 132 Systems totaling 17 MW
- Residential 1,750 systems totaling 10.5 MW under APS control
- Battery Energy Storage Systems (BESS) to increase reliability in rural territory 2 MW/8MWh

Moving forward, APS is looking at the following renewable energy projects:

- APS owned battery storage to be dispatched between 3-8:00 PM for residential customer peak shaving, and load congestion to improve power quality.
- Energy Storage RFP for 106 MW to be located with utility solar. Not looking at solar by itself.
- Investment in Community Solar of $10M - $15M for the next 3 years to target limited income residential. Installations will be 4kW – 8kW and APS owned and operated.

APS reported that unlike rooftop systems, Utility Scale Tracking systems were still seeing 80% of the facility's capacity online at the time of system peak, providing peak savings to the utility. Operational Challenges reported by APS include erosion control, warranty management, new technologies, inverters, manufacturers exit (suggest 5-year full-wrap warranty), design for future stronger weather, upgrades, and disposal costs (one recycler Cleanline is in the Midwest and offers disposal at $35 per panel).

APS recommends that projects should consider design standards, insurance coverage, and to have an End of Life policy for disposal of panels.

Gila River Indian Community Utility Authority

GRICUA primary driver for renewable energy projects was for reliability, not profit. However, GRICUA anticipates additional benefits from their first solar project including long term operations and maintenance jobs, rate stabilization, revenue for energy assistance programs, land lease revenues for community, and community educational benefits. GRICUA also is careful in solar planning to minimize risk to the Community. This includes a solar policy that ensures that non-solar customers do not subsidize solar customers. This is ensured through GRICUA's "buy/sell" arrangement with solar customers where customers pay the full-retail tariff for all energy consumed, and all solar produced is separately metered and purchased by GRICUA at GRICUA's avoided cost rate.

Most of GRICUA's presentation reflected their lessons learned in the development of their first Solar RFP. Their current solar RFP was the result of a 3-year process. GRICUA conducted an analysis of residential use and determined it was not economic to retrofit older homes. Community Solar provided a better economic option. Proceeding with community solar, GRICUA performed extensive community outreach, and presentations with Council and economic committee, development of interconnection policies, determination of project location (community versus allotted lands), and initial land review.

The project site selected crossed two districts and presentations were given to both communities. The Community approved the use of the land and the site went through GRIC land review processes (formalized under the Hearth Act). The site is strategically sited near transmission lines and important GRIC customers. The RFP was initiated after the site was selected and sited (community acceptance, land review), but the land lease was still being negotiated. GRICUA presented various financing considerations including the use of the New Market Tax Credits and various loans by DOE, USDA, and DOI Energy & Economic Development. For simplicity, GRICUA decided to go with a PPA rather than forming a Development Company. The terms of the PPA will include 3rd party build/offtake provisions, no financial commitment by GRICUA, and assignment of risk to the project developer to the greatest extent possible.

GRICUA is working with other Community customers on smaller installation projects. GRICUA installed 48 kW of Solar Parking at its new building providing demonstration and education opportunities to the community.

GRICUA recommends that you know what you are getting with solar and understand your load shape with and without solar generation. It is also important to ensure you have the ability to back-up intermittence issues related to solar.

Insights from Arizona Utilities

Overall, TOUA made invaluable contacts to support them as they move forward with their own renewable energy project planning. NTUA provides a good example for utility scale solar that can provide a new source of revenue for utility operations, as well as partnerships that can result in a second utility scale project. On the other hand, GRICUA has provided a great model for community solar that minimizes investment risk and provides clean energy and education for the community. Both SRP and APS are investing in storage projects which is an example of a project that provides a new level of reliability to their customers. APS also discussed a Microgrid Project to serve a congested load pocket. All of which are viable options for TOUA to consider when planning their own renewable energy projects. It is important that TOUA first considers and identifies the purpose of the renewable energy project, whether it be a source of revenue, reliability, or educational, in order to distinguish the type of structure and level of investment that best suits the need.

Learning with TOUA Customers

One of the primary objectives of this study was to evaluate TOUA customer preferences and knowledge regarding solar energy. Through the development of a customer survey, TOUA sought to gather customer feedback while also taking the opportunity to use the communication channel to educate its customers on the customer-owned and community based solar systems and the cost realities of these investments. TOUA's hope through education was to counter some of the misconceptions about solar energy and the prevailing belief that solar could replace a customer's energy bill completely or was without any associated costs.

To reach a statistically significant representation (90%-95% confidence level) of its customer base TOUA needed to gather 250-340 responses. TOUA took three opportunities to gather the necessary feedback. The solar customer survey was administered on the following dates and times:

1. October 19, 2018 TOUA Customer Appreciation Day, Sells District
2. February 2, 2019 Tohono O'odham Nation Rodeo, Sells District
3. March 15, 2019 TOUA Direct Mail

Developing & Administering the Survey

The questions for the survey were developed based on a national study performed by the Smart Electric Power Alliance (SEPA) to gauge the overall interest in solar generation at the residential customer level. Through a collaborative process with TOUA staff, the survey questions were adjusted to reflect the energy needs of a typical TOUA customer. In general, the questions were designed to identify what district the customer resides in and their level of interest for investing in solar for their home or their community in the next five (5) years. Along with gauging their interest, the survey provided an educational opportunity to communicate the potential costs and benefits related to solar investments. Estimated costs for a rooftop solar system and community solar lease were provided based on NRECA data models developed by TOUA staff for contextual understanding.

The Customer Survey was administered using an online tool used to collect and analyze the survey results. The TOUA Customer Appreciation Day and the TON Rodeo are both events that receive high attendance and for that reason were the first two occasions that the customer survey was administered. Throughout the Customer Appreciation Day groups of TOUA customers entered the training room at the TOUA Office to view a brief presentation to provide context on Rooftop Solar and Community Solar for those who were not familiar with the terms before taking the survey. At the TON Rodeo tablets were used to administer the solar customer survey. On both occasions TOUA staff were on hand to help answer any additional questions and assisted customers who asked for help while taking the online customer survey.

To reach more of their customers, TOUA created a paper copy of the solar customer survey and mailed it out directly to customers. To incentivize customer responses, a five-dollar ($5) bill credit was offered to households completing and returning the survey.

Results of the Solar Customer Survey

The survey was answered by 370 TOUA customers from October 2018 – March 2019. Based on the data received, the customers have a genuine interest in solar energy development for their community. The following observations are drawn from each event:

TOUA Appreciation Day Results – October 19, 2018

Most of the customers participating in the survey (33 %) were from the Baboquivari District. When asked to rank the reason that best describes why they are interested in solar the majority chose to lower their monthly electric bill and to help the environment. When asked to choose between rooftop solar or community solar the majority (65%) chose community solar.

TON Rodeo – February 2, 2019

Most of the customers participating in the survey (22 %) were from the Baboquivari District. When asked to rank the reason that best describes why they are interested in solar the majority chose to lower their monthly electric bill and to help the environment. When asked to choose between rooftop solar or community solar the majority (44%) chose community solar.

Mail-In Paper Survey – March 15, 2019

The majority of the customers participating in the survey were concentrated in the San Xavier (26%) and Sells (23%) Districts. When asked to rank the reason that best describes why they are interested in solar the majority chose to lower their monthly electric bill and to help the environment. When asked to choose between rooftop solar or community solar the majority (41%) chose community solar.

Overall, customers surveyed were shown to have a strong interest in solar in general, and a preference for community solar as a more affordable option.

Customer Feedback

The survey provided a great opportunity to directly dialog with TOUA customers. When presented in person, the questions asked of staff highlighted that customers would benefit from additional education on the basics of solar photovoltaics, maintenance requirements, billing impacts, and how benefits would be received. Several questions were also received regarding state legislation being proposed at the time that would set new renewable energy targets for the state's investor-owned utilities and whether TOUA customers would be impacted. Additionally, customer's knowledge of, or experience with, previous solar installations in surrounding districts were highlighted and questioned for comparison with modern day systems.

The survey prompted two requests for TOUA staff to attend District meetings for further discussions on solar energy. Visits by TOUA staff to the Big Fields community and the Pisinemo District again highlighted the need for basic educational materials regarding how a solar system works, how much they would cost, and what benefits a customer might gain. In the Pisinemo District meeting, having only previously been exposed to the solar systems that were installed as part of a grant-subsidized program led by the community college, guests were surprised by the potential high cost of new solar systems. TOUA also received comments that the survey should also have allowed them to respond that they have no interest in solar at all.

Observations

The survey experience proved to be a worthwhile process to engage with TOUA customers and receive feedback. The general impressions received is that more education is needed on the basics of solar power and the cost and benefit realities of an investment in solar. By-in-large, TOUA customers were primarily incentivized to want solar based on the idea that it would save them money but a strong desire for environmental stewardship was also exhibited in the survey results. Customer's surveyed also demonstrated that they are not heavily influenced by decisions of community neighbors, nor seek to be influencers themselves when choosing to procure solar generation or not. Overall, customers demonstrated a balanced

desire for either customer-owned or community-sized solar investments driven by either an appeal for control over a personal system or the affordability of a community project.

The information gathered should be reviewed and incorporated into educational material that can be provided in conjunction with future customer events. TOUA should continue to poll its customers to monitor changes in customer needs and interests and level of understanding. Knowledgeable staff should continue to be available during future events to provide opportunities for TOUA customers to be heard. Direct District level presence is also important to maintain open lines of communications which will be necessary for future collaborative efforts.

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Learning from Existing Solar Customers

In addition to the customer survey, TOUA sought the experience and perceptions of existing TOUA residential and commercial customers whom benefited from small solar installations. The review was designed to gauge the level of participation customers have with the system, awareness of system production, maintenance required, and overall experience as solar customers.

Results of the case study are inherently limited by the available data of the existing projects. Prior to 2018, TOUA did not have the metering equipment installed to record the solar production of their customer's solar installations. Electric consumption data was reviewed to examine each customer usage before, during, and after the installation of photovoltaic system; however, the data provided proceeded the time period that production data was supplied for making it difficult to draw conclusions. Still, this case study attempted to gather the data available regarding the facilities installed, method of financing, impact on net household usage, and amount of customer-owned solar energy produced and purchased by TOUA.

Of the two (2) commercial and eleven (11) residential customer-owned installations, only one system was financed by the customer themselves. The remaining customers were beneficiaries of grant-funded projects.

Residential Solar Customers

Five residential customers in the Pisinemo District were outfitted with solar under one USDA grant while another five apartments in the Gu Achi District associated with a day school are beneficiaries of a system operated by the Bureau of Indian Education. One customer in the San Xavier District self-financed a residential system.

Pisinemo District

The 48 families who live in the Pisinemo District of the Tohono O'odham Nation reside in an area so remote that some had to get their power by stringing extension cords to a neighbor's house. Now, however, they have new solar panels to provide electricity for heating, cooling, and cooking. Residents of the district are now using the power of the sun, thanks to Tohono O'odham Community College (TOCC) and its partner, the University of Massachusetts–Lowell.

Using a grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA), the two schools gave 25 TOCC occupational technology students on-the-job training in solar panel installation – one home has a freestanding power system while others are tied-in to a grid.

TOCC's program is in response to a request from local community leaders who wanted to explore power sources that may help them supplement – or replace – the commercial utility grid. Five (5) homes have received either a small rooftop or pedestal mounted system.

Figure 7 - Pisinemo NIFA Grant Funded Solar Installations – Source: https://www.usda.gov

This project was funded under NIFA's Tribal Colleges Research Grants Program, which builds institutional research capacity at the 1994 land-grant institutions and funds projects to enhance student research skills. Research funded under this grant typically address community, reservation, or regional challenges.

Net Metered Solar Production Data Pisinemo Residential Customers				
	Customer 1	Customer 2	Customer 3	Customer 4
Dec-18	96	114	13	94
Nov-18	107	138	50	128
Oct-18	60	147	18	88
Sep-18	49		7	57
Aug-18	39		3	
Jul-18	57		6	
Jun-18	64		20	
May-18	98		49	
Apr-18	151		83	
Mar-18	108		29	
Feb-18	102		30	
Jan-18	68		30	
Average	83.25	133	28.17	91.75

Table 3 – Net Metered Solar Production data for the Pisinemo Residential Customers

System production data was provided for four of the five Pisinemo customers and available for a limited number of months in 2018 for two of the customers. Production is sparse and the net metered solar production shown in Table 3 reflects the smaller sizes of the installations in Pisinemo. Net Metered Solar Production in 2018 ranged from a low of 3 kilowatt-hours to a high of 151 kilowatt-hours. This would have an equivalent value of $0.17 to $8.73 in utility bill savings when calculated using the Schedule DG average 2018 rate of $0.0578 per kilowatt-hour. Net household usage for these four accounts ranged from an average monthly usage of 603 kilowatt-hours to 948 kilowatt-hours. It is unclear how much of the household use was offset by solar.

Each house received six Schott Solar 250-watt ASE-250-DGF/50 solar panels for a total of 1.5 kilowatts per house. TOUA staff mentioned that at some point the TOCC provided panels at some location had fallen down and had to be re-connected by TOUA staff. It is unclear if maintenance is being performed on the panels. Grant funded systems lack the production guarantees and maintenance oversight that prevails in modern solar lease agreements. Pisinemo customers were unreachable during the case study to discuss their experience with the systems.

Gu Achi District

Five homes in the Gu Achi District are owner-operated by the Bureau of Indian Education in association with the Santa Rosa Day School near the Santa Rosa village. The homes have been outfitted with 18 - 280-watt poly-crystalline based panels manufactured by Q-Cells/Hanwha for a total output of approximately 5 kilowatts. Systems were installed on the roofs of carports located at each residence.

Net Metered Solar Production Data Santa Rosa Day School Customers				
	Customer 1	Customer 2	Customer 3	Customer 4
201812	424	413	348	
201811	594	554	441	
201810	569	444	279	
201809	706	521	393	524
201808	732	584	137	540
201807	840	598		652
201806	778	617		731
201805	0	619		722
201804	0	420		567
201803	0	0		401
201802	180	0		173
201801	351	0		0
Average	574.89	530	319.6	538.75

Table 4 – Net Metered Solar Production data for the Santa Rosa Day School Residential Customers

System production data was provided for four of the five Santa Rosa Day School residents and available for a limited number of months in 2018. The apartment units have a higher rate of turnover and it appears that production might be only measured when a tenant is in place. Net Metered Solar Production shown in Table 4 for 2018, ranged from a low of 137 kilowatt-hours to a high of 840 kilowatt-hours. This would have an equivalent value of $8.04 to $49.31 in utility bill savings when calculated using the Schedule DG average 2018 rate of $0.0578 per kilowatt-hour. Overall excess generation of these units demonstrate the similarity in the system size and household use of these five accounts. Limited household consumption data was provided for three of the accounts. Based on the data, it appears the apartments all have similar builds and consumption patterns, ranging from a low of 308 kilowatt-hours to a high of 761 kilowatt-hours for an average monthly usage of approximately 530 kilowatt-hours, shown in Figure 11. Based on the data it appears that the size of the installed solar panels where deliberately matched to equal the expected monthly usage totals of the residents.

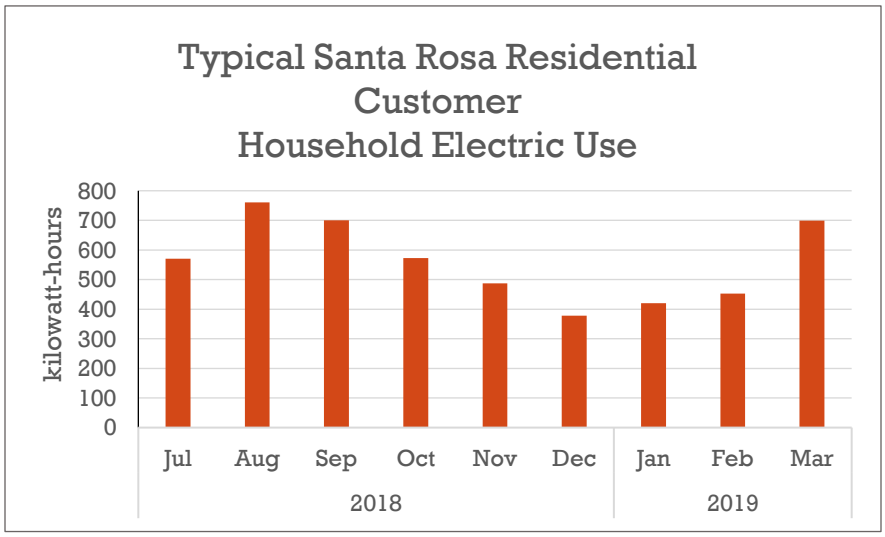

Figure 8 - Typical Santa Rosa Residential Customer Household Electric Use

During the preparation of the case study several former and current tenants at the Santa Rosa Day School were interviewed. Tenants lease the living quarters and have no knowledge of the origination of the system. One former tenant was of the belief that the plan was to retrofit all the apartment units located at the school. The tenant interview reported that living in a house with solar was a positive experience and it was her belief that the system operated normally and allowed them to save money on her monthly electric bill. Tenants reported that their electric bill remained around $70 per month which compared favorably against other tribal residents she spoke with and reflects the consumption patterns of the units. Tenants are not responsible for the maintenance of the system and are generally unclear on who provides the maintenance. In general, tenants reported having little knowledge of the systems and how solar works or impacts their bill. Upon discussing community solar with a former tenant as an alternative method for procuring renewable energy, the tenant believed that community solar was a good idea and they would be interested. Not knowing about community solar prior to the interview the former tenant thanked the interviewer and said they "learned something new today". Overall everyone interviewed was happy and supportive of solar energy but had no plans to invest personally in the technology.

Figure 9 - Aerial Image of Residential Solar near the Santa Rosa Day School

San Xavier District

One residential customer in the San Xavier District was interviewed. The customer had purchased a system through a local installer. According to their experience the system had only worked for one month, saving the customer $17 on their utility bill, before the inverter stopped functioning properly. The customer has since reached out to the installer and is still awaiting a response. Overall the customer appears to be in support of solar and batteries and believes they would have a positive experience if the systems worked. In contradiction of the customer's response, TOUA production data shows the system has been mostly online and generating, producing on average 70 kilowatt-hours per month, but has been as low as 0 kilowatt-hours per month and as high as 184 kilowatt-hours per month.

Commercial Solar Customers

For the Study two commercial customers were evaluated; the Santa Rosa Health Center in the Gu Achi District, and the San Xavier District Administration Building.

San Xavier District Administration Building

The San Xavier District Administration Building installed a solar canopy in its parking lot. Completed in June of 2013, the project was installed by Solar H20 and consisted of photovoltaic panels from SunPower mounted on a steel parking shade canopy and a 60-kilowatt inverter by Fronius International. The installation was made possible via a $200,000 grant issued by the Grand Canyon Trust and managed by the Wa:k O'odham foundation established by the San Xavier District. The solar installation allowed the District Administration building to qualify for Gold Lead Certification issued by the U.S. Green Building Council.

Figure 10 - Aerial View of Solar Canopy at San Xavier Admin Bldg

Source: https://www.google.com/maps

Production data was reviewed for 2018. November 2018 the system appears to be offline and had otherwise averaged 4,456 kilowatt-hours per month with a low of 3,114 and a high of 6,525 kilowatt-hours. Based on the Schedule DG rates this would be a monthly credit estimated at $180 to $377 to the customer. The system appears to have peaked in the spring period with lower production during the summer season. This is counter to what would be expected of a system in Arizona which typically yield their highest production in the summer months. It is unclear whether the panels orientation, panel soiling, or other system malfunction had any impact on the systems output in 2018.

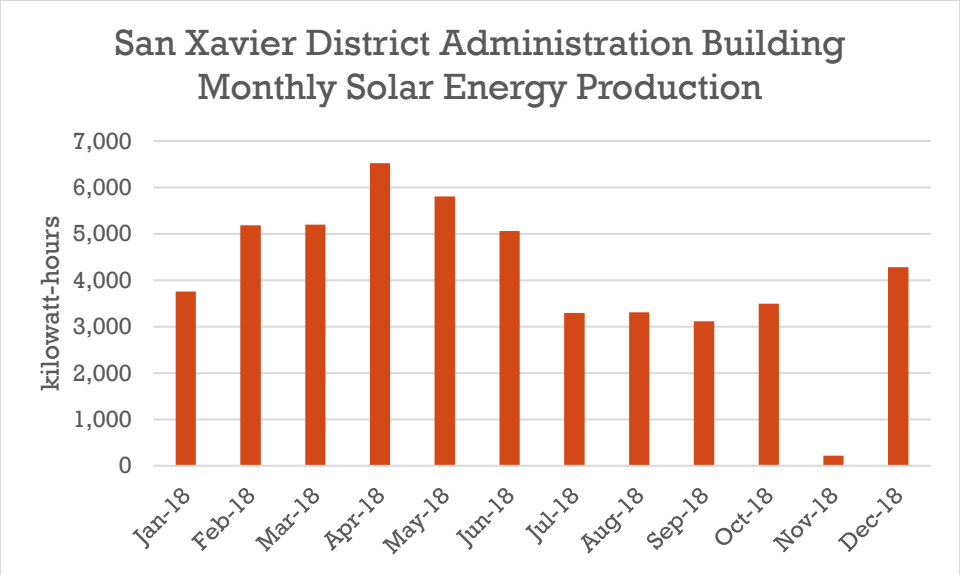

Figure 11 - Solar Production Data for San Xavier Admin Bldg

Customer usage data was reviewed for the 2012-2015 months preceding, during, and after the installation of the solar canopy. Prior to the added solar, the customers energy requirements exceeded 11,000 kilowatt-hours during the summer months. During the first year of solar, customer usage peaked at 13,769 kilowatt-hours but also exhibited negative energy consumption in certain months. One year later consumption usage appears less variable, peaking at 9,671 kilowatt-hours. While the peak usage data provided for the months during the second year of the installation do show a reduced peak and more consistent usage patterns, the variability in data provided and lack of corresponding production data at this time make it difficult to draw conclusions or verify customer's claims of energy savings.

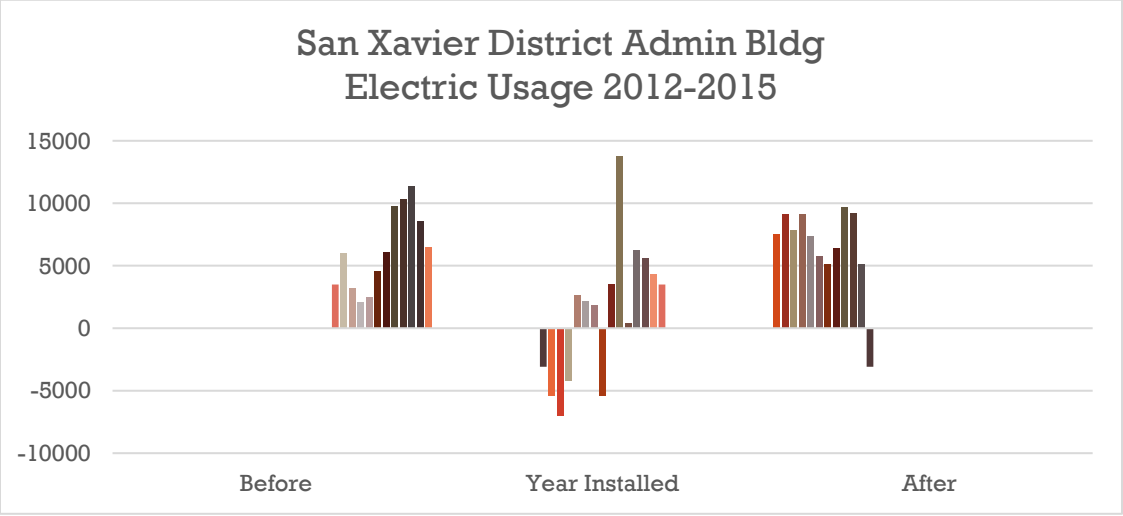

Figure 12 - Monthly Customer Usage Before, During, and After Installation of Solar Canopy

An interview with the Districts Procurement Manager, Mr. Richard De La Cerda, revealed that the District's overall experience with the solar installation has been positive. Mr. De La Cerda believed that the solar energy has reduced the buildings energy costs by approximately 30%. Shortly after the system was operational in 2013, the District's Vice Chairman was quoted saying the system was saving the district

about $1,000 per month. The system has required very little maintenance and any maintenance requests are handled by Solar H20. Mr. De La Cerda was certain they would make the same decision again and the district has recently gone out for bids in August of 2018 for additional solar shade structures to be added to a new 6,452 square foot Senior Services Center and an existing 5,603 square foot maintenance building. This District will be self-financing the newly planned solar investments. Presently the District is not looking at additional investments in battery storage and Mr. De La Cerda did not believe they would be interested in a community solar project since they are already solar owners themselves.

Santa Rosa Health Center

The Santa Rosa Health Center located in the Gu Achi District has five outpatient exam rooms, three dental chairs, and an optometry exam room to serve the local community. The existing solar was installed and operational in May of 2012. The Santa Rosa Health Center's solar installation consists of four (4) strings of ground-mounted solar panels. Produced by SHARP, the polycrystalline solar panels have a PTC[1] rating of 216.5 watts per panel and are connected to a 60-kilowatt Solectria grid-tied inverter. The Santa Rosa Health Center was the first solar installation on TOUA's distribution system.

Figure 13 - Aerial Image of Santa Rosa health Center's Ground-Mounted Solar

System production data was reviewed for 2018. The data showed that the system was functioning well in January 2018, producing 1,820 kilowatt-hours in that month and resulting in a Schedule DG credit of approximately $105. Since January the system output has declined at a near constant rate and has been completely offline in recent months. The health clinic was contacted during the study and the current staff was unaware of the systems relation or impact to the health clinic, and persons knowledgeable of the system were not currently employed. The interviewee mentioned that they were personally in strong support of solar in general and was an owner of a residential solar system as a Tucson Electric Power customer.

[1] PTC or PCUSA Test Condition more closely measures real world test conditions versus the manufacturers STC or standard test condition.

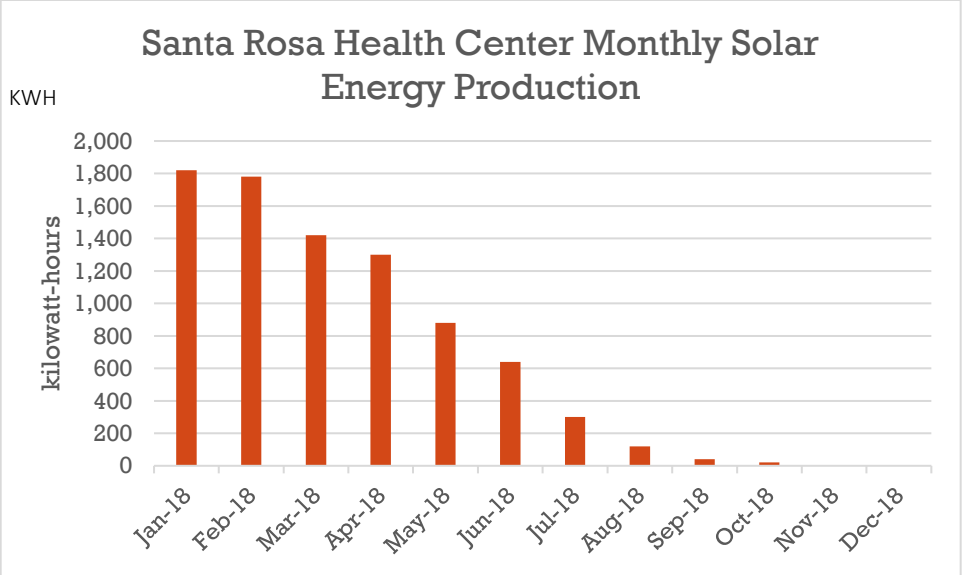

Figure 14 - Solar Production Data for Santa Rosa Health Center

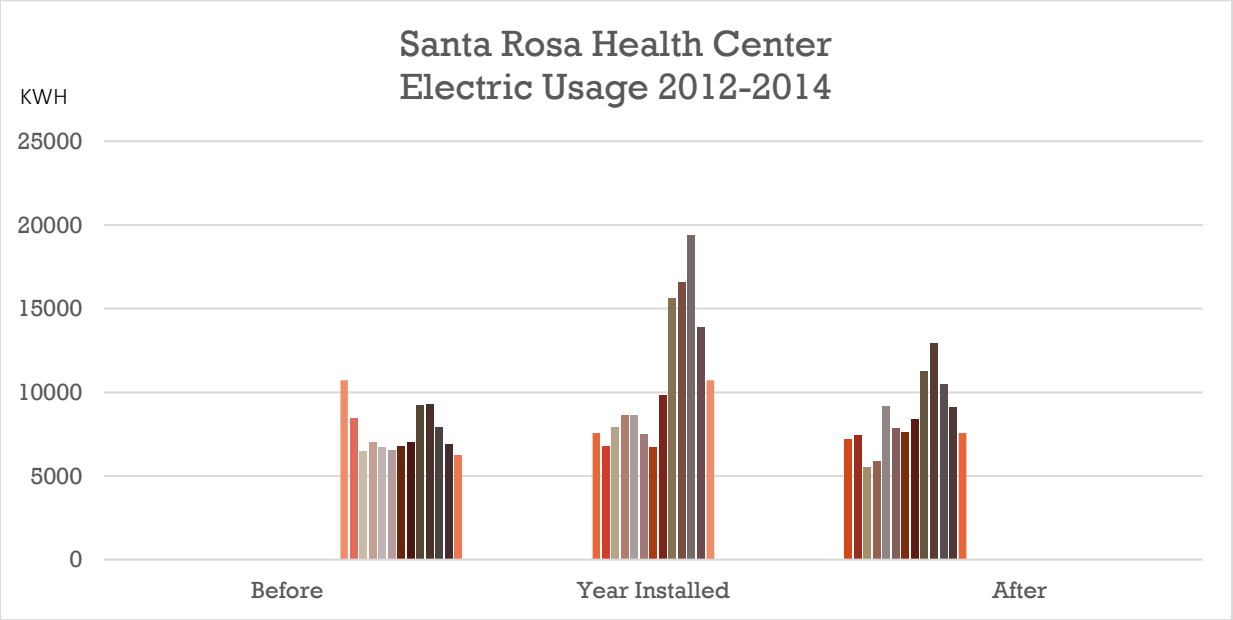

Figure 15 - Monthly Customer Usage before, During, and After Installed Solar

Customer usage data was reviewed for the 2012-2014 months preceding, during, and after the installation of the solar. Prior to the added solar, the customers energy requirements exceeded 10,000 kilowatt-hours during the summer months. During the first year of solar, customer usage peaked at 19,380 kilowatt-hours in July 2012. One year later consumption usage appears less variable, peaking at 12,960 kilowatt-hours in August 2013. While the peak usage data provided for the months during the second year of the installation do show a reduced peak and more consistent usage patterns, the variability in the data provided make it difficult to draw conclusions.

Lessons Learned from Existing Solar Customers

Review of existing systems installed on TOUA's distribution system highlights customers who have been beneficiaries of systems and have not taking part of planning, constructing, or maintaining the systems. While installations have created some visibility and support for solar generated resources, customers generally lacked the knowledge of how they worked or the full impact on their utility bill. Similar to the recommendations gained through the customer survey, TOUA should develop educational materials on the basics of solar generation and basic maintenance practices.

Due to the nature of facilities being financed through external grants, it is possible that existing facilities are contributing to the misconceptions of solar energy being free. Of the systems reviewed, only the Santa Rosa Day School systems had the potential to fully offsetting the customers usage. TOUA may review how the consumption and production day are exhibited on the customer's utility bill to more clearly identify to the customer how the systems are impacting monthly utility costs. Additional information and or training on maintenance of the solar system as well as how it is connected/serves the residence may contribute to a better understanding of the solar asset.

With most of the systems being financed through external grant mechanisms, existing systems might be lacking the standard production guarantees that typically are included in solar leases that help ensure installers are fully maintaining the systems. TOUA should provide a courtesy inspection and panel cleaning to help ensure the systems are functioning to their fullest capacity and should advise customers how to self-monitor the systems.

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Conclusion

TOUA's examination of past solar projects, other Arizona utilities' renewable energy programs and solar projects, customer survey, and customer's experience with installed solar yields valuable lessons for TOUA and creates new pathways and opportunities to dialog with its customers. The exchange with customers has highlighted existing support for customer-owned and community based solar systems, as well as emphasizes the general need for basic education on the fundamentals and potential costs and benefits of solar power. Based on the Study, the following observations are provided as recommendations for future TOUA decision making.

Purpose

- Previous TON efforts and efforts made by other Arizona utilities highlight the importance of having a clearly defined project purpose. The project purpose will aid decision making when identifying the system design and site selection. Whether the purpose is to develop new sources of revenue, target specific reliability needs, or environmental stewardship, the project's purpose will distinguish the scale of the system, level of investment, business vehicle, and site requirements needed for the project's success.

Customer Education

- While customers are generally supportive of solar, customers lack a basic understanding on how solar systems work, how they are financed, maintenance requirements, and TOUA's distributed generation policies.
- Communicating on a regular basis with the community about prior/existing/planned solar projects' purpose and life cycle is important. Regular newsletter, emails, or radio announcements will help eliminate misinformation from spreading.
- While federally grant-funded projects may assist in developing and deploying new projects, grants may also be contributing to perception that solar power is free.
- Additional information or training on maintenance and bill credits for existing residential solar system as well as how it is connected/serves the residence may contribute to a better understanding of the solar asset for the customer.

Collaboration

- When projects depend on parallel projects, (i.e. transmission capacity projects) outside of TOUA's operational boundaries, having alternatives planned will make the project more robust. Monitoring and participating in the efforts of others may help provide mutual benefits. Planning and communication will take a large role in these types of projects.
- Obtaining site control and ensuring the appropriate business models are available preceding a project will help ensure project success.
- Having a project champion to lead planning schedules and ensure all partnerships are adhering to the planned schedule can insure TOUA's readiness to respond quickly to new opportunities.

Market Awareness

- Developing awareness for changes in the comparable value of distributed generation resources, market demand, and available deliverability options can contribute to a project's success and help buffer against investment risks.