U.S. Department of Energy
Energy Efficiency and Renewable Energy

Native American Sustainable Energy Systems – Navajo Solar Electric Case Study

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

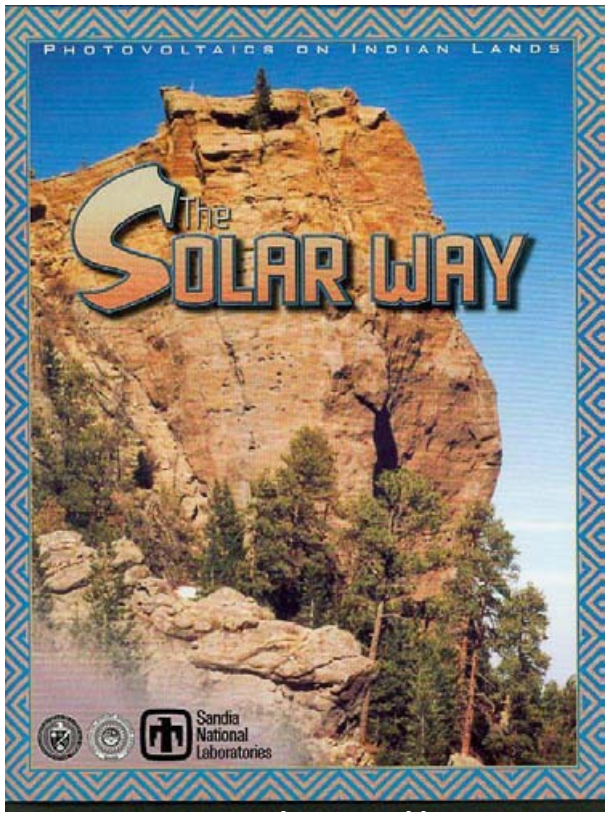
Sandia National Laboratories

Where is Sandia National Labs?

- New Mexico
- California

- Nevada
- Hawaii
- Texas

The Solar Way: Photovoltaics On Indian Lands Published At Sandia



The full-color, 60-page document illustrates the myriad uses of PV on tribal lands throughout the United States.

The book uses the Seven Generations philosophy to come to organize the material.
Caring for the earth and things on it, and living as sovereign people for Seven Generations

The book is intended to help tribes make informed decisions about photovoltaics.
With extensive contacts listed, tribes can network and also conveniently seek technical assistance as they move forward with solar electricity projects.

http://www.sandia.gov/pv/docs/solarwaytoc.htm

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The Navajo Nation

- The Navajo Nation is the largest tribal indigenous nation in the US.
- There are ~ 280,000 Navajo Nation members.
- The tribal land base covers ~ 26,000 square miles in New Mexico, Arizona & Utah

Approximately 18,000 Navajo households remain without electricity

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Why Photovoltaics (PV) on the Navajo Nation?

- Remote and isolated location
- Expensive line extension costs
  - Approximately $27,000 per mile
- Unique customers who never had electrical service
- Viable technology option that fits in well with the culture
- Tribal utility status
  - Available alternative financing options to cover high capital costs of PV equipment

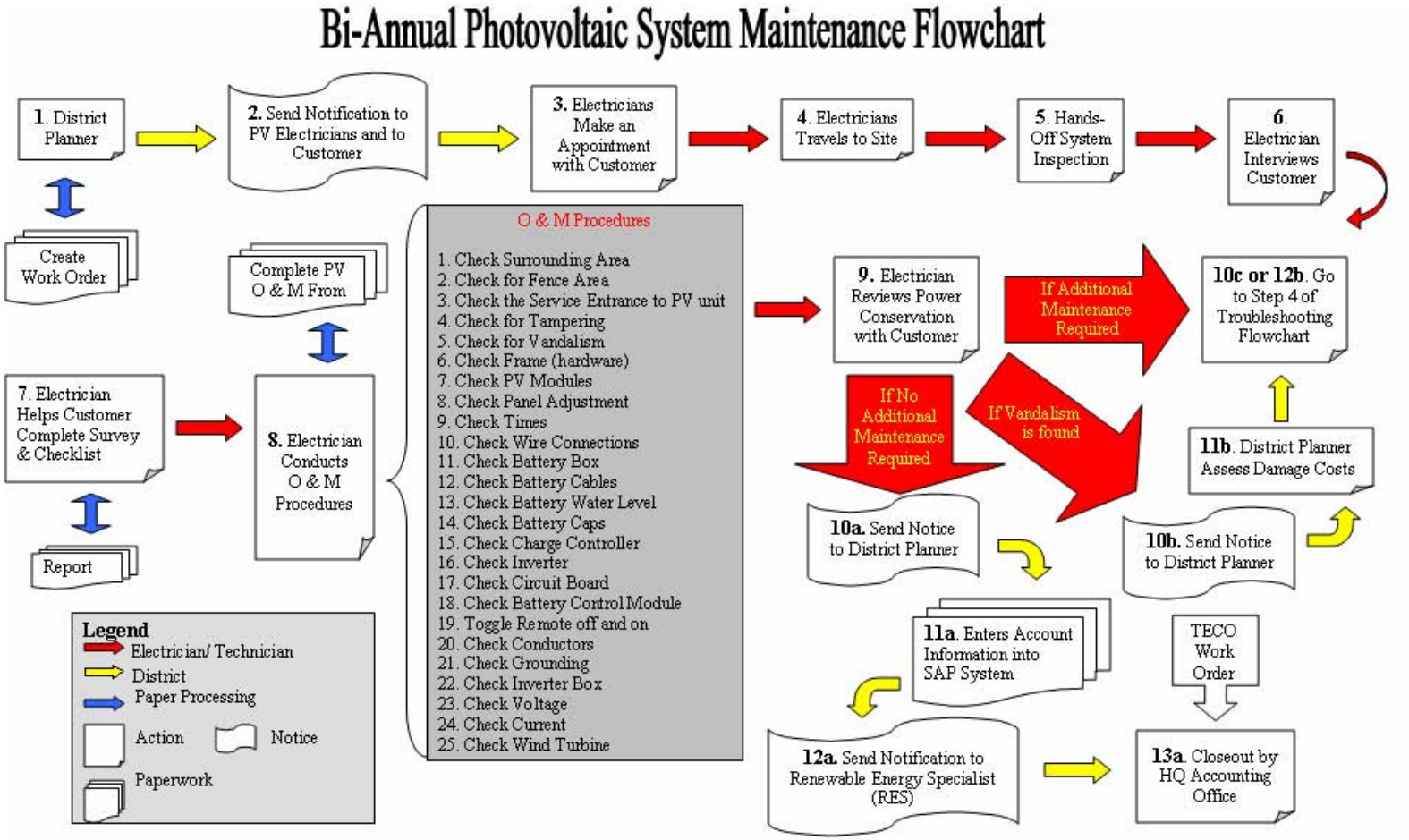
Monument Valley, Utah located on the Navajo Nation

After a decade of implementation of an alternative off-grid energy source, NTUA is a leader in the rural solar electrification.

DOE/Sandia's technical assistance to the Navajo Nation through NTUA's Solar Program

- Support NTUA as a Leader in Rural Solar Electrification
- Assist NTUA Solar Program Coordinator to create a sustainable program
- Convey NTUA's success in solar to others, including the Department of Energy

In 2000, DOE, Sandia and Navajo Nation signed a MOU for collaboration and technology transfer for the Navajo Nation, which emphasizes energy, environment, education, economic development, communication



The flowchart symbols, legend, and formatting were taken from NTUA's existing PV installation process.

Customer Education: Managing Loads

NTUA electrician, Vircynthia Charley reviews load management with customer

- The O&M process begins with customer education.
- Customers must realize that electricity produced from the PV system is available in a limited quantity.
- Customers must learn to manage their electrical loads in the cycle of usage of a PV system to keep the battery charge level balanced.
- Customer service representatives and electricians review with the customers how to manage their limited electrical supply in order to ensure the sustainability of the PV system.

Sandia in partnership with NTUA created an education video to help customers make an informed decision about requesting PV or hybrid system

NTUA's partnership with DOE/Sandia helped to create a sustainable solar program

- **External Technical Advice**
  - Specification creation and modifications
  - Technical evaluations of procurement proposals (RFPs)
  - Existing O&M processes documented & improved
  - Training activities for electricians and customer service representatives
  - PV panel failure analysis and report
  - System optimization testing and recommendations
  - Future development of O&M data which can be added to the DOE Reliability Database
- **Customer Education – "Power from the Sun" video**
  - The O&M process begins with customer education.
  - Customers must realize that electricity produced from the PV system is limited and they must manage their electrical loads.

NTUA hybrid unit delivered to Sandia for testing. Sandia and SWTDI technical staff with NTUA's Larry Ahasteen

Along with appropriate equipment, a sustainable solar program includes operations and maintenance processes and educated end-users

2005 TEP/ Sandia College Interns

Pictured left to right at Hopi Old Oraibi Village: Tanya Martinez, Deborah Tewa, Sandra Begay-Campbell, and Jennifer Coots.

Tanya Martinez (Mi'KMaq) Power Engineering graduate student, University of Massachusetts – Lowell, BS - Electrical Engineering.
Her paper "*Remote Monitoring System Design - Sustainable Systems For The Navajo Tribal Utility Authority".*

Deborah Tewa (Hopi) BS - Indigenous Studies, Northern Arizona University.
Her paper *"NativeSUN: A Model for Sustainable Solar Electric Systems on Indian Lands".*

Jennifer Coots (Navajo) MBA - Finance, University of New Mexico.
Her research focused on the tribal housing mortgage finance for renewable energy systems.

2004 TEP/Sandia College Interns

Pictured left to right at Hopi Tribe Petroglyph: Benjamin Mar, Jennifer Coots, Colin Ben, Deborah Tewa, & Sandra Begay-Campbell.

Benjamin Mar (Cherokee), BS – Electrical Engineering, Worchester Polytechnic Institute
His paper entitled **"***Navajo Tribal Utility Authority: Photovoltaic Hybrid Operation and Maintenance Process for a Sustainable Program*"

Jennifer Coots (Navajo), MBA – Finance, University of New Mexico
Her paper entitled *"A Decade Of Changes To An Alternative Power Source For A Rural Utility."*

Colin Ben (Navajo), MA – American Indian Studies, University of Arizona. His paper entitled *"Researching Renewable Energy Systems Available to Indian Country*"

Deborah Tewa (Hopi), BS - Indigenous Studies, Northern Arizona University.
Her research focused on DOE's Reliability Database for Off-grid PV systems.

2003 DOE Office of Science Interns

Pictured left to right at Navajo - Monument Valley: Keith Candelaria, Velissa Sandoval & Shawn Tsabetsaye.

Keith Candelaria (San Felipe/Jemez), BS - Environmental/Earth Science, Dartmouth College
His paper entitled, *"Native American Renewable Energy Approaches: Navajo Tribal Utility Authority and NativeSun."*

Velissa Sandoval (Navajo/Zuni), BS - Electrical Engineering
Her paper entitled, *"Women Champions in Solar Energy."*

Shaun Tsabetsaye (Zuni) is a graduate student in electrical engineering, University of New Mexico, BS – Electrical Engineering.
His paper entitled, *"Navajo Tribal Utility Authority: Electrification Demonstration Program - Developing a Sustainable Tribal and Rural Co-operative Solar Program".*

Suggestions for the future…

- Invest / procure additional PV equipment
  - USDA RUS loan use for additional PV / hybrid equipment or other solar service products
    - Lease-to-purchase high efficiency PV refrigerators (for those who can't afford the hybrid tariff)
  - HUD NHA partnership for zero energy off-grid homes with integrated PV system
- Develop other renewable energy for the Navajo Nation
  - Wind farm development
  - Biomass development at old sawmill plant
  - Distributed energy resources (DER) for clusters of remote homes
- Participate with Navajo Nation in energy and water policy planning through system modeling
  - One of Sandia's goals is to construct models and system capabilities to help people build or rebuild their nations and communities
  - This process includes implementation partners:
    - To apply systems approaches and assessment tools to characterize key needs related to technology and system-level factors
    - Understand the key needs and proposed solutions based on factors such as security, economics, culture, etc.

Today, approximately 18,000 Navajo households remain without electricity