## ARTICLE IN PRESS

The Electricity Journal xxx (xxxx) xxx-xxx

ELSEVIER

Contents lists available at ScienceDirect

# The Electricity Journal



journal homepage: www.elsevier.com/locate/tej

# Navajo residential solar energy access as a global model

## Sandra K. Begay

Sandia National Laboratories, United States<sup>1</sup>

### ARTICLE INFO

Keywords: Navajo Indian tribes Solar energy Solar residential system Photovoltaic Off-grid systems

## ABSTRACT

This case study focuses on the Navajo Nation's efforts to provided residential power access through solar photovoltaic systems to some of its approximately 34,000 remote off-grid tribal members. The solution the Nation has adopted in collaboration with Sandia National Laboratories offers insights into how the Navajo Tribal Utility Authority's work could serve as a residential model to meet the needs of the 1.2 billion people globally who are without electrical residential power.

#### 1. Introduction

#### 1.1. Background of Navajo electrification

When Vircynthia Charley was a young girl growing up on the Navajo Reservation in the 1970s, she did not have running water to drink or any system for sewage waste, heat, or electricity. If her grandmother saw her sitting idly, she would tell her to make herself active: go cut and haul wood to heat their hogan (traditional Navajo home) or go herd the sheep. During schooldays, Ms. Charley dutifully took the 50-mile, one-way bus ride away to attend public school, then came home and did her chores before trying to do her homework by the light of a kerosene lamp at night. After high school, she joined the army and was deployed abroad to defend our country, but was honorably discharge a couple of years later due to injuries from the Desert Storm conflict. She returned to the Phoenix area and got a job as an electrician outside of the reservation. She enjoyed putting her knowledge to use and perfected her trade over her 15-year career.

Ms. Charley was also exposed to modern amenities such as television, indoor plumbing and heating, which started her heartfelt desire to make these modern comforts available to her Navajo people. Ms. Charley maintained this desire to electrify the homes of her neighbors when she joined the Navajo Tribal Utility Authority (NTUA), a Navajo Nation's tribal enterprise, as an electrician in the early 1990s. Originally employed as a journeyman, Ms. Charley's responsibilities were responding to service calls, outages, meter reading and unfortunately, shutting off electrical power to those who could not pay their bills. Her assignments and duties continued to grow over time, as did her original desire to electrify the homes of her people, the Navajo Nation.<sup>2</sup> (Fig. 1)

The Navajo Nation, or Diné Bikéyah ("Land of the People"), is the largest American Indian reservation in the United States. The reservation extends throughout northeastern Arizona, northwestern New Mexico, and southeastern Utah, totaling 27,000 square miles and about 332,000 Navajos, with fewer than 45,000 Navajos (13%) living off the Navajo Nation.<sup>3</sup>

The reservation is ecologically characterized as a high plains desert and is spotted with mesas and canyons. It contains significant natural resources, including surface water and groundwater, rangelands, forests, irrigated farmlands, lakes, fish, and wildlife, as well as substantial reserves of coal, oil and natural gas, wind and outstanding solar resources. With over 270 sunny days a year, the Navajo Nation is the largest contiguous premium solar resource area in the West, with over 424 square miles of prime development area<sup>4</sup>, equating to over 3 GW in solar PV potential.<sup>5</sup> However, the Navajo Nation has designated land use plans throughout the Nation with minimal non-allocated land for

https://doi.org/10.1016/j.tej.2018.07.003

1040-6190/ © 2018 Elsevier Inc. All rights reserved.

Please cite this article as: Begay, S.K., The Electricity Journal, https://doi.org/10.1016/j.tej.2018.07.003

E-mail address: skbegay@sandia.gov.

<sup>&</sup>lt;sup>1</sup> Sandia National Laboratories is a multi-mission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. <sup>2</sup> Beyond the Grid: Solar power on the Navajo Nation video. Arizona State University film project by Courtney Columbus, Katrin Mehler, Brittany Nixon, and Lisa Marie Schlesinger https://vimeo.com/194008631

<sup>&</sup>lt;sup>3</sup> http://navajotimes.com/news/2012/0112/012612census.php.

<sup>&</sup>lt;sup>4</sup> Arnold Leitner, Fuel from the Sky: Solar Power's Potential for Western Energy Supply, report for National Renewable Energy Laboratory, July 2002, NREL/SR-550-32160.

<sup>&</sup>lt;sup>5</sup> Doris, E., Lopez, A., Beckley, D., Geospatial Analysis of Renewable Energy Technical Potential on Tribal Lands, NREL, 2013, DOE/IE-0013.

## ARTICLE IN PRESS

#### The Electricity Journal xxx (xxxx) xxx-xxx



Fig. 1. Navajo Nation field visit photos of Canyon de Chelly, AZ and Kayenta Solar Farm, AZ. Source: Jessica Lin.

#### development.

Historically, Navajo's economy was based on farming, hunting, and grazing of livestock. The Navajo people have traditionally practiced a herding lifestyle that requires large tracts of land to support grazing livestock such as sheep and cattle, leading to a traditionally dispersed population. As a result, non-electrified homes could exist anywhere from 1 to 45 miles away from the electrical grid.<sup>6</sup> Consequently, it is cost-prohibitive to provide utility services to individual homes on much of the Navajo Nation (Fig. 2).

The Navajo Nation is the least electrified of all Indian lands; the Navajo reservation accounts for 75% of un-electrified Indian house-holds.<sup>7</sup> An estimated 32% of Navajo Nation's inhabitants lack electricity or 34,000 members are without electricity.<sup>8</sup> The cost to electrify off-grid homes with line extensions could be approximately \$35,000 single-phase or \$60-80,000 three-phase per mile.<sup>9</sup> At this rate, it could cost as much as \$350 million over a period of 10 years to provide electricity to off-grid Navajos.<sup>10</sup> The Navajo Tribal Utility Authority (NTUA), which services the majority of the Navajo Nation, can afford the cost of construction including right-of-way costs in areas with a population density of more than eight homes per mile. Below that number, the costs fall on individual families who cannot afford the electrical line extension to

electrifying their home.

#### 1.2. Definition of U.S. energy access

Energy access discussions refer to those Americans that do not have electricity because they lack grid-tied power or distributed resources. There are about half a million Americans without basic electricity service, or who live in energy poverty. Energy poverty is defined as the "inability to cook with modern cooking fuels and the lack of a bare minimum of electric lighting to read or for other household and productive activities at sunset".<sup>11</sup> Most of these people live in overseas territories and on American Indian reservations.<sup>12</sup>, <sup>13</sup> In fact, tribal lands have the highest rates of un-electrified homes in the contiguous United States and Alaska.<sup>13</sup>

According to the International Energy Agency (IEA), modern energy services are crucial to human well being and to a country's economic development.<sup>14</sup> The IEA asserts that access to modern energy is "essential for the provision of clean water, sanitation, and healthcare and for the provision of reliable and efficient lighting, heating, cooking, mechanical power, transport, and telecommunication services". The graph below illustrates the link between electricity and the Human Development Index. From an economic development standpoint, electricity has been reported to increase literacy rates,<sup>15</sup> which has an effect

<sup>&</sup>lt;sup>6</sup> Cata, Nora, Sustainable Rural Electrification: Residential Solar Energy on the Navajo Nation, Sandia National Lab, 2012.

<sup>&</sup>lt;sup>7</sup> U.S. Energy Information Administration. Energy Consumption and Renewable Energy Development Potential on Indian Lands. SR/CNEAF/2000-01. April 2000. Table ES

<sup>&</sup>lt;sup>8</sup> Testimony by the Navajo Nation to the Regulatory Commission Washington, DC 20426, Grid Reliability and Resilience Pricing, Docket No. RM 8-1-000, October 2017.

<sup>&</sup>lt;sup>9</sup> Battiest, Terry. "Navajo Tribal Utility Authority Solar Program System Data and O&M Initiative for DOE Solar Technologies Database." Tribal Energy Program intern research paper, Sandia National Laboratories, 2007. SAND #2010-7617 P.

<sup>&</sup>lt;sup>10</sup> Bain, Craig, Crystal Ballentine, Anil DeSouza, Lisa Majure, Dean Howard Smith, and Jill Turek. "Navajo Electrification for Sustainable Development: The Potential Economic and Social Benefits." American Indian Culture and Research Journal 28, no. 2 (2004): 67-79.

<sup>&</sup>lt;sup>11</sup> UN Development Programme, Energy Services for the Millennium Development Goals, in pursuance of UN Millennium Development Goals (New York, 2005).

<sup>&</sup>lt;sup>12</sup> World Bank. World Development Indicators 2015: Access to electricity (% population). Last updated July 2015. http://data.worldbank.org/data-catalog/ world-development-indicators. Accessed July 15, 2016.

<sup>&</sup>lt;sup>13</sup> U.S. Energy Information Administration. Energy Consumption and Renewable Energy Development Potential on Indian Lands. SR/CNEAF/2000-01. April 2000. Table ES-3.

<sup>&</sup>lt;sup>14</sup> International Energy Agency, World Energy Outlook 2017, Paris, France, 2017. http://www.worldenergyoutlook.org/resources/energydevelopment/.

<sup>&</sup>lt;sup>15</sup> Akanksha Chaurey and Tara Chandra Kandpal, "Assessment and evaluation of PV based decentralized rural electrification: An overview," Renewable

Download English Version:

# https://daneshyari.com/en/article/11007974

Download Persian Version:

https://daneshyari.com/article/11007974

Daneshyari.com