

Introducing Renewable Energy on Tribal Lands or Comprehensive and Holistic Alternative Energy Planning for American Indian Nations

Michael Tulee

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Reading Committee:

Kristiina A. Vogt, Chair

Daniel J. Vogt

Linda Campbell

Tom G. Colonnese

Program Authorized to Offer Degree:

School of Environmental and Forest Sciences

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Michael Tulee

Abstract

Michael Tulee, M.Ed.

Chair of Supervisory Committee:
Kristiina A. Vogt
School of Environmental and Forest Sciences

Tribes are interested in developing their alternative energy resources but have not had a comprehensive assessment that would allow them to prioritize what resource should be developed. They have commissioned studies of the supply capacity of specific energy sources such as biomass or wind; however, these studies have been conducted in isolation from other competing uses of these lands and they have not explicitly included their impacts on cultural resources. These studies were not designed to address how a decision may impact tribal quality of life, other forms of resource production and a tribe's future resource base. This lack of a holistic and comprehensive assessment creates barriers for projects to move to the next stage even when studies suggest that sufficient supplies of a resource are available and can be economically viable to develop.

The goal of this research was to provide a platform where indigenous communities can make decisions that maintain the delicate balance between controlling one's own decisions, rooted in Native culture, and have the technological knowledge found in educational institutes and organizations, to prioritize what technologies and businesses to develop. This study had two objectives: (1) strengthen the political and technical capacity of tribes to develop their energy resources; and (2) develop a process for prioritizing resource development that is rooted in each tribe's culture and is economically viable. A case study approach was used to explore whether the production of biofuels, i.e., methanol, from wood wastes was a realistic option to develop niche products using tribal land resources.

Since alternative energy resource supplies are located in rural areas and on many tribal lands, energy resources can be the vehicle driving sustainable economic development in rural communities if they were to become the regional suppliers of these limited alternative energy resources. Today, this is not happening even though rural areas need economic revitalization; tribes living in rural areas have much higher unemployment rates compared to urban areas (7-8%). Despite the high regional potential to develop alternative energies on tribal lands, this potential is not a reality today and there are many barriers that limit its development. Biofuel production is an ideal green industry to develop since it will be rurally based, provides a diversity of technical employment opportunities, and would not compete with the traditional products industries.

To stimulate alternative energy resource development on American Indian Nation lands, a decision-process is needed to provide a comprehensive assessment of what energy supplies exist and how each resource production would impact cultural resources (e.g., open spaces, hunting, fishing, traditional foods, etc.) for all tribes living within the contiguous U.S. borders. Several factors limit or are barriers to tribes to develop their energy resource potentials: knowledge of what resources exists on tribal lands; lack of energy planning capacity to prioritize which energy resource to develop locally that does not impact their sovereignty, quality of life, increase external controls on tribal resource

decisions and their future resource base (e.g., Colville Business Council Resolution 1996-23); and the matching of the appropriate conversion technology to the available renewable resources that is economically viable and culturally acceptable, and does not degrade the environment for future generations. This knowledge could potentially stimulate the tribal development of alternative energy resources in a holistic manner and facilitate identifying their training needs so each tribe can independently develop their resources. It would move tribes beyond developing an energy resource because it happens to be fashionable or in vogue on the global radar screen at the moment or because subsidies currently exist to develop it.

It is generally accepted that if a region can develop its green economic potential that this will (1) create new employment opportunities for a highly skilled work force, (2) It would contribute towards regional energy security and rural economic revitalization based on abundant regional resources. Since alternative energy resource supplies are located on many tribal lands, energy resources can be the vehicle driving sustainable economic and job development. Alternative energy enterprises create direct and associated jobs in the bio-energy industry with salaries ranging from \$38,000 to over \$100,000 per year. For example, a diversity of job skills is needed by a biofuels industry: from bio-fuel production and marketing, certifying or assessing the sustainability of feedstock production/logistic, conversion technology to produce liquid fuels, renewable energy planning, and the business development of green energy enterprises.

Tribes interested in developing their alternative energy resources need a comprehensive assessment that would allow them to prioritize what resource should be developed and what business enterprises to support. Any assessment needs to address other competing uses of these lands and resources as well as the impacts on cultural resources. This decision also has to examine how a decision may impact tribal quality of life, other forms of resource production and a tribe's future resource base.

Several factors limit or are barriers to any tribe to develop their energy resource potentials: knowledge of what resources exists on tribal lands; lack of energy planning capacity to prioritize which energy resource to develop locally that does not impact their sovereignty, quality of life, increase external controls on tribal resource decisions and their future resource base; and the matching of the appropriate conversion technology to the available renewable resources that is economically viable and culturally acceptable, and does not degrade the environment for future generations. A comprehensive assessment whether it is worthwhile for a tribe to pursue alternative energy enterprises will need to be able to address all these aspects.

This project will build the capacity for tribes to prioritize how they want to develop and use their resources so that it has business viability but is still rooted in culture. It will introduce new energy technologies on tribal lands that can foster new employment opportunities in energy and allow tribes to stimulate the regional development of renewable energy resources. Because tribes already contribute significantly to regional economies, tribal capacity in developing renewable energy technologies will contribute towards the vitalization of rural economies currently facing high unemployment and few employment options. It will also stimulate the use of regional resources to stimulate sustainable development and begin to contribute towards regional energy security.

To make these decisions, each tribe needs to be able to comprehensively evaluate the impacts of resource consumption on the vulnerability of their lands to future land-uses and changes in the resource base as well as to identify any of its cultural impacts. This approach is similar to the Millennium Ecosystem Assessment report coordinated by the United Nations Environment Programme (UNEP) and published in 2005 that focused on global evaluations of environmental conditions. This assessment was an international effort to inventory global **ecosystems**, their contribution to human development and well-being by countries. The MEA approach needs to be adapted beyond its focus on assessing ecosystems and scaled to the needs of each tribe and their cultural norms. It needs to facilitate tribes identifying what energy resources exist for each tribe and for them to prioritize the suitability of different energy options that they may decide to develop on their lands. This needs to be a comprehensive assessment approach that prioritizes the energy choices in a cultural and a livability of development framework. This is possible by establishing data layers relevant to tribal lands and ranking each scalar unit according to the different energy resources that are suitable and available for a tribe. The assessment process then ranks the available lands for each energy resource based on the metrics used to prioritize the alternative energy resources. This needs to be followed by a data layer that ranks the economic viability of each energy resource and the future implications of pursuing an energy resource. The ability to layer the different factors that are impacted by a resource allows the decision-maker to make informed choices for each resource and to compare it to other options. This is similar to the approach used by FAO's Bioenergy and Food Security (BEFS) project to determine what lands were or were not suitable for Tanzania to grow bioenergy crops by producing a suitability index. The suitability index was connected to costs to grow the crops as well as identifying lands that needed to be excluded from consideration, areas where malnutrition was too high so food crops could not be replaced by oil crops, and those areas not available because of infrastructure development.

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Chapter 1. Introduction to why this research is needed

1.1. Sustainable PNW regional clean energy futures are linked to PNW Tribes

Even though tribes face significant socio-economic challenges, their ownership of resources and potential to be investors in developing technologies place tribes in a unique position to accelerate the adoption of regional clean technologies. Socioeconomic conditions facing Pacific Northwest tribes are a persistent problem that can be resolved using tribally owned resources to spur economic development on tribal and adjacent non-tribal lands. Tribes own abundant resources and land that are amply able to provide business incentives because of their sovereign status, they can stimulate regional economic development. Ownership of abundant resources means that competition for feedstock supplies is less likely to limit the building of technology infrastructures that require large and guaranteed supplies of resources. If the tribes are interested in a particular clean technology, they can guarantee the longer-term supplies of feedstock needed by an emerging industry. Recently, several clean technologies did not receive approval or permits to begin construction or went bankrupt because of a lack of reliable feedstock supplies. Therefore, tribes can reduce barriers to developing and commercializing clean technologies when manufacturing facilities are built on their lands. Furthermore, economically successful tribes also control their own affairs and insulate their dispute resolution from political interference or isolate the business managers from political forces yet keep them accountable to the community (Taylor 2008).

Tribes can leverage regional opportunities because of their long history of managing and developing multiple tribal enterprises at the regional level. The tribes in the PNW have been organized at the regional level to provide technical assistance and a clearinghouse for individual tribes in areas as diverse as economic development assistance through their economic development corporation (ATNI EDC); forests through the intertribal timber council (ITTC); energy planning training (ATNI Energy); and technical training programs to improve roads and bridges (TTAP), to name a few.

Today, an integral part of any business plan is the need to know whether a product will be accepted or rejected by the consumer (Anderson and Narus 1998). By adopting an American Indian Business model to evaluate the feasibility of developing a clean technology, it will decrease the chance that consumers will reject a technology that already factors in societal, cultural and environmental factors. Therefore, clean technologies satisfying tribal cultural values are less likely to be rejected by non-tribal consumers for environmental reasons. Implementation of resource-based technologies continues to face societal conflicts because of environmental concerns which impact their commercialization potential.

Tribes can reduce the costs of introducing new clean technologies into the market because their sovereign status provides them several tax advantages for non-tribal businesses that want to locate their manufacturing facility on tribal lands or employs tribal members in any aspect of supplying or producing a clean technology product. Some of these advantages can be summarized as: (1) “Regulatory flexibility - On trust land, tribes have autonomy to make decisions outside of State, County, and City government rules; (2) Property tax exemption - On trust land, tribes are not subject to property taxes unless agreed upon with service providers; (3) Indian Preference - In certain government contracts, tribes have Small Business Administration set-asides; (4) No Permitting cost - On trust land, most development activities are exempt from State Permitting Requirements; and (5) Employment tax credits - Non-tribal businesses may receive tax credits for hiring tribal members” (<http://www.cedco.net/working.shtml>).

Tribes have established novel business models where they honored the intellectual property of the developers and businesses that were non-tribal entities. Legal experts were used to write contracts that satisfied the different tribal laws particular to a tribe and did not infringe on non-tribal business intellectual properties. Tribes also facilitated technology development but not control of the day-to-day operations and further development of these technologies. Prior to starting the development of the technologies, contracts were signed by all parties involved.

1.2. Research focus and methodology

Evaluating what types of energy should be developed and for this production to be evaluated as sustainable is challenging. The typical assessment protocol used today requires data and an understanding of the entire life cycle of an energy supply before it is accepted as being sustainable and not having any negative societal impacts. A life cycle assessment mostly also focuses on measuring ecological and engineering indicators and not how a community of people are impacted by consuming an energy resource. The common renewable resources are wind power, biomass, and solar which are all important to one tribe or another. These energy sources can be developed on tribal lands but there is a need to understand which energy option is realistic to develop without jeopardizing cultural resources.

A suite of tools have been developed to assess the resiliency of natural environments to the extraction of resources to produce energy. However these tools have not been designed to measure the impact of their collection or extraction on cultural resources. This makes it difficult to evaluate which renewable energy source would be most suitable to develop on tribal lands under an environment of climate change. Since tribes have to live with the decisions that are made on their lands, it is even more challenging for tribes to make energy decisions that do not cause other problems.

Tools do exist to measure social sustainability but these approaches require a significant amount of data which diminishes their utility for selecting energy resources. For example, the large amounts of data that are needed to measure social sustainability would necessitate years of data collection. Since decisions need to be made today and not 20 years in the future, years of data collection are not an immediately useful option. Today, social aspects of sustainability are mainly measured using economic metrics. Because economic indicators are only one facet of social sustainability, they are not fully effective in assessing all aspects of social sustainability. There is a need to move beyond these narrow metrics because they may conclude that energy use in a locality is sustainable when in fact its society may not be truly sustainable. One approach to help achieve more complete sustainability is to focus on cultural values as part of an assessment. This might then highlight additional indicators that may be more valuable to help assess, and to manage for, sustainability.

As part of this research, the following research questions were explored to understand the context of potential tribal renewable energy projects. The goal is to provide insights as to what might be barriers for tribes to be engaged in renewable energy projects. This research should also provide insights to mechanisms that could be used to further increase renewable energy projects on non-tribal lands.

- Why would the development of projects for tribal energy production be important?
- What are the barriers and opportunities to develop renewable energy enterprises on tribal lands?
- What is the typical approach to evaluate, to adopt and implement new projects that would be relevant for renewable energy projects?
- How will this renewable energy project be different from those existing outside of tribal lands?
- Do renewable energy projects address cultural values?
- Are renewable energy projects compatible with tribal business models?
- How do we introduce energy research into our tribal systems?
- How should these energy systems be implemented and what are the advantages of implementing these on tribal lands?
- What should these programs look like if they are to be successfully implemented on tribal lands?
- What tools and strategies will be offered and what are the lessons learnt for pursuing renewable energy projects on tribal lands?
- What will be the significance of successfully implementing our goal and will this provide insights to successfully implement renewable energy projects beyond tribal lands?

The role of the researcher is to explore, discover and disseminate information that best informs society in formulating a renewable energy model that will provide impacting economic/cultural results. The rationale for selection of these particular research methods will be numerous. The reasoning is primarily:

- First**, find out if tribal members are open to allowing renewable energy programs within, or near their lands.
- Second**, this study's intent will be to help guide an acceptable renewable energy program.
- Third**, the study will provide tribal members with maximum knowledge and skills that will inform their renewable energy decisions.

This research for this study was based on a literature research as well as a case study on the production of biofuels to add context to the research questions posed above. There is considerable published literature on tribal practices, especially for business as summarized by Miller (2012), as well as cultural practices. The published literature is however fragmented and does not reflect how individuals in a tribe might respond to the research questions. For example, a cultural specialist will provide more rich narrative on the barriers and opportunities for renewable energy project than reading non-tribally written publications. The publications however provide a historical angle on how decisions were made and practices that were implemented in the past.

Native American resource, cultural, and business leaders from various tribes located in the Pacific Northwest have been part of informal discussions to address the research questions mentioned above. Given that multiple tribes will be targeted, numerous and varying cultural norms were important considerations during these discussions. As a member of the Yakama Nation, I have been able to hear and participate in meaningful discussions on energy production on tribal lands. Tribal protocol and etiquette were observed and carefully monitored so as not to misrepresent tribal energy needs and expectations of the preferred energy production systems. Anonymity of respondents is essential. Links between research questions and chosen methodologies will be very much intertwined.

First and foremost, a historical and document search was conducted to provide a base of knowledge to explore tribal energy production systems and whether a tribe will adopt a particular energy system. The second form of inquiry was based on discussions with tribal leaders and elders will be a part of data gathering. Based on cultural beliefs, many elders will not agree to "write things" down on a piece of paper; the idea being, that it will simplify their process of providing maximum input suited to their needs. This approach utilized as a measuring instrument of behaviors and attitudes toward the concept of tribal energy in general and the

introduction of an energy system on, or near their reservation. It is critical to understand the acceptance levels of local populations of a newly introduced model that will impact their “everyday” lives.

Chapter 2. Introduction to why the world needs Tribal renewable energy

2.1. Context for Tribal renewable energy

Highly volatile global oil and natural gas markets as well as the climate impacts attributed to fossil fuel use are all contributing towards increased societal interests in renewable and alternative energy resources. However, it is only recently that technological breakthroughs are allowing these resources to be economically developed. Despite interest in developing alternative energy resources, it has been challenging to shift the global economy from fossil fuels to renewable energies at the scale needed. (Biello 2011) Fuel production and standards are being altered in the U.S. as federal renewable fuel standards calls for 30 billion gallons of renewables to be in the transportation fuel pool, by the year 2020. With over 136 billion gallons of gasoline currently being consumed each year, this will represent an enormous hike in domestic alternative fuel production.

Regionally energy resources on tribal lands may make the difference in whether a region can reach its goal of becoming energy secure. Since the American Indian Nations own an estimated 10% of the contiguous U.S. energy resources, they have the potential to be significant players in these alternative energy markets. This 10% figure quoted by DOE is a nationwide figure which does not reflect the full potential for tribes to be regional suppliers of alternative energies and the role they should be playing to secure regional energy supplies. The importance of regional energy supplies is apparent in Washington State where 23% of the total state's electricity in 2008 was generated by one dam (Grand Coulee) that was built on lands belonging to the Confederated Tribes of the Colville (EIA-860. Annual Electric Generator Report); the Colville were not involved in the decision to build the Grand Coulee dam and have not benefited from its electricity production like the large cities of Washington.

Before tribes can begin to think about the potential of developing renewable energy enterprises, it will be important to understand why this discussion is occurring now and that fossil energy technologies is driving the adoption of alternative energy supplies. Energy security is a salient issue in marginal, rural areas, where access to energy can be frequently disrupted. (UNDP 2004) Developing business enterprises on American Indian reservations has to balance their energy production with the opportunities and constraints found in producing energy using natural resources found in rural and more isolated locations. For tribes, the energy technology developed has to satisfy several factors. On top of this list are sovereignty and the need to not have any impacts on cultural resources. (Gardner 2012)

Developing large scale renewable energy industries in rural areas has not been a high priority for non-tribal business entrepreneurs. They have assumed that large scale industries are most economical and avoided energy industries that are more compatible in rural areas where

transportation distances are too prohibitive at distances of less than 100 miles to a facility. (Taleb; Vogt 2012)

Most energy technologies are designed to be most economically efficient at large and centralized scales but rural and indigenous communities can seldom afford to take advantage of such solutions. Decentralized approaches to renewable energy production have tremendous potential to provide energy solutions for rural, indigenous communities since the resources are abundant at the local level. It would allow a tribal nation to utilize its own resources to develop a business in energy and it would ensure the tribe's sovereignty. Energy resources need to come from tribally owned lands. Tribes need to develop businesses using resources that they own on their lands and where they make the decisions on how to move a business forward.

One of the biggest challenges tribes face is the high unemployment rates found on tribal lands and the history of embattlement of tribes by the European colonialists that still continues today. (Marchand 2013) Developing business enterprises in the renewable energy field can help tribes utilize resources located on Indian reservations. It would also help to develop enterprises that maintains their cultures and traditions and does not impinge on tribal sovereignty.

It is important to learn what makes tribal businesses successful since these are the same factors that will determine how readily renewable energy supplies develop on tribal lands. The Harvard Project identifies sovereignty and culture as key factors in successful tribal businesses. (Gardner 2012) Retaining or restoring cultural resources is central to any tribal business venture. Potential business enterprises are not viable if their business activities cannot meet established goals on cultural resources located on a reservation. There are many examples of tribes **not** moving forward on a lucrative business venture because it posed a risk to their cultural resources. Culture is not to be sold for only economic gain during any tribal business deal.

Five years ago, Colleen Cawston (former Chair of the Confederated Tribes of the Colville) summarized to the Bioenergy IGERT class at the University of Washington the factors that she said had to be satisfied for a tribe to move forward on any business venture. The noteworthy comment is that the key characteristics of successful tribal businesses are not the common elements of most successful western world business enterprises (Marchand 2013). Colleen mentioned (Marchand 2013):

- *“The importance of maintaining and restoring tribal languages – languages are the manner in which tribal members link to nature, so any decision **cannot impact the survival and restoration of tribal languages***
- ***It is very important for tribes to make their own business decisions, i.e., maintain their sovereign rights.** An ability to maintain sovereign rights is logical considering how the tribes have been mistreated and their rights, lands and resources taken away from them*

- *It is the important that no land is lost as part of developing a business venture - This is just as critical for a successful tribal business venture*
- *Some items or resources are not negotiable and will not be traded away during a business venture.”*

The factors just mentioned as being important for a successful tribal business enterprise are the same as those needed to develop energy enterprises based on resources found on reservation lands. Ultimately, resources that are found and available on reservation lands will determine which energy technology is culturally, economically and environmentally acceptable to tribes. Decision-making on what technology to adopt by a tribe results in minimal negative impact to tribal life and cultures.

Renewable technologies have tremendous potential to provide energy solutions since the resources are abundant and locally owned on reservation lands. Renewable energy choices are also relevant for rural and indigenous community globally since they can be provided in a distributed mode locally but also be able to satisfy regional power needs during periods of peak demand. The advantages and disadvantages of biomass, wind and solar will be compared to fossil energy; most of our current indicators for assessing energy choices were developed for fossil fuels. Furthermore, fossil carbon will continue to be an important energy supply consumed globally as long as global energy consumption remains high. Some tribes have abundant fossil resources that they will continue to sell but the renewable resources are alternative sources of energy that can help a tribe to expand its economy.

2.2. Tribal opportunities in energy production

During the year 2007, over 4,159 TWh of electricity was consumed by U.S. interests. (**Figure 2.1**; (Dixon 2010) The U.S population base will keep expanding at a steady pace, meaning that an increase in the amount of energy will need to be tapped to power all our societal needs. It is estimated that by the year 2030, approximately 5,055 TWh of electricity will be required to power all U.S. domestic needs. (Dixon 2010) This creates opportunities since someone will have to provide this energy. Ideally a substantial portion of this could be provided regionally by the tribes because of their energy resources and culturally based energy production practices.

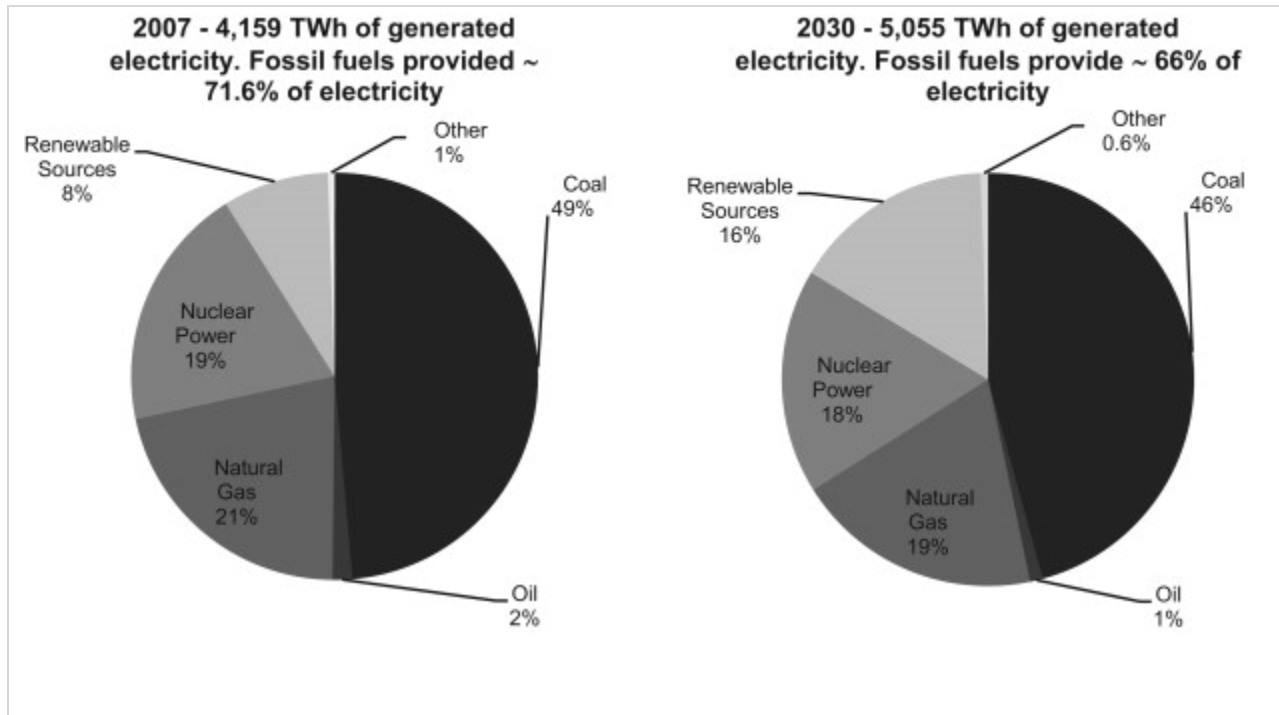


Figure 2.1. U.S. electricity generation by fuel source. (EIA 2009)

Today, the U.S. is the second largest (after China) greenhouse gas emitter in the world. (EIS 2009) So the negative aspect of this energy consumption is the increasing energy demand of the growing U.S. economy. The U.S. carbon dioxide (CO₂) emissions are expected to continue to rise but most of this is based on fossil energy supplies and not renewable energy supplies. (EIS 2009) Most of the renewable energy supplies are located in the rural areas where Indian Reservations are located.

The geographical locations of Indian Reservations suggest that tribes stand to gain economic opportunities if renewable energy is developed. It is estimated that 118 out of 298 Indian Reservations, holds biomass promise (arable land) within the United States. (Bronin 2012) Of the biomass found in rural areas, much of the public biomass areas are harvesting less biomass because of the concerns with biodiversity loss. This means that tribes, that are sustainably managing their lands, in contrast to non-tribal areas, are in a better position to restore the health of their lands while collecting biomass energy supplies.

Over the past 4 decades, American Indians have been gaining increased governing control of their resources on their lands which allows them to manage their lands for renewable energy

resources. Indian tribes also have a unique legal relationship with the U.S. federal government and increased opportunities under the EPA Act 2005. Under this act, tribes can exercise greater permitting authority in promulgating tribal renewable portfolio standards, net-metering, and other renewable energy policies to support the use of wind power to meet their goals of energy sustainability. (Flowers)

Native American tribes face many constraints today in developing renewable energy. Most, if not all tribes are steadfastly concerned that their cultural ways may be heavily impacted through introduction of intruding agents within their sacred, tribal lands. (Acker 2003) In South Dakota, a 30 megawatt wind-farm was being planned and one of the first feasibility tests specifically conducted was ethnographic, where crucial cultural significance of sacred sites was determined. (Garry 2009) Additionally, environmental concerns such as the damming of a pristine river, internal/external tribal politics, and economic costs are hindrances in Indian country in the development of renewable energy. Research suggests that increased federal policies that promote true tribal control over decision-making and resource use, will more than likely increase successful development. (Royster 2008).

Chapter 3. Review of fossil and renewable energy production systems

3.1. The problems with fossil energy

Since the dawn of Industrial Revolution, fossil fuel energy has played a key role in enabling human conveniences. Great inventions at both small and industrial scales were achieved that brought even more human advances and comforts. Medicines devised, technologies upgraded, and man-made infra-structures surged. Fossil fuel was seemingly plentiful and very affordable. A century of oil, natural gas, and coal exploitation systematically catapulted the United States as the world's largest economy. Aggregations of oil companies drilled into the earth throughout the United States.

As domestic oil became more difficult to locate and extract, foreign oil was being touted as the solution. One day in 1973 however, a group of oil exporting nations in the middle-east known as Organization of Arab Producing Exporting Countries (OAPEC) applied an "oil embargo" targeting western countries, the United States being one of them. This unified fossil fuel distribution approach sent a shockwave of stress worldwide, resulting in radical shifts of energy policy. Since this oil embargo, multiple energy plans have been applied, yet even today, fossil fuel still reigns as the "dominant source of energy."

In addition, by the year 2050, the U.S. is projected to reach the 440 million population mark and globally, the human population will surpass the 9 billion. (US Census Bureau) Both India's and China's populations have surpassed the one billion mark, along with their developing industrialization, are resulting in an accelerating world demand for fossil fuel energy resources. Both are emerging as the largest economies in the world. (Vogt 2008)

According to the Central Intelligence Agency, the average American citizen consumes about 10.6 liters of oil per day, which is about 13 times as much as the average amount of oil consumed by a Chinese Citizen, although 82% of China's electricity needs are now being met through the coal industry. (Breeze 2007) India is experiencing an 8% annual economic growth rate and in order to sustain this rate for the next few decades, they will have to triple their energy consumption. (Kelkar 2009) Coal is also the main driver of India's electrical needs as 75% of their electricity is powered by coal. (Breeze 2007)

At a minimum, the U.S. electric power industry is facing higher levels of challenges on multiple fronts: increasing demand, environmental concerns, national security threats, price spikes, and an aging infra-structure. (Felder 2008) Currently, the United States consumes 20% of global electricity and demand in the U.S. is also projected to reach nearly 5467 billion KWH by the year 2026.

At one point, the U.S. consumed half of the energy being produced in the world, and is still consuming the “lion’s share,” approximating 18.3 million barrels per day (USEIA 2014), resulting in an annual average of 7.5 billion barrels of oil. Additional demand in the name of industry and advancement in a growing number of countries has arrived. In more recent years, technological and industrial advancements made by both China and India have caused accelerated fossil fuel consumption worldwide. In fact, China is projected to surpass the United States later on this year as the world’s largest net importer of crude oil. (Daly 2014)

The bottom line is that our planet’s fossil fuel supply is dwindling due to ever-increasing population numbers (now exceeding 6.3 billion) utilizing fossil fuels. World fossil fuel supply is finite. (Brecha 2008) If humans are to survive energy shortage challenges on a global scale, it is clear that alternative energy resources must be utilized. Research suggests that there is a need to decode or unpack sustainability so that both societies and environments can retain their resiliency and still also the development of the world’s human capital while continuing to consume the globe’s resources. (Hsu 1986)

No one knows precisely how much outstanding fossil fuel exists in our world’s reserves but scientific estimations indicate that conventional peak of all oil production will occur within 10 years. (Bentley 2002) Some claim that peak production has already been achieved. (Guseo 2007) The U.S. imports oil from around the world. In fact, 40% of the petroleum that the U.S. consumes is imported from distant countries. (USEIA 2014) It must be noted that dependence on foreign oil poses a great risk to any importing country’s national and economic security. In fact, the import of foreign oil is driving up the United States’ national trade deficit. (Amadeo 2013)

Today’s decisions can increase the vulnerability of humans and ecosystems to future disturbances, such as climate change. (Vogt 2008) In addition, the energy economy is quite volatile in the global fossil fuel market arena. For instance, during the last half of the 20th century, forecasting future oil production was seemingly straightforward, well understood, and very reliable (**Figure 3.1**). For the first half of the 21st century however, these commonplace assumptions do not apply. (Nehring 2009) Because of the increasing complexities in extracting fossil fuel oil from earth’s depths, the costs are increasing. Although estimations of natural gas availability on U.S. soil are currently favorable, the debate of “fracking” and its environmental impacts have not waned.

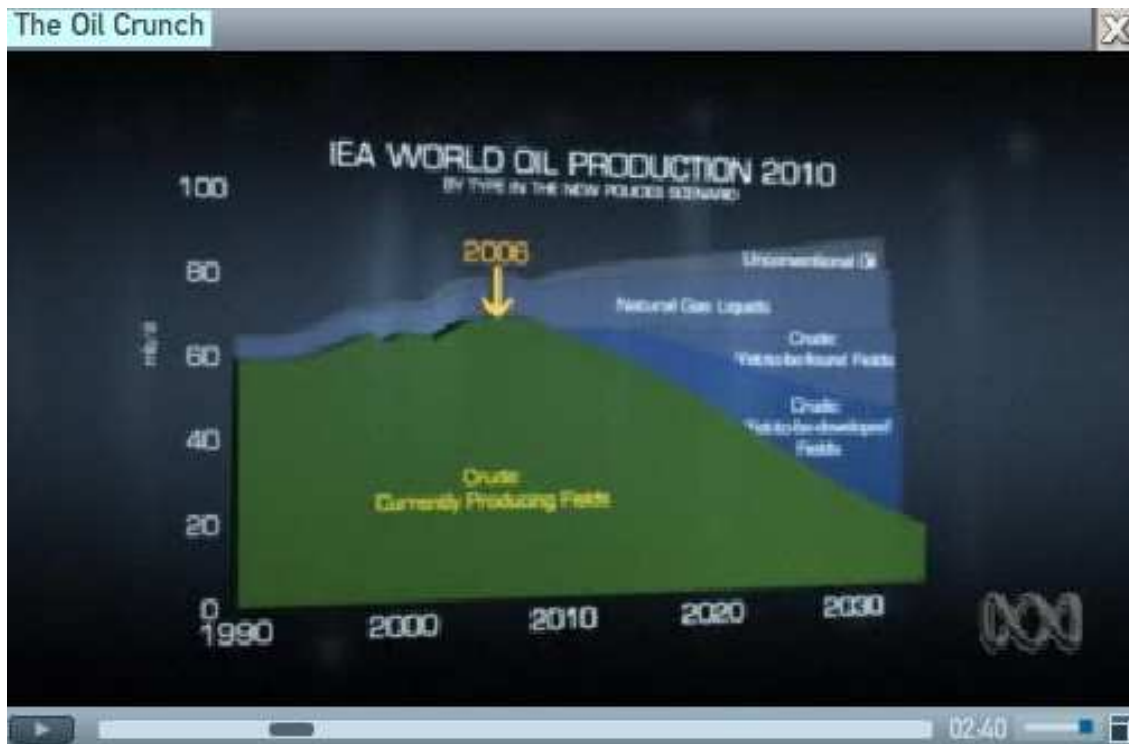


Figure 3.1. Chief Economist Fatih Birol advising that the conventional oil peak happened in 2006. (IEA 2006)

[<http://www.bing.com/images/search?q=photos+gasoline+peak+2006&qpv=photos+gasoline+peak+2006&FORM=IGRE#view=detail&id=A2801A1449F884FAD39534CB50079C96171B246B&selectedIndex=0>]

The global scientific community in large part, is observing an increase of strident non-renewable energy consumption, resulting in an overabundance of greenhouse gases (such as CO₂) and in the coming decades, global warming. (Hansen & Lacis 1998) Carbon dioxide is an important greenhouse gas linked to global warming. Fossil fuel combustion accounts for about 70% of the annual emissions of global CO₂ while land-use changes account for the remaining 30 percent. (Vogt 2010) In fact, since the industrial revolution era began, atmospheric greenhouse gas content has increased from 280 ppm to the current 390 ppm. (Hansen, Sato, Lacis et al. 1998) Since 1995, the world's sea level has risen three inches. The U.S. extreme weather events are up 30 percent and ice sheets in Greenland and Antarctica are down 4.97 trillion metric tons of ice. "Simply put, we are rapidly remaking the planet and beginning to suffer the consequences," says Michael Oppenheimer, professor of geosciences and international affairs at Princeton University.

In the year 2000 alone, approximately 26 Gt of CO₂ was emitted into earth's atmosphere. Atmospheric CO₂ and CH₄ levels are now higher than at any time in the past 400,000 years. (EASAC 2012) Given the anticipated increase in GDP of all countries across the globe, it is estimated that approximately 77 Gt of CO₂ emissions will be released into our atmosphere, meaning that if a sequestration model is not globally applied by the end of this century, 770 ppm of CO₂ content will be "coveting" our skies by the year 2100. (Lincoln 2005)

Many scientists believe that due to anthropogenic actions, earth's sea levels will rise, agricultural productivity will be altered globally, as well as disease patterns and ultimately substantial economic dynamics will be affected. (Lincoln 2005) It is estimated that each day humans are spewing in excess of 85 million metric tons of heat-trapping greenhouse gasses into our atmosphere. (Halter 2014) Just 1 MW of electricity being "traditionally" produced, results in 1,341 kg of CO₂ being emitted into earth's atmosphere. (Masterson 2010) Even more alarming, 41% of all CO₂ being emitted into earth's atmosphere is originating from electric utility generation. (Heimman, Solomon 2004)

Coal power plants produce almost two-thirds of the sulfur dioxide emissions in the U.S., the main cause of acid rain. (Clemmer 2000) They also generate more than one-quarter of the emissions of nitrogen oxides, the primary contributor to smog. In 2008, the EPA claimed that the highest emissions of nitrogen oxide in the United States were from the "Four Corners" coal plant located on the Navajo Indian Reservation. (Navarro 2010) Nitrogen oxide atmospheric emissions can contribute to regional excess ozone formation, which can adversely affect human lung capacity.

It must be noted that on the horizon, coal powered energy plants are decreasing in numbers of sites. On top of the CO₂ emissions that coal plants were largely responsible for, they are also not proving to be as profitable as they once were, although they are still the cheapest form of electrical production. (Breeze 2007) Since 2008, coal plants were responsible for 50% of anthropogenic CO₂ emissions, today that number has decreased to 37%. On the other hand, natural gas has increased from 22 to nearly 33% of the current CO₂ atmospheric emissions. Interestingly enough, natural gas burns cleaner than coal, producing approximately half of the carbon emissions per unit of electricity generated and 30% less than liquid petroleum. (Kelkar 2009) However, even with a natural gas-dominated electricity system, carbon emissions will not decline because natural gas will be replacing low-carbon nuclear power.

The Intergovernmental Panel on Climate Change (IPCC) maintains that the earth's surface temperature has increased by over 1 degree C since 1940. It is asserted that the "melt" season at the Arctic Circle is increasing "in days" and has been for four decades now, meaning that the Arctic is warming. Although CO₂ is being labeled as the main driver of climate change, a perhaps even more dangerous gas known as "methane" is on the horizon. Wetlands across our

planet account for 30 percent of the global methane budget. The wetlands serve as carbon dioxide sponge because the gas gets trapped in their cool, oxygen-poor, waterlogged soils. At the same time, microbes break down the rich organic matter wetlands contain and release metabolic byproducts, including methane. (Tyrell 2015)

Tropospheric methane has also been measurably increasing in content. Methane occurs through natural means in animal waste, soils and has been known to be stored in what are known as ocean “sinks.” It was recently discovered that over 570 methane plumes known as gas hydrates are being released from the Atlantic Ocean sea floor (see **Photo 3.1**). These plume releases are critical because methane gas, upon being released into the atmosphere, are 10-20 times more effective at trapping heat than CO₂, potentially become a super potent greenhouse gas agent. Even if the methane gas does not reach earth’s surface and is converted to CO₂ within the ocean’s waters, it will still increase ocean acidification. (Hand)

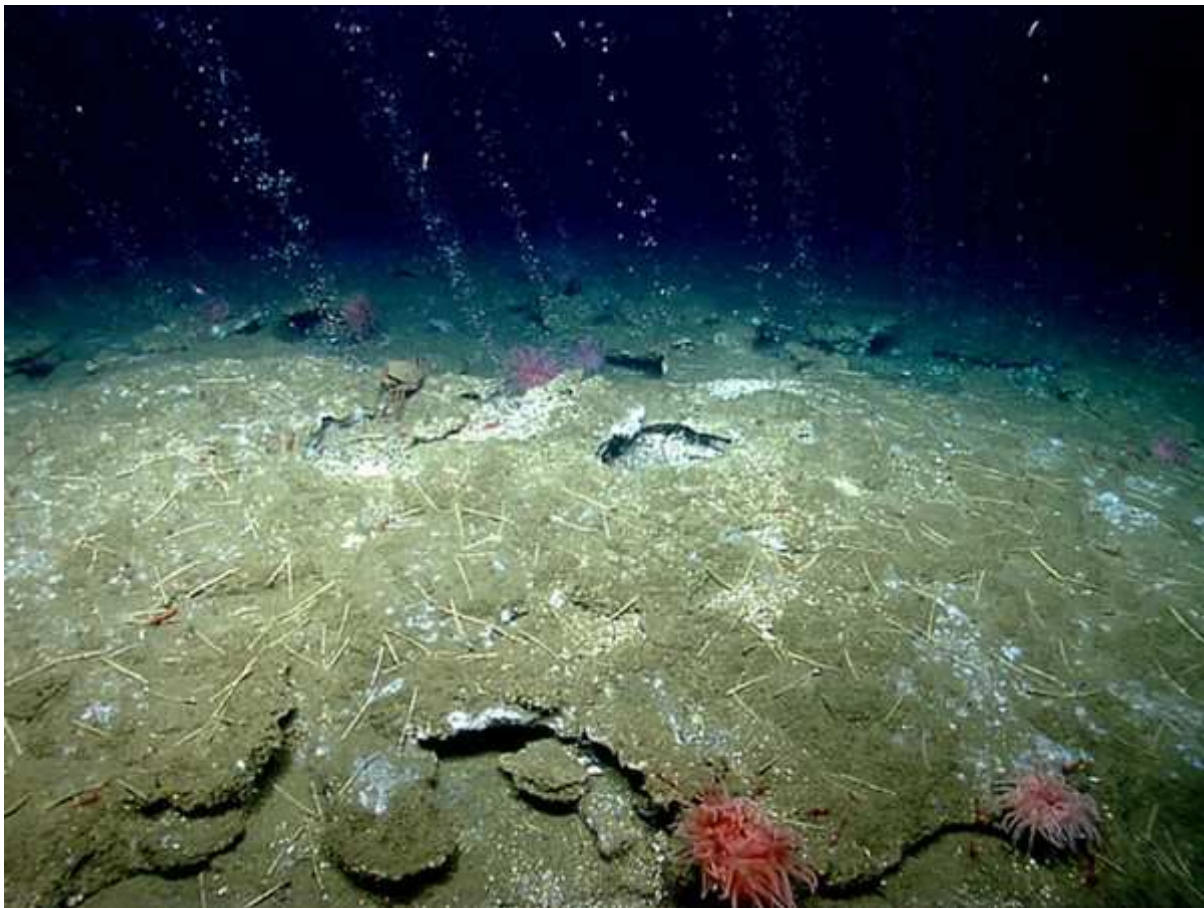


Photo 3.1. Methane gas being released from ocean floor east coast U.S. (2013 Northeast U.S. Canyons Expedition/NOAA Okeanos Explorer Program)

Even the coldest places on earth are not immune to climate change. A major glacier known as “Thwaites,” located on the West Antarctic Ice Sheet has collapsed (see **Photo 3.2**). What this means is that the globe’s water level will irreversibly rise 2 feet. (Hickey 2014) Additionally, because of this glacial collapse, there is a distinct possibility that another 3.65 meters of water will rise onto shores worldwide. In large part, global climate change is being tagged as a catalyst of this collapse and will accelerate. (Hickey 2014) Even more alarming, satellites have detected a dramatic ice loss in the Antarctica peninsula. In 2014 alone, it was estimated that approximately 60 cubic km of ice melted away from the peninsula. To give some perspective, 4 cubic km provides enough domestic water supply for the United Kingdom. (Amos 2015)



Photo 3.2. Thwaites ice shelf taken during an October 2013 Operation Ice Bridge aerial survey. (James Yungel / NASA Photo)

The culminating result of greenhouse gas buildup in our atmosphere will be catastrophic to say the least. NOAA reports that the month of June 2014 was the hottest month recorded on record. (NOAA) It would only make sense that accelerating the transition from fossil fuel to renewable energy is the answer but this is not the case. In fact, it is projected that even in the year 2030 oil will still be the primary energy fuel of choice. (Vogt 2009)

Growing fears of climate change on a global scale are on the horizon. Research is showing that a gradual warming trend is occurring on earth's surface, causing disastrous results. Global Warming in the form of heat waves, droughts, floods, poor crops, glacial dissipation, and abrupt weather patterns are becoming more frequent. (Fiset 2007) Studies show that climate change can impact human health on a global scale. For example, severe droughts in African regions are known to cause shortages of food, resulting in a decrease in human resistance to disease. (Vogt 2010)

On a global scale, insect infestation areas are also projected to "migrate" northward due to global warming at a rate of 7 kilometers per year. (Barford 2013) In fact, "mountain pine beetles" are insects that are becoming a great concern in the forest community. Attacks from these pests result from trees that are under stress from injury, poor site conditions, fire damage, overcrowding, root disease or old age. (Leatherman 2014). Cold winter seasons that used to effectively kill pine beetles are decreasing in strength, meaning that increasing numbers of these pine beetles are surviving the milder winters. (Valentine 2014) These pine beetles have destroyed major swaths of ponderosa, whitebark, lodgepole, Scotch, and limber pines in 19 western U.S. states and in Canada's Western provinces. The beetle infestation, along with disease, threatens 94 national forest areas in 35 states.

The threat of disease is also a growing concern in the research community. It is believed that global warming will increase the number of cases of Malaria, dengue fever, Japanese encephalitis and tick born encephalitis, especially in developing countries. (Kurane 2010) Mosquitoes (carriers of the once nearly-decimated disease malaria) are benefiting from global warming. (Halter 2014)

Both temperatures and precipitation will increase in the Pacific Northwest. These changes will unfortunately result in decreased stream flow, soil moisture and snow pack, meaning that water storage will be negatively impacted also. (see **Photo 3.3**; Parmalee 2001) The answer therefore is to "decrease", not increase greenhouse gas concentrations through promotion of alternative/renewable energy productions. Remaining on the same fossil fuel energy consumption path will only add to an already mounting global atmospheric carbon emission level never seen before by mankind. It has been determined that an energy imbalance is being caused by an influx of greenhouse gases emitted into the earth's atmosphere, resulting in a "radiative forcing." (Shines and Sturges 2007)



Photo 3.3. In this July 19, 2007 file photo an iceberg is seen off Ammassalik Island in Eastern Greenland. A new assessment of climate change in the Arctic shows the ice in the region is melting faster than previously thought and sharply raises projections of global sea level rise this century. (AP Photo/John McConnico, File)

3.1.1. How can the U.S. make progress toward a renewable energy future?

How can the U.S. make progress toward a renewable energy future? Overwhelmingly, scientific evidence is pointing toward global climate change. Even so, what can be done about it? The Obama administration proposed a climate change mitigation strategy in the U.S. that would require the entire power sector, America's largest carbon polluter, to bring its emission levels 30% below where they were in 2005 before the year 2030. (Resnikoff 2014) Theoretically, it appears to be a viable option. Studies show that the US population could actually cut its energy consumption in half without compromising its quality of life as demonstrated by citizens of Switzerland, who currently consume 50% less energy than the average U.S. citizen. (Gohlke 2008)

Research also indicates that as much as 125 years' worth of CO₂ atmospheric emissions may be sequestered in the future by injecting CO₂ into exploited oil, coal and natural gas fields. The barrier however, is that it is costing \$53 per MT to "clean" CO₂ effluents before injecting it into these vacant fields. Studies show that all physical regions of the U.S. could potentially contribute substantial renewable electricity supply in 2050. (Owano 2012) Some have predicted that renewable energy can and will power 35% of our global energy system (out of 140,000 TWh) by the year 2050 and 50% (out of 20,000 TWh) of our electricity needs. (Destuni 2010) An ambitious California state legislature recently passed an initiative with the hope that it will incentivize 1,000,000 Californians to transition from a highly polluting fossil fueled powered transit system, to more of a hybrid/electric car society. (Culverwell 2014) This bill will provide \$2,500 rebates to California car drivers switching from their gasoline powered vehicles to hybrid/electric cars.

3.1.2. Is the solution stronger State and National standards?

We already have the tools to start significantly ramping up renewable energy. Some states are actually taking pre-emptive measures designed to curtail carbon emissions. Texas now generates nearly a 1/3 of its energy from wind-power. (Henry 2014) Another example of how carbon emission reduction is being approached is through what is known as the "Regional Greenhouse Gas Initiative" (RGGI). This particular program is the first market based emission reduction program in the United States. Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont have all combined to utilize a "cap and trade" formula in the Northeast U.S. sector that allows carbon emissions to be auctioned off to electric power producing plants. Power plants are allowed to emit 82,553kg of carbon emissions per year within these nine states. Once surpassing the 82,553kg allowance, the power plant companies are then required to pay dollars to the RGGI program based on overage. The RGGI then turns around and reinvests those dollars into alternative energy endeavors and energy saving programs in those states. (RGGI.org)

Even more, electricity transmission line upgrades will become increasingly important if society is going to evolve into more of a renewable energy system. In the past, even siting transmission lines was a very difficult process. The U.S. Department of Energy authorized the right to exercise the "right of eminent domain" as part of the siting process on a national basis in two different areas in the U.S. (Lax 2008) In 2009, the U.S. Department of Energy invested \$4.5 billion into energy system upgrades meaning that "smart meters" and additional energy smart systems were installed into electrical energy systems. Farther into the future, if large scale electricity transmission from renewable energy sources is to become more prevalent, energy smart grid will need to be implemented in attaining higher distribution efficiency. (Joskow 2012)

Technological advances are constant. University of Washington researchers are suggesting that algae energy systems may be the “wave of the future.” In times past, algae required conditions that limited efficient algae biofuel production. By sequencing genomes of algae, UW researchers are now able to produce “brown” algae in colder, cloudier climates. (Knoth 2014) Another author argues that a “hydrogen driven” energy system holds the key to the future simply because it will be the growth of tangible environmental concerns that will drive its demand. Hydrogen can be obtained through diverse (renewable and non-renewable) resources, can be stored as a fuel, and used for transportation and distributed heat for power generation. It is also asserted that it will potentially provide energy security. (Edwards 2007) It has been challenging to shift the global economy from fossil fuels to renewable energies at the scale needed (Biello 2011) so the shift to renewable energy future is not a reality today.

3.2. Introduction to advantages/disadvantages of the three renewable energy supplies

The advantages and disadvantages of biomass energy, wind energy and solar power are briefly summarized below since it is one of the factors that need to be known to determine the adoptability of an energy source [Most of the material in this section was published in Vogt et al. 2010 with M. Tulee as a co-author]. This summary helps to identify why an energy supply might be culturally compatible for a tribe to develop on a reservation. It also helps to understand why one tribe may or may not think that one of these energy supplies would be good to develop into a tribal business. This brief introduction will start first by mentioning forest biomass for energy.

3.2.1. Biomass

Forest biomass is an important resource found on reservations and tribes are acknowledged as leaders in the practice of sustainable forest principles. There are many timber tribes who own abundant timber and biomass waste supplies on their reservations. Rigdon recounted the importance of forests in Indian Country:

“In the continental United States 193 Indian reservations in 33 states have 6.9 million ha or 17.1 million acres of forest land....In the Pacific North-west, the annual allowable sale quantity from Indian forest is about 500 million board feet, almost half of the volume available from the Forest Service and Bureau of Land Management lands under the North-west Forest Plan....The commercial forestry on Indian reservations has immense potential for generating economic gain for tribes, but Native American values provide a unique context within which forestry must be conducted. On most tribal lands, the utilization of forest resources is

balanced with important resource values such as religion and culture, water quality and wildlife and fish...

Therefore forest biomass will help maintain tribal sovereignty. It is therefore an important energy enterprise to develop on a reservation. Biomass supplies therefore are economically valuable energy supplies that tribes can manage competitively against other non-tribal biomass suppliers. This is also a resource that has regional importance.

Advantages of biomass harvested from forests, timber industry waste stream to produce energy:

- Forest materials are abundant and a readily available source of biomass
- Some forests need to be managed to restore their health, the continuous provision of ecosystem services, and to reduce their fire risk
- Machinery is available to collect biomass environmentally
- Biomass can be managed to increase carbon sequestration by storing carbon in a forest or by collecting small amounts of material to convert to liquid fuels
- Invasive woody shrubs or trees can be controlled by reducing their re-invasion risk when their biomass is converted into liquid fuels
- Microbial or chemically contaminated biomass can be used to produce energy
- Multiple conversion technologies (e.g., pyrolysis, gasification, combustion) exist to convert biomass rapidly (seconds to minutes) and efficiently (approaching 50%) to a variety of alcohols, bio-oils or char
- Using biomass to produce energy creates a diversity of technical and professional jobs (e.g., managers, engineers, truckers, business entrepreneurs, marketers).

Disadvantages of biomass:

- High bulk density of wood biomass makes it expensive to transport wood materials further than a 80.5 km radius from the collection point; this limits the adoption of co-generation facilities to a short radius around existing mills
- Just combusting biomass is not an efficient manner to generate energy even though the efficiency of boilers and steam turbines has improved
- Biomass wastes are costly to dispose of because of the need to transport the materials and many landfills do not accept biomass materials
- Half of the global population is dependent on burning wood for energy and in some regions this approaches 90% of the population. Since Food and Agricultural Organization (FAO) has determined that wood fuel supplies are insufficient to supply the demand, it means that energy demand cannot be satisfied if wood is only burned and the human development potential is significantly reduced
- Scientists are just developing the tools to determine how much and where to collect biomass materials from forests so ecosystem services (e.g., water, productive capacity of

trees and shrubs, endangered species habitat, etc) can continue to be obtained from forests while also obtaining an economic return from them.

3.2.2. Wind

Wind can be an important energy supply for tribes. Generating wind power has caused some problems in that the most ideal sites for generating wind energy are also those where the lands are good hunting grounds. In Washington, wind power generation is also more difficult to control the high and low flow periods. Wind power was unable to supply the power grid last year because there was too much water flowing over the dams. So wind energy may be more of a problem for a tribe to be able to manage a business enterprise since it has to be able to access the electric grid. Finally, tribes cannot compete against the power industry to supply the consumers needing electricity.

Advantages of wind power:

- Wind is a renewable energy resource that can be used to generate energy in most places globally
- Wind is abundant and an unlimited supply of power (wind power can be considered a form of solar energy since winds are caused by the heating of the atmosphere by the sun which means that there are no limits to wind power unless the sun “burns out”)
- Wind is a clean fuel source since does not require the combustion of fossil fuels to generate power and therefore it does not generate pollutants
- Wind is locally generated and therefore provides local energy security
- Since wind turbines can be installed on farmlands or other rangelands, it can contribute towards the development of rural economies when companies rent these lands
- Since people are also needed to maintain wind turbines, wind energy contributes toward new job creation in rural areas facing high unemployment
- Wind power can substitute for fossil fuels used to produce electricity
- A variety of wind energy systems are currently available to satisfy a range of customer needs - from small modular units providing ~1 kw of energy to the massive wind facilities capable of providing more than 3.6 MW of electricity.

Disadvantages of wind power

- Wind energy production is strongly controlled by geographic constraints since wind speeds need to be sufficiently high to generate power
- Sites with sufficient wind speeds are frequently located in remote areas and therefore at a great distance from where the electricity is consumed (e.g., a city)
- Wind does not always blow consistently so that wind generation would be intermittent and thus electricity would have to be stored for use during the non-windy periods

- The consumer demand for power is offset from the wind supply capacity so that the highest wind levels are often measured after midnight to about noon while the demand for power is the highest from noon to the late evening
- Wind power has not been adopted in some locations because zoning regulations and land use restrictions preclude its installation
- Lack of or insufficient existing infrastructure (e.g., gridlines) capable of transporting electricity to the customers
- There is a need to acquire land rights to build the required infrastructure to transport electricity from the site where it is generated since the grid system has to cross multiple land ownerships
- Wind infrastructures to produce electricity have to compete with other alternative land-uses and electricity generation may have a lower priority.

3.2.3. Solar

Advantages of solar enterprises:

- Practically no operating and maintenance costs once installed
- The price of solar cells are progressively getting more affordable
- Sunlight is a completely sustainable fuel
- Solar power is economically viable in remote, off-grid applications
- Energy payback period (amount of time before you recover the energy lost in production) has recently dropped to 1-2 years
- As the scale of manufacturing increases, and research in thin-film and organic PV's continue, the energy cost could potentially fall to \$0.03-0.05/kWh
- Ability to sell excess energy back to the grid
- The toxicity has been largely over-stigmatized – only 0.02 g of cadmium are released into the atmosphere per GWh for CdTe-based panels
- Converted to an equivalent basis of CO₂ emissions, CdTe panels emit 20-60 g/kWh, compared to the world average for all technologies of 660 g/kWh
- Efficiencies continue to increase, approaching 40% in a non-commercial setting, while costs continue to decrease.

Disadvantages of solar power enterprises:

- High capital investment compared to coal, and even other renewable technologies
- Integrating over their respective lifetimes, solar energy is more costly than other renewable energy resources.
 - The energy source, by nature, is intermittent, which forces a dependency on: Energy storage – in times of excess production, the energy could be converted to potential energy (batteries, hydroelectric, etc.); Grid efficiency

- Large required land area for solar plants
- The conversion efficiency is greatly dependent on the amount of solar radiation received, making cloudy regions less viable as well as the higher latitude areas where sunlight is minimal during the winter months.

Therefore it is obvious that each renewable energy source has advantages and disadvantages similar to what is found with fossil energy sources. Each of these points have to be used by a tribe to determine which renewable energy supply is most realistic for them based on resources and other demands on the land resources.

3.3. Western scientific evaluation metrics for energy sustainability

The western world scientific evaluation tools and the criteria that they developed will be first discussed to demonstrate their lack of inclusion of cultural traditions. These are measurable factors that the western world expects to see data on before making a decision about using any energy source. These criteria, to a large extent, measure the negative impacts of energy use:

- 1) Energy return ratio, and
- 2) Environmental metrics:
 - A) Greenhouse gas emissions and climate impacts
 - B) Land conversion to energy crops; and
 - C) Toxic chemicals released during the use of each energy supply.

These indicators will be briefly discussed next and text are extracted from Vogt et al. (2009) which I am a co-author. It is interesting to note that all of these indicators just mentioned are important for Native Americans because they all have the potential to have negative impacts on cultural resources as well as a tribe's sovereign lands. However, the land conversion is probably the most important if it decreases the health of an already diminished tribal land ownership.

- ***Energy choices based on the energy return ratio.*** *The energy return ratio selects energy supplies based on how much energy is produced compared to how much is consumed during the production of that energy. An energy supply with a high energy return ratio is most desirable. Selecting an energy based on the energy return ratio, hydropower is ranked as the most energy efficient approach to produce electricity when compared to all the other sources of energy. Hydropower has a potential to produce over 200 times more energy compared to what is consumed during the life-span of this technology. The energy return ratio suggests most fossil fuels would be less acceptable to use to produce energy. Compared to the renewable energy supplies, most of the fossil fuels provide much lower levels of energy payback. Part of the lower energy return for fossil fuels (e.g., oil, natural*

gas) is the higher energy investments required to obtain these resources from more distant, less readily accessible, locations.

- **Environmental and social metrics.** Environmentally-based indicators are commonly used to measure whether negative impacts or externalities are likely to occur from producing energy using any material.

The most commonly used metrics have focused on: A) how much land conversion is needed to grow the crops (e.g., loss of forest lands into agricultural use such as palm oil plantations, sugar cane or soybean fields replacing natural forests), B) how much fossil carbon is emitted into the atmosphere during the production and consumption of an energy source, and C) the amount of toxic chemicals are released into the environment during the production and use of material producing energy. Each of these will be discussed next to clarify how each common environmental and social metrics could impact a tribe. Finally, energy use sustainability will be analyzed via comparison model through a tribal “lens.”

A) Land conversion. Decades of research have documented the potential negative impacts of land-use changes and land-use conversions on soil health and the plant productive capacity. Land-use changes, especially the conversion of tropical forests into agriculture, have been implicated with negative environmental impacts such as altered climate patterns as well as reduced soil fertility. These types of impacts are immediately recognized by societies because of a loss of food security when crop yields go down. Therefore, land conversion potentially can decrease the future ability of the land to grow food crops from the same piece of land. Within the last 10 years, the production of biofuels has emerged as a new driver for causing land conversion and loss of a lands ability to grow similar yields of crops.

B) Fossil carbon emissions. One globally acceptable and readily quantifiable environmental metric to look are energy materials utilized to produce energy products and the amount of carbon dioxide emitted into the atmosphere. The entire carbon life-cycle (LCA) of the energy production, maintenance and fueling is documented. Emission rates are calculated using LCA approaches to estimate CO₂ emissions from multiple sources. The amount of CO₂ emissions that are avoided is an acceptable metric to monitor because of that role that CO₂ has in global warming. Furthermore, three fourths of the CO₂ emitted globally occurs during the combustion of fossil fuels. Therefore it is very logical to measure CO₂ emissions when comparing fossil and renewable energy supplies.

Since coal is such a plentiful fossil carbon available to produce energy, researchers are actively working at capturing and storing the carbon released

during its combustion; this technology is still being developed. A significant benefit of coal is its abundance, many countries have their own coal supplies and technology allows it to be efficiently converted to electricity to provide uninterrupted power. Several of the southwestern and northwestern U.S. tribes own coal deposits. Recently they have been having difficulty in selling as much coal because power plants are decreasing their buying of coal as part of their carbon mitigation efforts.

The importance of managing the carbon cycle to society is apparent from the number of countries attempting to regulate the amount of carbon that is allowed to be emitted from fossil fuel combustion. These avoided carbon emissions are traded in global carbon markets. Carbon markets allow businesses or organizations to determine how they will directly decrease their industrial carbon emissions or how much carbon credits they will buy from those better able to sequester carbon in order to reduce their emissions.

C) Chemical pollution from energy production and use. *Many fossil materials used to produce energy can release toxic chemicals into our environment during some phase of producing the energy. Despite this potential, as a society we have not typically selected our energy supplies based on the amount of toxic chemicals released into the environment. Most energy supplies were selected because they were abundantly available (e.g., coal) and not because of the problems of managing their toxic wastes.*

Society also has institutionalized the management, regulation and remediation of toxic chemical inputs into the environment. Despite these safeguards, release of chemical toxins is an issue that society still has to face. On indigenous and Native American reservation lands, the mining of uranium is occurring today because of the renewed interest in nuclear power. This renewed interest in mining uranium on tribal lands is occurring despite the fact that past mining operations left a toxic legacy of major health problems for Native Americans.

Out of all the energy supplies used by society, coal appears to have the most negative environmental impacts. The potential for chemical spills from coal mining continues to exist even if these chemical spills are not an everyday event. These spills have also made coal a less preferred material to produce energy in some locations in the U.S. The problem the coal industry faces is a result of the federal regulations which do not allow waste products to be emitted from coal plant smokestacks. Therefore, these chemicals are captured and stored as solid waste piles. In 2000, the US EPA determined that there were 300 landfills and 300 surface impoundments that included coal wastes; coal wastes are being produced by 440 coal fired utilities generating electricity in the U.S. The U.S.

EPA assessment identified potentially 24 cases of coal waste storage were 'potential damage cases' because either sulfate, cadmium, chromium, zinc, boron, nickel, arsenic, selenium, manganese, fluoride, chlorides, poly-nuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs) were detected in residential drinking water wells. The sites identified were mostly locations where fossil fuels were used to generate power.

The three renewable energy sources need to be compared to the common fossil energy indicators used to measure whether the energy consumption is sustainable. The energy return ratio does not provide a useful metric to compare these renewable energy sources since each produces significantly more energy than what is consumed during the energy production phase.

In addition, CO₂ emissions are not important indicators to monitor except for those cases in which fossil fuels are used in some phase of the energy production or its delivery to the consumer. The three renewable energy sources are all carbon neutral so the metric of the amount of carbon emissions is not relevant.

Land-use conversion is an indicator that needs to be monitored when using biomass for energy or wind power; this is not relevant for solar energy. Solar energy has the potential to release toxic chemicals at the end of the life cycle of a solar panel because of the metals used in their manufacture.

	Energy Return Ratio	Land-use Conversion	CO ₂ Emissions	Toxic chemicals
Biomass	O	X	O	O
Wind	O	X	O	O
Solar	O	O	O	X

X –indicator relevant to include; O –not relevant

This brief review of the common renewable energy sources and how their sustainability are measured will ground the reader to understand other issues that tribes need to consider before developing energy enterprises. The next chapter will examine why tribes need to be part of the renewable energy scene if this energy production will expand in the U.S.

Chapter 4. Context of viable tribal business enterprises in renewable energy

4.1. Why renewable energy needs to come from Tribal lands

After the Revolutionary War, the new United States adopted the doctrine of discovery and continued the process of land acquisition. The official white attitude toward Indian lands was that discovery gave the United States exclusive right to extinguish Indian title of occupancy either by purchase or conquest. (Deloria 1988) Indians were systematically placed in barren, windy, or mountainous regions, far removed from the richest farming soils. (Marks 1998) The U.S. government's original intent was to "keep the Indian out of the way" by placing them on lands that the incoming settlers found unsuitable for development. Ironically, many of these once "undesirable" tribal lands are now potential hosts to renewable wind, solar, wave, and biomass energy production. Vast amounts of renewable energy sources are potentially located underneath and on Indian reservation lands and tribes are well positioned to take advantage of development opportunities. (Warner 2013)

Today, vast amounts of winds sweep through the Great Plains states on a regular basis. As many as 300 days of sunshine per year dominates the Southwest U.S. Millions of ha of forested lands cover the Pacific Northwest. The Pacific Ocean also provides constant water current energy, as well as strong winds up and down coastal areas of western United States. Many tribes are physically located in these potential renewable energy areas.

Multiple forms of renewable energy sources are theoretically located underneath and on 38.44 million ha of Indian reservation lands. (Bronin 2012) On a national scale, it is estimated that 10 percent of all U.S. derived energy exists on Indian lands (DOE). Many tribes are located in areas specifically suited for renewable energy generation. In fact, tribal lands have the potential to produce 17.6 trillion KWh of electricity a year from solar power alone (about 4.5 times the total amount of electricity generated in the U.S. in 2004). Tribal lands also are capable of producing an estimated 535 billion kilowatt hours of electricity per year from wind power. (Fonseca 2010) One estimation claims that wind resources on Tribal lands in the Great Plains area alone could power over 50 million homes. (Meisen 2010) It only makes sense that Indian tribes that are effectively providing renewable energy to others will be helping their own people economically, socially, and culturally.

There is a great need on Indian reservations all over the United States. Studies show that American Indians continue to rank at, or near the bottom of nearly every social, health and economic indicator, with the lowest life expectancy of all ethnic groups and with higher rates of diabetes, tuberculosis, alcoholism and suicide than other segments of the U.S. population. (Kurata 2009) A preponderance of American Indian tribes located on reservations throughout the U.S. face economic hardships on a daily basis.

According to the 2010 U.S. Census, Native Americans have a median household income of \$35,000, compared to mainstream America's \$50,000 median income. (U.S. Census) Indian tribes throughout the U.S. are struggling profusely to make economic gains in our society, with thirty-three percent of Native Americans now living in poverty. (Butrymowicz 2013)

On Indian reservations, unemployment plagues Native Americans at a 50% rate, which is the highest amongst all ethnicities in the U.S., making them the poorest ethnic group in the United States. (O'Brien 1998) On the Navajo Indian reservation, it is estimated that over 50% of Indian owned homes are without electricity or plumbing.

On some reservations, it is estimated that 80 cents out of every dollar immediately leaves the Indian reservation, resulting in very little self-sustaining commerce on the reservation. The resulting outflow of economic benefits to the state from reservations only impoverishes Indian reservations. (Miller) Interestingly enough, there are a number of tribal casinos within the United States that are economically successful, but it must be pointed out that even these successful tribes experience difficulty in raising the standard of living for its tribal members. (Treuer 2012) Nearly a third of all Native Americans are without health insurance. (Rogers 2014) In fact, the poorest county in the United States is located on Indian land.

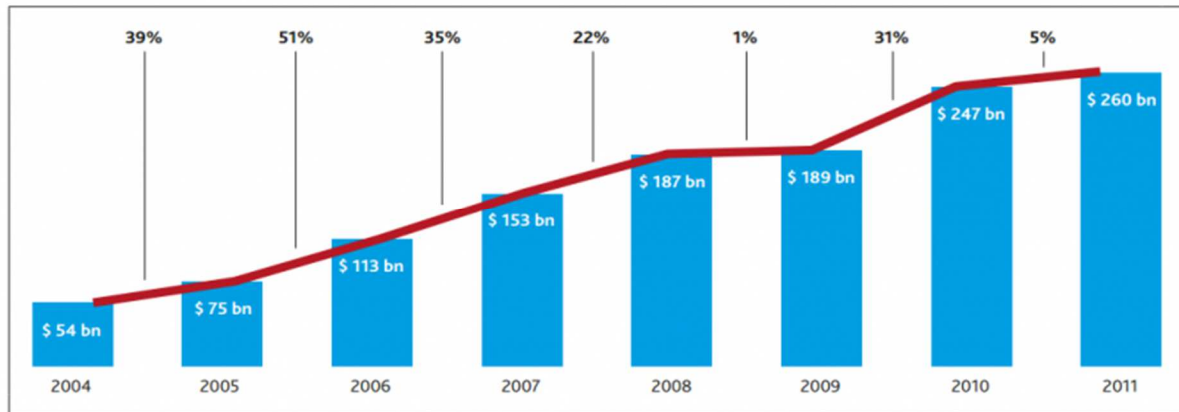
Native Americans also have the highest high school dropout (50%) rates of all ethnic groups. (Swaim, Beauvais, Chavez, and Oetting 1997) Native American students' test scores in science and math have remained stagnant compared to the national mainstream average in our public school system. (Zehr 2010) As indicated before, Native Americans have the highest suicide rate of all ethnic groups in the United States (Wallace, Calhoun, Powell, O'Neil, & James 1996). Based on these alarming statistics, it is quite evident that there are many deep "needs" by many tribes throughout the United States. All of these negative social elements present on Indian reservations collectively represent complex and oftentimes, severe "dilemmas" on a community-wide basis that serves to hinder tribal socio-economic gains.

Indian tribes can potentially be key partners in the energy production arena for decades on end. Tribes are located throughout the U.S. sporadically, but on lands that have great potential for renewable energy production. It is estimated that one-tenth (38.44 million ha total, 21.44-trust land) of all lands on the U.S. are located on "Indian reservation or territory lands." These reservation lands are the result of "federal Indian treaty" period agreements (1787 and 1871) between the U.S. government and Indian tribes throughout the United States.

4.2. The Time is Right

It is imperative that tribes not delay informed decisions related to energy production especially efficient and economically renewable energy production. Keys to successful capture of renewable energy dollars require innovation, determination, smart planning, and maintenance and follow through. Globally, dollars invested toward the renewable energy field have increased 500% since 2004 (**Figure 4.1**).

Global Total New Investment in Clean Energy 2004-2011 (US\$ Bn)



Includes Corporate and Government R&D, and small distributed capacity. Adjusted for re-invested equity. Does not include proceeds from acquisition transactions.

Source: Bloomberg New Energy Finance

Figure 4.1. The global total new investments in clean energy between 2004 and 2011. (Bloomberg New Energy Finance)

Many tribes are specifically located in areas suited for renewable energy generation. By producing renewable energy, tribes have the perfect opportunity to provide comforts and services for their members that has never been seen before. (Shahinion 2007) Indian tribes learning about the renewable energy industry and how can it help their people economically, socially, and culturally will serve to strengthen the argument for sustainable energy programs positioned on, or near their reservation.

According to U.S. government analysis in 2012, wind was America's largest source of new electricity generation capacity, accounting for 43 percent of all new installations. (**Figure 4.2.**, USDOE) Altogether the United States has deployed about 60 Gw of wind power (enough to power 15 million homes). Research suggests that as much as 22% of all wind derived energy can be produced from tribal lands.

Deployment and Cost for U.S. Land-Based Wind 1980-2012

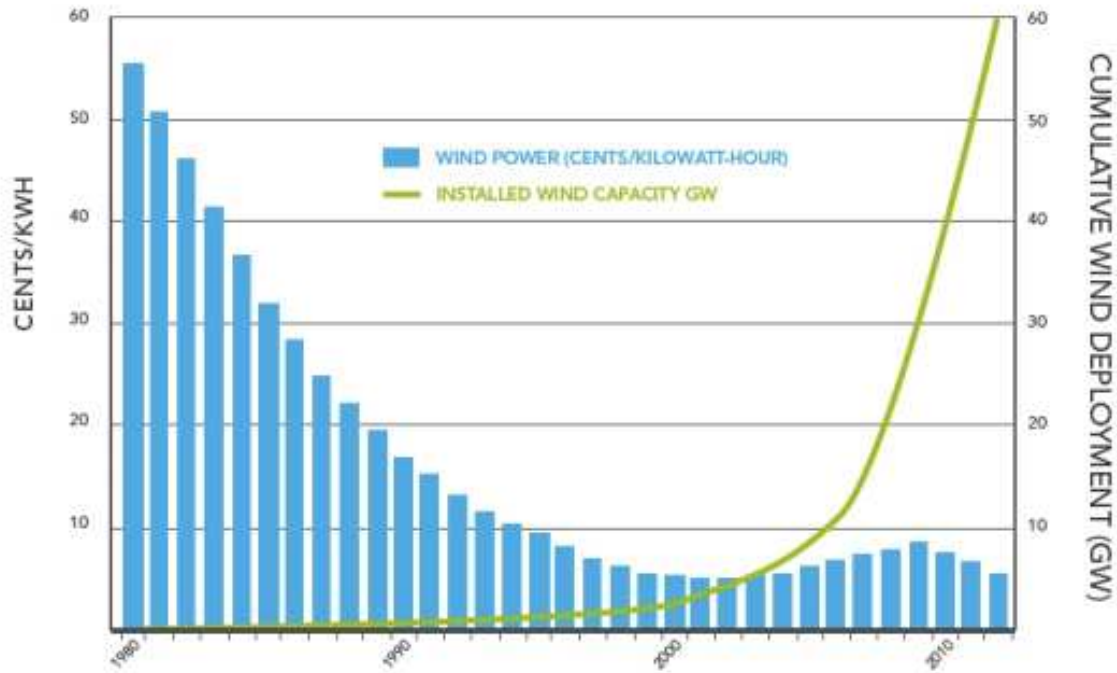


Figure 4.2. Deployment and cost of U.S. land-based wind. (U.S. Dept. of Energy)

Indian tribes are well positioned to take advantage of energy development opportunities, including renewable energy and energy efficiency because of the vast amount of land and energy resources they control on their reservations. (Warner 2013) Some tribes, such as the ones located in southwest and mountainous areas of the U.S. are located at geographical and topographical points very much suited for solar energy harvest (**Figure 4.3**; Appleby) and wind (**Figure 4.4**).

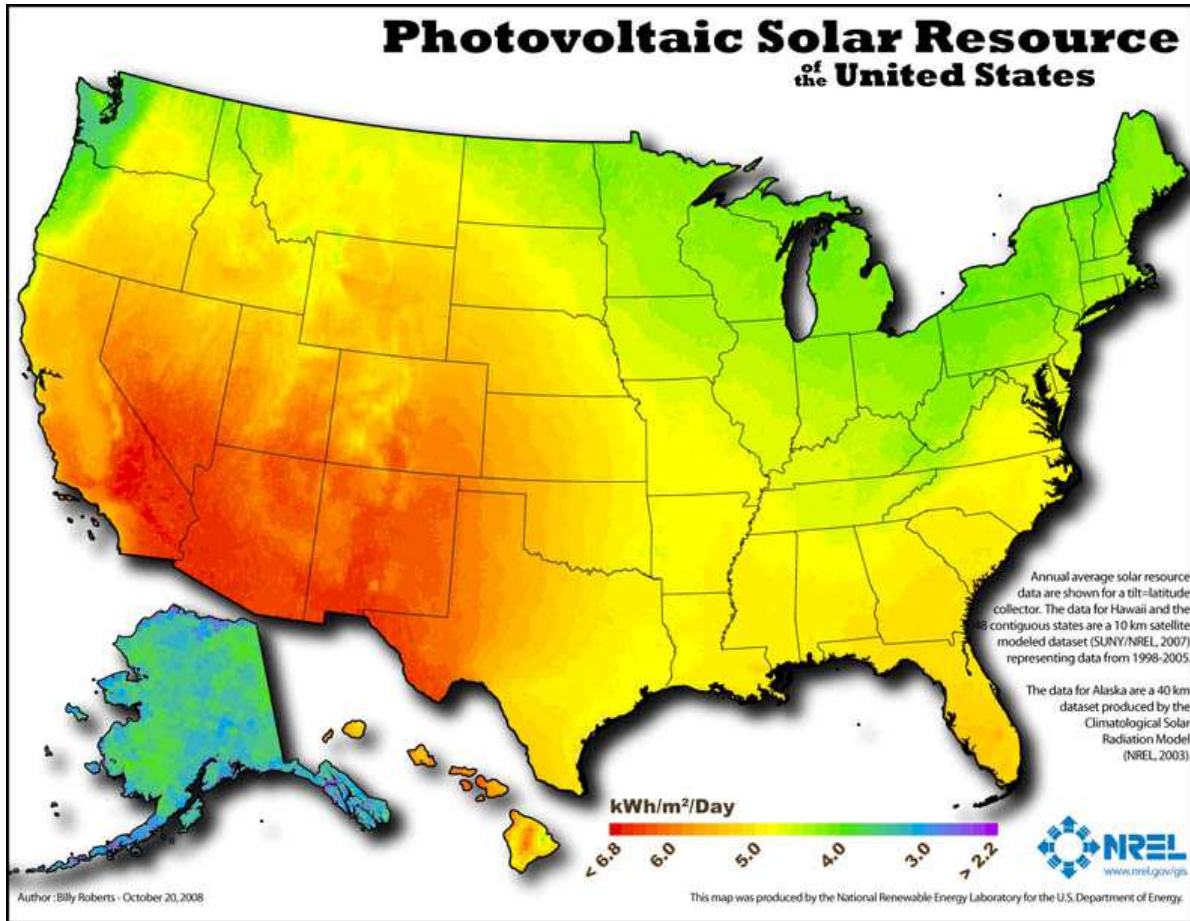


Figure 4.3. Solar power potential for the U.S. by region. (NREL)

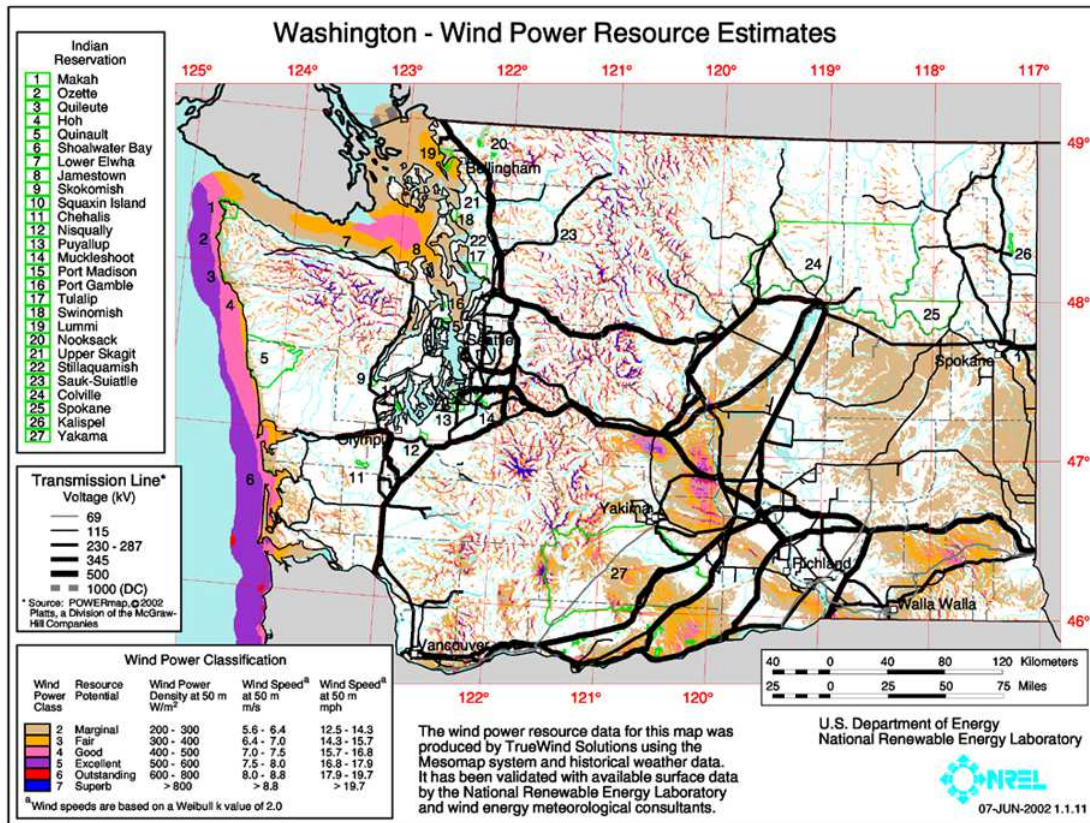


Figure 4.4. Wind power energy potential for the state of Washington. (NREL)

In the Great Plains area alone, 23 tribes have more wind potential than almost anywhere in the world, with 300 gigawatts of wind knocking at their front door. (**Figure 4.5.**; Laduke 2006) On a national scale, it is estimated that 10 percent of all U.S. derived energy exists on Indian lands (DOE).

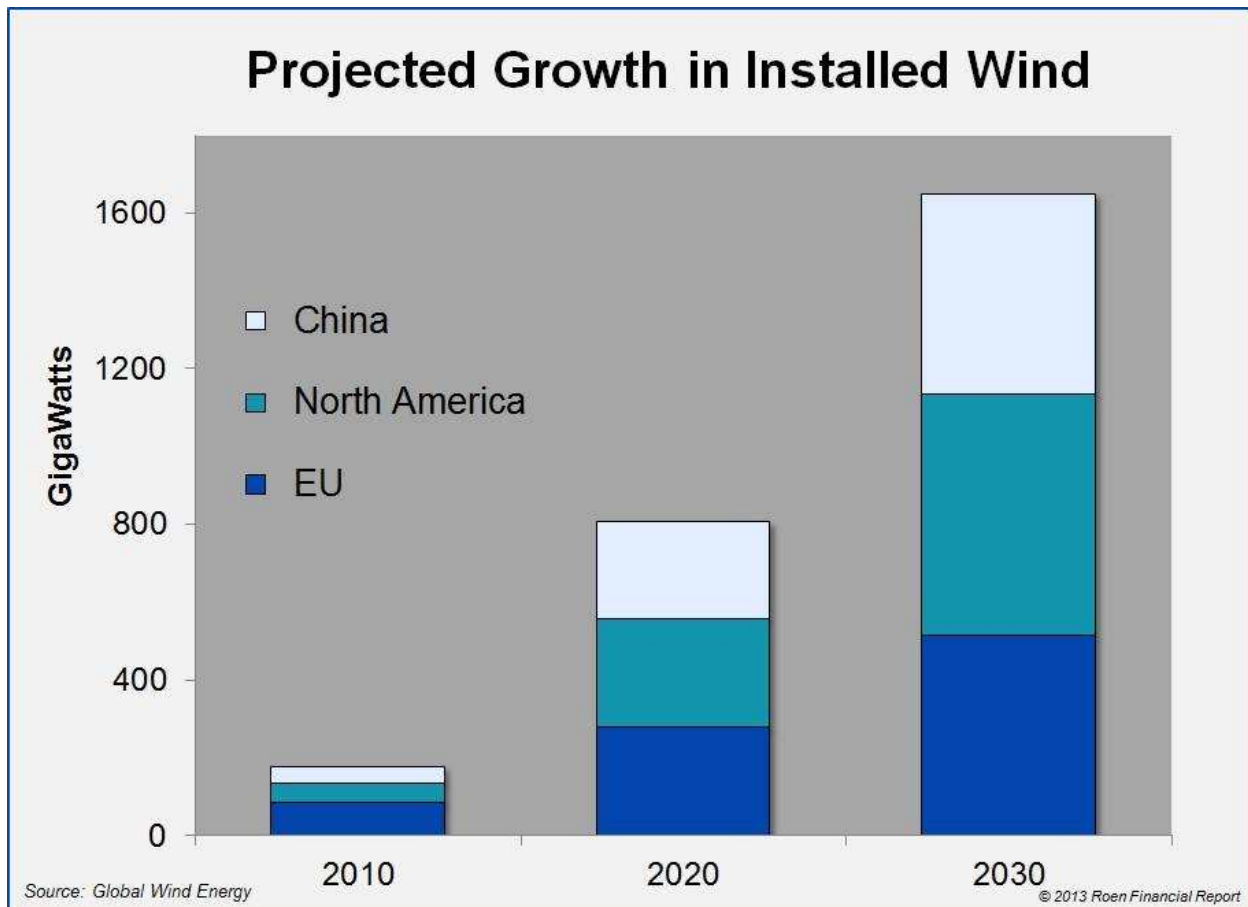


Figure 4.5. Projected growth in wind energy in China, North America and the EU. (2013 Roen Financial Report)

Our society’s challenge to solving our looming energy crisis is at hand and tribes are certainly in position to play an integral role to energy solvency. Tribes across the nation, especially those located in rich, forested areas, windy regions, sun drenched valleys, and ocean bearing waterways are ripe for renewable energy production. It must be pointed out that the U.S. is transitioning (however slow) from a fossil fuel powered society to more of a “greener” world, meaning that renewable energy generation is beginning to take hold. Tribes can seize the opportunity to be at the forefront of new energy systems. It would be like looking back at the “horse and buggy” transition to the automobile during the early 1900’s that one can in hindsight, grasp that there is a gradual paradigm shift. (Smith; Solo 2014) It will not happen overnight, but the change is imminent. Even now, a majority of states have adopted varying minimum renewable energy requirements, known as Renewable Portfolio Standards (RPS) (**Figure 4.6**).

These standards require that a state mandated percentage of electricity generation must originate from a renewable energy source. (Harrington 2009)

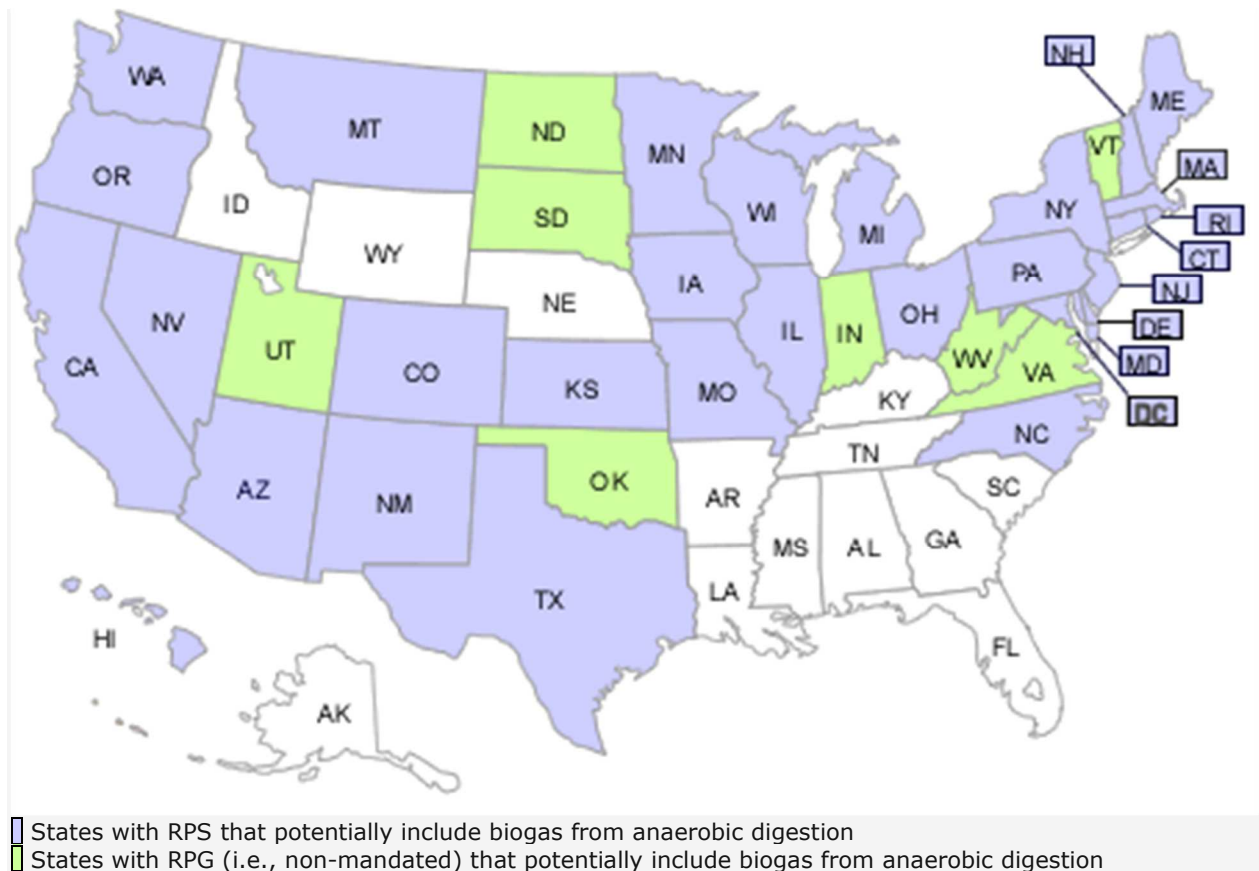


Figure 4.6. States with Renewable Portfolio Standards (RPS) in the U.S. (NREL)

Renewable energy systems are increasingly becoming more efficient. Recently a group known as PVMC, (Photovoltaic Manufacturing Consortium) along with the NREL developed a solar energy system known as “CIGS” (copper, indium, gallium, and selenium) that has proven to be higher in energy output efficiency/cost than all other working solar energy systems. (Mattson; Power 2014) It would behoove tribes to be among the first to launch these renewable energy manufacturing systems at an industrial level on their reservations. It is estimated that on a regular basis, blowing winds on the southern and western tips of the Yakama Indian Reservation reach speeds of 27-30.5 kph, easily surpassing minimum requirements for wind turbine placement.

Some tribes, like the Sioux, Dine', Yakama and Warm Springs are already exploring the possibility of renewable energy production. The Rosebud Sioux Tribe is planning to develop wind power on eight different northern plains reservations with ranges of 10 to 150 MW of generation on each reservation. (Suagee 2009) The Yakama Nation formed their own electric utility system in 2006, resulting in a 4.2 MW hydro-electric program powering multiple tribal government facilities throughout the Yakama Indian reservation. (Bodley 2013) The Yakama Nation is also currently seeking funding options for a bio-mass renewable energy plant. The Warm Springs tribe is planning to build a 40 MW woody biomass plant on 100 acres within its reservation boundaries utilizing non-commercial timber, wood waste, as well as hog fuel. The Dine' are currently planning a 250-500 MW wind turbine system that is being hailed as a major power and job provider in the works. (Kaushik 2012)

For many tribes, renewable energy harvest could prove to be an enormous economic boom. A significant amount of dollars potentially generated through renewable energy harvest may provide hundreds, if not thousands of job opportunities for Native Americans and non-Native Americans alike on Indian reservations. Through job creation, an injection of economic dollars into an Indian reservation economic system will trigger a "multiplier effect." (Smith 2000) Improvements in the "qualities of life" for whole tribal communities can become a reality. Affordable energy can become a commonality for tribal members, with tribes possibly even "selling" excess produced energy to non-tribal interests groups. Having access to electricity has not always been easy for tribal people. In fact, it is estimated that if you live on an Indian reservation, you are ten times more likely to lack electrification, and if you do have access to electricity, you are more than likely paying a higher proportion of your salary to utilize it. (Gough 2004)

Before there can be a discussion of the potential for tribes to adopt renewable energy systems there is a need to understand the opportunities and constraints of producing biofuels out of waste wood materials. A case study of methanol production from wood wastes is being used to determine whether it makes economic sense to develop these systems on tribal lands. This is a generic comparison since the information particular to any tribe is confidential. There is utility of conducting this type of comparison since it does suggest whether a case can be made for this type of energy production. Each tribe can determine whether they have sufficient wood wastes to support the biofuels production system.

4.3. Culture and Native American business model to produce renewable energy products

Indeed, all tribal business decisions are first and foremost culturally driven. In contrast, western world business enterprises are driven by economics and how much money can be made. These

stories will be woven together to demonstrate that the design for a sustainable business enterprise needs to be culturally driven enterprises that include economics as part, but not the only, driver of the business activity.

Tribes are launching culturally based business models that are proving to be complex and prosperous for themselves and surrounding interests. Tribes have been successful business entrepreneurs for hundreds of years before the arrival of the European colonialists. (Miller 3012) They are again building business enterprises based on decisions that are first and foremost cultural.

There were many battles, as part of an ongoing national push, to eviscerate Native American culture by European colonialists and settlers. (Marchand 2013) This took many forms and suppressing languages, religious beliefs, songs and ceremonies were part of the battles. Native Americans all across the U.S. survived the ongoing federal efforts to eliminate their cultures and traditions and have been rejuvenating in more recent times. Today, Native Americans in large part, hold great reverence for their cultural traditions. In fact, much of their tribal identity is based on their distinct cultural beliefs and practices. Tribes are taking additional steps to preserve what they consider strong traditional values. Virtually all tribes will consult members known as “elders” in making major tribal decisions. Part of a tribe’s survival and prosperity depends on vital business decisions.

Culture and traditions are kept alive by folklore and stories and are passed among several generations in a family or tribe. In contrast to the western world, Native Americans have folklore and stories that are critical as a way to teach, entertain, and communicate with other tribal members on how to make ethical choices based on traditional cultures and knowledge. These stories pass down the beliefs and values held by each tribe. This is one part of tribal life that Native Americans were able to retain after they were evicted from their lands and lost their resources. (Marchand 2013)

Native Americans have maintained a link to intergenerational knowledge because of their strong cultures and keeping the connection to nature. This means that native peoples have many traditional knowledge stories that help individual tribal members or the community to make culturally acceptable decisions. This traditional knowledge is just as important in how and what business decisions are made.

In contrast to Native Americans, the western world people lack this long-term traditional ecological knowledge found with people who live for several thousand years on the same lands. This means that the western world business practices are very short-term and financially based. Business leaders do not use knowledge or cultural practices passed down through families or tribes to determine what practices will be ethical, equitable or does not harm nature.

The western world probably assumed that most tribal cultures and traditions were lost upon the arrival of the European colonialists to North America. This did not happen despite the negative impacts of the Western European arrival into the new world landscape. Millions of Native Americans were killed because of European introduced diseases. The Europeans discovered that native inhabitants were contracting what were considered “common” Western European sicknesses (mumps, measles, smallpox and chickenpox). By the millions, Native American people died. In many instances, whole tribes were wiped out.

What few remaining Native American people remained standing after the onrush of disease were rounded up and placed on what were known as Indian reservations. Being placed on Indian reservations, multiple U.S. policies greatly hindered Native people from gaining any kind of economic prosperity. Soon, the government would also systematically suppress Native cultural traditions in the name of assimilation through the school system (Marchand 2013).

Over the course of 450 years, blatant attempts by Western European interests to quash “nativeness” were finally curtailed at an official level by the U.S. government. With the passing of the Civil Rights Act of 1965, federal government policy transitioned from an assimilation of Native Americans to more of a cultural support model. This means that Native Americans needed to retain their cultures and traditions in the face of all the attempts to assimilate Native Americans into the European introduced cultures.

Even though the Civil Rights Act was designed to empower Indian tribes, previous heavy handed federal policies and governmental tactics administered by US officials rendered many tribes virtually incapacitated. One by one, able tribes began to take steps toward revitalization, maintenance and rejuvenation of their cultural beliefs and traditions. By that time, all tribes had limited financial sources, formal education, infrastructure, and work experience. These obstacles resulted in profuse struggles across the board for tribes in helping their people advance their socio-economic status. Along with the disparity of economic playing field, many of these affected tribes had lost much by way of cultural traditions. Despite this, tribal business enterprises need to include culture as part of making decisions on what economic activity to pursue.

4.4. Tribal business enterprises compared to western world business models

Tribal business enterprises have to satisfy and be compatible with tribal cultures. The Harvard Business School has identified what makes a tribal business successful. These practices are summarized well in Marchand et al 2013 (extracts from Miller):

“According to the Harvard Business School, successful tribal businesses have several attributes. The Harvard Project assessed over 100 tribal businesses enterprises to identify the key elements of successful tribal economic enterprises [8]:

- *“First, tribal governments have to exercise their sovereignty...control and make their own decisions about what businesses to create and operate on reservations, how tribal natural resources...will be developed,...how businesses will be structured and what their missions will be...*
- *..tribal governments ... develop strong institutions to assist and regulate business development...ensure the rule of law in Indian Country...tribal governments give people more procedural protections than do other governments...*
- *...cultural issues are very important...Few tribal cultures and reservation populations...support businesses that are antithetical to their core beliefs and institutions...”*

The three elements of a successful tribal economic enterprise will not be found in western world business enterprises. Part of this difference is explained by the fact that the western world and Native Americans have fundamentally different views of nature and how societies use natural resources (Marchand 2013). These differences are important to know since it dictates the decisions made by each group to determine what business enterprises should be built and how natural resources should be exploited. In the western world, the lack of nature link appears to result in an over-exploitative approach to harvest, gather and use of natural resources (Marchand 2013). This contrasts Native Americans are closely coupled to nature and respect nature. They respect nature and nature is not something that should be sold as a commodity for economic profit. The cultural benefits that a tribe receives from nature that have no monetary value are more important for native peoples.

Since 1965, tribes have made strides to strengthen their cultural values by tapping into their tribal elder’s cultural knowledge. Tribes throughout the U.S. understood that cultural traditions must be preserved at all costs in the name of identity. At the same time, tribes realize that an economic engine must be engineered on their reservations through venture planning. Tribal economic planners present tribal business ideas to tribal leaders. These potential business venture ideas are then vetted though a cultural lens. The key factor here is that the strategic plan must fall within an acceptable cultural range based on tribal elder consulting.

In a Western European based business model, the approach is presented to an owner of a business, or a business leader, then to perhaps a business board. A major difference between a tribal enterprise and a mainstream business is that a mainstream business will put no, or very little thought into social elements, such as local cultural values. The bottom line for traditional

Western European business models is: Will this product be monetarily profitable? Whereas in a tribal system, first and foremost, cultural resources will be prioritized as a measure element, in contemplating business ventures on reservation lands. (FDNI)

In contrast to the tribes and their decision use of traditional knowledge, any notions of cultural compromise will not be acceptable by tribes and the business proposal will be shelved. These compromises include: loss of land, tribal sovereignty, natural resources, language, or degrees of tradition. Tribes are determined to ensure that all cultural practices and resources remain intact for future generations. None of these compromises are very relevant for the western business models. None of these would derail a western business model moving forward as a business enterprise. What does cause a business to be derailed for a western world business is if the monetary profit is not satisfactory or if the costs and benefits do not balance at the appropriate rate.

The second item taken into consideration for Western European business models will be: How will this business proposal influence the physical environment? In times past, environmental concerns were of little concern when introducing a new business model. For over two centuries, this approach was unrelenting. Only recently has the global economy countries considered environmental impact to a greater extent and even then, many standards of their practices in the physical development of lands, have not improved markedly. Many lands have been decimated over the years. Mining, oil refining, large scale factories, chemical plants, and coal plants are among the biggest culprits. More recently, “fracking” is becoming more of an environmental concern and is being debated increasingly in our society.

Tribes traditionally were known as “stewards of nature.” It was, and is not in their best interests to develop lands for monetary profit. One by one, tribes assert that because of their relationship with “the creator,” reverence and care are spiritually directed toward all of the creator’s creations. This explains why certain physical landmarks such as mountains, trees, rocks, and rivers, are places of spiritual significance and are places of high reverence. Time after time, business proposals were presented to tribes and were rejected because of environmental concerns.

Native people believe that man was never intended to conquer all natural settings of the earth. Instead, Native people believe that because a being is only on the face of earth for a very limited time, reverence and care of the earth should be heeded for the next generation.

4.4. Sustainable business enterprises consuming natural resources

Achieving sustainable business practices using natural resources has not been reached by the western world business enterprises because of the focus on monetary reward for nature resources. Today, global communities expect businesses to practice environmental and social sustainability at the same time as building economies using nature's resources. The fact that there is a long tribal history of building successful business enterprises, while practicing a cultural decision process, suggests that tribes have something to teach the western world business community. The economic collapses that began in the end of 2010 around the world followed the historical approaches that are the elements of the western world business model. Perhaps it is time to move beyond these models that have had such bad impacts on nature and society. Businesses built on a cultural decision process do not sell all of nature for profit. It is this decision process that has value for western world business leaders because it does not harm nature and it is equitable.

Last year, Taleb (a former derivatives trader) wrote a book about how businesses needed to change and be more connected to the cycles of change in the environment and society. He suggested many key rules. The ones that he mentioned that are sustainable practices followed by tribes are worth mentioning. He wrote that businesses needed to be favored that learned from their mistakes and not businesses whose mistakes percolate through the economy (Taleb 2012). He mentioned that "Decision makers must have skin in the game."

If one compares Taleb's key rules to the Native American or the western world business model, his rules are found with the Native American business model. They are currently not used in the dominant western world business models. Taleb wrote his book because of his concerns that the wrong business models were being used.

Several of the elements of the Native American business model are alluded to by Taleb. They are not found in the western world model. The Native American business has the following elements that need to be added to the western world business models:

- Native American business plans consider the livelihood of the 7th generation beyond the individuals making the decisions today
- Native American business plans are implemented within the reservation boundaries so the good and bad decisions will be known very quickly; the tribe has to live with the bad decisions
- Respecting nature is more important than selling nature for economic profit.

When economic benefit is the only goal of a business plan (the western world business plan), decision made on natural resources will be biased towards over-exploitation of nature. Nature

will not be respected and nature will degrade as resources are over-harvested. Nature will not be around for the 7th generation since it will be harvested by today's generation.

Tribes are emerging as the successful engines of regional economic development. The Coquille Tribe introduces \$23 million into the regional economy through their casino and the RV Park (Coquille website). There needs to be a new story written where these business models are used to develop the natural resource economies of rural areas. The many examples of successful and diverse business enterprises (in timber, minerals, land leasing, manufacturing, agriculture, ranching, grazing, tourism, fishing, water, etc) written by Miller in his book "Reservation Capitalism" summarizes why tribal business models are worth adopting. These practices are important to read and practice if sustainable business is what society wants.

Chapter 5. Case study of wood-biofuels from Tribal lands

Since liquid fuels produced from biomass materials has gained significant traction over the last 10 years and since this can result in a niche market of higher valued products, it is worthwhile using a case study approach to explore the feasibility of tribal lands being used to produce liquid biofuels. Pursuing this energy production option addresses several other problems that create other environmental issues for society. The problem will be first addressed since these externalities are what makes biofuels cost effective to pursue.

5.1. Abundant wood wastes exist on Tribal lands

Tribal initiative to utilize woody biomass, currently not utilized in lumber/paper production, and designed decentralized processors to develop bio-fuels needed in the bio-diesel marketplace, can provide alternative products in tribes. Forests in Washington are highly altered because of past land-use practices and currently strained to provide the multiple outcomes (forest products, enhanced wildlife habitat, recreational uses, etc.) at the level society expects. In Washington, it is unacceptable and unsustainable to not manage forests to increase their health, environmental benefits, economic uses, and reduce risks of catastrophic fire or blowdown. Sufficient funds to restore these forests to sustainable conditions do not exist. Lacking market incentives to utilize forested biomass from pre-commercial thinning operations, the costs to transition young forests into either enhanced habitat or commodity production will continue to outstrip the available funds of land managers. There are few markets or products that can be produced from low quality wood fiber or landfill-bound wood waste so these materials are mainly, left at logging landing sites, in situ, piled-burned or disposed in landfills. However, if these materials could be processed in an efficient and effective manner that produces new energy related products, the private market factors would then assist land owners/managers in meeting their multiple forest-related objectives.

There are almost 7.3 million ha of forestland on Indian reservations in the United States. (IFMAT; Rigdon 2003) Approximately 3.1 million forested ha are classified as timberland, with the remaining 4.12 million ha classified as woodland (that is, forest with less than five percent canopy cover of commercial timber species but at least ten percent total canopy cover). Of these totals, 5.7 million acres are classified as commercial timberland and 3.5 million acres as commercial woodland. Noncommercial acres include those that are unproductive, inaccessible, or reserved. (IFMAT 2003)

It must be pointed out that increasingly, health (both tribal and non-tribal) of our forests are weakening due to multiple factors. Few will dispute that one of the main causes of forest health

is that widespread fuel accumulation has resulted from decades of fire exclusion in forested areas. More specifically, the health of tribal forests is being threatened by density-related issues such as wildfire, insects, and disease, which will increasingly compromise long-term forest sustainability. (IFMAT 2003)

5.2. The PROBLEMS that need SOLUTIONS

There are few markets or products produced from low quality wood fiber, landfill bound wood waste and/or wood containing chemicals. Currently, these wood materials are mainly piled and burned or disposed of in landfills or toxic waste dumps, incurring costs with no benefits. This biomass can be converted to meet renewable energy needs. The addressable market for one of the liquid fuels (e.g., methanol) is currently over \$4 billion dollars in the United States. (Methanol Institute) The larger market opportunity for bio-methanol is the growing demand for alternative transportation fuels in the United States.

Unfortunately, today methanol is mainly produced from nonrenewable resources (e.g., natural gas or coal). For example, China has committed to using methanol as an important alternative to petroleum fuel and plans to finalize their state methanol fuel standards by mid-2008 (Interfax-China). “Even without the standards in place, China will put 1 billion to 2 billion gal of methanol toward fuel use this year, Dolan says”. (Kemsley 2007) China Shenhua Energy Co., China’s leading coal extracting company, has teamed up with several chemical and petrochemical companies to develop its coal-to-methanol technology; they plan is to produce about 3 million tons/year of methanol which would be converted to ethylene/propylene which represents 10% of the total production by one of its partners, Dow Chemical. (Kemsley 2007)

Methanol can be very environmental and can help to reduce the carbon and environmental footprint that results from the combustion of fossil fuels. The California Energy Commission has reported that M85 would reduce the emissions of toxic air pollutants by 50% compared with gasoline alone. Also, the costs to adapt current infrastructure on vehicles to accommodate methanol would be less than \$150. (Ridge 2012) This would be less onerous than developing an infrastructure to compress and transport hydrogen or liquefied natural gas. Methanol burns cleanly, producing CO₂ but eliminating other products of gasoline combustion such as benzene and particulate emissions. (Methanol Institute) “Methanol is harder to ignite than gasoline and burns cooler, making it less of a fire hazard. It’s also miscible in water, and would likely dilute and biodegrade in a spill.” (Kemsley 2007)

Valuable products and energy can be produced from wood fiber/wastes agriculture waste, and chemically impregnated wood wastes that currently have no economic return, are expensive and difficult to manage as wastes and create high environmental risks. New jobs that pay a living

wage can result from these new markets. Furthermore, significant displacement of fossil resource consumption with carbon neutral resource consumption is needed to address atmospheric carbon buildup.

Methanol can be produced and consumed within the same region. Examples of methanol markets are (Vogt 2010):

- **Transportation fuels:** bio-methanol can replace petroleum as a transportation fuel and is already sold as M85 (85% methanol: 15% gasoline or diesel). Methanol is used to transform vegetable oils to biodiesel; 10% of biodiesel is methanol.
- **Electricity:** Methanol can be used in gas turbines to produce electricity and is considered a superior fuel for this use. In the future, methanol will be used to power hydrogen fuel cells to produce electricity yielding higher efficiencies of conversion compared to turbines and allowing smaller scale generation. For example, a typical house in Seattle (needing ~3 kW of power) using methanol-fuel cells could obtain 1 month of electricity from the methanol extracted from 3 tons of wood.
- **Battery Replacement:** Small appliances and personal electronics devices of the near future will be powered by methanol fuel cells instead of batteries. Computers and MP3 players already exist that run for 20 hours on a single methanol-fuel cells. Nearly every major electronics manufacturer plans to release portable electronics powered by methanol fuel cells within the next few years.
- **Waste Treatment:** Methanol is used by hundreds of wastewater treatment plants to control nitrate pollution - a growing problem as areas experience population growth. Large waste treatment plants using methanol denitrification cost \$100 million less than the closest alternative for nutrient removal.

5.2.1. Key technologies in methanol production

Any tribe will need to identify the scale and attributes of mobile, small-scale biomass to bio-methanol plant that would be technically and economically successful. A successful biomass to methanol plant will require the integration of four existing technologies (**Figure 5.1**); two of these are currently available at a large commercial scale. In principle, all of the required technologies exist but they have not been brought together in a commercially available integrated system that can be used to produce bio-methanol at a small, transportable scale. (Upadhye)

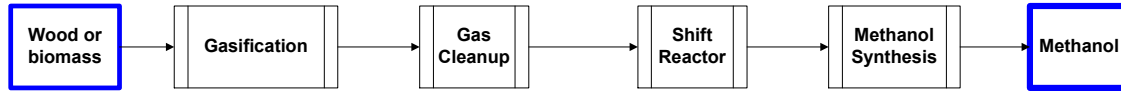


Figure 5.1. A simplified process flow diagram showing the integration of four technologies to convert biomass to methanol. (Upadhye)

Small-scale biomass gasification is known technology that must be developed to the required standards of reliability, maintainability, and availability (RAM). Shift reaction and methanol synthesis are well-developed, and commercially available on large scale. The value to be added is to scale down the existing technology.

5.2.2. The benefits and comparisons between bio-ethanol and bio-methanol

When comparing ethanol and methanol, several factors have to be considered when determining which alcohol you might want to produce:

- The feedstock type is more restricted for ethanol because the current technology for ethanol production is still mainly using fermentation using microbes. (Upadhye; Vogt 2008) The microbes need sugars/starch to produce ethanol so that most of the plant biomass cannot be used to produce ethanol. Fermentation, sometimes used for other feed stocks containing starches and sugars, is difficult because over half to two thirds of woody biomass is comprised of cellulose and lignin that will not easily ferment. Cellulosic ethanol is predicted to be technology that will take 5 years to develop. This contrasts methanol that can use a variety of feedstocks (from forest residues, municipal solid waste, agricultural wastes) and the chemistry does not impact the conversion technology used.
- Because of the technology, ethanol can take several days to produce while methanol is a process that takes minutes. (Upadhye; Vogt 2008)
 1. Because of the portions of biomass used in making ethanol and methanol, the conversion efficiency will vary considerably. The efficiency of conversion of sugar cane biomass into ethanol is 10% because only the sugars are converted using microorganisms.
 2. Similarly, corn stover converted to ethanol only has a conversion efficiency of 30% and only the cellulose and sugars are converted.
 3. Wood converted to ethanol also only has a 25-36% conversion efficiency since only the sugars and cellulose are converted and no lignin is converted.
 4. By contrast, today's technology allows cellulosic and lignaceous materials to be converted to methanol at efficiencies approaching and higher than 50%. This efficiency results from both cellulose and lignin being converted to syngas (a

mixture of hydrogen, carbon monoxide and carbon dioxide) and ultimately to methanol.

- Ethanol is mainly produced from food crops that have a cultivation cycle while methanol has been produced from wood for over 350 years and is the preferred biomass to produce to methanol.
- Methanol has a more diversified product stream since it can be used as a transportation fuel, in fuel cells to produce electricity or to replace batteries for small appliances, in sewage treatment plants to reduce nitrification. Ethanol mainly functions as a blend with gasoline.

Several biomass conversion technologies exist to produce liquids or gases using wood (**Table 5.1**). Each conversion technology is at a different stage of commercialization.

Table 5.1. Possible conversion technologies and their stage of development to produce liquid fuels or gases using wood. (Upadhye; Vogt 2008) ME = Methanol

Conversion approach	Integrated Gasification / Reformer	Fermentation (ET synthesis)	Fermentation (Methane synthesis)	Direct Combustion
Material used	Total Biomass	Grains	Compost/ Sludge	Total Biomass
Products produced	Methanol, Di-methyl ether, Electricity	Ethanol	Methane	Electricity with Steam turbines
Conversion efficiency	ME 40 – 57% (ME-fuel cells 33%)	30%	low	<25%
Facility size	Small or large	Large not best, react rate slow	Small	Small or large
Comments	Higher conversion efficiency, no scale limits	Competes food production	Gas: storage transport problem; must direct produce electricity	Must directly produce electricity, lower efficiency
Development status	developing	Commercialized	Small scale commercial	Commercialized

There are no technological barriers or new technology that needs to be developed to integrate the technology for building mobile biomass conversion facilities. Utilizing and adapting existing technologies to process various forest materials creates greater marketable opportunities.

The potential revenue and costs of building a small scale methanol system are provided next. This assessment suggests that developing these systems would be a very viable option to convert abundant wood wastes to liquid fuels on Tribal lands.

5.3. Potential revenue and costs of processing, conversion, and any processes related to produce bio-methanol from forest biomass

There are several revenue stream possibilities from producing liquid fuels like methanol using Tribal wood wastes. One revenue option is to build ‘electric highways’ in the PNW U.S. and this option will be explored next for this case study. These electric highways would need to combine two technologies co-located in an ‘electrical charging station’: Direct alcohol fuel cell that consumes alcohols and a mobile, truck mounted biomass liquefaction plant (thermally integrated gasification system) to produce methanol from biomass. These two technologies can be used to generate electricity with a cell using green methanol produced from biomass. In addition to an ‘electrical charging’ island for electric vehicles, it is possible to explore the potential of using these charging stations as locations for travelers to recharge cell phones or computers. An electrical highway will take advantage of the fact that tribes are located along our major transportation networks and have located commercial centers and own gasoline stations adjacent to these highways (e.g., Quil Ceda Village, Tulalip Indian Reservation in Washington State).

It is essential to build an ‘electric highways’ that is not only cost competitive to fossil fuel stations but it would also need to satisfy environmental and cultural criteria of tribes. Any clean technology has to be price competitive to their fossil-based counterparts to be commercially viable. At the same time it also has to encompass cultural, environmental and business values of the tribes and to sustainably consume tribal resources. Regional consumers expect environmentally produced products but appear to want a renewable version of the fossil based product that and do not appear willing to pay more for the fossil-based counterparts. The combined technology appears to satisfy these expectations.

For example, economic analyses of the small-scale methanol production facility reported that methanol produced using their technology would cost \$0.79/3.78 liters and one mobile unit would produce about 669892 liters of methanol a year. (Unpublished business plan) A 100 kw NDC Power fuel cell would require 1135 liters of methanol/day which can be produced from 2

Table 5.3. Assumptions used to evaluate the mobile methanol production unit.

Wholesale market price for methanol (Feb 2008)	\$7.95	per liter
Production rate for methanol	628	Conservative conversion efficiency: liters of methanol at 50% conversion efficiency from 1 dry metric ton of biomass (BDT)
Biomass throughput per day	5	Conservative throughput: bdts/work day
Trucking Batch	18,927	liters to fill 1 truck
TOTAL Methanol production/day	3,140	total liters/day
Gross Revenue with Wholesale market price/day	\$24,963	Revenue/day selling methanol wholesale price
Biomass Harvest costs	\$21	dollars per BDT to mobilized methanol machine
Trucking cost	\$650	per day
US Operating cost	\$1,500	per day
Processing costs (\$0.79/gal; \$2.99/liter)	\$9,389	
Total costs	\$11,560	per day
Net Revenue = revenue - costs	\$13,403	Net revenue per day
Operating days per year	200	Per year
Net revenue for total operating days	\$2,680,600	US \$ net revenue/200 days
Equipment selling price	\$650,000	
Payback for equipment purchase	<1	year

BDT = bone dry tons

An example of using methanol produced using wood-methanol and fuel cells to provide electricity for a casino (**Table 5.4**). A typical NW Tribal casino needs 2.0 MW facility for its power generation (Mukumoto, personal communication).

Table 5.4. Example of how much wood-methanol and power would be needed to generate electricity in a 2.0 MW facility.

CURRENT COSTS	per year			
buy electricity for casino (\$50,000/mo)	600,000			
Casino & Tribal Office 6.4 cents/kw, avg. Casino 699,000 Kwh/mo. & 20,400 Kwh/mo.	552,499			
Electricity Generation				
<i>NEW COSTS - 2 MW Me-fuelcells</i>	NEW COSTS - Level 2 charging station (7.2 kw) - need 108,455 ltrs. ME/yr		52,396	
equipment produce methanol \$2,000,000	2,000,000	equipment produce methanol	660,000	
UTC fuel cell equipment, install, maintenance Est cost/1-200kW fuel cell	1,455,447	charging station/unit	2,000	
5 - 200 kW fuel cells cost	7,277,237	7.2 kW fuel cell	52,396	
TOTAL COSTS	9,277,237		714,396	
<i>NEW COSTS - 2 MW gasifier/engine, Capital costs biomass-fired systems (Nexterra, Phoenix Energy, Enviro Energi</i>				
	9,000,000 - 11,000,000			
REVENUES				
	per year	REVENUES	Non-wholesale price ME = 208.1 ltrs \$3.20/3.78 ltr.	Wholesale price 0.90/3.78 ltr
Sell electricity to utility at 6.4 cents/kW from 2 MW facility	17,958	Selling methanol for biodiesel, fuel cells used in charging station 108,455 ltrs.	91,683	25,786
AVOIDED COSTS				
Electricity in 2.0 MW facility producing 1,000,000 Kwh/mo.	768,000			
Total avoided natural gas-ME purchase costs/yr for 2 MW (7,157,080 ltrs. ME) wholesale price	2,625,372			

NOTE: NW Tribal Casino - need 2.0 MW facility; gasifier needs 7,157,080 ltrs. ME, 2 green metric tons wood, avoid emitting 1,444 MG/yr. C

5.4. Employment opportunities from wood-based liquid fuels

The conversion of the currently unused/underutilized woody-biomass into new products would result in the developing of new jobs and markets. Most tribal and other rural communities face few job options and high unemployment rates. Most industries do not relocate to rural areas unless they are producing a product for a niche market since it is not economical to manage the high transportation costs that they would incur. So there is a need to develop industries that can be local or regional and are based on using local materials to produce a product that has a diversity of market demand at local/regional, national and international levels and has export potential.

Developing new jobs and new markets in rural areas or on tribal lands has been pursued on many levels. However, most successful programs arise when local resources are utilized that are readily available and sustainable. When involving natural resources, new job creation efforts have to address rural economic needs and expectations, while also addressing more urban-centered environmental compliance demands. Utilizing woody biomass as a new market for bio-fuels, and bio-fuel components within existing forest practices, could align various expectations and create new opportunities for industry, environment, and local economies.

The benefit of such a dual approach is that solutions are being pursued for increasing rural economic viability and sustainability by using forest materials to develop new products and energy at the same time. Tribes and rural communities could become methanol suppliers to the newly emerging markets in small appliances powered by methanol-fuel cells, or as a provider of methanol for use as a motor vehicle bio-fuels. Forest waste biomass has the added benefit of not competing with food crops, existing lumber products, and can be collected in such a way that no land-use alterations are needed. The benefits of adopting mobile units to convert forest materials to liquid fuel can be summarized as:

- Increase rural economic viability and sustainability by using biomass to develop new products and energy;
- Contribute to regional climate change mitigation by promoting the use of environmentally sound approaches to renewable resource (forest materials) utilization;
- Promote the eco-security of forests by managing forest materials, which currently have little economic value, to reduce the risk of fire.

Rural communities have been interested in developing local industries to create jobs and revitalize their economies. Mostly, the options most recently pursued have been the creation of jobs from computer related, or tourism related, industries and away from the forest industry

focus that used to provide high paying employment opportunities in the past. However, the long-term sustainability of such activities have not proven as reliable as the traditional economic uses of forests.

Utilizing unused or underutilized forest materials, woody biomass, in the production of energy, bio-fuels, and/or bio-fuel components allows for a “triple win.” Such utilization can create new sustainable jobs in traditional industrial sectors; develop new sources of “green,” sustainable and renewable fuel and energy sources to meet growing national demands; and, provide a market incentive to costly management activities that result in increased habitat for wildlife. The development and deployment of transportable processors of woody-biomass can also prevent the problems that arise when an existing centrally located mill is no longer able to operate do to broader national and global market forces. Similar experiences are now being seen in the emerging biofuels industries with several large scale biomass-to-alcohol plants recently closing, or on the brink of closure, due to market conditions or conditions associated with insufficient supplies of biomass to feed the facility. Utilizing decentralized, mobile processors providing a preliminary, or market ready, material ensures the ability of rural communities to utilize woody-biomass in a manner that does not require dependence upon “one user/purchaser.”

5.4.1. Direct employment opportunities

Direct impacts of producing a mobile wood based bio-liquid system are: development of ~50 new jobs per mobile integrated system ranging from those employed in the collection of the biomass, foresters developing management plans that can be certified to be sustainable so carbon credits can be obtained and the collection can be certified to be sustainable, those associated in the transportation of the liquid fuels, and those with engineering education who need to maintain and repair the integrated systems. The goal is to have a minimum of 20 mobile systems in operation at any time, therefore producing liquid fuels will ultimately produce **~1,000 NEW JOBS.**

Many other jobs will result from implementing these mobile renewable energy systems: building a manufacturing facility in a rural area to construct and sell these units, individuals to market and distribute the liquid fuels to markets. Each manufacturing facility will create **~50 NEW JOBS** while the marketing and sales will create **~ 10 NEW JOBS.** The total employment possible are summarized in **Table 5.5** and **Table 5.6.**

Table 5.5. Estimated employment created for acquiring the wood needed by one mobile methanol system in operation (does not include foresters developing management plan, certification, transport of liquid fuels, educators or trainers).

Function	Job Duties	# of Direct Employment	Area of Employment	Indirect Employment	Other Rural Development
Plan Harvest	Determine areas for harvest	2, depends on scope	Tribe, DNR, Forest Service, County	Support personal	Develop forest management technology, (GIS, remote sensing) through local community college
Acquire Raw Materials	Collect material	3	Rural area		
Process Material	Drive truck, operate system, load material	3	Rural area	Repair/ Maintain equipment	
Distribute Methanol	Transport methanol to wholesale, retail markets	2	Rural Area	Distribution Facilities	Component of Biodiesel Fuel for Fuel Cell
Total		10			

Table 5.6. Estimated employment created constructing mobile methanol system.

Function	Job Duties	# of Direct Employment	Area of Employment	Indirect Employment	Other Rural Development
Construct System	Build, design system	30-50	Rural area, Reservation	Parts suppliers, Facilities for production	Develop Technical Training at local community college to support system
Marketing and Sales	Develop regional, national, international markets	10	Rural area, Reservation		
Total		40-60			

Since biofuels production takes local materials found in rural areas, it is ideal for rural revitalization and does not compete with existing rural jobs. It has the potential to re-establish the economic viability of rural areas and reduce the vulnerability of rural areas to global market drivers; timber used to be a viable industry in rural areas of Washington that has been dramatically reduced due to conservation concerns, the losses of old growth forests as well as the fluctuations in global timber prices and the shift in which regions of the world are the preferred global suppliers of timber. There is urgency to provide alternative options for tribal revitalization by using locally based wood materials.

Based on EU studies, the replacement of fossil fuels by even a small portion of biofuels appears to trigger the development of thousands of new jobs. According to a European Union study, for every 1% that biofuels replaces total fossil fuels consumed, 45,000 to 75,000 new jobs will be created in rural areas (http://www.agrinergergy.ecologic.eu/download/background_note_workgroup1_lei.pdf). It has also been suggested that more jobs will be created from producing renewable energy than continuing to use fossil fuels to produce energy. Kammen et al. (2004) has also reported that you get three to five times the amount of jobs in the renewables area than you do in fossil fuels (<http://rael.berkeley.edu/old-site/renewables.jobs.2006.pdf>).

5.4.2. Indirect employment opportunities

The indirect impacts of adopting mobile methanol systems are: Decreasing unemployment occurring in Washington organizations and companies by developing new demands for either the expertise they provide (employees involved in designing tree harvesting strategies that are certifiable as being sustainable, developing policy relevant for biofuels to become a product provided by organizations to meet its fiduciary responsibilities to its trusts) or products that they produce (e.g. trucking companies, gas stations, biofuel producers, fuel cell companies, small appliance businesses). In the EU, it has been estimated that every job in biomass conversion to renewable energy will result in at least 10 other jobs. If this amplifier effect is correct, the potential of adopting 20 of these integrated units and one operational manufacturing facility can result in ~2,600 jobs with more security. A study conducted in Oregon in 2006 suggests that each direct job will result in 2-3 indirect jobs which would result in 520 to 780 secure jobs (http://www.oregonforests.org/media/pdf/Biomass_highlights.pdf).

Training will be needed for tribes and other rural people to be employed in the new industries and new markets that will result from adopting these integrated systems. This will open up opportunities for educational institutions such as Community Colleges (and/or technological schools/centers) to integrate new curricula into their activities.

To further understand how realistic it is to develop renewable energy sources on tribal lands, it is important to examine and compare the business tools used to evaluate whether a tribal (as well as a non-tribal) energy production systems are sustainable. This comparison will demonstrate the differences that exist between the tribal and non-tribal business tools. These differences determine whether a tribe will develop its renewable energy production systems so it is important to discuss these differences. The next chapter will explore these relationships and how they impact what business options are viable for tribes.

Chapter 6. How can alternative energy projects incorporate a tribe's traditional knowledge and cultural norms?

It is vital that all future energy projects on tribal lands directly incorporate tribal knowledge in planning, implementing, and maintaining energy production. Since the very first oil derricks and coal mines were being carved and drilled on tribal lands, there has been very little, or no tribal input regarding production deliverables. During the early days of fossil fuel energy extraction on tribal lands, virtually all implementation decisions were administered by the energy companies. The intent of energy producing companies was not to observe cultural or environmental externalities, but rather to make decisions designed to maximize monetary profit. Eventually, environmental awareness became increasingly a concern to the public, leading to higher degrees of energy development control. Because of the complexities of human need, social concerns are more and more, becoming a part of the energy development equation. Cultural factors fit within the context of social element. Research shows that formal institutions of government must align with contemporary local norms and customs on use of authority. When formal institutions recognizes and respects indigenous cultures a long lasting stability ensues. (Taylor 2008)

There is also incentive for investing energy companies to pay considerable attention to meeting socially accepted energy production models. Examples of environmentally destructive events also spilled over to extensive social concerns, such as the Union Carbide/Bhopal chemical leak disaster and the Exxon Valdez wreckage. Not only was the environment severely altered, but also much undesirable public relation was attached to the offending parties. These moments of cataclysm are not the kind of faces businesses would like to portray because it is bad for economic profitability. (Morhardt 2002)

It has also been established that the U.S. Department of Interior recognizes that transmission line “siting” will be done in a way that will protect America’s natural and cultural heritage and will consult with Indian tribes. (Rave 2010) Traditionally, tribes believed that nature is not to be conquered or owned. They always believed (and believe) that nature will still be here when we are all gone. During our short duration of time here on earth, it is believed that we must be stewards of the earth, rather than its master, lest we are prepared to endure great disasters during our lifetimes.

There are many benefits from adopting renewable energy systems. By evolving into a “green” revolution, cleaner air and water will result, more efficient products will be produced, and global warming will be dealt with, resulting in higher energy prices but lower bills and greater productivity, healthier people and export industry in clean power that the world will want to buy. (Friedman 2008) Many of the benefits will be discussed next. This will be followed by the challenges that still make it difficult to reach a renewable energy goal.

6.1. Benefits of clean energy production by tribes

Tribes have the natural resources used to produce energy. Many tribes are located in areas where there are significant renewable energy resources, including woody biomass, biomass waste resources, geothermal, hydroelectric, solar, and wind.

Even though added attention had been directed toward our society's looming energy crisis, renewable energy expansion still has not arrived. In fact, oil, coal, natural gas and hydro-electric dams are still dominating the global market to a large extent. (Stevens) Even more, renewable energy exploration and production has not taken hold on Indian reservations to the extent it has on the open market. In large part, this is so because on many Indian reservations, developing natural resources with advanced technologies on a large scale is a relatively new concept. Native people (particularly elders) on reservations for the most part, oppose any kind of "physical changes" (development) on their lands due to the fear of environmental poisoning that may devastate their lands. Historically, Native people are known to have been less "invasive of nature's settings" in comparison to the newcomers.

6.1.1. Cultural rejuvenation through renewable energy dollars

By introducing renewable energy production on tribal lands, tribal cultural traditions can be preserved and even rejuvenated. In 1491, before the coming of Columbus, it is estimated that anywhere from 5-20 million Native Americans lived in the United States. All these individual tribes had distinct and intact cultures, languages, beliefs, governmental systems and sustainable ways of living. After the coming of the European however, whole tribes were wiped out due to diseases, wars, and starvation. In fact, at the turn of the 20th century, a mere 250,000 Natives were left standing in the United States. Not only were the numbers of Native Americans small, but also their cultural base, languages, beliefs, and tribal governmental systems were almost eliminated from the face of the earth.

Today, many tribes are struggling to preserve what was considered their traditional ways. Many of these tribes are seeking to rejuvenate, preserve, or enhance their tribal members' knowledge and practice of their traditional ways. Unfortunately for them, many of their knowledgeable elders are dying off. Spoken languages, Religion, environmental and cultural knowledge are all being lost with the passing of these elders. A robust tribal economy powered by a highly productive renewable energy system can be the key factor in preserving Indian cultural knowledge and languages. By reinvesting into their cultural programs through economic dollars, tribes can augment, or accelerate their tribal members' cultural knowledge base.

A number of tribes are already familiar with the “energy” field within the U.S. as a number of oil deposits were discovered and extracted from lands throughout the United States on Indian reservations during the 1900’s. Today, petroleum oil is still being pumped (although few in number) from Indian reservations in the Midwest. Coal is also being mined from a select few Indian reservations located in certain parts of the U.S. Coal mining however, is very controversial because of its environmental externalities. Water quality and stream life are often degraded because sediments and fish tissue oftentimes will absorb and harbor concentrations of potentially toxic trace coal elements such as nickel, lead, cadmium, iron, and selenium.

If renewable energy can be effectively tapped from Indian reservations, tribes can play integral roles in helping stem excess carbon emission problem as well as provide energy to an expanding, demanding society. Energy is an exceptionally valuable commodity in the modern world and is unlikely to decrease in value or demand. In fact, according to the Energy Information Administration (EIA), energy is expected to increase in both value and demand. (Meisen 2010) Historically, Indian tribes throughout the United States conducted business on a regular basis on an “inter-tribal” basis. Bartering of goods and services between tribes was a commonality before the arrival of the “European.” Anthropologists and archeologists are discovering that Native Americans engaged in extensive trade with each other, including long distance trade, especially in regions of high Native population density. (Carlos 2012) After the arrival of the non-Indian, systematic wholesale changes effectively altered “Native America” in the form of enslavement, disease, death, wars, and displacement. (Jones) From the onset of federal Indian treaties, the construct of tribal business waned.

6.1.2. Education and renewable energy programs

Although mainstream education institution numbers have increased over the last few years by way of vocational schools and community colleges, there still lacks education programs on or near tribal lands that could possibly enable tribes to form cultural education programs. To date, there are 36 tribal colleges (US Dept. of Ed.) and over 581 tribes located throughout the U.S. (NCAI). In large part, tribal education centers are located in rural areas thus limiting technical education program implementation. Advanced technologies in the computer industry however, may hold the key in solving “isolation” barriers through “webinars, skype and email highway.” Introducing college level training and curriculum in the field of “Indian Education” can be a key factor in promoting and formulating strong Indian cultural knowledge within a tribe powered by renewable energy dollars. Providing education to Native American students in their immediate environment is an effective approach in causing a positive learning environment. (Lomawaima 1995)

In the past, teaching students on, or near Indian reservations in what was considered a “traditional method” (**Photo 6.1**) did not sufficiently draw consistent numbers of committed students. (Swisher, Dahle 1989) In fact, since 1879, US governmental methods of educating Indian students have not proved fruitful because assimilation of Native Americans was the intent, rather than acculturated edification. (Reyhner 2006) A preponderance of American Indians located on reservations throughout the United States are still facing economic hardships on a daily basis. In fact, American Indians are considered the poorest ethnic group in the United States. Ironically, sky-high unemployment rates plague American Indians in both Alaska and the “Great Plains” states despite high employment rates for the non-Indian in these same regions. (Austin 2010) There are few banks, large grocery stores, or retail outlets on reservations, and an almost complete absence of businesses where people can spend discretionary recreational dollars. Adequate roads and housing, clean water and sanitation, telephones and electricity are all in short supply on most reservations. (Glianna 2001)



Photo 6.1. Native elder teaching her students the art of Indian “beading.” (Lomawaima)

By working with tribal members in a culturally appropriate manner, a type of education program that simply does not exist anywhere in the United States is very much possible. Tribal elders, tribal leaders, prospective workers, and educators, will all play vital roles. This education program will take extended measures in devising education programs in a culturally sensitive manner on all tribal lands. Because there is much diversity in cultural beliefs amongst tribes regarding their resources, each education site will require tailored preparations in advance. A diversified learning approach, means integrating cultural factors in providing instruction to the students will be necessary.

Providing education tools to tribal members on Indian reservations would provide immeasurable benefits in assisting tribes explore the possibilities of clean, energy extraction and production on Indian reservations. Learning about renewable energy and how it can actually provide energy to tribal members at no, or very little monetary cost, without harming the environment, and will pay economical, if not social dividends to all tribal stakeholders. Tribal members can also learn how this harvested energy can potentially be sold on the open market to neighboring non-tribal interests at a profitable margin. Further by preemptive outreach to the partnering tribes tools can be developed based on their knowledge of their natural, cultural, infrastructural, and technological resources in putting together a comprehensive education program.

6.1.3. Adopting a tribal business model

Methanol production using wood wastes has great potential as a viable renewable energy system on tribal lands. The benefits of methanol in our society include: lower production costs, meaning that it is cheaper to produce relative to other alternative fuels. There is improved safety in the usage of methanol because it has a lower risk of flammability compared to gasoline. The domestic production of methanol will increase national energy security. Methanol can be manufactured from natural sources. Its use could help reduce U.S. dependence on imported petroleum.

Although methanol can be produced from multiple sources, (natural gas, coal, oil, or biomass) ideally, it would be most environmentally sound being produced from renewable biological sources. At present time, methanol is mainly produced in large factories at extreme pressures using carbon dioxide, hydrogen and carbon monoxide from natural gas. By harvesting from biomass origins such as conifer trees, forested Indian nations can potentially be producers of highly productive methanol in the energy landscape.

By utilizing methanol as an energy source, a viable business model is possible. Today, there are nearly 18 million acres of forested land on 275 Indian reservations in twenty-six states (**Figure 6.1**). But how do we begin the process? First it must be determined if the production of

methanol on tribal lands will be profitable, environmentally safe and culturally acceptable to the tribe. (Vogt 2009) A natural resource (in this case methanol) is identified, measured and determined as a potential energy provider on tribal lands. Once methanol (or any energy resource) has been verified as a strong provider of an energy source, the tribe must determine in what capacity it will serve. Will methanol be harvested and developed for small or large scale? The tribe must also determine whether to utilize the methanol as a domestic source of cheap, (or free) energy to its tribal members, or as a commercialized economic tool. Once this determination has been made, the tribe then must then determine what will be the most economic method of harvest, conversion and delivery of the finished energy product.

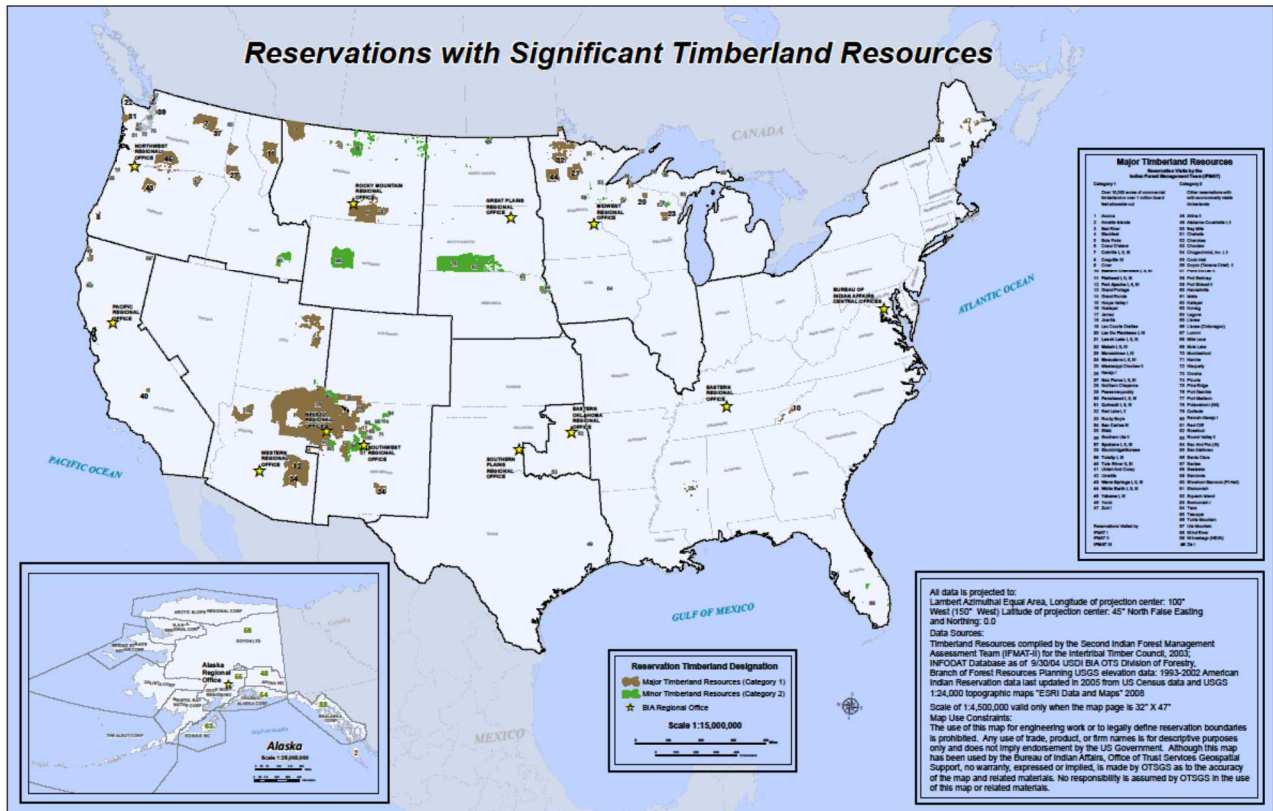


Figure 6.1. Tribes with significant forest timberland resources are shown in brown color. (IFMAT)

It has been established that fossil fuels are finite. Renewable energy production and harvest are becoming more prevalent by the day. The question is: What is the optimal renewable energy choice that will suit tribes' needs as they enter this field? This question will be on "center stage for many tribes. The options are multiple but complex. For example, what may prove to be

highly productive for one tribe, may not prove to be very suitable for another. Such factors as soil content, water availability, atmospheric moisture, vegetation, wind continuity, sun availability, economy of scale, and raw material availability, all serve as elements that help determine renewable energy direction. It is important that tribes “get it right” the first time in launching renewable energy production on their lands. There may not be a second chance for these intrepid tribes as financial resources are usually delicately positioned on tribal lands and may be withdrawn for other, un-related uses.

6.2. Challenges: A boom? or a dis-economy of scale for tribes?

Tribes all over the United States have a great opportunity to develop renewable energy but are facing major challenges. (Meisen 2010) Even though many tribes are located in areas specifically suited for renewable energy generation, there exists very little, or no viable infrastructures that are able to usher in harvestable actions on a major scale. The implementation of renewable energy systems on Indian Reservations is a monumental challenge because of multiple and oftentimes, complex interest clashes stemming from both inside and outside of Indian country. Even more, generational inheritance of passed down histories of betrayal of the “Indian” has resulted in a legacy of “distrust” of the non-Indian world.

As tribes seek to expand business activities, the need to further develop robust legal business environments and sound governance becomes critical. Underdeveloped legal, or outdated governance structures, insular tribal policies, and politicized business management are barriers to business and economic development in many Native American communities. (Woodrow 2012)

6.2.1. Sovereignty

Also, there is a strong determination from virtually all federally recognized tribal members to retain what is known as “tribal sovereignty.” Because of aboriginal political and territorial status, Indian tribes possess certain pre-existing sovereignty, subject to diminution or elimination by the United States, but not by the individual states. (Prygoski 2013) Tribal sovereignty is a concept that tribes base their very existence as a nation, separate from neighboring states and the federal government. All federal treaty tribes made agreements with the United States government in years past that even today, guarantees tribal “sovereign” rights on their lands.

Tribes guard their sovereign rights with vigilance and any perceived weakening of their sovereign rights has never been acceptable, especially in relation to state governments within the United States (**Figure 6.2**). State incentives for renewable-energy development has proved challenging to tribes because oftentimes the state require tribes to create a state-chartered

organization. Tribal governments are guarded against relinquishing sovereign immunity to individual states, subjecting themselves to state laws and reporting requirements. (Tungovia; Torbit 2010) Therefore, any kind of outside interest or actions being introduced in Indian country is carefully vetted before any kind of allowances are made by tribes.



Figure 6.2. Depiction of Tribal governments guarding their sovereignty rights against infringement by State laws and regulations.

Tribal leaders carefully listen to not only elders, but to “the will” of their tribal people. Cultural values passed down from elders to the next generation include retaining “naturalness” of mother earth. The earth, trees, mountains, rivers and animals are all spiritually considered sacred to Native Americans on their lands. Even when animals are hunted and killed, it is a common practice for Native people to give reverence and thanks to the creator. Native people on Indian reservations can play critical roles in answering a looming national energy crisis but first, social and environmental obstacles must be overcome.

6.2.2. Lack of funding for renewable energy projects

Although federal legislation and funding approved during the George W. Bush administration enabled enhanced renewable energy production within the U.S., progress has been slow in coming. In fact, the amount of U.S. dollars invested into renewable energy research and development has dwindled in the last 5 years from over \$9 billion to a little over \$7 billion. In 2009, Tribes sought \$52 million for renewable energy projects but only \$6 million in funding was made available. In addition, some tribes are deterred from participating due to the department of Energy's cost share requirements. (NCAI) What this means is that federal funds made available to tribes will also require a set percentage of tribal dollars being made available to the funded project. Most tribes will not have the necessary assets on hand to contribute to the proposed project.

In today's world, and in times past for that matter, tribes have had to compete for investment dollars to be leveraged on their tribal lands. To be successful, tribes must offer outside investors the opportunity to earn economic returns that will commensurate with the returns they might earn elsewhere. (Atkinson, Nilles 2008) In fact, just acquiring capital for business start-ups and economic expansion for tribal business enterprises and independent Indian-owned businesses located in Native American communities are challenges. (Woodrow 2012) The structure of business transactions on tribal lands have traditionally not been in tribes' favor. In 1934, Commissioner of Indian Affairs John Collier (under the Roosevelt Administration) pushed through federal legislation that enabled tribal self-governance, and eliminated land allotments that effectively halted the onrush of land grabs by non-Indians. This legislative act became popularly known as the Wheeler-Howard Act. (Deloria 1988) Also included within this new tribal governance system was an establishment of a revolving loan program for tribal development and tribal business charters, which effectively marked a "new" beginning of tribal businesses on Indian reservations.

6.2.3. Bureaucratic process

Bureaucracy in multiple forms can and does prove to be quite challenging when getting energy program off the ground. For instance, in order for a tribe to even acquire a permit requires approval from four different federal agencies, whereas for non-tribal land interests, only four "steps" in totality are required. (Regan 2014) One needs to look no further than the Navajo Nation to understand the difficulties in setting up desired business ventures on Indian land. The Navajos require conducting an archaeological survey, obtaining a letter of support from the tribe's president as well as a dozen additional steps that slow the process. (Economist)

According to a report conducted by the Government Accountability Office (GAO), the Bureau of Indian Affairs (BIA) was overloaded with internal breakdowns which had resulted in delays, causing tribes to miss out on opportunities to generate revenue. The report also said that Native American reservations could have produced much more solar and wind energy, but the Bureau of Indian Affairs had actually hindered energy development on tribal lands. An existing antiquated 1961 regulation resulted in the BIA taking a ‘one-size fits all’ approach to processing all surface leases. This system, lacked a defined process or deadlines, making it common for a simple mortgage application to languish for several years waiting approval from the federal government. (Gerdes 1012) Let alone being slow to identify land and resource ownership, the BIA lacked adequate staffing to review energy-related documents. (NYT)

In 2012, the Department of Interior announced a streamlined approval process for renewable energy projects. Included in the recent policy was improved efficiency and transparency in the land leasing approval process that resulted in tribes gaining more information in negotiating with developers. (K&L Gates 2012) These changes were intended to increase the efficiency and transparency of the BIA approval process for the residential, business, wind energy evaluation, and wind and solar resource leasing of Indian land. (DOI) It also supported landowner decisions regarding the use of their land, supported tribal self-determination, increased flexibility in compensation and valuations.

A great majority of Indian tribes throughout the U.S. are struggling to help their members make economic gains in our society. Although the introduction of gaming casinos has proven to be an economic boon for a number of tribes, a great majority of tribes however, are still in a state of great peril. At a fledgling stage, tribes are beginning to explore and invest their time and dollars toward multiple economic engines. One of the possibilities that can be a key factor in promoting economic advancement on Indian reservations is the introduction of “renewable energy” in tribal communities.

6.2.4. Need to work in concert with U.S. federal tax policies

There are federal incentives available to businessmen/investors that tribes can utilize, one being the “New Markets Tax Credits.” The NMTC is a mandate established by congress in 2000 that enables individuals or corporations to invest in tribal lands that will create jobs or material improvements on Indian reservations. (Kokodoko 2011) However, there are multiple and complex challenges to overcome in investing in Indian country through NMTC. One of the major challenges tribes face in securing NMTC investment dollars is the recovery of monetary investment to the lenders in the event of borrower default. (Woessner 2006)

Needless to say, the solutions for Native Americans are complicated because of the special legal obligations owed to them by the federal government as a result of long-standing treaties and federal Indian policy. (Stegman 2012) For instance, when first written, the intent of the Indian Tribal Energy Development and Self-Determination Act (ITEDSA) of 2005 was to provide tribes with a framework for developing renewable energy infrastructure. However, certain complications still hinder the ITEDSA from helping tribes fully realize energy prosperity. It is claimed that the ITEDSA is flawed for failing to correct for misplaced financial incentives for renewable energy development by tribes. (Bronin 2013) Also, the law continues federal policies that ensure that non-Indians and non-tribal business entities often reap far greater economic rewards than tribes or members of tribes. Thus, it can be seen that tribes have great opportunities to be providers of renewable energy, but it is currently a major challenge to establish. (Rave 2010)

Historically, federal tax policies did not favor Native tribes on renewable energy development. The guarantee of tax-free status of tribes on Indian reservations guaranteed that tribes could not utilize tax credits granted by the federal government. (Shahinon 2007) However, both wind and solar energy investment rules changed. As recently as 2013, tax codes prevented tribes from effectively utilizing what are known as production tax credits. Production tax credits did not enable economic profit for tribes, nor did it afford them decision-making powers while working with investing partners. (Anderson 2013)

Recent alterations to IRS policy now allows broader economic production on tribal lands. The IRS (Internal Revenue Service) also announced through “private letter,” that an American Indian tribe can elect to “pass through” a thirty-percent credit to a third party lessee, meaning that investing entities can now share economic benefit of a tax credit with partnering tribes. (Akin-Gump) Tribes have the ability to partner with, and pass through to a 3rd party equity investor a 30% federal tax credit. (Burton, Nessbaum, Gump 2013) This particular federal tax arrangement provides tribes a unique opportunity as renewable energy developers because they will be the only entities that are not subject to federal income tax that may do so. Tribes will have a unique advantage especially in the solar development field as they are not subject to federal income tax but may pass through tax credits to tax equity investors.

Also, through the American Recovery and Reinvestment Act in 2009, the US government made available to tribes, a \$2 billion bond issuance known as the Tribal Economic Development bonds. (Depaul 2012) New federal guidelines meant that tribes could apply to IRS for “TED” bonds that could be issued as a tax exempt or as a tax credit bond. Either way, it enables tribes to borrow at a lower rate in concert with local governments or states on tribal lands.

Problematic to TED program however is that many of the tribes that are seeking dollars to fund projects (such as renewable energy) must have the ability to pay back the borrowed dollars based

on a challenging formula. (Bernstein 2013) Multiple factors such as repayment period, number of households, and per-capita income on an Indian reservation determines the ability of a tribe to repay a loan. The per-capita allocation statistics are high. I suspect that the financial analysts and the policymakers who designed the TED bond program believe most Native American Tribes receiving a TED allocation would not be able to repay the TED loan.

The arrival of Community Development Financial Institution (CDFI) is proving to be instrumental in breaking tribal economic barriers. The origin of the Native Initiatives dates back to September 1994 when Congress passed the Riegle Community Development and Regulatory Improvement Act. This Act created the CDFI Fund and mandated that it conduct a study of lending and investment practices on Indian reservations and other lands held in trust by the United States. (CCH) The CDFI Fund is a \$195 million initiative that is specifically designed to promote financial services in Native Communities. These initiatives are leading to increased credit, capital and financial services in Native Communities. Specifically, the study recognized barriers to private financing, identified the impact of such barriers on access to capital and to credit for Native peoples, and provided options to address these barriers. Through the CDFI initiative, strategic planning of renewable energy programming can be established on Indian reservations.

The Politics behind policy change must take effect. For instance, just to even establish siting for transmission infrastructure, it is a difficult obstacle for the US government to overcome. It is quite common for states to question and challenge federal authority's jurisdiction to site land for transmission development. (Lax 2008)

Renewable energy still has not taken hold in the United States to the extent it has in other countries. In fact, European countries have now increased utilizing non-fossil fuel energy to power their needs at a 15% rate, while the United States is hovering right at 7%. Even more alarming, tribally controlled renewable energy programs are formulating at an even slower pace than non-tribal enterprises. In fact, tribal renewable energy programs are still at the very beginning stages of development. In many tribal council chambers throughout the U.S., introduction of renewable energy is barely at the "discussion stage."

Although the numbers of renewable energy system startups nationwide will increase significantly for the next few decades in the form of wind turbines and solar panels, fossil fuels are still overwhelmingly proving to be "king," i.e., dominating the energy market. (Ailworth 2014) This is because the overall market of renewable energy is still not "cost-competitive" in relation to fossil fuels. For instance, additional bastions of natural gas have been discovered within the United States and harvest has been accelerated because of the practice of "fracking." This increase in natural gas harvest is causing natural gas prices selling on the energy market to drop, thus "undercutting" both wind and solar powered energy systems.

Even so, renewable energy is becoming more cost competitive. According to a study by the International Renewable Energy Agency, costs associated with extracting power from solar panels have fallen as much as 60 percent in just the past few years. (IRENA) Also 118 countries now have at least some type of renewable energy policy or goals by the early part of 2011, suggesting that renewable resources are likely to become the major source of energy worldwide in the coming years. (Yirka 2011)

This study had a goal to define a viable approach to establishing alternative energy systems on Indian Reservations throughout the U.S. Today, renewable energy is considered a novice concept on Indian reservations. This study shows that that renewable energy production on Indian reservations is achievable and with great benefits. Identification and navigation of business, cultural and environmental challenges tribes face in the development of renewable energy will be achieved. Finally this research identified economic, cultural, and educational payoffs that potentially await tribes.

An effective renewable energy program on or near Pacific Northwest Indian reservations can be an impetus that will result in socio-economic gains that will benefit tribal members on many fronts. Successful implements of multi-disciplinary renewable energy programs can positively impact whole communities by transforming them into high functioning societies. Tribal communities are capable of devising their own renewable energy harvest systems.

Chapter 7. Concluding comments

What are the best choices for “tribal renewable energy?” Certainly this question is quite critical for tribes’ to consider. Ultimately, a carefully vetted strategic plan must be crafted that will enable tribal economic viability, and social benefits, as well as preserving environmental stability and cultural resources on their lands. During the initial days of energy provision (via fossil fuel) to society, the only concern was whether the project was going to be profitable to the providers. For instance, oil was discovered and extracted from lands globally, including in the U.S. during the early 1900’s. Eventually, environmental concerns became a world-wide concern, leading also to social concerns that evolved into a “sustainable” and responsible model of energy capture on a global level beginning in 1992. (Earth Summit)

The bigger question remains unanswered: Which renewable energy option will pay the most benefits to society? When narrowing down the scope, it all boils down to which energy option will pay the most dividends, all the while incurring the least cost in helping a society? Although coal appears to be dwindling on the energy market, coal shall rise again because at some point, natural gas prices will systematically increase, all the while coal remains abundantly cheap. (Ansolabehere 2007) An alternative sustainable energy source must be found to coal.

Rather the cost of global climate change must be added to the equation, or at least the cost of avoiding climate change. Choices await tribal entities that choose to harvest renewable energy. As mentioned before, petroleum oil is still being pumped from a few Indian reservations in the Midwest. Coal is also being mined from a select few Indian reservations located in certain parts of the U.S. Coal mining however, is very controversial because of its environmental externalities. Water quality and stream life are often degraded because sediments and fish tissue oftentimes will absorb and harbor concentrations of potentially toxic trace coal elements such as nickel, lead, cadmium, iron, and selenium. (Lindsey 2007)

Research shows that the answer lies in curtailing carbon emissions sooner, rather than later. By implementing renewable energy production systems on a short timeline, curtailment, or even gradual reversal of rising climate temperatures can be achieved. Also, in a world that is on a constant upward population trajectory, energy demands will go up. There is always the possibility of a manufactured energy crisis that can blanket nations on a global scale, as demonstrated by Arab Oil Nations (OPEAC) in the past. Unfortunately, countries that rely heavily on external energy sources are at the mercy of their providers.

Therefore, renewable energy production and consumption are critical to world security matters as it can actually mitigate world instability. The usage of renewable energy can reduce fuel imports and insulate economies to some extent from fossil fuel price spikes and swings, thus increasing energy security, especially for the United States.

Currently, coal, petroleum oil and natural gas dominate the energy production field in the United States. Coal burning in power plants throughout the United States provides 50% of our nation's electrical energy and an estimated 66% of our steel production energy comes from coal plant burning. Coal plant burnings are considered very detrimental to our environmental well-being however due to the poisonous effluents emitted into earth's atmosphere. It is estimated that over 200 coal contaminated sites now exist in 37 states. (EarthJustice) Further, petroleum oil fields are progressively becoming more difficult to locate and extract.

Indian tribes are faced with historic challenges that prevent large scale economic development. First, there exists very little, or no viable infrastructures that are able to usher in harvestable actions on a major scale. Throughout the years tribes have been hindered by several obstacles, including insufficient funding for business endeavors. Historically, Indian tribes have not had financial accessibility to resources designed to stimulate tribal economies. A funding solutions for tribes would be if:

The United States government should reconsider the cost share requirement that is currently being enforced by the Department of Energy in federally funded energy projects.

At the moment, states and local governments have access to financial and technical resources that tribes do not. By crafting legislation that will provide tribes with the same access to financial and technical resources that state and local governments, there will be heightened interest in the renewable energy field from tribes.

Tribes are also faced with extremely limited tax credit benefits. Outside entities experience potential "double taxation" from both state and tribes that essentially, prevent them from investing on tribal lands. Transmission line infrastructure is also problematic because it is very expensive and complex to plan and implement on tribal lands. Also, historical events over the years between Indian tribes and non-Indian interests have resulted in a constant loss of Indian lands, culture, languages, natural resources, and sovereignty, culminating in a great distrust that tribes hold towards a society dominated by Whites.

The bottom line is that our planet's fossil fuel supply is dwindling due to ever-increasing population numbers (now exceeding 6.3 billion) utilizing fossil fuels. At one point, the United States consumed half of the energy being produced in the world. The United States is still consuming the "lions share" of the world's fossil fuel supply but now, there is additional demand in the name of industry and advancement in a growing number of countries. In more recent years, technological and industrial advancements made by both China and India have caused

accelerated fossil fuel consumption worldwide. If humans are to survive energy shortage challenges on a global scale, it is clear that alternative energy resources must be utilized.

With the ever increasing challenge of meeting energy demands on a global scale, alternative energy exploration is becoming more important each day. Not only are oil reserves becoming more difficult to locate, it is, and will become more expensive as the world demand increases. Consider, in the year 2005, petroleum oil was selling on the United States market for \$25 per barrel, but triggered by the devastation wrought by Hurricane Katrina, oil prices skyrocketed to as high as \$149.00 per barrel, equating to gasoline prices reaching as high as \$4.85 per gallon in some parts of the country.

Even today, gasoline prices are not “parachuting” below the \$3.00 mark even though in 2014 and 2015, the price of gas hovered above \$2.00/gallon. Because of high fuel prices, Americans are becoming more conscientious about energy sources and are demanding remedies. Devastations resulting from Hurricane Katrina prompted action at the national level, putting “alternative energy” on center stage. Former President George W. Bush brought national attention toward alternative energy by announcing what was known as an “advanced energy initiative”, designed as a concentration of federal efforts toward clean energy resource capture. President Bush announced that federally funded research programs would help find relief for frustrated Americans.

The leading sources of CO₂ emissions in the U.S. are coal-fired power plants. There are increased efforts to regulate major greenhouse gas polluters, and new emphases on developing so-called “clean coal” technologies of carbon capture and “sequestration” (**Photo 7.1**; burial). But the benefits of these measures are uncertain, and sequestration is in its infancy. As with nuclear waste, the question becomes: how long can buried coal gases stay buried? That aside, most U.S. coal now comes from mountain-top removal mining (see back cover and chapter four) which is transforming the glorious mountains of several states into wastelands, and will never qualify as “clean.” In any case, coal reserves are far lower than have been reputed, making long term viability doubtful.



Photo 7.1. In this Jan. 20, 2015 file photo, a plume of steam billows from the coal-fired Merrimack Station in Bow, N.H. AP Photo/Jim Cole

Dynamically, the energy economy is changing due to the volatility of fossil fuel markets. Growing fears of climate change on a global scale are on the horizon. The extraction of fossil fuel oil from earth's depths is becoming more complex and expensive. Although estimations of natural gas availability on U.S. soil are currently favorable, the debate of "fracking" and its environmental impacts have not waned.

At a fledgling stage, tribes are beginning to explore and invest their time and dollars toward multiple economic engines, one of which is the introduction of "renewable energy" in tribal communities. The implementation of renewable energy systems on Indian Reservations is a monumental challenge because of multiple and oftentimes, complex interest clashes stemming from both inside and outside of Indian country. Even more, generational inheritance of passed down histories of betrayal of the "Indian" has resulted in a legacy of "distrust" of the non-Indian world.

Tribes all over the U.S. have a great opportunity to be providers of renewable energy but it is currently a major challenge to establish. (Rave 2010) Renewable energy production is progressively becoming more prevalent on a global scale but has yet to gain traction on tribal lands. The need for renewable energy is becoming greater as time marches on.

Additional energy sources will be necessary to meet power demands both nationally and worldwide. Unfortunately, the scientific community in large part, is observing an increase of strident non-renewable energy consumption, resulting in an overabundance of greenhouse gases and in the coming decades, global warming. (Hansen & Lacis 1990) Although there are pockets of scientific theory that disputes that Global warming is a reality, nine out of ten scientists assert that the global climate change has arrived and is being altered by anthropogenic means.

As can be seen in **Table 7.1**, both temperatures and precipitation will increase in the Pacific Northwest. These changes will unfortunately result in decreased stream flow, soil moisture and snow pack, meaning that water storage will be decreased also, negatively impacting man’s resource needs. The answer therefore is to “decrease”, not increase greenhouse gas concentrations through promotion of alternative/renewable energy productions.

Table 7.1. Average and range of projected changes in temperature and precipitation for the Pacific Northwest. Reported averages are changes relative to 1970-1999, for both medium (A1B) and low (B1) scenarios and all models (39 combinations averaged for each cell in the table). The ranges for the lowest to highest projected change are in parentheses.

	Temperature Change (F°)	Precipitation Change (%)
2020s	+2.0 (+1.1 to +3.3)	+1.3 (-9 to +12)
2040s	+3.2 (+1.5 to +5.2)	+2.3 (-11 to +12)
2080s	+5.3 (+2.8 to +9.7)	+3.8 (-10 to +20)

Source: Washington Climate Change Impact Statement: Evaluating Washington’s Future in A Climate Change. A report by The Climate Impacts Group University of Washington. June 2009

Remaining on the same fossil fuel energy consumption path will only add to an already mounting global atmospheric carbon emission level never seen before by mankind. It has been determined that 70% of global Greenhouse gases emitted into the earth’s atmosphere originate from the burning of fossil fuel. (Vogt) In addition to this growing environmental problem, it is also estimated that fossil fuel availability will be greatly depleted in a little over 100 years from now. (Pimental; Rodriques 1994)

Although federal legislation and funding approved during the George W. Bush administration enabled enhanced renewable energy production within the United States, progress has been slow in coming. In fact, the amount of US dollars invested into renewable energy research and development has dwindled in the last few years. In the last 5 years alone, a 25% drop in federal dollars from over \$9 billion to a little over \$7 billion.

Compared to European countries, the United States' renewable energy production and consumption has been lagging. Interestingly enough, some European countries have been utilizing renewable energy since the 2nd century B.C. in the form of windmills. European countries are also outpacing the United States in the utilization of bio-mass energy, even though European countries pale in comparison to U.S. wooded areas which today, approximates 747 million forested acres. It is expected however, that renewable energy will become more prevalent domestically, resulting in increased technological expansion demand. In keeping pace with these technological demands, increased energy programs will also need to be established. Mainstream education institutions instruct college students on planning, development and maintenance of renewable energy infrastructure. Their approach to providing training and certification of renewable energy knowledge is based on scientific background studies.

By providing germane renewable energy education to targeted tribes, heightened understandings will aid them in making critical harvest decisions that can heavily impact their reservations economically, environmentally, and socially. (K. Vogt 2010) Renewable energy education programs can help tribes maximize efficiencies of renewable energy harvest and distribution to both Native and non-Native interests. Formulating partnerships with tribes is a must that will include relying on tribal expertise in providing cultural appropriate learning tools in working with tribal members. Providing technical scientific knowledge to tribal members will only be accomplished through collaboration with tribal elders, leaders, and ambitious members.

By working with tribal members in a culturally appropriate manner, a type of education program that simply does not exist anywhere in the United States is very much possible. (K Vogt 2010) Tribal elders, tribal leaders, prospective workers, and educators, will all play vital roles. This education program will take extended measures in devising education programs in a culturally sensitive manner on all tribal lands. Because there is much diversity in cultural beliefs amongst tribes regarding their resources, each education site will require tailored preparations in advance. A diversified learning approach, means integrating cultural factors in providing instruction to the students will be necessary.

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