Solar Potential on Black Mesa
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Executive Summary

The Black Mesa region has the potential to produce between 1,422 and 6,083 MW electricity from solar development.

Full development of solar potential on Black Mesa could produce as many as 2,800 permanent jobs and as much as $357 million per year in regional economic benefit.

Purpose and Background

Black Mesa is a region in Northeastern Arizona within the Navajo Nation (Diné) and Hopi tribal lands. For much of the past century, the coal industry mined large areas of Black Mesa. Many areas of the formerly mined lands have been reclaimed or are scheduled for future reclamation, due to recent and proposed mine closures. Diné and Hopi tribal leaders are now assessing future uses for the reclaimed land, requiring that any proposed land use must respect the cultural and natural heritage of the Diné and Hopi peoples, while providing revenue, job growth, and economic development for the region.¹

Black Mesa’s natural abundance of sun offers great potential for the development of solar power without stripping the land of its natural resources. In addition, as an alternative to mining jobs, solar energy projects create 3 to 11 times as many jobs as fossil fuel or nuclear projects; so not developing solar projects misses an enormous opportunity to create more jobs, while honoring Diné and Hopi traditions.² This analysis evaluates the specific solar potential of Black Mesa and assesses the related economic benefit for the Diné and Hopi peoples.
Solar Potential
Black Mesa has 12,805 acres of currently reclaimed land and 25,235 acres that will be reclaimed in the future. *Given the excellent solar conditions on these lands, the 12,805 acres of currently available lands could be used to generate as much as 1,422 MW of electricity. Adding lands reclaimed in the future could increase this to a total of 6,083 MW.*

Using reclaimed mine land presents a unique solution to the environmental and cultural concerns that often accompany solar development. Particularly in the American southwest, the large amount of land needed for current solar technologies risks endangering delicate desert ecosystems. Such concerns have led proponents to consider locating new solar projects on previously disturbed land, as a way to minimize any additional impacts. Because previous mining activities have already disrupted the environmental and cultural features of Black Mesa, a new solar development on the reclaimed land would be unlikely to increase the previous levels of disturbance. This feature of previous disruption will reduce the need for additional review, prior to permitting solar development.

In addition, the reclaimed lands in the Black Mesa region are ideal for solar power generation, because they have:

1) The necessary physical characteristics for solar technology;
2) Access to an electrical grid;
3) Existing infrastructure, such as roads and local transmission lines, that will decrease permitting and construction costs for potential developers; and
4) Lighter environmental, cultural, and archaeological permitting burdens due to their status as brownfields (defined by the EPA as mine-scarred lands).

Job Growth and Regional Economic Development
The abundance of reclaimed land allows for a utility-scale solar project that could bring extensive job growth and economic development to the region. For example, although the number of jobs created by different solar technologies varies widely, depending on the type of technology used, *generating 1,422 to 6,083 MW of solar power has the potential to create between 285 and 2,859 well-paying, operational jobs and between 683 and 38,019 temporary (mainly construction) jobs.*

As well as creating direct jobs in construction and operation, renewable energy keeps the dollars in the regional economy, which then multiply and produce additional economic benefit. *Assuming each job pays an average of $50,000, developing solar resources on Black Mesa will add between $35.6 million and $357 million to the regional economy during each year of operation, along with an additional $85.4 million to $4 billion during each year of construction.*
Financing Options and Strategies
Financing for solar development in tribal regions can take various forms, depending on the preferences of each tribe. Other tribes have used three basic financing models: maintaining full, partial, or no ownership of their solar projects. Each model comes with advantages and disadvantages to the tribe. Tribal leaders will need to determine which model best suits the needs, goals, and resources of their tribe; however most solar development projects on tribal land follow the partial ownership model. Examples of financing methods are included in this analysis, below, along with suggestions for potential financers and purchasers of the energy.

Job creation and economic benefits are in proportion to the amount of money invested. Utility-scale solar development—generating enough energy to be sold to a utility for resale to their customers—is usually considered to be 1MW or larger. A 1MW test project on Black Mesa could require as little as 6 acres of land and $3.5 - $5 million in investment capital, which is readily available from various funding sources, (see below in the section on Potential Financing Models on page 21). Because developing all 12,805 acres of available land would require proportionally more investment capital, it is likely that solar development of the formerly mined land on Black Mesa will occur in phases, as funding becomes available and developers recognize the business opportunities available.

Conclusion
Solar power generation on reclaimed land sites on Black Mesa provides an excellent opportunity for long-term job creation and sustainable economic development, which could result in up to 2,859 operational jobs and up to 38,019 construction jobs, as well as $85.4 million to $4 billion in annual construction revenue and $35.6 to $357 million in annual long-term revenue for the local economies.
Introduction

The Black Mesa Waste Coalition (BMWC) has prepared this report, in partnership with To’ Nizhoni Ani’ and support from Natural Capitalism Solutions (NCS).

Benefits to the Region
Solar development on Black Mesa would provide long-term jobs and economic benefit to the region without requiring the Diné and Hopi people to compromise their cultural heritage and way of life. Currently 12,805 acres of land on Black Mesa have been reclaimed, with another 25,235 set for future reclamation, totaling 38,020 acres that will eventually be available for solar development. Fully utilizing all of this acreage would provide 1,422 to 6,083 MW of electricity and result in 285 to 2,859 operational and 683 to 97,328 construction jobs. Those jobs would then generate between $35.6 and $357 million in annual long-term revenue for the local economies along with $85.4 million to $12.2 billion per year during years of construction. Most importantly, solar power plants require skilled employees for operational and maintenance positions. Bringing solar development to the region would also bring training and advancement opportunities for the Diné and Hopi people.

Scope and Limitations of Analysis
This analysis looks solely at the aspects of solar development for Black Mesa. Other forms of renewable energy, such as wind or geothermal were not included in the scope of this analysis.

The cost projections used here are “thumbnail” calculations based on reported costs for similar solar projects. More detailed calculations from potential developers/financers would depend on project-specific conditions.
Solar Potential on Black Mesa

A Unique Opportunity

Black Mesa offers a unique opportunity for solar projects. The rapid increase in solar development within the last decade has raised concerns about the use of environmentally sensitive land for large-scale projects. This concern is raised because many desert areas otherwise well suited for solar development, due to the high levels of sunlight they receive, are also home to delicate ecosystems. However, reclaimed land, such as that on Black Mesa, presents an ideal situation for solar energy and provides an innovative solution to environmental, archaeological, and cultural concerns since various mining processes have previously degraded the land.

Additionally, the abundance of reclaimed land on Black Mesa will allow for utility-scale solar development that could bring substantial economic development to the region. As mentioned previously, out of Black Mesa’s 65,000 total acres, 12,805 acres are currently reclaimed and 25,215 acres have been marked for future reclamation. Figure 1, on the next page, provides the status of each mining area on Black Mesa and shows the location of the reclaimed land, labeled as “completed project” (in blue). See Appendix A: Reclamation Status by Mining Site for a more detailed list.
Abundant Solar Resources
With or without the environmental benefit of locating on previously disturbed land, the Black Mesa area has the physical characteristics ideal for solar development—it is flat and has abundant sunlight. According to the National Renewable Energy Laboratory (NREL), land with the “greatest potential for [solar] development” needs high levels of sunlight, must be available in parcels larger than 1 square kilometer, have a slope of less than 3%, and cannot be environmentally sensitive or include a major urban area. Figure 2 displays the areas of Arizona designated by NREL as having the “greatest potential for solar development” with Black Mesa highlighted. All of the 38,020 acres of land that will be reclaimed satisfy NREL’s requirements.
Figure 2: Areas with greatest potential for solar development (NREL 2007).

Generating Potential
Current solar projects require 6.25 to 9 acres of land per megawatt (MW) of electricity generated depending on the technology, thus if fully utilized solar development on the reclaimed lands of Black Mesa could produce between 1,422 MW and 6,083 MW of electricity. The reclaimed land on Black Mesa occurs in relatively large parcels spread across six sectors within the Navajo Nation. Table 1, on the next page, breaks down the development potential by subsection within Black Mesa. (More detail about acreage requirements can be found in the Solar Technologies section. See Appendix B: Maps of Reclaimed Land by Sector.)
Table 1: Black Mesa Solar Generation Potential

<table>
<thead>
<tr>
<th>Sector</th>
<th>Available Land (Acres)</th>
<th>Generation Potential (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Currently Reclaimed</td>
<td>12,805</td>
<td>1,422-2,049</td>
</tr>
<tr>
<td>Total To Be Reclaimed</td>
<td>38,020</td>
<td>4,224-6,083</td>
</tr>
<tr>
<td>Total North of Joint Use Area</td>
<td>6,075</td>
<td>675-972</td>
</tr>
<tr>
<td>Reclaimed before 1990</td>
<td>2,520</td>
<td>280-403</td>
</tr>
<tr>
<td>Reclaimed before 1990 North of Joint Use Area</td>
<td>1,940</td>
<td>215-310</td>
</tr>
<tr>
<td>Yellow Water, Mine Areas N-1 and N-2</td>
<td>1,000</td>
<td>111-160</td>
</tr>
<tr>
<td>Mined Areas N-7 and N-8</td>
<td>940</td>
<td>104-150</td>
</tr>
<tr>
<td>White Grass, Mined Area N-14</td>
<td>1,650</td>
<td>183-264</td>
</tr>
<tr>
<td>White Grass, Mined Area J-16</td>
<td>1,350</td>
<td>150-216</td>
</tr>
<tr>
<td>White House, Mined Areas J-19</td>
<td>1,060</td>
<td>118-170</td>
</tr>
<tr>
<td>Owl Springs Sector, Mined Area J-7</td>
<td>1,040</td>
<td>116-166</td>
</tr>
</tbody>
</table>

Existing Infrastructure

Land suitable for solar development is often located in remote desert areas with minimal physical infrastructure, such as power lines or roads. Connecting solar power generation facilities to the existing electrical transmission grid is often one of the biggest hurdles for solar developers and financiers, due to the added cost of building new transmission lines. The prior mining activity by Peabody Coal resulted in a network of power lines running through Black Mesa (Figure 3). A 230 kV transmission line, along with the associated right-of-ways, substations, and support service areas, connects to a regional transmission grid and could be used to transport electricity to an outside utility.

Figure 3: Southwestern U.S. Electrical Transmission Grid
Boxed area shows Black Mesa connection (WRP 2008).
Pre-existing access to transmission lines offers such a financial advantage that the Arizona Corporation Commission used this as a criterion in determining the regions in that state best suited for solar development (Sixth Biennial Transmission Assessment 2010-2019 Draft Report, Docket No. E-00000D-09-0020). The Commission identified a series of “transmission corridors” that could easily transmit solar generated electricity to the electrical grid and recommends future solar development occur along these corridors when possible. One of those “transmission corridors,” shown in 4, runs directly through Black Mesa.

Figure 4: Electricity Transmission Corridors
Along with access to a transmission grid, previous mining activity has created an infrastructure of roads, wells, ponds, and plant facilities that will additionally alleviate construction costs. Figure 5, below, illustrates the network of roads currently running through Black Mesa. More detail is available in Appendix B: Maps of Reclaimed Land by Sector, which show the roads running through each reclaimed area.

**Figure 5: Network of Roads in Black Mesa**

**Previous Archeological and Cultural Clearances**

Black Mesa is located within the Navajo Nation and Hopi Tribal area, both of which have rich cultural and archeological resources that hold immense and irreplaceable value for the families who have lived on the land for generations. Federal programs to preserve these resources require the completion of extensive surveys, analyses, and protection programs, before any potentially destructive land use can take place.

Mined lands on Black Mesa are among the very few areas of the Navajo Nation and Hopi tribal areas where cultural and archeological clearances have already been issued. As a result of mining activity, few, if any, of the cultural and archaeological resources remain intact on the reclaimed lands. The surveys needed for future land use on reclaimed land will therefore be greatly reduced, or perhaps eliminated. Because these clearances can be very costly and time-consuming for large-scale projects, anything that eases the process will be a great advantage for a solar developer.
Solar Technologies
Available solar technologies range widely in price, efficiency, water use, and maturity. Each technology has advantages and disadvantages regarding these variables.

Types of Solar Generation
Solar technologies have generally been classified into two broad categories.

1) **Concentrating Solar Power (CSP)** technologies use parabolic troughs, dish systems, or arrays of mirrors to focus the sun’s rays to produce heat, which is then used to generate electricity from solar-heated steam, heated gas, or other heat-based systems;

2) **Photovoltaic (PV)** systems produce direct-current electricity from sunlight shining on a semiconductor, such as silicon.

Note: Some PV systems also use various methods to concentrate sunlight onto PV panels, somewhat blurring the historical distinction between “concentrating” and “photovoltaic” systems.

For the purposes of this analysis, five of the most common solar technologies are described here.

CSP—Parabolic Trough Systems
The most commonly used technology for utility-scale solar projects, parabolic trough systems, concentrate the sun’s energy to produce heat that then drives a steam turbine. These systems require a cooling system that has traditionally used large amounts of water (wet cooling). Recently, however, a dry cooling system has been created in order to address water resource concerns that have arisen in the arid climates where solar projects are often located (dry cooling). Dry cooling systems are more expensive and less efficient than their wet cooling counterparts but can result in significant savings of water, which can be expensive in arid climates.

![Figure 6: Parabolic Trough Systems](image)
CSP—Stirling Dish Engine

Dish systems also concentrate the sun’s energy, but do so in order to run a heat engine that requires water only for cleaning purposes. Dish systems are reported to be noisier than other solar options; however, technologies are currently being developed to lessen this concern.

![Image of Stirling Dish Engine]

**Figure 7: Stirling Dish Engine**

CSP—Power Tower

Power towers are made up of an expansive array of mirrors that focus sunlight on a central tower that serves as a collector. Similar to the parabolic trough systems, the heat is used to run a steam turbine, and the system requires either wet or dry cooling. Recent projects are utilizing the dry cooling technology; however, as with parabolic trough systems, it is more expensive and less efficient than wet cooling.

![Image of Power Tower]

**Figure 8: Power Tower**
Flat Panel PV

Until recently, large-scale PV systems were too expensive to be cost-competitive; however the use of less expensive semi-conductor materials, improvements in panel mass production; and government/utility incentives and subsidies have made PV technology for utility-scale projects cost competitive. Still, this technology is still expensive when compared with other solar systems.

Figure 9: Flat Panel PV

Concentrating PV

The creation of concentrating photovoltaic systems made them cost-competitive with other, thermal-concentrating technologies, before technological improvements decreased the price non-concentrating, flat panel production. Today CPV systems are still less expensive than flat panel systems and are potentially superior to CSP systems because they require no water for operation, thus representing an attractive option that is neither water intensive, loud, or requires expensive dry cooling systems.

Figure 10: Concentrating PV Systems
For development purposes on Black Mesa, the mechanical details are less important than the other factors such as generating potential, water requirements, cost, and job growth potential. As stated previously, no single technology is superior across all categories. Deciding which technology (or combination of technologies) to use will be determined by unique regional concerns, infrastructure, and cost factors.

**Generating Potential**

Each solar technology has a different land requirement that ranges from 6.25 to 9.0 acres per MW generated. Current solar projects were referenced to determine which solar technologies have the lowest acreage needs and could thus produce the most amount of electricity on Black Mesa. Figure 6 provides the acreage requirements and corresponding generating potential for the available technology options.

### Table 2: Generating Potential Based on Land Use Requirements

<table>
<thead>
<tr>
<th>Technology</th>
<th>Acreage Requirements (Acres/MW)</th>
<th>Generating Potential on Black Mesa (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP – Parabolic Trough (Wet Cooling)</td>
<td>6.25(^7)</td>
<td>2,049 – 6,083</td>
</tr>
<tr>
<td>CSP – Parabolic Trough (Dry Cooling)</td>
<td>9.0(^8)</td>
<td>1,423 – 4,224</td>
</tr>
<tr>
<td>Stirling Dish Engine</td>
<td>9.3(^9)</td>
<td>1,377 – 4,088</td>
</tr>
<tr>
<td>Power Tower (Dry Cooling)</td>
<td>9.2(^10)</td>
<td>1,392 – 4,132</td>
</tr>
<tr>
<td>Concentrating PV</td>
<td>8.3(^11)</td>
<td>1,542 – 4,581</td>
</tr>
<tr>
<td>Flat Panel PV</td>
<td>6.0(^12)</td>
<td>2,134 – 6,337</td>
</tr>
</tbody>
</table>

**Water Requirements**

PV technologies, both flat panel and concentrating, and Stirling engine CSP systems use negligible amounts of water, mainly for cleaning the panels or reflectors. However, until recently water-intensive CSP systems were more commonly used for large projects, instead of PV systems, because of cost. While PV was historically the more expensive technology, recent technological breakthroughs and government or utility rebates and incentives have dramatically decreased the cost of PV systems. Depending on incentives and rebates, PV can be cost-competitive with CSP systems, particularly in areas with costly water rights. Table 3 lists the water requirements of each technology.
Table 3: Water Required for Various Solar Technologies  
(*Given generating potentials listed in Table 2*)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Water Use (gallons/MWh)</th>
<th>Water Use Annually (Gallons/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP—Parabolic Trough (wet cooling)</td>
<td>760-1000(^{13})</td>
<td>2.73 billion – 10.7 billion</td>
</tr>
<tr>
<td>CSP—Parabolic Trough (dry cooling)</td>
<td>40-80(^{14})</td>
<td>99.8 million – 592 million</td>
</tr>
<tr>
<td>CSP—Stirling dish engine</td>
<td>76 - 100(^{15})</td>
<td>196 million – 766 million</td>
</tr>
<tr>
<td>CSP – Power Tower (Dry Cooling)</td>
<td>45(^{16})</td>
<td>123 million – 366 million</td>
</tr>
<tr>
<td>CSP – Photovoltaic</td>
<td>76 - 100(^{17})</td>
<td>206 million – 803 million</td>
</tr>
<tr>
<td>Flat Panel Photovoltaic</td>
<td>76 - 100(^{18})</td>
<td>284 million – 1.1 billion</td>
</tr>
</tbody>
</table>

If the full potential of solar development on Black Mesa were realized using a wet cooling CSP system, between 1.89 and 10.7 billion gallons of water would be needed every year. The fundamental principals of the Diné and Hopi peoples suggest that other, less water-intensive technologies would be more culturally appropriate on Black Mesa. In addition, the saved water could have greater value and provide more benefit if used for other purposes, thus if the long-term costs of water use are considered, other technologies will likely be more cost effective.

For more information see Appendix D: Water Resources for Different Technologies.
Cost Projections

Many factors need to be considered when deciding on solar technology; however cost is usually one of the most important. Figure 7 shows the price estimates for the most common, currently available solar technologies:

<table>
<thead>
<tr>
<th>Technology</th>
<th>Current investment in $\text{millions/ installed MW}$</th>
<th>Total investment in $\text{billions required}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP – Parabolic Trough (Wet Cooling)</td>
<td>$3.5^{19}$</td>
<td>$7.1 – $21</td>
</tr>
<tr>
<td>CSP – Parabolic Trough (Dry Cooling)</td>
<td>$3.1^{20}$</td>
<td>$4.4 – $13</td>
</tr>
<tr>
<td>Stirling Dish Engine</td>
<td>$3.0^{21}$</td>
<td>$4.4 – $13</td>
</tr>
<tr>
<td>Power Tower (Dry Cooling)</td>
<td>$3.4^{23}$</td>
<td>$5.3 – $16</td>
</tr>
<tr>
<td>Concentrating PV</td>
<td>$3.3^{24}$</td>
<td>$5.1 – $15</td>
</tr>
<tr>
<td>Flat Panel PV</td>
<td>$6.1^{25}$</td>
<td>$13 – $39</td>
</tr>
</tbody>
</table>

While Table 4 attempts to show a price comparison between the various solar technologies, project costs vary; one technology may not always be less or more expensive than another. The cost for CSP parabolic trough technology is based on the average of all 9 GW worth of projects currently being developed, while the other estimates are based the reported cost of a single, example project.\textsuperscript{26}

Importantly, this analysis shows that current projects using dry cooling, Stirling dish engine, or concentrating PV systems are often cost competitive with CSP parabolic trough wet cooling systems, thereby eliminating the balancing act between cost and water use.

Formal cost estimates need to be made, using the specifics of Black Mesa, in the event of any future project development.
Job Growth Potential

One of the biggest advantages to solar development is the job growth potential. The American Society of Mechanical Engineers found that solar energy development creates 3-11 times more jobs than the equivalent development of coal based energy. More specifically, solar development on Black Mesa has the potential to create 285 to 2,859 well-paying, operational jobs and 683 to 97,328 temporary (mainly construction) jobs. Figure 8 displays the job growth potential of various technologies. As with the cost projections, the numbers are based off the reported job creation from current solar projects:

Table 5: Potential Job Creation on Black Mesa

<table>
<thead>
<tr>
<th>Technology</th>
<th>Operational Jobs</th>
<th>Construction Jobs</th>
<th>Operational Jobs</th>
<th>Construction Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP – Parabolic Trough (Wet Cooling)</td>
<td>0.47²⁸</td>
<td>6.25²⁹</td>
<td>669 – 2,859</td>
<td>8,894 – 38,019</td>
</tr>
<tr>
<td>CSP – Parabolic Trough (Dry Cooling)³⁰</td>
<td>0.20</td>
<td>1.65</td>
<td>285 – 1,217</td>
<td>2,348 – 10,037</td>
</tr>
<tr>
<td>Stirling Dish Engine³¹</td>
<td>0.21</td>
<td>0.48</td>
<td>299 - 1,277</td>
<td>683 – 2,920</td>
</tr>
<tr>
<td>Power Tower (Dry Cooling)³²³³³⁴</td>
<td>0.22³²</td>
<td>4.97³³</td>
<td>313 – 1,338</td>
<td>7,072 – 30,233</td>
</tr>
<tr>
<td>Concentrating PV³⁴</td>
<td>0.25</td>
<td>1.00</td>
<td>356 – 1,521</td>
<td>1,423 – 6,083</td>
</tr>
<tr>
<td>Flat PV³⁵</td>
<td>Few</td>
<td>16.00</td>
<td>Few</td>
<td>2,768 – 10,037</td>
</tr>
</tbody>
</table>

Most solar technologies have similar job growth potential, however CSP parabolic trough systems using wet cooling generate the most operational and construction jobs. On the other end of the spectrum, flat panel PV systems require little operation and maintenance; therefore, very few long-term jobs are created from a flat panel PV project. While differences in job creation potential exist between the available technologies, any form of solar development promises to create both immediate construction jobs and long-term, well paying operational jobs. Due to the skill level required for the operational jobs, solar development also would attract training opportunities for Navajo and Hopi residents.
Financing Options

Financing Models

In general, renewable energy projects are economically attractive because they can take advantage of Federal tax credits such as the Federal Production Tax Credit (PTC) and the Investment Tax Credit (ITC), various state tax credits and incentives, and utility rebates. Because Black Mesa is on tribal land, financing must be structured carefully and intentionally to be eligible for federal and state tax credits, incentives, and rebates. Most tribal entities cannot participate directly in these financial incentives.

As a result, many tribes have opted for “joint venture” financing models where a tribal entity—i.e. the tribe in a corporate capacity, such as the Navajo Tribal Utility Authority (NTUA), or other tribal business such as the Dine Power Authority (DPA)—partners with a non-tribal company, and all aspects of the project, such as funding, management, operation, and power purchase agreements, are divided between the partners. A joint venture allows the private investment partners to take advantage of the necessary tax credits and provide additional capital and expertise, while allowing the tribe to retain partial ownership and control.

In other instances, where a tribe retains either no ownership or full ownership, they must either sacrifice control and economic benefits to a non-tribal entity, or take on the entire financial and planning burden. “No ownership models,” where the tribe acts solely as the lesser of the land, are often pursued as a way to ‘test the waters’ of renewable energy development; the tribe gains valuable expertise and builds a foundation for taking a more active role in future projects. The tribe need not bear any financial risk; however, in the “no ownership model” the tribe also sees comparatively little economic benefit.

At the opposite extreme, a tribe could opt for a “full ownership model,” absorbing all the financial risk as well as the economic benefit. While full economic benefit may sound promising in theory, to date, no tribe has independently financed a major renewable energy project on its own, because they do not qualify for most federal tax credits. Thus, it is financially more advantageous for tribes to join with another entity to benefit from federal credits and incentives. Also, under current economic conditions, most tribes do not have sufficient access to capital to finance projects on their own. Conditions may change, if the Senate passes legislation allowing tribes to realize tax credits for renewable energy development without the need of an external partner.\textsuperscript{36} & \textsuperscript{37}

Within the Navajo Nation, a number of tribal entities exist or could be created to develop a solar project, such as a political subdivision like the NTUA, a Navajo enterprise like the DPA, or a newly created energy company. In particular, the NTUA would be a convenient vehicle for project development; its financial and portfolio size would allow it to absorb some of the risk associated with a renewable energy project. The following are three possible approaches in which such an entity could finance its own project (with or without federal incentives).
1) Using the traditional financing tools, the tribe raises capital for the project through debt and equity means.

2) The tribe (or a political subdivision) issuing tax-exempt bonds to raise capital (the key feature of tax-exempt bonds is that they offer low interest rates).

3) The tribe (or a political subdivision) issuing Clean Renewable Energy Bonds (CREBs). A relatively novel financial tool created in the Energy Policy Act of 2005, these bonds amount to a zero interest loan for the tribe. Instead of the tribe paying the interest on the bonds (as they would with a normal bond) the bondholder earns tax credits at a rate similar to earning interest on normal bonds.

Examples of Renewable Energy Development on Tribal Land

Kumeyaay Wind I (KWI)—No Ownership

The Campo Band of the Kumeyaay Nation allowed a 50 MW Wind Farm to be built on their lands and acted solely as the passive landowner and lessor in this project. The project was undertaken by the band in part to ‘test the waters’ of wind power generation by exploring its compatibility with their culture, gaining knowledge of how to operate a wind farm, and building a foundation for taking a more active role in future projects.

Using the knowledge gained with KWI, in April 2009 the band and two non-tribal development partners (Invenergy LLC, a wind development company, and San Diego Gas & Electric, a public utility) initiated a 160 MW wind project, Kumeyaay Wind II (KWI), also located on the Campo reservation. The project will provide the band with lease royalties, as well as 12% equity ownership interest (~20 MW), and an option for tribal buy-out after 20 years of operation. The terms of the agreement also dictate a preference to tribal businesses in construction, and to tribal members in employment and training.

North Antelope Highlands Project—Joint Venture

The Rosebud Sioux Tribe (RST) partnered with the wind development company, Citizens Wind, to develop a 190 MW project. The partners formed an ownership corporation, a holding corporation for the project, and are looking at forming an LLC. They plan only to develop the project, and then sell it to a separate entity once it is operational. In the sale, they will charge development fees, which will be received in proportion to the ownership interest of each partner. The RST has a 20% ownership interest (with an option to raise their participation to 33%, if they contribute more development funds) and Citizens Wind has an 80% interest.

Pueblo of Jemez—Joint Venture

The tribe located in New Mexico is currently in the process of developing a 4 MW PV solar facility. Their project is particularly notable, because it comes closest to following a full ownership model. The development work has been funded primarily by a number of grants from the DOE and the State of New Mexico Energy Minerals and Natural Resources Department, which have gone towards covering the costs of the contracting services needed in the pre-construction phases of the project (such as finance and business plans, feasibility studies, equipment purchase, and commissioning). Much of the technical development work was accomplished with in-house, tribal expertise. In addition, they have received considerable service donations from engineering, legal, and financial firms in the area.
The project itself is projected to cost approximately $19.9 million, too much for the tribe to pay out of pocket. Their finance model (developed by Red Mountain Energy Partners, a tribal energy planning company based out of Phoenix, AZ) involves a combination of debt financing and equity provided by two federal tax credit programs (the Investment Tax Credit (ITC) and the New Market Tax Credit (NMTC)). These two tax credits will cover roughly two-thirds of the project’s costs, and they intend to cover the outstanding costs with a traditional bank loan. The tribe plans to form a tribally owned corporation that can then enter into a joint venture (LLC) with a bank, which will be able to take advantage of the ITC and NMTC. The equity investment provided by the tax credits reduces the amount of debt needed to finance the project, which will ultimately allow the project to sell power at a lower, more competitive price.

The above financial information was summarized from a report by the Western Resource Advocates. See Appendix E: Financing, for the full report.

Financial Incentives for Renewable Development in Arizona

The cost of renewable energy is continually decreasing as technologies improve and demand increases; however, most renewable energy projects still require federal and state incentives to produce cost-competitive electricity. State incentives widely vary and can be an important decider in the location of solar project. Arizona (AZ) currently has a number of tax credits, as well as the renewable energy standard (RES) which requires utilities to purchase 15% of their electricity from renewable sources by 2025. The following is a summary of the incentives available to a solar project located in AZ, all of which can be found in the U.S. Department of Energy’s Database of State Incentives for Renewables & Efficiency (http://www.dsireusa.org/solar/).

- **Federal Renewable Energy Production Incentive**: $0.021 per kilowatt-hour (kWh) for the power produced during the first 10 years of operation. Available to Indian tribal governments or political subdivisions thereof.

- **Federal Renewable Electricity Production Tax Credit (PTC)**: $0.011 per kWh for power produced during first 10 years of operation. Available only to businesses that pay federal corporate taxes.

- **Accelerated Depreciation**: part of the PTC that allows the investor to deduct the costs of depreciation from their income during the first five years of the projects operation, thereby lowering taxes.

- **Federal Investment Tax Credit**: 30% reduction on investment in solar. Available only to businesses paying federal corporate taxes.

- **AZ Non-Residential Solar & Wind Tax Credit**: 10% of installed cost that can be applied as both a corporate and personal tax credit ($50,000 max).

- **AZ Renewable Energy Production Tax Credit**: $2 million per year maximum.
  - Year 1: $0.04 per kWh
  - Year 2: $0.04 per kWh
  - Year 3: $0.035 per kWh
  - Year 4: $0.035 per kWh
  - Year 5: $0.03 per kWh
  - Year 6: $0.03 per kWh
  - Year 7: $0.02 per kWh
  - Year 8: $0.02 per kWh
  - Year 9: $0.01 per kWh
  - Year 10: $0.01 per kWh
• **AZ Property Tax Exemption for Solar Systems**: Equipment assessed at 20% of its depreciated cost.

• **AZ Energy Equipment Property Tax Exemption**: 100% of increased value.

• **AZ Sales Tax Incentive**: 100% of sales tax on eligible equipment.

• **Grants**:
  - Tribal Energy Program grants;
  - U.S. Department of Treasury renewable energy grants;
  - Additional government grants - Departments of Interior, Agriculture, Commerce, and Housing and Urban Development, along with the Environmental Protection Agency all have grants available to projects on tribal land.

• **Loans**:
  - Tax-exempt commercial loans to the tribe;
  - U.S. Department of Energy guaranteed loans;
  - Clean Energy Renewable Bonds (CREBs) with 0% interest rate.

**Potential Financers**

Due to technological improvements and federal and state level policies subsidizing renewable energy, solar generated electricity is becoming a cost-competitive option. While current solar projects continue to prove themselves, demand is increasing rapidly. The authors of this report took the liberty of contacting **three solar financing firms: Mainstreet Power, Pristine Sun, and Tessera Solar solely to gauge interest level. All expressed interested in solar development on Black Mesa**. The next step would be for tribal leaders to send out a Request for Proposals (RFP) in order to solicit bids from these developers and others, to determine which financing and development firm proposes the best option for Black Mesa.

**Potential Purchasers**

The national trend is toward more renewable and less fossil fuel derived energy. As an illustrative example, the L.A. Department of Water and Power currently purchases 477 MW of electricity from the coal-fired Navajo Generating Station (NGS); however, LADWP recently declined to renew its purchasing contract with NGS, set to expire in 2019, and is instead looking for renewable sources of energy. Such examples are now common, with most states adopting renewable energy standards (RES), requiring utilities to purchase a certain percentage of their electricity from renewable sources. Arizona, along with the surrounding states New Mexico, Nevada, Utah, Colorado, and California all have an RES, creating high demand for renewable energy production in the region.³⁸

Any development decisions should assume municipal and investor-owned utilities will be interested in purchasing solar generated power from Black Mesa. To illustrate such interest, the authors have contacted potential purchasers who have expressed interest in solar generated electricity from Black Mesa. **Along with the L.A. Department of Water and Power, the U.S. Air Force, Nevada Power, Tucson Electric, and Arizona Public Service would all be potential purchasers of power from Black Mesa.**
Conclusion

The Black Mesa region of the Navajo Nation and Hopi tribe reservations has some of the world’s best solar resources as well as existing infrastructure from previous mining activity that make it ideal for new solar development. There is the potential for 1,422 to 6,083 MW of solar power generation.

The region has access to a 230 kV transmission line, an infrastructure of roads and water wells, and previous environmental, cultural, and archaeological clearances that would dramatically cut construction costs of a solar power facility.

In addition, such development would provide much needed jobs and economic development to the region. Solar power stations require both short-term construction and long-term, well paying, operational and maintenance jobs. The latter would provide valuable training and education programs for the Diné and Hopi people. If fully developed, Black Mesa has the potential to create 285 to 2,859 operational and 683 to 38,019 construction jobs, which would result in $35.6 to $357 million in annual long-term revenue and $85.4 million to $4 billion in additional annual revenue during years of construction.

This analysis demonstrates that tribal leaders and community planners could achieve significant benefit from solar development on the reclaimed lands of Black Mesa.
## Appendices

### Appendix A: Reclamation Status by Mining Site

<table>
<thead>
<tr>
<th>Coal Resource Area</th>
<th>Total Acres</th>
<th>Mining and Reclamation Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-01</td>
<td>350</td>
<td>Mined and reclaimed⁴</td>
</tr>
<tr>
<td>N-02</td>
<td>650</td>
<td>Mined and reclaimed⁴</td>
</tr>
<tr>
<td>N-06</td>
<td>2,890</td>
<td>Active mining and reclamation in 780 acres, 2,060 acres reclaimed, 50 acres proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>N-7/8</td>
<td>940</td>
<td>Mined and reclaimed⁴</td>
</tr>
<tr>
<td>N-09</td>
<td>2,170</td>
<td>Active mining and reclamation on 375 acres, no acres reclaimed, 1,795 acres to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>N-10</td>
<td>1,790</td>
<td>Active mining and reclamation in temporary cessation; 55 acres disturbed, 130 acres reclaimed, 1,605 acres to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>N-11</td>
<td>800</td>
<td>Mined and being reclaimed, 295 acres reclaimed, 505 acres in reclamation, no additional areas to be mined in the future⁴</td>
</tr>
<tr>
<td>N-14</td>
<td>1,650</td>
<td>Mined and reclaimed⁴</td>
</tr>
<tr>
<td>N-99</td>
<td>3,880</td>
<td>Undisturbed, to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-01</td>
<td>480</td>
<td>Mined and reclaimed</td>
</tr>
<tr>
<td>J-02</td>
<td>900</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-03</td>
<td>100</td>
<td>Mined and reclaimed</td>
</tr>
<tr>
<td>J-04</td>
<td>520</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-05</td>
<td>1,220</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-07</td>
<td>1,040</td>
<td>Mined and reclaimed</td>
</tr>
<tr>
<td>J-08</td>
<td>730</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-09</td>
<td>470</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-10</td>
<td>430</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-14</td>
<td>950</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-15</td>
<td>730</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-16</td>
<td>1,350</td>
<td>Mined and reclaimed</td>
</tr>
<tr>
<td>J-19</td>
<td>3,910</td>
<td>Active mining and reclamation in 2,080 acres, 1,060 acres reclaimed, 770 acres to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-21</td>
<td>5,280</td>
<td>Active mining and reclamation in 980 acres, 2,630 acres reclaimed, 1,870 acres to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-23</td>
<td>2,500</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
<tr>
<td>J-27</td>
<td>70</td>
<td>Mined and reclaimed</td>
</tr>
<tr>
<td>J-28</td>
<td>1,440</td>
<td>Undisturbed, proposed to be mined and reclaimed in the future⁴</td>
</tr>
</tbody>
</table>

SOURCE: Peabody Western Coal Company 2008
Appendix B: Maps of Reclaimed Land by Sector

Figure 13: Owl Springs Sector Current Land Use

Figure 15: Sand Springs Sector Current Land Use
Appendix C: Existing Infrastructure

“The existing power line infrastructure within the Black Mesa Lease Area is connected to the regional electrical transmission grid to provide the electrical power used to operate the dragline excavators and other equipment and facilities associated with coal mining and handling operations. The power supply for the mine comes through a substation connected to a 230 kV transmission line between Page, Arizona and Four Corners Power Plant in New Mexico north of the Black Mesa Leases (WRP 2008). These same transmission facilities can be used to send power from solar generation facilities on Black Mesa to the grid.

This electrical transmission connection, illustrated in Figure 3 (WRP 2008), above, identifies the existing transmission infrastructure in the Southwestern U.S. (map modified to highlight the connection of the Black Mesa lease area to the regional electrical grid).

The existing transmission network to and within the Black Mesa lease area, including the associated rights-of-way, substations, and support service areas, will be valuable assets for any solar power development project using the Reclaimed Areas.”

(Black Mesa United 2005b)
Appendix D: Water Resources for Different Technologies

The potential water use of large, commercial-scale solar power plants is an important consideration, particularly in the arid West. The water used to generate solar energy varies tremendously, depending on the type of solar plant. Photovoltaic panels, for example, use virtually no water, while some types of concentrating solar power plants can consume large volumes of water.

Solar facilities use water in several different ways. The most common type of concentrating solar power (CSP) system uses parabolic mirrors (or troughs) to capture and focus sunlight, generating heat, steam, and electricity. The steam must be cooled and condensed using water (in once-through or wet re-circulating systems) or air (in dry-cooled systems). Hybrid cooling systems use water for cooling during summer months, and air for cooling during cooler months. The average water use for a plant relying on hybrid cooling depends on what portion of the year it uses wet cooling. Other CSP systems, like the Stirling dish engine system, use mirrors to concentrate solar radiation, but do not require water for cooling. In addition to water used in the cooling system, solar plants use water to wash plant mirrors, but this water use is much smaller than the water consumed by the cooling system (estimated at only 10% of the total water needed for a solar thermal plant). At a solar PV facility, a very small volume of water is used to wash the PV panels on a regular basis.

Wet-cooled solar thermal plants have been slightly more water-intensive than conventional coal or nuclear plants (Figure 11). Most plants have relied on wet-cooling systems, which consume approximately 760 to 1,000 gallons/MWh produced. More recently, many proposed solar thermal plants have chosen dry cooling systems, which increases both capital and operating costs but decreases water use considerably. A dry-cooled facility would use 40 to 80 gallons/MWh, primarily for washing mirrors. The cost and feasibility of adopting a dry cooling system depends on typical summer temperatures at the Black Mesa mine reclaimed lands.

The total volume of water consumed at a solar thermal plant depends entirely on the technology employed. A 250 MW, wet-cooled solar thermal plant could consume as much as 2,200 AF (716 million gallons) of water annually. If the same plant relied on dry cooling, it would only consume approximately 225 AF of water (73 million gallons). A solar PV facility would consume a negligible amount of water. For comparison, Peabody’s coal mining and slurry operation pumped over 1.3 billion gallons of water each year. 39

Extensive development of solar thermal generating capacity on the Black Mesa reclaimed lands—if plants rely on wet cooling—could have a substantial impact on water resources. Developers must consider the impact of solar plants on local aquifers and water supplies, and should ensure that plants’ water use does not exceed the “safe yield” of groundwater aquifers. In addition, as decision-makers evaluate potential solar plants, it will be important to consider whether plants’ water use would compete with the water needs of local communities in the next 40 - 50 years (or the lifetime of the power plants), or would adversely impact cultural or environmental resources.
Figure 11: Typical Rates of Water Consumption for Electricity Generation

Error bars are included where available.
Appendix E: Financing

Introduction
The Navajo Reservation holds some of the most abundant renewable energy resources (including wind, solar, and geothermal) in the country and the development of these energy resources presents a unique opportunity for the tribe to advance its economic and social interests while maintaining traditional values and customs. However, developing a renewable energy project is a major undertaking, and requires considerable funds, knowledge, and time. A central concern for any potential project on reservation lands is in what way and to what degree the tribe should be involved (i.e. project ownership). This paper attempts to address aspects of this question, and examines features of the basic ownership models for renewable energy projects on the Navajo Nation.

This discussion specifically addresses utility scale projects (i.e. Megawatt (MW) level output), as opposed to the distributed generation projects that many tribes have undertaken. While projects at the utility scale are often the most complex and costly to develop, they also provide the most energy and offer the greatest potential benefits (in financial terms) to the tribe.

Ownership Models
The ownership structure of a utility scale renewable energy project is key in that it largely determines what incentives and financing options will be available. Three basic structures are explored below: no tribal ownership, a joint venture, and full tribal ownership.

No Tribal Ownership
The most basic model for the tribe is to lease land to a non-tribal developer, with the tribe acting only as a lessor. The tribe collects taxes and a land lease fee, but has no ownership stake in the project itself. The project will be subject to taxation by the Navajo Nation in addition to the property taxation from the County. Due to this tax burden, it might be important to negotiate better taxation terms from the Nation to attract developers, as has been done with coal companies in the past.

Advantages and Benefits to Tribe:
+ Tax and land lease revenue to Navajo Nation/land owners
+ No financial risk for tribe (financial risk, in each case, will largely depend on the tribes financial stake in the project)
+ Some of the expenditures for construction, as well as the ongoing operations and management of the facility, will enter the Navajo economy
+ Jobs and training for tribal members could be negotiated for
+ Presents a good avenue to judge the feasibility of a renewable energy project on Navajo lands, and possibly to gain experience with a particular developer

Disadvantages for the Tribe:
– Relative to other ownership options, lesser benefits accrue to tribe
– Concerns could be raised about tribal sovereignty

40
41
42
43
Joint Venture

In a joint venture, a tribal entity (i.e. the tribe in a corporate capacity, Navajo Tribal Utility Authority (NTUA), or other tribal business such as the Dine Power Authority (DPA)) partners with a non-tribal company to develop the project. All aspects of the project, such as funding, management, operation, and power purchase agreements, are divided between the partners.

Private investment partners are useful primarily for the capital and expertise that they can bring to a project. Private Investors (particularly specialized, renewable energy development companies) are often able to bring considerable capital to the table, as many have access to investment capital, financial partners lined up, and strong relationships and contacts within their industry. They are also a source for the technical knowledge expertise that is needed in project construction and design (in both the physical and financial structure of the project).

The non-tribal partner also plays another, key role in a project: they provide a way for the project to take advantage of federal tax incentives for renewable energy production, namely, the Federal Production Tax Credit (PTC) and accelerated depreciation. A major difficulty that all tribes face in developing renewable energy projects is that, because they are not subject to Federal taxation, they are unable to qualify for Federal tax incentives. The Production Tax Credit is a tax credit (2.1-cent per kilowatt-hour (kWh)) for the power produced during the first ten years of a wind, solar, or geothermal energy facility’s operation. Accelerated depreciation allows the investor to deduct the costs of depreciation from their income during the first five years of the projects operation, thereby lowering their taxes. These incentives remain absolutely vital to the financial viability of renewable energy projects (both on and off the reservation).

The current terms of the PTC necessarily lead to a partnership structure in which the tribal partner does not ‘own’ the project in the first ten years (the full lifetime of a PTC), and instead collects a management fee (in place of power sales revenue). During this period the non-tribal partner(s) have up to a 99% ownership interest in the facility, while the tribe maintains what amounts to a token share (the reason being that the smaller the tribal share, the more the remaining tax credits can be used by the non-tribal investors to pay off their initial investment). Then, after the PTCs expire, the ownership ‘flips’ over to the tribal partner who then has anywhere from a 100% to 1% ownership stake in the project.

To illustrate how this model might be applied in a more detailed manner, consider a project that is owned jointly by a tribal LLC and a non-tribal corporate partner. This model allows the tribe to benefit from some degree of project ownership and the financial gains that accompany it, decreases the amount of up-front startup capital that is required, and allows for the use of federal tax incentives. Under this scenario, the tribe would form a limited liability corporation (LLC), possibly with the participation of private investors (such as renewable energy developers or banks), that would undertake all of the early project development activities, such as resource monitoring, project planning, site selection, zoning, and permitting. The LLC would then seek out a corporate investor (tax-motivated, looking for a ‘passive’ investment opportunity). With a commitment from the corporate investor to acquire interest in the project when it becomes operational, the LLC would then construct the project (using debt financing). Once the project is ready (finished and generating power), the corporate partner makes its equity investment. Over the next ten years, the corporate partner realizes its required return on the project (using the PTCs and accelerated depreciation benefits).

After the ten-year period, and the expiration of the PTCs, the ownership ‘flips’ and the LLC becomes the majority owner of the project (while the corporate investor maintains it’s legally
required ownership interest). As the debt is typically paid down in the first ten years, the LLC is able to benefit fully from the project’s revenue stream.

Another important point is that the federal government provides loan guarantees for tribally owned renewable projects. Any loan made to a tribe for the purpose of renewable project development, then, is backed with the credit of the federal government. This ensures that lenders are willing to lend money with better terms, with the confidence that there is no potential for default.

Advantages and Benefits to Tribe:
+ The outside investment company provides the expertise and startup capital for the project.
+ Tax and land lease payments go to Navajo Nation/land owners.
+ Management fee paid to tribal partner
+ Low cost of debt due to Federal loan guarantees
+ Production Tax Credits and accelerated depreciation are available
+ Project ‘flips’ to tribal ownership after a minimum of ten years, at which point the tribe can benefit fully from the revenue stream from power sales
+ A joint venture can be structured to build tribal capacity and increase responsibility over time, with the explicit goal of creating jobs and experience for tribal members at all levels of project management
+ Exposes the tribe to the least financial risk while still maintaining an ownership stake.
+ Tribal partner does not pay county, state, or federal taxes

Disadvantages for the Tribe:
− Negotiations, legal concerns, and general cooperation with a non-tribal partner can be challenging

It is useful to note that most developers must be provided with incentives to develop on tribal lands. Locating a given project on the nation must be attractive relative to developing the project off the reservation. There are a number of ‘natural’ advantages to citing a project on the Nation, such as the quality of the renewable resources present on Navajo lands (discussed above), the existing organizational capacity and the existing transmission infrastructure.

However, the tribe can also make the reservation more attractive on the reservation by undertaking activities that would demonstrate the advantages of the project and reduce some of the development work that must be done for any project. Such activities include: resource assessments, feasibility studies, streamlining or initiating the process for permitting and building a project, or even developing the project to the extent that an investor only needs to commit funds towards the project for it to proceed.
**Full Tribal Ownership**

Under this scenario, the tribe is the full owner of the project, and its development is undertaken and managed without an outside investor. A number of tribal entities exist or could be created to develop the project, including the tribal government, a political subdivision like the NTUA, a Navajo enterprise like the DPA, or a newly created energy company. In particular, the Navajo Tribal Utility Authority might be a convenient vehicle for project development because of its financial and portfolio size, which might allow it to absorb some of the risk associated with a renewable energy project. To reduce the financial risk, and still realize gains from ownership, A.D Mills suggests in his thesis *Wind Energy in Indian Country: Turning to Wind for the Seventh Generation*, that the NTUA might take full ownership of a relatively small part of a wind farm (turbines producing 10MW on an 80MW farm, in his example) that is otherwise owned by a non-tribal developer. This option is less capital intensive, and therefore also entails less financial risk.

Even though the tribal developers would not have to pay county, state, or federal taxes (which reduces overall costs), they would also not be able to take advantage of the PTC or depreciation incentives. The fundamental challenge, in this model, therefore becomes raising capital for the project. The federal loan guarantee would also apply in this context, and would provide better financing terms for all debt.

While there are potentially numerous ways and mechanisms for the tribe to finance its own project, here are three possible approaches.

1) Using the traditional financing tools, the tribe raises capital for the project through debt and equity means

2) The tribe (or a political subdivision) issuing tax-exempt bonds to raise capital (the key feature of tax-exempt bonds is that they offer low interest rates).

3) The tribe (or a political subdivision) issuing Clean Renewable Energy Bonds (CREBs). A relatively novel financial tool created in the Energy Policy Act of 2005, these bonds amount to a zero interest loan for the tribe. Instead of the tribe paying the interest on the bonds (as they would with a normal bond) the bondholder earns tax credits at a rate similar to earning interest on normal bonds.

**Advantages and Benefits to Tribe:**
- Greatest potential financial benefits to tribe (full power sale revenues collected)
- Complete tribal control over the facility
- Exempt from county, state, and federal taxes.

**Disadvantages for the Tribe:**
- Lack of access to PTC’s and Accelerated Depreciation
- Large financial burden placed on tribal developer (development and capital costs, as well as interest payments under some scenarios)
- High financial risk
- The Treasury Department, who oversees CREB financing, favors smaller projects. Therefore the size of the project might have to be reduced in order to receive funding, or only partially funded by CREB’s. This requirement might, however, dovetail with the small NTUA ownership scenario described above.
- Full tribal ownership remains a fairly untested alternative, and there are few guiding precedents.
An Additional Approach: ‘Local Governance Act’ Certified Chapters

The Local Governance Act (LGA) legislation grants individual chapters on the Nation levels of authority and autonomy that are similar to those possessed by off-reservation municipalities. Certified chapters develop stronger local governments, and can conduct their own land-use planning and zoning, determine taxation, approve businesses leases, issue bonds, and oversee their own infrastructure development. Chapters generally present attractive locations for projects because they are able to address many of the business obstacles that can be present on the reservation. These include uncertain land ownership, vague zoning policies, slow business permitting, and cumbersome bureaucracy. LGA chapters have often streamlined business leasing and legal processes, and their governments have the capacity to be more nimble in decision-making. With the ability to issue bonds (notably, tax-exempt bonds) and impose taxes, LGA chapters may also be better able (i.e. more easily and more quickly) to raise funds than ordinary chapters. The ability to determine taxation could be a major boon to negotiations with non-tribal developers and investors.

Shanto, the first chapter to be certified under the LGA, is already exploring utility-scale renewable energy production on its lands. The Chapter is currently partnered with Citizens Wind Energy, a wind energy developer, to assess the feasibility of a utility-scale wind energy development. In addition, they have formed a community development corporation to serve as a holding company for the operation.

Case Studies

The Campo Band of the Kumeyaay Nation

The Campo Band of the Kumeyaay Nation a tribe in Southern California, have allowed for a 50 MW Wind Farm (Kumeyaay Wind I (KWI)) to be built on their lands, which became operational in 2005. The tribe acted as a passive landowner (i.e lessor) in this project, and only receives lease royalties for the land occupied by the project.

This project was undertaken by the band in part to ‘test the waters’ of wind power generation; exploring its compatibility with their culture, gaining knowledge of how to operate a wind farm, and building a foundation for taking a more active role in future projects. In particular, they see the advantages of possessing an active ownership stake in a wind farm, relative to those of a passive lessor role. Building on the experiences gained with KWI, in April 2009 the Band and two non-tribal development partners (Invenergy LLC, a wind development company, and San Diego Gas & Electric, a public utility) initiated a 160 MW wind project, Kumeyaay Wind II (KWII), which will also be located on the Campo reservation. This project will provide the Band with lease royalties, as well as 12% equity ownership interest (~20MW), and an option for tribal buy-out after 20 years of operation. The terms of the agreement also dictate a preference to tribal businesses in construction, and to tribal members in employment and training. KWII is expected to commence commercial operation in 2012.
The Rosebud Sioux Tribe (RST)

The RST has undertaken two utility-scale wind projects on their reservation in South Dakota: the Owl Feather War Bonnet Wind Farm and the North Antelope Highlands Project.

At the Owl Feather Bonnet Wind Farm, the RST acts as a passive landowner receiving payments based on a percentage of the gross revenue stream from the farm, which was developed by Distributed Generation Systems, Inc. (DISGEN). In addition, the tribal economy benefited from construction of the farm (i.e. materials and jobs), as well as ongoing operations and management (i.e. well paying jobs for tribal members). They have also retained the right to purchase the farm after the production tax credits expire. The project was funded from Department of Energy Grant, as well as in kind payments from DISGEN and RTC.

At the North Antelope Highlands Project, which is still in development, the RST has partnered with Citizens Wind, a wind development company. They currently aim to develop a 190 MW project. The partners have formed an ownership corporation and a holding corporation for the project, and are also looking at forming an LLC. They currently plan only to develop the project, and then sell it to a separate entity once it is operational. In this sale they will charge development fees, which will be received in proportion to the ownership interest of each partner. The RST has a 20% ownership interest (with an option to raise their participation to 33%, if they contribute more development funds) and Citizens Wind has an 80% interest.

The Pueblo of Jemez

The Jemez Pueblo, a tribe in New Mexico, is currently in the process of developing a 4 MW PV solar facility. Their project is particularly notable in that it will be owned entirely by the tribe.

The development work has been funded primarily by a number of grants from the DOE and the State of New Mexico Energy Minerals and Natural Resources Department. These funds have mostly gone towards covering the costs of the contracting services needed in the pre-construction phases of the project (such as finance and business plans, feasibility studies, equipment purchase and commissioning). Much of the technical development work was accomplished with in-house, tribal expertise. In addition, they have received considerable service donations from engineering, legal, and financial firms in the area.

The project itself is projected to cost approximately $19.9 million. Too much for the tribe to pay out of pocket, their finance model (developed by Red Mountain Energy Partners, a tribal energy planning company based out of Phoenix, AZ) involves a combination of debt financing and equity provided by two federal tax credit programs (the Investment Tax Credit (ITC) and the New Market Tax Credit (NMTC)). These two tax credits will cover roughly two-thirds of the project's costs, and they intend to cover the outstanding costs with a traditional bank loan. They plan to form a tribally owned corporation that can then enter into a joint venture (LLC) with a bank, which will be able to take advantage of the ITC and NMTC. The equity investment provided by the tax credits reduces the amount of debt needed to finance the project, which will ultimately allow the project to sell power at a lower, more competitive price.
Appendix F: Resources for Further Information

In addition to the resources cited throughout the paper, the following resources may be useful:

**Tribal Energy Program**

“The Tribal Energy Program, under the Department of Energy’s (DOE’s) Office of Energy Efficiency and Renewable Energy, promotes tribal energy sufficiency, economic development, and employment through the use of renewable energy and energy efficiency technologies.”

**Guide to Tribal Energy Development (Tribal Energy Program)**

A step-by-step guide to the development process, plus renewable energy and energy efficiency information for tribal decision makers and staff.

**Financial Opportunities (Tribal Energy Program)**
([http://apps1.eere.energy.gov/tribalenergy/financial.cfm](http://apps1.eere.energy.gov/tribalenergy/financial.cfm))

A useful directory of government grant programs, as well as information about a variety of other funding sources.

**Tribal Business Structure Handbook**

Provides a detailed analysis of the business structures available to Native American Tribes, many of which would be applicable to renewable energy ventures on the Nation.

**Community Wind Financing Handbook**

Explores various business and financing structures for wind farms. Despite the fact that it deals exclusively with wind projects, and is not specifically focused on tribal initiatives, the information presented is general enough to apply to virtually all tribal energy projects.

**The Tribal Energy and Environmental Information Clearinghouse**
([http://teiec.anl.gov/index.cfm](http://teiec.anl.gov/index.cfm))

“This site includes information about energy resource development and associated environmental impacts and mitigation measures; guidance for conducting site-specific environmental assessments and developing monitoring programs; information about applicable federal laws and regulations; and federal and tribal points of contact.” Particularly useful is the directory of grant programs and incentives.
Appendix G: Endnotes

3 See http://www.epa.gov/brownfields/overview/glossary.htm for definition of “brownfield.”
4 Diné CARE, “Energy and Economic Alternatives,” 82 (Economic benefit calculated as total wages/salaries times 2.5, assuming dollars paid as salary circulate within the regional economy at least 2.5 times).
13 Appendix D.
14 Appendix D.
15 Appendix D (10% of wet cooling system use).
17 Appendix D (10% of wet cooling system use).
18 Appendix D (10% of wet cooling system use).
20 “Amargosa Road Solar Energy Project, Draft EIS.”
21 Conversation with Tessera representative. August 2010.
23 “Ivanpah Solar Electric Generating System.”
26 “CSP Summit 2010: Dispatches from San Francisco.”


30 “Amarosga Road Solar Energy Project, Draft EIS.”


33 “California Public Utilities Commission Approves BrightSource Energy Contract with Southern California Edison.”


35 Schlichting. “FPL’s Opening of a Record Solar PV Plant.”


40 For basic descriptions of these resources on the Navajo Reservation, visit:
(Wind) http://www1.eere.energy.gov/tribalenergy/guide/wind_az.html
(Solar) http://www.nrel.gov/gis/solar.html
(Geothermal) http://www1.eere.energy.gov/tribalenergy/guide/geo_arizona.html

41 There are numerous publications and resources available that address tribal energy development, and a list of some of the most useful resources is provided at the end of the paper.

42 It is assumed that any project located on the Reservation will be taxed (Possessory interest Tax and Business Activity Tax) by the Navajo Nation, even if it is fully owned and operated by a Navajo enterprise.

43 A modified tax structure is desirable to help address the issue of double taxation by the Navajo, County, and State jurisdictions. For an example of such a tax structure, see page 72 in http://www.sanjuancitizens.org/air/Jan%202008%20-%20Alternatives%20to%20Desert%20Rock%20Full%20Report-Dine%20CARE.pdf

44 Having a non-tribal entity involved so heavily with a project may raise concerns about giving up too much tribal control and authority. This alone has the potential to erode political support on the reservation (e.g. among the tribal council). Both parties seek to maximize their return on a project; therefore identifying a joint ownership structure that satisfies both parties is a critical element of negotiations.

45 Currently, the PTC has been extended until the end of 2012.

46 At the Paragon Ranch solar project (currently being developed by the Navajo Nation and the NTUA in partnership with Matinee LLC), however, the tribe is seeking an unprecedented 51% (majority) ownership interest.


48 Tribes and their political subdivisions are able to issue tax-exempt bonds for activities that are considered to be “essential government functions.”

49 CREB’s were created to subsidize the development renewable energy projects by entities that are ineligible for PTC’s, like tribes.
A detailed account of the development process for this project can be found at
http://apps1.eere.energy.gov/tribalenergy/pdfs/rosebud03final.pdf