# Sustainable Development for the Navajo Nation

## Replacing the Navajo Generating Station with Renewable Energy

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# 1. INTRODUCTION

Mining coal and burning it for electricity, two of the most environmentally destructive industries in America, cast a long and dirty shadow over the Navajo Reservation. The Navajo Generating Station (NGS) and the Kayenta coal mine damage the land and the people around them: scarce water supplies are used up; air emissions harm the health of neighboring communities and add to global warming; and the commitment to coal blocks other, more sustainable paths to development.

In exchange for these harms, the economy of coal offers little to the Navajo Nation. Despite the misleading name, the "Navajo" Generating Station is 100 percent owned and controlled by outside businesses and government agencies. While NGS and the Kayenta mine provide employment and revenues, they inhibit other alternatives that could provide greater economic benefits, within a context of clean development and community control.

*At NGS and elsewhere, there are other ways to generate electricity that are less harmful to the environment, and more economically beneficial to tribal communities and to surrounding areas.*

There are powerful interests committed to the continuing operation of NGS. With a capacity of 2,250 megawatts (MW), it is the largest coal-burning power plant in the western United States. Although it is almost 40 years old, it is newer and more efficient than many other coal plants. The federal government owns one-fourth of NGS and uses its share of the plant's electricity to power the Central Arizona Project, the long, uphill aqueduct that supplies water to Phoenix, Tucson, and other central Arizona communities. The other owners of NGS profit from its ability to produce electricity at a seemingly low cost—since the true costs are hidden from view.

The issues addressed in this study are relevant both to the controversies surrounding NGS, and to broader questions of environmental justice. The bedrock of our analysis is the reality and the promise of renewable energy: at NGS and elsewhere, there are other ways to generate electricity that are less harmful to the environment, and more economically beneficial to tribal communities and to surrounding areas. Over the past 10 years, tribal organizations and communities have supported the growth of grassroots voices, urging council delegates and local leaders to make sound and healthy decisions. Today, the utilities that own and operate power plants are facing tribal nations and other host communities at a crossroads: they can struggle to prolong the lives of aging coal plants, or they can develop the abundance of clean energy resources that offer a more sustainable future.

The sustainable future described here is not a recipe for poverty. It does not call for sacrificing the jobs and incomes offered by existing energy projects. Just the opposite: the sustainable alternative replaces those economic benefits with more secure, longer-term employment and development. At the same time, renewable energy respects the sanctity of sunlight, earth, wind, and water, allowing communities, agriculture, and traditional ways of life to coexist with the production of energy and the creation of new jobs and skills. The opportunities for community control of renewable resources provide the foundation for path-breaking advances in grassroots democracy.

# 2. THE HIDDEN COSTS OF NGS

## 2.1. NGS vs. the Environment

Environmental regulations are beginning to constrain the continued operation of NGS. Although it is a relatively new plant with some environmental controls in place, it is not in compliance with federal rules regulating regional haze pollution or with the new Mercury and Air Toxics Standard (MATS). The U.S. Environmental Protection Agency's (EPA's) proposed finding on haze standards would require the installation of selective catalytic reduction (SCR) systems to reduce $NO_x$ (nitrogen oxide) emissions from all three NGS units. MATS compliance may require installation of controls such as activated carbon injection (ACI) systems or baghouses. The EPA's obligation to regulate greenhouse gas emissions from existing power plants, which is now under discussion in Washington, could pose further challenges to coal plants such as NGS, which emits millions of tons of carbon dioxide each year. Meanwhile, the Los Angeles Department of Water and Power, which owns 21 percent of NGS, is prohibited by California law from making long-term investments in coal plants, and is planning to sell its share of NGS by 2015. NV Energy, owner of 11 percent of NGS, is divesting all its coal capacity and plans to sell its share of the plant by 2019.

Both SCRs and baghouses are major expenses that would make NGS much less profitable to operate. EPA has already offered an extension in the timeline for installing SCR, postponing this requirement until 2021-2023. A recent proposal endorsed by NGS owners, a few environmental groups, and the Navajo Nation leadership would agree to close one unit of NGS by 2020, in exchange for postponing the requirement of installing SCR on the remaining two units until 2030. See the appendix for a more detailed account of the effects of environmental regulations on NGS.

Year after year, NGS causes other environmental impacts as well. The plant uses up to 34,000 acre-feet of water per year from Lake Powell, nearly 70 percent of Arizona's allotment of water from the Upper Basin of the Colorado River. Until recently, NGS paid a ludicrously low $7 per acre-foot for this water, while other water users in the region pay significantly more per acre-foot.[1] Coal mining at Kayenta pollutes the Black Mesa region. And the air pollution emitted from NGS has harmful effects on the health of surrounding communities.

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[1] US Bureau of Reclamation, "Glen Canyon Unit Colorado River Storage Project Contract For Water Service From Lake Powell," Contract No. 14-06-400-5033, January 17, 1969, available at: https://docs.google.com/file/d/0BzAD-1g8l2r1N2M5M2FhMDYtMDI0Ny00MzFjLWIyODgtZjRiYzEyODMzM2Qz/edit?hl=en; Central Arizona Project, "Final 2013-2018 Rate Schedule," June 7, 2012, available at: http://www.cap-az.com/Portals/1/Documents/2012-06/Approved%202013-2018%20CAWCD%20Final%20Water%20Rate%20Schedule.pdf; see also http://indiancountrytodaymedianetwork.com/2013/05/20/arizona-generating-station-needs-benefit-navajos (Peabody Western Coal Company pays $471 per acre-foot for lease of Navajo Aquifer Water and was paying over $1,000 per acre foot from 1997-2007)

## 2.2. NGS vs. Health

NGS, despite its existing environmental controls, continues to emit pollutants that injure the health of surrounding communities. There are no local studies of these effects, but estimates can be developed from national studies of coal plant impacts.

A 2010 study by Abt Associates on behalf of the Clean Air Task Force estimates the deaths and other health effects attributable to fine particle pollution from coal-fired power plants. Fine particle emissions are very dangerous pollutants, made up of soot, heavy metals, sulfur dioxide, and nitrogen oxides. The most dangerous particles are the smallest ones (less than 2.5 microns in diameter). These particles are so tiny they can bypass the lung's natural defenses and enter the bloodstream, where they can be transported to vital organs such as the heart and brain. The health impacts from fine particles are felt most severely by the most vulnerable among us—the elderly, children, and those who already suffer from respiratory diseases such as asthma or bronchitis. The Abt study finds that every year more than 13,000 deaths and tens of thousands of cases of chronic bronchitis, acute bronchitis, asthma, congestive heart failure, acute myocardial infarction, dysrhythmia, ischemic heart disease, chronic lung disease, and pneumonia are attributable to fine particle pollution from U.S. coal plant emissions.[2]

Table 1 shows the estimated incidence of certain types of health impacts due to the amount of fine particle pollution emitted from NGS.

**Table 1. Death and disease attributable to fine particle pollution from NGS**

| Type of Impact | Annual Incidence |
|---|---|
| **Deaths** | 16 |
| **Heart attacks** | 25 |
| **Asthma attacks** | 300 |
| **Hospital admissions** | 12 |
| **Chronic bronchitis** | 11 |
| **Asthma ER visits** | 15 |

*Source: "Find Your Risk from Power Plant Pollution," Clean Air Task Force interactive table, accessed December 19, 2013.*

# 3. NGS and the Navajo Economy

The main argument in favor of NGS, for the Navajo Nation, is that it creates jobs and incomes. An analysis from Arizona State University (ASU) estimating Navajo employment resulting from NGS and the Kayenta mine projects that – if all three NGS units continue running – the power plant and mine directly create more than 800 well-paid Navajo jobs and indirectly lead to 500 other, more modestly paid jobs. In addition, the study projects that the lease payments and tax revenues from NGS and Kayenta create

[2] http://www.catf.us/fossil/problems/power_plants/existing/map.php?state=Arizona accessed August 23, 2013.

1,500 Navajo jobs.[3] Royalty payments from NGS to the Navajo Nation, now only about $3 million per year, are scheduled to increase to $44 million in 2019 as a result of lease renewal. The ASU study assumes an even higher total of payments from NGS plus Kayenta combined.

The ASU study is unmistakably partisan, emphasizing, if not exaggerating, the benefits of NGS and Kayenta. All economic estimates are presented in 2020 dollars, which are likely to be 16 to 22 percent higher than the actual (2011) data used in the study.[4] No alternatives are discussed; the ASU report essentially compares NGS and the Kayenta mine to doing nothing that creates jobs. Not surprisingly, running NGS and Kayenta is better for the economy than doing nothing.

The real economic issue, however, is the comparison between the current coal economy and an alternative based on renewable energy and sustainable development. Can the same levels of employment and income be created by an alternative that respects the integrity and importance of nature, protects human health, and relies on renewable energy?

# 4. REPLACING NGS WITH JOB-PRODUCING RENEWABLE ENERGY

If, as recently proposed, one of the three NGS units shuts down no later than 2020, this would mean a loss of about 280 well-paid jobs at NGS and Kayenta. If NGS royalty payments are proportionally reduced, it would also mean a loss of about $15 million in annual royalties. (It would, however, free up more than 11,000 acre-feet of water per year, a resource that could and should be put to use to support Navajo community development through economic activities such as irrigating potential Navajo farmlands.)

Could these economic losses be replaced by renewable energy? The sun and the wind are among the most abundant, cheapest, and least damaging resources that can be harnessed to produce electricity. Years ago, these might have seemed like utopian dreams, far too expensive for practical use. But steady progress in development of the technologies and reduction in costs have turned solar and wind power into effective, affordable alternatives. What would it take for the Navajo Nation to replace one-third of the economic benefits of NGS with renewable energy?

[3] Anthony Evans, Tim James, Melissa Gamez, and Eva Madly, "Navajo Generating Station & Kayenta Mine: An Economic Impact Analysis for the Navajo Nation," Arizona State University, April 2013. The study also estimates that a few hundred additional jobs are indirectly created by NGS and Kayenta; any large project would create jobs indirectly at similar rates.

[4] The calculation of 2020 dollars is never explained in the ASU study, but one footnote mentions inflating 2011 data to 2020 dollars using the IMPLAN model's inflation forecast. IMPLAN forecasts price increases of 16 to 22 percent from 2011 through 2020 for coal industry incomes and value added.

## 4.1. The Navajo Nation's Potential for Renewable Development

Several studies have confirmed that there is vast potential for solar and wind power in the Navajo Nation. A 2012 study by the National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy, looking specifically at clean-energy alternatives to NGS, estimated that the Navajo Nation has an astonishing 1,200,000 MW of utility-scale solar capability, and nearly 1,800 MW of wind resource potential, 500 MW of which is of high quality (with a predicted capacity factor of 35 percent or more).[5]

A 2008 study of alternatives to the proposed Desert Rock power plant, done by Ecos Consulting for Diné Citizens Against Ruining our Environment (DinéCARE), provides maps identifying high-quality wind resources in Cameron and in several locations around Kayenta, and extensive high-quality solar resources in numerous areas of the Navajo Nation.[6]

Finally, county-level studies by Northern Arizona University in 2007 identified the potential for wind energy in Coconino, Navajo, and Apache Counties, the three counties of Arizona that contain most of the Navajo Nation.[7] These studies identified more than 15,000 MW of commercially developable wind potential in the three counties, with 1,100 to 1,200 MW of it representing high-quality wind resources.[8]

The potential for large-scale renewable energy is also demonstrated by pilot projects and planning processes that are already underway. A 15 to 20 MW solar photovoltaic (PV) farm[9] is being developed in the southern portion of Coconino County by Pacific Blue Energy Corporation; due to the cooler temperatures associated with the elevation of the site, it will benefit from increased photovoltaic efficiency.[10]

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[5] D. J. Hurlbut, S. Haase, C.S. Tuchi, and K. Burman, "Navajo Generating Station and Clean-Energy Alternatives: Options for Renewables," NREL, June 2012, pp. 16, 17.

[6] DinéCARE, "Energy and Economic Alternatives to the Desert Rock Energy Project," January 2008, maps on pp. 81, 87, available at http://www.creativegeckos.com/dinecare/pages/Coal/pdfs/Alternatives_to_Desert_Rock_Full_Report.pdf.

[7] Susan K. Williams et al., Northern Arizona University, studies prepared for the Arizona Wind Working Group, April 2007: "Arizona Wind Energy Assessment: Apache County," available at http://www.windpoweringamerica.gov/pdfs/wpa/az_counties_apache.pdf; "Arizona Wind Energy Assessment: Coconino County," available at http://www.windpoweringamerica.gov/pdfs/wpa/az_counties_coconino.pdf; "Arizona Wind Energy Assessment, Navajo County," available at http://www.windpoweringamerica.gov/pdfs/wpa/az_counties_navajo.pdf.

[8] "Commercially developable" means Class 3-7 wind resources; "high-quality" means Class 4-7 wind resources.

[9] While the original plans were for a 15-MW farm, the company has stated that 20 MW is possible, and the Solar Energy Industries Association believes that the development is, in fact, a 20 MW farm.

[10] Becky Stuart, "Plans to develop 15 MW solar farm in Arizona underway," *PV Magazine*, June 25, 2010, available at http://www.pv-magazine.com/news/details/beitrag/plans-to-develop-15-mw-solar-farm-in-arizona-underway_100000284/#axzz2c3qUMpyK.

The Boquillas Wind Project, under development by the Navajo Tribal Utility Authority (NTUA), is an 85-MW wind farm located near Seligman, AZ, west of Flagstaff. It will be a 51 percent Navajo-owned enterprise. Salt River Project, the Arizona utility, has agreed to buy power from the project.[11]

The largest initiative to date, which unfortunately stopped just short of success, was the proposal for a 500-MW wind farm at Gray Mountain in the Cameron chapter on the western edge of the Navajo Nation. Private developers were willing to provide the entire cost of the project, and to make payments to the Cameron chapter and the Navajo central government totaling $5 million per year; they also offered an option for later Navajo purchase of 20 percent of the project, at the cost of construction. Strongly supported by the Cameron chapter, the Gray Mountain project was debated for years. Although it was ultimately approved by the Navajo Nation Council (after defeating a veto by then-President Joe Shirley), the delays drove away the developers and prevented construction. Three developers expressed serious interest in the project at various times during the lengthy negotiations.[12]

This record of experience with solar and wind development shows that renewable energy in the Navajo Nation is a viable investment, if the conditions are right. The Gray Mountain experience, in particular, shows that multiple outside investors are willing to pay the upfront costs of investment in wind power, and suggests that they might also be willing to pay annual royalties of $10,000 per MW (based on the offer of $5 million per year for the proposed 500-MW Gray Mountain project).

## 4.2. Replacing NGS Jobs: A Renewable Energy Scenario

If one unit, or one-third, of NGS closes, and the Kayenta mine also cuts back by one-third, then the Navajo Nation will lose roughly 280 well-paying jobs at those two enterprises. These jobs have extensive ripple effects throughout the economy, as the spending by workers and employers generates other jobs.

What would it take to replace those 280 jobs with renewable energy?

Roughly the same number of jobs would be created by building and operating 900 MW of renewable energy. For this analysis we assume 750 MW of wind and 150 MW of solar photovoltaics. This could, for instance, consist of a wind facility the size of the proposed wind farm at Gray Mountain, another wind farm of half that size, and new solar installations totaling 7 to 10 times the size of the Pacific Blue Energy Corporation solar project in Coconino County. Our scenario includes a majority of wind power solely in order to reduce costs; wind power is cheaper to build than solar power, per MW of capacity. Solar power creates slightly more jobs per MW than wind, so a 900 MW scenario that includes more than 150 MW of photovoltaics would create even more jobs than our estimates.

The renewable energy scenario creates three categories of jobs:

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[11] Alastair Bitsoi, "Wind project holds promise for tribe," *Navajo Times*, 4 August 2011, available at http://navajotimes.com/news/2011/0811/080411wind.php.

[12] This story is described in multiple sources, including Cindy Yurth, "Waiting for a fair wind," *Navajo Times*, November 29, 2012, available at http://navajotimes.com/news/2012/1112/112912cam.php.

- Direct employment in building and maintaining wind and solar facilities;
- Indirect and induced employment resulting from the same facilities; and
- Jobs created by spending the royalties paid by the developers (or by spending the profits, if the facilities are owned by Navajo communities).

The analysis is based on our ongoing research on renewable energy at Synapse Energy Economics, and relies in part on the IMPLAN and NREL JEDI economic impact models.[13] IMPLAN is a widely used model, which was also used in the ASU report; JEDI is a model that focuses on renewable energy technologies.

### Direct employment

Jobs are created both in building renewable energy facilities, and in maintaining and operating them after construction. Construction jobs happen once, when the facility is built; maintenance jobs continue year after year, throughout the lifetime of the facility. We have converted construction employment into permanent jobs by assuming it is spread out over 20 years. So, for example, we would convert 100 person-years of construction into 5 permanent jobs.

With this assumption, the direct employment under our 900 MW renewable energy scenario is shown in Table 2. The total is 284 jobs, roughly the same as the number of direct jobs that would be lost by shutting down one-third of NGS and the Kayenta mine.

**Table 2. Direct Employment in Renewable Energy**

| | | *Direct employment* | | |
|---|---|---|---|---|
| | **Capacity (MW)** | **Construction** | **Maintenance** | **Total Direct Employment** |
| **Wind power** | 750 | 92 | 129 | 221 |
| **Solar photovoltaics** | 150 | 20 | 42 | 62 |
| **Total** | 900 | 113 | 171 | 284 |

### Indirect and induced employment

In addition to the direct jobs in construction and maintenance, wind and solar power create other types of employment. Economic models often distinguish between indirect jobs at other companies that sell products or services to the energy facilities, and induced jobs, created when workers at the facilities spend money on other products and services (for instance, jobs created when construction workers buy food or pay for auto repairs). For simplicity, we have combined these two categories, and refer to them both as “indirect” employment. There are almost 500 indirect jobs resulting from our scenario, as shown

[13] We used the IMPLAN dataset for Arizona; we modified some JEDI default values based on our own research on the evolution of renewable energy costs and characteristics.

in Table 3; about 300 are indirect results of construction, and 200 are indirect results of the ongoing maintenance expenditures.

**Table 3. Indirect Employment in Renewable Energy**

| | | *Indirect employment* | | |
|---|---|---|---|---|
| | **Capacity (MW)** | **Construction** | **Maintenance** | **Total Direct Employment** |
| **Wind power** | 750 | 179 | 162 | 341 |
| **Solar photovoltaics** | 150 | 113 | 40 | 153 |
| **Total** | 900 | 292 | 202 | 494 |

## Jobs created by royalty payments

The third category of jobs results from royalty payments from energy developers to the Navajo Nation—either to the central administration, to local chapters or communities, or both. Based on the Gray Mountain wind farm proposal, we assume that royalties will amount to $10,000 per MW per year. The ASU study estimates that royalty payments to the Navajo Nation create 17 jobs per million dollars at 2020 prices; corrected for inflation, this is a little more than 20 jobs per million dollars at 2011 prices. As a result, the royalty payments assumed in our scenario would create more than 180 jobs, as shown in Table 4.

Royalty payments, of course, only occur if the renewable energy projects are developed by outside developers. If they are developed by Navajo community groups, chapters, or the Navajo Nation as a whole, there may not be any royalty payments. In that case, we assume that local control of development will lead to profits from the projects, equal to at least the amount of royalties shown in Table 4, which will be in Navajo hands. Spending these profits should create at least as many jobs as the royalties shown in Table 4.

**Table 4. Employment due to royalty payments**

| | Capacity (MW) | Annual Royalties | Employment |
|---|---|---|---|
| **Wind power** | 750 | $7,500,000 | 153 |
| **Solar photovoltaics** | 150 | $1,500,000 | 31 |
| **Total** | 900 | $9,000,000 | 184 |

## Employment summary

Table 5 summarizes the three categories of employment. Almost 1,000 jobs are created by a 900 MW renewable energy scenario that replaces one of the three units of NGS and one-third of the Kayenta mine.

**Table 5. Summary of Employment Created by Renewable Energy**

| | | *Total employment* | | | |
|---|---|---|---|---|---|
| | **Capacity (MW)** | **Direct Jobs** | **Indirect Jobs** | **Jobs from Royalties** | **Total Employment** |
| **Wind power** | 750 | 221 | 341 | 153 | 716 |
| **Solar photovoltaics** | 150 | 62 | 153 | 31 | 246 |
| **Total** | 900 | 284 | 494 | 184 | 962 |

Significant investments are required to build these facilities and create these employment benefits. The estimated construction cost of our scenario is $1,463 million for wind turbines and $450 million for photovoltaics. Is this scenario, with capital costs of $1.9 billion, affordable? It is encouraging to see that investors were willing to pay the full costs of wind power development at Gray Mountain; this suggests that with clarity about leasing terms, private funding could be obtained for wind development. Solar power, with higher costs per MW, may still need some government subsidy—but the Navajo Nation, with some of the best solar potential in North America, is one of the places where this important technology is closest to profitability. Solar power may also be easier to install on a small-scale, community-controlled basis, providing practical experience with both renewable energy and grassroots involvement in economic development.

# 5. Other Economic Development Opportunities that Arise from Replacing NGS with Renewable Energy

Replacing NGS with renewable energy would not only create jobs associated with the renewable energy investments, themselves; this approach would create opportunities for other desirable economic initiatives, which we address in the following sections.

## 5.1. Water for Navajo Agriculture

Agriculture is at the core of the traditional Navajo way of life. Much of the population is engaged in ranching and farming, raising sheep, cattle, and horses, as well as growing food. In the arid environment of the Navajo Nation, water is the limiting factor for the growth of food, pasture, and forage crops. The water now used by NGS could be redirected to enhance the prosperity of Navajo agriculture.

U.S. government statistics provide a portrait of Navajo agriculture—although the important categories of food production for subsistence (non-marketed) consumption and for ceremonial uses are often under-reported. Five counties encompass most of the reservation: Apache, Coconino, and Navajo in

Arizona, and McKinley and San Juan in New Mexico.[14] While some non-Indian areas are included in these counties, farms operated by American Indians account for more than 85 percent of either the total number of farms or total farm acreage in each county.

Pastureland represents 94 percent of total farm acreage across the five counties. The main crops are vegetables, fruits, and forage crops (hay, grass silage, or greenchop), with a scattering of corn, wheat, beans, barley, sorghum, and oats. The most prosperous agricultural district is in San Juan County, which has more than half the irrigated acreage, and more than half the total acres of cropland, of the five-county area. Outside of San Juan County, most farm revenues come from livestock, particularly from raising and selling cattle and sheep. (Although horse ownership is widespread, sales of horses are only a modest source of income.) One of the most important traditional occupations, weaving, is built on the availability of wool. The expansion of weaving, which could be a key part of a sustainable development strategy for the Navajo Nation, requires a reliable supply of wool.

Only 14 percent of farms in the five-county area reported hiring farm labor; most are small, family-operated farms. San Juan County is the only county where farmers as a whole reported making a profit on farming; according to the Census of Agriculture, farmers in the other four counties lost money.

It is hard to exaggerate the importance, and the scarcity, of water for Navajo agriculture. According to the U.S. Department of Agriculture, "the average value of production for an irrigated farm was three times higher than conventional dry land farms that are non-irrigated."[15] For the United States as a whole, 6.1 percent of farm acreage is irrigated; for Arizona and New Mexico as a whole, the percentage drops to 2.5 percent; for the five-county Navajo area, only 0.7 percent of farm acreage is irrigated. In 2007 there were 78,000 irrigated acres in San Juan County, but less than 25,000 irrigated acres in the other four counties combined.

Water problems are endemic to the region: a study of vulnerability and adaptation to climate change in semi-arid farms and ranches in Arizona found that water stress, and in particular drought, was "by far the most important climate-related concern among each of the ranchers interviewed," and in particular among ranchers reliant on rain-fed pastures for livestock grazing.[16] Increasing the availability of water resources for ranchers and farmers in the region could have a substantial impact on livestock production, with the added bonus of potentially making these farms less susceptible to drought.[17]

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[14] Data in this section are from the 2007 Census of Agriculture volumes for Arizona and New Mexico (the latest volumes available).

[15] Glenn D. Schaible and Marcel P. Aillery, "Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands," USDA Economic Research Service, Economic Information Bulletin Number 99, September 2012.

[16] Ashley R. Coles and Christopher A. Scott, "Vulnerability and adaptation to climate change and variability in semi-arid rural southeastern Arizona, USA," Natural Resources Forum, Vol. 33 (No. 4), 2009, pp. 297-309.

[17] Marcela Vasquez-Leon, Colin Thor West, and Timothy J. Finan, "A comparative assessment of climate vulnerability: agriculture and ranching on both sides of the US-Mexico border," Global Environmental Change, Vol. 13 (2003), pp. 159-173.

Livestock may fare better than many crops under arid conditions, and sheep are said to be able to tolerate water restriction better than many animals.[18] For any livestock, however, a lack of water, particularly when paired with heat, has adverse effects on animal health.[19] Water requirements rise when it gets hot: the daily water intake of beef cattle increases by about 50 percent when the temperature jumps from 80° to 90° F.[20]

### Water rights: the unfulfilled promise

Throughout the western United States, water rights are complex and contested. Facing many powerful groups with rival claims, the Navajo Nation has been unable to secure legal rights to its promised share of major water bodies. The expansion of irrigated agriculture in San Juan County reflects, in part, the earlier success in establishing Navajo rights to significant amounts of water from the San Juan River (although a subsequent settlement, expanding the San Juan entitlement, was reached only recently and may face court challenges). In contrast, the near-absence of irrigation in the Arizona portion of the Navajo Nation reflects the failure to establish uncontested rights to Colorado River water—including the Little Colorado River, an important source of water for the southwestern Navajo region.

It has been clear for decades that the Little Colorado River offers a key opportunity to expand water supplies and irrigation for Navajo communities. A 1981 engineering study for the U.S. Department of Interior, Bureau of Indian Affairs described the potential for a reservoir on the Little Colorado near Leupp, capable of storing 77,000 acre-feet of water and irrigating 20,000 acres of farmland at minimal cost.[21] A detailed study by the Navajo Nation's Division of Natural Resources identified prospects for 19 projects along the Little Colorado, providing irrigation to more than 40,000 acres and creating more than 500 new jobs in agriculture.[22] Most of the potential irrigated acres and jobs were in Leupp, Birdsprings, and Cameron.

Resolution of the still-unsettled water rights on the Little Colorado and elsewhere is crucial to the future of Navajo agriculture—and has the potential to employ hundreds of people, helping to replace the jobs at NGS and Kayenta. The 34,000 acre-feet of water from Lake Powell, now used at NGS, could be redirected to expand drinking water supplies and to contribute to irrigation in the western parts of the Navajo Nation. Both a clear settlement of water rights and a rejection of water-wasting technologies such as coal combustion are needed to create a sustainable future for the Navajo Nation.

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[18] A. Sahoo, Davendra Kumar, and S.M.K. Naqvi (Eds.), "Climate Resilient Small Ruminant Production," National Initiative on Climate Resilient Agriculture, Izatnagar, India, 2013.

[19] Sahoo et al. 2013.

[20] "Nutrient Requirements of Beef Cattle: Seventh Revised Edition, 1996," National Academy Press, Washington, D.C., 1996, p. 81.

[21] Morrison-Maierle, Inc., *Navajo Water Resources Evaluation*, Volume XIII, "Little Colorado River Basin Resources and Development Plan," 1981.

[22] Jacques Seronde, "Little Colorado River Basin Irrigation Projects: Preliminary Cost-Benefit Estimates," 1992.

## 5.2. Ecotourism: The Untapped Potential

Mining and burning coal interferes with another important opportunity for sustainable development, namely, the creation of an ecotourism industry. Tourists will not be offended by clean, non-polluting solar panels and wind turbines; indeed, environmentally oriented visitors may find renewable energy to be an attraction. In contrast, tourists do not generally choose to spend time around coal mines and coal-burning power plants.

Currently there is very little tourism in the Navajo Nation. Those who do visit major attractions such as Monument Valley or Canyon de Chelly often stay outside the Navajo territory, coming in and out on buses, or else stay in a few facilities operated by national hotel chains. The Navajo tourism website lists just 14 hotels with a total of less than 1,200 rooms, along with a handful of smaller lodgings, in the entire 27,000 square miles of the Navajo Nation.[23] Restaurants, tour guides, and other tourism services are similarly sparse.

Ecotourism, motivated by the desire to visit undisturbed natural areas and traditional cultures, is one of the fastest-growing forms of tourism. American Indian tribes in general have been slow to develop ecotourism markets, as noted in a study of the Standing Rock Sioux Reservation.[24] That study found a substantial untapped market for ecotourism, noting the need to ensure the compatibility of new tourism ventures with Sioux culture and values.

The need for clear communication about conflicting values and priorities is highlighted in a case study of proposals for ecotourism development in Gallup, New Mexico, involving the Churchrock chapter of the Navajo Nation.[25] Initiated by non-Navajo groups in Gallup, the project called for expansion of biking and hiking trails, including a major Pyramid Peak loop trail. Cross-cultural misunderstandings and clashing attitudes toward land use hindered project planning and defeated the most ambitious proposal; although the Gallup area has an extensive trail system, the loop trail for Pyramid Peak was never built.

On the other hand, the potential for community-controlled development of ecotourism remains an attractive alternative. One notable success story is the development of ecotourism facilities and renewable energy by the Ramona Band of Cahuilla Indians.[26] Located in a remote area of southern California, the Ramona Band has developed an off-the-grid, renewable energy-based economy centered on ecotourism enterprises. Their goal is to present alternative energy education combined with programs highlighting Cahuilla cultural traditions, and to attract visitors interested in this experience. Renewable energy sources now provide 90 percent of all energy used in the Ramona Reservation.

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23 http://www.discovernavajo.com.

24 Robert R. Hearne and Sheldon Tuscherer, "Stated Preferences for Ecotourism Alternatives on Standing Rock Sioux Reservation," 2008, *Great Plains Research* 18, pp. 131-142.

25 Marcella LaFever, "Empowering Native Americans: Communication, Planning, and Dialogue for Eco-Tourism in Gallup, New Mexico," 2011, *Journal of International and Intercultural Communication* 4, no. 2, pp. 127-145.

26 See their website, http://www.ramonaband.com/index.html.

Although it is a small-scale example, the experience of the Ramona Band is important evidence of the potential for an economy based on ecotourism and renewable energy.

# 6. CONCLUSION

Electricity from NGS looks like a bargain—but that is only because so many of the true costs are hidden. When the true costs are included, the renewable alternatives look much better, promoting sustainable development of clean, community-controlled resources. At present, some of the poorest people in the region, in the Navajo Nation, are absorbing the true costs of coal power, subsidizing electricity used by others with the health of their people and their land. Economic and environmental justice demands a different solution.

Naming the problem is not enough to solve it. Challenges remain—to implement policies based on the true costs of coal, and to allocate the gains and losses from a new energy strategy. The analysis presented here shows that the new energy strategy is worth working for, and that the challenges can be overcome.

The prospects for renewable energy in the Navajo Nation are bright, with ample solar and wind potential confirmed by multiple studies. The renewable energy scenario developed here would replace the direct jobs lost by shutting down one of the three NGS units, as is now proposed. It would also create indirect jobs, for a total of almost 1,000 jobs—more than the number of jobs that would be lost by shutting one unit of NGS and one-third of the Kayenta mine. The harm to health in communities surrounding NGS and Kayenta would be reduced. As much as 11,000 acre-feet of water, one-third of the amount now consumed by NGS, would become available for other uses such as irrigation. Expansion of irrigation would strengthen agriculture in the Navajo Nation and would allow the expansion of weaving. Replacing fossil fuels with renewable energy would also boost the prospects for creation of an ecotourism industry, one of the important opportunities for sustainable Navajo development.

The renewable energy scenario, as an alternative to NGS, affirms our fundamental connection with nature, relying on the sun and the wind to replace dirty and destructive industries. It protects the air, the land, the water, and traditional ways of life based on harmony with the environment. It is compatible with new initiatives to promote sustainable economic development of the Navajo Nation, seeking to reduce poverty, create community-controlled enterprises, and respect the natural world that we all depend on. It is, quite simply, a better way to live.

# APPENDIX: ENVIRONMENTAL REGULATIONS AFFECTING NGS

The Navajo Generating Station (NGS) is made up of three identical, supercritical steam generating units, each with a gross capacity of 803.1 MW (the net capacity is 750 MW, after subtracting energy needed to run the plant). NGS consumes about 8 million tons of low-sulfur bituminous coal each year from the nearby Kayenta coal mine on Black Mesa. The plant began operating in 1974 and provides electricity to customers in Arizona, California, and Nevada. It also supplies power to the Central Arizona Project, a massive pumping project that sends 1.5 million acre-feet of Colorado River water from western Arizona to central and southern Arizona for irrigation and municipal uses. From 2010 to 2012, NGS produced an average of 16,423 GWh of electricity (net) per year and had an average capacity factor of 78 percent.[27]

One of the largest coal-fired power plants in the country, NGS generates significant air emissions, including sulfur dioxide, nitrogen dioxide, particulate matter, and carbon dioxide, as shown in Table A1.

**Table A1. Emissions Summary for NGS**

| Pollutant | Rate (lb/MMBtu) | Average annual total (tons/year) |
|---|---|---|
| $SO_2$ | .055[(1)] | 4,664[(1)] |
| $NO_x$ | .24[(2)] | 19,302[(1)] |
| PM | .06[(3)] | 5,099[(4)] |
| $CO_2$ | 205.2[(1)] | 17,437,000[(1)] |

*Notes: (1) Estimated from EPA Clean Air Markets Division (CAMD) data, 2010-2013*
*(2) Based on current permit*
*(3) From Sargent & Lundy SCR Cost Study*
*(4) Estimated from (3) and EPA CAMD data, 2010-2013*

These emissions can affect visibility in nearby national parks such as Grand Canyon, Bryce Canyon, and Arches national parks, and can harm public health in surrounding communities. As the power plant closest to the Grand Canyon, NGS has been at the center of concerns about emissions that lead to haze. The greatest recent controversy about NGS costs and emission controls arose from the commitment to reduce haze in the region.

## Environmental Compliance Obligations

NGS does have a number of environmental controls already in place, including hot-side electrostatic precipitators for particulate control and forced oxidation spray-type wet scrubbers, which remove approximately 92 percent of sulfur dioxide ($SO_2$) emissions. The scrubbers require 130,000 tons of limestone and 3,000 acre-feet of water each year, and produce over 200,000 tons of gypsum as a saleable byproduct. In 2009, NGS also began installing low-NOx burners with separated over-fire air,

[27] EIA Form 923 Generation and Fuel.

which helped reduce emissions of nitrogen oxides (NOx) by approximately 40 percent from previous levels.[28]

The plant is cooled with mechanical draft cooling towers and uses approximately 28,000 acre-feet of water from Lake Powell for cooling, scrubbing, boiler water, and other uses.[29] Finally, NGS was one of the first power plants built with a zero liquid discharge system and uses brine concentrators and a crystallizer to remove solids and produce distilled water for reuse in the plant. Much of the fly ash produced as a result of the combustion process is sold to make concrete or for "Flexcrete," light-weight concrete blocks that are manufactured in Page and marketed to the Navajo community for use as homebuilding materials.[30]

Despite its existing controls, NGS still faces significant costs to comply with current and future environmental regulations. The plant currently exceeds the mercury standard set in the 2011 Mercury and Air Toxics Standard (MATS).[31] Compliance may require installation of one or more Activated Carbon Injection (ACI) systems by April 2015 (or 2016, if a one-year extension is granted).

In February 2013, EPA published its proposed best available retrofit control technology (BART) determination for addressing regional haze pollution from NGS. If finalized, the proposal would require the installation of selective catalytic reduction (SCR) systems on all three NGS units within five years of a final determination (thus the deadline will be in 2019 if the final rule is issued in 2014). EPA estimates that the total capital cost of SCR installation at NGS would be approximately $496 million, while a study by the consulting firm Sargent & Lundy (S&L),[32] commissioned by NGS, estimated the cost of SCR installations at about $544 million.[33]

The S&L study also identified additional controls that may be needed in order to accommodate potential emissions increases caused by the SCR systems. According to S&L, SCR systems can increase sulfuric acid mist formation due to the oxidation of $SO_2$ across the catalyst. If the SCR system cannot be designed to minimize increased sulfuric acid mist formation below the level that would affect the plant's permit, dry sorbent injection (DSI) would be required upstream of the existing scrubber systems. S&L estimates that the addition of DSI systems would require an additional $3 million per unit. The additional sorbent injection could in turn lead to significant increases in particulate emissions. The existing electrostatic

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[28] EPA CAMD Data 2004-2013.

[29] NREL Report "Navajo Generating Station and Air Visibility Regulations: Alternatives and Impacts," revised March 15, 2012.

[30] Jonathan Thompson, "Ashes to houses: One of coal's big messes is transformed into building blocks," *High Country News*, November 20, 2007.

[31] See EPA Docket ID# EPA-R09-OAR-2013-0009-0004: mats_final_current_base_hap_inven.

[32] Sargent & Lundy, "Navajo Generating Station SCR and Baghouse Capital Cost Estimate Report, S&L report # SL-010214, revision D," 2010, available at http://www.ngspower.com/pdfx/Jan2013/Sgt-Lundy_Cost_Study.pdf.

[33] The main differences in the cost estimates stem from EPA using a lower interest rate for capital recovery (7 percent compared to S&L's 9.8 percent) over a longer equipment life period (30 years compared to S&L's 20 years). EPA also eliminated AFUDC, owners' legal costs and insurance, and other miscellaneous owners' costs that S&L included in its estimate.

precipitators (ESPs) and wet scrubbers may be able to control the additional particulate emissions in order to maintain the plant's permitted levels; however, if the DSI systems increase particulate emissions beyond the existing equipment's ability to remove them, pulse jet fabric filters (baghouses) would be required. S&L estimates that baghouses at NGS would add another $160-$220 million in costs to each unit.

**Table A2. Particulate Control Costs for NGS**

| Control | EPA Estimate of Total Capital Cost | S&L Estimate of Total Capital Cost |
|---|---|---|
| **SCR** | $496,000,000 | $544,000,000 |
| **SCR + DSI** | N/A | $554,000,000 |
| **SCR + DSI + Baghouse** | N/A | $1,130,000,000 |

In its proposed BART determination, EPA also proposed an alternative that would allow NGS to delay SCR installation until 2021 for unit 1, 2022 for unit 2, and 2023 for unit 3. EPA claims that NGS may need more time to plan for installation of the SCR systems due to numerous uncertainties regarding the plant's lease, right-of-way renegotiations, and obligations under the National Environmental Policy Act (NEPA). EPA is authorized to allow alternative BART proposals, "provided the alternative results in greater reasonable progress than would have been achieved through installation of BART" and EPA "must ensure that all necessary emission reductions occur during the period of the first long-term strategy for regional haze, or in 2018 for States [including Arizona] that were required to submit regional haze SIPs in December 2007."[34]

EPA justifies this delay as "better than BART" by arbitrarily tilting the scales in favor of the new alternative. It does so by double-counting the benefits of the installation of low-NOx burners at NGS in 2009-2011. If NGS had waited until 2018 to install low-NOx burners, as it perhaps could have under prevailing regulations, then cumulative NOx emissions from 2009 through 2018 would have been about 100,000 tons higher. To calculate emissions under its alternative proposal, EPA first calculates cumulative emissions under the alternative, *including* the benefits of early installation of low-NOx burners. These emissions are higher than under the original BART proposal. EPA then gives NGS roughly 100,000 tons of emissions credit for the "early and voluntary" installation of low-NOx burners, despite the fact that it has already counted this emission reduction once. Stripped of double counting, EPA's own numbers show that, in reality, this allegedly "better than BART" alternative will result in an increase of more than 50,000 tons in cumulative NOx emissions from NGS over the period of 2009-2044.[35] This means more pollution for the communities living around the NGS plant, and more haze throughout the region.

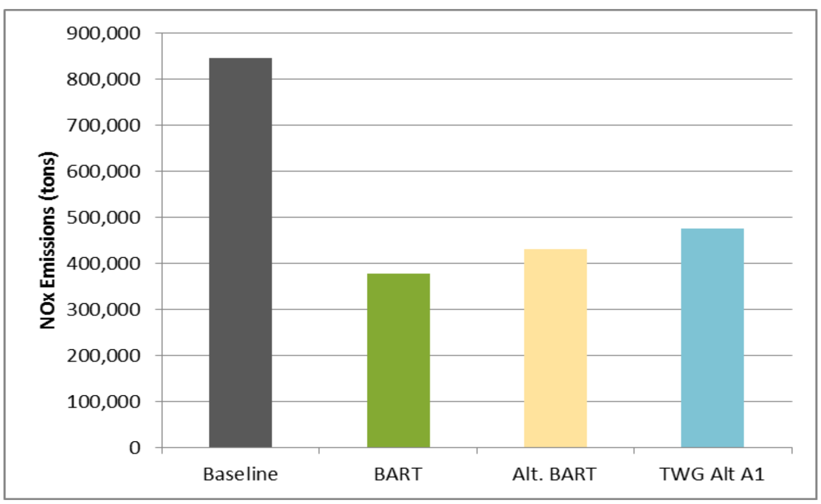
[34] 78 Fed. Reg. 8274, 8288 (February 5, 2013).

[35] *See* 78 Fed. Reg. 62509, 62515 - Table 2 (October 22, 2013).

On September 25, 2013, EPA signed a supplemental proposal[36] approving as "better than BART" a proposal by the Technical Work Group (TWG), a group of stakeholders that include the owners of NGS, the Department of the Interior, Environmental Defense Fund, Western Resource Advocates, and the Navajo Nation leadership. The TWG alternative establishes a lifetime cap on NOx emissions from 2009-2044 that is equivalent to the cumulative emissions that would be emitted by NGS during the same period under EPA's original BART determination – but it does so by again double-counting the benefits of early introduction of low-NOx burners. The TWG alternative does not commit to one particular course of action; instead, it offers multiple possible scenarios for meeting its emission reduction goal. One widely discussed option would involve shutting down one unit by the end of 2019 and installing SCR on the remaining two units by the end of 2030. TWG, however, offered several other alternatives, all of which were described as being "better than BART," postponing until a later date the decision about which one would actually be pursued.

Like the "better than BART" proposal offered by EPA, none of the TWG alternatives actually reduces emissions as much or as quickly as EPA's original BART determination. Instead, the TWG alternative also avails itself of the double-counting "credit" for the early installation of low NOx burners that EPA applied to its own alternative proposal. This would lead actual NOx emissions to be well in excess of EPA's BART determination. For instance, extrapolating from EPA's numbers, the option in which one unit of NGS is shut down at the end of 2019 and SCRs are installed on the remaining two units at the end of 2030 would result in almost 100,000 additional tons of NOx[37] emitted from NGS over the period from 2009-2044, compared to the original BART proposal.

**Figure A1. 2009-2044 Total NOx emissions without low-NOx burner credit**




As Figure A1 above shows, without the extra reductions from the double-counting credit, none of these alternatives is actually better than BART for those living and breathing near NGS.

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[36] 78 Fed Reg. 62509 (October 22, 2013).

[37] *See* Table 2 from 78 Fed. Reg. at 62515: assuming a 1/3 reduction in total emissions for the retirement of one unit at the end of 2019 and an 80 percent reduction in NOx beginning in 2031 from the installation of SCR.

Despite its lack of a defined strategy—or actual emission reduction improvements over the BART determination—EPA has proposed to find that the TWG alternative, or family of alternatives, is "better than BART."

## Carbon Dioxide Regulation

With the addition of SCR systems to control $NO_x$, and especially if DSI and baghouses are included for sulfuric acid mist and particulate control, NGS will likely be well-positioned to comply with potential future air quality regulations, such as more stringent particulate matter and ozone standards. However, even at over a billion dollars for the combination of SCR, DSI, and baghouses, these controls may not be the most significant economic challenge facing NGS. The costs of greenhouse gas regulation could be much worse for the plant's future prospects. As shown in Table A1, NGS emits as much as 17 million tons of $CO_2$ per year; costs per ton charged on those emissions will quickly become a major economic burden on the plant.

Greenhouse gases are already being regulated by the EPA through the New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs. Recently, EPA proposed a $CO_2$ emissions performance standard for new fossil fuel fired power plants, and President Obama has committed to adopt similar controls on existing fossil plants. In 2013, EPA amended its Social Cost of Carbon estimate (used in cost-benefit analyses of energy efficiency standards and other policies) to reflect a societal benefit of reducing carbon emissions of $43/ton in 2015, rising to $80/ton in 2050.[38]

Many observers, including a growing number of electric utilities, believe that it is only a matter of time before power plants like NGS will have to start paying for the carbon emissions they dump into the atmosphere each year. Even at modest carbon prices, these costs could dwarf those of the most expensive SCR retrofit option for NGS. Figure A1, below, shows the estimated impact on the costs of energy from NGS of additional NOx controls (SCR and baghouse) as well as the addition of a carbon price averaging $16/ton over the next 30 years—a price much lower than EPA's Social Cost of Carbon. This carbon price is the low-case estimate from the Synapse Energy Economics 2012 update on carbon pricing for utility planning; we offer it as a minimal estimate, and recommend consideration of our mid case and high price scenarios, as well.[39]

In Figure A1, the striped section at the top of each bar represents the effects of the Synapse low case carbon price, introduced in 2020. This figure demonstrates that, under such a carbon price scenario, it would be less economic to run Unit 2 than to buy power on the open market from an existing gas plant. At higher carbon prices, such as the Synapse mid case or high price scenario, NGS electricity would be

[38] These carbon costs were calculated at 2007 prices, and are often quoted in that form; we have adjusted them to 2013 prices. For the original data, see http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf.

[39] Rachel Wilson et al., "2012 Carbon Dioxide Price Forecast," Synapse Energy Economics, October 2012, available at http://www.synapse-energy.com/Downloads/SynapseReport.2012-10.0.2012-CO2-Forecast.A0035.pdf.

far more expensive than getting power from either new or existing gas plants. Since the economics of the three units are virtually identical, the same conclusions apply to Units 1 and 3.

**Figure A1. Costs of NGS vs. Gas Plants**