Wind Energy in Indian Country:
Turning to Wind for the Seventh Generation

by

Andrew D. Mills

Submitted in partial satisfaction of the requirements for the degree of

Master of Science

In the

Energy and Resources Group

of the

University of California, Berkeley

Approved: ____

Daniel Kammen Date

Professor, Energy and Resources, Goldman School of Public Policy

University of California, Berkeley

Approved: ____

Alastair Iles Date

Post-Doctoral Scholar

University of California, Berkeley

Received by the Graduate Secretary: ______________________________

Jane Stahlhut Date

Abstract

Utility-scale wind projects are increasingly being developed in rural areas of the United States. In the West in particular, many of the Native American reservations have large areas of windy lands suitable for large-scale wind projects. A number of these tribes are interested in developing wind projects on their land for the purpose of economic development. The aim of this project is to show how wind energy projects on tribal lands can benefit economic development. Further, the project will explore the role of tribal decisions and federal incentives on the feasibility of a project. Although a number of studies have investigated the total impact of wind energy projects on rural economies, no comprehensive study has been carried out for a tribal wind energy project.

Tribal wind energy projects are different than other rural wind projects in a number of important ways. The tribe has the option of becoming more than a simple landowner by participating in a project as a partner with an outside investment company or by developing the project on their own. A tribe also has the ability to set laws pertaining to taxation of energy projects, labor preferences, and requirements for preference treatment of tribal businesses in contracts. A proposed 80 MW wind farm with the Navajo Nation provides an opportunity to explore the economic impact of a wind farm on tribal lands. Using the Navajo wind farm for creating scenarios based on different options available to the tribe, I investigate three primary questions:

(1) How do the opportunities and risks associated with the wind farm interact with the economic development goals of the Navajo Nation?

(2) What are the possible opportunities for the Navajo economy to benefit from a wind farm? In addition to construction jobs, tax revenue, and lease fees I show that Navajo businesses have the capacity to participate in the various stages of a wind farms life.

(3) In what ways can the Navajo Nation participate in owning the wind farm and how do federal incentives impact the feasibility of the wind farm?

The methods used to answer these questions involve: interviews with Navajo businesses, tribal officials and employees, wind developers, and federal officials; an assessment of the Navajo government and economy through official tribal data and documents; and a comparative financial analysis of tribal wind projects.

Acknowledgements

I am indebted to a very long list of people that have motivated, guided, critiqued, and supported this project. I was initially turned toward the topic of the economic development impacts of renewable energy projects through discussions with Carla Din of the Apollo Alliance. Her dedication and enthusiasm for linking renewable energy and energy efficiency to economic development is inspiring. She connected me with Bineshi Albert of the Southwest Climate Council who helped me to understand the issues in the southwest surrounding energy development.

Dr. Alastair Iles invited me to assist with his research on energy justice in the southwest in February 2005. The week we spent conducting interviews with tribal leaders, grass roots activists, business owners, and even an informal interrogation of a hitchhiker on the Navajo Nation was an experience that I will always be grateful for. I learned an incredible amount from the opportunity to work very closely with Alastair during the two years I spent at ERG.

Numerous ERG students provided valuable feedback and guidance throughout this project. Sidney Dietz showed me the intricacies of the Navajo Nation and its history. Sid always challenged me to try to look a little deeper under the surface for topics on development. Merrill Jones was supportive in helping me to understand wind financing. Cliff Chen, Naïm Darghouth, and Cyrus Wadia provided great conversations, feedback, ideas and most importantly friendship.

I would also like to thank the faculty and staff of ERG. In particular, Dr. Alex Farrell was a supportive advisor and a tremendous help in going through the CHPS process. Dr. Dan Kammen never failed to provoke interesting conversations about the role that renewable energy can play in our future. I would also like to thank Dan for being a reader and advisor for this project.

This project would have never been possible without the support from Larry Ahasteen of the Navajo Tribal Utility Authority and Dr. Earl Duque of Northern Arizona University. Larry suggested the primary direction of this project. His role in providing electricity to the 35% of homes on the Navajo Nation that lack access to the electricity grid should be commended. I would like to thank Larry for providing feedback on draft documents and for many interesting conversations. Earl Duque provided advising and a stimulating working environment with Sustainable Energy Solutions at Northern Arizona University. Earl and Larry spent two brutal days showing me the (im)proper way to use a jackhammer during the installation of the 30m anemometer on Gray Mountain. The researchers at SES provided detailed insight to the wind industry and the wind project development process. John Gaglioti deserves credit for answering any question I had about the wind industry. Grant Brummels from SES will never cease to amaze me with this enthusiasm and dedication to making a better world possible. It was a pleasure to work with him at NAU and to jointly present our work at a RAEL talk in March 2006.

Finally, I would like to thank Bob Gough of the Intertribal Council on Utility Policy for his assistance and feedback, participants in interviews for their time and insights, the ERG community in general for making such a place possible, and my family for all of the love and support.

This material is based upon work supported under a National Science Foundation Graduate Research Fellowship. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation.

ABSTRACT .... **II**

ACKNOWLEDGEMENTS .... **III**

LIST OF FIGURES AND TABLES .... **VI**

COMMONLY USED ABBREVIATIONS .... **VII**

I. INTRODUCTION AND METHODOLOGY **1**

I.1 METHODOLOGY 1

II. BACKGROUND AND CONTEXT **3**

II.1 THE WIND INDUSTRY 3
II.2 TRIBAL WIND PROJECTS 4
II.3 NAVAJO NATION AND ENERGY DEVELOPMENT 6

III. WIND ENERGY AND ENERGY DEVELOPMENT **10**

III.1 MOTIVATION 10
III.2 APPROACH 11
III 3 BENEFITS OF ENERGY DEVELOPMENT 11
III.4 CRITIQUES OF ENERGY DEVELOPMENT 17
III.5 DISCUSSION OF WIND ENERGY AND ENERGY DEVELOPMENT 23

IV. ECONOMIC IMPACTS OF WIND ENERGY PROJECTS **25**

IV.1 CONSTRUCTION PHASE 26
IV.2 OPERATIONS PHASE 31
IV.3 DISCUSSION OF IMPACTS 38

V. INCREASING BENEFITS OF WIND ENERGY THROUGH TRIBAL OWNERSHIP **39**

V.1 MODEL DESCRIPTION 40
V.2 MODEL ASSUMPTIONS 41
V.3 MODEL RESULTS 44
V.4 DISCUSSION OF TRIBAL WIND FINANCE RESULTS 53
V.5 UNCERTAINTY ANALYSIS 55

VI. SUMMARY AND CONCLUSIONS **58**

BIBLIOGRAPHY: **61**

APPENDIX I: NAVAJO ECONOMY AND WIND ENERGY **67**

AI.1 PURPOSE: 67
AI.2 METHODOLOGY: 68
AI.3 GENERAL DESCRIPTION OF NAVAJO ECONOMY 68
AI.4 CONSTRUCTION IMPACTS ON NAVAJO ECONOMY 69
AI.5 CAPACITY: 70
AI.6 LINKAGES: 72
AI.7 LOCAL SHARE: 74
AI.8 JEDI MODEL OF WIND FARM IMPACTS: 75

APPENDIX II: NAVAJO BUSINESSES **77**

APPENDIX III: JOB MULTIPLIERS IN THE NAVAJO ECONOMY **81**

AIII.1 INTRODUCTION: 81
AIII.2 METHOD: 81
AIII.3 DATA: 82
AIII.4 RESULTS: 83

APPENDIX IV: TRIBAL WIND FINANCE MODEL **85**

AIV.1 COMPARISON OF OWNERSHIP MODELS FOR NAVAJO WIND FARM 85
AIV.2 FINANCIAL MODEL OF WIND FARM 86
AIV. 3 EXAMPLE MODEL SPREADSHEET – COMMERCIAL SCENARIO 98
AIV.4 WHOLESALE ELECTRICITY PRICE FORECASTS 100
AIV.5 UNCERTAINTY ANALYSIS 101

List of Figures and Tables

Figure 1 - Location of interviewees 2
Figure 2 - Wind resource on Indian lands in the United States 4
Figure 3 - Wind Map of the Gray Mountain region in the Navajo Nation 7
Figure 4 - Geographic location of mineral resources on the Navajo Nation 8
Figure 5 - Comparison of energy exported from the Navajo Nation to the energy consumed on the Navajo Nation .. 8
Figure 6 - Comparison of total employment impacts of different energy technologies 25
Figure 7 - Crane and water tower in the town of Chinle, AZ on the Navajo reservation 29
Figure 8 - Comparison of total O&M costs to the expenditure that remains in the local economy 32
Figure 9 - Illustration of Phase I of project structure to utilize the PTC 43
Figure 10 - Breakdown of costs and sources of income for a Commercial wind farm on the Navajo Nation 46
Figure 11 - Nominal cash flow diagram for direct impacts of Joint Venture wind farm on Navajo economy 48
Figure 12 - Cash flow for Investment partner for Navajo Joint Venture wind farm 48
Figure 13 - Comparison of minimum price for wind energy contracts to the direct impacts 51
Figure 14 - Comparison of the value of each set of incentives for the ownership scenarios 54
Figure 15 - Typical inputs for a wind farm 67
Figure 16 - Illustration of the multiplier effect when dollars are recycled in a local economy 81
Figure 17 - Wholesale electricity price forecast for major electricity trading hubs in the western US 100

Table 1 - Concentration of workforce in economic sectors for the Navajo Nation and the entire United States 13
Table 2 - General description of tasks performed during construction and operation of wind farm 27
Table 3 - General estimate of construction jobs for 80 MW wind farm 30
Table 4 - Estimate of O&M jobs created for 80 MW wind farm. 33
Table 5- Key assumptions for wind farm financial model 41
Table 6 - Assumptions used for each scenario 42
Table 7 - Tribal Wind Finance Model Results 45
Table 8 - Minimum power purchase price for feasibility 50
Table 9 - Minimum increase in wind resource 52
Table 10 - Summary of key uncertainties in scenarios used to produce Figure 13 56
Table 11 - Comparison of local share for Navajo wind farm in comparison to JEDI default values 75
Table 12 - Scenario specific assumptions and results from JEDI model of wind farm on the Navajo Nation 76
Table 13 - Navajo Nation employment data by sector 83
Table 14 - Analysis of job multipliers for the Navajo Nation economy 84
Table 15 - Key assumptions 91
Table 16 - Assumptions for scenarios 98
Table 17 - Uncertainty Analysis 101

Commonly Used Abbreviations

CF	Capacity Factor: Ratio of energy produced to energy that would be produced if wind farm was operated at rated capacity at all times
CREBs	Clean Renewable Energy Bonds
DOE	US Department of Energy
DSCR	Debt Service Coverage Ratio
EPAct	Energy Policy Act
JV	Joint Venture
IOU	Investor Owned Utility
IRR	Internal Rate of Return
NECA	Navajo Engineering and Construction Authority
NN	Navajo Nation
NTUA	Navajo Tribal Utility Authority
O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PTC	Federal Renewable Energy Production Tax Credit
REPI	Renewable Energy Production Incentive
RPS	Renewable Portfolio Standards

I. Introduction and Methodology

Winds of change are blowing in Indian Country – and bringing with them a new source of sustainable jobs and revenue. Numerous tribes in the United States have pursued clean, renewable energy sources ranging from ancient design practices that use passive solar heating or passive cooling to modern, utility-scale wind turbines. While different tribes have unsuccessfully attempted to build wind projects in the past, recent developments in Indian wind energy projects demonstrate that wind energy projects on tribal land are not only possible, but provide an opportunity for participation in clean energy development. Patience, dedication, and hard work are the virtues that tribal champions continue to use to transform distant ideas into towers in the ground.

The objective of this project is to provide a detailed examination of the opportunities and benefits of wind energy projects on tribal lands. Many questions arise as tribal members consider wind energy projects. What are the economic benefits of a wind farm? What options are available for maximizing the benefits to the tribe? Are wind projects compatible with development goals of the tribe? In some cases tribes do not have the opportunity to examine these questions in detail before a wind project developer approaches tribal planners with proposals. It is the objective of this paper to help clarify and illustrate ways that wind projects can benefit tribes and ways tribes can ensure that the project is a good deal. Hopefully this document can be of assistance to tribes who are in the position that Arvin Trujillo, the Executive Director of the Division of Natural Resources, described when asked if the Navajo Nation was considering wind energy projects during a speech to the World Bank:

> … we are focused on fossil fuel development, but we are wanting to look at renewable alternatives. The issue there is again looking at an [Navajo Nation] Energy Office or looking at a process of that nature that helps us get expertise in it. I'll be frank with you; I've got a lot of people coming into my office with wind, solar, and biomass, etc. Basically they are saying "Man, have I got a deal for you", but I have no way of really evaluating whether these projects or prospects are worthwhile (Shirley and Trujillo 2003).

This project will specifically focus on a proposed 80 MW wind farm on the Navajo Nation. The Navajo Tribal Utility Authority received a feasibility grant for the wind farm in the summer of 2005 from the Department of Energy, Tribal Energy Program. The Navajo Nation example will reveal issues that may be similar for other tribes, but it is important to realize that all of the Native American tribes are very different from one another. The Navajo Nation is the largest Native American reservation both in terms of population and land area. Many of the businesses, political institutions, and resources on the Navajo Nation are not always available to other tribes. The benefits and opportunities offered by wind farms will vary from tribe to tribe and should therefore be evaluated independently. That being said, it is hoped that this project can be a useful guide for both people within the Navajo Nation and for other tribes.

I.1 Methodology

The evaluation of wind energy development was approached from an interdisciplinary perspective. Three primary areas were analyzed using approaches from basic economics, finance, and social sciences. The first question, examined in Section III, was: How do the benefits of wind farms interact with the development goals of tribes? This question is examined in an indirect manner by situating wind energy in the broader category of energy development. The benefits and critiques of energy development are evaluated using various theories from economic development.

This approach helps to understand where wind energy fits within economic development. It also helps to evaluate the pros and cons of developing wind energy for the purpose of economic development.

The second question, which is examined in Section IV, is: What are the expected economic impacts of a wind farm on the Navajo Nation? Evaluation of wind project impacts was done using project impact analysis explained in detail by Davis (1990) and applied to wind projects by Northwest Economic Associates, (NEA) (2003).

The final question, in Section V is: Can tribes increase the benefits of wind farms by taking part in the ownership of a wind farm? The general approach to this question was to use a comparative analysis of various finance structures. Comparative analysis of wind farm ownership structures has been applied to scenarios that did not involve tribes by Wiser and Khan (1996) and Bolinger *et al.* (2001, 2004, 2005).

The project relies in part on interviews with tribal leaders, federal officials, wind developers, and tribal business owners. The interviews were conducted in a semi-structured manner by the author either in person or over the phone. To preserve confidentially, no names were recorded and hence results from interviews are paraphrased throughout this document but never directly quoted. The locations of the interviewees are shown in Figure 1.

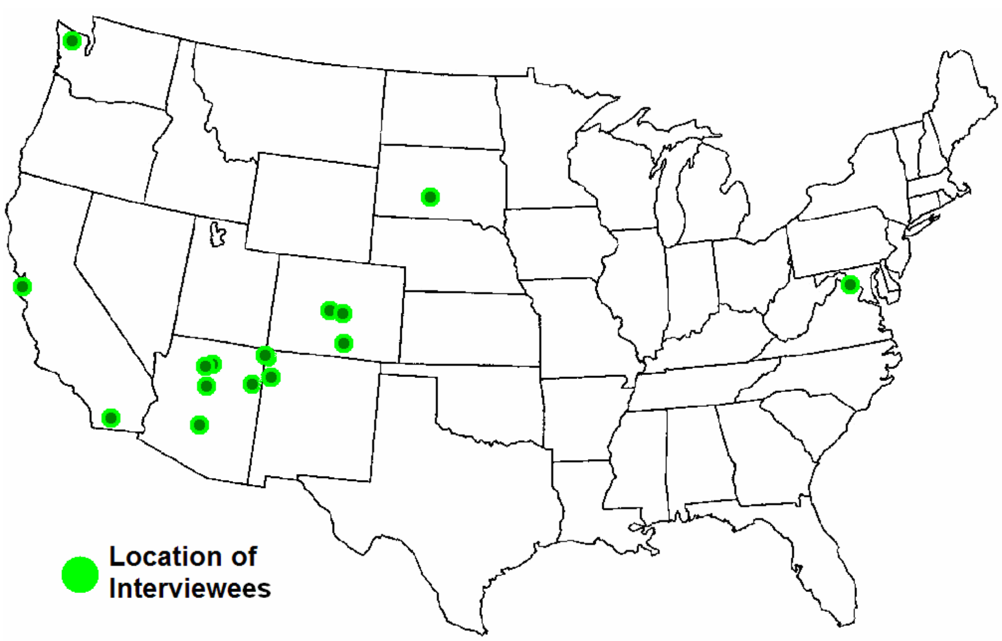

Figure 1 - Location of interviewees. All interviews were conducted by the author, in person or over the phone, during the period of June 2005 to March 2006.

In addition to interviews, the author spent the summer of 2005 working with the Sustainable Energy Solutions group at Northern Arizona University and with employees of the Navajo Tribal Utility Authority.

Finally, much of the understanding of wind energy, economic impacts of wind farms, and energy development with the Navajo Nation comes from an extensive literature survey. Key authors and collections of important research are identified as much as possible throughout this document.

II. Background and Context

This analysis of the potential for wind energy in Indian Country is limited to a specific form of wind projects and a limited set of criteria. The type of wind projects of interest fall into a subset of energy development whereby utility-scale wind farms are built for the purpose of exporting electricity from tribal lands to other regions. Energy development, as used in this context, is a particular development pathway in which a tribe chooses to develop and export energy resources for the purpose of economic development.

The ability of a tribe to develop wind energy projects for the purpose of exporting electricity greatly depends on the quality of the wind resource, the cost of constructing a wind farm on land with high wind potential, and the cost of connecting the wind farm to the electricity grid. These factors are the primary determinates of wind projects and must be evaluated in detail. The purpose of the feasibility study for NTUA was to examine exactly those sorts of questions. This project on the other hand has a different set of objectives and questions as described in the introduction. It should not be confused with a detailed feasibility study.

Similarly, this project does not include analysis of distributed generation projects that many tribes have initiated. For instance, NTUA has a multi-decade, ongoing electrification project that uses renewable energy to provide electricity to homes far from the grid. Other tribes have installed sub-utility scale wind turbines to reduce electricity bills and to demonstrate renewable energy technologies. These projects are very important for the tribes and can contribute to economic development, but their impacts and characteristics are distinct from an energy development pathway described above (see LaDuke 2004 for an overview of past projects) .

While there is no mention of solar projects in this analysis, it is expected that large, utility scale solar projects built on tribal lands for the purpose of exporting electricity will have similar characteristics to wind projects. The primary reason for not broadening the subject to include large solar projects is that until recently the cost for such projects has remained prohibitively high, and therefore the utility-scale solar industry is not as mature as the utility-scale wind industry.

II.1 The Wind Industry

The wind industry in the past few years has matured in the United States. Large investment firms now own wind projects. Goldman Sachs, a large institutional investor, recently bought a small wind development company and created a wind development subsidiary called Horizon Wind Energy. Babcock & Brown, also a large investment company, is the owner of a 50 MW wind farm on tribal land called the Kumeyaay Wind Project near San Diego, CA. The total installed wind capacity in the United States is now 9,149 MW and is expected to grow by 3000 MW in 2006.[1]

Two primary drivers of the wind industry are the Production Tax Credit (PTC) and state wide Renewable Portfolio Standards (RPS). The PTC is a tax incentive to owners of wind farms. As of 2006, every megawatt-hour (MWh) of energy produced by a wind farm in its first ten years of operation entitles the wind farm owner to a tax credit worth $19, which rises with inflation. In order to use the tax credits the owner must have a sufficient tax burden to offset federal income taxes. If the owner does not have sufficient tax appetite, as it is called, to fully utilize the PTC the tax credits are wasted because they are non-transferable. The PTC and declining turbine prices now make wind energy cost competitive with many sources of electricity. However, the PTC has expired three times

[1] American Wind Energy Association. 2006. "U.S. Wind Industry Ends Most Productive Year, Sustained Growth Expected For At Least Next Two Years." AWEA press release, January 24. Available at: http://www.awea.org/

in the past decade, leading to a boom-bust cycle in the US wind industry. The current PTC is set to expire at the end of 2007.

In addition to the PTC, a number of states have an RPS that requires utilities to purchase or generate a certain amount of renewable energy by a target date. Wind energy projects make up a large portion of the RPS procurements in a number of states.

Given the growing size of the wind industry and the entry of major institutional investors, it is expected that a current shortage of wind turbines will be temporary. Right now turbine manufacturers cannot make enough turbines to meet demand so many projects are being forced to wait until after 2007, when the PTC is set to expire, to obtain turbines.

II.2 Tribal Wind Projects

Interest is growing in large wind energy projects on tribal lands. The first Native Renewable Energy Summit was held in Denver in November 2005 (see Caley 2006 for description). A Law Seminars International Conference on Southwest Tribal Energy Development in April 2005 and an Arizona Governor's Tribal Energy workshop in August 2005 both focused substantially on renewable energy projects, particularly wind projects.

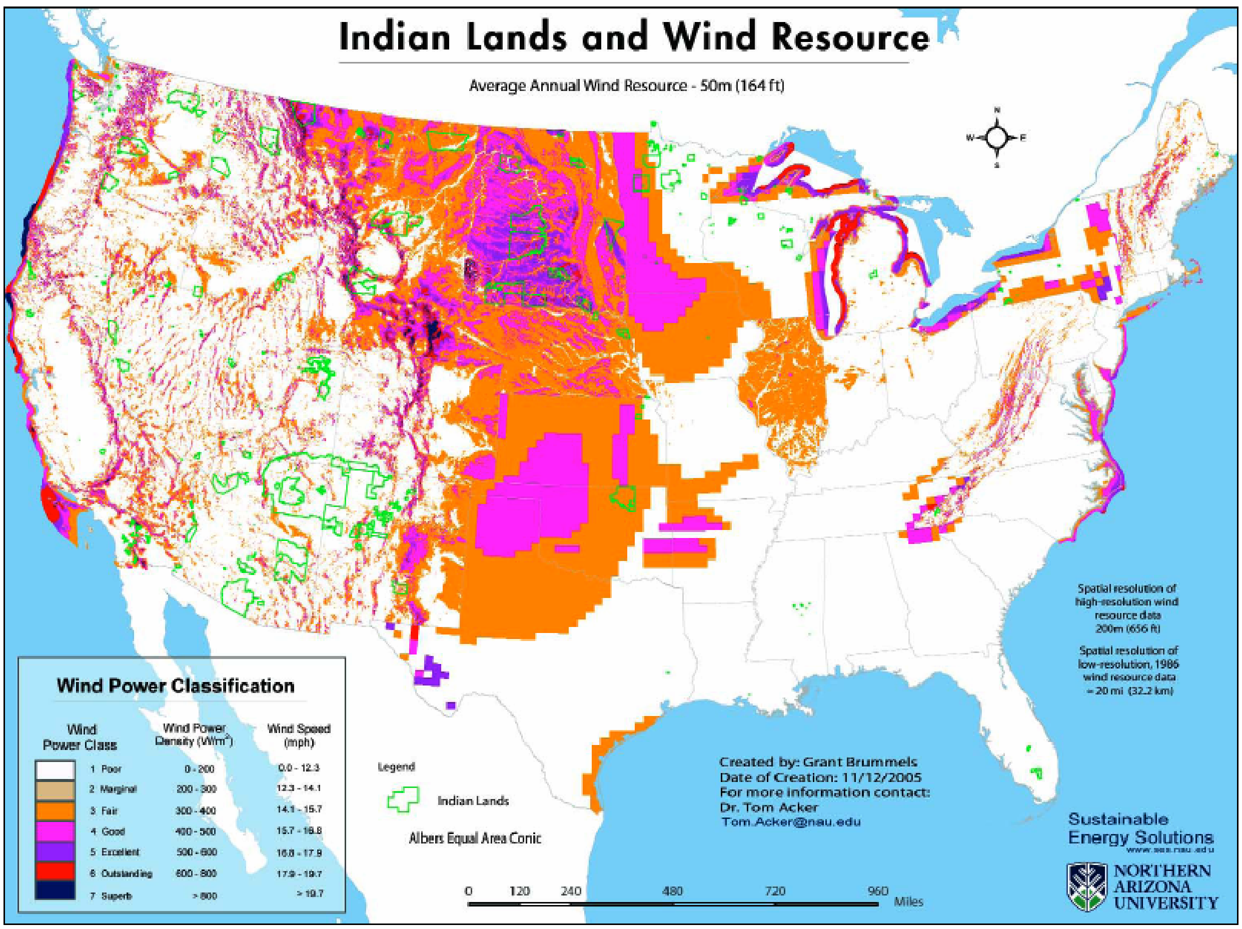

Figure 2 - Wind resource on Indian lands in the United States. Map by Grant Brummels, Northern Arizona University. Map is taken from Caley (2006).

Figure 2 shows an overlay of the wind resource on Indian lands. Tribes in the Plains region have by far the largest potential for wind development, but they are far from large markets for wind electricity. Tribes like the Navajo Nation are in areas with less wind, but they are much closer to large markets for renewable energy.

The literature pertaining to renewable energy projects on tribal land is quite sparse with three notable exceptions. Dean Suagee highlighted many issues with renewable energy that tribes, project developers, and policy makers will have to consider in an issue brief for the Renewable Energy Policy Project (Suagee 1998). A year later, the Energy Information Agency was asked by the Secretary of Energy to conduct a survey and prepare a report on the use of electricity on tribal lands and the potential for developing renewable energy projects (EIA 2000). Acker *et al.* (2003) and Bain *et al.* (2004), both research teams from Northern Arizona University, are two more recent additions to the literature that investigate specific aspects of renewable energy projects on tribal lands. Acker *et al.* (2003) evaluated the potential for wind energy projects on western tribal lands to contribute to regional clean air goals. Bain *et al.* (2004) discuss the possible opportunities for developing small businesses in support of solar electrification on the Navajo Nation.

Since the EIA study and the Suagee article were published, many aspects of the renewable energy industry have changed. In particular, for the first time large wind projects are now built on tribal lands. Therefore it is worthwhile to review two examples of Native wind energy projects in more detail.

II.2.1 Rosebud:

The Rosebud Sioux Tribe in South Dakota built the first example of a tribal owned, utility-scale wind turbine in 2003. With the huge wind resource available in South Dakota, the tribe plans to use a stepping-stone approach to go from a small project to eventually many multi-megawatt wind farms. The tribe will increasingly participate in the process along the way.

In 2003, the Rosebud Sioux installed a single 750 kW wind turbine at the tribe's casino. The electricity is used to meet a portion of the casino power requirements. The PTC was not available to the Rosebud because the tribe owns and operates the wind turbine but does not have a federal tax burden. Instead of the PTC, the Rosebud turbine was financed with a low interest loan from the Rural Utility Service, a grant from the Department of Energy, and the upfront sale of "green tags" to a company called *Native*Energy. Green tags are the clean and renewable attributes of wind energy and can be unbundled from the physical power to be sold to a separate entity. The upfront sale of the green tags generally leads to a lower unit price of the tags, but adds certainty in the financing necessary to get the project built. In August 2005, *Native*Energy became majority owned by Native Americans with plans to support further wind energy projects in Indian Country.[2]

With the experience gained from owning and operating the wind turbine, the Rosebud partnered with Distributed Generation Systems, Inc. to develop a 30 MW wind farm. An 18-month DOE grant was used to complete technical, environmental, and financial studies, and negotiate all of the contracts necessary for the pre-construction phase of project development. The power will be sold to Nebraska Public Power District, a rural cooperative that owns the transmission lines near the wind farm site. At this point the project is on schedule to begin construction in 2006. In contrast to the first wind turbine project, the 30 MW wind farm be built with the assistance of an outside investor. A tribal entity and the investor will form a form a joint venture.

[2] Press release, August 16, 2005: "*Native*Energy is now Native-owned!" Available at: http://www.nativeenergy.com//Native-owned_RELEASE_8-16-051.pdf

According to one Rosebud member, the construction of the 30 MW project has the potential to create 30-40 short-term jobs and provide a million dollar boost to the local economy. During the life of the project, the wind farm will provide four jobs to tribal members operating and maintaining the wind farm.

The Intertribal Council on Utility Policy, ICOUP, is providing longer term planning and policy assistance to expand the number of wind farms and increase the level of tribal participation in energy development. Eventually, planners want to develop eight 10-MW wind clusters on different reservations, scale each project up to 50-MW and then replicate the projects on additional sites (Caley 2006).

II.2.2 Campo Band of the Kumeyaay Nation:

While the first tribal owned, utility scale wind turbine was the 750 kW Rosebud turbine, the first wind farm on tribal land was the Kumeyaay Wind Project on the Campo Band of the Kumeyaay Nation. The 50 MW wind farm is composed of twenty five 2 MW turbines on a ridge near the tribe's Golden Acorn Casino. The Campo Band is a small Indian tribe located in the mountains about one hour east of downtown San Diego, CA.

The Kumeyaay Wind Project is also the first project that fits the description of energy development described at the beginning of this section. Babcock & Brown owns the wind farm and the tribe collects a land lease fee. The wind farm was developed by a wind developer, Superior Renewable Energy, who approached the tribe with the proposal to develop a wind farm on their land after many years of various entities monitoring the wind resource in the region. As one wind developer familiar with the project understands it, the tribe agreed to take steps that essentially made the tribe's land look like private land to the investor. For most tribes this means that the tribe must sign a limited wavier of sovereign immunity indicating that the tribe can be taken to a non-tribal court for dispute resolution. Investors sometimes require these steps before they are willing to make a large, long-term investment on tribal lands.

For smaller tribes, human resources may be tied up running the day-to day operations of the tribe, making it difficult to devote resources toward development of a wind farm. In these cases, an outside developer and owner building and owning the wind farm makes more sense than the tribe devoting significant resources to do the project on their own.

In addition to these examples, there are several other tribes around the U.S. that are looking at building wind projects on their land. A few points learned by tribes trying to develop wind projects is that it is important for tribal members to customize the project to fit the resources that are available, not only the wind resource and access to transmission, but also the human resources and the priorities of the tribe. Patience in the development process is important due to the many factors that must come together at the same time to make a successful project. And lastly, community outreach, in a way that brings impacted community members to the decision making table is essential for avoiding opposition to wind projects.

II.3 Navajo Nation and Energy Development

The Navajo Nation is currently conducting a feasibility study for an 80 MW wind farm. In June 2005, a team installed a 30-m wind assessment town on a site called Gray Mountain in the southwest corner of the Navajo Nation. Estimates from the National Renewable Energy Lab (NREL) put the technical capacity of the site at 430 MW in areas that are at least a Class 4 wind resource, with nearly half of the area having at least Class 5 winds.[3] High Class 4 winds and higher are generally considered to be commercially developable wind sites.

The Gray Mountain site is promising for wind farm development because in addition to the wind resource, large transmission lines are built near the site. As shown in Figure 3, two 500 kV lines cross the high quality wind resource area on Gray Mountain. An additional 69kV line runs north and south through the nearby town of Cameron, less than ten miles from the windy area. These three transmission lines are owned by Arizona Public Service (APS), an IOU subject to Arizona's RPS. Two additional high voltage lines, owned by the Western Area Power Administration, run north and south parallel to the 69 kV line. The federal government must procure 7.5% of the energy it consumes from renewable resources by 2013. Renewable energy that is generated on Indian land is double counted toward meeting this requirement. The double counting leads to a higher value for tribal green tags to the federal government (EPAct, Sec 203).

A wind energy project that would export electricity to other areas fits within the energy development pathway that the Navajo Nation has pursued for decades. A map of the geographical location of energy resources is shown in Figure 4.

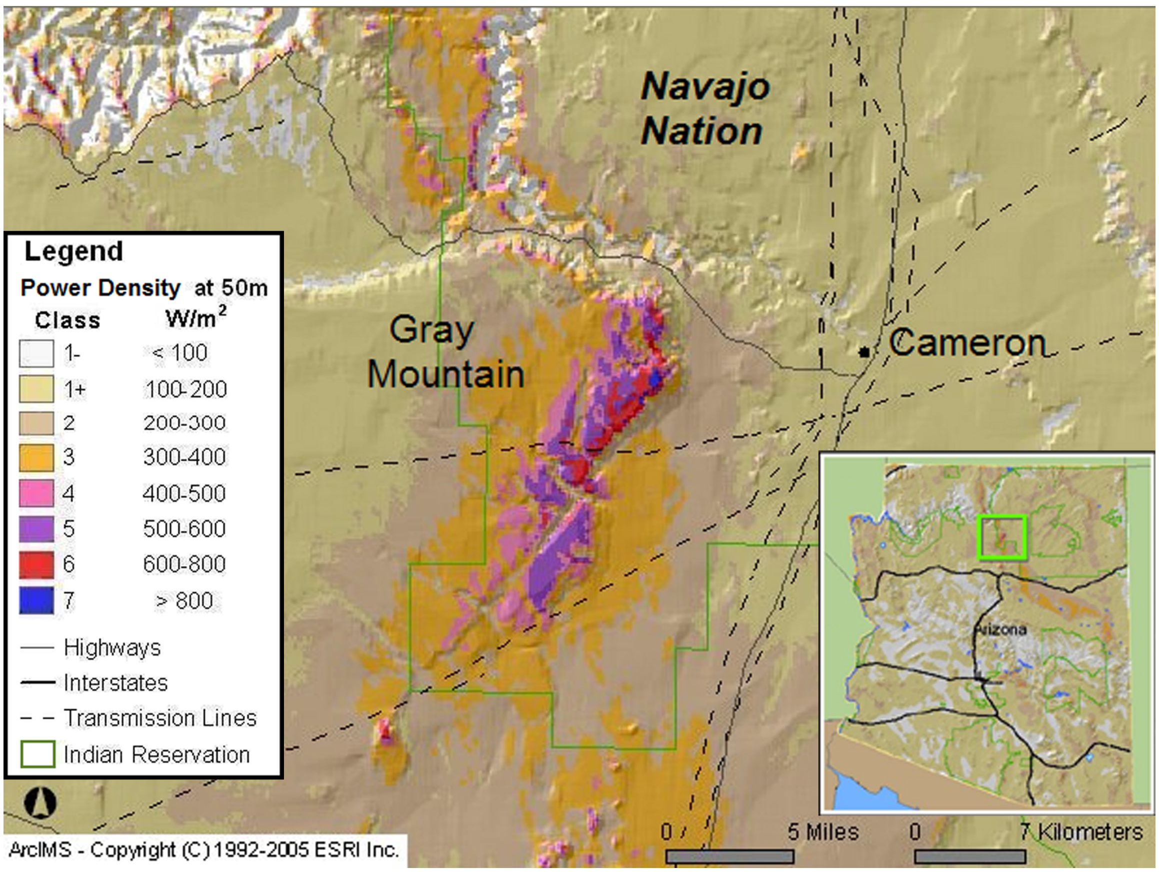

Figure 3 - Wind Map of the Gray Mountain region in the Navajo Nation

---

[3] Amanda Ormond, "Arizona Wind Energy Resource Potential," June 25, 2004 presentation to the Arizona Corporation Commission: http://www.cc.state.az.us/utility/electric/EPS5-REAPO.ppt

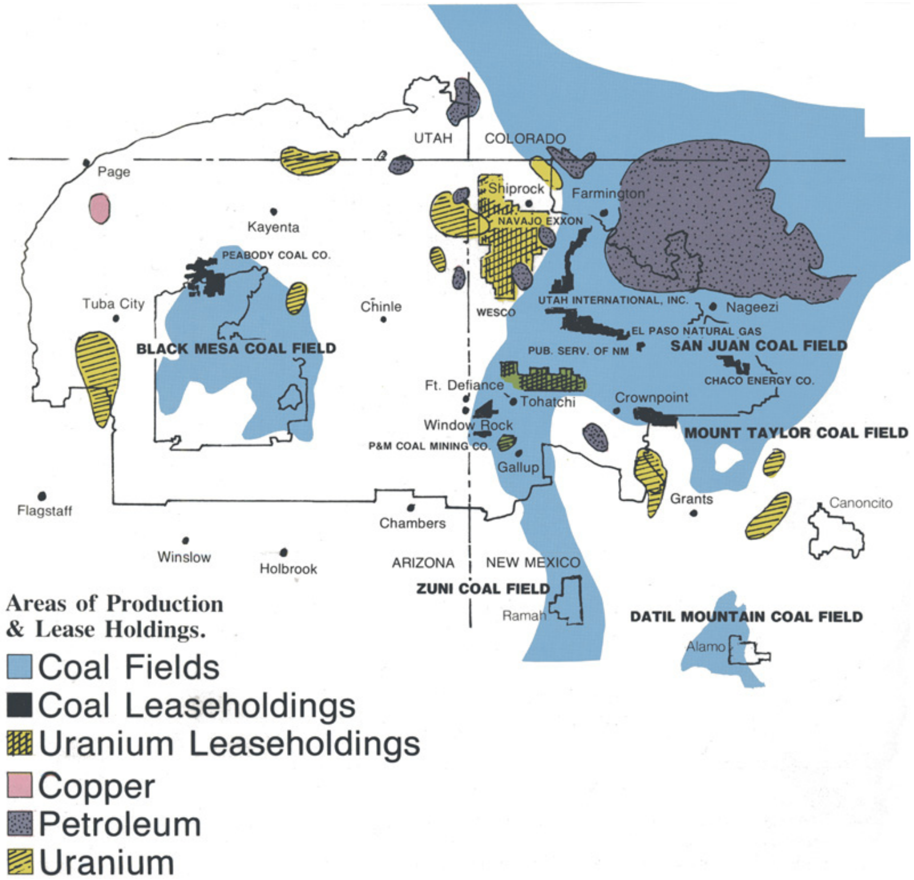

Figure 4 - Geographic location of mineral resources on the Navajo Nation, from "Navajo Natural Resources" (1987).

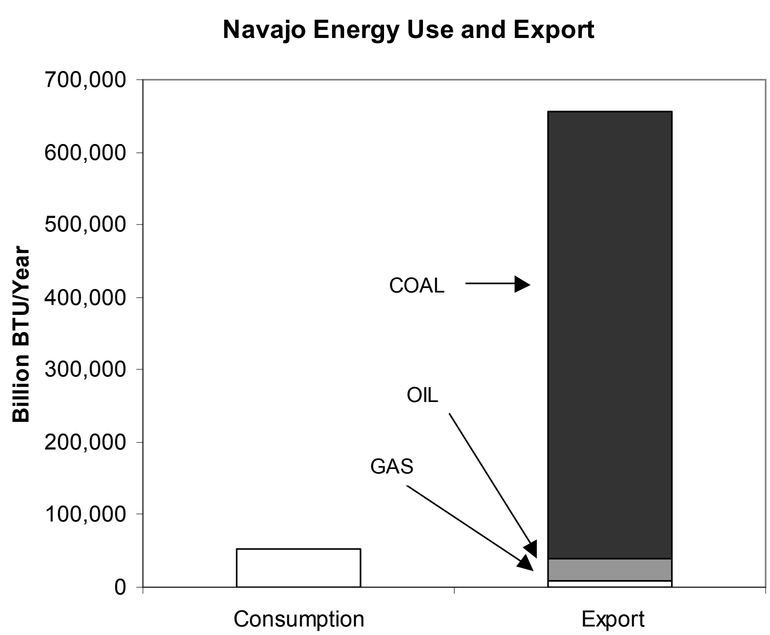

Figure 5 - Comparison of energy exported from the Navajo Nation to the energy consumed on the Navajo Nation

A rough estimate of the current energy content of energy resources exported from the Navajo Nation in comparison to the energy used on the Navajo Nation is shown in Figure 5. The calculation was done using data from Trib Choudhary, an analyst for the Division of Economic Development (Choudhary 2003), data on tribal energy use from a survey of energy use on tribal lands (EIA 2000), and numerous simplifying approximations. Clearly, the Navajo Nation is a significant net exporter of energy resources.

The primary reasons that the Navajo Nation is pursuing energy development were discussed by the President of the Navajo Nation, Joe Shirley Jr. and Arvin Trujillo of the Division of Natural Resources in a speech to the World Bank in 2003 (Shirley and Trujillo, 2003). Reasons included the chronic high unemployment rate and the high rate of poverty, which were both above 40% in 2000 (Choudhary, 2003). Shirley mentions that education is very important to the Navajo Nation, and it is supported through college scholarships to many Navajo students. However, the troubling aspect of education was the lack of skilled jobs on the reservation for the youth to return to. Many obtain an education but then remain in cities like Albuquerque and Phoenix where they can find high paying jobs. Shirley and Trujillo also focused on the lack of infrastructure on the Navajo Nation. Revenues to the tribal government from energy development, they assert, would allow the Navajo Nation to build infrastructure that is required for sustained economic development.

The merits of energy development for achieving these goals is discussed in detail in Section III, but it should also be mentioned that issues around energy development are increasingly provoking opposition to energy development from within the tribe.

At the end of 2005 energy resource exports were reduced due to the closure of a mine on the Black Mesa coal field. The coal from the mine was sent to the Mohave Generating Station in Laughlin, Nevada via a 270-mile coal slurry pipeline. Water for the coal-slurry pipeline was pumped from the aquifer underlying Black Mesa. Mohave shut down in part due to requirements for air pollution equipment upgrades, but also due to the Navajo and Hopi tribes requiring alternative sources of water for the coal-slurry pipeline. In the original leases between the Hopi and Navajo tribes and the coal mining company, Peabody Coal, the tribes allowed the use of the aquifer for the coal slurry pipeline. After years of internal pressure, tribal members succeeded in convincing the tribal governments to force Peabody to look for alternative sources of water for the coal slurry pipeline. Uncertainty in establishing a reliable water source made it difficult for the owners of the Mohave power plant to ascertain the future costs of the plant.

Mohave is operated and majority owned by Southern California Edison, a California IOU. The California Public Utilities Commission therefore has regulatory authority over the operation of the power plant. As part of hearings on the fate of the Mohave Generating Station, the CPUC directed SCE to conduct a feasibility study for power plants that could be built to replace or complement the power from Mohave. The study was called the "Mohave Alternatives/ Complements Study" or MACS and was performed by Sargent and Lundy and Synapse Energy. Two of the options included in the MACS study were a 450 MW wind farm and a 500 MW solar power plant on the Navajo Nation. The study is quite detailed and briefly examines the economic impacts expected to accompany the energy projects (Sargent & Lundy 2006). Where appropriate, results from the MACS study are included in this project for comparison. I participated in the MACS process and submitted comments on the direction and scope of the study and on the draft results. The interested reader should review the results from the MACS study for a detailed comparison of the potential feasibility and economic impacts of wind, solar, and coal gasification projects on Navajo land.

III. Wind Energy and Energy Development

The focus of this study is to analyze the economic impacts of wind farms and the opportunities for tribes to increase the economic impacts through taking part in the ownership of a wind farm on tribal lands. This information helps understand the potential benefits of developing a wind farm, but it is not sufficient information to determine whether or not tribes should devote time and resources toward developing wind projects. Tribes will need to assess the benefits of wind energy in the context of the economic development goals of the tribe.

Such an assessment presents many challenges. For example, to understand the economic development goals of a tribe one first must grapple with questions like:

- What is the definition of economic development?
- How do you measure or characterize development progress?
- Who is defining the development goals?

The reason that these questions are challenging is partly due to the fact that the answers that are available depend on whom one asks. One group's characterization of economic development will vary depending on whether the group is a business that develops energy resources, a federal agency responsible for administering the federal government's trust responsibility, a tribal government, a local decision making body, or an individual. Furthermore, different groups will have different incentives for pursuing one type of development pathway over another, often leading to conflicts between various groups. Imbalances in the power and influence between groups can lead to one viewpoint dominating multiple conflicting perspectives.

Therefore, instead of answering these questions directly, this section highlights justifications for pursuing energy development and arguments against it. Wind energy is situated in these justifications and critiques. The remaining sections of the project then further evaluate the specific impacts of wind energy on economic development.

III.1 Motivation

The motivation for critically assessing wind energy in the context of economic development is to unpack two general perspectives with regards to renewable energy projects on tribal lands. The first perspective perceives wind energy as another form of energy development and evaluates its merits based on the economic benefits such as increases in revenue, number of jobs created, and the potential size of the market. These benefits are then compared to other forms of energy development, such as developing a coal resource or oil and gas, to determine the relative merits of each development opportunity (i.e. Sargent & Lundy 2006).

The second perspective, however, starts with a historical evaluation of energy development on tribal lands and recognizes a pattern of environmental destruction, adverse health impacts, and, accordingly, a lack of economic development on tribal lands. Renewable energy is viewed as offering an alternative that will allow tribes to develop without the corresponding destructive effects of energy development (i.e. LaDuke 2004).

These two perspectives approach the issue of development in different ways and for that reason evaluate energy development using different criteria. They are both valid approaches and ask important questions, but neither perspective on its own is sufficient to comprehensively evaluate opportunities and costs associated with energy development. There is a rich set of theories and frameworks for evaluating development that encompass much more than these two perspectives. The merits of energy development, and renewable energy development, can be situated in these understandings to achieve a more comprehensive assessment of energy development.

III.2 Approach

Instead of providing answers to the difficult questions posed at the beginning of this section, I evaluate wind energy development by drawing attention to the various arguments for and against energy development in the development literature. I reviewed literature that both describes broad theories and applies those theories to the specific example of development on the Navajo Nation. In addition, observations from my own experience working with the Navajo Tribal Utility Authority in the summer of 2005 were used to indicate where wind energy fits into this picture.

The analysis is presented in the following manner: first, I evaluate ideas and theories that are commonly used to justify energy development. The justifications for energy development are lumped into three categories: Economic Base, Comparative Advantage, and Self-Determination. An assessment of these theories helps to understand questions such as: Why is energy development pursued in the first place? What opportunities does wind energy offer that contribute to economic development? And: How does wind energy compare to other forms of energy development?

In the second part of the analysis I present three different critiques of energy development loosely labeled Dependency, Basic Needs, and Socially Embedded Economies. These critiques raise important questions such as: Who benefits from energy development? What sectors are neglected when the focus is energy development? And: Why does energy development provoke opposition? Again, wind energy will be evaluated in the context of these critiques of energy development.

III 3 Benefits of Energy Development

III.3.1 Economic Base and the Regional Economy

In analyzing a regional economy, the term "multipliers" is often used. This is in reference to the portion of the money that is spent in a regional economy that remains in the economy. For every dollar earned in the Navajo economy it is estimated that only $0.29 is spent within it. In other words, $0.71 from every dollar earned on the Navajo Nation leaks out of the economy by people choosing to purchase products from outside of the Navajo economy. The income multiplier for the Navajo economy is then 1.4 (see Appendix III and Choudhary 2003, 75). In general, an income multiplier of 1.4 indicates that for every $1,000 of income earned in the regional economy, a total of $1,400 of economic activity occurs in the regional economy before the original income leaks out. Consequently, dollars need to be continually added to sustain a regional economy. The economy cannot be completely self-sufficient with any leakage rate.

The original money earned in the Navajo economy can come from transfers from federal sources such as grants or welfare transfers. Or it can come from other sources such as adding value to products and selling natural resources. The latter sources of spending are referred to as the economic base. The base provides the foundation of an economy that other businesses, such as the service sector or the public sector, are built upon. The income derived from the economic base is used to purchase services from these other sectors (Davis 1990, 9-28). In this simple conception of an economy, the only way to build an economy is through increasing the economic base. Development in this case is synonymous with increasing the export of products and increasing the import of dollars into the regional economy.

Development of natural resources, including energy sources like coal or renewable resources such as timber products, adds to the economic base. Wind energy can contribute to the economic base in a similar manner. If the power from the wind farm is sold to utilities in Arizona or California, for instance, then the income earned by local wind farm employees or land lease fees adds to the economic base of the Navajo economy. With just this characterization of the local economy, the only criterion for evaluating a project is to look at the quantity of revenue that the project will add to the local economy.

III.3.2 Comparative Advantage

The idea of comparative advantage builds upon the economic base theory by examining the question of why some products of an economy form part of the economic base and some do not. The answer according to the theory of comparative advantage, is that a regional economy must be able to produce a product with higher quality, lower price, or some other improved attribute than other regional economies for it to be purchased by consumers from other regions. In other words, if a regional economy has a comparative advantage with a certain product it can collect "rent" on that product, which adds to the economic base (Gunton 2003).

Comparative advantage indicates a regional economy should have a high quality resource that is inexpensive to extract, with regards to natural resources. Additionally, the economy must have access to a market for the product. One could argue that the Navajo Nation has a comparative advantage with its coal resource due to the large size of the coal reserve, the low sulfur content and high heating value characteristics, and the proximity to the high energy consuming cities of the southwest.

In the extreme, the provision of "sinks" for environmental pollutants can be seen as a "resource" that can increase a region's comparative advantage. Interestingly, the relatively clean air in the Intermountain West compared to the increasingly clogged air in cities like Los Angeles during the 1960's was a large reason for utilities to initially turn to the Colorado Plateau and the Navajo Nation's coal resources (Wiley and Gottlieb 1982, 41-53).

The skills of a work force and capacity of local businesses can produce a comparative advantage. Table 1 shows that the while 4.6% of the workforce in the Navajo Nation is in the mining sector, only 0.4% of the workforce is in the mining sector in the US in general. This concentration of the workforce in the mining sector supports the argument that that the Navajo Nation has a comparative advantage in the mining sector. Conversely, only 1% of the Navajo Nation is employed in the manufacturing sector in comparison to 13% of the US workforce.

Another way to assess the comparative advantage is a statistic called the location quotient. The location quotient is the ratio of the percentage of the workforce employed in a sector in the regional economy to the percentage of the workforce employed in the same sector for the economy as a whole. A location quotient greater than one indicates the regional economy is a net exporter of the products of that sector (Davis 1990, 16). For example, in the case of the mining sector the percentage of the workforce employed in the mining sector for the US is assumed to be the level of employment in that sector required to be self-sufficient. The location quotient for the mining sector is then 4.6%/0.4% which is 11.5. The high location quotient for mining is a sign that the Navajo Nation is a net exporter of mining products. Conversely, a location quotient of 0.07 for the manufacturing sector indicates that the Navajo Nation is a net importer of manufactured goods.

Concentration of Workforce in Economic Sectors			
	Percent of Workforce in Sector, 2001		
Sector	Navajo Nation	United States	Location Quotient
Agriculture	0.7%	N.A.	N.A.
Construction	2.7%	5.2%	0.52
Finance/ Insurance/ Real Estate (FIRE)	1.2%	5.8%	0.21
Government/ Public	27.4%	15.8%	1.73
Manufacturing	1.0%	13.4%	0.07
Mining	4.6%	0.4%	11.50
Retail Trade	9.4%	23.1%	0.41
Service	46.2%	31.0%	1.49
Transportation/ Communication/ Utilities (TCPU)	6.6%	5.4%	1.22

Table 1 - Concentration of workforce in economic sectors for the Navajo Nation and the entire United States. Workforce data from Choudhary 2003. Data on U.S. agriculture employment was not collected.

The Navajo Nation also has a tribal business, the Diné Power Authority (DPA), whose sole purpose is to develop energy projects. The projects will generate electricity using Navajo resources and send the power to cities in the southwest over transmission lines developed by DPA. Developing power projects includes an involved permitting process that requires interaction with local community governments, the Navajo Nation government, the Federal Energy Regulatory Commission, the Environmental Protection Agency, and potential power purchasers. If DPA can successfully develop a project, such as the Desert Rock Power Plant, the abilities and knowledge gained by the organization may provide it with a comparative advantage for future power projects.

The theory of comparative advantage is also useful for understanding wind energy projects. As will be explored in more detail in later sections, a wind project on the Navajo Nation can have a comparative advantage over wind projects built elsewhere in the region either if incentives lower the power purchase price or if a wind farm on Navajo land has a better wind resource than other places.

The 50 MW wind farm on the land of the Campo Band of the Kumeyaay Nation may have offered a comparative advantage in comparison to nearby potential sites for several reasons. First, the Manzanita Band, which neighbors the Campo Band, had been collecting wind data for six or seven years before obtaining a Department of Energy feasibility study for a wind farm. While the DOE feasibility study was being conducted, a wind project developer contacted the Campo and Manzanita Band to propose developing a wind project with the tribes. Without the feasibility study and wind data already completed, a wind project developer would need to fund and perform these tasks on their own. The developer would be exposed to the risk that the wind assessment results would not support further development. However, the tribes lowered the risk to a project developer by having wind data and an initial scoping showing a promising wind resource.

In addition, the Campo Band approved of the proposed use of their land and obtained regulatory approval from the Bureau of Indian Affairs for the wind farm in a relatively short timeline. In contrast, land neighboring the reservations, managed by the Bureau of Land Management (BLM), is currently going through a much longer process for approving the development of wind farms on the land. The proposal to install wind farms on the BLM lands sparked opposition from a local chapter of the Sierra Club. A representative of the Sierra Club indicated that they did not oppose the development of the wind farm on the tribal lands.[4]

The development of the 50 MW wind farm on the Campo lands indicates that they had a comparative advantage in comparison to other sites. The Campo Band now collects a royalty for allowing the 50 MW wind farm on their land that can be considered the "rent" on their comparative advantage.

The example of the Campo Band also illustrates that a comparative advantage is not just an endowment of a resource. The political and institutional structure along with active efforts to promote development also produce a comparative advantage for which a rent can be collected. Jamil Khan found that early political support at the local level was well correlated with more wind energy development in a comparison of land use planning for wind power at three Swedish municipalities (Khan 2003).

Stephen Cornell and Joseph Kalt from the Native Nations Institute and the Harvard Project on American Indian Economic Development, respectively, argue that in fact the endowment of natural resources has very little to do with the economic development success of tribes. Instead, the issue of political and institutional structure is the primary determinate of success (Cornell and Kalt, 1998). In the context of the theory of comparative advantage, a tribe must structure its political and institutional environment in a way that produces value to investors for which the tribe can then collect rent. According Cornell and Kalt then, for energy development to be successful the tribe must have an appropriate institutional structure in place. One key element of tribal institutional structures is elaborated upon in the next section.

III.3.3 Self-Determination, Capacity Building, and Energy Development

The third justification for energy development is that energy development promotes economic development through building capacity within the tribe to manage and carry out projects.

Self-Determination is a term applied to a shift in federal policy toward Native Americans that occurred in the 1970's. Immediately prior to the era of Self-Determination, official federal policy was oriented toward steadily terminating the trust responsibility of the federal government over tribal lands. The Indian Law scholar Charles Wilkinson describes the struggle that tribal activists went through in the 50's and 60's as they increasingly demanded and acquired responsibility over their own reservations. Their aim was to change the federal government's orientation toward tribal governments as a temporary arrangement while Native Americans became assimilated into mainstream society to policies that recognized tribes desire to maintain their reservation system and choose their own future (Wilkinson 2005, 189-205). Primarily, the shift to Self-Determination reduced the role of the Bureau of Indian Affairs in managing reservations and conceded that responsibility to tribal governments. Wilkinson points out that tribal control has been a long standing goal: "Ever since the establishment of the reservation system, Native Americans held dear the impulse to govern their homelands free of BIA control" (ibid, 189).

The first steps toward tribes practicing self-determination came in the 1960's with federal Office of Economic Opportunity programs. The OEO programs provided funds directly to tribal governments to spend on projects that met their priorities. The OEO programs contrasted with the programs that were typically directed and managed by the BIA in what is commonly called a "top heavy, paternalistic" manner (ibid, 191). The success of the OEO programs lay in that the tribe began taking on responsibilities and practicing control and leadership over projects (ibid, 193). Self-Determination was formalized in 1975 with the Indian Self-Determination and Education Assistance

[4] Krueger, Anne. 2005. "Sierra Club to tackle issues on wind-turbine locations" *San Diego Union-Tribune*, June 23.

Act. At the heart of the policy was a structure that would allow the tribes to contract with the BIA or the Indian Health Service to receive funding for projects and carry them out on their own (ibid, 197). Self-Determination allows tribes to provide for the needs of their people according to their own goals instead of federally imposed goals (Ambler 1990, 25-6).

One of the elements that linked tribal self-determination to increased economic development was that besides the tribes choosing their own future, they also began to take on leadership roles in projects on their land. Studies found that tribally managed projects transferred skills and information to members, enhanced tribal employment, and lead to retention of expenditures in the tribal economy (Ambler 1990, 28). In general, conditions improve on tribal lands when their rights to self-government are respected (Suagee 1998).

Cornell and Kalt make a strong argument that economic development on tribal lands requires self-determination:

> Among the most powerful arguments for tribal sovereignty is the simple fact that it works. Nothing else has provided as promising a set of political conditions for reservation economic development. Nothing else has produced the success stories and broken the cycles of dependence on the federal system in the way that sovereignty, backed by capable tribal institutions, has done. …To date… only one federal policy orientation has been associated with sustained economic development on at least those Indian reservations that have exercised de facto sovereignty through their own institutions: the self-determination policy that emerged in the 1970s. In other words, not only does tribal sovereignty work, but the evidence indicates that a federal policy of supporting the freedom of Indian nations to govern their own affairs, control their own resources, and determine their own futures is the only policy orientation that works. Everything else has failed. (Cornell and Kalt 1998, 209)

Energy development can play and important role in economic development by building capacity within tribes and by providing revenues to tribal governments for economic development projects. Capacity is built within tribal governments by taking on responsibility of managing energy projects. Capacity can also be built within tribal businesses by taking part in energy projects as sub-contractors, partners, or even project owners.

The thesis of Marjane Ambler's book on Indian control of energy development, *Breaking the Iron Bonds,* is that early energy development with tribes did not involve the tribes in the decision making process and that they had no control over energy development. The lack of control was associated with very little economic benefits to the tribes. The boom and bust nature of energy development made the revenues that tribes collected unreliable. But by the 1980's, she argues, self-determination provided an opportunity to tribes to direct the value created through energy development toward economic development in the tribal economy. Tribes used their sovereign powers to institute taxes on energy companies, require employment of tribal members, and regulate energy companies operating on their land. The funds earned by energy development were directed toward building stores, banks, and other services on tribal land, boosting economic development (Ambler 1990, 30). Successful control of energy development required information about the energy resources of the tribes such as the quantity and quality of the resource and the value of the resource in energy markets. Tribes also had to exercise financial control over companies so that they could be sure that proper accounting was taking place for purposes of taxation and collecting royalties (ibid). An organization called the Council of Energy Resource Tribes or CERT was formed by tribal leaders to facilitate and encourage capacity building in tribal governments. CERT continues to operate today providing technical assistance, Indian energy policy advocacy, and assistance in capacity building.[5]

Energy development is linked to economic development through self-determination in that the revues from energy development projects on tribal lands can diversify funding for tribal programs away from federal grants. While significant federal spending accompanied the early years of the self-determination policy, those funds began to drastically decline with the Regan administration in the early 1980's. In many cases tribal governments felt that the tribal economy was not sufficiently developed to raise funds through taxation of local businesses to compensate for federal budget cuts. The funds that were available needed to be directed toward provision of basic services like education and health instead of economic development. One alternative source of funds that many tribes have turned to is energy development. Simply put: "Some tribes look to their minerals as a possible way of freeing themselves from complete dependency on the whims of Washington, D.C." (Ambler 1998, 29).

As tribes began to exercise more control over energy development on their lands, they gained the capacity to become the energy producers, if they were willing to accept the additional financial risks. One tribe, the Southern Ute in the Four Corners area of the Southwest, has gone much further than trying to improve the benefits of outside companies developing energy resources on their lands in the oil and gas rich San Juan Basin. Recognizing that by taking on more of the financial risk of energy projects they could increase the return to the tribe, the Southern Ute formed the Red Willow Production Company and became producer of natural gas. The funds from energy development are invested in growth funds, non-energy business ventures, provide for payments to elders, and have been used to invest in new buildings on the reservation (Wilkinson 2005, 346).

Wind energy offers the same potential as energy development in boosting economic development through capacity building and self-determination. For tribes that depend on energy revenues for their tribal programs, wind energy offers the potential to partially diversify the source of revenues. In the short run, periods of energy resource price fluctuations can be stabilized with funds from wind projects. Of course in the long run, the value of wind energy depends on the cost of alternative energy prices. If the price of natural gas were to fall to a low level for an extended time, a tribe like the Navajo Nation would have royalties and taxes on gas reduced and the rent they could collect on selling electricity from a wind project would also be reduced.

The federal government plays an important role in enabling tribes to build the capacity to develop renewable energy projects through the DOE Tribal Energy Program. The Tribal Energy Program offers two types of grants to tribes: a "First steps" grant that helps tribes bridge the gap between a general interest in a project and a commercially viable project and a second grant for feasibility studies of specific projects. For wind energy the "First steps" grant allows tribes to assess their wind resource through installation of wind towers on potential sites in addition to assessing the energy needs of the tribe and the capacity to develop energy projects. If the wind resource is found to be suitable for development and potential markets for the electricity are found, a tribe can then apply for a feasibility study grant. The feasibility grants are sufficient to fund the majority of steps that a wind developer would go through to develop a wind farm including indentifying financing, obtaining interconnection agreements with utilities, establishing a market for the wind power, and completing environmental and cultural assessments. If the feasibility study shows that the wind farm can be built, then there are few steps left between completing the feasibility study and beginning construction of a wind farm.

As the Kumeyaay Wind Project shows, a tribe does not necessarily require a federal grant to fund resource assessments and feasibility studies to get a wind farm built on their land. However

[5] Council of Energy Resource Tribes, http://www.certredearth.com/

these grants make more sense in the context of self-determination: the purpose is not just to develop their wind resource, the program also aims to build capacity within the tribes to manage energy projects, and in some cases carry out the development process on their own.

The Kumeyaay and Rosebud examples also show that while Ambler estimated that only forty of the three hundred federally recognized tribes have conventional energy resources (Ambler 1990, 29), renewable energy projects may be feasible for tribes that do not have conventional energy resources.

In conclusion, energy development is often associated with economic development for tribes because it builds capacity and promotes self-determination. Many tribes feel that without the funds from energy projects they would be chronically dependent on fickle federal funds.

III.4 Critiques of Energy Development

Just as there are many justifications for pursuing a path of energy development, there are many critiques of energy development. Wind energy is subject to many of these same critiques, but it is fundamentally different in a few important ways that are explored in the next section.

Common critiques of energy development will be lumped into three coarse categories: dependency, basic needs, and the social embeddedness of economies. After introducing each of the three theories, a few examples of the critiques from the literature are discussed in the context of the Navajo Nation.

III.4.1 Dependency

Broadly, the idea of dependency is summarized in the common phrase "the development of underdevelopment." Dependency is a critique of the idea of the economic base in that underdeveloped regions become specialists in providing raw materials and resources that are used in developed regions to create manufactured goods. Substantial value is added to products in the latter stages of processing, but very little of that value is transferred to the developing region. Furthermore, when large multi-national companies control the extraction of the resources the developing region often forgoes the opportunity to build capacity in the production of the base resource. Instead, the local economy simply provides access to the resource and unskilled or semi-skilled laborers (See Palma 1989 and Kay 1991).

Beyond the lack of opportunity to capture value, the dependency critique argues that the success of developing a base resource can distort the structure of the regional economy. Instead of entrepreneurs developing a strong, diversified economy, the businesses that do emerge in the regional economy are oriented toward providing services to the large industrial companies that extract resources (Gunton 2003, 69). The services provided by the government can become focused on increasing the development of just one sector and income to the government becomes tied to the production of the resource. The economy of the entire region and the services provided by the government become linked to the price of the export resource. Moreover, if the resource is depleteable, the economy contracts as the resource becomes more and more difficult to extract in comparison to alternative resources.

One measure of the degree of specialization in the production of energy resources is called the "oil dependency" metric. The "oil dependency" of the Navajo Nation is the ratio of the value of the energy exports (oil, coal, and gas) to the gross regional product of the Navajo Nation (Ross 2001). A rough approximation of the "oil dependency" for the Navajo Nation was found to be 1.1 using data available in the Comprehensive Economic Development Strategy of the Navajo Nation (Choudhary 2003) and energy prices from the Energy Information Agency. The most oil dependent national economy in the world is Angola (68.5). Norway, which exports a considerable amount of oil has an oil dependency of 13.5. The 25th of the top 25 most oil dependent nations has an oil dependency of 3.5 (Ross 2001).

Although the Navajo Nation would not be considered as "oil dependent" as these other countries, it is also important to realize that 15- 20% of the Navajo Nation annual funds are from royalties on energy resources. If the grants from external sources like the federal government are not included in the sources of annual funds, then the share of energy resources increases to 25-50% of the Navajo Nation budget (Choudhary 2003, 65 - Table 7). Furthermore, the second largest recipient of revenues from the Navajo General Fund is the Division of Natural Resources (ibid, 64 – Table 6C). Overall these statistics indicate that the Navajo Nation is oriented toward a heavy reliance and focus on energy development.

Discussions of the Navajo economy in the context of dependency often focus on the importance of the tribe being in control of energy development. By control, most authors are referring to the right to dictate the pace and laws surrounding energy development on their lands (Owens 1979, Ruffing 1980). However, gaining control of energy development is only one part of the dependency critique. The second part is that even with control over the pace and quality of energy development the Navajo government needs to steer the economy in diverse directions so that the economy does not become specialized in providing services to energy extraction companies.

One could easily argue that the Navajo Nation is focusing significant efforts on increasing the level of energy development at the expense of supporting alternative development pathways (for example, the speech by Shirley and Trujillo to the World Bank, 2003). Many authors draw from dependency theories to show why the Navajo Nation is locked into an energy development pathway.

One of the more important historical reasons for the orientation of the Navajo government toward energy development was that the Navajo government was first formed in 1922 by the federal government to act as a representative of the Navajo interests in signing oil leases on Navajo land. As part of organizing the relationship between the federal government, the Navajo Business Council (as it was first called) and energy developers, the Interior Department set policy such that the Navajo government would own all of the mineral resources on tribal land, rather than individual Navajo owning rights to the mineral resources (Wilkins 2002, 101-3).

At the end of World War II, the still fledgling tribal government turned to economic development to improve the conditions in Navajoland in hopes that young people would not feel forced to live elsewhere (Iverson and Roessel 2002, 189). In a process LaDuke and Churchill refer to as "Radioactive Colonialism", the driver of economic development became, with pressure from energy companies and the Bureau of Indian Affairs (BIA), revenues from leasing land for large-scale extraction of the Navajo's mineral resources by private non-Navajo enterprises. The Vanadium Corporation of America and Kerr-McGee provided $6.5 million in uranium mining revenues and jobs for Navajo miners. The miners worked under dangerous and unhealthy conditions, but many of the jobs were the only wage employment ever brought to the southeastern part of the reservation. An oil boom in Navajoland between 1958-62 provided tens of millions of dollars in revenues to the tribal government (Iverson and Roessel 2002, 218-20).

The Tribal Council used the revenues to provide services to many of the Navajo and increasingly employed Navajo in government related jobs. The government officials and workers, along with the few that obtained jobs in the capital-intensive extractive industries formed a class with similar economic interests. Their wealth and power increased with increasing energy development. LaDuke and Churchill explain: "With this reduction in self-sufficiency came the transfer of economic power to a neo-colonial structure lodged in the US/tribal council relationship: 'development aid' from the US, an 'educational system' geared to training the cruder labor needs of industrialism, [and] employment contracts with mining and other resource extraction concerns… for now dependent Indian citizens."(LaDuke and Churchill 1985, 110)

The relationship between economic development and energy development was further extended in the 1960's with the development of large coalmines and power plants on Navajo lands. The federal government played numerous roles in support of connecting energy developers and the tribal government. One example that illustrates the diverse ways in which the federal government encouraged energy development with tribes was a stipulation in the contracts for cooling water for the Mohave Generating Station in Nevada that specified that the owners of Mohave could only use the Colorado River for cooling water as long as the power plant used "Indian Coal"[6] (also see Wiley and Gottlieb 1982, 41-53; and Wilkinson 1996, 1999 for more of the history of coal development in the Western Navajo Nation).

Recommendations for economic development in initial stages of the self-determination era focused not on how to build a diverse economy, but how to take control of energy development and ensure that the Navajo Nation received the best deal for their resources. In describing the role of policy in energy development on the Navajo Nation one author focuses on the capital-intensive nature of energy development. Whereas one recommendation might be to shift the focus to other development pathways, her recommendation was to take steps to ensure that the jobs that are created by energy development go toward tribal members. She recommended that provisions should be included in contracts for training and preference hire for tribal members with all energy development projects (Ruffing 1980, 56-7).

A major transition point in the history of energy development on Navajo lands involved the Chairman of the Navajo Nation, Peter McDonald, declaring that changes needed to take place before the Navajo Nation would support continued development of energy resources on their land in the 1970's. Two major points he stressed included making sure that energy development was being carried out for the benefit of the Navajo people and that the tribe should be given opportunities to participate in and control energy development (Robbins 1979, 116). The main critique of both these stances from dependency theory is that even with control over energy development, it is still a capital-intensive, highly technical, and tightly controlled industry (Owens 1979, 4). The Navajo Nation can participate in energy development, but not without creating distortions in the orientation of the economy and government.

In this same vein, it is difficult to argue that wind energy is inherently different that other forms of energy development from the dependency perspective. While it is possible for the Navajo Nation to take steps to ensure that the tribe will obtain the maximum benefit from wind development, such as ensuring that tribal members and Navajo owned businesses have preference in hiring, it is not likely that the tribe can become a self-sufficient wind developer without severely distorting the priorities of the economy and Navajo government. The alternative is to allow a specialized, large company from off the reservation to develop the wind farm, with the possibility that a Navajo partner can take part in the ownership of the wind farm. While the Navajo Nation may now have the institutional structure in place to control wind energy development on their land, wind development is still subject to the dependency critique.

III.4.2 Basic Needs

If dependency leads to distortions in the economy and the focus of the government, one portion of society that is commonly hurt the worst is the poor. The oil dependency metric is useful

[6] Southern California Edison, "SCE-2 - Description of Future Contractual Needs, the Consent Decree, the Plant, and Implementation Requirements" Before the Public Utilities Commission of the State of California, pg 7, May 17,2002

for evaluating if a regional economy has become too oil dependent by comparing other development indicators like poverty rates and the World Bank's human development index (HDI). In an Oxfam report on extractive sectors and the poor, Political Scientist Michael Ross found that increasing levels of oil dependence was correlated with lower HDI ratings across the 25 most oil dependent nations. The HDI is a composite metric that includes indicators for per capita income, education, and health. Two of the conclusions from the study were that oil dependence tends to reduce the rate of economic growth and that the economic growth that does occur offers few direct benefits to the poor. (Ross 2001, 16).

The concept of basic needs became important in the development literature in the 1970's. The importance of this era in critiques of development in general was that it pointed out that development extended far beyond the concept of increasing national economic growth. Dudley Seers in his essay, "The Meaning of Development" argues that growth in an economy that does not directly address issues of absolute poverty is not development (Seers 1969). Seers's essay leads ultimately to the question: Development for whom? Is economic growth for the middle and top echelons of the regional economy the same as reducing the poverty rate for the poor? Robert McNamara continues with the conclusion that if it is the rural poor that are a priority then a sound development strategy would directly address the population that are of concern rather than concentrating on the modern sector (McNamara 1973).

Similarly, if the priority of development on the Navajo Nation is addressing the high poverty and unemployment rates, then energy development is at best an indirect route to addressing those needs, and at worst a diversion from the issues that are a priority of the Navajo Nation. In assessing the impacts of the construction of a power plant in the western region of the Navajo reservation, the Navajo Generating Station near Page, AZ, researchers found that a primary selling point of the plant by the power plant developers was the jobs that were promised to accompany the development of the power plant. During the assessment, the researchers concluded that only 2.2% of the skilled workers lived within 80 miles of the plant (Levy 1980). Interviews with Navajo workers at the power plants found that the skilled workers tended be much younger, they came from all over the reservation, and most supported increased energy development. The unskilled workers were older, local Navajo that were more interested in issues surrounding grazing and community affairs than energy development (Henderson 1979). The assessment of the impacts of the power plant supported the conclusion of earlier research that rural industrial projects are not necessarily the solution to "the sagging economic fortunes of rural America" (Little and Lovejoy 1979, 43).

In the same way, wind projects may provide jobs for Navajo workers that are more mobile, skilled, and less tied to the particular community where the wind farm will be built. In my personal experience with a government official from the Cameron Chapter I found that there was very little interest in the potential for a large wind energy project. The priority of the chapter was in providing basic infrastructure to residents of the community such as water and electricity. While the revenue to the tribe may help pay for such improvements, a development policy, according to the basic needs critique, would be more effective if it focused on solutions that lead to development for those in question. Indirectly addressing issues of poverty by focusing on energy development is likely to be an ineffective approach. As Robert Wood pointed out in a critique of the World Bank's approach to basic needs, a top down approach to addressing the basic needs of rural communities is not necessarily the best solution. Instead poverty alleviation would be more successful with structural changes to provide access, assets, and information that the poor need to compete in market place (Wood 1986). Creating economic opportunity for the impoverished may be more effective than focusing efforts on energy development that may or may not eventually redirect funds from the top down.

Section II mentions that the leadership of the Navajo Nation turns toward energy development out of concern with the high levels of unemployment and the high poverty rates on the Navajo Nation. While this may be an important issue for the majority of Navajo, it is clear that there is not a consensus within the Navajo Nation that energy development is a possible solution.

III.4.3 Social Embeddedness of Economies

In most basic terms the third critique of energy development starts with the understanding that "the economy is intensely social and the social is intensely economic" (Curry 2003, 419). Karl Polyani initiated a strand of development literature by arguing that the economy is embedded within society using the idea of fictitious commodities to show the interconnected nature of society and markets.

Polanyi identifies two types of commodities, the genuine commodities, which are produced by humans for the purpose of exchange in markets and the fictitious commodities of land, labor and money. For centuries commodities have been bought and sold in markets while the use of land and labor have been regulated by social norms. Land is another word for nature and is therefore not a human made commodity while labor, is simply another word for employment of human beings. Polanyi argues that society is comprised of these fictitious commodities. The idea that they can be organized or self-regulated, via the price mechanism of supply and demand, is an attempt to disembed the fictitious commodities from society. Any attempt to disembed these commodities has disastrous consequences:

> To allow the market mechanism to be the sole director of the fate of human beings and their natural environment… would result in the demolition of society…. [Labor] cannot be shoved about, used indiscriminately, or even left unused without affecting also the human individual who happened to be the bearer of that particular commodity. In disposing of a man's labor power the system would incidentally, dispose of the physical, psychological, and moral entity 'man' attached to that tag. Robbed of the protective covering of cultural institutions, human beings would perish from the effects of social exposure; they would die as the victims of acute social dislocation through vice, perversion, crime, and starvation. Nature would be reduced to its elements, neighborhoods and landscapes defiled, rivers polluted…, the power to produce food and raw materials destroyed (Karl Polanyi quoted in Block 2001, 75-6).

Polanyi argues that there is a moral impediment to disembedding the economy from society. It is simply wrong to treat nature and human beings as objects whose value is determined entirely by the market. Subordinating the organization of nature and human beings to market forces violates principles that have governed societies for centuries: nature and human life have almost always been recognized as having a sacred dimension (Block 2001, xvii – xxxix).

In trying to understand the impacts of energy development on families that were directly impacted by energy development on the Navajo Nation, a group of anthropologists in the early 1980's applied enthoscience methods to unearth the social impacts of energy development. Instead of applying a cost benefit analysis approach whereby the economic value of the social costs were compared to the economic benefits of energy development, the researchers recognized that they must begin with a framework that allows for some costs to a way of life to not have a simple monetary value. Essentially they recognized that what determines the quality of life in not always based on the monetary value of resources. Instead, if energy development were to occur and cause impacts, certain mitigating steps would need to be in place to prevent severe deterioration in the way of life for families impacted by energy development. The researchers evaluated the impacts by first establishing the possible costs to the way of life. Then instead of looking at benefits to offset the costs, they evaluated possible mitigations to the costs that would be required before the impacted families could even begin to assess any benefits that would accompany energy development (Schoepfle *et al.* 1984, 887-8).

The most severe impacts of energy development were found to be forced relocations of families from land that was going to mined, reductions in the numbers of livestock, and denial of access to traditional lands (ibid). The researchers found that the loss of grazing permits was the most threatening outcome in the possible impacts of energy development. The permits were important due to the way the grazing permits were linked to many other dimensions such as lifestyle, kinship, housing, animals, and sacred places (ibid, 894). The authors of the study do not conclude that the adverse impacts of energy development on families necessarily precludes energy development, but their work in the context of Polanyi's theories of development help to understand why after 13,000 relocations of Navajo families in the past three decades on the Navajo Nation[7] many within the Navajo Nation oppose continuing energy development.

The idea of a socially embedded economy supports the claim by an advisor to the Navajo government on energy development in the 1970's, Lorraine Turner Ruffing, that Navajo economic development is subject to cultural constraints. Ruffing asserted that economic development would occur more rapidly on the Navajo reservation if the development strategy took into account differences in the social structure (Ruffing 1976, 612). Ruffing found that often Navajo allocated resources to traditional activities, which did not disrupt their way of life. Even when partaking in non-traditional activities like wage work, many preferred to remain in their local area even if it meant lower wages (ibid). One researcher went as far as to suggest that energy development would always be destined to lead to degradation in the quality of life for many Navajo due to the "disharmony" caused by extracting energy resources (Ellis 1988, 130).

Cornell and Kalt produced a significant body of research that shows that compatibility of institutions and culture matter to economic development (see Cornell and Kalt 1997,1998; Cornell and Gil-Swedberg 1995 for example). One of the critical issues in establishing a culturally appropriate development agenda for tribes is to determine: "What do we hope to preserve or protect? What are we willing to give up?" (Cornell and Kalt 1998, 206). The Executive Director of the Division of Natural Resources, Arvin Trujillo, indicated that there is an element of the Navajo Nation that has made it clear that they are not willing to accept the adverse impacts of energy development (Shirley and Trujillo 2003). The shut down of the Mohave Generating Station in 2005 reflects people within the Navajo Nation and Hopi Tribe mobilizing support for the tribal governments to refuse to allow pumping groundwater for the transport of coal.[8] Increasingly in the Navajo Nation, energy development is opposed on the grounds that it uses too much water. Water is a key element in Navajo maintaining their ability to raise livestock and maintain their way of life.

Where wind energy is drastically different than other forms of energy development is that developing wind projects does not produce the damaging effects that has made energy development devastating for many impacted people. Issues over forced displacements, loss of the ability to graze livestock, and consumption of valuable and spiritually important water resources do not accompany wind projects. As Bob Gough, an advocate of tribal wind projects, explains: "Some reservations have 60 to 80 percent unemployment… [With renewable energy] you are able to find an economy that does no harm to the environment and provide skilled jobs… and after 30 years you don't have

[7] Statistic from Shirley and Trujillo 2003

[8] Kraker, Daniel. 2006. "The End of an Era on the Colorado Plateau" *High Country News,* January 23.

holes in the ground like you do with mining." [9] While that may not be a startling conclusion, the framework of Karl Polyani helps to extend environmental impacts from an abstract concept to having a direct relationship with economic development and improving the quality of life. If people within the Navajo Nation decide that they can manage the other risks in energy development pointed out in the dependency and basic needs critique then wind energy offers a promising alternative to the extraction of energy resources.

III.5 Discussion of Wind Energy and Energy Development

The motivation for this section was to better understand the two perspectives on wind energy development outlined in Section III.1: one that assumes wind energy is fundamentally similar to other forms of energy development, and the other that looks to renewable energy as an answer to the past environmental destruction wrought on tribal lands by energy development.

The sample of theories of economic development helps to illustrate the strengths and weaknesses of each perspective. Wind energy can add to the economic base of tribal economies through exporting electricity off of the reservation and importing dollars through taxes, land lease, fees, operations and maintenance jobs, and possibly revenues earned by the tribe taking part in the ownership of the wind farm.

For tribes to export electricity, they must offer a comparative advantage over other areas. This advantage may involve a higher quality wind resource or access to markets, but it also can involve institutional factors that make wind projects on tribal lands more attractive to investors or power purchasers. Furthermore, diversifying tribal government revenues away from reliance on federal funds can enhance tribal self-determination.

In this respect, wind energy is similar to other forms of energy development. Tribes have turned to energy development in the past to increase the economic base and enhance tribal self-determination. Many tribes have put significant effort into creating a comparative advantage for development of their resources through participation in organizations like the Council of Energy Resource Tribes (CERT) and lobbying for incentives from the federal government such as the application of the Production Tax Credit – nominally a renewable energy incentive, to "Indian Coal" in the EPAct 2005 (Section 1301.d).

Wind energy is also quite similar to other forms of energy development when examined through the critiques of energy related to dependency and basic needs. The fact that wind energy involves a capital intensive, technologically advanced, and highly specialized industry means that it can draw productive efforts away from sectors that more directly involve activities that promote improved quality of life for the most impoverished.

The primary difference between wind energy and other forms of energy development is that it does not have the same adverse impacts to the land that has accompanied previous efforts at energy development. Wind does not remove significant portions of land from productive use and it does not require significant amounts of water. For the portion of the Navajo Nation that supports energy development as long as it allows them to continue a way of life that requires grazing land and water use, wind energy may be a preferred solution.

Given the strengths and weaknesses of wind energy development, it is obvious that it is a choice that the Navajo Nation must make for themselves – there is not a clear answer as to whether or not they should devote resources toward developing wind projects. Wind is not the answer to the problem of economic development on tribal lands, but it can offer benefits that will aid tribes in

[9] Bob Gough as quoted in Caley (2006)

their efforts. Cornell and Gil-Swedband (1995) indicate that the priorities of tribes should be in exercising self-determination and creating an environment that promotes the kind of development that the tribe wants to see. Jack Utter captures the challenge of economic development on Indian lands in the following quote:

> All who are concerned should also remember that tribal businesses and other economic development are not panaceas for the various problems facing Indian country. Native culture and the hundreds of Indian nations are not so simplistic as that. Better businesses and job opportunities, however, will go a long way toward improving economic self-determination, to which American Indians seem to be firmly dedicated (Utter 2001, 237).

Understanding that wind energy alone will not be the solution to the myriad issues on tribal lands, wind farms can contribute to economic development and support other economic development efforts within tribes. The next sections qualitatively and quantitatively evaluate the benefits that wind farms can bring to tribal economies.

IV. Economic Impacts of Wind Energy Projects

The impacts of wind farms on regional economies are examined in detail in the following section. Important questions from the previous discussion include:

- How do wind farms add to the economic base of a tribal economy?
- Do the tasks related to building and operating wind farms offer opportunities to build capacity within the tribe?
- What opportunities are available for wind farms to provide revenues to tribal governments?

Wind energy projects impact local economies. A number of reports and studies indicate utility-scale wind projects produce benefits for local economies through the creation of jobs, increased tax revenue, and land lease payments paid to the local landowners (NEA 2003; GAO 2000; Cox 2004; BBC 2000). While Kammen *et al.* (2004) argue that renewable energy projects can produce more jobs on a per unit of energy basis than coal and gas plants (Figure 6), they acknowledge that the majority of the jobs in the wind industry result from the manufacture of turbine components and the construction and installation of wind farms[10].

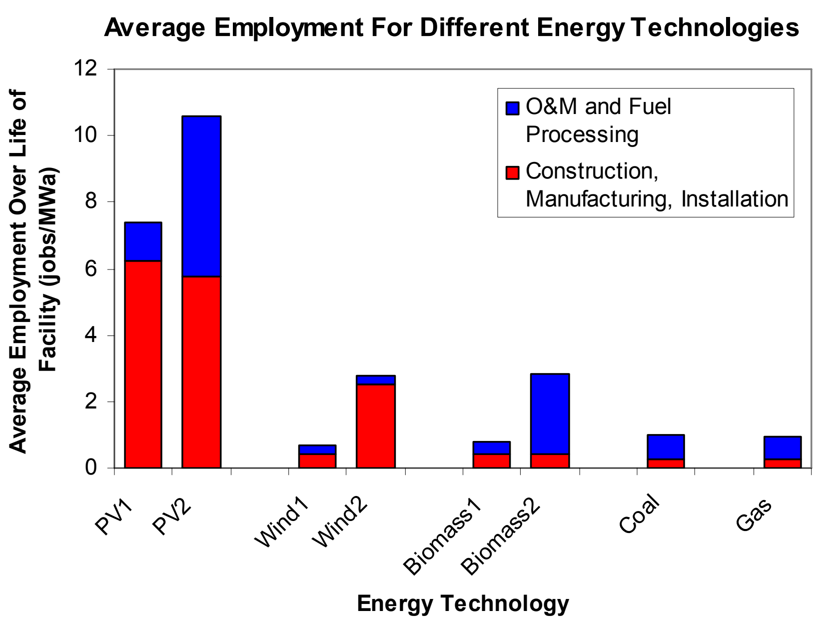

Figure 6 - Comparison of total employment impacts of different energy technologies by Kammen *et al.* 2004. A high and low estimate is given for each of the renewable technologies. Note that estimates of total employment do not distinguish between regional and national employment impacts. "MWa" refers to the average power that is produced by each type of facility. PV stands for photovoltaic installations.

A detailed analysis of labor inputs to various energy technologies from the Renewable Energy Policy Project indicates that about 66% of the 4.8 person-years per MW of wind capacity

[10] Also see Wood (2005) for a summary of studies that analyze jobs created by renewable versus fossil fuel power.

required for wind energy are in the manufacturing of components for the wind turbines. Only 32% of the total jobs are not related to the manufacture and transport of wind turbine components.[11]

Unless a manufacturing facility in the local economy makes components related to wind turbines, the local job creation is limited to servicing turbines, installing the wind farm, and developing the wind project. Therefore of the estimated 4.8 person-years required, 1.5 person years per MW are available for local laborers. Furthermore, the local benefits associated with wind farms differ substantially with local economic conditions. In particular, the total impact of a wind farm will depend on the amount of goods and services that can be purchased locally (NEA 2003; NWCC 2004a; GAO 2004). Performing a detailed assessment of the local economy is then a very important step in estimating the potential economic impacts of a wind project.

A methodology for local economic assessments is presented by the National Wind Coordinating Committee (NWCC 2004a) based on detailed case studies of local economic impacts of wind farms by Northwest Economic Associates (NEA 2003).

The tasks for performing the assessments include;

- *Identification of the Impact Phases:* Wind projects have two distinct phases, a short-term construction period and a long-term operations and maintenance period
- *Identification of Inputs:* Some materials and labor inputs can be obtained locally while the remainder is imported into the area
- *Identification of Sources of Inputs:* Who can provide the inputs for the wind farm in the local economy?
- *Interview Local Sources:* Interviews establish the capacity of local businesses to provide inputs and the linkages between firms in the local economy.
- *Estimate Total Effects*: The total impact of the wind farm, which is the sum of direct, indirect, and induced impacts, is then found using an Economic Input-Output model such as IMPLAN (NWCC 2004a).

The NWCC methodology was used to establish that a wind farm on the Navajo Nation has the potential to use materials from the Navajo Nation, provide jobs for Navajo laborers, and create business for Navajo owned firms. A detailed description of the methodology and results can be found in Appendix I. The remainder of this section will summarize the results and discuss the implications.

IV.1 Construction Phase

The duration of the construction period of wind farms typically ranges from six months to two years depending on the size of the wind farm, the complexity of the terrain, and interconnection with the existing grid. During this period, the most important source of benefits to the local economy is the salaries and wages paid to local workers. The Northwest Economic Associates' (NEA) case studies of economic impacts of wind farms on local economies concludes that changes in household income are the most important impacts in local economies because money spent in sectors other than households is more likely to leave the local economy (NEA 2003).

[11] I would like to acknowledge and thank Carla Din of the Apollo Alliance for brining this data to my attention (Private Communication, May 30, 2005). The manufacturing jobs include: Blades (26%), Towers (8%), Gearboxes (6%), Nacelles (5%), Monitoring Controls (5%), Turbine Assembly (4%), Brakes (4%), Generators (4%), Couplings (2%), and Rotor Hubs (2%). Transportation is 2% of total person hours. The remaining 32% of total jobs is from: Servicing (20%), Installation (11%), and Development (1%). All data are from Singh and Fehrs (2001).

While the construction period is short, it brings modest benefits to the local economy. The majority of money spent during the construction phase will quickly leave a rural economy because much of the equipment, such as the turbines, turbine blades, and tower, is manufactured in outside of the local economy. The benefits to the local economy are increased when local contractors and suppliers are used. Even though some wind farm construction tasks are highly specialized, local firms are often used as subcontractors due to proximity to the construction site, knowledge of the local regulations, and a working relationship with local skilled and unskilled laborers.

According to the results from the NEA case studies, highly skilled personnel from within the local area, when available, can participate in the equipment and installation phase, such as interconnecting the wind farm to the transmission grid and assisting with the erection of the wind turbines. Local workers and contractors, even in areas lacking a highly skilled labor pool, often do many of the balance of plant tasks, such as building roads to the site and excavating and preparing foundations. (NEA 2003) A study of the local economic impacts of a wind farm in rural Minnesota indicates that local contractors, crews, and suppliers were used during the construction period (DanMar 1996). A number of studies of impacts of wind farms on rural areas agree that the local economic benefits are greater in counties that have a large economic base and large population, because those wind farms are likely to have greater local participation (DanMar 1996; NEA 2003; GAO 2004; Costanti 2004).

IV.1.1 Construction Inputs, Sources, and Linkages

Interviews with Navajo businesses, persons familiar with developing wind farm projects, and information available in the literature were used to determine the important tasks required for constructing wind farms. The tasks include building roads, excavating foundations, pouring concrete foundations and laying foundation rebar, installing turbine towers, installing turbines, connecting the turbines to the electrical grid, and building an on-site utility shed. A general description of tasks is shown in Table 2.

Description of Construction Tasks

Wind Farm Task:	Description:
Site Preparation and Utility Shed	Building dirt roads, excavation of foundations, compaction of soil, construction of a field site for monitoring wind farm
Foundation Concrete and Rebar	Preparing field mix plant for concrete, laying foundation rebar and pouring concrete
Transformers, Collection System, and Substation	Installing transformers at each turbine, excavating and laying underground electrical cable between turbines, connecting to substation
Steel Erection and Engineering	Erecting tubular steel towers in multiple sections, installing turbine and blades using large crane, designing wind farm and electrical system
Operations and Maintenance	Long term monitoring of wind farm performance and performing routine maintenance

Table 2 - General description of tasks performed during construction and operation of wind farm

At this point, a wind farm has yet to be built in Arizona, let alone on the Navajo reservation. Hence, none of the Navajo firms interviewed had worked specifically on wind farm construction. This, however, does not mean that they are inexperienced in tasks commonly related to wind farm construction and operations.

Navajo companies established the skills for many of the tasks in Table 2 through performing tasks related to infrastructure construction, such as roads, bridges and pipelines, oil and gas operations in the San Juan Basin, and specialized tasks for the Navajo Agricultural Products Industries (NAPI) and Navajo utilities.

A contractor from Shiprock, NM, for instance constructed an industrial hydro pump for an irrigation project for NAPI. The Navajo Engineering and Construction Authority (NECA), a tribal enterprise, regularly installs water infrastructure in collaboration with the Indian Health Services. The large water towers found in several towns around Navajo require steel erection and crane operation skills that are similar to the erection of wind turbines.

The Navajo Tribal Utility Authority (NTUA) maintains a vast rural electric distribution network around the reservation. The engineers and technician within NTUA regularly work with high voltages, installing transformers and distribution lines up to 69 kV. Depending on the desires of the utility management and board, it is possible that NTUA could provide much of the capacity to construct and operate the wind farm.

In comparison to other rural areas where wind farms are built, tribal governments have the power to create preference laws that promote the use of tribal businesses and hiring of Indian employees. The Navajo Business Opportunity Act, for example, requires businesses operating within the Navajo Nation to provide Navajo-owned businesses the opportunity to bid on projects when requests for bids are issued.[12] In the case of wind farm on the Navajo reservation, the preference practices promote the use of capable Navajo firms in both general contracts and specialized sub-contracting. The Navajo Nation can increase the impact of building a wind farm by encouraging Navajo firms to be prepared to bid on available contracts. Regulations on the Navajo Nation require that all procurements for larger than $50,000 must be publicly advertised and open for bidding.[13] The Navajo Nation can increase the chances that Navajo businesses will benefit by ensuring that they have advanced notice that the project is being developed and to be prepared to offer a bid when a request for proposals is issued for the wind farm construction.

Similarly, Navajo Nation labor preference laws ensure qualified Navajo workers will have priority in hiring. The labor laws apply to all ranges of positions from unskilled, temporary jobs to management positions. While the labor laws will allow qualified Navajo workers to obtain many of the available positions, the laws do not specifically state that the Navajo employees need to be from the local communities where the project is located. Thus qualified workers from the Cameron area, near the wind farm location, will be in competition with workers from all over the Navajo Nation or even tribal members that reside in towns outside the Navajo Nation borders.

[12] Navajo Business Opportunity Act, Title 5, Chapter 2 at: http://www.navajobusiness.com/doingBusiness/
[13] Navajo Nation Procurement Process, Division of Economic Development, Business Regulatory Department. Available at: http://www.navajobusiness.com/pdf/DngBus/BusRegultry/CertifcnForms/Proc-Process.pdf

Figure 7 - Crane and water tower in the town of Chinle, AZ on the Navajo reservation. Erecting a water tower requires skills similar to erecting steel towers for turbines.

Beyond the question of the capacity of Navajo firms is the issue of linkages within the Navajo economy. Often in rural areas, very little of the supplies are available within the local economy, reducing the beneficial impact of the wind farm construction. The situation on the Navajo reservation is similar, with two important distinctions. First, large concrete mixing plants are commonly built at construction sites within the reservation, making a Navajo concrete supplier viable. Tuba City, just north of the town of Cameron, AZ is home to a concrete supplier with over thirty years of experience in large concrete jobs. The supplier imports cement from cities south of the reservation, but the concrete aggregate materials are available from Navajo suppliers. Second, NECA and a few of the larger Navajo construction firms own a portion of the construction equipment. Large specialized equipment, such as the crane will need to be rented from off-reservation. Similarly, materials such as foundation rebar, the turbines, electrical equipment, and steel towers will need to be imported.

In general, Navajo laborers will not be in short supply to perform routine tasks such as excavation, road building and foundations. One contractor estimated that as many as one hundred Navajo workers are easily available in the area of Tuba City alone. Tasks that are more specific to wind farms will most likely require on-the-job training by an experienced worker. For instance a regular ironworker would be able to train Navajo workers to erect the steel towers. Skilled Navajo electricians are also available as sub-contractors, but in general are in much shorter supply than un-skilled workers. Again though, NTUA has many skilled electricians in-house that would be able to assist with the wind farm construction.

Previous experience with the construction of wind farms in rural areas indicates that the services a local community provides to non-local laborers during the construction period can also provide an important boost to local economies (Cox 2004; DanMar 1996; NEA 2003). Providing services such as food and lodging during the construction period may provide a boost to the economy of Cameron, AZ. The Cameron Chapter has a population around 1,200 people and the town includes a large trading post with a hotel and restaurant, and a number of gas stations. Not all of these businesses are Navajo owned, most notably the hotel and trading post[14], but they do employ a large number of local residents. Tuba City, only about 30 miles north of Cameron, can provide many services that are not available in Cameron such as the a hardware store.

From the point of view of total economic impacts, there are two competing pressures in regards to housing workers for the construction projects. Hotel and food service revenue, and the Navajo tax revenue associated with these services, increase if the workers stay in local hotel rooms. However, that will also increase the costs of the project. Local workers bring a cost advantage because they will not require housing, but that reduces the economic impact to the hotels. Furthermore, Navajo business owners indicated that often if the Navajo workers do not have local housing available, a temporary camp is set up during the construction period rather than pay the costs of hotel rooms. Clearly, the exact impact of the construction of the wind farm is uncertain before the building process actually begins.

A general estimate of the construction period job impacts can be made by simply scaling other studies to an 80 MW wind farm. This method yields an "order of magnitude" estimate, Table 3[15], but ignores many of the differences of the particular local economy that are captured in the economic input-output modeling for a particular region.

General Estimate of Construction Jobs Scaled to 80 MW Wind Farm

Source:	Wind Farm:	Size (MW):	Number of Construction Jobs:	Person-years/MWp:	Estimated Jobs for 80 MW Wind Farm:	Notes:
Cox 2004	"Typical Wind Farm"	100	210	2.1	168	Direct and Indirect job impacts, Full Time Equivalent jobs at 2000hr/yr
DanMar 1996	Kenetech Project	25	42.4	1.7	135.5	Detailed Estimates from Interviews
Sargent and Lundy 2006	Gray Mountain, Projection	450	700	1.6	124.4	Projection based on REDYN Economic I-O Model (Pp. 9.15 - 9.23)
GAO 2004	Solano High Winds	162	250	1.5	123.5	General Estimates from Interviews

Table 3 - General estimate of construction jobs for 80 MW wind farm. Construction job estimates for specific projects are scaled to 80 MW and are shown as full time equivalent positions for one year.

Based on the estimates in Table 3, an 80 MW wind farm will require 120-170 full time equivalent jobs during the construction period. A more detailed estimate of the job impacts specific to the Navajo Nation leads to a prediction that around 100 jobs will be created in the Navajo economy using NREL's Jobs and Economic Development Impacts model (JEDI). The analysis is presented in Appendix I, Section 8.

---

[14] The trading post has been mired in controversy in the past because it is located on fee land, instead of trust land, that was purchased by the original trading post owners before the Navajo Nation boundaries were extended to surround the land owned by the trading post. The trading post was subjected to the Navajo Hotel Occupancy Tax, but it has been ruled in the Supreme Court (Atkinson Trading Post, Inc. *v.* Joe Shirely Jr.) that the trading post is not subject to the tax because it is on fee lands. See Melmer, David. 2001. "High Court Attacks Sovereignty." *Indian Country Today* June 13. Available at: http://www.indiancountry.com/content.cfm?id=363

[15] Note that the number presented in Table 3 are a mix of direct construction jobs and total jobs created during the construction period. The latter distinction includes the direct, indirect, and in some cases induced effects of building a wind farm. Again, the purpose of this table is not to obtain an exact estimate of the number of jobs, just to obtain a rough approximation.

IV.1.2 Quality of Construction Jobs

In addition to the quantity of jobs it is worthwhile to assess the quality of the construction jobs created by the wind farm. The first major issue is that the construction period is short, meaning that a large number of workers will be employed, but then either quickly out of work again or will turn to other jobs. The seasonal and project-based nature of construction work leads to low average income. Furthermore, a number of Navajo companies tend to hire construction workers for specific projects rather than as full time employees. The high rate of unemployment on the Navajo reservation will not necessarily be improved by creating short-term construction jobs.

Furthermore, construction jobs are not the best paying jobs in the Navajo economy. In 2001 Navajo construction workers earned an average income (salary and benefits) of $20,500. The Construction sector, which employs 3% of the Navajo work force, earned the second lowest average income. The lowest average income was $13,100 earned in the Retail sector, while workers in the Service sector averaged $32,100.[16] According to the analysis presented in Appendix III, an additional construction job leads indirectly leads only to 0.26 additional jobs in the Navajo economy, whereas an additional service job would create roughly 0.4 additional jobs.

The limited construction period and the relatively low pay for construction jobs indicates that the expected impact of the construction period will be modest, which is a similar conclusion reached in many of the previous studies on the impacts of wind farm construction (GAO 2004; NEA 2003). Nonetheless, it can be inferred from this discussion and the results in Appendix I that a substantial portion of the available construction jobs can be filled by Navajo laborers and that the construction period for a wind farm will provide benefits to the Navajo economy. The jobs that are created are important to economic development due to the multiplier effect within the Navajo economy and the skills that are gained from working on a wind project.

IV.2 Operations Phase

The operations phase of the wind farm produces different impacts on the local economy than the construction phase. The difference is partially due to the duration of the operations phase, which is expected to last twenty to twenty-five years in comparison to the short construction period. The operations phase is also different because of the source of impacts. In addition to the jobs required to operate and maintain a wind farm, land lease payments are generally made to the local landowner, the local government collects property taxes, and general supplies are purchased in the local economy.

The NEA case studies of the impacts of wind farms on local economies suggested that the operations phase produced benefits to the local economy, but the impacts were lessened due to poor linkages between the wind farm and sectors in the local economy. The local economies in the case studies were based on natural resources and poorly diversified. The important impact of the wind farm on the local economy was through increases in household income. The increase in household income was due to employment with the wind farm, land lease payments to local landowners, and changes in taxes (NEA 2003; NWCC 2004b).

One detailed study of the impacts of a wind farm on a rural economy estimated that about half of the total expenditure during the O&M phase remained in the local economy. A major source of the money that remains in the economy is the wages paid to the O&M staff as illustrated in Figure 8. The comparison of total O&M expenditures and the portion of those expenditures that "filter in to the local economy" shows the importance of wages and salaries paid to O&M staff.

[16] Data obtained from Choudhary (2003, 84; Table 19). See Appendix III for a more detailed discussion.

While the labor costs are only about half of the total O&M costs, they make up almost 90% of the O&M expenditure that filters in to the local economy (DanMar 1996, 18).

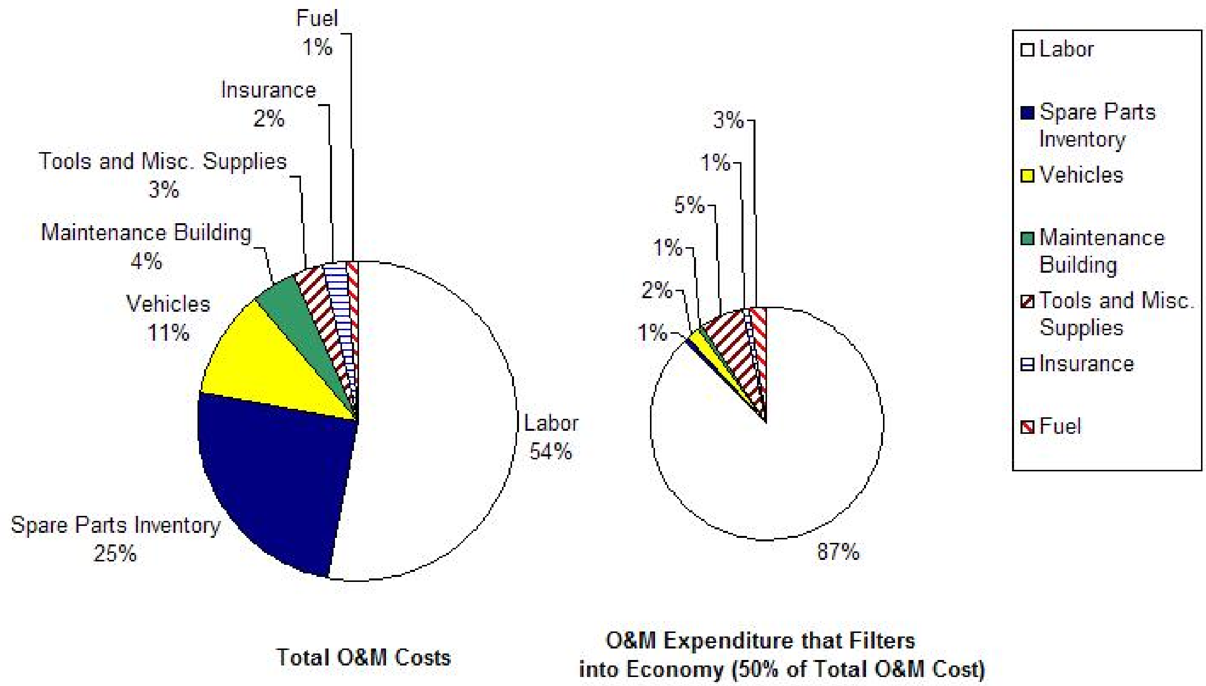

Figure 8 - Comparison of total O&M costs to the expenditure that remains in the local economy for a 25 MW wind farm in Minnesota. The chart on the left shows how much of the total O&M cost is attirbuted to each category of expenses. The chart on the right is an estimate of how much of the O&M cost that filters into the local economy is attributed to each sector. Only 50% of the total O&M cost is spent in the local economy. Adapted from DanMar (1996, Table 3-4, pp. 18).

IV.2.1 Operations Inputs, Sources, and Linkages

The operation of a wind farm primarily consists of monitoring the wind farm and routine maintenance such as changing the oil in rotating machinery, cleaning blades, maintaining electrical equipment, and routine machine shop work. According to a study of the potential benefits of wind energy in New Mexico, having a good machine shop near the wind farm is "essential to manufacturing replacement parts and keeping the turbines operational." (BBC 2000, IV-8)

Technicians are often selected from the outstanding laborers in the construction crews. The technicians are trained for the positions by the wind farm operator once the construction period is completed. Management or supervisory positions are typically filled with non-local specialized personnel (BBC 2000, IV-8).

The impact on the Navajo economy has the potential to be increased if NTUA provides the operations and maintenance services (O&M) for the wind farm. NTUA is experienced in providing the O&M services for the local electrical distribution grid, water services, and gas distribution. As part of these services, NTUA maintains a monitoring system called the SCADA or Supervisory Control and Data Acquisition system for monitoring the performance of the distribution grid.

Maintaining and monitoring a wind farm will require similar skills. Technicians may still require specialized training, but turbine manufactures routinely train local workers for such positions.

In addition, a number of Navajo businesses indicated that they could provide welding and metal working services for maintaining the wind farm.

The number of positions required for operating a wind farm varies with the size of the project and the date at which the project came online as shown in Table 4. This table illustrates that there is a broad range of estimates for the number of O&M positions. The two earliest projects have the highest estimate for total number of O&M positions while more recent wind farms and estimates are significantly lower.

Arough estimate for the number of O&M positions based on the data in Table 4 is that 4-10 O&M positions will be required for an 80 MW wind farm. In a similar manner to the Construction Impacts section, a detailed estimate of the total O&M job impacts was made using JEDI. The JEDI analysis, in Appendix I, Section 8, leads to a prediction of 21 direct jobs created by the O&M phase, with an additional 14 to 23 jobs created indirectly. Comparison of the JEDI estimates to Table 4 indicates that the JEDI model may be over predicting the economic impacts of the wind farm during the O&M phase.

General Estimate of Direct O&M Jobs Scaled to 80 MW Wind Farm

Source:	Wind Farm:	Size (MW):	Number of O&M Jobs:	Jobs/MWp:	Estimated Jobs for 80 MW Wind Farm:	Notes:
GAO 2004	Altamont	268.7	53.7	0.20	16.0	Online 1983-90
DanMar 1996	Kenetech Project	25	5	0.20	16.0	Online 1994
GAO 2004	Storm Lake	194.25	23	0.12	9.5	Online 1999
Cox 2004	Colorado Green	162	15 - 20	0.09 - 0.12	7.4 - 9.8	Online 2003
GAO 2004	Ponnequin	31.65	2.33	0.07	5.9	Online 1998-2001
GAO 2004	Solano High Winds	162	7	0.04	3.5	Online 2003
Interviews	Rosebud Sioux, Projection	30	4	0.13	10.7	Projection, Schedlued for Construction in 2006
Kammen *et al.* 2004	-	-	-	0.10	8.0	Literature Review
Sargent and Lundy 2006	Gray Mountain, Projection	450	21	0.05	3.7	Projection based on REDYN Economic I-O Model (Pp. 9.15 - 9.23)

Table 4 - Estimate of O&M jobs created for 80 MW wind farm. Estimate is made by scaling the number of jobs at existing wind farms or planned wind farms to 80 MW.

IV 2.2 Quality of O&M Jobs

The O&M jobs are full time positions that will last for the life of the wind farm. Assuming that the Transportation/ Communication/ Utilities (TCPU) sector can be used as a proxy for the wind farm O&M jobs, Appendix III shows that the O&M jobs will have an important impact on the Navajo economy. Jobs in the TCPU sector had an average income (salary and benefits) of $69,200.

The TCPU sector was the second highest paying sector behind the Mining sector, which has an average income of $77,000. For every job created in the TCPU sector, roughly 0.86 additional jobs are created in the Navajo economy. It is not certain that the O&M positions created by the wind farm will have exactly the same pay and benefits as the average for the TCPU sector, but the O&M positions are generally understood to be high paying positions.

While the number of jobs that an 80 MW wind farm will create is low, these jobs are very important in the local economy due to the high income and long duration of the jobs. Tribal planners for a 30 MW wind farm on Rosebud land in South Dakota included requirements for tribal members to be hired and trained for the O&M positions that will be created by the wind farm. The labor laws on the Navajo Nation will insure that qualified Navajo workers will have priority for positions, but the Navajo Nation may also want to stipulate in contracts that Navajo workers are trained for all of the O&M positions.

While the Navajo labor laws will help secure O&M jobs, they do not stipulate that the workers must come from the local chapter. It is important that the residents of Cameron are fully aware that while the wind farm will bring jobs to the Navajo economy, residents from Cameron may have to compete for the jobs with other Navajo workers.

IV.2.3 Land Lease Payments and Taxes

Land Lease Payments:

Aside from the operation jobs directly created by wind farms, land lease payments and taxes are two additional impacts of wind farms. Wind farm owners typically lease land for the turbines and the right of way for roads and supporting infrastructure rather than buying it. Land lease payments have a significant effect on local economies due to the increase in household income if payments are made to local land-owners. According to NEA, land lease payments were a significant source of household income for the landowners with turbines (NEA 2003, ES-5). Increases in household income reverberate through the economy when households spend the additional income within the local economy. Land lease payments generally range from $2,500 -$4,000/MWp/year (Flowers 2005; Costanti 2004). Lease payments are negotiated with the wind farm developer and can take the form of annual payments or upfront lump payments. In general, sites with better wind resources near transmission lines that provide access to markets for wind energy are able to negotiate for better lease payments. However, a lack of information on the part of the landowner puts them in a worse bargaining position (GAO 2004). W*industry*, a non-profit group that supports community wind projects, indicates that landowners working together and sharing information can help achieve the greatest benefits for the local landowners (Windustry 2005)

Wind farms on Native American lands are different in that the person living on the land may not own it. The federal government holds most reservation land in trust for Native American tribes. On the Navajo Nation, for instance, the Navajo Nation holds all land in common for the Navajo tribe according to stipulations in the 1868 Navajo Peace Treaty with the federal Government (Thal 1981, 49). In a sense, the members of a tribe become the tenants of the land and the tribal government is the landlord with a certain level of oversight by the federal government. So rather than a private land owner signing land lease agreements with a wind farm owner, a wind farm on Native American land will most likely sign agreements with the tribal government for access to the land.

For the Navajo Nation, the details involved with surface property rights add additional layers of complexity to development of wind farms. On Navajo Nation trust land, tension exists between customary users of land, grazing permit holders, and the central tribal government. I will explain the tension briefly to illustrate the texture of the situation, but the interested reader should consult more thorough treatments of the subject (for instance Dietz 1998, Forthcoming; Gilbreath 1973; Iverson 1981; Iverson and Roessel 2002; Thal 1981).

Traditional, customary users of Navajo land tend to use the land for grazing livestock such as sheep and cattle. For a significant time, no firm property rights were established for where a family could graze their livestock. In the 1930's as the Navajo population grew and stresses to the land increased, federal officials became concerned about the potential for overgrazing. In response the Bureau of Indian Affairs implemented a program to limit the number of livestock that would be supported by Navajo land. This program became known as the Stock Reduction Program because the BIA program called for not only limiting the number of livestock but going a step further in reducing the size of herds. Navajo herders were assigned grazing permits that allowed a limited number of sheep to graze on an ill-defined[17] plot of land.

The grazing permits are negotiable and can therefore be traded between members of the Navajo Nation. However, an outsider such as a bank that wishes to foreclose on a loan cannot take ownership of trust land (Thal 1981, 30; "Dineh Bikeyah" 1989, 7). The fact that nearly all of the available land was permitted for grazing and that the terms of the grazing permits are indefinite, means that the permits have come to symbolize a form of private property to the grazing permit holders.

The tension between the common property conception of the tribal government and the private property conception of the grazing permit holders is brought to view when the interests of the tribal government differ from the interests of the grazing permit holder. In particular, tension exists when the tribal government supports economic development activities, such as mining, commercial agriculture, rights-of-way for power lines or pipelines, and quite possibly a wind farm, that disrupt the grazing permit holders on the land of interest (Thal 1981, 30-58).

While the Navajo tribal government has the power of eminent domain and can condemn land for economic development purposes, it chooses not to do so. Instead, the tribal government goes through a process of land withdrawal that involves negotiating consent from grazing permit holders. The negotiation process is voluntary for both the permit holders and the tribal government. In the negotiation process, the grazing permit holder will either freely consent for land withdrawals (typically when the project is for a local economic development initiative supported by the community members and the local chapter) or the permit holders will negotiate for compensation (ibid., 68-92). The process of acquiring consent for land withdrawal is seen as buying out the permit holder (ibid., 73), or paying to obtain consent from permit holders ("Dineh Bikeyah" 1989, 10). The withdrawal process involves getting the permit holder to sign away rights to the land that is withdrawn either indefinitely or for a specified period.

The land withdrawal is one of the steps that the tribal government goes through in issuing a business site lease. When a company or business wants to build a store or factory, they must apply to the Navajo Tribal government for a business site lease. Businesses site leases last for 25 or 99 years. To apply for a business site lease, the applicant must first obtain the permission of the grazing permit holder, which may consist of a family not just a single person, to withdraw the land from their grazing permit for the business site lease. At this point the Navajo government will negotiate with the grazing permit holder for compensation that will be paid by the business site lease applicant. Once consent is obtained, the local chapter must pass a resolution approving the application. The decision making process in local chapters may not be as fast as an outside applicant would be normally used to. Chapters need time and access to information in order to participate as equals in the decision making process (Levy 1980, 15). In a sense the chapter should not be thought

[17] Ill-defined in that no detailed surveys were carried out to identify the extent of a grazing permit area. Instead, as Thal shows, grazing regions were identified in rudimentary ways such as a circled area on a topographical map (Thal 1981, 26)

of as an entity that needs to be convinced of the merits of a proposal, but rather a decision making body that benefits from objective data.

Once a chapter approves the business site lease the application is sent to the central Tribal government for numerous other approvals including the signature of the President of the Navajo Nation and the Bureau of Indian Affairs ("Dineh Bikeyah", 9-11).

In some cases, the grazing permit holder will have land appraised to determine the fair market value of the land that the permit holder should ask for as compensation (Thal 1981, 88). Fair market value is typically assessed based on the number of sheep units that the land can support. The arid climate leads to a relatively low value for land. For instance, in compensating permit holders for developments such as railroad lines and an airport the developers paid about $135-175/acre ($2006) (ibid., 126-32). A wind farm of 1.5 MW wind turbines generally requires about 130 acres per MW of installed capacity. Therefore, if all of the land is withdrawn for the wind farm, the total fair market value of the grazing permits for the farm (10,400 acres for an 80 MW wind farm) is expected to be approximately $18-23,000/MW ($1.4-1.8 million for the whole 80 MW wind farm). If on the other hand only the land required for turbine foundations, support equipment, and roads were to be withdrawn for the wind farm (about 2% of the land area or 210 acres), the total fair market value would be only $350-450/MW ($70-91,000 for an 80 MW wind farm).

The use of a fair market value based on the alternative uses of the land and an up-front lump sum to obtain access to the land contrasts with the common way that private landowners off trust land engage with wind farm developers. For instance, guidelines for wind farm compensation published by *Windustry* indicate that even when farmers have to pull productive cropland out of production for a wind farm the market value of the lost income amounts to little more than $100 per turbine per year (Windustry 2005). The fair market value for their loss of income however is not the value that the farmers use to negotiate land lease payments from wind developers. Instead farmers base their decisions on the rates paid to other farmers, which tends to be closer to the $2,500-4,000/MW-yr estimate reported at the beginning of this section.

Furthermore, the *Windustry* report indicates that an upfront payment, in contrast to an annual payment, is the least desirable compensation package. A lump sum payment means that the local landowner has no stake in the long-term success of the wind project, which can potentially lead to an adversarial relationship with the wind farm owners. Moreover the benefits of a lump sum payment disappear rather quickly while the wind farm remains for 20 or more years (ibid.).

If a lump sum payment is made to the local permit holder to withdrawal the land, and the payment is based on the fair market value of grazing permits, then the Navajo tribal government can negotiate for the remaining value in the land lease payment with the wind farm owner. The payment to the tribal government will likely be the difference between the typical land lease payments for wind farms and the compensation paid to the grazing permit holders. This allocation however excludes the local chapter from directly benefiting from the wind farm. The lack of incentive to the chapter may cause delay in obtaining a chapter resolution in support of the wind farm.

Although the challenges with building a wind farm on trust land are not insurmountable, the description of the process for gaining access to the land indicates why developers and tribal officials are also looking at sites on tribal fee lands away from the reservation. These lands are not permitted in the same manner and do not require the land withdrawal process. If a wind farm is going to be built on trust land, it will be very important from the investor's point of view to have any ambiguities or questions about access to land clarified before the project will move forward. On the Navajo Nation, the process of clarification presents challenges and may take time, but it is not impossible.

In summary, land lease payments have an important impact on local landowners. A wind farm on Navajo land will be different in that the wind farm will be constructed on trust land held in common by the Navajo government, but treated similarly to private property by the grazing permit holder. Instead of negotiating a land lease fee with the grazing permit holder, the land will most likely be withdrawn by the Navajo government and the grazing permit holder will receive a lump-sum payment based on the fair market value of the land for grazing. The difference in value between the compensation to withdraw the land and the fair market value for land lease payments will most likely be paid to the Navajo government.

Taxes:

In addition to income taxes that a business pays to the federal and state government, counties often levy property taxes based on the value of businesses and property improvements within their jurisdiction. Wind farms are subject to these taxes in most areas. The impact that a wind farm has on the tax base depends on the size of the wind farm and the size of the county (GAO 2004; NEA 2003). Taxes paid by wind farms can have an important effect in rural economies by either reducing the tax burden for households or increasing spending on government services.

Tribal governments also have the power to tax businesses that operate on tribal land. In this sense, building a wind farm with tribal governments is fundamentally different than partnering with a private landowner to build a wind farm on their land. The tribe is not just a commercial partner; it is a sovereign authority with the power to tax (Hanula 1987, 7).

An important case in which the Supreme Court affirmed Indian power to tax was *Merrion v. Jicarilla Apache Tribe (1982)* in which they specified the Indian power to tax as follows:

> The power to tax is an essential attribute of Indian sovereignty because it is a necessary instrument of self-government and territorial management. This power enables a tribal government to raise revenue for its essential services. The power does not derive solely from the Indian tribe's power to exclude non-Indians from tribal lands. Instead, it derives from the tribe's general authority, as sovereign, to control economic activity within its jurisdiction, and to defray the cost of providing governmental services by requiring contributions from persons or enterprises engaged in economic activities within that jurisdiction (Echohawk 2004, 650; citing 455 U.S. 130 (1982)).

The Navajo Nation waded through seven years of litigation, eventually reaching the Supreme Court, to confirm its right to impose taxes on energy companies operating within the Navajo land. The Navajo Nation instituted two important taxes in the late 1970's - the Possessory Interest Tax and the Business Activity Tax. The energy company Kerr-McGee immediately challenged the ability of the Navajo Nation to unilaterally impose these taxes on its business operations. The Supreme Court upheld the right of the Navajo Nation in *Kerr-McGee v. Navajo Nation (1985)* (Hanula 1987, 6).

The taxes were imposed to correct for situations in which the states could collect more tax revenue from energy activities on Navajo land than the Navajo Nation it self was receiving. A classic example was the State of Arizona receiving more than the Navajo Nation from a coal power plant on the Navajo land. Before the Navajo Nation established its taxes the State of Arizona collected more than four times as much in taxes on the Navajo Generating Station than the Navajo Nation received in coal royalties, land rents, and rights-of-way combined (Owens 1979, 8).

The Possessory Interest Tax (PIT) is levied on rights given to companies to perform certain activities on Navajo land such as coal mining, oil extraction, and businesses site leases. The Business Activity Tax (BAT) is levied on wealth created within the Navajo Nation, which includes the production of electricity (Choudhary 2003, 5; Hanula 1987, 7). The BAT allows for deductions based on wages and salaries for Navajo employees and for expenditures on Navajo goods. The exemptions encourage businesses to use Navajo labor and goods, which in turn supports the Navajo economy (Owens 1979, 7).

These taxes can be levied on a wind farm on the Navajo lands. The Navajo Tax Commission will determine the actual value of the taxes that a wind farm will be responsible for paying. The impact of these taxes on the viability of a wind farm is discussed in later sections. But it is clear that the Navajo Nation has the potential to increase tax revenues by allowing a wind farm to be built on their land.

IV.3 Discussion of Impacts

The local impacts of a wind farm are expected to be modest, yet not insignificant. The number of temporary construction jobs for an 80 MW wind farm is expected to be 100 full time equivalents. The O&M jobs will be in the range of 4-10 jobs. While renewable energy may create more jobs than fossil fuel, the fact that approximately 66% of the total number of jobs created by wind power involve manufacturing outside of the local economy reduces the local benefits.

A wind farm can add to the economic base of the Navajo economy through taxes on the wind farm project, a land lease fee, and through local spending of O&M costs. It is very important that residents from within the Navajo economy fill the jobs that are created by the wind farm. Ensuring that tribal members obtain jobs is particularly important for O&M jobs, which have the most important impact on the local economy.

The construction impacts may be short term and will not add significantly to the economic base, but they will help build capacity with Navajo workers and Navajo businesses that participate in building the wind farm. The skills that are learned in building a wind farm may be applied to other wind projects on or near the Navajo Nation or to projects that require tasks similar to building wind farms.

Finally, the revenues that the tribal government earns through taxes and the land lease fees can be used to support projects that are more closely tied to the economic development goals of Navajo government. However, recalling the critiques of this energy development model, it should be remembered that the effectiveness of turning these revenues into economic development will greatly depend on the tribe's institutional capacity to foster economic development. Simply generating revenue for the tribal government is not enough to ensure economic development.

The next section will investigate the ways in which the revenues to the tribal government or to a tribal business can be increased through taking part in the ownership of the wind farm.

V. Increasing Benefits of Wind Energy through Tribal Ownership

A number of the studies on the economic impact of wind farms on rural economies indicate the economy significantly benefits if instead of a land lease payment, the landowners participate in the ownership of the wind farm. Essentially, if the wind farm has local ownership then a greater portion of the revenues from the sale of electricity that would have otherwise vanished out of the economy to an outside owner are recycled in the local economy (GAO 2004; Welsh 2005).

For wind farms in Indian Country, the possibility of local ownership raises interesting questions. The high capital cost of wind farms leads to a central role for financing in determining the feasibility of wind farms. The lack of private ownership and non-transferability of title to land means that a tribal member would have a difficult time securing a loan for a wind farm on land of which a bank cannot take ownership. The tribal government and tribal corporations on the other hand have various other possibilities for raising capital or assuaging the concerns of potential lenders. Therefore, when looking at ownership options for wind farms in Indian Country, it will be assumed that the tribal government or tribal entities are the only participants from the tribe.

Still unresolved is then the role the tribe can play in owning a wind farm. How will the role of the tribe impact the benefits of the wind farm to the tribal economy? Furthermore, how do federal incentives for renewable energy constrain or promote different roles for the tribe? Overall, however, the most important question is: Are wind projects on Native American lands economically viable?

To begin answering these questions, four different scenarios will be evaluated, all of which will be based on projections for the 80 MW wind farm at Gray Mountain on the Navajo Nation. The purpose of this analysis is not to identify the exact cost of the wind farm, instead it is a comparative analysis in which similar assumptions are made for various scenarios to highlight the effect of specific changes on the relative feasibility of a wind project. In this case scenarios involving a wind farm on the Navajo Nation are compared to a Benchmark model. The Benchmark model uses the exact same assumptions for wind resource, capital cost, and financial requirements, except that the wind farm is not on tribal land. The scenarios are as follows:

- *Commercial wind farm on private land in Coconino County outside of the Navajo reservation (Benchmark):* The commercial wind farm off of the reservation will provide a benchmark for assessing the financial viability of a wind farm on tribal land. If the Navajo wind farm is much less financially attractive than one built off of the reservation then the potential for building a successful project is severely reduced.
- *Commercial wind farm on Navajo trust land with the tribe as a simple landowner (Commercial):* The simplest role for the tribe is to lease the windy lands to an outside developer. The tribe collects taxes and a land lease fee, but does not have an ownership stake in the wind farm.
- *Joint Venture wind farm between outside company and tribal entity (Joint Venture):* In a joint venture, a tribal entity partners with an outside company. For reasons that are explored in further detail below, the federal Production Tax Credit (PTC) leads to a partnership in which the tribal partner does not own the wind farm in the first ten years, instead the tribal partner collects a management fee. After ten years, the ownership "flips" to the tribal partner who then owns anywhere from 100% to 1% of the wind farm.
- *Tribal owned wind farm (Tribal-owned):* In the last scenario, the tribe is the full owner of the wind farm. Three sub-scenarios are investigated in which 1) the tribe raises

capital for the wind farm though traditional debt and equity means, 2) the tribe issues tax-exempt bonds to raise capital, or 3) the tribe issues Clean Renewable Energy Bonds (CREBs) that were authorized in the Energy Policy Act 2005 to finance the wind farm.

The comparative analysis approach to modeling alternative finance structures is more completely described by Wiser and Khan (1996) and Bolinger *et al.* (2001, 2004, 2005).

V.1 Model Description

For the purpose of this discussion, there are three main perspectives from which a wind farm will be assessed: the power purchaser, the financers – in terms of both debt and equity, and the tribe.

From the perspective of the power purchaser it is important to determine the cost of electricity from the wind farm. The cost of electricity in terms of the cost per MWh will be assessed relative to the Benchmark wind farm. Wind farms are typically financed through a combination of debt and equity financing. Equity is the upfront cash paid by the owner of the wind farm. The return on equity is through the profits earned over the life of the wind farm. Debt, on the other hand, is provided through a loan from a lending institution or through issuing bonds. Debt lenders set an interest rate and expect to be repaid the full value of the loan plus interest. If the wind farm does worse or better than expected, the debt payments do not change. If priority for paying back initial investments in the wind farm were to be arranged in a hierarchal manner, debt lenders would have the first priority and equity would have the lowest priority.

Debt lenders will ensure their investment is safe by requiring a buffer between the revenues that the wind farm is expected to generate in any period to the minimum debt payment in that same period. A wind farm is considered to have failed financially if in any period the wind farm owners are not able to make the minimum debt payment, thereby defaulting on the loan. Again, the risk of default for the wind farm will be assessed relative to the Benchmark wind farm. Equity investors, in contrast to debt lenders, understand that there is significant risk that a wind farm will not perform as well as expected, but they are willing to take the risk in most cases if the expected return on investment is sufficiently high. The return on investment from the Benchmark wind farm will be used to compare the attractiveness of the other wind farm scenarios.

Finally, from the tribe's perspective, a wind farm off tribal lands will most likely produce no benefits to the tribe. Therefore, it will be sufficient to look at the benefits to the tribe for the three scenarios that include a role for the tribe. In addition to benefits, some scenarios involve the tribe taking a financial stake in the wind farm. To account for this the financial risks to the tribe will also be assessed.

These three perspectives can all be examined in a financial model of a wind farm. While it is not possible to accurately predict the cost and viability of the proposed 80 MW wind farm due to the simplicity and lack of data in this model, the model will be useful in describing the interaction of various incentives, taxes, and ownership structures. Furthermore, the model helps to understand the viability of tribal wind farms from the different perspectives.

Further details of the financial model are described in Appendix IV. The remainder of this section will discuss the results of the model in the context of the various scenarios.

V.2 Model Assumptions

The major assumptions for the wind farm model are shown in Table 5. The critical parameters for a wind farm feasibility study are the capital costs of the wind farm and the quality of the wind resource, as shown by the capacity factor (CF). A CF of 33% represents a Class 5 wind resource. While these two parameters are critical to the feasibility of a wind farm, they are also highly uncertain. For the purpose of a comparative analysis it is reasonable to assume these numbers as long as they are used in all scenarios.

For the purpose of this study, the O&M cost is also very important for two reasons. First, a portion of the O&M cost will be spent in the local economy. Second, as the wind farm ages the O&M costs will become more expensive as components begin to fail and require more maintenance. In this study it is assumed that 80% of the first year O&M costs occur in the local economy, but that escalations in cost beyond the inflation rate are due to the purchase of spare parts that are imported into the local economy.[18] The assumptions for each scenario are shown in Table 6.

Key assumptions for financial modeling of Navajo wind farm

Assumption:	Value:	Expected Range:
Capacity (MW)	80	
Capacity Factor	33%	25 - 39%
Installed Capital Cost ($/kW)	$1,500	$1,200 - 1,600
O&M Expense ($/kW-yr)	$10.00	
O&M Escalation Rate (nominal)	12%	3% - 12%
Portion of first year O&M expense spent in Navajo Economy	80%	
Land Lease Expense ($/MW-yr)	$3,000	$2,500 - 4,000
Navajo Possessory Interest Tax	3.0%	
Navajo Business Activity Tax	5.0%	
Coconino County Property Tax	2.0%	
Inflation Rate	3%	
Discount Rate (nominal)	10%	

Table 5- Key assumptions for wind farm financial model

[18] See Section AIV.2.2.3 for more details

Assumptions for Each Ownership Scenario

Assumption:	Benchmark	Commercial	Joint Venture	Tribal Owned Commercial	Tribal Owned Tax- Exempt	Tribal Owned CREBs
Tax Issues:						
Coconino County Property Tax	Yes	Yes	Yes	No	No	No
Navajo Nation Taxes	No	Yes	Yes	Yes	Yes	Yes
Effective Income Tax	39.5%	39.5%	39.5% (Non-Tribal Partner)	0%	0%	0%
Production Tax Credit ($/kWh)	$0.019	$0.019	$0.019	N/A	N/A	N/A
Depriciation Incentive	5-Year MACRS	5-Year MACRS	5-Year MACRS	N/A	N/A	N/A
Fees:						
Management Fee ($/MW-yr)	N/A	N/A	$9,000 - First Ten Years Only	N/A	N/A	N/A
Finances:						
Financial Structure	Flexible	Flexible	Flexible	Flexible	Flexible	Flexible
Equity: Min. After Tax IRR	12%	12%	12%	12%	12%	12%
Debt Term (yr)	12	12	12	12	20	15
Debt Interest Rate	7.0%	7.0%	5.5%	5.5%	5.0%	0.0%
Minimum Coverage Ratio	1.4	1.4	1.25	1.25	1.25	1.25

Table 6 - Assumptions used for each scenario

V.2.1 Benchmark

The Benchmark scenario represents the characteristics of a wind farm built today. The capital cost of the wind farm is met with a combination of equity investment and debt. The equity investor requires an after tax internal rate of return on the investment of 12%. The interest rate for debt is 7%. Debt lenders require that the coverage ratio, which is the ratio of the revenues minus costs to the minimum debt owed for each period is 1.4. The coverage ratio is also called the Debt Service Coverage Ratio (DSCR).

The wind investments are driven by tax incentives for wind farms. The first is the Production Tax Credit (PTC) which allows the owner to deduct $0.019 from their taxes for every kWh the wind farm produces in its first ten years. The second is accelerated depreciation, which allows the owner to deduct the costs of depreciation from their income, thereby lowering their taxes, in the first five years of the wind farm life. Both of these incentives require that the investor have a sufficiently large tax-appetite to be able to gain value from these tax credits. For illustration, the wind farm will earn approximately $4.5 million in tax credits from the PTC in the first year. If the owner does not regularly pay more than the $4.5 million in federal taxes, then the PTC will not be fully utilized. In all scenarios, it is assumed that non-tribal investors have a sufficient tax-appetite to fully utilize the PTC and accelerated depreciation incentives.

V.2.2 Commercial

The Commercial wind farm on the Navajo Nation is owned by an outside, tax paying investor that is now subject to taxation by the Navajo Nation in addition to the property taxes from Coconino County. There are no other differences between this scenario and the Benchmark.

V.2.3 Joint Venture

In this scenario, the Navajo Nation will take part in the ownership of the wind farm through a joint venture partnership with an outside tax-paying investment company. The Joint Venture model is used for two reasons. First, the investment company, and not the tribe, provides the capital. Second, the Navajo entities do not pay federal income taxes and cannot therefore utilize the PTC and deprecation incentives. In general, it is accepted that large wind farm projects are not economically viable without the additional value of the PTC in the project finances.

To overcome this barrier, the Navajo Nation can enter into a joint venture with a tax-paying investor having sufficient tax appetite to utilize the PTC. In the case of multiple project owners, the value of the PTC is split according to each entities "ownership interests in gross sales from the facility" (Golub, 2005). Howard Golub, presents a hypothetical case where in the first phase of the project, 99% of the PTC is allocated to the tax-paying investor, while control of the facility and 1% of the ownership, and therefore 1% of the PTC, is retained by the tribal partner. The 1% of the PTC allocated to the tribal owner is not utilized, but the tax-paying investor is able to use 99% of the tax credit. During the first ten years the tribal partner receives a management fee during this phase of the project, in lieu of revenues from sale of the power. In this case the management fee is about three times the value of a standard land lease payment. This is approximately the management fee proposed for the 30 MW rosebud wind farm. Figure 9 illustrates the project structure during the first phase of the project.

Once the ten-year PTC life ends and the investor has recouped much of its initial investment, the Navajo partner has the option to take part in the ownership of the plant. Ownership "flips" from the investor to the tribal partner, giving this development model the name "flip-structure". This model of ownership is commonly used in community wind projects in Minnesota, typically called the "Minnesota Flip Structure" (Bolinger 2004). The community wind projects are groups of landowners that partner with an investor to build wind farms on their land, while retaining partial local ownership. The details of community wind financing are discussed by Kubert (2004). For the base case it is assumed that the Navajo partner becomes a 50% owner at the end of the first ten years.

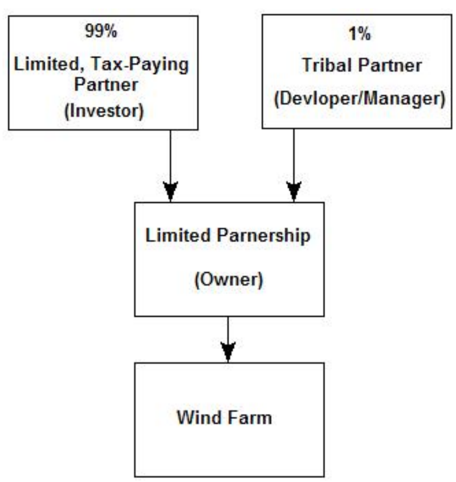

Figure 9 - Illustration of Phase I of project structure to utilize the PTC (Adapted, with permission, from Golub, 2005)

The federal government has also authorized loan guarantees for renewable projects with Native Americans. The effect of the loan guarantee is to back any loan made to a tribe with the credit of the federal government. Lenders are then willing to lend money with better terms, knowing that if the tribe defaults, the federal government will back the investment. The better lending terms are shown in by the 5.5% interest rate for the debt loan and the reduction in the DSCR from 1.4 to 1.25. These assumptions are discussed in detail in Section AIV.2.4.3.

V.2.4 Tribal Owned

The tribe can also build the wind farm without an outside investor. The advantage of this option is the increase in control over the facility and the potential for increased revenues to the tribe. The disadvantage is that the tribe does not pay federal income taxes and is therefore not able to utilize the PTC or depreciation incentives.

It is assumed that the federal loan guarantee is available and provides improved financing terms for all debt. In addition to the traditional financing mechanism, two scenarios are investigated in which the capital is raised through bonds. The first scenario uses tax-exempt bonds. The bondholder is not required to pay tax on the interest earned from tax-exempt bonds and is therefore usually willing to buy bonds at a lower interest rate. The second scenario involves Clean Renewable Energy Bonds. From the perspective of the bond issuer, the tribal government in this case, these bonds are effectively similar to a zero interest loan. Instead of the tribe paying the interest on the bonds the bondholder earns tax credits at a rate similar to earning interest on normal bonds. See Section AIV.2.5 for more details.

V.3 Model Results

V.3.1 Comparison of Scenarios to Benchmark - given fixed purchase price

The first question is: How attractive are these ownership scenarios in comparison to the benchmark wind farm? In this exercise, the minimum levelized cost of the Benchmark wind farm becomes the power purchase price for the remaining scenarios. The finance structure is then adjusted for each scenario to meet minimum coverage ratio requirements, if possible, while maximizing the return on equity. The results are shown in Table 7.

Model Results: Comparison of Ownership Scenarios, Real Levelized Price is Fixed at Benchmark level

				Navajo Nation Owned:		
Model Results:	Benchmark:	Commercial:	Joint Venture:	Commercial:	Tax-Ex. Bond:	CREB's:
PPA: Price of Energy						
First Year Energy Price ($2006/MWh)	$53	$53	$53	$53	$41	$44
Price Escalation Rate	0%	0%	0%	0%	3.1%	2.1%
Nominal Levelized Price ($/MWh)	$53	$53	$53	$53	$55	$55
Real Levelized Price ($2006/MWh)	$40	$40	$40	$40	$40	$40
Financing Results						
Equity Share	58%	62%	55%	53%	35%	15%
After-Tax IRR	12%	10%	10%	2%	1%	13%
Debt Share	24%	38%	45%	47%	65%	85%
Minimum Coverage Ratio	1.40	1.40	1.25	1.25	1.25	1.25
Average Coverage Ratio	1.60	1.60	1.40	1.45	1.37	1.29
Risk of Default	5%	8%	33%	23%	56%	53%
Benefits to Navajo Nation ($000 - Net Present Value)						
NN Taxes ($2006/yr)	N/A	$6,476	$6,407	$6,631	$3,972	$6,352
Land lease ($2006/yr)	N/A	$2,583	$2,583	$2,583	$2,583	$2,583
NN Owner ($2006/yr)	N/A	N/A	$11,114	($28,768)	($20,261)	$4,039
O&M spent in Navajo Economy ($2006/yr)	N/A	$6,889	$6,889	$6,889	$6,889	$6,889
Total ($2006/yr)	$0	$15,948	$26,993	($12,665)	($6,817)	$19,863
Financial Risk to Navajo Nation	N/A	N/A	9%	23%	56%	53%

Table 7 - Tribal Wind Finance Model Results. The minimum power purchase agreement price is found for the Benchmark case subject to equity and debt constraints. The remaining scenarios are price takers at the same real levelized price as the Benchmark case. The scenarios show the effect of different ownership options and incentives on the attractiveness of wind farms on Native American land.

V.3.1.1 Benchmark Model Results

The minimum power purchase price for the Benchmark wind farm is a nominal $53/MWh ($40/MWh in real terms). The low return on equity of 12% that was assumed for this model leads to a relatively low cost of equity and therefore a large share of equity in the finance structure (58% equity). The coverage ratio constraint is only binding in the last year of debt payments (year 12), yet the price escalation rate is 0%. If the price were to escalate, the power purchase price could be further reduced by better matching the revenue stream to increases in operating costs due to O&M escalations. However, because the minimum return on capital is also a binding constrain a reduction in profits in the early years of the project would require much greater returns in later years. These two effects balance with one another such that the optimal price escalation rate is 0%. The high average and minimum coverage ratio lead to a very small chance (5%) that the project will ever default on loan payments.

Due to the assumption that the Benchmark wind farm is not on the Navajo land, this wind farm produces no direct benefits to the Navajo Nation.

V.3.1.2 Commercial Scenario Results

The only difference in assumptions between the Commercial wind farm on the Navajo Nation and the Benchmark model is the addition of Navajo Nation taxes and the assumption that all land lease payments and a portion of the O&M costs are spent in the Navajo economy.

The debt constraint of a minimum coverage ratio of 1.4 was met for the Commercial wind farm finance structure by increasing the equity investment in the wind farm. However, the target return on equity of 12% was not met. The effect of the Navajo Nation taxes was to decrease the return on equity to 10%. From the debt perspective this wind farm has additional financial risk (8% chance of default) due to the assumption that Navajo taxes are an operating expense that must be met before the debt payment is made.

Overall, the effect of Navajo Nation taxes is apparent, but not unreasonable. The wind farm is still financially viable, but with a slightly lower return on investment and slightly higher risk of default.

A breakdown of the Commercial wind farm costs and revenues are shown in Figure 10. This figure is useful for evaluating the impact of incentives that would change the costs or revenues for a wind farm. For instance, the Navajo Nation taxes, as shown add approximately \$2.3/MWh to the cost of the wind farm. Based on the assumptions of the wind finance model, this increase in taxes must be offset by a decrease in profit, or the return on investment to the equity investor. But because a decrease in profits also decreases the tax liability of the wind farm, a 1% increase in costs is accompanied by less than a 1% decrease in after-tax profits.

Another way to offset this increase in costs is to increase the revenue earned by the wind farm owner. If for instance, the wind resource on the Navajo Nation is in fact better than the wind resource off of the reservation (as is the case for Gray Mountain) the increase in taxes may not decrease the financial viability of the wind farm.

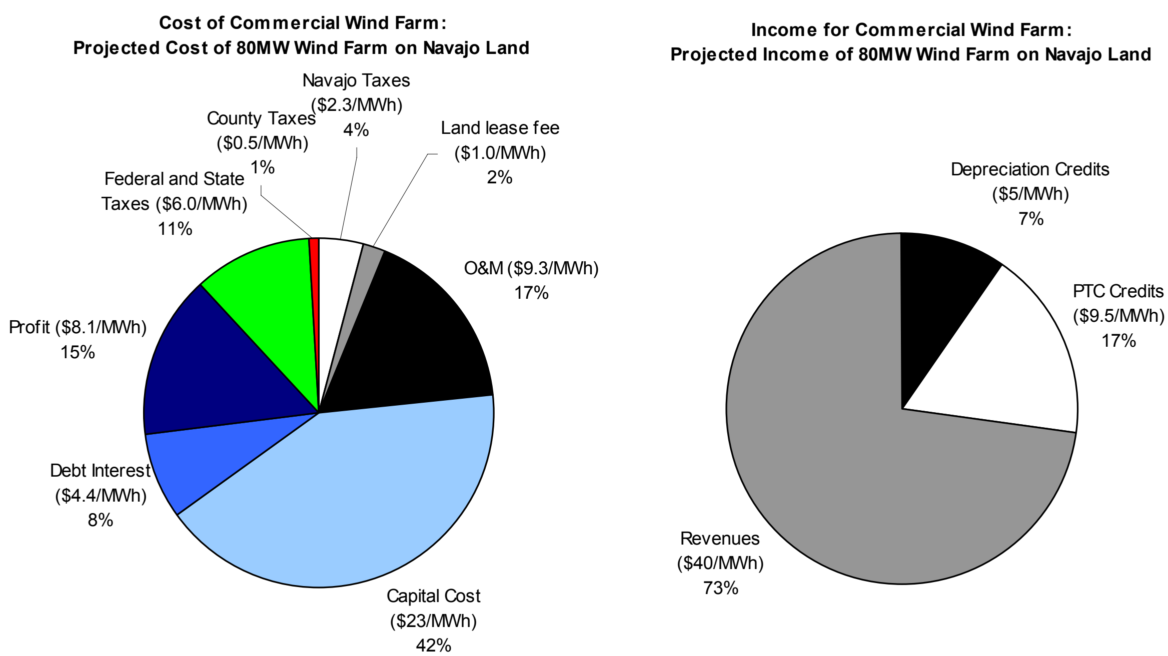

Figure 10 - Breakdown of costs and sources of income, in real levelized dollars, for a Commercial wind farm on the Navajo Nation. The financing terms for the wind farm are given for the Commercial scenario in Table 7.

V.3.1.3 Joint Venture Scenario Results

The two primary differences between the Joint Venture scenario and the Commercial wind farm scenario are the flip structure and the federal loan guarantee. The effect of the federal loan guarantee is to reduce the minimum coverage ratio and the cost of debt. The cost of debt for the commercial wind farm is shown in Figure 10 to be 8% of the total cost. The lower coverage ratio requirement and the lower interest rate leads to an increased share of debt in the finance structure. But even with the greater debt share the total cost of debt interest decreases by 8% assuming that the loan guarantee drops the debt interest rate by 1.5 percentage points.

This reduction in costs is capitalized by the Navajo partner who earns a substantial management fee in the first ten years of operation and then 50% of the profits for the remaining 10 years of the wind farm life.

Table 7 illustrates a critical result for this scenario: even though the Navajo Nation earns substantially more from the Joint Venture scenario than the commercial scenario, an equity investor earns a 10% return on investment in both scenarios. This means that based on the return on investment alone an outside investor will be indifferent between a joint venture and sole ownership of the wind farm.

Table 7 also shows that the risk of default in the Joint Venture model is greater than the Commercial scenario and Benchmark model. This increase in risk of default is due to the decreased minimum debt service coverage ratio from 1.40 to 1.25. The increase in risk of default is assumed to be acceptable due to the credit backing of the federal government through the loan guarantee.

Because a Navajo partner assumes partial ownership of the wind farm after year 10, but before the debt is completely paid off in year 12, the Joint Venture model also exposes the Navajo Nation to financial risk. According to the Joint Venture scenario, there is a 9% chance that the wind farm will default on its loans while the Navajo partner owns 50% of the wind farm.

The reason why the Navajo Nation would put itself in a position to be exposed to this financial risk is that taking part in ownership of the wind farm, according to this scenario, requires no capital from the Navajo partner yet increases the net present value of the wind farm to the Navajo economy by $11 million over the 20 year life of the wind farm.

A cash flow diagram of money to the Navajo economy however shows that the majority of this income is earned only after the Navajo partner becomes part owner (after 10 years) and the debt is paid off (after 12 years), Figure 11.

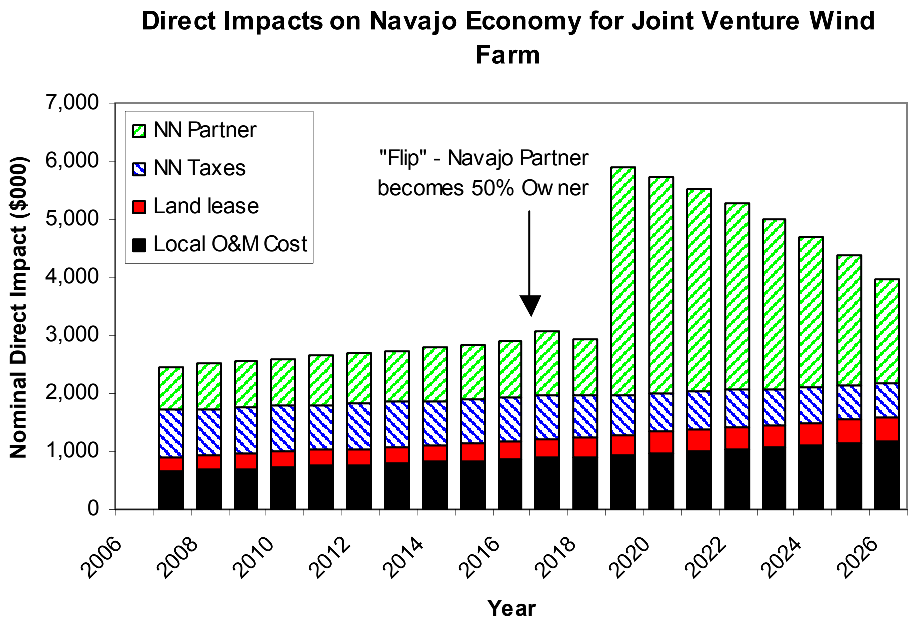

Figure 11 - Nominal cash flow diagram for direct impacts of Joint Venture wind farm on Navajo economy

The investment partner earns a major part of its revenue from tax credits both through accelerated depreciation and the PTC as shown in Figure 12. The investor earns a substantial portion of its income in the first five years through depreciation and the PTC. In this scenario, the investor has a positive cash flow in the fifth year of operation.

In some community wind projects the investor fully recoups the investment in the first ten years so that once the PTC ends, the investor turns over 100% ownership to the Joint Venture partner. If the Navajo partner were to assume 100% ownership after the flip, the Investor return would be reduced by 1.2% while the net present value of the Navajo partner's earnings would increase by over $5 million.

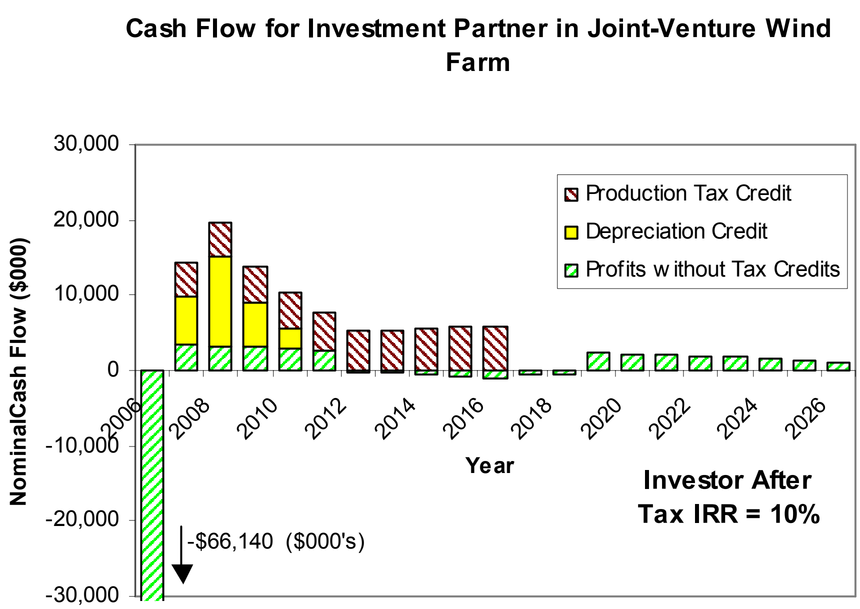

Figure 12 - Cash flow for Investment partner for Navajo Joint Venture wind farm

One artifact of the method used to model this ownership scenario is apparent in Figure 12 during the years from 2017 to 2019 where the investor is actually losing money in those two years to remain a partner in the project. It is highly unlikely any investor would willingly enter into such a partnership unless the expected returns for the remaining years were very high. This problem is dealt with in Section IV.3.2 where the minimum improvements in either the power purchase price or the wind resource are found such that the wind farm structure becomes feasible.

V.3.1.4 Tribal-Owned Scenario Results

The results in Table 7 show only one of the Tribal owned scenarios are attractive given the assumptions for each scenario. The CREB financed project meets the minimum return on investment requirement while the other two scenarios are not financially attractive. The Tribal Owned – Commercial scenario does lead to a reduction in costs in that the Navajo owner does not pay federal and state income taxes (and county taxes too although this effect is insignificant). But the accelerated depreciation and PTC tax credits are no longer available to the Navajo owner. As Figure 10 shows, these sources of income make up over 25% of the revenue to the owner of a Commercial wind farm. Without these incentives available to the Navajo partner, the Tribal Owned - Commercial wind farm is not feasible at the Benchmark power purchase price. The reason for the infeasibility is that the return on equity, which would have to come from the Navajo Nation, is well below the target 12% return. If no equity was available from the Navajo Nation then the coverage ratio requirements of debt lenders would not be able to be met.

The one scenario that is feasible is through the use of Clean Renewable Energy Bonds (CREBs). These bonds reduce the cost of debt to zero from the perspective of the Navajo owner. As the debt interest rate is already low, in this case it is assumed to be 7% without any federal incentives, the incentive offered by the use of the CREBs is reduced. This is also apparent in Figure 10: the cost of debt interest for a commercial wind farm is only $4.4/MWh while the value of the PTC and accelerated depreciation combined is approximately $15/MWh. But the zero cost of interest, the low debt service coverage ratio, and the longer maximum term for the CREB wind farm lead to a project that would have a 13% return on equity at the Benchmark power purchase price.

Two additional aspects of the CREB program should be mentioned in the context of financial feasibility. First, according to the way the Treasury Department has set up the CREB program, projects will be selected for CREB financing based on the size of the funding request, beginning with smallest requests first. This decision was made due to the expected shortfall of bonds available in comparison to demand and the lack of technical manpower in the Treasury Department to evaluate each project by merit or means other than the size of the request. Therefore, a full request for an 80 MW wind farm, which would be over $100 million in CREB funds for a program that is only funded to $800 million in total, is not likely to be selected. To access funds either the size of the project would have to be reduced or only a small portion of the project would be funded by CREBs.[19]

Second, according to Wiser and Khan (1996) one way to improve the feasibility of a wind farm is through utility ownership, whereby the wind farm becomes part of the assets of the utility. The risk of default is then spread through the other revenue streams of the utility, effectively allowing the DSCR to be reduced to 1.0. The financial risk of an 80 MW wind farm is much larger than NTUA would be able to absorb. NTUA's peak load is only approximately 100 MW. Therefore only a small number of turbines could be owned by NTUA. However, if the DSCR were

[19] See IRS Notice, and February 9th Teleconference call on CREBs hosted by the Environmental Law and policy Center: www.cleanenergybonds.org

to be reduced to 1.0 then the tribal equity share could be reduced to 0% and project would still be feasible, although there is significant financial risk that the revenues required to pay the debt payments will not be available from just the wind farm in any particular year. Therefore NTUA owned wind turbines would only be an attractive option if the utility is willing to manage the financial risk associated with inter-annual variation in the wind resource.

Taking into account the increased benefits that would be available through utility ownership and the increased likelihood of obtaining CREB financing for small projects, one option would be for NTUA to take over ownership of 10 MW of wind turbines of the 80 MW wind farm for example. This would allow the economies of scale of a full 80 MW wind farm to still be accessed while encouraging full tribal ownership of a portion of the wind farm.

V.3.2 Minimum Improvements for Feasibility

Another way to approach the question of financial feasibility is to determine the increase in power purchase price or the improvement in the wind resource between the Navajo Nation and alternative wind sites. If for instance the wind resource on Gray Mountain is a Class 6 wind resource and the only other sites in the area are Class 4 or 5 then an investor may be willing to pay higher taxes for the Navajo wind farm than to pay less in taxes but generate less electricity on another site. Analogously, the Navajo Nation could instead find alternative mechanisms to increase the value of each unit of energy that is sold, though mechanisms such as green tags. For the first exercise, the minimum DSCR and return on equity requirements as shown in Table 6 are met for each scenario by increasing the power purchase price.

The results for increases in power purchase price are shown in Table 8.

Model Results: Comparison of Ownership Scenarios, Minimum PPA Price to Meet Finance Constraints

				Navajo Nation Owned:		
Model Results:	Benchmark:	Commercial:	Joint Venture:	Commercial:	Tax-Ex. Bond:	CREB's:
PPA: Price of Energy						
First Year Energy Price ($2006/MWh)	$53	$57	$56	$71	$49	$44
Price Escalation Rate	0%	0%	0%	0%	3.1%	2.1%
Nominal Levelized Price ($/MWh)	$53	$57	$56	$71	$67	$54
Real Levelized Price ($2006/MWh)	$40	$42	$42	$53	$48	$40
Financing Results						
Equity Share	58%	58%	51%	31%	19%	15%
After-Tax IRR	12%	12%	12%	12%	12%	12%
Debt Share	42%	42%	49%	69%	81%	85%
Minimum Coverage Ratio	1.40	1.40	1.25	1.25	1.25	1.25
Average Coverage Ratio	1.60	1.58	1.39	1.39	1.43	1.30
Risk of Default	5%	7%	32%	21%	29%	52%
Benefits to Navajo Nation ($000 - Net Present Value)						
NN Taxes ($2006/yr)	N/A	$6,965	$6,830	$9,214	$4,912	$6,311
Land lease ($2006/yr)	N/A	$2,583	$2,583	$2,583	$2,583	$2,583
NN Owner ($2006/yr)	N/A	N/A	$11,702	$5,816	$3,334	$3,194
O&M spent in Navajo Economy ($2006/yr)	N/A	$6,889	$6,889	$6,889	$6,889	$6,889
Total ($2006/yr)	$0	$16,437	$28,004	$24,502	$17,718	$18,977
Financial Risk to Navajo Nation	N/A	N/A	9%	21%	29%	52%

Table 8 - Minimum power purchase price to meet the financial constraints for feasibility for each ownership scenario.

The same results can be described graphically by comparing the benefits of each ownership scenario to the Navajo economy versus the minimum power purchase price, Figure 13. This figure also includes a forecast of wholesale electricity prices and the cost of power from a new coal plant as a reference for wholesale electricity prices (See Appendix IV, Section 4 for details).

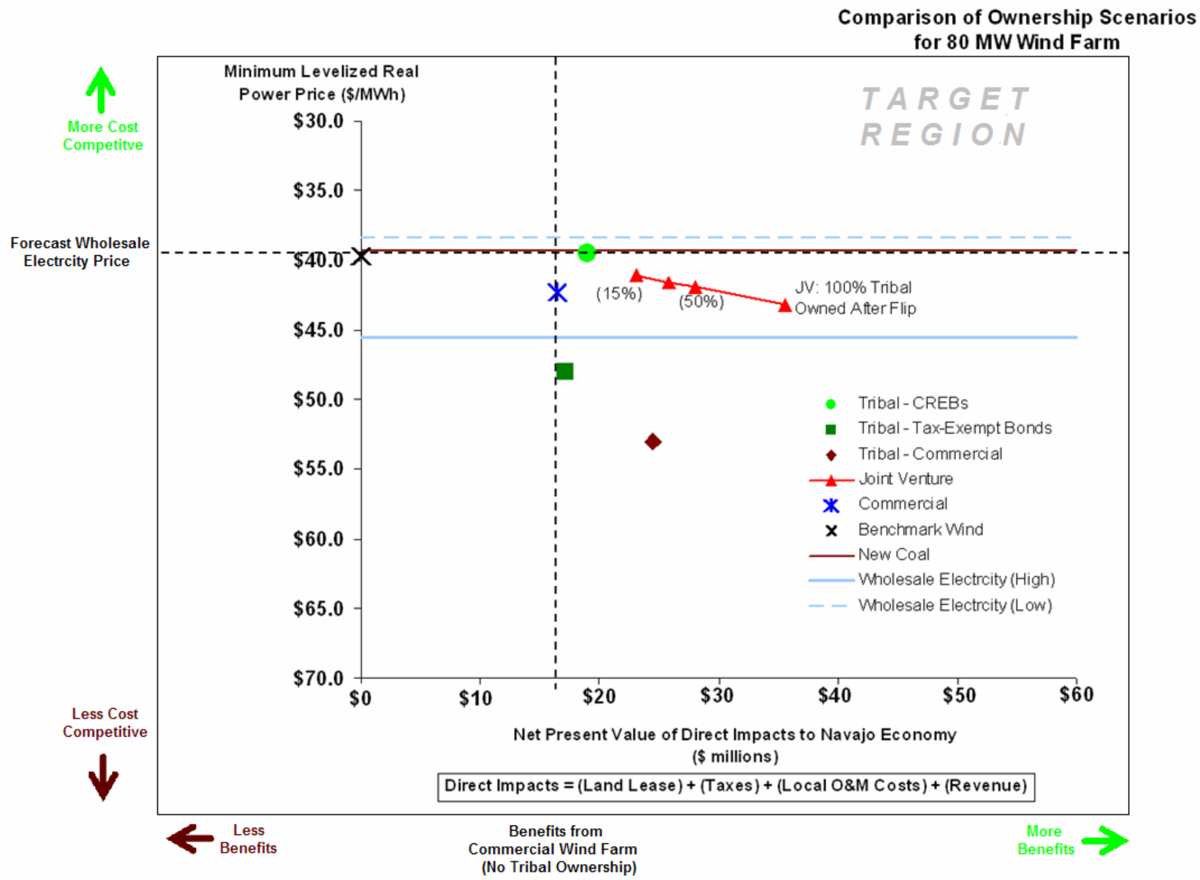

Figure 13 - Comparison of minimum price for wind energy contracts to the direct impacts on the Navajo economy for each ownership model. The values on the axis depicting the cost of energy are reversed so that the chart shows that moving up increases the cost competitiveness of the wind farm ownership model (or decreases its costs), while moving to the right increases the benefits to the Navajo Nation. The Joint Venture model includes a sensitivity analysis based on the assumed ownership of the wind farm by the tribal partner after the first ten years of the PTC end. The base assumption is that the tribe assumes half ownership (50%) and the sensitivity includes full ownership (100%), 35% ownership, and 15% ownership. If the Navajo Nation were to take part in ownership of a wind farm off of the Navajo reservation (such that the direct impacts become only the revenue from ownership) the direct impacts would be the difference between the benefits from the ownership model on the Navajo Nation and the benefits from the Commercial model.

In Figure 13, the greatest direct impact on the economy while providing the lowest cost of wind energy occurs in the upper right corner of the plot. The further right a point is on the plot, the greater the benefits to the tribe, hence the "Target Region" label in Figure 13. While the further up the point is, the lower the minimum price for wind energy. The points that best match these criteria are the Joint Venture scenario and the Tribal owned wind farm financed with CREBs. The wind farm that is the least financially viable is the Tribal owned wind farm financed using commercial debt with a loan guarantee. The model is not viable due to the lack of PTC and accelerated depreciation incentives.

The Joint Venture wind farm produces more benefits to the tribe than a traditional Commercial wind farm. In addition, the cost of energy is lower for a Joint Venture wind farm assuming that the federal loan guarantees for tribal energy projects discussed in Section AIV.2.4.3 improve the debt financing terms.

One important point from Figure 13 is that additional scenarios would be financially viable if the wind farm could rely on the federal REPI incentive. The REPI is worth approximately \$19/MWh for the first ten years of the project, or \$9.50/MWh over the full 20-year life of a wind farm. However, as discussed in Section AIV.2.5.2 and by Wiser and Khan (1996), the REPI is unreliable because it is a federal appropriation rather than a tax credit. Therefore, payments are subject to variation as Congressional funding changes from year to year. Were the REPI to be fully available and reliable, then the two bond financed Tribal-owned scenarios would be viable.

The other important aspect of the results is to consider the risk to the tribe in each case shown in Table 8. With a commercial wind farm, the tribe is not liable for the project in the case of a default and assumes no direct management of the project. On the other extreme, ownership of a wind farm through a political subdivision exposes the tribe to more risk. These risks will need to be balanced according to the desires of the Navajo Nation and potential investment partners.

Figure 13 can be used to evaluate the benefits to the Navajo economy if the Navajo Nation were to take part in the ownership of a wind farm that is not on Navajo land. In this case, the only benefits from the wind farm are the revenues the Navajo partner earns. A wind farm not on Navajo land would not be subject to Navajo taxes and would not pay a land lease fee to the Navajo Nation. Furthermore, if the wind farm were not on Navajo land Navajo labor preference laws would not apply to the hiring of O&M workers. Even if there was a mechanism available to ensure Navajo members were hired for O&M jobs for off-reservation wind farms, it is not clear that the Navajo O&M workers would then add their income to the economic base of the Navajo economy. Therefore, the benefits of the Navajo Nation owning a wind farm off of the Navajo reservation are shown by the difference between the benefits of the particular tribal ownership model and the benefits of the Commercial model. The numerical value is shown by the "NN Owner" row in Table 8. A Joint Venture model with a 100% ownership flip after ten years would produce approximately half of the benefits by building it off of Navajo land than by building the same wind farm on the Navajo Nation.

Instead of considering the extra revenue that a tribal wind farm would have to earn to be cost competitive with the Benchmark, a second exercise is to evaluate how much better than the wind resource at a site off of the reservation the wind resource on the Navajo Nation would have to be to be cost competitive. The results are shown in Table 9.

Required Minimum Wind Resource to Make Wind Farm Cost Competitive With Benchmark

			Joint Venture				Tribal Owned		
Scenario:	Benchmark	Commercial	100%	50%	35%	15%	Commercial	Tax-Ex.	CREBs
Wind Resource: (CF%)	33.0%	34.6%	35.1%	34.3%	34.1%	33.8%	44.0%	40.0%	32.8%

Table 9 - Minimum increase in wind resource, as shown by the wind farm capacity factor, to make wind farms cost competitive with the Benchmark wind farm. The Benchmark wind farm is assumed to have a 33% CF.

The tribal owned wind farms financed using tax-exempt bonds or commercial financing need to have unreasonably high capacity factors to be able to sell power at the same price as the Benchmark wind farm. However, the required difference in wind resource for the other scenarios is within the uncertainty of the estimate of the wind resource at Gray Mountain.

V.4 Discussion of Tribal Wind Finance Results

The taxes that can be levied on wind projects on the Navajo Nation land will slightly decrease the financial attractiveness of a wind farm on Navajo land in comparison to one not on Navajo land. However, in the case of a Commercial wind farm developed by an outside investor, the taxes only decrease the return on investment by less than two percentage points. If the lands on the Navajo Nation have a CF that is 5% better than the CF available on sites off of Navajo land, or if by locating on the Navajo Nation the commercial wind farm is able to improve the power purchase price by $2/MWh then a wind farm on Navajo land will be just as competitive. The other alternative is for the Navajo Nation to reduce the tax burden on the wind farm as an incentive, but the projected tax revenue has the potential to bring two times the benefits to the Navajo economy than only obtaining the land lease.

The important result from this analysis is that a joint venture wind farm between a Navajo partner and an outside investor has the potential to drastically increase the benefit of a wind farm to the local economy, while not reducing the financial attractiveness of the wind farm compared to a standard commercial wind farm. This of course hinges on the ability of a joint venture to be able to access a federal loan guarantee authorized in the EPAct 2005.

If the Navajo Nation wants to be the full owner of a wind farm, the most financially attractive financing mechanism is through the use of Clean Renewable Energy Bonds. A wind farm financed with CREBs would require no additional revenue source to be as financially attractive as the Benchmark model. However, the tradeoff comes in that the tribe is now exposed to significant financial risk and the CREB program favors smaller projects. This leaves open the possibility of NTUA piggybacking with a larger wind farm developed by an outside company. NTUA could use CREBs to finance a small number of the wind turbines in the larger wind farm. Lamar Power and Light used a similar piggybacking approach when it purchased four, 1.5 MW turbines for their wind farm through Xcel who was developing the much larger Colorado Green Wind Farm in Colorado. [20]

The high cost of power from the Tribal – Commercial and Tribal – Tax- Exempt Bonds models show that ability to utilize the PTC makes a drastic impact on the feasibility of wind farms. Or conversely, a wind farm that is fully owned by the tribe and financed using tax-exempt bonds or commercial financing will have to have an unreasonably high CF to be able to sell power at the same price as a commercial wind farm that is utilizing the PTC.

The value of each package of incentives used to evaluate the minimum power purchase price shown in Table 8 can be compared to the minimum power purchase price for a commercial wind farm with no PTC, as shown in Figure 14. Because the PTC is set to expire at the end of 2007, it is worthwhile to evaluate the impact of the other incentives in comparison.

[20] Personal Communication, Lamar Light and Power, June 2005

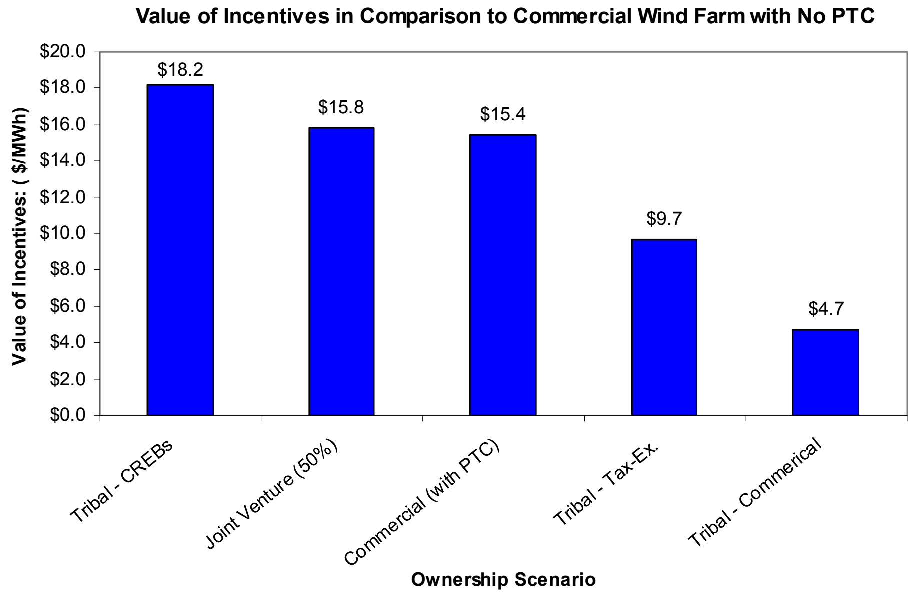

Figure 14 - Comparison of the value of each set of incentives for the ownership scenarios in comparison to a Commercial wind farm on the Navajo Nation without the PTC.

The most valuable set of incentives is shown to be the incentives used in the Tribal owned – CREBs scenario. In this scenario, the wind farm is owned by the tribe and financed with CREBs and a federal loan guarantee. The value is due to the lack of federal, state, and county taxes, the avoided cost of debt interest, the shift away from a high share of equity (which must earn at least a 12% return on investment), and the improvement in debt service coverage ratio due to the federal loan guarantee.

The Joint Venture scenario is the next most valuable set of incentives, which includes the PTC and a federal loan guarantee. These incentives more than counter the increase in costs that accompany the management fee that would be paid to the tribal partner in the first ten years of the project and the 50% drop in ownership share to the investment partner after the flip.

The value of the PTC is $9.5/MWh over the 20-year life of a wind farm, yet the Commercial scenario with the PTC shows that the lack of the PTC would drive the minimum power purchase price up by more than $9.5/MWh to $15.4/MWh. There is one primary reason for the increase. The value of the PTC is fully added to the return on investment to the equity owner of the wind farm. In contrast, without the PTC the equity owner would have to increase the power purchase price, and thus their taxable revenues. Since the combined federal and state taxes take 39.5% of the taxable revenue and the Navajo Nation would take an increased amount in taxes on net revenue, losing the PTC would drive the power purchase price up by more than $9.5/MWh to still meet the 12% after-tax return on investment target.

The Tribal owned scenario where the wind farm is financed with tax-exempt bonds and a federal loan guarantee, but no PTC does have substantial value, but as was shown in Figure 13, this package of incentives in not sufficient to make wind energy cost competitive with the forecast wholesale electricity prices.

The final scenario, a Tribal owned wind farm financed with commercial debt but using a federal loan guarantee, has the lowest value. The value is due to the federal government agreeing to take on the risk of the project defaulting and due to the lack of federal and state taxes on a project owned by a tribal government.

The last discussion point is that tribes may pursue opportunities that will allow them to become partners in wind farms that are not on their land. This option may produce benefits to the tribe's economy by bringing revenues into the tribal economy, but it will not bring the tax, local O&M spending, and land lease benefits that a wind farm on their land will bring. Furthermore many of the incentives that bring value to a tribal owned wind farm may not be available for a wind project that is not on their land.

V.4.2 Conclusions

In answer to the questions posed at the beginning of this section, wind projects in Indian Country are financially viable. The tribe benefits the most from projects in which the tribe is part owner in the wind farm. Due to the federal incentives including the PTC and federal loan guarantees, the Joint Venture scenario between an outside tax paying investor and a tribal entity provides the largest benefit to the Navajo economy and can be the most financially attractive option for a large wind farm on Indian lands.

It is also interesting to note the significant impact of tax incentives, including the PTC and the accelerated depreciation, on determining the viability of wind farms. The PTC has expired numerous times since it was first authorized in 1992 and is currently set to expire at the end of 2007. The wind industry spends a significant amount of time ensuring that the PTC is renewed, and for good reason. However, tribes, and any other entities that do not have a sufficient tax appetite to utilize the PTC, do not have an equivalent incentive available to them. The REPI as it was noted, is unreliable because it is a congressional appropriation. If an incentive, such as the REPI were to become reliable, for instance by making it a tradable tax credit rather than an congressional appropriation, scenarios such as the Tribal owned wind farm financed with Tax-Exempt bonds would move much closer to financial viability. The CREBs, while significantly enhancing the financial viability of wind projects, are currently being issued in a manner that encourages small renewable energy projects. The CREB program would be much more effective at supporting large wind farms built to export power to other regions if it were to be expanded to support large projects. Figure 14 shows that with the assumptions used in this analysis the CREB financing with a federal loan guarantee is more valuable to a tribal government than the PTC is to a Commercial wind project.

V.5 Uncertainty Analysis

Many of the numbers used in this analysis are estimates and are subject to change in specific cases. Therefore, an uncertainty analysis was carried out to test the robustness of key results from the tribal wind finance model.

The full sensitivity analysis is presented in Appendix V, Section 5. This section summarizes the three key uncertainties for each of the three most interesting scenarios. The analysis looks at specific assumptions to test the relative effect of the assumptions. The three cases analyzed are: the Commercial wind farm on Navajo land, the Joint Venture with an outside investment partner, and a Tribal owned wind farm financed with the Clean Renewable Energy Bonds (CREBs). The results of the uncertainty analysis are shown in Table 10 and explained in detail below.

Summary of Uncertainty Analysis

Sensitivity Scenario	Initial Value	Sensitivity Analysis Value	Change in Minimum PPA ($/MWh)	Percent Change in Minimum PPA
Commercial Scenario				
Increase in both debt cost and equity cost	Debt = 7% Equity = 12%	Debt = 9% Equity = 14%	$5.4	12.8%
Joint Venture Scenario				
No reduction in financing cost due to federal loan guarantee	DSCR = 1.25 Debt = 5.5%	DSCR = 1.4 Debt = 7%	$3.3	7.9%
Tribal Owned- CREB Scenario				
Decrease in maximum CREB debt term	15 years	12 years	$5.1	12.9%

Table 10 - Summary of key uncertainties in scenarios used to produce Figure 13. The full analysis is presented in Section AV.5.

V.5.5 Discussion of Uncertainty Analysis

The sensitivity scenarios reflect reasonable changes in the assumptions used to estimate the minimum power purchase price for each ownership scenario. The sensitivity analysis only considers changes in the financing terms. It does not consider the assumptions for the CF of the wind farm and the installed cost of the wind farm. Both the CF and the installed cost will have very significant impacts on the cost of power from the wind farm, but they will not substantially change the results of the scenarios relative to the benchmark wind farm. For the interested reader, McGowan and Connors (2000) describe a generic uncertainty analysis based on the CF and installed cost.

V.5.5.1 Commercial Scenario

The cost of power from a wind farm financed with commercial financing terms is sensitive to the cost of debt and equity due to the capital-intensive nature of wind energy. The cost of equity has been low in recent years, but it could rise if other investments become more profitable. Similarly, debt rates tend to be pegged to an international debt interest rate called the LIBOR rate. If this rate increases, the cost of the power from the wind farm will also increase. In the sensitivity analysis case, both the equity and debt cost increase by percentage point leading to a 13% increase in the minimum power purchase rate, or an increase of about $5/MWh. The difference between the high and low wholesale electricity rates in the same region is also about $5/MWh. A $5/MWh increase in the cost of wind power may make it unattractive in comparison to alternative generation technologies, but it should be noted that an increase in debt and equity cost would also affect the cost of new fossil fuel generators.

V.5.5.2 Joint Venture Scenario

The major assumption in the Joint Venture scenario is that the federal loan guarantee decreases the cost of debt and the minimum debt service coverage ratio as it shifts financial risk away from the project and onto the federal government. In the worst case, if the federal loan guarantee were to have no effect on the financing terms, it would raise the cost of power by about 8% or $3.3/MWh. The lack of value in the federal loan guarantee would not make the Joint

Venture wind farm infeasible, but it may make it more attractive for the outside investor to build the wind farm without the tribal partner.

It should be noted that a decrease in the management fee to the tribal partner during the first ten years of the partnership would not have a significant change in the power purchase price. Decreasing the management fee by 50% would have a very significant affect on the direct benefits to the tribe of the wind farm, but it would only decrease the power purchase price by 3%. Clearly, it is worth it for tribes to negotiate for a good management fee if a joint venture is pursued.

V.5.5.3 Tribal Owned – CREBs Scenario

One surprising result in the sensitivity analysis was the sensitivity of the CREB scenario to changes in the maximum bond term. The Secretary of the Treasury determines the bond term based on the current interest rate for Treasury Bonds. As the interest rate increases, the maximum debt term decreases. If the debt term were to fall from the expected term of 15 years to 12 years it would increase the cost of power by 13% or just over $5/MWh. This level of increase in the cost of wind power could potentially make the wind farm less attractive than the projected wholesale electricity prices in the region. It would certainly make the wind farm less attractive than the Benchmark wind farm and possibly the Commercial wind farm.

VI. Summary and Conclusions

The challenge with tribes turning to wind energy for the purpose of economic development is avoiding the situation that Cornell and Kalt describe as happening all too often on tribal lands. How can wind energy projects be carried out in a way that they are not "the occasional business opportunity of reservation legend, when some eager investor would arrive at tribal offices with a proposal 'guaranteed' to produce millions of dollars for the tribe?" They assure us that "such investors still appear, promises in hand" (Cornell and Kalt 1998, 187). While it is clear that wind energy can bring benefits to tribal economies, the broader issue is: Can energy projects promote the long lasting sustained development that would be required to reduce the levels of unemployment and poverty? Cornell and Kalt place the responsibility firmly on the tribes to avoid the "jobs and income" approach to development whereby the problem is identified as being a lack of jobs and a lack of income leading to a solution that is to get tribal planners to "Go get some businesses going". They say that this approach has fed a cycle of failed tribal businesses where tribes end up "back at square one, once again asking the planner to 'get something going'". (Cornell and Kalt 1998, 191-4).

Wind energy projects cannot be a solution to the development goals of tribes on their own, but must be accompanied by an active effort of tribes to define what development means to them, determine how they plan to reach their development goals, and establish how to involve multiple levels of tribal decision making bodies in the process. Energy development projects can, in general, support such efforts by providing funds to implement the development projects and programs that the tribe decides to implement, but simply providing a source of income is not on its own enough to lead to development.

Furthermore it is important to recognize that electricity from a wind farm is an intermediate good. Significant value is added to products and services using electricity, but much of that value occurs downstream of the electricity generation process in manufacturing, service industries, and as an energy service to the end user. When the tribe exports electricity it becomes a nearly homogenous product with the electrons produced from power plants all over the west. It is not easy to extract extra value from the electricity that is produced from wind farms on tribal lands. *Native*Energy is on the right track with a "green-tag" program that allows tribal wind farms to sell the renewable attributes of wind energy to users that are willing to pay more for it, but it is unclear how long lasting a market for green-tags will be.

Focusing too much effort on energy development projects can lead to distortions in the economy and the structure of the government that pull resources from efforts that may otherwise help in creating a diverse economy. Wind energy projects can help diversify sources of revenues for tribes that are not already devoting significant effort to energy development. However, in the situation with the Navajo Nation, it is easy to argue that they need to evaluate additional energy projects very carefully to ensure that they are not supporting projects that could potentially reduce the diversity of the economy.

Tribes should consider who it is that will benefit from wind energy development projects. The jobs created by wind farms will tend to be skilled positions. If the primary goal of the tribe is to address issues of poverty and unemployment, it is the tribes' responsibility to ensure that in addition to creating skilled jobs, the revenues from wind farms are used in ways that address the development goals more directly. Such a task is complicated by the fact that a top down approach to addressing development goals may not be effective. Tribes should ensure that their approach to development is set up in a way that enables the development that they want to see before or in concert with efforts to increase sources of revenue to implement such projects.

Given the limitations of wind energy as a tool for development, wind projects can support economic development on tribal lands without the adverse environmental impacts that accompany other forms of energy development. The sale of electricity generated by wind farms to utilities in the area surrounding the tribe's land will add to the economic base of the tribal economy. The benefits are produced primarily through tribal taxation of the wind farm, the land lease fee, and income to O&M employees that are part of the tribal economy. The job impacts of wind farms are modest, but the jobs that are created are important in that they contribute to the economic base of the tribe's economy.

The tribal economy can also benefit in that the tasks involved in developing, building, and operating a wind farm can be applied to other similar projects. Tribal members managing or participating in these tasks can build capacity within the tribal economy. Wind farms support self-determination by providing a diverse source of income to the tribal government. The tribe can then use these funds to support projects in the tribal economy that lead to development that matches the development goals of the tribe.

Tribes can take steps to increase the benefits of wind farms on their land. One way to increase the benefits is by ensuring that tribal members obtain the jobs created by the wind farm. The Navajo Nation's labor preference laws or stipulations in contracts with the wind farm owners can help tribal members obtain the jobs. Tribes may also want to ensure that training is available to qualified tribal members for skilled positions related to the construction and more importantly the operation of the wind farm.

Tribes can use their ability to set taxation laws on their land to increase the benefits of wind farms. The Navajo Nation taxes were due in part to the lack of benefits of energy development on their land in the late 1970's. The same taxes applied to a wind farm are expected to be worth about twice as much as the land lease fee to the Navajo government.

In the best case, tribes taking part in the ownership of wind farms has the potential to double the direct impacts of a wind farm on the tribal economy. For tribes that have the resources and are willing to manage the additional financial risk associated with ownership of wind farms, revenues from ownership may be an important source of income to the tribal government or a tribal business.

It is important, however, to recognize that for a wind farm to be built on the tribe's lands for the purpose of exporting the electricity to other regions, the tribe must offer some sort of comparative advantage. This comparative advantage can come in the form of a high quality wind resource and transmission lines that provide access to markets for wind power. But a comparative advantage can also be produced through the tribe supporting wind development on their land by assessing the wind resource, streamlining the process for permitting and building a wind farm, or developing the wind project to the point that an investor simply needs to put money into the project for it to go forward.

Increasing taxes, requirements for training tribal members for wind farm jobs, and taking part in the ownership all have to potential to increase the costs of power from the wind farm. Additional costs will, in most cases, need to be offset by additional value that the tribe brings to a wind farm project.

The scenario that produced the most direct benefits to the Navajo economy involved a joint venture partnership with an outside investment partner. The increase in benefits was due to a management fee that a Navajo partner would earn in the first ten years of the project followed by a share in the ownership after the PTC was no longer available. According to the assumptions in the scenario, the cost of the wind farm would not necessarily increase above the cost of a commercial wind farm on their land. The reason that the costs did not increase was due to the federal loan guarantee that the tribe would bring to the partnership. Similarly, if the tribe can offer a slightly better wind resource on their land than on land off of the reservation, the cost of power from the wind farm on their land could be competitive with wind farms that do not pay the Navajo taxes. Hence, tribes will need to balance the additional benefits that they get from wind farms through provisions that increase the costs with other comparative advantages.

Tribes should understand the requirements that investors and debt lenders have when determining the feasibility and attractiveness of wind farms so that they can negotiate for the maximum value that will still allow the project to be built. If tribes are too aggressive with requirements for wind farms they may potentially turn investors away.

Similarly, developers and investors interested in building wind farms on tribal land should take steps to understand the needs and requirements of the tribes they will potentially be partnering with. One important consideration is that energy development is often linked to issues of self-determination. Statements by the former Navajo Chairman, Peter McDonald, that energy development on the Navajo Nation should be carried out for the benefit of the Navajo tribe apply to wind energy too. The tribe should be treated as a partner in the project and be provided with information that allows them to make informed decisions instead of simply trying to persuade the tribe – at any level of decision making from the Tribal Council to local chapters, that they will benefit from wind projects.

Many tribes may prefer to implement wind projects on their own. One major impediment to doing so at this point is the lack of appropriate incentive mechanisms for tribes to build large wind farms on their own. The fact that tribal governments do not pay a federal income tax makes them ineligible for the PTC. A wind farm that is owned by a tribe and financed with commercial debt would be significantly more expensive than a commercial wind farm with the same wind resource that is eligible for the PTC. Or, put another way, the tribe would have to have an unreasonably high quality wind resource to be cost competitive with commercial wind farms in other areas. The ability for tribal governments to issue tax-exempt bonds for qualifying uses would lower the cost of power from a tribal owned wind farm, but it would still be too costly or require too high of a wind resource to be cost competitive.

The one incentive that is promising is the Clean Renewable Energy Bonds. A wind farm financed with CREBs would even have a cost advantage over a commercial wind farm that uses the PTC. However, the CREB program, as it is currently implemented does not support large wind farms. The cap on the value of CREBs, currently at $800 million for the first two years of funding, would need to be increased substantially for the proposed 80 MW wind farm on the Navajo Nation to be wholly financed with CREBs. The REPI would also be an attractive incentive if it were to be implemented in a way that adds certainty to the program funding. As it is currently implemented, the REPI depends on year-to-year appropriations from Congress and has consistently been underfunded.

In conclusion, wind energy can contribute in certain ways to the economic development of tribal economies, but wind energy development is subject to some of the same critiques of the more broad energy development pathway. Tribes need to understand the risks and benefits of wind energy from all levels of decision-making - from the local level to the central tribal government. Programs like the DOE Tribal Energy Program that support feasibility studies and build capacity within tribes to manage and assess energy projects are important for facilitating the tribal decision making process. However, it is important for advocates of wind energy development to recognize that development is a multi-faceted process that goes far beyond providing "jobs and income" to tribes. Wind energy can contribute to economic development, but it must be carried out with broader efforts of tribes to develop in ways that are appropriate to their goals and needs.

Bibliography:

Acker, TL, WM Auberle, EPN Duque, WD Jeffery, DR LaRoche, V Masayesva, and DH Smith. 2003. "Implications of the Regional Haze Rule n Renewable and Wind Energy Development on Native American Lands in the West." *Wind Energy* 6(4)(October-December): 347-54.

Ambler, Marjane. 1990. *Breaking the Iron Bonds: Indian Control of Energy Development.* Lawrence, KS. : University Press of Kansas. 351 p.

Bain, C., C. Ballentine, A. DeSouza, L. Majure, H. Smith, J. Turek. 2004. "Navajo Electrification for Sustainable Development: The Potential Economic and Social Benefits" *American Indian Culture and Research Journal* 28(2): 67-79

BBC Research and Consulting. 2000. *Potential Economic Benefits from Commercial Wind Power Facilities in Quay County.* Santa Fe, NM: New Mexico Energy, Minerals and Natural Resources Department. July 15.

Bingham, Sam and Janet Bingham. 1987. *Navajo Chapters.* Rev. ed. Tsaile: Navajo Community College Press.

Block, F. 2001. *Introduction to Karl Polanyi, The Great Transformation* [orig. 1944], Boston: Beacon Press.

Bolinger, Mark, Ryan Wiser, Tom Wind, Dan Juhl, Robert Grace, Peter West. 2005. A *Comparative Analysis of Community Wind Power Development Models.* Paper LBNL-58043. Available at: http://repositories.cdlib.org/lbnl/LBNL-58043/

Bolinger, Mark, Ryan Wiser, Tom Wind, Dan Juhl, Robert Grace. 2004. *A Comparative Analysis of Community Wind Power Development Options in Oregon.* Prepared for The Energy Trust of Oregon, July. Available at: http://www.energytrust.org/RR/wind/OR_Community_Wind_Report.pdf

Bolinger, Mark, Ryan Wiser and William Golove. 2001. *Revisiting the "Buy versus Build" Decision for Publicly Owned Utilities in California Considering Wind and Geothermal Resources.* LBNL-48831. Berkeley: Lawrence Berkeley National Laboratory. October. Available at: http://eetd.lbl.gov/EA/EMP/

Boyer, L.B. 1979. "Tax Alternatives." Pp. 119-28 in *Economic Development in American Indian Reservations*, ed. Roxanne Dunbar Ortiz. Albuquerque: Native American Studies, University of New Mexico.

Brooks, R. and S. Cheew. 1984. "The Federal Loan Guarantee Program: A Unified Approach," *Journal of Corporation Law.* 10 (1)(Fall): 182-232.

Brunt, David. 1973. "Taxation and the American Indian." *Indian Historian* 6(2)(Spring): 7-10, 42.

Caley, Nora. 2006 "Native Renewables Energy Summit Touts Potential." *North American Windpower.* January.

Carlson, Virginia L. 1995. "Identifying Neighborhood Businesses: A Comparison of Business Listings." *Economic Development Quarterly* 9(1)(February): 50-59.

Choudhary, Trib. 2003. *2002-2003 Comprehensive Economic Development Strategy of the Navajo Nation.* Window Rock, AZ: Navajo Nation, Division of Economic Development

Costanti, M.. 2004. *Quantifying the Economic Development Impacts of Wind Power in Six Rural Montana Counties Using NREL's JEDI Model.* National Renewable Energy Laboratory: SR-500-36414.

Cornell, Stephen and Joespeh P. Kalt. 1998. "Sovereignty and Nation-Building: The Development Challenge in Indian Country Today." *American Indian Culture and Research Journal* 22(3): 187-214.

_____. 1997. "Successful Economic Development and Heterogeneity of Government Form on American Indian Reservations." In *Getting Good Government: Capacity Building in the Public Sectors of Developing Countries*, ed. Merilee S. Grindle. Cambridge: Harvard University Press.

Cornell, Stephen and Marta Cecilia Gil-Swedberg. 1995. "Sociohistorical Factors in Institutional Efficacy: Economic Development in Three American Indian Cases." *Economic Development and Cultural Change* (43)(2)(January): 239-68.

Cox, Craig. 2004. "From Snack Bars to Rebar: How Project Development Boosted Local Businesses Up and Down the Wind Energy 'Supply Chain' in Lamar, Colorado." Colorado Wind & Distributed Energy: Renewables for Rural Prosperity Proceedings, Colorado Springs, CO. April 13-14. Available at: http://www.eere.energy.gov/windandhydro/windpoweringamerica/

Curry, George N. 2003. "Moving Beyond Post-Development: Facilitating Indigenous Alternatives for 'Development'." *Economic Geography* 79(4): 405-423

DanMar and Associates. 1996. *Economic Impact Analysis of Windpower Development in Southwest Minnesota.* Southwest Regional Development Commission, Slayton, Minnesota. September.

Davis, H. Craig. 1990. *Regional Economic Impact Analysis and Project Evaluation.* Vancouver: University of British Colombia Press. 182 p.

Dietz, Sidney Bob II. 1998. *Navajo Hegemony: Formation and Expansion of the Navajo State.* Masters Thesis, Energy and Resources, University of California at Berkeley.

_____. Forthcoming. Doctoral Thesis, Energy and Resources, University of California at Berkeley.

"Dineh Bikeyah." 1989. *Navaho* 1(12): 7-13

Echohawk, Larry. 2004. "Balancing State and Tribal Power to Tax in Indian Country." *University of Idaho Law Review* 40(3): 623-56.

EIA. 2000. *Energy Consumption and Renewable Energy Development Potential on Indian Lands.* EIA Report SR/CNEAF/2000-01, Washington D.C: Department of Energy. April. Available at: http://www.eia.doe.gov/cneaf/solar.renewables/page/pubs.html

Ellis, Michael G. 1988. "Navajo Economic Behavior." *Journal of Behavioral Economics* 17(13)(Summer): 119-31.

Energy Policy Act (EPAct). 2005. United States Public Law 109-58, August 8.

Flowers, Larry. 2005. "Wind Energy for Rural Economic Development." Presentation at AWEA Windpower 2005, Denver, CO. May 18.

Gilbreath, L. Kent. 1973. *Red Capitalism: An Analysis of the Navajo Economy.* Norman: University of Oklahoma Press. 157 p.

Goldberg, M., K. Sinclair, M. Milligan. 2004. "Job and Economic Development Impact (JEDI) Model: A User-Friendly Tool to Calculate Economic Impacts from Wind Projects" 2004 Global WINDPOWER Conference; Chicago, IL, USA; March 29-31. NREL/CP-500-35953.

Golub, Howard. 2005. "Financing Tribal Energy Projects," presentation at Law Seminars International: Tribal Energy - Southwest, Las Vegas, NV. April 7.

Government Accountability Office (GAO). 2004. *Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities.* GAO-04-756. September.

Healey, Michael and Michael B. Rawlinson. 1993. "Interviewing Business Owners and Managers: A Review of Methods and Techniques." *Geoforum* 24(3): 339-55.

Hanula, Robert W. 1987. "The Navajo Tax System." *Arizona Bar Journal* 23(4): 6.

Harris, F. and P. Navarro, 2000. "Promoting Wind Energy Development in an Era of Restructuring." *The Electricity Journal* 13(1)(January/February): 34-39.

Henderson, Al. 1979. "Tribal Enterprises: Will They Survive?" Pp. 114-18 in *Economic Development in American Indian Reservations*, ed. Roxanne Dunbar Ortiz. Albuquerque: Native American Studies, University of New Mexico.

Henderson, Eric B. 1979. "Skilled and Unskilled Blue Collar Navajo Workers: Occupational Diversity in and American Indian Tribe." *Social Science Journal* 16(2)(April): 63-80.

Henson, Eric and Jonathan B. Taylor. 2002. *Native America at the New Millennium.* Cambridge: Harvard Project on American Indian Economic Development, Harvard University. Available at: http://www.ksg.harvard.edu/hpaied/

Iverson, Peter. 1981. T*he Navajo Nation.* Connecticut: Greenwood Press.

Iverson, Peter and Monty Roessel. 2002. *Diné: A History of the Navajos.* Albuquerque: University of New Mexico Press.

Kammen, Daniel M., Kamal Kapadia, and Matthias Fripp. 2004. *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* RAEL Report, University of California, Berkeley.

Kay, C. 1991. "Reflections on the Latin American Contribution to Development Theory." *Development and Change* 22: 31-68.

Khan, Jamil. 2003. "Wind Power Planning in Three Swedish Municipalities." *Journal of Environmental Planning and Management* 46 (July)(4): 563-581.

Kubert, Charles. 2004. *Community Wind Financing: A Handbook by the Environmental Law & Policy Center.* Chicago: Environmental Law and Policy Center. Available at: http://www.elpc.org/documents/WindHandbook2004.pdf

LaDuke, Winona. 2004. *Indigenous People, Power and Politics: A Renewable Future for the Seventh Generation.* Minneapolis, MN: Honor the Earth. 46 p.

LaDuke, Winona and Ward Churchill. 1985. " Native America: The Political Economy of Radioactive Colonialism." *Journal of Ethnic Studies* 13(3)(Fall): 107-32.

Levy, Jerrold E. 1980. "Who Benefits from Energy Resource Development: The Special Case of Navajo Indians." *Social Science Journal* 17 (1)(January): 1-19.

Little, Ronald L., and Stephen B. Lovejoy. 1979. "Energy Development and Local Employment" *Social Science Journal* 16(2): 27-49.

Longbrake, David and Geyler, James F. 1979. "Commercial Development in Small, Isolated Energy Impacted Communities." *Social Science Journal* 16(2): 51-62.

McGowan, J. G. and S. R. Connors. 2000. "Windpower - A Turn of the Century Review" *Annual Review of Energy and the Environment* 25(November): 147-97.

McNamara, Robert. 1973. "Paupers of the World and How to Develop Them." Address to the Board of Governors, World Bank, speech delivered in Nairobi, Kenya.

"Navajo Natural Resources." 1987. *Maazo* 1(8)(Spring): 20

National Wind Coordinating Committee (NWCC). 2004a. *A Methodology for Assessing the Economic Impacts of Wind.* Washington D.C.: RESOLVE. June.

_____ 2004b. *Economic Development Impacts of Wind Power – Summary of Case Study Results.* Washington D.C.: RESOLVE. June.

Niles, Kathleen. 2005. " Structuring Energy Projects: Tax Considerations" presentation at Law Seminars International: Tribal Energy - Southwest, Las Vegas, NV. April 7.

Northwest Economic Associates (NEA). 2003. *Assessing the Economic Development Impacts of Wind Power.* Prepared for NWCC. Washington D.C.: RESOLVE. February 12.

Owens, Nancy Jean. 1979. "Can Tribes Control Energy Development?" *American Indian Journal* 5(1)(January): 3-17.

PacifiCorp. 2005. *2004 Integrated Resource Plan Update Report.* Portland, OR: PacifiCorp IRP Resource Planning. November. Available at: http://www.pacificorp.com

Palma, J. 1989. "Structuralism" in *Economic Development; The New Palgrave.* ed. John Eatwell, Murray Milgate, Peter Newman. New York: W.W. Norton

Redlinger, Robert Y., Per Dannemand Anderson, and Poul Erik Morthorst. 2002. *Wind Energy in the 21st Century: Economics, Policy, Technology and the Changing Electricity Industry.* New York: Palgrave. 245 p.

Robbins, Lynn Arnold. 1979. "Navajo Energy Politics" *Social Science Journal* 16(2)(April): 93-119.

Ross, M. 2001. *Extraction Sectors and the Poor.* Boston: Oxfam America. Available at: http://www.oxfamamerica.org/

Ruffing, Lorraine Turner. 1976. "Navajo Economic Development Subject to Cultural Constraints." *Economic Development and Cultural Change* 24(3)(April): 611-21.

______. 1980. "The Role of Policy in American Indian Mineral Development." Pp. 39-73 in *American Indian Energy Resources and Development*, ed. Roxanne Dunbar Ortiz. Albuquerque: Native American Studies, University of New Mexico

Sargent & Lundy. 2006. Study of Potential Mohave Alternative/Complementary Generation Resources: Pursuant to CPUC Decision 04-12-016. Prepared for Southern California Edison, Report SL-008587. Chicago, IL: Sargent & Lundy LLC. February.

Schoepfle, G. Mark, M. Burton, and Kenneth Y. Begishe. 1984. "Navajo Attitudes toward Development and Change: A Unified Ethnographic and Survey Approach to and Understanding of Their Future." *American Anthropologist* 86(4): 885-904.

Seers, Dudley. 1969. "The Meaning of Development," *International Development Review* XI: 2-6.

Shirley, Joe Jr. and Arvin Trujillo. 2003. *Resource Development as a Tool for Nation Building.* Speech to the World Bank. March 5. Available at: http://www.worldbank.org.

Singh, Virinder and Jeffery Fehrs. 2001. *The Work That Goes Into Renewable Energy.* Research Report No. 13. Washington D.C.: Renewable Energy Policy Project. November. Available at: http://www.repp.org

Suagee, Dean. 1998. *Renewable Energy in Indian Country: Options for Tribal Governments.* Renewable Energy Policy Project, Issue Brief No. 10. May. Available at http://www.repp.org/repp_pubs/repp_publications.html

Tegan, S. 2005. Comparing Statewide Economic Impacts of New Generation from Wind, Coal, and Natural Gas in Arizona, Colorado, and Michigan. Prepared for Windpower 2005, Denver, CO. May 15-18. Available at: http://www.eere.energy.gov/windandhydro/windpoweringamerica/economics.asp

Thal, Alexander J. 1981. "Fairness in Compensation Procedures: A Case Study of Navajo Tribal Land Acquisition Policies." Diss. State University of New York at Buffalo. 235 p.

Utter, Jack. 2001. *American Indians : Answers to Today's Questions.* Norman : University of Oklahoma Press. 494 p.

Welsh, Teresa. 2005. *Small Packages, Big Benefits: Economic Advantages of Local Wind Projects.* Mount Vernon, Iowa: The Iowa Policy Project. April. Available at: http://www.iowapolicyproject.org/2005_reports_press_releases/050405-wind.pdf

Wiley, Peter and Robert Gottlieb. 1982. *Empires in the Sun: The Rise of the New American West.* New York: G.P. Putnam's Sons.

Wilkins, David. 2002. "Governance within the Navajo Nation: Have Democratic Traditions Taken Hold?" *Wicazo Sa Review* 17(1)(Spring): 91-121.

Wilkinson, Charles. 2005. *Blood Struggle: The Rise of Modern Indian Nations.* New York: Norton. 543 p.

____. 1999. *Fire on the Plateau.* Washington: Island Press.

____. 1996. "Home Dance, the Hopi, and Black Mesa Coal: Conquest and Endurance in the American Southwest", *Brigham Young University Law Review* 1996: 449.

Windustry. 2005. *Wind Energy Easements and Leases: Compensation Packages.* Minneapolis, MN: Windustry. September. Available at http://www.windustry.com/easements

Wiser, R. and E. Kahn. 1996. *Alternative Windpower Ownership Structures: Financing Terms and Project Costs.* Berkeley: Lawrence Berkeley National Laboratory. LBNL-38921.

Wood, Elisa. 2005. "Jobs in the renewable energy economy." *RE World* (February) Available at http://www.earthscan.co.uk

Wood, Robert. 1986. "Basic Needs and the Limits of Regime Change." pp. 195-231 in *From Marshall Aid to Debt Crisis: Foreign Aid and Development Choices in the World Economy.* Berkeley: University of California Press:

Appendix I: Navajo Economy and Wind Energy

AI.1 Purpose:

The local economic impacts of a wind farm will depend on the capacity of local businesses within the Navajo economy to participate in the construction and operations of the wind farm. In general rural economies tend to be poorly diversified, meaning that much of the labor and materials are imported from outside of the local economy. The Navajo Nation is predominately rural, but between tribal enterprises, Navajo contractors and construction material suppliers, and a large labor pool it appears that a significant portion of the inputs to a wind farm can be supplied locally. Figure 15 illustrates the total inputs to a wind farm, but the question remains of how much of the supplies and labor required for the wind farm will be supplied locally.

Typical Inputs for Wind Power Development Projects

Construction Costs
Materials
Construction (concrete, rebar, equipment, roads and site preparation)
Electrical (drop cable, wire,)
High-voltage line extension

Labor
Foundation
Erection
Electrical
Management/supervision

Equipment Costs
Turbines (excluding blades and towers)
Blades
Towers
Transformer
High-voltage Substation/Interconnection

Project Planning and Development
Site Evaluation
Engineering
Legal Services
Land Easements
Permitting and Site Certification

Wind Plant Annual Operating and Maintenance Costs
Personnel
Field Staff
Administrative
Management

Materials and Services
Vehicles
Miscellaneous Services
Fees, Permits, Licenses
Utilities
Insurance
Fuel (motor vehicle gasoline)
Tools and Miscellaneous Supplies
Spare Parts Inventory
Financing (average annual debt payment)
Equity Payment - Individuals (average annual payment)
Equity Payment - Corporations (average annual payment)
Land Lease

Figure 15 - Typical inputs for a wind farm from NWCC 2004a.

The purpose of this section is to describe companies operating within the Navajo Nation that regularly perform tasks similar to those found in building and operating a wind farm. The qualitative description is then used to make a quantitative estimate of the local share of expenditures that will remain in the Navajo economy when a wind farm is built.

AI.2 Methodology:

Interviews with employees from tribal enterprises, Navajo contracting firms, and Navajo material suppliers were conducted in-person or over the phone in the period from July to August 2005. The aim of the interviews was to estimate the ***capacity*** for Navajo businesses to participate in the wind farm tasks, to estimate the ***local share*** of spending on jobs similar to the tasks in wind farm construction and operations, and to explore the ***linkages*** between the company and other Navajo businesses and workers.

The interviews were semi-structured and in general covered the following topics:

- Experience with jobs similar to those needed in constructing and operating a wind farm
- Procedure for bidding on contracts and hiring laborers
- Linkages between the company, suppliers, and service providers
- Estimates of portion of spending that remains in the Navajo Economy

The questions were focused only on the tasks identified as similar to the company's previous experience or within the scope of the business. Businesses were selected for interviews from the source list for certified Navajo businesses published by the Business Regulatory Department, Navajo Nation Division of Economic Development.[21] Keywords for each business were used to determine businesses that were likely to have experience performing tasks similar to those required for wind farms. Appendix II provides a sample of businesses and keywords used to select potential interviewees. Healey and Rawlinson (1993) provide useful guidance on interview techniques with business owners to understand the structure of a local economy.

AI.3 General Description of Navajo Economy

The Navajo Nation is a rural, sparsely populated region spanning the Four Corners of the Southwest. While the majority of towns and villages are very small, the Navajo government uses the term 'growth center' to describe a number of towns that are growing considerably larger than the majority of towns. Towns like Window Rock, Shiprock, Tuba City, and Chinle have large, growing populations, shopping centers, and a growing number of businesses. These growth centers help to reduce the leakage rate of the Navajo economy by providing the facilities that many used to drive to find in border towns like Gallup, Farmington, and Flagstaff. That is not to say that everything can be found on the reservation. The leakage rate of the Navajo economy still exceeds 70%, meaning that the majority of income earned in the Navajo Nation is spent in towns outside of the Navajo economy (Choudhary, 2003).

In order to increase the local impacts of construction and other economic activity on the Navajo economy, the Navajo Nation requires that Navajo businesses have priority when bidding on contracts or providing services and Navajo laborer have preference in hiring practices.

The government supports numerous tribal enterprises that serve a similar purpose in ensuring that Navajo monies are retained in the local economy. The Navajo Tribal Utility Authority provides electricity, gas, and water to homes and businesses within the Navajo Nation. The Navajo Engineering and Construction Authority provides construction services primarily in government-to-

[21] Business Regulatory Department, Navajo Nation Division of Economic Development. 2005. *Source List – Certified Navajo Businesses* St. Michaels, AZ: Division of Economic Development. June 2005. Available at http://www.navajobusiness.com/doingBusiness/

government operations such as improvements for the Indian Health Services, within the Bureau of Indian Affairs. The Navajo Business Opportunity Act distinguishes between Navajo owned businesses and tribal enterprises. First priority in awarding contracts for bids goes to 100% Native American owned businesses, while tribal enterprises and majority but less than 100% Native American owned businesses are second priority. Third priority is all other businesses. Of course any businesses must be able to show that they are capable of meeting the demands of a contract before it will be awarded to them.

The combination of Navajo business preference, tribal enterprises, and Navajo preference for labor ensures that the Navajo economy will have significant impacts during the construction of a large wind farm.

AI.4 Construction Impacts on Navajo Economy

The following list describes the general tasks that are completed during the construction of a wind farm. This list was shown to interviewees during in-person interviews. The numbers are not exact, instead they are general estimates made using information in the literature, communications with persons involved in the wind industry, and personal judgment (BBC Research 2000; Cox 2004; DanMar 1996).

AI.4.1 Description of Tasks during Wind Farm Construction and Operations

General

- Proposed wind farm is 80 MW, or about fifty, 1.5 MW turbines
- Site is on top of Gray Mountain, just southwest of Cameron, in the Western region of the Navajo Nation
- Total construction period is around one year

Roads/ Excavation/ Site Preparation:

- Building and expanding dirt roads capable of supporting a very large crane and semi-trucks carrying large wind turbine blades
- Semi-hilly terrain, on the order of 10-20 miles of roads
- Excavate for foundations, 10,000 - 20,000 cubic yards excavation in dense soil with scattered rocks, each hole is about 300 cubic yards (approximately 20ft wide and 30ft deep)

Utility Shed:

- Construction of a single story building/ utility shed for operations and maintenance phase of wind farm
- On the order of 2,000 – 4,000 square feet with office, storage, parking lot, and fencing

Foundation Concrete:

- Cast-in-place foundations, most likely field-mixed concrete
- 10,000 – 20,000 cubic yards of concrete for whole wind farm, with approximately 300 cubic yards per turbine

Foundation Rebar:

- Reinforcement for foundation and mounting bolts for wind turbine tower
- 1000-2000 tons of rebar for whole wind farm, 45,000 lbs per turbine

Transformers:

- Transformers at each turbine (about 50) to connect to 'collection system'. Approximately 590V to 34kV conversion, rated at 2 – 3 MVA.
- Transformer pad and wiring to connect to wind turbine

Collection System (Underground wiring):
- Underground, three-phase 34kV cable between each turbine and the substation
- Excavation and backfill of wire trench
- On the order of 10 miles of cable

Substation/ High Voltage Interconnection:
- 69kV to 500kV interconnection voltage with local transmission system
- Connection of substation to existing system (<1 mile to 10 miles of HV lines)
- Pad for substation
- **Or** possible upgrades of existing switching station (Moenkopi Substation – 500 kV)

Steel Erection:
- Steel tubular towers, in multiple sections, up to height on order of 70 meters (230 feet)
- Erection is done using a large crane (300-450 ton capacity).
- Process is repeated fifty times during construction phase
- Wind turbine and blades are mounted at top of towers

Engineering:
- Civil engineering and collection/interconnection system electrical engineering

Operations and Maintenance:
- Long term (20 years) O&M phase
- Monitoring wind farm performance
- Cleaning blades, maintaining generators, electrical equipment
- Oil changes, routine machine shop work

Today, firms that specialize in constructing wind farms build most wind farms. Experienced, specialized firms can reduce costs by carrying out the construction process in an organized and efficient manner. Typically the firm will receive a contract and fee for management and supervision of the process. Local laborers carry out many of the less specialized tasks, while experts provide supervision.

While this traditional model of development will provide substantial benefits to the Navajo economy, utilizing Navajo firms and supervisors can increase the local benefits while building capacity for future wind projects. The following section will explore the capacity of Navajo businesses to participate in the construction and operation of a wind farm.

AI.5 Capacity:

In addition to NTUA and NECA, which are both tribal enterprises, numerous general contractors and specialized tradesman operate 100% or majority owned businesses. NTUA and NECA both have considerable in-house expertise and equipment to perform routine tasks related to their central role. On the other hand, many of the businesses operate with much less overhead: they tend to rent equipment, hire laborers for particular jobs, and in some cases operate from the owner's home. Contractors that do business with the Navajo government are required to have a state certification.

Many of the large construction jobs are in support of major activities in Navajoland. The Navajo Agricultural Products Industry (NAPI) requires irrigation and pumping support, the Indian Health Services contracts for installation of water infrastructure and water towers, and the oil and gas operations in areas like the San Juan Basin require contractors. Construction for government, residential, and commercial buildings also includes installation of infrastructure and materials that would be used in building a wind farm.

To explore the capacity of Navajo firms, the following section will compare the tasks described in the previous section to construction jobs that Navajo firms have done in the past.

AI.5.1 Site Preparation and Utility Shed

The first two tasks, roads/excavation/site preparation and building a utility shed are common construction tasks that Navajo firms have done in the past. The only challenge to building roads and compacting the soil for turbine foundations will be the scarce water resources. A Navajo firm that has done uranium mine reclamation work in the Cameron area indicated that reclaimed water from a water treatment facility in Tuba City or Flagstaff will have to be trucked to the site, unless there is running water in the seasonal Little Colorado River.

AI.5.2 Concrete and Rebar

Local firms can supply the concrete for the foundations. One local concrete supplier has built nearly fifty field-mix plants for large concrete pours in the past thirty years and owns all of the necessary equipment. The supplier works all over the reservation, so supplying concrete for a wind farm on Gray Mountain will not pose a challenge. Similar jobs include large bridges and multi-million dollar buildings. Rebar for the foundations is similarly a routine task for contractors experienced in building bridges and large buildings.

AI.5.3 Transformers, Collection System, and Substation

NTUA regularly works with voltages up to 115kV and owns extensive 69kV sub-transmission lines. With in-house expertise, NTUA regularly installs transformers rated for loads on the order of 20 MW. They also work with smaller transformers to connect homes and buildings to the NTUA distribution grid. A large substation, operating above 200kV is outside of the normal operations of NTUA, but connecting the wind farm to a 69kV or similar line is possible.

Navajo general contractors have excavated, laid cable, and back filled trenches, but they tend to sub-contract the electrical work to specialized tradesman. A few such specialized Navajo businesses exist, but outside of NTUA, highly skilled electricians are somewhat rare. One Navajo general contractor indicated that they have installed underground lines for Arizona Public Service (APS), but that the utility was responsible for installing the electrical equipment. The contractor also installed underground water and sewer lines.

AI.5.4 Steel Erection and Engineering

While none of the firms interviewed had experience with erecting wind turbines, a number had worked on installing water towers. The water towers have tubular steel supports and a large, heavy weight at the top of the supports – similar to a wind turbine. A NECA employee indicated that a few experienced ironworkers could be used to train inexperienced workers in the erection of the towers and turbines. Because the process of installing a tower and turbine is repeated numerous times, Navajo construction workers will have no trouble participating in this step.

The crane operator, on the other hand, tends to be a specialized operator that focuses only on installation of wind turbines, due to the critical and complicated nature of the position.

A firm experienced with wind farms will most likely do the engineering for the wind farm. Local contractors will have a significant amount to offer to the engineering firm in terms of the characteristics of the soil and similar subtleties. They should be utilized in the design phase even if an outside firm is contracted for this step.

AI.5.5 Operations and Maintenance

NTUA is experienced in O&M for the electrical grid, water services, and gas distribution. For instance, NTUA maintains a monitoring system called the SCADA or Supervisory Control and Data Acquisition system for monitoring the performance of the distribution grid. Maintaining a wind farm will require similar skills. Technicians will need specialized turbine maintenance, but turbine manufactures routinely train local workers for such positions. Navajo businesses provide welding and metal working services that can be used to maintain the wind farm.

AI.5.6 Summary

While no Navajo firms have built a modern wind farm, many have experience in supporting or managing similar activities on Navajo land. The only tasks that will most likely need to import specialized businesses will be the engineering of the wind farm and foundations, the substation electricians (if the interconnection voltage is above 115kV), and crane operators. It appears that Navajo workers and firms, collectively, have sufficient experience to be able to lead the other jobs.

AI.6 Linkages:

After establishing that Navajo firms can participate in the construction and operations of a wind farm, it is necessary to survey the linkages between businesses. Linkages refers to the ability and tendency for one Navajo firm to purchase inputs, such as concrete aggregates for making concrete, from another firm within the Navajo Nation. Such a linkage would be described as a backward linkage, whereas a forward linkage would be the selling of a product to another Navajo firm. These linkages produce an "indirect effect" when money is spent on the service or product of another firm. Economic Input-Output models, such as IMPLAN, are used to evaluate these linkages, but interviews with businesses can be just as revealing.

Many of the interviewees indicated that they try to purchase as much as they can from other Navajo businesses and hire Navajo workers. However, products or services are often not available on the reservation or in some cases, it is easier to purchase products or services from off-reservation cities. This section will focus on linkages within three areas: equipment and materials, labor, and services.

AI.6.1 Equipment and Materials:

Construction jobs often require heavy machinery. NECA indicated that it owns substantial amounts of construction equipment while one of the contractors owns commonly used machinery like excavators and water trucks. The other firms will rent equipment depending on the job. To the contractor, this makes more financial sense because the equipment needs vary according to jobs and seasons. So unless a construction firm plans to be using a particular piece of equipment year-round, for all jobs, the firm will rent the equipment. Even NECA will rent equipment during the peak construction season rather than own equipment that only is used a few months out of the year.

All of the equipment is bought or rented from border towns, such as Farmington and Flagstaff, no companies indicated that they were able to obtain machinery from within the Navajo Nation. While renting from off-reservation companies makes financial sense to individual firms, it also contributes to the leakage rate of the Navajo economy. If a Navajo rental company existed, a portion of the profits and wages paid to workers would remain in the Navajo economy.

Materials commonly used in construction such as tools, lumber and other hardware are available from numerous retail stores. Tuba City has a True Value hardware store that would provide many of the common construction materials. Concrete suppliers also operate in various locations around the reservation, including Tuba City. The concrete aggregate materials, like gravel and sand, are available from Navajo owned pits in the area. Cement is not available on the reservation and will have to be imported from cities like Phoenix.

Aside from the general construction materials and concrete suppliers, none of the materials needed for the construction of the wind farm are manufactured or sold on the reservation, as is common in other rural wind farm projects. Transformers, cable, towers, and the turbines will all have to be imported.

AI.6.2 Labor:

Many of the firms indicated that labor is hired for specific projects instead of hiring a full time workforce. While construction work is somewhat seasonal, laborers are often busy year round with construction jobs. Or in the case of the tribal enterprises they may have a full time staff that is used in other capacities during the slow season, or even occupied with employee training programs.

The tendency to hire Navajo employees and the Navajo Nation employment preference laws lead to contractors hiring 80-95% Navajo workers for a typical job. If NTUA is responsible for the high voltage electrical work, it is reasonable to assume the same percentage Navajo workforce for a wind farm on Navajo land. There is a large pool of qualified Navajo workers – including carpenters, welders, and equipment operators. None of the interviewees indicated that they have experienced a shortage of Navajo workers. The contractor usually will send out a core crew of supervisors to the area where the construction will occur. The remaining workers come from the surrounding region. A job in Tuba City, for example, would not have trouble attracting on the order of one hundred workers during the one-year construction period. If advertising for workers was not sufficient to attract enough workers, a contractor will go to the local unemployment office where a database of workers is kept.

One contractor suggested that a typical job would be composed of the core 20% supervisors and 80% laborers. In the best case it can be expected that all of the laborers and 75% of the supervisors will come from the Navajo Nation. Of the 80% of the laborers, most will be from the area near Tuba City and Cameron. Skilled positions like electricians, might be in short supply in the local region, but NTUA can provide expertise where necessary.

In the case that specialized supervisors are all imported from off-reservation, the labor force can still be expected to be 80% Navajo. The supervisors provide the direction and on-the-job training necessary to get a worker inexperienced in jobs related to building a wind farm up to speed.

AI.6.3 Services:

In addition to labor and materials, construction businesses often use local services to operate the businesses or to provide for the workers during the construction period. Most interviewees responded that off-reservation firms performed services such as accounting and auditing. During the construction period, the contractors will use local gas stations for fueling, but hotels and restaurants were not used by all of the workers. Part of the reason that local workers are used in construction jobs is that it reduces the costs for labor because workers can stay at home and prepare their own meals. Even when laborers travel to a job site for extended periods, they will be more likely to camp at a campground or the job site if the weather permits. It can therefore be expected that the local room and board services will be less than for other rural wind farms in harsher climates.

AI.6.4 Summary:

Navajo businesses will for the most part patronize other Navajo businesses and laborers when available. Equipment is typically rented from off-reservation towns. Regular construction materials are available on the reservation at retail stores, but special materials like high voltage cable, transformers, and turbine components will have to be imported.

Most of the labor for the construction will come from the region around the wind farm location. It is unlikely that there will be a shortage of qualified Navajo workers, but there is a chance that at least a portion of the supervision for the wind farm will have to be imported. Because a large portion of the workers may commute to the work site from home, services during the construction period may be less than one would expect for a rural wind farm.

AI.7 Local Share:

A key assumption for estimating the local economic impact of a wind farm will be the share of money that is directly spent in the local economy to build and operate the wind farm. In the JEDI model, this is referred to as the 'Local Share'. Based on the previous sections, the assumptions for local share are shown in Table 11 and are compared to the default assumption provided by the model.

A recent study by the General Accounting Office (GAO) used the JEDI model to estimate the local impacts of wind farms in various counties around the United States. The report describes reasons for changing the default assumptions for the local share. One of the critical parameters in the construction phase is the portion of the construction materials that are acquired locally. In very small, isolated counties few construction materials were available locally, leading to a local share parameter of 4-10 percent for construction materials. Pecos County in Texas is a typical small, poorly diversified rural county. At the other extreme, urban counties like Alameda County in the San Francisco Bay area, are estimated to provide 90 percent of the construction materials in the local economy (GAO 2004).

The local share of the construction materials cost for a wind farm on Navajo land is based on the assumption that local firms will provide all of the concrete, equipment for excavation, and equipment for building roads. The result is that the remaining materials, primarily rebar, will be imported from off- reservation. The local share is then about 50 percent for construction material cost. However, if a local concrete supplier is not used, or all of the equipment is rented from off-reservation, this parameter could drop to as low as 10 percent. The importance and uncertainty in this parameter mean that Monte-Carlo simulation will be useful for exploring the range of possible outcomes. The other uncertain parameters will be the local share of electrical labor and the annual wind speeds (to be used in another section of this model). The remaining adjustments to the local share are self-explanatory and the final results are not as sensitive to the local share parameter.

Comparison of Local Share Assumptions for JEDI Model

	Local Share		
Construction:	JEDI Defaults:	Navajo Wind Farm:	Notes:
Materials			
Construction (concrete, rebar, equip, roads and site prep)	90%	50%	Concrete, site prep, and road inputs are all available locally, rebar and other equipment will be imported
Transformer	0%	0%	
Electrical (drop cable, wire)	100%	0%	
HV line extension	100%	10%	Nearly all of the materials for line extension will be bought elsewhere
Labor			
Foundation	100%	100%	
Erection	75%	75%	Labor is local, but an experinced crane operator and tower technician are imported (25%)
Electrical	75%	95%	Assume that nearly all of the electrical work is done by NTUA or other skilled Navajo electricians
Management/supervision	0%	50%	An experienced local contractor can contribute to supervision
Equipment Costs			
Turbines (excluding blades and towers)	0%	0%	
Blades	0%	0%	
Towers	0%	0%	
Other Costs			
HV Sub/Interconnection	100%	10%	The concrete pad and fencing can be done locally
Engineering	0%	0%	
Legal Services	100%	50%	Most interviewees used off-reservation support services
Land Easements	100%	100%	
Site Certificate/Permitting	100%	100%	
Wind Plant Annual Operating and Maintenance Costs:			
Personnel			
Field Salaries	100%	100%	
Administrative	100%	100%	
Management	100%	100%	
Materials and Services			
Vehicles	100%	0%	New vehicles are not available on the reservation
Misc. Services	80%	80%	
Fees, Permits, Licenses	100%	100%	
Utilities	100%	100%	
Insurance	0%	0%	
Fuel (motor vehicle gasoline)	100%	100%	
Tools and Misc. Supplies	100%	100%	
Spare Parts Inventory	2%	2%	

Table 11 - Comparison of local share for Navajo wind farm in comparison to JEDI default values

AI.8 JEDI Model of Wind Farm Impacts:

Multiple scenarios were used with JEDI to evaluate the expected job impacts of the 80 MW wind farm on the Navajo Nation. It is difficult to model regional economies that do not fit within county boundaries when using a platform based on the IMPLAN model. Since the Navajo Nation spans three states and six counties, no attempt was made to build and Input-Output model for the

Navajo Nation. Instead, the multipliers for Arizona were used with the local share estimates for the Navajo economy. Therefore the results presented in this section are not meant to exactly predict the number of jobs that will be created by the wind farm, instead this exercise yields a rough estimate and helps to understand how jobs are created.

The JEDI model used all of the JEDI default values except for the total installed cost, local shares, O&M costs, and land lease costs, and taxes. The total construction cost was changed to $1,500/kW to match the expected cost of the wind farm. The local shares were changed to reflect the assumptions in Table 11. The O&M costs were set at $13.25/kW. This value was selected so that the total direct impacts of the O&M phase per year match the real levelized value of the expected direct impacts of the wind farm on the Navajo economy found in Table 7. The land lease cost was set to match the assumed land lease payment of $3,000/MW. The taxes were set manually to reflect the sum of the expected real levelized tax revenue and any revenue from owning the wind farm. Three scenarios were evaluated using the results from Table 7. The scenarios include: a commercial owned wind farm, a joint venture with the Navajo partner taking 50% ownership after the flip, and a wind farm financed with CREB's. The scenario specific inputs to JEDI along with the results are shown in Table 12.

Assumptions and Results from JEDI Scenarios

Scenario:	Commerical	Joint Venture	Tribal - CREBs
Assumptions			
Real Annual Payment			
Taxes	$601,636	$595,226	$590,116
Ownership Revenues	-	$1,032,517	$375,233
Total	$601,636	$1,627,743	$965,349
Land Lease	$239,967	$239,967	$239,967
Local O&M	$640,005	$640,005	$640,005
Results			
Construction Job Impacts (One year)			
Total	**96**	**96**	**96**
Direct	40	40	40
Indirect	26	26	26
Induced	31	31	31
O&M Job Impacts (Each year for 20 years)			
Total	**35**	**44**	**38**
Direct	21	21	21
Indirect	4	5	4
Induced	10	18	13

Table 12 - Scenario specific assumptions and results from JEDI model of 80 MW wind farm on the Navajo Nation

Appendix II: Navajo Businesses

The following list is a sample of businesses that are majority owned by Navajo taken from the Business Regulatory Department Source List.[22] The description of the business in the list was used to identify businesses that have experience in tasks similar to those required in building and operating a wind farm. This list is for illustration only. It is not exhaustive nor should it indicate that the businesses are qualified to build a wind farm.

Wind Farm Task	Possible Navajo Business
Roads/ Excavation/ Site Prep.	
	KFowler Construction Co., Tuba City, AZ
	Navajo Engineering & Construction Auth.; Shiprock, NM
	NHC Construction Co.; St. Michaels, AZ
	Silver State Construction Co., Inc; Shiprock, NM
Utility Shed	
	Navajo Engineering & Construction Auth.; Shiprock, NM
	NHC Construction Co.; St. Michaels, AZ
Foundation Concrete	
	Dine' Contractors, Inc.; Tuba City
	KFowler Construction Co., Tuba City, AZ
	J & J Welding & Construction; Shiprock, NM
	Navajo Engineering & Construction Auth.; Shiprock, NM
	Silver State Construction Co., Inc; Shiprock, NM
	SWC Transit Mix, Inc.; Tuba City, AZ
Found. Rebar	
	Dine' Contractors, Inc., Tuba City
	KFowler Construction Co., Tuba City, AZ
	Navajo Engineering & Construction Auth.; Shiprock, NM
Transformers	
	H.D. Williams Electrical Services; St. Michaels, AZ
	KFowler Construction Co., Tuba City, AZ
	Navajo Engineering & Construction Auth.; Shiprock, NM
	Shiprock Electrical Service; Shiprock, NM
Collection System	
	H.D. Williams Electrical Services; St. Michaels, AZ
	KFowler Construction Co., Tuba City, AZ
	Navajo Engineering & Construction Auth.; Shiprock, NM
	NHC Construction Co.; St. Michaels, AZ
	Shiprock Electrical Service; Shiprock, NM

[22] *Source List – Certified Navajo Businesses* ; See note 21.

Silver State Construction Co., Inc; Shiprock, NM

Substation/ HV Lines

H.D. Williams Electrical Services; St. Michaels, AZ
KFowler Construction Co., Tuba City, AZ
Navajo Engineering & Construction Auth.; Shiprock, NM

Steel Erection

Dine' Contractors, Inc.; Tuba City
J & J Welding & Construction; Shiprock, NM
KFowler Construction Co., Tuba City, AZ
Navajo Engineering & Construction Auth.; Shiprock, NM

Engineering

H.D. Williams Electrical Services; St. Michaels, AZ
Silver State Construction Co., Inc; Shiprock, NM

Operations and Maintenance

J & J Welding & Construction; Shiprock, NM
NTUA, Tuba City Wastewater Facility

Business Contact Information:	Keywords:
Dine' Contractors, Inc. PO Box 2963 Tuba City, AZ 86045 Priority 1 Phone: (928) 283-4466 Contact Person(s): Larry Farrell	Description: General Contractor **Foundation concrete and rebar; steel erection**
H.D. Williams Electrical Services PO Box 1456 St. Michaels, AZ 86511 Priority 1 (505) 879-9915 Phone: Contact Person(s): Harrison Dominick Williams	Description: Sub Contractor **Transformers, underground wiring, sub-station/ high voltage work, engineering services**
J & J Welding & Construction PO Box 2830 Shiprock, NM 87420 Priority 1 Phone: (505) 368-5000 FAX No. (505) 368-5000 Contact Person(s): Dahlia A./Benjamin Scott	Description: General Contractor **Foundation concrete, steel erection, O&M support**

KFowler Construction Co. PO Box 3189 Tuba City, AZ 86045 Priority 1 Phone: (928) 283-4646 FAX No. (928) 283-5933 Contact Person(s): Ken Fowler	Description: General Contractor **Roads, foundation concrete and rebar, transformers, underground wiring, sub-station/ high voltage work,**
Navajo Engineering & Construction Auth. PO Box 969 Shiprock, NM 87420 Priority 2 (Tribal Enterprise) Phone: (505) 368-5151 Contact Person(s): William C. Broughton	Description: General Contractor **Roads, utility shed, foundation concrete and rebar, transformers, underground wiring, sub-station/ high voltage work,**
N H C Construction Company PO Box 1053 St. Michaels, AZ 86511 Priority 1 Phone: (928) 871-3278 FAX No. (928) 871-3279 Contact Person(s): Norman H. Chee	Description: General Contractor **Roads, utility shed, underground wiring**
Shiprock Electrical Service PO Box 2387 Shiprock, NM 87420 Priority 1 Phone: (505) 327-5340 Contact Person(s): Gene Lee	Description: Special Trades Contractor **Transformers, underground wiring**
Silver State Construction Co., Inc. PO Box 3000 Shiprock, NM 87420 Priority 1 Phone: (505) 368-4144 FAX No. (505) 368-4175 Contact Person(s): Viviene Tallbull	Description: General Contractor **Roads, foundation concrete, underground wiring, engineering**
SWC Transit Mix, Inc. PO Box 766 Tuba City, AZ 86045 Priority 1	Description: Supplier **Foundation concrete**

Phone: (928) 283-6878

Contact Person(s): Shannon Tooke

Appendix III: Job Multipliers in the Navajo Economy

AIII.1 Introduction:

In addition to the quantity of jobs created, it is also important to look at the quality of jobs. One useful metric is the employment multiplier for a sector. As explained below, this metric is a simple indicator for the total number of jobs that are created in a local economy when an additional job is added to a particular sector.

AIII.2 Method:

A simple Income-Expenditure analysis, as presented by H. Craig Davis (1990), was performed to estimate the employment multipliers for the Navajo economy. The model is based on the fact that of a certain amount of money, $X, spent in the Navajo economy, a portion will be then spent on goods and services from outside the local economy, and the remainder will be spent again in the local economy, $X*r. Of the dollars that are spent within the economy, a portion will leak out and some will stay within the economy and so on. This process is referred to as recycling dollars in the local economy or the multiplier effect. The money spent outside of the local economy is called the leakage, $X(1-r) (Davis 1990, 30). Visually this process is represented in Figure 16, for a case in which the initial stimulus $X = $ 1000 and the fraction of the expenditure that remains in the local economy is 0.3.

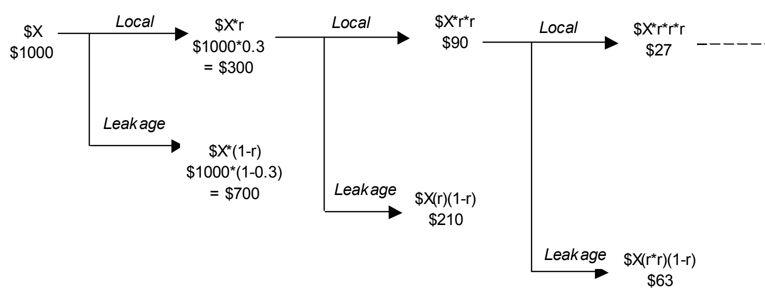

Figure 16 - Illustration of the multiplier effect when dollars are recycled in a local economy.

For a direct investment of $X, the total impact to the local economy is then,

$$\$X\left(1+r+r^2+r^3+r^4+.....r^n\right)=\$X\left(\frac{1}{1-r}\right) \text{ for all } 0 < r < 1$$

The income multiplier for an economy, M_y, is then defined as,

$$M_y = \left(\frac{1}{1-r}\right)$$

The definition of the income multiplier indicates that the income earned by employees in the local economy will be recycled through the local economy in a manner shown in Figure 16.

Furthermore, it is possible to estimate the additional jobs that will be created in an economy by creating a job in a specific sector of the economy. The approach used by Davis (1990) is to calculate the additional income required to create an additional job in the economy, using the service sector as a proxy for additional employment. Therefore the employment multiplier for sector *i* is then,

$$M_{e,i} = (M_y - 1)\frac{(average\ \ wage\ in\ \sec tor\ i)}{(average\ wage\ in\ service\ \sec tor)} + 1$$

Davis defines the terms in this equation and their meaning:

> The first term in the equation represents the income generated in the local service sector (total income less one dollar of income in sector *i*) per dollar of income in sector *i*. The first term multiplied by the numerator of the second yields the number of dollars induced in the service sector by one job in sector *i*. This product divided by the denominator of the second term is an estimate of the employment generated in the local service sector by a job in sector *i*. Finally, the addition of one to the product of the first two terms is the addition of the job created in sector *I* to those generated in the service sector. The three terms represent the total employment in the economy resulting from one new job created in sector *i* (Davis 1990, 38).

The assumptions in this simple model are that the expenditure patterns of employees in each sector are no different that the expenditure pattern in the overall economy and that the sectors are homogenous (Davis 1990, 38; 45).

AIII.3 Data:

Trib Choudary (2003) of the Division of Economic Development for the Navajo Nation, complied statistics on the employment, earnings, and output for nine sectors in the Navajo economy based on data from 2001 (Choudhary 2003, 84; Table 19). The data is shown in Table 13. To estimate the leakage rate of the Navajo economy the Division of Economic Development conducted a survey to determine the fraction of total personal income that was spent in the Navajo Nation. Of the $1,217,554,156 in total personal income, only $348,448,594 was spent in the Navajo economy in the same period. Thus, the leakage rate for the Navajo economy is estimated to be 71.38% (Choudhary 2003, 75; Table 15) and the portion of income spent in the local economy, r, is 28.62%.

Employment by Sectors in the Navajo Nation, 2001

Sector	IMPLAN Sector	Navajo Employees	Non-Navajo Employees	Total Employment		Salary and Benefits	Gross Receipts
				Number	Percent of Workforce		
Agriculture	1-27	222	7	229	0.7%	$5,613,614	$26,535,295
Construction	48-57	817	60	877	2.7%	$17,984,248	$61,506,770
Finance/ Insurance/ Real Estate (FIRE)	456-462	385	14	399	1.2%	$11,401,553	$7,937,420
Government/ Public	510-512; 522-23	8,634	257	8,891	27.4%	$215,823,543	$173,568
Manufacturing	58-432	283	30	313	1.0%	$6,906,918	$27,360,460
Mining	28-47	1,256	244	1,500	4.6%	$115,461,531	$454,971,640
Retail Trade	448-455	2,837	223	3,060	9.4%	$39,991,095	$231,305,889
Service	463-509; 525-527	11,553	3,447	15,000	46.3%	$481,878,495	$159,007,195
Tansportation/ Commun-ication/ Utilties (TCPU)	433-446	1,703	448	2,151	6.6%	$148,793,159	$223,509,180

Table 13 - Navajo Nation employment data by sector, adapted from Choudhary 2003, 84; Table 19

AIII.4 Results:

The income multiplier for the Navajo economy is 1.40. Thus, for every dollar of additional income earned another forty will cycle through the economy. This low rate of recycling is indicative of the high leakage rate of the Navajo economy.

The employment multipliers for the Navajo economy are shown in Table 14. The sectors with the biggest impact on the Navajo economy per job are the mining and Transportation, Communication, and Utilities sectors. However, the combined employment in these two sectors is only about 10% of the Navajo workforce. The one surprising result in Table 14 is the relatively low impact of manufacturing jobs in the Navajo economy.

Analysis of Job Multipliers for the Navajo Nation Economy (Leakage Rate = 0.7138)

Sector	Total Employment	Salary and Benefits (Income)	Average Income ($/Employee)	Wage Ratio (to Service Sec.)	Employment Multiplier
Agriculture	229	$5,613,614	$24,514	0.76	1.31
Construction	877	$17,984,248	$20,507	0.64	1.26
Finance/ Insurance/ Real Estate (FIRE)	399	$11,401,553	$28,575	0.89	1.36
Government/ Public	8,891	$215,823,543	$24,274	0.76	1.30
Manufacturing	313	$6,906,918	$22,067	0.69	1.28
Mining	1,500	$115,461,531	$76,974	2.40	1.96
Retail Trade	3,060	$39,991,095	$13,069	0.41	1.16
Service	15,000	$481,878,495	$32,125	1.00	1.40
Tansportation/ Commun-ication/ Utilties (TCPU)	2,151	$148,793,159	$69,174	2.15	1.86

Table 14 - Analysis of job multipliers for the Navajo Nation economy

Appendix IV: Tribal Wind Finance Model

AIV.1 Comparison of Ownership Models for Navajo Wind Farm

AIV.1.1 Overview

The ownership and structure of the proposed 80 MW wind farm on the Navajo land will have significant impacts on the incentives available for the wind farm, the direct impacts on the Navajo economy, and the cost of energy from the wind farm. With the various nuances of ownership structures, such as eligibility for the Production Tax Credit (PTC) or exemption from state and federal taxes, it can be difficult to determine the financial viability of a wind farm. A general comparative analysis is a useful tool for estimating the effect of each combination of incentives and structures. An important question is whether or not it is financially viable for the Navajo Nation to operate a wind farm without an outside investment partner.

AIV.1.2 Ownership Models:

Three ownership models will be considered: 1.) a traditional commercial wind farm, based on a project-finance structure, where the Navajo Nation is simply the landowner, 2.) a joint venture between an outside investor and a Navajo partner based on a flip-structure, and 3.) a tribal-owned wind farm financed either as a commercial project or through a political subdivision authorized to issue tax-exempt bonds or Clean Renewable Energy Bonds. Each ownership model is described below.

- *Commercial Wind Farm:* An outside company owns and operates the wind farm on Navajo land. The wind farm owner pays a land lease fee to the Navajo Nation based on the size of the wind farm. The wind farm is financed through traditional commercial terms, including the utilization of the production tax credit and depreciation incentives.
- *Joint Venture – "Flip" Structure:* An outside, tax paying investor, joins with a Navajo partner in a joint venture company to own the wind farm. The outside investor retains nearly 100% of the ownership of the wind farm so that it can fully utilize the PTC and depreciation. The Navajo Nation receives a land lease fee and the Navajo partner receives a management fee. At the end of ten years, the ownership "flips" to the Navajo partner. Financing terms are based on federal loan guarantees for tribal energy projects.
- *Navajo Owned:* An enterprise of the Navajo Nation, either an existing enterprise or a newly created one, would finance the wind farm through either in a traditional commercial manner or through a political subdivision. The political subdivision model would finance the wind farm entirely through bonds. Tax-exempt bonds have low interest rates, while the new Clean Renewable Energy Bonds (CREBs) provide an interest-free source of debt.

AIV.1.3 Comparative Analysis:

The result of the comparative analysis is a comparison of the levelized cost of energy for the wind farm required to meet the financing constraints, the direct impacts on the Navajo economy, and the exposure to financial risk. However, the importance of a comparative analysis is in understanding the source of the impacts and the effects of different incentives that will be available in some scenarios but not others.

The benefits of each ownership option and the financial viability, based on the cost of energy, can be compared to the risks and barriers associated with each option.

AIV.2 Financial Model of Wind Farm

AIV.2.1 Method of Comparison

A financial model of a wind farm is developed for each ownership scenario. For comparison, many key assumptions, discussed below, are kept constant. For instance, the operations and maintenance costs is assumed to be the same, independent of who owns and operates the wind farm. These assumptions may not always hold true, but for the purpose of a simple comparison theses assumptions will be sufficient.

The Benchmark model is an optimization model. The objective of the model is to minimize the levelized cost of energy over the assumed 20-year lifetime of the power plant. This cost is minimized subject to financing constraints such as a minimum return on the equity investment or a minimum ratio of the net income to the total debt payment for each year. The primary variable in the model is the price of energy. Additional variables include the debt/equity ratio.

For the remaining scenarios, the wind farm is considered to be a price taker at the minimum price of the Benchmark wind farm. Two questions are then investigated: 1) What is the financial attractiveness of the wind farm from the perspectives of the financers and the tribe? 2) What addition revenue would be required to make the wind farm as attractive as the Benchmark model?

AIV.2.2.1 Direct Impacts

The result of the model includes a simulation of the cash flow to the Navajo economy in the form of taxes, land lease fees, direct expenditures in the local economy for operations and maintenance costs, and revenues or profits when a Navajo entity owns a part of the wind farm. The net present value of each cash flow reduces the 20-year cash flows into one descriptive statistic for each ownership structure.

AIV.2.2.2 Risk Analysis

Finally, the exposure of entities to financial risk associated with owning a wind farm is projected based on the probability of defaulting on a loan in at least one year of the debt term, p_F. A default on a loan payment is assumed to occur when the net income (NI_i) generated by the sale of wind energy for any particular year (i) is less than the debt payment for that year (D_i) as shown below. The net income is the operating revenue (OR_i) minus the operating expenses (OE_i) and the operating revenue is the product of the annual energy generation (E_i) and the revenue requirement or price for the wind energy (P_i).

$$\text{Default if : } NI_i < D_i \tag{1}$$

$$NI_i = OR_i - OE_i = E_i{*}P_i - OE_i$$

(2)

Therefore:

$$\text{Default if: } E_i < E_{Fi} = \frac{D_i + OE_i}{P_i}$$

(3)

Where E_{Fi} is the annual energy production that would lead to the net income exactly equaling the debt payment for that year. If the annual energy production is less than E_{Fi}, then the project will default on the loan.

For any particular year, the debt service coverage ratio is the ratio of the net income to the debt payment:

$$DSCR_i = \frac{NI_i}{D_i}$$

(4)

For a given mean annual energy production, $\overline{E}$, it can be shown that:

$$E_{Fi} = \overline{E}\left(\frac{D_i + OE_i}{DSCR_i \cdot D_i + OE_i}\right)$$

(5)

For the purpose of the risk assessment, it is assumed that the annual energy production, E_i, is normally distributed about a mean annual energy production , $\overline{E}$, with a standard deviation of the annual energy production of σ.

Therefore the probability, p_i, of defaulting on a loan for any particular year is the area under the tail of the normal distribution for which $E_i<E_{Fi}$:

$$p_i(E_i < E_{Fi}) = \int_{-\infty}^{E_{Fi}} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\tfrac{1}{2}\left(\frac{\overline{E} - E_i}{\sigma}\right)^2\right) dE_i$$

(6)

Which can be found with a simple statistics calculator in Excel by calculating the "Z-statistic" where:

$$Z = \frac{\overline{E} - E_{Fi}}{\sigma} = \frac{\overline{E}}{\sigma}\left(1 - \frac{D_i + OE_i}{DSCR_i \cdot D_i + OE_i}\right)$$

(7)

The probability that the wind project will default in at least one year, p_F, is then:

$$p_F = 1 - \prod_{i=1}^{n}(1 - p_i)$$

(7)

Where *i* goes from the first year that the Navajo are responsible for repaying a portion of the debt to the last year in which they must repay the debt.

AIV.2.2 Key Assumptions and Uncertainties

A number of assumptions are made in the model. These assumptions are used in each of the different ownership models. The wind farm in each case is 80 MW in a Class 4-6 winds regime at high elevation.

AIV.2.2.1 Capacity Factor

McGowan and Connors (2000) describe the relationship between the wind regime and the expected capacity factor (CF) of a wind turbine with a hub height of 50m. The range of the CF is about 25% for a low Class 4 site to about 39% for a high Class 6 site.[23] The high elevation of the site will reduce the CF whereas the greater hub heights of modern turbines will increase the CF, in this study it is assumed that these two opposing effects will cancel out. The estimate for the wind farm CF is the middle of a Class 5 wind regime, or a CF of 33%.

It is important to understand that the CF is a critical parameter for estimating the price of wind power. Unfortunately, without at least one year of hub-height data at the site, the estimates from the Arizona wind map will have to suffice for this comparative analysis.

For the risk analysis, it is assumed that the annual energy production of the wind farm is uncertain, but normally distributed about the estimated mean annual energy production. The standard deviation, σ, is estimated to be 10 percent of the estimated mean energy production, or $\sigma = 0.1 * \overline{E}$ (Redlinger *et al.* 2002, 108).

AIV.2.2.2 Installed Cost

The installed cost of the wind farm is also a critical parameter. Recent increases in turbine prices in the United States means that the installed cost is likely to be much higher than the commonly cited estimate of $1,000/kW. Other uncertainties in the installed cost include the site characteristics: roads will need to be built from the highways to the top of Gray Mountain, there is uncertainty around the availability of water for soil compaction, and it is unclear what upgrades will need to take place to interconnect the wind farm to the transmission system. Without further studies, a rough estimate of $1,500/kW for the total installed cast is used. The range of this estimate is large, from about $1,200/kW to $1,600/kW.[24] The reasons given for the for the increase in turbine prices is based on increased demand for turbines and increasing costs of raw materials such as concrete, fuel, and steel.

AIV.2.2.3 Operations and Maintenance Costs

The O&M expense covers a broad range of estimates from $12.50/kW-yr (Costanti, 2004), to $20/kW-yr (Tegan, 2005). However, these estimates typically assume that the O&M cost does

[23] McGowan and Connors, 2000. Statistics are reported in Figure 5.

[24] A recent wind farm built on the land of the Campo Band of the Kumeyaay Nation is cited as costing $80 million for a 50 MW wind farm, or approximately $1,600/kW: Krueger, Anne. 2005. "Sierra Club to tackle issues on wind-turbine locations" *San Diego Union-Tribune*, June 23.

not increase more than inflation over the life of the wind farm. Operating experience with wind turbines shows that the O&M cost does in fact increase as the plant ages (McGowan and Connors, 2000). The data similarly suggests that larger and more recently designed wind turbines have lower O&M escalation rates than older and smaller wind turbine technology. As will be shown below, the escalation of O&M costs is a significant factor to consider, especially in the joint venture option where the Navajo partner assumes ownership of a ten-year-old plant. A wind farm that is ten years old will have higher maintenance costs than a new wind farm, significantly impacting the benefits to the tribal partner for the remainder of the wind farm operation.

This analysis includes an estimate for the increase in O&M costs based on operating experience the 600kW turbines (McGowan and Connors, 2000 - Table 4). An estimate of a nominal 12% O&M escalation rate is a close fit to the data presented by McGowan and Connors (2000). The initial O&M cost is estimated to be $12.50/kW-yr with an escalation rate that ranges from the inflation rate to a nominal 12% escalation rate.

AIV.2.2.3.1 O&M Expenditure in Local Economy

The direct impact of the wind farm on the Navajo Economy will greatly depend on the portion of the O&M expenses that are spent in the Navajo economy. These expenses will primarily be wages and salaries for technicians and management. A study of the impacts of a wind farm in rural Minnesota (DanMar, 1996) shows that a small portion will be locally available material such as tools, basic hardware, and fuel.

Based on an assessment of the local economy in the Cameron and Tuba City, AZ region it is assumed that approximately 80% of the first year O&M costs will be spent in the Navajo economy, but that any escalation in costs above the rate of inflation are due to imported spare parts (See section III.2 for more details). This assumption prevents the model from overstating the O&M spending in the local economy in later years as most O&M escalation costs may be due to equipment failure that require imports. This estimate will be sufficient for this comparative study.

AIV.2.2.4 Land Lease Fee

The Navajo Nation will negotiate the land lease fee for a wind farm, but the land lease fee will most likely be close to the land lease fee typically charged by other landowners. The common range of land lease expenses is in the range of $2,500 - $4,000/MW-yr. This value depends on the value of the site – in particular the quality of the wind resource and the proximity to available transmission lines.

For the comparative analysis, it is assumed that the land lease fee will be $3,000/MW-yr, increasing with inflation. This payment will most become revenue for the Navajo Nation, but it could also be paid to those with grazing permits on Gray Mountain or the local Cameron Chapter.

AIV.2.2.5 Navajo Taxes

Two taxes will be levied on the wind farm by the Navajo Nation. The taxes are the Possessory Interest Tax (PIT) and the Business Activity Tax (BAT). The tax is assumed to be levied on all of the different ownership models, even if a Navajo enterprise operates the wind farm. The Navajo Tribal Utility Authority, for instance, is a tribal enterprise but it still is responsible for paying taxes for operating a business within the Navajo Nation.

The PIT is described as, "the right to be on Navajo land performing a particular activity. The most common forms of possessory interests are oil and gas leases, coal leases, rights-of-way and business site leases" (Choudhary 2003, 5). For electricity generation on the Navajo Nation, the tax rate is 3% of the appraised market value of the possessory interest.[25] The appraised market value can be calculated from a number of methods by the Office of the Navajo Tax Commission. For this model, it is assumed that the value is calculated based on the income method, such that the PIT will be:

PIT = 3%* [Gross Revenues – (O&M Costs + Land Lease + Management Fees …
+ State and Federal Taxes)]

The BAT "is a tax on the net source gains (gross receipts less deductions) from the sale of Navajo goods or services…"(ibid, 5). According to the BAT regulations, power production is included as an applicable activity.[26] The deductions include "a standard quarterly deduction of the greater of $125,000 or 10% of gross receipts, salaries and wages paid to Navajos, the cost of purchasing Navajo goods and services, and other payments made to the government of the Navajo Nation"(ibid, 5). The net source gains are then taxed at a rate of 5%. For this model, the local share of the O&M expenses is used to estimate the "salaries and wages paid to Navajos" and "the cost of purchasing Navajo goods and services."

AIV.2.2.6 Coconino County Taxes

The Coconino County levies property taxes on commercial developments. The Benchmark wind farm, off of the Navajo Nation land will not be taxed by the Navajo Nation but will be required to pay the Coconino County tax. The tax is based on the Full Cash Value (FCV) and the Limited Property Value (LPV) as assessed by the Coconino County Assessor. In this study it is assumed that the FCV and LPV are equal and assessed in a similar manner to the Navajo PIT tax. The tax rate for a commercial property is then 2% of the FCV.[27]

It is not uncommon for counties to tax property on Indian lands, even trust land, around the United States. Similarly, it is not uncommon for property to be taxed on the Navajo Nation, especially for businesses that are not Navajo owned (Wilkins 2002, 123). It is assumed that only in the tribal owned wind farm scenarios is the wind farm not assessed Coconino County taxes. The legality of counties assessing property taxes on Native American trust land has been questioned, but is not a certain matter.

AIV.2.2.7 Inflation and Discount Rate

The inflation rate is estimated to be 3% for each year. The discount rate is used to estimate the present value to the Navajo Nation of taxes and wages earned in future years. This model uses a nominal discount rate of 10%.

Table 15 summarizes the assumptions used in each of the different financial models.

[25] See PIT statues, http://www.navajobusiness.com
[26] See BAT Regulations, http://www.navajobusiness.com
[27] The Assessment ratio for Commercial property is 25% and the tax rate for the Navajo Reservation is 8.0842% assuming FCV = LPV. The tax rate is then 25%*8.0842% = 2.02%. See http://co.coconino.az.us/assessor.apx for more details.

Table 15

Key assumptions for financial modeling of Navajo wind farm		
Assumption:	**Value:**	**Expected Range:**
Capacity (MW)	80	
Capacity Factor	33%	25 - 39%
Installed Capital Cost ($/kW)	$1,500	$1,200 - 1,600
O&M Expense ($/kW-yr)	$12.50	
O&M Escalation Rate (nominal)	12%	3% - 12%
Portion of first year O&M expense spent in Navajo Economy	80%	
Land Lease Expense ($/MW-yr)	$3,000	$2,500 - 4,000
Navajo Possessory Interest Tax	3.0%	
Navajo Business Activity Tax	5.0%	
Coconino County Property Tax	2.0%	
Inflation Rate	3%	
Discount Rate (nominal)	10%	

AIV.2.3 Commercial Wind Farm Assumptions

The next section will detail the assumptions used in each ownership model. The commercial wind farm is financed with a combination of debt and equity. The debt/equity structure is flexible in this case, so that the levelized cost of energy is minimized. The financing model is based on a project-finance arrangement. Project financing, as opposed to corporate financing, means that the wind project must earn sufficient revenue each year to cover all of the annual expenses (Wiser and Khan 1996, 4).

The equity for the wind farm is from an investor with a large tax appetite, such that the investor can benefit from the Production Tax Credit and accelerated depreciation. The equity partner is assumed to require a nominal 12% return on the initial investment in the Benchmark case. The benefits from the PTC and accelerated deprecation factor into the calculation of the internal rate of return.

The PTC is a federal income tax credit for renewable energy production. It is currently valued at 1.9 cents/kWh for the first ten years of the project lifetime. The PTC expired at the end of 2002 and has since been renewed for short periods through legislation. Most recently the PTC was extended from January 1, 2006 to January 1, 2008 in the Energy Policy Act 2005.[28] Because the

[28] See the EPAct 2005, Section 1301

PTC is a tax credit, the owner of the wind farm must have a sufficient tax burden to fully utilize the value of the PTC. Tribal governments and enterprises do not pay federal taxes and cannot therefore benefit from the PTC.

The second incentive available in the commercial wind farm is accelerated depreciation. This is also a tax-based incentive. The accelerated deprecation reduces the tax burden of the wind farm owner in the first five years of the project lifetime. For this model, the 5-year MACRS schedule is used, whereby 95% of the initial capital cost of the wind farm is depreciated at a rate of 20%, 32%, 19.2%, 11.52%, 5.76% in each of the first through fifth years, respectively.

AIV.2.3.1 Financing Terms

Wiser and Kahn (1996) show that the financing terms have a significant impact on the cost of energy for a wind farm due to the capital intensive nature of the project. The interest rate on debt is treated as a given whereas two other terms form important constraints in the financial model: the minimum after-tax internal rate of return on the equity investment (IRR), and the minimum debt service coverage ratio (DSCR).

The nominal interest rate for commercial debt is assumed to be 2% above the LIBOR rate. The LIBOR reflects the cost of debt when there is very little risk, and is currently near 5%. The additional 2% on top of the LIBOR rate reflects the risk associated with investing in wind farms. In nominal terms, the debt rate is assumed to be 7% for a term of twelve years.

The nominal after-tax IRR is assumed to be 12% over the twenty-year life of the project. The calculation of the IRR includes the PTC and accelerated deprecation tax incentives.

The DSCR is calculated each year during the first twelve years of the project, when debt payments are still being made. The DSCR is the ratio of the total cash available (operating revenues minus the operating expenses) and the total debt payment. For a wind farm the minimum DSCR is commonly 1.4. It should be noted that the interest rate and expected after tax IRR are considerably lower than numbers used by Wiser and Khan (1996) due to recent trends in wind financing.

AIV.2.3.2 Federal and State Taxes

Even if the wind farm is on Navajo land, a commercial wind farm, owned by an outside company will be required to pay state and federal taxes. The state tax rate is 6.968% as of January 1, 2005.[29] The marginal federal tax rate is assumed to be 35%. The effective income tax rate is then 39.5% of the taxable income.[30]

AIV.2.4 Joint Venture Wind Farm Assumptions

The joint venture model differs from the commercial wind farm model in three important ways: ownership changes after the first ten years, a Navajo partner earns a management fee during first ten years, and forming a partnership between an outside company and a Navajo entity may make better financing terms accessible through the federal government.

AIV.2.4.1 Tax Incentives

[29] See: http://www.taxadmin.org/fta/rate/corp_inc.html
[30] Calculated from the NREL Wind Finance Calculator

The main purpose of forming a joint venture between a tax paying investment partner and a Navajo entity is to access the tax-based incentives from the federal government. It is assumed that the investment partner is able to access the full PTC and depreciation incentives. Because the PTC is split between the owners of the wind farm (based on share of earnings) the investment partner will have to own nearly 100% of the wind farm. The Navajo partner only holds an emblematic share in the ownership of the wind farm in the first ten years.

AIV.2.4.2 Flip Structure

In this model it is assumed that the investment partner yields full ownership of the wind farm to the tribal partner after ten years. It may turn out that the tribe can only attract an investment partner if a lower share of ownership is sought or the tribal partner may not be comfortable assuming all of the risk of the wind farm. But for this example, the investment partner essentially walks away from the project after ten years and the Navajo partner retains full ownership. Furthermore, it is assumed that the investment partner provides the full equity investment in the project and therefore must earn the minimum IRR in the first ten years.

During the first ten years, the Navajo partner earns a management fee from the wind farm owner in addition to the land lease fee paid to the Navajo Nation. This management fee will be negotiated between the two partners. However, for the purpose of this model, it will be assumed that the management fee is three times the land lease fee. In that way, the Navajo Nation earns a total of four times the amount that they would earn by just acting as landowner. In the second decade of the wind farm life, the Navajo partner will own the wind farm, no longer earning a management fee but still paying the land lease fee.

AIV.2.4.3 Financing Terms

The joint venture financial model is still based on a project finance structure, but provides access to improved financing terms. Title V – the "Indian Tribal Energy Development and Self Determination Act" - of the EPAct 2005[31] includes language authorizing loan guarantees "for an amount equal to not more than 90 percent of the unpaid principal and interest due any loan made to and Indian tribe for energy development".[32]

According to Dean Suagee (1998), one of the "most significant obstacles to conventional lending transactions in Indian Country [is] … [lender's] need to protect their investments in the event of default". Federal loan guarantees mitigate risks to lenders by establishing a "general obligation of the United States backed by its full faith and credit"(Brooks and Cheew 1984, 206). The purpose of a loan guarantees is to redirect the resources of the private sector to areas that are in the interest of the federal government (ibid, 200-1). The guarantee reduces the risk to the lender associated with financing energy projects by ensuring the lender that they will receive the principal and interest payment in the case of a default by the wind farm owner (ibid., 208).

Loan guarantees are viewed as a "low cost" mechanism for promoting private investment in sectors or projects that would otherwise be viewed as too risky. From the point of view of the

[31] See EPAct 2005, Section 502

[32] EPAct 2005, Section 503, which updates Title XXVI of the EPAct 1992,Sec 2602(c) p531. Because the loan guarantee is made specifically for a loan made to an Indian tribe, instead of the investor, the Navajo partner may have to assume the debt as part of the management of the wind farm. Nevertheless, the loan is backed by the credit of the US rather than the tribe or investment partner.

federal government, the costs are viewed as only the cost of program administration and the portion of loans that default (ibid., 187).[33]

Harris and Navarro (2000) indicate that loan guarantees in effect relax the interest rate and DSCR terms for financing the debt portion of wind farms. Their analysis suggests that a loan guarantee will reduce the risk premium of a wind farm to that of a mature technology, such as a gas turbine power plant in the late 1990's.[34] For the Joint Venture wind farm model, the loan guarantee is assumed to reduce the debt interest rate by 1.5% in comparison to a commercially financed wind farm and the DSCR requirement is assumed to drop to 1.25.

AIV.2.4.4 Federal and State Taxes

Both the federal and state government will tax the income earned by a non-Indian partner in the wind farm. As for the tribal partner, IRS "Revenue Ruling 67-284 states that an Indian tribe, as an income producing entity, is not subject to income taxation".[35] Kathleen Nilles asserts "any business operated directly by a federally recognized Tribe will be free of income tax … A partnership or LLC [Limited Liability Corporation] involving a Tribe and nongovernmental members or partners should generally yield tax-free income to the Tribe"(Niles 2005).

In some cases, the tribe may prefer to insulate the political functions and the business functions of the tribe, by creating a semi-autonomous political subdivision, like a Tribal Authority or a tribal government-controlled business corporation. The tax status of a business corporation is a complex issue, and will not be addressed here. Establishing a political subdivision is just as complex, but is addressed in Section AIV.2.5.2. For the purpose of the model, I assume that the Navajo partner is a tribal business that does not pay income taxes on income from the management fee nor the income earned once the tribe takes over ownership.

AIV.2.5 Tribal Owned Wind Farm Assumptions

Tribal ownership of the wind farm exposes the tribe to additional risk from the wind farm, but it makes different financing terms available, and may significantly increase the benefits to the tribe. There are various ways that the tribe can own the wind farm. For the Navajo wind farm, it will be assumed that the wind farm is owned either as a commercial project of a Navajo enterprise such as the Diné Power Authority or as part of a utility that is considered a political subdivision of the Navajo Nation – namely the Navajo Tribal Utility Authority (NTUA).

AIV.2.5.1 Tribal Owned – Commercial Wind Farm

A tribal owned wind farm using a commercial model has several distinct disadvantages, but is a useful comparison and tool for exploring the effect of federal incentives for wind energy.

AIV.2.5.1.1 Tax Issues

[33] Ibid., 187: Brooks and Cheew argue that an "externality" of loan guarantee programs is that they increase the cost of debt in the private sector, and therefore the cost of debt for the Federal government. The "unrestrained growth of federal credit activity" places upward pressure on interest rates (p.189).

[34] Volatility in natural gas prices since 2001 have most likely changed the risk premium associated with CT's since the late 1990's when natural gas prices were low and stable.

[35] See http://www.irs.gov/govt/tribes/article/0,,id=102543,00.html

Because the Navajo Nation does not pay federal taxes, the PTC and accelerated depreciation incentives will not be available for this wind farm. These incentives have a significant impact on the finances of a wind farm. Therefore, not having access to these incentives is expected to greatly reduce the viability of this ownership model. On the other hand, the state or federal government will not tax the earnings from the wind farm.

Furthermore, it is assumed that Coconino County will not tax property that is fully owned by a tribal entity.

AIV.2.5.1.2 Equity

Ownership of a commercially financed wind farm entails an equity investment by the Navajo Nation. A large farm requires a significant equity investment, which in many cases may not be available from the tribal government. If it is available, it is assumed that the return on equity is also 12% for a tribal owned wind farm. Depending on the length of the payback period, the investment will be subject to an opportunity cost. The opportunity cost is due to the earnings the equity could earn in other investments. There are many ways to account for this opportunity cost, but for simplicity, it is assumed that deflating the earnings by the discount rate is sufficient to account for this additional cost.

AIV.2.5.1.3 Financing Terms

In this case it is assumed that the debt for the wind farm will be obtained from outside sources. The only advantage the tribe will have is the loan guarantee described in Section 0. It is assumed that because the loan guarantee replaces the credit status of the borrower with that of the federal government, the terms of a guaranteed loan are independent of the borrower, and therefore the same debt terms described in Section AIV.2.4.3. This assumption may not always hold since the loan guarantee only covers 90 percent of the loan, leaving the lender exposed to a small portion of the risks that will vary with the borrower. However, it should be a sufficient assumption for this exercise.

AIV.2.5.2 Tribal Owned – Public Utility

An alternative to a standard commercial project is to finance the wind farm through a tribal authority, through which different financing mechanisms will be available. In addition, the risks of the project are spread throughout the utility as a whole, not just the wind farm project.

This ownership model is differs from the previous models in that there can be no equity investment. Instead the wind farm can be financed entirely by debt, and the earning requirement is diversified among many projects. However, in the case of the Navajo wind farm, power requirement of NTUA's customers is only on the order of 100 MW. The energy from an 80 MW wind farm is most likely going to be sold to a third party load serving entity.[36] In this case, the wind

[36] In addition to the small load in comparison to the wind farm, there are three other items to consider: transmission, cost of energy, and value of green energy. The proposed site for the wind farm is on the far southwest corner of the Navajo reservation. The power lines in this area are owned by APS and the federal government - NTUA does not own any of the lines in the area. Therefore NTUA would have to pay wheeling charges to the transmission line owners to move the power to their load centers. Second NTUA receives a low cost allotment of federal hydropower through the Western Area Power Administrator (WAPA) in addition to contracts for low cost fossil fuel power. NTUA does not generate any electricity at this point. Third, IOU's subject to state RPS's and the Federal government have requirements

energy will be most likely sold through a long term PPA at a fixed price, similar to the previous examples.

Owning the wind farm as part of a utility authority allows for an assumption that the debt payments can be augmented by revenue streams other than from the sale of the wind energy. Therefore, it is assumed that the DSCR is 1.25 for the wind farm.

AIV.2.5.2.1 Tax Issues

Again, the PTC and accelerated depreciation incentives will not be available for this wind farm but the earnings will not be taxed by state of federal governments.

AIV.2.5.2.2 Financing Terms – Tax Exempt Bonds

Tribes, and their political subdivisions, can issue tax-exempt bonds for activities that are considered "essential government functions". Non-tribal public utilities issue tax-exempt bonds, which have the advantage of lower interest rates than taxable bonds. Following Wiser and Khan (1996), it is assumed that the interest rate for tax-exempt bonds issued by a public utility is a nominal 5.5%. Bonds also offer a longer term for debt. In this case we will assume that the debt period is the same as the life of the wind farm – 20 years.

Not all tribal entities are eligible for issuing tax-exempt bonds. In general, political subdivisions are eligible if they perform essential government functions. For instance, in 1984, the IRS determined NTUA was qualified as political subdivision of the Navajo Nation government.[37] Definition of a political subdivision of the tribal government entitles the entity to the same rights as states in terms of being able to raise financing through issuance of tax-exempt bonds.[38]

The Navajo Tribal Council created NTUA in 1959, officially becoming a Navajo enterprise in 1965. NTUA's purpose is to provide utility services to customers within the Navajo Reservation. As an authority, NTUA is "a subordinate economic organization of the Navajo Nation created pursuant to the law of the Nation for the purpose of carrying out business purposes of the Nation."[39] The Navajo Tribal Utility Authority is confirmed as a non-profit Authority, subdivision and public agency of the Navajo Nation. At the same time, the operation of NTUA and the obligations owed or assets owned by NTUA are solely those of NTUA and not subject to Navajo Nation control: NTUA "shall have legal existence separate and apart from that of the government of the Navajo Nation".[40] The activities and powers of NTUA "are public purposes for public uses and are essential governmental functions for which funds may be expended, property acquired and notes, bonds or other obligations may be issued".[41]

NTUA operates as a not-for-profit entity, separate from tribal control while maintaining the powers of the Navajo Nation by providing essential government functions. NTUA has the additional goal "of providing an annual return on investment to the Navajo Nation".[42] NTUA can borrow funds with up to $150 million of outstanding long-term debt, providing a lien on any of its

---

to procure energy from renewable sources. Since NTUA does not have such a requirement, wind energy will be more valuable to other energy providers.

[37] Revenue Procedure 84-36

[38] IRC Section 7871 (Tribes Treated Like States for Federal Tax Purposes), as described by the IRS: http://www.irs.treas.gov/govt/tribes/article/0,,id=108359,00.html

[39] NTUA operating code: http://www.ntua.com/download/plan_operation_draft.pdf

[40] ibid,

[41] ibid

[42] ibid.

revenues, contracts, or fixtures for collateral. NTUA can also enter into agreements or contracts with private organizations, such as corporations.[43]

AIV.2.5.2.3 Financing Terms - Clean Renewable Energy Bonds

Clean Renewable Energy Bonds were introduced and authorized in the EPAct 2005[44] to incentiveize renewable energy development by public entities that are not eligible for the Production Tax Credit. The bonds are available to cooperative electric companies and government entities including an "Indian tribal government, and any political subdivision thereof"[45]. Due to the specific language with regards to political subdivisions of the Indian tribal government, it is likely that entities eligible to issue CREB's will have to meet the standards for tax-exempt bonds.

To the wind farm owner, the bonds are essentially zero interest debt. The bond issuer is liable only for the face vale of the bond, not the interest. Instead, the bondholder receives a federal tax credit in lieu of an interest payment.

The CREBs are designed to overcome some of the challenges with the other incentive available to public entities called the Renewable Energy Production Incentive or REPI. The REPI is a production incentive similar to the PTC, except that it requires an actual appropriation of federal monies to the program, where as a tax-credit does not. This has plagued the REPI program in the past because although the REPI has been authorized for many years, each year Congress must allocate funding to pay for the REPI. Many times the program receives insufficient funds to cover all of the requests, leaving some renewable generators without the extra incentive needed to make a project financially attractive. The uncertainty in REPI funding reduces the effectiveness of the incentive in promoting new renewable energy development. For this reason, the REPI is not included in this analysis, although projects eligible for the CREB's and tax-exempt bonds would also be eligible for the REPI.

The Clean Renewable Energy Bonds are modeled after an existing program called the Qualified Zone Academy Bonds, which are used by state and local governments to finance improvements to schools. These bonds have been available for many years even though the bonds were only initially authorized for two years. The bonds, according to attorneys familiar with the QZAB's, have been well received by issuers and financial markets.[46]

CREBs can be issued after December 31, 2005 and before December 31, 2007. The total value of all bonds issued in this program cannot exceed $800 million. The maximum term for the bonds is determined by the Secretary of the Treasury each month by following a formula in which: the maximum term will result in a present value of 50 percent of the face value of the bond at the age of maturity using a discount rate equivalent to the interest rate of tax-exempt bonds issued the same month[47]. Assuming a 5.0 percent tax-exempt bond interest rate leads to a maximum term of 15 years with the following relation:

$$\text{Maximum Term} = \text{Ceiling}\,[LN(2)/LN(1+\text{Interest Rate})]$$

[43] ibid.
[44] See EPAct 2005, Section 1303
[45] EPAct 2005, Section 1303; referring to Amendments to Internal Revenue Code of 1986, Section 54.j.3
[46] Dorothy Franzoni and Matt Nichols, "United States: Congress Approves Creation of Clean Renewable Energy Bonds," Legal Alert published by Sutherland Asbill & Brennan LLP on August 10, 2005, available at http://www.sablaw.com/files/tbl_s10News/FileUpload44/14555/LegalAlertCongressApprovesCreationAugust82005.pdf
[47] EPAct 2005, Section 1303; referring to Amendments to Internal Revenue Code of 1986, Section 54.e.2

AIV.2.6 Summary of Ownership Options

The key assumptions for each ownership model are shown in Table 16.

Table 16

Assumptions for Each Ownership Scenario

				Tribal Owned		
Assumption:	Benchmark	Commercial	Joint Venture	Commercial	Tax- Exempt	CREBs
Tax Issues:						
Coconino County Property Tax	Yes	Yes	Yes	No	No	No
Navajo Nation Taxes	No	Yes	Yes	Yes	Yes	Yes
Effective Income Tax	39.5%	39.5%	39.5% (Non-Tribal Partner)	0%	0%	0%
Production Tax Credit ($/kWh)	$0.019	$0.019	$0.019	N/A	N/A	N/A
Depriciation Incentive	5-Year MACRS	5-Year MACRS	5-Year MACRS	N/A	N/A	N/A
Fees:						
Management Fee ($/MW-yr)	N/A	N/A	$9,000 - First Ten Years Only	N/A	N/A	N/A
Finances:						
Financial Structure	Flexible	Flexible	Flexible	Flexible	Flexible	Flexible
Equity: Min. After Tax IRR	12%	12%	12%	12%	12%	12%
Debt Term (yr)	12	12	12	12	20	12
Debt Interest Rate	7.0%	7.0%	5.5%	5.5%	5.0%	0.0%
Minimum Coverage Ratio	1.4	1.4	1.25	1.25	1.25	1.25

AIV. 3 Example Model Spreadsheet – Commercial Scenario

Commercial *Commercial wind farm on the Navajo Nation land*

ASSUMPTIONS:	Value:	Notes
Capacity (MW)	80	
Capacity Factor	33%	Class 4-6 winds
Installed Capital Cost ($/kW)	$1,500	($2006)
O&M Expense ($/kW-yr)	10	($2006)
O&M Escalation Rate (nominal)	12%	
Local O&M Spending First Year	80%	
County Property Tax Rate	2%	Levied on Full Cash Value
Production Tax Credit ($/kWh)	$0.019	($2006) Increases w/ Inflation
Inflation Rate	3.0%	
Navajo Discount Rate (nominal)	10%	
Real Discount Rate	6.8%	

NAVAJO NATION:		
ASSUMPTION	Value:	
Land Lease Payment ($/MW-yr)	$3,000	($2006) Increases w/ Inflation
Management Fee ($/MW-yr)	$0	
Navajo Possessory Interest Tax	3.0%	(Based on net income)
Navajo Business Activity Tax	5.0%	(Revenues with deductions)
RESULTS	Value: ($000)	
NN Taxes ($2006)	$6,965	
Land lease ($2006)	$2,583	
O&M spent in NN Economy ($2006)	$6,889	
Total ($2006/yr)	$16,437	
Financial Risk	N/A	

POWER PURCHASE AGREEMENT:	
ASSUMPTION	Value:
Price Escalation Rate	0.0%
RESULTS	
Real Levelized Price ($2006/kWh)	$0.0423
Nominal Levelized Price ($2006/kWh)	$0.0569
First Year Energy Price ($2006/kWh)	$0.0569

DEBT:	
ASSUMPTIONS:	Value:
Debt Share (%)	42%
Interest Rate	7.0%
Debt Term (yr)	12
Minimum DSCR	1.4
RESULTS:	Value:
Minimum DSCR	1.40
Average DSCR	1.58
Risk of Default	7.4%

EQUITY:	
ASSUMPTIONS:	Value:
Equity Share (%)	58%
Target IRR	12%
Effective Income Tax Rate	39.5%
RESULTS	
After Tax IRR	12%

PRO-FORMA CASH FLOW											
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Electric Output (MWh)		231,422	231,422	231,422	231,422	231,422	231,422	231,422	231,422	231,422	231,422
Electricity Sales Price ($/kWh)		0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
Operating Revenues ($000)											
Revenues		13,164	13,164	13,164	13,164	13,164	13,164	13,164	13,164	13,164	13,164
Operating Expense ($000)											
O&M Expense		896	1,004	1,124	1,259	1,410	1,579	1,769	1,981	2,218	2,485
Land Lease Expense		247	255	262	270	278	287	295	304	313	323
Navajo PIT Expense		361	357	353	349	344	339	333	326	319	311
Navajo BAT Expense		529	528	527	525	524	523	522	520	519	518
County Tax Expense		240	238	236	233	230	226	222	218	213	207
Total Operating Expenses		2,273	2,381	2,502	2,636	2,786	2,953	3,140	3,349	3,582	3,843
Operating Income ($000)		10,891	10,783	10,663	10,528	10,378	10,211	10,024	9,815	9,582	9,322
Financing ($000)											
Debt Funds	50,281										
Equity Funds	69,719										
Total Capital Investment	120,000										
Cash Available Before Debt		10,891	10,783	10,663	10,528	10,378	10,211	10,024	9,815	9,582	9,322
Debt Interest Payment		3,520	3,323	3,112	2,887	2,646	2,388	2,112	1,817	1,501	1,163
Debt Principal Repayment		2,811	3,008	3,218	3,443	3,684	3,942	4,218	4,514	4,829	5,168
Total Debt Payment		6,330	6,330	6,330	6,330	6,330	6,330	6,330	6,330	6,330	6,330
Tax Effect on Equity ($000)											
Operating Income		10,891	10,783	10,663	10,528	10,378	10,211	10,024	9,815	9,582	9,322
Deprication (5 yr MACRS)		22,800	36,480	21,888	13,133	6,566					
Interest Payment		3,520	3,323	3,112	2,887	2,646	2,388	2,112	1,817	1,501	1,163
Taxable Income		-15,429	-29,020	-14,338	-5,492	1,166	7,823	7,912	7,998	8,081	8,159
Income Taxes (w/o PTC)		-6,094	-11,463	-5,663	-2,169	460	3,090	3,125	3,159	3,192	3,223
Production Tax Credit		4,529	4,665	4,805	4,949	5,097	5,250	5,408	5,570	5,737	5,909
Tax Savings (Liability)		10,623	16,128	10,468	7,118	4,637	2,160	2,283	2,411	2,545	2,687
After Tax Net Equity Cash Flow ($000)	-69,719	15,184	20,580	14,800	11,316	8,685	6,041	5,976	5,895	5,797	5,678
Cummulative Cash Flow ($000)		-54,535	-33,955	-19,155	-7,839	846	6,886	12,863	18,758	24,555	30,232
Payback Boolean		0	0	0	0	1	1	1	1	1	1
Debt Service Coverage		1.72	1.70	1.68	1.66	1.64	1.61	1.58	1.55	1.51	1.47
NN CASH FLOW:											
NN Taxes		890	885	880	874	868	862	855	847	838	828
Land lease		247	255	262	270	278	287	295	304	313	323
O&M spent in Navajo Economy		659	679	699	720	742	764	787	811	835	860
RISK ANALYSIS:											
Z Statistic		3.46	3.38	3.29	3.19	3.07	2.95	2.81	2.65	2.47	2.27
Probabilty of no default in each year (%)		99.97%	99.96%	99.95%	99.93%	99.89%	99.84%	99.75%	99.59%	99.32%	98.85%

PRO-FORMA CASH FLOW										
Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Electric Output (MWh)	231,422	231,422	231,422	231,422	231,422	231,422	231,422	231,422	231,422	231,422
Electricity Sales Price ($/kWh)	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
Operating Revenues ($000)										
Revenues	13,164	13,164	13,164	13,164	13,164	13,164	13,164	13,164	13,164	13,164
Operating Expense ($000)										
O&M Expense	2,783	3,117	3,491	3,910	4,379	4,904	5,493	6,152	6,890	7,717
Land Lease Expense	332	342	352	363	374	385	397	409	421	433
Navajo PIT Expense	301	194	180	166	156	146	134	121	106	89
Navajo BAT Expense	516	520	519	518	516	514	513	511	510	508
County Tax Expense	201	129	120	111	104	97	89	80	71	59
Total Operating Expenses	4,134	4,302	4,661	5,067	5,529	6,047	6,626	7,273	7,997	8,808
Operating Income ($000)	9,030	8,863	8,503	8,097	7,635	7,117	6,539	5,891	5,167	4,357
Financing ($000)										
Debt Funds										
Equity Funds										
Total Capital Investment										
Cash Available Before Debt	9,030	8,863	8,503	8,097	7,635	7,117	6,539	5,891	5,167	4,357
Debt Interest Payment	801	414	0	0	0	0	0	0	0	0
Debt Principal Repayment	5,529	5,916	0	0	0	0	0	0	0	0
Total Debt Payment	6,330	6,330	0	0	0	0	0	0	0	0
Tax Effect on Equity ($000)										
Operating Income	9,030	8,863	8,503	8,097	7,635	7,117	6,539	5,891	5,167	4,357
Deprication (5 yr MACRS)										
Interest Payment	801	414	0	0	0	0	0	0	0	0
Taxable Income	8,229	8,449	8,503	8,097	7,635	7,117	6,539	5,891	5,167	4,357
Income Taxes (w/o PTC)	3,251	3,337	3,359	3,198	3,016	2,811	2,583	2,327	2,041	1,721
Production Tax Credit										
Tax Savings (Liability)	-3,251	-3,337	-3,359	-3,198	-3,016	-2,811	-2,583	-2,327	-2,041	-1,721
After Tax Net Equity Cash Flow ($000)	-551	-805	5,144	4,899	4,619	4,306	3,956	3,564	3,126	2,636
Cummulative Cash Flow ($000)	29,682	28,877	34,021	38,920	43,539	47,845	51,801	55,365	58,491	61,127
Payback Boolean	1	1	1	1	1	1	1	1	1	1
Debt Service Coverage	1.43	1.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NN CASH FLOW:										
NN Taxes	818	714	698	684	672	660	647	632	616	598
Land lease	332	342	352	363	374	385	397	409	421	433
O&M spent in Navajo Economy	886	912	940	968	997	1027	1058	1090	1122	1156
RISK ANALYSIS:										
Z Statistic	2.05	1.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probabilty of no default in each year (%)	97.99%	97.28%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

AIV.4 Wholesale Electricity Price Forecasts

IV.4.1 Comparison of Cost of Wind Farm to Wholesale Electricity Prices

The minimum power purchase price for a new wind farm should be in the same range as the cost of additional wholesale electricity in the region around the wind farm. One way to assess the cost of additional demand for electricity is to forecast future wholesale electricity rates at major regional trading hubs near the wind farm. The wind farm on the Navajo Nation would be near the Four Corners trading hub in the Four Corners region of the Southwest.

PacifiCorp produced two wholesale electricity forecasts for four trading hubs in the western United States during their Integrated Resource Planning (IRP) process. The first forecast was produced during 2004 and an updated forecast was produced in late 2005 to reflect changing "market fundamentals" such as increases in the cost of natural gas. The forecasts are shown in Figure 17. The Four Corners forecast is labeled "FC". The other hubs are Palo Verde (PV) in southwestern Arizona, the California-Oregon Border (COB), and Mid-Columbia (Mid-C) in central Washington near the Grand Coulee dam. An important point from the forecast is that the difference between the forecast at the end of 2004 and late 2005 is greater than the difference in the cost of electricity between geographical locations. It is also important to notice that the Four Corners electricity price is consistently lower that the price in other regions for a given forecast.

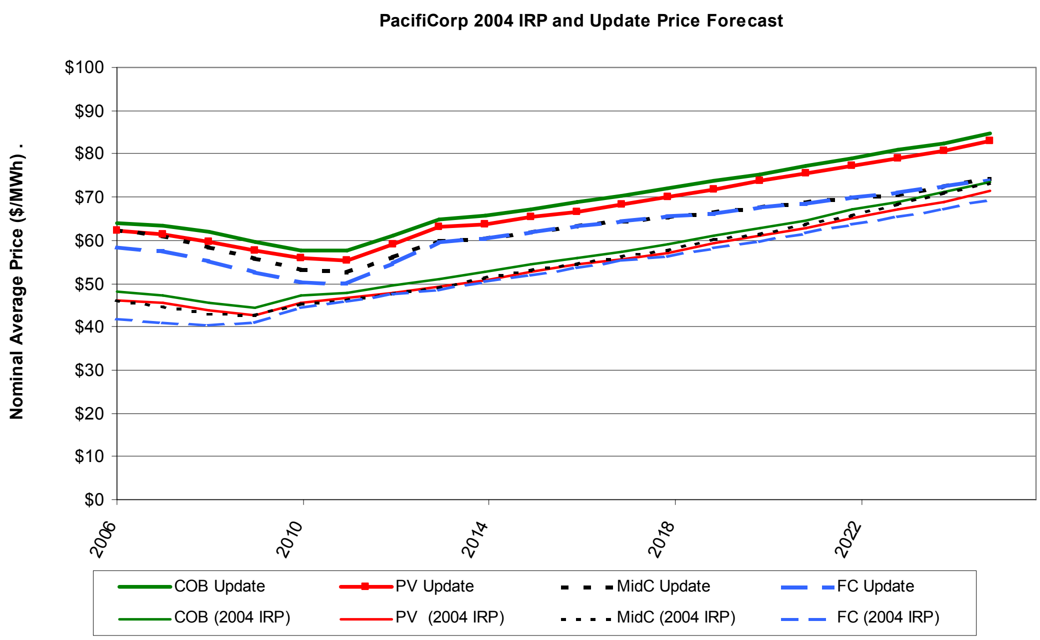

Figure 17 - Wholesale electricity price forecast for major electricity trading hubs in the western US. Data from PacifiCorp (2005, 52).

The forecast includes an expected $8/ton of CO_2 tax to be implemented throughout the west by 2012: "In recognition of the timing uncertainty, initial CO2 costs are probability-weighted. Costs begin to appear in CY 2010, but they are multiplied by a probability of 0.5. Likewise, CY 2011 prices are multiplied by a probability of 0.75. By CY 2012, the full inflation adjusted $8/ton CO2 cost adder is imposed, growing at inflation thereafter." (PacifiCorp 2005, 75).

The values in Figure 13 were calculated from the PacifiCorp forecast of prices at the Four Corners hub. The "High" electricity price is from the updated (late 2005) forecast while the "Low" price was derived from the initial forecast made in late 2004. The nominal values shown in Figure 17 were converted to levelized real prices by assuming a 3% inflation rate.

AIV.5 Uncertainty Analysis

Many of the numbers used in this analysis are estimates and are subject to change in specific cases. Therefore, an uncertainty analysis was carried out to test the robustness of key results from the tribal wind finance model.

Instead of carrying out a broad Monte Carlo analysis or sensitivity analysis, this section only looks at specific assumptions to test the relative effect in comparison to the Benchmark model. Only the three most interesting cases will be analyzed: the commercial wind farm on Navajo land, the Joint Venture with an outside investment partner, and a tribal owned wind farm financed with the Clean Renewable Energy Bonds (CREBs). The results of the uncertainty analysis are shown in Table 17 and explained in detail below.

Uncertainty Analysis

Sensitivity Scenario	Initial Value	Sensitivity Analysis Value	Initial Real Levelized Minimum PPA ($/MWh)	Sensitivity Minimum PPA ($MWh)	Percent Change in Value	Percent Change in Minimum PPA
Commercial Scenario						
Increase in cost of equity by two percentage points	12%	14%	$42.3	$45.1	16.7%	6.6%
Increase in cost of debt by two percentage points	7%	9%	$42.3	$44.6	28.6%	5.4%
Increase in both debt cost and equity cost	12%, 7%	14%, 9%	$42.3	$47.7	-	12.8%
Joint Venture Scenario						
Increase in Minimum DSCR	1.25	1.4	$41.9	$43.3	12.0%	3.3%
Increase in Minimum DSCR and Cost of Debt	1.25, 5.5%	1.4, 7%	$41.9	$45.2	-	7.9%
Change in Management fee	$9,000/MW-yr	$11,250/MW-yr	$41.9	$42.6	25.0%	1.7%
	-	$6,750/MW-yr	$41.9	$41.2	-25.0%	-1.7%
	-	$4,500/MW-yr	$41.9	$40.7	-50.0%	-2.9%
Tribal Owned- CREB Scenario						
Decrease in CREB term to 12 years	15 years	12 years	$39.5	$44.6	-20.0%	12.9%
Benchmark Model						
Debt term is increased to 15 years	12 years	15 years	$39.7	$38.4	25.0%	-3.2%
Cost of debt increases by two percentage points	7%	9%	$39.7	$41.8	28.6%	5.2%
Cost of debt decreases by two percentage points	7%	5%	$39.7	$37.6	-28.6%	-5.3%

Table 17 - Uncertainty Analysis. The first column indicates a plausible scenario that would affect the results presented in the primary analysis as shown in Figure 13. The next two columns indicate the value that was used in the primary analysis and the value used in the sensitivity analysis. The effect of changing the values is shown in columns four and five by the change in minimum power purchase price to meet the financial constraints listed in Table 6. The final two columns indicate the relative change in the values as a percentage of the initial value.

AIV.5.1 Commercial Scenario

AIV.5.1.1 Increase in the cost of capital

One challenge for wind farms on tribal lands is that the potential pool of financers that are willing to invest equity or debt on tribal land may be smaller than the pool available in other areas. This creates upward pressure on the cost of capital. It is difficult to know if and by how much the cost of capital will increase so this effect was not modeled in the main analysis.

AIV.5.1.2 Increase in the cost of equity by two percentage points

An equity investor may require that the expected return on the investment is greater for a project on tribal lands than in other projects. If the cost of equity increases for a commercial farm on tribal land by 2% points, from a nominal 12% after-tax internal rate of return to 14%, then the minimum power purchase price increases from \$42.3/MWh to \$45.1/MWh. The increase in the cost of equity by two percentage points increases the cost of energy by about \$3/MWh or a 7% in comparison to the scenario presented in

.

AIV.5.1.3 Increase in the cost of debt by two percentage points

Similar hesitancy to invest in projects on tribal land may drive up the cost of debt. If the cost of debt is raised from 7% to 9% the minimum power price increases by \$2.3/MWh or about 5%.

AIV.5.1.4 Increase in both the cost of debt and the cost of equity

In a worst case scenario, the cost of both debt and equity would increase each by two percentage points. The resulting minimum power purchase price would be \$5.4/MWh or about 13% higher. This scenario shows that increasing both the debt and equity cost has a synergistic effect such that the sum of the increase in cost due to each individual change is less than the increase in costs from the two changes together.

AIV.5.2 Joint Venture Scenario

The two major assumptions for the joint venture model are first, that a federal loan guarantee for a wind farm involving a tribal partner will reduce the cost of debt and the debt service coverage ratio and second, that the management fee for a Navajo partner will be \$9,000/MW.

AIV.5.2.1 Federal Loan Guarantee and the effects on debt requirements

If the federal loan guarantee does not reduce the DSCR from 1.25 to 1.4 as has been suggested in the literature (Harris and Navarro 2000), the cost of power from a joint venture wind farm will increase by \$1.4/MWh or by about 3%. If in addition, the cost of debt does not fall, the increase in the cost of energy will be \$3.3/MWh or 8%. Without the benefits of the federal loan guarantee, a joint venture wind farm on Navajo land may potentially cost almost \$6/MWh more than a wind farm off Navajo land (the Benchmark model).

AIV.5.2.2 Change in Management fee

Part of a joint venture relationship between a tribal partner and an investor is that during the first 10 years of the project life, the tribal partner manages the wind farm and earns a management fee. The sensitivity analysis shows that decreasing the management fee by 50%, from $9,000/MW-yr to $4,500/MW-yr only decreases the cost of power by about 3%. However, in the joint venture model the net present value of the total earnings to the Navajo partner (assuming 50% ownership after the flip) would go from $11.7 million with a management fee of $9,000/MW-yr to $8.7 million if the management fee were 50% less. Therefore a 50% reduction in the management fee would reduce the cost of power by 3% but it would also decrease the earnings of the Navajo partner by 25% over the life of the wind farm.

AIV.5.3 Tribal Owned – CREB Scenario

The CREBs have a maximum debt term limit that is set by the Secretary of the Treasury. The debt term is calculated based on the current interest rate for tax-exempt bonds as described in Section AIV.2.5.2.3. As the interest rate increases, the maximum debt term decreases. At 5% interest rates the debt term is 15 years but at a 6% interest rate the maximum term would fall to 12 years.

The small change in tax-exempt bond interest rates from 5% to 6% would increase the minimum price for a wind farm financed with CREBs by about $5.1/MWh or an increase of almost 13%. Such a drastic increase in the price of power from a wind farm financed with CREBs would make the CREB wind farm much less attractive to a power purchaser than the Benchmark model.

AIV.5.4 Benchmark Model

Changes in the Benchmark model are interesting in particular to the relative attractiveness for the CREB scenario due to the zero interest rate of the CREBs. If the cost of debt increases for a typical wind farm, then the relative attractiveness of a CREB wind farm will increase. Figure 13 shows that the CREB wind farm and the Benchmark model have approximately the same cost of power. If however, the interest rates for debt increase from 7% to 9% the CREB wind farm will cost approximately $2.3/MWh less than the typical commercial wind farm.

The sensitivity analysis also shows that increasing the debt term from 12 years to 15 years would decrease the cost of power slightly, but the extended debt term would also increase the risk of default.