

Coping with Climate Change: Options for the Navajo Nation

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Introduction

This project reviews the options to reduce the Navajo Nation's vulnerability to the future impacts of climate change while improving current economic and livelihood opportunities for tribal residents. Climate change models for the US Southwest predict increased aridity and desertification which may have detrimental impacts on the tribe's current economy and Navajo livelihoods.

At the same time, climate change may open new economic opportunities, as the Southwest increases its demand for renewable and non-fossil fuel energy. The Navajo Nation seems to be well positioned to capitalize on this rising demand and become an energy provider. Currently, the Navajo Nation is pursuing a new coal plant at Desert Rock, a development aimed at improving the economy and creating local jobs; however, many Navajo people oppose the plant for cultural and environmental reasons.

Our project will compare alternatives to the coal plant, such as geothermal, solar, and wind power generation, and present a tool to assist Navajo Nation decision makers when choosing among multiple economic development and energy alternatives. Our aim is to contribute directly to an adaptation strategy for the Navajo Nation as well as indirectly to a mitigation strategy for the tribe and the greater Southwest region by improving the local economy, finding viable alternatives to the coal plant, and providing consumers with an additional source of non-fossil fuel energy.

Overview of the Navajo Nation

The Navajo Nation is the largest federally-recognized Indian tribe in the country with a population over 180,000 and an area of 17.5 million acres spanning Arizona, New Mexico, Utah, and Colorado.¹ The Navajo Nation government consists of three branches: the Navajo Nation Council comprised of an 88-member legislature, a President who serves as the Executor for the Executive branch, and a judicial branch with district courts and a Supreme Court.²

Although the Navajo Nation is often seen as a "model" tribe regarding many issues (for example, the Navajo judicial system is often viewed as a model tribal judicial system for other tribes to follow), the Navajo Nation faces the same dire problems as many other tribes across the country. The economy of the Navajo Nation is often characterized as similar to the economy of developing countries. In 2004, the unemployment rate on the reservation was 48%, while the average rate of unemployment in the United States is 5.7%.³ The per capita income of the Navajo Nation in 2004 was \$7,734 and the U.S. average was \$30,547.⁴ Other numbers are just

as bleak – 43% of the Navajos on the reservation live below the poverty line and only 56% have a high school diploma.⁵

The Navajo Nation relies on three main sources for revenue. The most important source is mining, which made up approximately 51% of the tribe's revenue in 2003.⁶ As a sovereign nation, the Navajo Nation imposes taxes on the reservation just as any other government can do, thus, taxes on the reservation accounted for 32% of the tribe's revenue in 2003.⁷ A large percentage of the taxes come from taxing mining operations on the reservation. Lastly, tourism accounted for 17% of the revenue in 2003.⁸ The reservation encompasses many attractions, such as Canyon de Chelly and Monument Valley, and it borders other large attractions, such as the Grand Canyon and Lake Powell. It is also a destination for many travelers interested in learning more about Native culture. The Navajo Nation holds various events like the Annual Navajo Nation Fair and various Indian markets. In 2003, there was an estimated three million visitors on the reservation.⁹

As noted above, mining is essential to the Navajo Nation's economy. But, this is not a new source of revenue. The Navajo Nation has a long history of natural resource extraction and its economy became dependent on this mining back in the 1920s. It is important to note that past resource extraction has not been run by a tribal entity; rather, the outside private sector has come onto the Navajo Nation to mine and simply pay part of their royalties to the tribe.

As of recent, the tribe relied heavily on four mines as a source of revenue and source of employment. Low-sulfur coal from the Navajo Mine is burned at the Four Corners Power Plant, which began operation in 1963, and power is delivered to utilities in Arizona, California, New Mexico, and Texas.¹⁰ The mine is operated by BHP Billiton and the plant is operated and owned by Arizona Public Service Company (APS).¹¹ The Navajo Mine is one of the largest employers on the reservation, employing more than 350 people.¹²

The Kayenta Mine, operated by Peabody Energy, began operation in 1973 and employs approximately 400 workers.¹³ Coal from the mine is crushed then shipped to the Navajo Generating Station.

Adjacent to the Kayenta Mine was the Black Mesa Mine, which was also operated by Peabody Energy. This mine employed about 240 workers and shipped steam coal to a generating station in Nevada.¹⁴ The generating station closed operations in January 2006, and because it was the sole buyer of coal from the Black Mesa Mine, the mine was also shut down in 2006.¹⁵

Similar to the Kayenta Mine shutdown, the McKinley Mine may also possibly be closed as its lease expires this year.¹⁶ The McKinley Mine, which began operation in 1960, is operated by Pittsburg & Midway Coal Mining, and provides power to major power companies in Arizona.¹⁷

Because the Black Mesa Mine has closed and the Kayenta Mine may do so also, the Navajo Nation is facing a drastic drop in annual revenue and an increase in unemployment. The Navajo Nation's Division of Economic Development recognizes this situation and has looked into options in order to avoid this crisis. One option is for the tribe to enter into the gaming industry,

and, in fact, the tribe is constructing a casino along Route 66 near Gallup, New Mexico.¹⁸ While the casino will undoubtedly create jobs and increase revenue, the amount of revenue it will generate is unknown. Casinos typically raise concerns and create tension within tribal communities; this casino will also likely be met with resistance from some tribal members.

In order to fill the void of the closed mines, the second option that the Navajo Nation's Division of Economic Development has pointed to is the newly proposed Desert Rock Coal Plant Project. Unlike previous mining operations, Desert Rock is a tribal endeavor, which is very important to the tribe because they are now able to manage the resource extraction that occurs on the reservation and benefit from it fully. Managing the plant is a form of self-determination for the Navajo Nation.

Desert Rock Coal Plant Project Overview

Dine Power Authority (DPA) in collaboration with Desert Rock Energy Company (a subsidiary of Sithe Global Power, a privately held international development company involved with electricity generation facilities)¹⁹ plans to construct the Desert Rock Power Plant, a hybrid coal-fired electric power-generating plant located in northwestern New Mexico, on Navajo land totaling \$3 billion.²⁰ Through the DPA, Navajo Nation has the option to become a partial owner in the project.²¹

The proposed project is to build and operate two mine mouth coal-fired power plants, which will be capable of producing up to 1,500 megawatts combined.²² In addition, the project should incorporate what is needed to minimize the effects on the environment.²³ For example, the Desert Rock plant will incorporate high-efficiency steam turbines and coal boilers and utilize draft dry cooling to reduce water consumption.²⁴ The proposed location of the Desert Rock Energy Project is within a 600-acre plot of land immediately adjacent to the existing Navajo Mine, which will provide low sulfur coal for power generation.²⁵

The Desert Rock Energy Project claims it will fulfill provide the following regional benefits:

- “Improve and enhance the existing electrical power system in the southwestern US and deliver competitively priced power to these markets”²⁶
- “Generate electricity from a low-sulfur coal source to relieve dependence on gas-fired plants and provide a low volatile predictable power supply for desert southwest utilities”²⁷
- “Support the Navajo Nation’s objective for economic development in the region by providing employment opportunities, revenue cash flow streams”²⁸ and “generating tax/royalty revenues”²⁹
- “Develop responsible uses of Navajo Nation resources”³⁰ and
- “Provide an economically stable and predictable power supply for utilities in the Southwest”³¹

Since the project is located on land owned by the Navajo Nation, it must comply with a Navajo Nation land lease permitted by the Bureau of Indian Affairs (BIA), which calls for review and compliance with the National Environmental Policy Act (NEPA) and therefore an Environmental

Impact Statement (EIS) must be produced.³² An EIS must consider the potential effects caused from the Desert Rock Energy Project on the environment including human, natural, and cultural resources.³³ In addition to the URS Corporation, the BIA and a number of federal and tribal agencies participated in preparing the EIS which was released in 2007 and included an analysis of potential environmental impacts as well as measures to reduce those impacts.³⁴

A barrier to the project was encountered in March 2008 when a New Mexico House committee voted seven to six not to grant an \$85 million state tax credit to Sithe Global and Dine Power Authority for building the coal plant.³⁵ The project was faced with another stumbling block when legislation was introduced March 2008 by Rep. Markey and Rep. Waxman known as the “Moratorium on Uncontrolled Power Plants Act of 2008”, which places a suspension on EPA or states permit to construct new coal-fired power plants without “state-of-the-art control technology to capture and permanently sequester the plant’s carbon dioxide emissions.”³⁶ Finally, the EPA is mandated to regulate CO₂ as an air pollutant under the federal Clean Air Act (*Massachusetts v. EPA*), making the granting of an air permit difficult for the Desert Rock Project.³⁷

Arguments for the Plant

Employment

The coal plant has the potential to create significant employment opportunities for the Navajo Nation. During the four year construction period the project can create on average 1,000 jobs and long-term employment at the plant will provide work for approximately 200 people.³⁸ An additional 200 people could be employed through mine expansion.³⁹ The wages of these workers are estimated at \$60,000 a year, more than twice the average Navajo workers full time salary.⁴⁰ In addition, a project of this scale requires local businesses that support its operation. New businesses created as a result of the project will create immeasurable economic benefits to the Navajo Nation. It is estimated that for every one job created at Desert Rock, three additional jobs will be produced in the region.⁴¹

Tax Revenue & Economic Development

The power plant’s operation will generate tax revenue for the Navajo Nation estimated to surpass \$17 million annually.⁴² “Over one-half the total annual direct revenues to the Navajo Nation and one-half of the non-construction jobs in the Navajo Nation are the direct result of the use of Navajo Coal.”⁴³ The royalties paid to the Navajo Nation from the use of its coal have the potential to exceed \$25 million annually.⁴⁴ Therefore, the total annual revenue benefit to the Navajo Nation is estimated at \$52 million.⁴⁵

Arguments against the Plant

Air Quality, Water Resources, Mercury, and Biological Resource

Air quality is already poor in the region; increased development and emissions from the plant would degrade air quality and visibility even further while increasing regional haze.^{46 47} It is recognized that an “uneven share of emissions levels affects low income, minority, very young and old individuals on the Navajo Reservation.”⁴⁸ Concerns relating to the impacts on groundwater, surface water, and water rights and permitting are apparent.^{49 50} Water quality issues have the potential to cause major public health problems and endanger species living in

the area.⁵¹ In an area with water conservation issues Desert Rock raises major concerns because the plant requires extremely large amounts of water to cool the facility (estimated at 5,000 acre feet/year).⁵² Proposed mercury emissions, estimated at 1,200 pounds per year, from the Desert Rock plant would only add to significant mercury emissions from the Four Corners Power Plant (1,174 lbs/yr) and the San Juan Generating Station (1,194 lbs/yr), which considerably contribute to public health impacts.^{53 54} Issues associated with surface disturbance; such as vegetation removal, habitat loss or fragmentation and changes to wildlife movement or corridors, could cause soil erosion and affect productivity and the protection of vulnerable species in the area.⁵⁵

Carbon Dioxide Emissions

Carbon dioxide, produced by coal-fired power plants, is a major contributor to global warming. The state of New Mexico has taken steps to reduce GHG emissions by forming a Climate Change Advisory Group, but Desert Rock could hamper the state's efforts to mitigate emissions.⁵⁶ Existing carbon dioxide emissions in the Four Corners region include 15.6 million tons per year (tpy) from the Four Corners and 13.4 million tpy from the San Juan plants for a total of 29 million tpy of carbon dioxide.⁵⁷ Desert Rock is projected to emit another 12.7 million tpy into the atmosphere.⁵⁸

Additional

San Juan Citizens and Dine Care, local groups opposing the Desert Rock Project, expressed concern that the Draft EIS fails to include complete information on "coal mining, water quality and quantity, groundwater testing, transmission power and cumulative impacts."^{59 60} The facility could be detrimental to the Four Corners region through increased emission levels of CO₂, mercury, and pollutant contributions that certain to "exacerbate health and environmental problems throughout the region, nation, and world."^{61 62 63}

Impact of Climate Change

The issues of climate change have helped push groups, like the San Juan Citizens and Dine Care, into action in order to protect their reservation and their people. Tribal cultural identities are deeply rooted in the environment, therefore, tribes like the Navajo Nation are very vulnerable to climate change. The Navajo Nation is in the Southwest, and within the Colorado River Basin, a region of the country that currently faces many water problems and these problems will only be exacerbated by climate change.⁶⁴

The Natural Resources Law Center at the University of Colorado Law School published a report detailing the impact of climate change on Southwestern tribes. The report discussed that climate change would lead to more water scarcity, a shift in water flow, and a reduction in water quality throughout the Southwest.⁶⁵ Specifically, one study projected that a 2 degree increase in temperature would lead to a 20% reduction in stream flows for the Colorado River Basin.⁶⁶ The exacerbated water problems of the Southwest will have a major impact on the Navajo Nation.

The Navajo Nation will be impacted by climate change in various ways. Because of water scarcity, sand dunes throughout the reservation will lose vegetation causing them to move, which has begun to create infrastructure problems such as houses moving and sand barriers on roads.⁶⁷ Also, loss of vegetation and water scarcity will affect the Navajos agriculture and livestock.⁶⁸

Sheep and cattle play an important role within the tribe as a key to Navajo peoples' livelihoods and cultural identities. Lack of water may also impact tourism on the Navajo Nation, and as stated above, a significant amount of Navajo revenue is generated from tourism. Further, existing power plants that use large amounts of water may also be affected by the water problems in the region. And lastly, the Navajo Nation will have to become strong advocates in order to protect their tribal water rights. As the demand for water continues to increase in the Southwest, and the amount of water available continues to decrease, the Navajo Nation's water rights will be contested. Although tribal water rights are federally reserved water rights, they will inevitably have to compete with private, state, and municipal water interests.

The Navajo Nation realizes that climate change is a real problem, but it is difficult to completely sever its dependence on natural resource extraction given the tribe's history and economic situation. Although the tribe struggles with these issues, it does recognize the role it plays in climate change and the importance of developing renewable energy resources.

Adaptation Background

Since the relationship between GHG emissions and their impacts is lagged, past emissions have already committed the planet to a 0.5 to 1 degree Celsius increase in temperature within the next few decades.⁶⁹ Therefore, no matter how much is invested in mitigation of GHGs, people and ecosystems will have to adapt to the changes caused by past emissions. Until recently, however, adaptation has received little policy attention in the United States.⁷⁰ However, as it becomes clear that the impacts of climate change are unavoidable and that the world's most vulnerable people are likely to bear the brunt of these impacts, attention has recently been redirected to adaptation.⁷¹

Adaptation, as defined by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, is an adjustment in social and ecological systems to cope with the impacts of climate change.⁷² Historically, human populations have adapted to climate variability through crop diversification, irrigation, insurance, and storage, but adaptation efforts which also factor in projected future climate change impacts are occurring only at small scales. Adaptation is not always successful, especially if it occurs spontaneously to climate-related events as they occur, as demonstrated to some degree by the Hurricane Katrina disaster in 2004 and subsequent efforts to rebuild New Orleans. Adaptation which is planned is likely to be less costly, avoid maladaptations, and may enable systems to take advantage of new opportunities presented by climate change. Planned adaptation is usually included in sector-specific developments, such as water resources management, flood prevention, and economic diversification.⁷³

The goal of adaptation is to reduce vulnerability to climate change and increase the capacity to take advantage of new opportunities.⁷⁴ Vulnerability to climate change is not uniform; rather different populations are differently vulnerable to the negative effects of climate change.⁷⁵ Vulnerability is defined as a function of exposure, sensitivity, and adaptive capacity, where exposure refers to the degree of severity of biophysical events such as droughts, floods and storms, sensitivity refers to inherent social characteristics such as location, poverty, and health status, and adaptive capacity refers to a society's ability to cope with the effects of climate

change.⁷⁶ The most vulnerable people tend to live in areas likely to be significantly impacted by climate change and possess few resources to adapt.

Given the Navajo Nation's location in the arid Southwest and projected exposure to more frequent and severe drought, and the high levels of poverty and unemployment of the Navajo people, means they are highly vulnerable to climate change. This vulnerability can be addressed three ways: by mitigating the impacts of climate change (i.e. through emissions reductions), decreasing sensitivity (i.e. by diversifying the economy and creating jobs, improving access to social services and alleviating poverty), and by enhancing adaptive capacity (i.e. by increasing financial assets). Therefore, efforts by national and regional governments to reduce carbon emissions, and by the Navajo Nation to create jobs and generate income, can be classified as attempts to reduce the Navajos' vulnerability to climate change.

Neither adaptation nor mitigation alone will be sufficient to address climate change and reduce vulnerability. Without real efforts to stabilize GHG concentrations in the atmosphere and improve sinks, adaptation will never be able to fully outpace the effects of climate.⁷⁷ Conversely, by focusing too heavily on mitigation and not enough on adaptation, society is forgoing opportunities to plan for the inevitable. The right balance between the two is difficult to achieve, since adaptation and mitigation occur at different scales. Mitigation has global benefits and consequences, while the effects of climate change- and the need to adapt to them- are felt locally.⁷⁸ The Stern Review Report (2006) suggests that "early and strong" mitigation will reduce the costs associated with future adaptations. The report also says that planned adaptation is more cost efficient than adaptation which occurs spontaneously.

For the Navajo Nation, regional and national mitigation strategies will directly impact their economic wellbeing, but they are not entirely within their control. The best option for the Navajo, therefore, is to carry out planned adaptation to the inevitable effects of climate change. The focus of this project is to examine whether certain adaptations carried out by the Navajo can also fit into a regional mitigation strategy. It seems plausible that the goals of economic development and adaptive capacity building on the Navajo Nation can synergize with a regional mitigation strategy in the form of renewable energy development and provision.

The United States and Carbon

The United Nations Framework Convention on Climate Change (UNFCCC), of which the United States is a signatory, aims to stabilize GHG concentrations in the atmosphere at a level that would "allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."⁷⁹ To achieve stabilization, global emissions must be reduced by 25 percent by the year 2050 and then further reduced to one fifth of today's level.⁸⁰ Globally, combustion of fossil fuels contributes to almost 60 percent of GHG emissions.⁸¹ Therefore, mitigation policy is likely to focus heavily on reduction of emissions from fossil-fuel intensive sectors like transportation and electricity generation. In the United States, several bills, including America's Climate Security Act (Lieberman-Warner), have been introduced in Congress proposing an economy-wide cap on GHG emissions with a tradable permits system to allow emitters to reach up to the imposed cap in the most economical way. Alternatively, a carbon fee may be imposed whereby emitters are

taxed per ton of carbon emitted. Either way, emitters in the US should anticipate having to pay for the rights to pollute. Many firms have recognized this and begun to change their business plans. Consumers, too, are beginning to place greater demand on low carbon products, such as renewable energy.

On a national level, there is a movement toward energy security. This movement focuses primarily on clean fuels for transportation and clean coal and nuclear technologies for residential and commercial use, but there is also increasing federal attention to solar and wind technologies. In his 2006 State of the Union Address, President Bush announced the Advanced Energy Initiative which encourages development of clean coal, nuclear, solar voltaic, and wind technologies to reduce energy consumption in homes and businesses, and proposed the \$148 million Solar America Initiative with the goal of making solar PV cost competitive with other forms of renewable energy by 2015.⁸²

State Climate Change Action Plans

In the United States, mitigation dominates the climate change discourse, but adaptation is beginning to gain a toehold at the state level. By 2007, 33 states in the US had developed or were in the process of developing state climate change action plans. Most of these plans include descriptions of projected impacts on the states from climate change, an inventory of GHG emissions data, and strategies for reducing emissions.⁸³ Only a few states on the west coast have adaptation plans in progress. However, six other states, including Arizona, recommended in their Climate Action Plans that adaptation be addressed as a separate topic.⁸⁴

Arizona's climate change action plan (CCAP) recommends that the state undertake aggressive measures to reduce GHG emissions to 2000 levels by 2020 and to 50 percent below 2000 levels by 2040.⁸⁵ In Arizona, the electricity and transportation sectors account for 77 percent of GHG emissions; therefore, the report suggests several policy options aimed at reducing GHGs in these sectors. Chief among these include a plan to increase Arizona's renewable energy portfolio.⁸⁶ Solar photovoltaic, solar concentrating, wind, and biomass are likely to be important to Arizona's electricity sector in the near future. On current trajectories, emissions from electricity use will increase by four percent per year due to increases in coal generated.⁸⁷ The CCAP emphasizes development of renewable energies in tandem with the use of advanced coal technologies like integrated gasification combined cycle (IGCC) and carbon capture and storage to contribute to a statewide mitigation strategy.⁸⁸

Other states in the region, including New Mexico, Utah, Nevada and Colorado have also completed climate change action plans and proposed similar reduction targets and mitigation strategies. Similar to Arizona, New Mexico has identified both renewable and advanced coal technologies as areas with the greatest potential to reduce state GHG emissions.⁸⁹ Along with states, tribes also have the ability to create their own climate change action plans or the option to work into the states' plans. Tribes and states should collaborate to coordinate such plans.

Demand for Renewable Energy

Currently, renewable energy sources in the Southwest region are limited, with only a few of the large utility companies and private enterprises generating power from renewable sources like

wind and solar that can contribute to the baseload power supply. Of the large utilities in the region, Arizona Public Service (APS) and Nevada/Sierra Pacific Power are most aggressively pursuing renewable energy to meet their states' renewable energy goals. In 2007, APS was named EPA's Energy Star Partner of the Year, and every year since 2001 has been ranked as one of the top two utility companies by Innovest Strategic Advisory for Environmental and Sustainable Performance.⁹⁰ APS has several power plants collectively generating more than 5 MW of solar power. In addition, the company's Redhawk power plant in Arlington, Arizona, uses algae to recycle carbon emissions from the power plant, and make ethanol and biodiesel. Conversations with representatives of APS suggest that the company is planning to expand provision of renewable energy to its customers in the coming years.⁹¹ Nevada/ Sierra Pacific Power, which distributes electricity to Las Vegas, purchases a portion of their power from external renewable energy sources. Those plants operate using geothermal, solar, hydro and biofuel resources. Nevada/ Sierra Pacific Power has stated that that they intend to be ranked first in the nation in solar watts per capita. By 2015, Nevada Power will spend about two billion dollars to develop new renewable energy capacity.⁹² In 2007, the company made a request for proposals, soliciting energy from "new and existing renewable energy generation".⁹³ Companies that have- or will have- the capacity to generate a minimum of 1 megawatt of renewable energy were eligible to apply.

PNM, New Mexico's largest natural gas and electricity supplier, does not have in-house renewable power generating capacity and purchases all of its green power from the New Mexico Wind Energy Center. Customers of PNM can elect to pay extra for a portion of their energy needs to be supplied by these wind turbines. A representative from PNM said that although the company is not currently seeking additional MW of green power, it will respond to the demands of its customers (pers. comm. 17-Mar-08).

As renewable energy assumes an increasingly important place in Southwest mitigation portfolios, and as state regulations support development of renewable energy technologies, create incentives for generation and consumption of renewable energy, and implement a regional cap and trade system for carbon, utility companies will continue to look for external providers of green electricity.

Department of Defense (DOD) installations throughout the Southwest are also potential buyers of renewable energy. The DOD is the single largest electricity user in the federal government and spends about \$5 billion of their annual budget to purchase energy.⁹⁴ In 2005, more than eight percent of the DOD's electric consumption came from renewable energy that was either self-generated or purchased; the DOD hopes to increase renewable energy use to 25 percent by 2025.⁹⁵ To achieve this target, DOD installations will first explore ways to generate renewable power on-base, but those without sufficient resources will purchase power from nearby non-DOD sources.⁹⁶ Kirtland Air Force Base (AFB) near Albuquerque, New Mexico is one of the largest DOD installations in the region, employing up to 40,000 people, including off-base contractors.⁹⁷ Kirtland AFB is actively pursuing renewable electricity, from both on-base and off-base sources. According to a representative of the Kirtland AFB Civil Engineering squadron, "Kirtland Air Force Base is always interested in renewable energy sources; [however], federal law requires our procurement to be based on cost, not source at this time" (pers. comm. 18-Apr-

08). Luke AFB near Phoenix, Arizona is also a major installation in the region, with close to 23,000 residents.⁹⁸ Both Kirtland and Luke AFBs are participating in a new Energy Enhanced Use Lease program to partner with the private sector for renewable energy supply to the bases.⁹⁹ DOD installations are attractive clients to renewable energy providers since they are extremely reliable and long-term customers (Chris Cassidy, USDA Rural Development, pers. comm. 13-Mar-08). The Navajo Nation, located just 200 miles from Kirtland AFB and 200 miles from Luke AFB, is geographically well positioned to be an energy supplier to both DOD installations. If the Navajo Nation can ultimately generate enough renewable energy at competitive prices, a business partnership with the two installations is a definite possibility.

Demand for electricity on the Navajo Nation itself is also high as an estimated 10,000 to 30,000 Navajo are without power. The Navajo Tribal Utility Authority (NTUA) is the main electricity provider to the Navajo people, serving approximately 38,000 customers on the 26,000 square mile reservation.¹⁰⁰ Due to the remoteness and difficult terrain of the reservation and limited funds, the NTUA admits difficulty with the upkeep of equipment and investment in new infrastructure and is not able to extend service to as many customers as it would like. Much of the infrastructure was installed in the 1960s, after the creation of the NTUA.¹⁰¹ The NTUA has no electricity generation capacity; instead, it buys all of its power from APS, Tucson Electric, and the Western Area Power Administration. The NTUA, a non profit organization, receives federal loans to distribute the power and small grants from the Navajo Nation Community Development Block Grant and Capital Improvement Offices for infrastructure development.¹⁰² Through a tariff system, the NTUA subsidizes the cost of power for its customers. Today, the power lines are heavily loaded, in need of maintenance and in some cases need to be replaced.¹⁰³ There is also some concern that the cost to purchase electricity will rise sharply in the near future, directly impacting the NTUA and its customers.

Alternative Energy Options

Given the growing demand for energy and push towards alternative energy, the Navajo Nation could become a large player in energy generation. There are multiple alternative energy options for the Navajo Nation, which are discussed below.

Geothermal

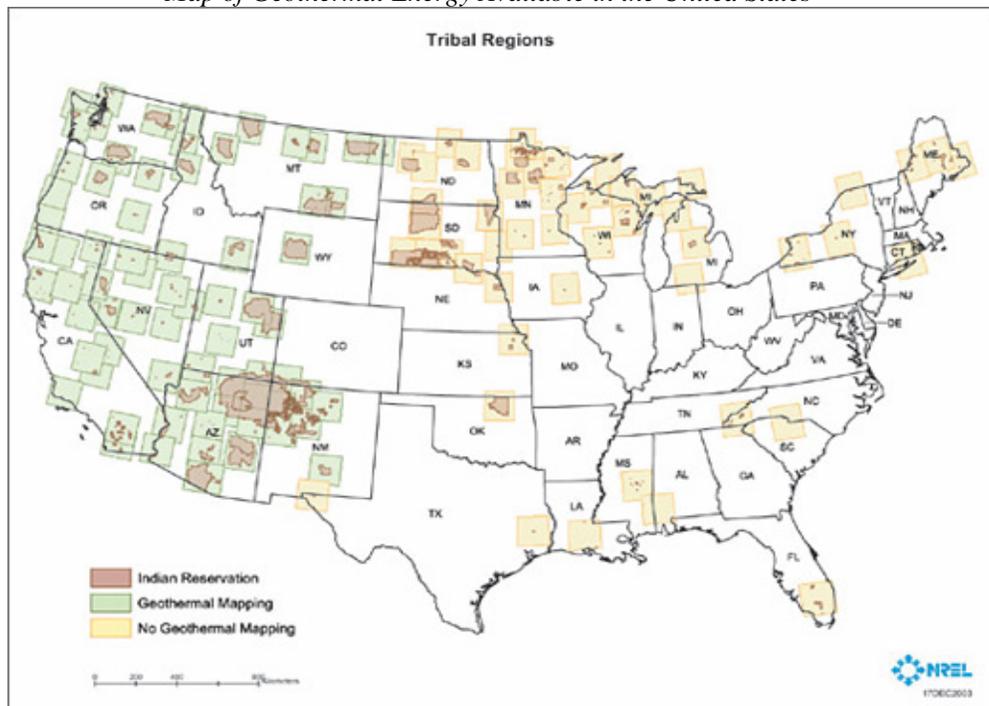
In order to understand the geothermal energy potential of the Navajo Nation the Geothermal Feasibility Study was used as a comparison. The study was prepared by McNeil Technologies, who was contracted out by the US Department of Energy. The plan investigated the potential to develop a geothermal district heating infrastructure at Red Rocks to provide a consistent, clean energy resource for the Pueblo of Jemez in New Mexico. It was found that the “geothermal system could provide stable energy prices over a long horizon with considerable benefit to the Pueblo of Jemez.”¹⁰⁴

The feasibility study revealed that the amount of geothermal energy from the site could be used as 1 MW of geothermal district heating for infrastructure.¹⁰⁵ The capital costs of the project would total \$900,000 but the operating costs of the site would be significantly less than a propane system, around \$48,000 annually.¹⁰⁶ The footprint of the facility would total only 53,000 square feet.¹⁰⁷ The number of jobs is minimal, totaling approximately three, but it was

found that the annual revenue from the project is around \$450,000.¹⁰⁸ The geothermal system would emit no or minor air emission and save 1,400 lbs of carbon from being emitted into the atmosphere annually. The royalty payments associated with the geothermal system will return funds to the tribe to offset utilization of the natural resource.¹⁰⁹

There is compelling evidence seen from the figure below that Arizona and New Mexico have ample opportunity to use its geothermal resource for direct use. Most of the geothermal energy located on the Navajo Nation is in geothermal wells and springs which have a temperature of between 20-50 and over 50 degrees C.¹¹⁰ While this would be sufficient for direct use of energy, the temperatures are not high enough to use for energy generation. Direct uses of geothermal energy include aquaculture, greenhouses, industrial or agricultural projects, resorts and spas, or space and district heating.¹¹¹ In summary, the Navajo Nation could expect to use geothermal energy for small scale direct uses.

Map of Geothermal Energy Available in the United States¹¹²



Biomass

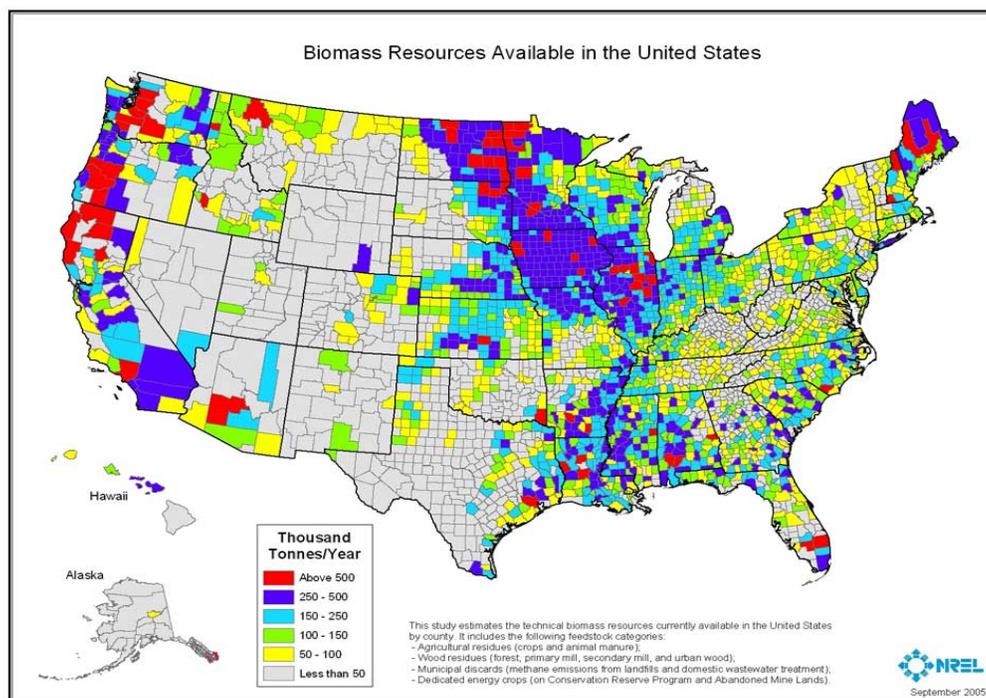
The biomass case study of the Ak-Chin Indian Community, in Pinal County, Arizona, was used to project the amount of biomass energy available to the Navajo Nation. The study looked at the feasibility of a bio-power installation. The direct benefits include electricity and hot water production to offset energy purchases.¹¹³

The study found that with the current chicken population of 1.5 million a digester could produce 1 MW of energy at a \$5.5 million cost of construction and annual cost of operation estimated at \$207,882 (cost of electricity would be around 6.5 cents per kwh).¹¹⁴ It is estimated that the Ak-

Chin could receive a total of \$133,517 per year in renewable tax credits and greenhouse gas credits, with the assumption that they would be avoiding 1,400 lbs of carbon emitted into the atmosphere per year.¹¹⁵ The project would develop three jobs, at an average salary of \$37,000. The footprint of the project is minimal totally 1/3 acre.¹¹⁶

The most economical sources of biomass for energy use is residue streams originating from commercial biomass processing, examples include animal, agricultural or food processing residues, lumber, and landfill methane capture.¹¹⁷ These residues are converted into methane using anaerobic digestion; the methane can then be converted into electricity using simple engine-driven generators.¹¹⁸ As seen from the map below, the biomass resources available within the Navajo Nation are minimal. In addition, significant amounts of energy cannot be produced from biomass. Therefore, the Navajo Nation has the potential to use biomass, like geothermal, for small-scale energy projects but cannot depend on it for large scale energy generation.

Map of Biomass Resource Available in the United States¹¹⁹

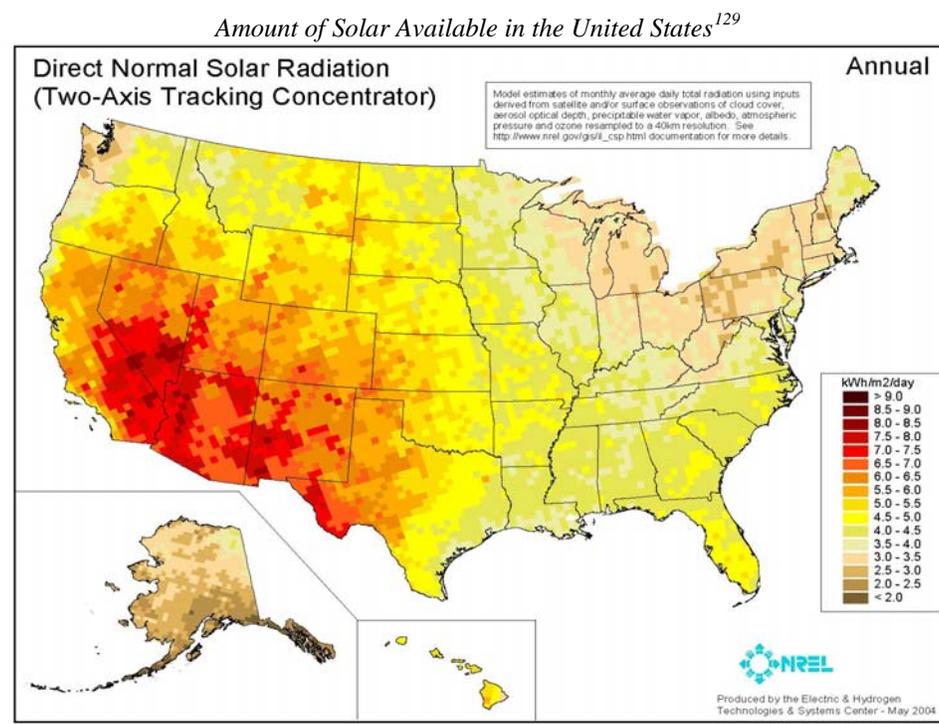


Concentrated Solar Thermal

The case study used to assess the concentrated solar capability for the Navajo Nation is the APS' current plans to construct a 280 MW concentrated solar power plant, Solana Generating Station. Solana's proposed location is 70 miles southwest of Phoenix, Arizona.¹²⁰ The plant is estimated to cost approximately \$1 billion, have very low operating costs¹²¹, and cover three square miles.¹²² The Solana Generating Station will create about 1,500 construction jobs and employ about 85 highly-skilled technicians, and the ripple effect will create another 11,000 to 15,000 jobs.¹²³ APS will pay around 14 cents per kilowatt-hour, four cents more than natural gas, for the concentrated solar energy generated from Solana¹²⁴, with an estimated value at \$4 billion.¹²⁵

The plant will also avoid 400,000 tons of carbon from being emitted into the atmosphere annually.¹²⁶

Unlike solar-photovoltaic plants (use direct sunlight to produce electricity) concentrating solar power uses the sun's heat to produce electricity. As parabolic mirrors follow the sun, direct solar energy is used to a heat transfer fluid.¹²⁷ The heat converts the liquid into steam, which then turns the plants' turbines to create electricity. This technology, when compared to solar-photovoltaic, allows the plant to produce more energy when exposed to direct sunlight.¹²⁸ Solana Generating Station is within close proximity to the boundaries of the Navajo Nation and has similar solar capabilities. Therefore, this project provides a good estimate for the amount of concentrated solar energy that could be produced in many areas of the Navajo Nation. The map shows that the areas of the Navajo Nation within Arizona and New Mexico have a high concentration of solar, in some cases higher than the rest of the country. Given the generation capability of Solana, it is projected that the Navajo Nation has the potential to produce large-scale energy generation from concentrated solar plants.



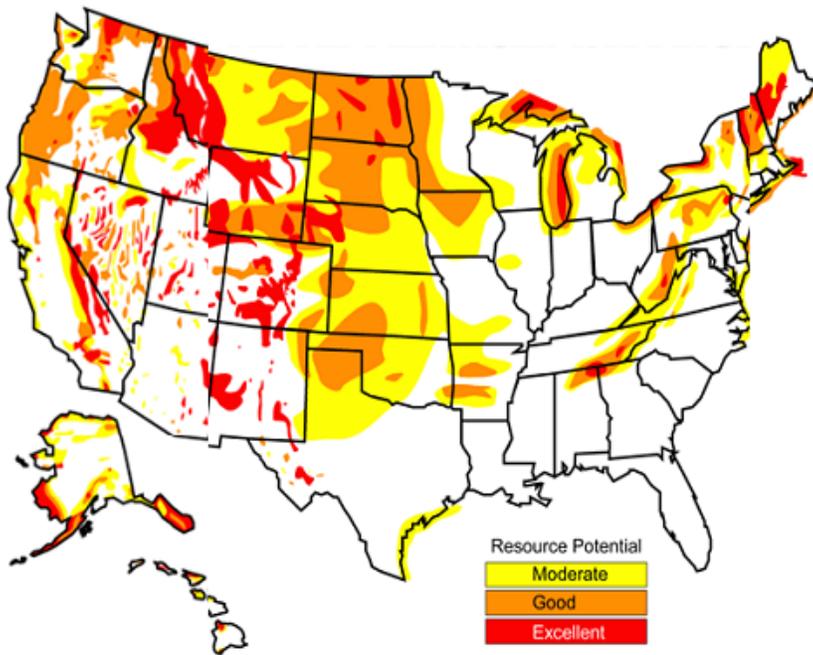
Wind Power

The Navajo Nation recently formed a partnership with the Citizens Energy Corporation of Boston to build a 500 MW wind farm.¹³⁰ This project demonstrates the wind capacity within the reservation. The project will be located in the Grey Mountains of Arizona, an area which has a high wind power potential.¹³¹ The wind resource in this location is class 4 and 5, estimates from the Department of Energy show that it could generate 800 MW, making it an excellent site for wind development especially since there are already transmission lines installed.¹³² The wind farm is predicted to bring in \$60-100 million in revenue over 25 years, \$3-4 million of which will be annual tax revenues. Construction will cost approximately \$750 million and bring in

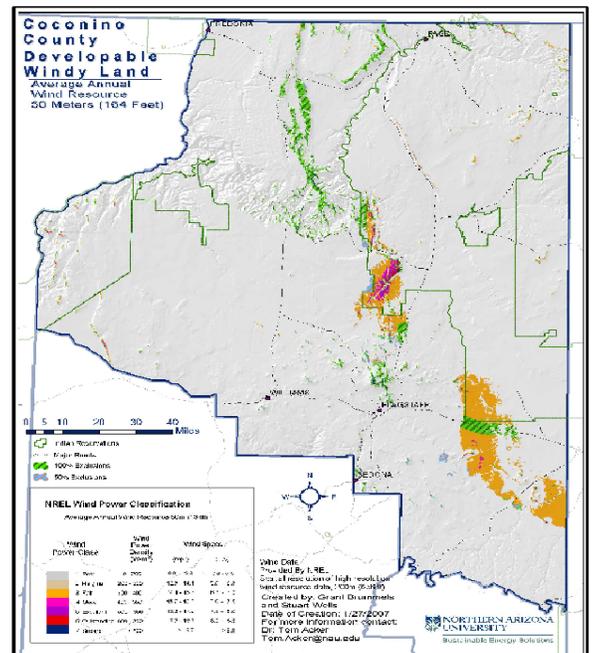
over 200 jobs.¹³³ Operating costs of the project will total about \$124 million annually which will require 20 jobs. The total project area is about 34,500 acres, cost of energy is predicted to be about 8 cents/kwh, and a whopping total of 350,000 million tons of carbon will be avoided annually.¹³⁴

This project, already in progress, demonstrates the wind energy potential for the Navajo Nation. There are other areas on the reservation which have as a similar potential. The Navajo have the potential to utilize large-scale wind energy projects to generate clean energy on the reservation.

Map of Wind Energy Potential for the United States¹³⁵



Wind Potential in Navajo Nation's Western Arizona Area¹³⁶



through these Navajo laws in order to pursue nuclear power. But tribal leaders have made their stance on uranium mining quite clear, as President Shirley stated, “The mining of uranium has done too much havoc to us as a people. We’re hurting for revenues, yes, we’re hurting for jobs, but we’re not going to get into something that has killed us and will continue to kill us.”¹³⁹

Funding for renewable energy projects on tribal lands

There are several resources, mostly federal, for tribes that are interested in pursuing renewable energy and economic development projects. In 2002, the Farm Security and Rural Investment Act (the Farm Bill) created the Renewable Energy Systems and Energy Efficiency Improvements Program (EERE) under Title IX, Section 9006. The funding mechanisms for this program are administered by the US Department of Agriculture (USDA) and the US Department of Energy (DOE) and provide grants, guaranteed loans, and grants and loans combinations to agricultural producers and small businesses pursuing renewable energy systems and energy efficiency improvements. On March 6, 2008, shortly after the passage of the most recent edition of the Farm Bill, the EERE announced it received \$15.8 million for grants and \$204.9 million for guaranteed loans for the renewable energy and energy efficiency projects.¹⁴⁰ The Rural Business-Cooperative Service (RBS) of the USDA is accepting applications for Fiscal Year 2008; grants ranging from \$2,500 to \$500,000 will be made available for renewable energy projects, grants ranging from \$1,500 to \$250,000 will be available for energy efficiency projects, and loan guarantees up to \$10 million will be available for renewable energy and energy efficiency projects.¹⁴¹ The USDA also offers grants and loans for renewable energy projects through the Rural Business Opportunities and Rural Economic Development programs. Both the EERE and the Rural Business Opportunities programs have earmarked funds specifically for economic development projects on tribal lands.

The DOE Tribal Energy Program operates with EERE funding and provides technical assistance, education and training for US tribal members developing and operating renewable energy projects.¹⁴² Currently, the US DOE Tribal Energy’s implementing arm, the Golden Field office, has \$2.5 million available for grants for renewable energy and energy efficiency deployment on tribal lands in the contiguous 48 states and is accepting applications; up to four grants ranging from \$200,000 to \$2.5 million will be distributed by the Golden Field Office in 2008.¹⁴³

Other funding sources for renewable energy include the private sector. Consulting firms and insurance companies are increasingly becoming interested in renewable energy financing, with some projects aimed specifically at renewable energy development on tribal lands. The partnership of the Dine Power Authority with Citizen’s Energy Corp for the Dine Wind Project, is the most prominent example of private sector funding for tribal renewable energy development.

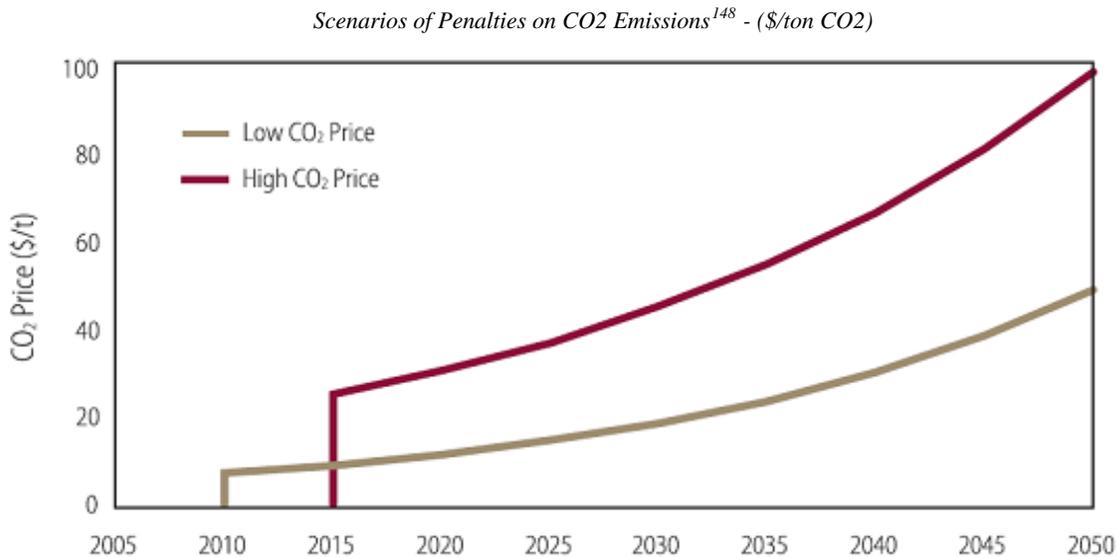
Insurance giant, American International Group (AIG), also finances renewable energy development on tribal lands. AIG Consulting (AIGC) implements the AIG Global Alternative Energy Practice program, intended for “the insurance, risk management and loss control needs of U.S.-based alternative energy clients, including organizations engaged in biofuel, hydroelectric, geothermal, solar and wind operations.”¹⁴⁴ According to AIG, insurance companies are increasingly exploring ways to reduce liability of climate related damages. AIG plans to provide

financing and risk assessment services for projects to reduce emissions, increase energy efficiency, support GHG trading schemes, and support renewable energy development and deployment. AIGC is currently working with US Native Americans and Canadian First Nations to “develop, build and operate renewable energy projects on tribal land” by providing risk finance, debt and equity funding, and political risk management.¹⁴⁵

Carbon Prices

The risk of carbon regulation is likely to play a major role in the development of new coal plants. For example, the California Public Utility Commission now requires industries to pay an \$8/ton carbon addition.¹⁴⁶ Carbon additions policies are likely to be adopted elsewhere in the US and will significantly increase the operating costs of coal-fired power plants. Since Global and DNA did not take into account the future costs of emitting carbon when determining the cost of building and operating the Desert Rock plant. There will be two options, both have the potential to be extremely costly, for dealing with carbon responsibility in the wake of government greenhouse gas emissions restrictions, to purchase carbon credits or use carbon capture technology (capture carbon emitted by the plant and sequester it in order to ensure it never reaches the atmosphere). Although it is difficult to predict the cost of carbon due to the lack of established markets in the US, the price of emissions will increase over time¹⁴⁷.

The Figure below is a graph from the Massachusetts Institute of Technology report, “The Future of Coal”, which projects the rising penalties related to carbon emission over time.



It is projected that emissions rights will be allocated by market mechanisms and the “cost will be the same whether the solution is carbon capture, carbon sequestration, or a carbon cap and trade system.”¹⁴⁹ The inclusion of these technologies means higher prices to operate the plant. A supercritical plant, which operates at temperatures and pressures above the critical point that result in higher efficiencies and lower emissions than traditional coal-fired plants,¹⁵⁰ such as Desert Rock, would see an increase of 81% in costs with capture technology added,¹⁵¹ The

increases in cost associated with retrofitting of technologies or purchase of carbon credits presents serious questions for capital and electricity costs.¹⁵²

In the case of the proposed Desert Rock plant, the report by Dine Citizens Against Ruining our Environment uses carbon price estimates from the Electric Power Research Institute for the near term, \$5/ton, and from the Intergovernmental Panel on Climate Change for the medium term, \$23/ton.¹⁵³ Using Desert Rock’s estimate of emitting 12.7 million tons of CO2 annually, estimates of carbon liability cost are presented in the table below.

Carbon Liability Costs¹⁵⁴

Year	Cost to Capture CO2	Annual Cost to the Desert Rock Power Plant
2008-2015	\$5 per ton	\$63.5 million
2015-2020	\$23 per ton	\$292.1 million

Another study by the National Energy Technology Laboratory estimates that Desert Rock would cost approximately \$1,575/kW to build and have electricity production costs of 6.33 cents/kWh without carbon technology.¹⁵⁵ Once carbon technology is included, the plants costs rise to \$2,870/kW or 11.48 cents/kWh.¹⁵⁶ These two data sets show the vast increase in price when carbon capture technology is included. Because carbon regulation will require that either carbon capture technology be built or carbon offsets be purchased, and the fact that Desert Rock currently fails to address the economic carbon risk, the Desert Rock project is not a not as economically attractive as it currently claims to be.

Conclusion

Climate change is expected to have significant impacts on the Navajo people’s economy and way of life. This report examined the potential for renewable energy development on the Navajo Nation to enhance resilience to climate change, and found that it is a promising adaptation strategy for the Navajo. The report also found that the resources available for tribes to develop the capacity to generate renewable energy, especially from solar and wind sources, are already in place and include both federal and private financing.

At the same time, renewable energy development on the Navajo Nation could contribute to a regional or national mitigation strategy by providing non-fossil fuel energy to city utilities and military installations. In the coming years, the US is likely to pursue mitigation targets with a specific focus on reducing emissions in the electricity generation sector. Regulations such as carbon taxes and cap-and-trade will likely mandate polluters to pay per ton of carbon emitted, thus reducing the economic attractiveness of carbon-intensive electricity generation, such as coal-fired power plants. Our report highlights the fact that the Desert Rock Project, while providing short-term benefits to the Navajo Nation, may ultimately prove to be less beneficial to

the Navajo economy when compared with the development of renewable energy. The energy options matrix, presented below, provides a comparison of the economic benefit of various energy types to Navajo decision makers.

Energy Options Matrix

	Energy (MW)	CO2 Emitted (TCE/year)	Cost of Construction	# of Jobs	Cost of Operating	# of Jobs	Area (acres)	Tax Revenue (per year)	Economic Benefit
Coal	1500	12,700,000	3,000,000,000	1000	-	400	592	52,000,000	1.25 bil over 25
Wind	500	-715000	750,000,000	200	124,000,000	20	34,500	4,000,000	60-100 mil over 25
Con. Solar	280	-400,000	1,000,000,000	1500	~10,000	85	1920	350,000,000	1 bil over 20
Geothermal	1	-0.64	900,000	-	48,000	3	0.001	-	13.5 over 30
Biomass	1	-0.64	5,500,000	-	208,000	8	0.333	133,000	9.2 mil over 20

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 - ⁴ Ibid.
 - ⁵ Ibid.
 - ⁶ Navajo Nation Division of Economic Development, Fast Facts Overview online
 - ⁷ Ibid.
 - ⁸ Ibid.
 - ⁹ Ibid.
 - ¹⁰ Choudhary, 2006
 - ¹¹ Ibid.
 - ¹² Ibid.
 - ¹³ Ibid.
 - ¹⁴ Ibid.
 - ¹⁵ Ibid.
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 - ¹⁸ Begay, 2008
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 - ²³ Ibid.
 - ²⁴ Sithe Global, Project Desert Rock online
 - ²⁵ Desert Rock, Fact Sheet #1 online
 - ²⁶ Ibid.
 - ²⁷ Ibid.
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 - ³⁰ Ibid.
 - ³¹ Desert Rock, Fact Sheet #3 online
 - ³² Desert Rock online
 - ³³ Ibid.
 - ³⁴ Ibid.
 - ³⁵ Christian Science Monitor, Desert Rock article online
 - ³⁶ Native Unity, Desert Rock article online
 - ³⁷ Washington Post online
 - ³⁸ Desert Rock, Navajo Nation online
 - ³⁹ Ibid.
 - ⁴⁰ Desert Rock, Commitment online
 - ⁴¹ Ibid.
 - ⁴² Ibid.
 - ⁴³ Ibid.
 - ⁴⁴ Ibid.
 - ⁴⁵ Ibid.
 - ⁴⁶ Desert Rock, EIS online
 - ⁴⁷ Desert Rock, Fact Sheet #2 online
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 - ⁴⁹ Desert Rock, EIS online
 - ⁵⁰ Desert Rock, Fact Sheet #2 online
 - ⁵¹ Desert Rock, EIS online

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- ⁵² San Juan Citizens, Desert Rock article online
⁵³ Environment New Mexico, Desert Rock article online
⁵⁴ San Juan Citizens, Desert Rock article online
⁵⁵ Desert Rock, Commitment online
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⁵⁹ Ibid.
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⁶¹ San Juan Citizens, Desert Rock article online
⁶² Ibid.
⁶³ Desert Online, Desert Rock article online
⁶⁴ Cordalis et al., 2008
⁶⁵ Hanna, 2007
⁶⁶ Christensen, 2004
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⁷² IPCC, 2007
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⁷⁵ Brooks et al., 2005
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⁷⁷ Klein et al, 2005
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⁸⁰ Stern Review Report, 2006
⁸¹ IPCC, 2007
⁸² The White House, 2006
⁸³ Pew Center on Global Climate Change, 2008
⁸⁴ Ibid.
⁸⁵ Arizona Climate Change Action Plan, 2006
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⁸⁷ Ibid.
⁸⁸ Ibid.
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⁹² Nevada Power online
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⁹⁷ Kirtland Air Force Base Economic Impact Statement, 2006
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