

## FORMATION OF HOPI SUSTAINABLE ENERGY PROGRAM

### Executive Summary:

The Hopi Tribal Government as part of an initiative to ***“Regulate the delivery of energy and energy services to the Hopi Reservation and to create a strategic business plan for tribal provision of appropriate utility, both in a manner that improves the reliability and cost efficiency of such services,”*** established the Hopi Clean Air Partnership Project (HCAPP) to support the Tribe’s economic development goals, which is sensitive to the needs and ways of the Hopi people. The Department of Energy (DOE) funded, Formation of Hopi Sustainable Energy Program results are included in the Clean Air Partnership Report.

The Hopi Tribe has an urgent need to begin a paradigm shift from a coal-dominated economy to one that is more diversified, including energy resources that are sustainable. However, to make the transition will take time and will require the Hopi Tribe to pursue sustainable energy development in a very pragmatic manner with formally established programs and businesses.

Following a multi-year economic development planning effort and a recent assessment of the environmental and economic impacts of varying energy options, the Hopi Tribe established a Sustainable Energy Program that will be responsible for providing input to the Tribe’s governing bodies to foster the development of business enterprises that provide energy systems or services based on sustainable energy technologies.

The Program will be responsive to the stated energy-related goal of the *Hopit Potskwaniat*, ***“To provide affordable and environmentally safe energy for local residents and business for the purpose of economic self-sufficiency”***. The Program will also be supportive of the economic and energy development strategies that emerge from the Hopi Clean Air Partnership Project, and complimentary to the establishment of the Hopi Utility Regulatory Board.

The program will provide a continuous office for energy related information and energy policy that will retain consistency throughout various political administrations.

### Project Overview:

One of the Hopi Tribe’s primary strategies to improving the reliability and cost efficiency of energy services on the Reservation and to creating alternative (to coal) economic development opportunities is to form and begin implementation of the Hopi Sustainable Energy Program.

The Tribe has very little experience with energy efficiency in buildings, cursory understanding of its wind resource and the requirements for wind farm development, and little or no experience with fuel cells and other sustainable energy technologies that may have application on the Reservation. The Hopi Sustainable Energy Program will develop experience in all of these areas in order to provide useful information to the Hopi Tribal Council and the Hopi Regulatory Utility

Board and to assist in implementation of sustainable energy projects that may result from Council or Board directives.

## **OBJECTIVES**

### **Objective 1: Program Start-up and Staff Training**

- Physically establish the office
- Establish its management structure and procedures
- Establish the program's relationship to the Hopi Tribal Council and the Hopi Utility Regulatory Board
- Hire and train interim staff

The Program is managed by the Hopi Clean Air Partnership Project Manager, whom will draft management plans and procedures for the Program that will be presented to the Hopi Energy Team and Tribal Council to determine management and decision-making protocol. Once the Hopi Utility Regulatory Board is established, the Project Manager will coordinate the roles and responsibilities of the Program with the Board.

During the initial startup and throughout the grant period the Project Manager and members of the Energy Team will participate in a broad range of training focusing on sustainable energy technologies, both on and at off reservation forums. Particular emphasis will be placed on training opportunities provided by other Tribal energy organizations that have successfully implemented sustainable energy programs. The Project Manager, Energy Team and others will receive on-site training from Program consultants to develop an understanding of the management and operating requirements of a sustainable energy program, the range of technical and programmatic options that could be pursued, and Federal, regional, state, and local energy policies that may affect Program operations.

### **Objective 2: Program Planning and Implementation**

Following completion of start-up and training, the Program will conduct the following activities:

- Seek input from the Energy Team, Tribal Council, Utility Regulatory Board, village leaders, Hopi public interest groups, businesses and the Hopi general public regarding perspectives and priorities associated with the sustainable energy project development on the Reservation;
- Develop a draft and final Sustainable Energy Plan based on the information gathered above;
- Develop a prioritized inventory and characterization of sustainable energy project opportunities based on a review of load data, sample energy audits, and renewable resource data derived from the Hopi Clean Air Partnership project and subsequent information gathering;
- An investigation of the merits of adoption or promotion of building or equipment efficiency codes/standards in Hopi buildings and other energy loads;

- Assess the availability/financing/incentive strategies that can be pursued to accelerate adoption of sustainable energy technologies;
- Coordinate with Federal agencies that manage energy-using facilities on the Reservation (BIA; schools housing units, administrative offices, and road equipment garages; I.H.S: regional medical clinic and housing units) and Federally –funded entities( Hopi Housing Authority: housing units via HUD funding) to investigate opportunities for sustainable energy project development;
- Coordinate with existing energy suppliers and other local utility companies for information gathering and for partnership opportunities.

## **ACTIVITIES PERFORMED**

### **Program Start-up and Staff Training:**

The Program was integrated into the HCAPP and managed by the Project Manager. The Project Manager and contracted consultants who provided technical and legal services, developed a draft document that outlined the program’s legal status and relationship to the Tribal government, programs and the private business sector. The draft was reviewed by Program staff and a final draft developed for presentation before the Hopi Energy Team for final review or acceptance before presentation before the full Tribal Council for adoption.

### **Program Planning and Implementation:**

Prior to developing a draft of the Hopi Sustainable Energy Plan, the Project Manager and contracted consultants interviewed Tribal officials and employees to gain a perspective on potential energy projects for development on Hopi lands. Based on the data derived from the interviews, the data was consolidated with other energy related data obtained through the HCAPP. Development of the Hopi Sustainable Energy Plan was initiated and is a major part of this final report.

Program staff provided technical assistance to the Hopi Energy Team in the Sunshine Pass Wind Project. The Project, a 60MW wind development project is partially located on Tribal fee land. An area located entirely on Hopi fee land was identified for a feasibility study to determine if a 100MW wind project can be developed. With technical assistance provided by consultants the Tribe can look at alternative financing options for the projects so the Hopi Tribe can participate as a partner in the projects.

In the summer of 2004 the former HCAPP Project Manager and an employee of Navajo Tribal Utility Authority (NTUA) conducted an inspection of the entire APS transmission line on Hopi and compiled a deficiencies list of the line; from which a reported was generated and submitted to APS. The inspection was performed in response to the Hopi Tribe’s interest in purchasing the transmission system.

The Program, Office of the Chairman and Hopi Energy Team co-sponsored an Energy Summit at the local Junior/Senior High School which was very well attended. Other Tribes with renewable energy programs, Western Area Power Authority (WAPA) and one coal mining company sponsored display booths. The Arizona Corporation Commission (ACC) held a panel discussion

on electrical and other utilities reliability on Hopi. Several individuals testified about how unreliable utilities are on Hopi. Soon after the Energy Summit, Arizona Public Service (APS) began making improvements to the transmission system which will be ongoing for the rest of this year.

The program's technical consultant conducted a one day on-site training on energy efficiency in buildings. The training focused on the use of energy efficient lighting fixtures for Tribal buildings, school buildings, federal facilities and village administrations buildings.

It is anticipated that staff of the HCAPP will manage the tribal Wind Feasibility project when the grant is awarded in late summer of this year.

## **Conclusions and Recommendations:**

### **Conclusion**

The Hopi Tribe through the implementation of this grant identified various economic opportunities available from renewable energy resources. However, in order to take advantage of those opportunities, capacity building of tribal staff is essential in order for the Tribe to develop and manage its renewable energy resources. As Arizona public utilities such as APS's renewable energy portfolio increases the demand for renewable power will increase. The Hopi Tribe would be in a good position to provide a percentage of the power through wind energy.

It is equally important that the Hopi Tribe begin a dialogue with APS and NTUA to purchase the 69Kv transmission on Hopi and begin looking into financing options to purchase the line.

### **Recommendations**

1. The Department of Energy and Hopi Tribe through continued funding work cooperatively to develop Tribal renewable projects for economic sustainability.
2. The DOE and Hopi Tribe cooperatively develop mechanisms that will ensure Hopi of long-term financial assistance for capacity building and project development.
3. Formation of a Hopi Utility Regulatory Authority
4. Hopi Tribe seeks out the most qualified wind energy developer to form a partnership with and begin to develop projects to take advantage of opportunities available.

### **Lessons Learned:**

The Hopi Sustainable Energy Plan developed as part of this grant identifies several sustainable economic opportunities for the Hopi Tribe both from its finite energy resources such as coal and renewable energy resources such as wind and solar. In order to take advantage of the opportunities that renewable energy presents, the Tribe must seek out the best qualified wind developer to partner with and become a major player in providing renewable energy power to Arizona utilities such as Arizona Public Service.

The Plan also identifies other economic opportunities such as ownership of the local transmission system that would be managed by a utility authority to provide a reliable source of electricity, and create more utility related jobs. The utility authority would also manage the Tribe's allocation of hydropower from the Western Area Power Authority (WAPA).

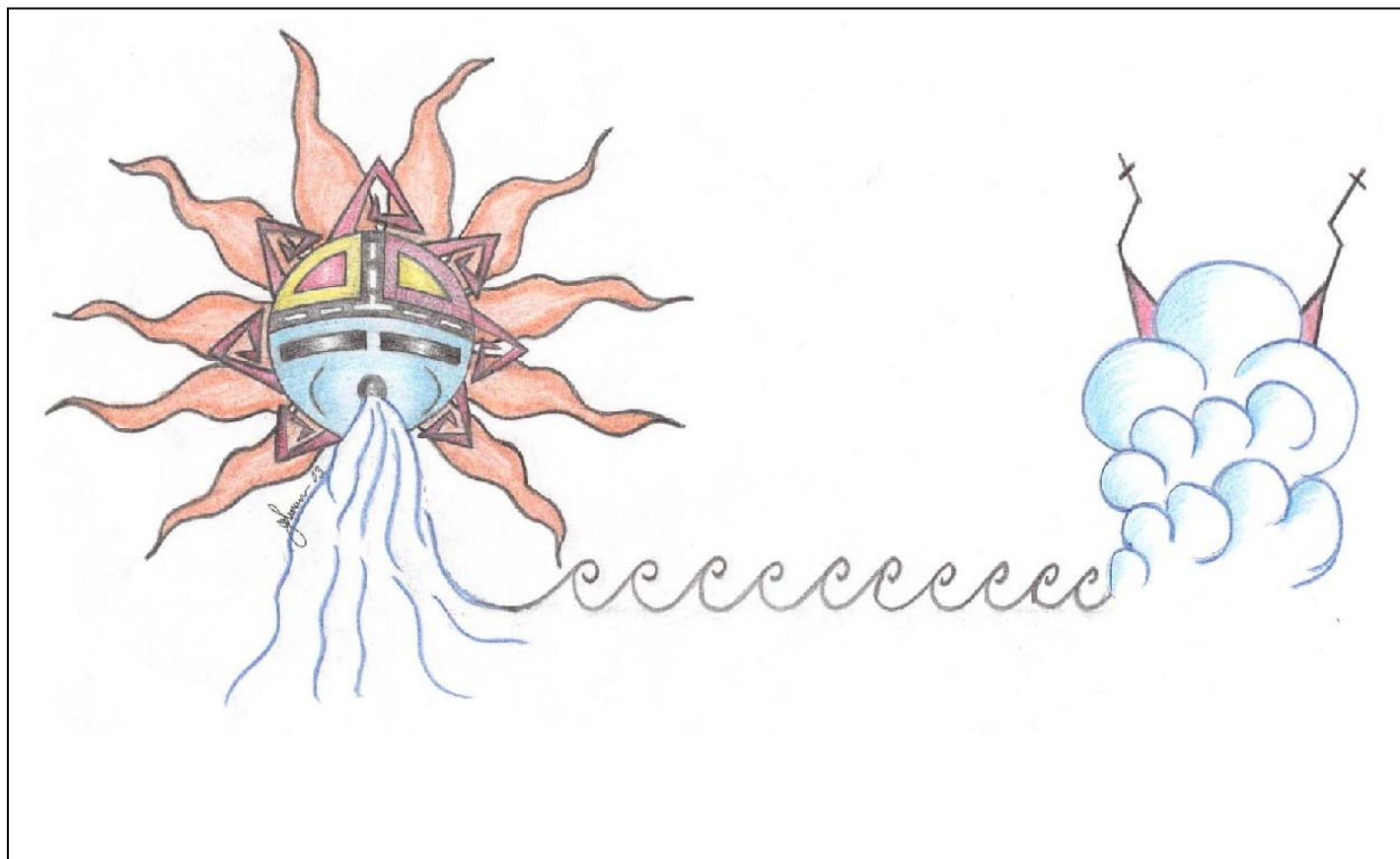
Energy efficiency technologies exist that would provide cost effective energy improvements to reduce wasteful operating expenditures and reduce the electrical load on the local distribution system and improve the visual and thermal comfort of building occupants.

The Tribe is aware of potential sustainable energy program funding sources it was not aware of prior to the grant work.

In order for the Plan to work effectively a tribal utility authority must be in place and continued funding from the DOE or other Federal agencies for project development and capacity building must continue as part of their Trust Responsibility and Obligations to the Tribes.



THE HOPI TRIBE  
AND  
THE US ENVIRONMENTAL PROTECTION AGENCY  
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## Report Authors and Report Content

This report is the result of a team effort between The Hopi Tribe and consultants specializing in energy, economics, and law. The work of producing the report was apportioned among the various specialists in each field of discipline and then edited for organization and continuity. The first draft of the report was published in August, 2003 for review by the Tribal Council's Task Teams and other tribal staff. Suggestions for improving the report will be taken and a final draft published upon approval by the Hopi-EPA Clean Air Partnership.

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The Hopi-EPA Clean Air Partnership team sincerely thanks all tribal members and tribal staff who contributed their time, expertise, attention and talents to the development of this report. Many tribal members and staff provided tours, described projects, attended meetings, contributed ideas, explained ongoing tribal programs, sent information, provided administrative support, and otherwise assisted in conveying an understanding of the issues and in keeping the project on schedule.

This report is drafted primarily in English. Our apologies to tribal leaders and members who would prefer the report were published bilingually. Upon request, effort will be made to translate portions of the report for those wishing a verbal translation.

Jamie Navenma created the Cover Art and the Team and the Tribe is grateful for his talented contribution



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## INTRODUCTION

This report was made possible by a grant to The Hopi Tribe from the United States Environmental Protection Agency (EPA), establishing the Hopi-EPA Clean Air Partnership. Funding for the project came from the EPA's clean air initiatives. The Project arose out of the mutual concerns of Hopi Tribal leadership and the EPA that new environmental regulations, especially clean air rules, would undercut the tribal economy by requiring the closure of the Mohave Generating Station, a 1580 megawatt generating facility in Laughlin, Nevada fueled by coal jointly owned by the Hopi and Navajo Tribes. The royalties paid to the Hopi and Navajo tribes from this coal are significant in the overall tribal economies and underwrite the Tribes' abilities to deliver essential governmental services within their respective jurisdictions.

Roughly one year was spent by a multi-disciplinary team gathering energy, legal, economic, and business information in order to present that information to tribal leadership and thereby enable the Tribe to consider the looming energy, development, and other decisions that are critical in the tribe's short-term/long-term strategy. This report provides that needed background information and analysis. It seeks to equip tribal leadership and other interested parties with a useful summary of regulatory changes, the energy industry's status and projected trends, related Hopi tribal issues, economic analysis and economic development opportunities.

While Hopi culture and government extend back to prehistoric times, the existing federally recognized Hopi tribal government is relatively new. The Hopi tribal Constitution was adopted in 1936. The Constitution and By-Laws of the Hopi Tribe established a centralized government comprised of representatives from the 12 Hopi villages. Each Hopi Village maintained a right under the Constitution to continue its system of traditional leadership and governance, including the right to decide matters of local concern. However, on matters that affected the general welfare of the entire tribe, the Tribal Government became the responsible authority. Because of the interplay between local village government and the centralized government, any centralized planning must consider both the authorities of the Tribal government and the authorities and the coordinated cooperation of the village governments.

The Hopi Tribe is not new to strategic planning. In 1988, The Hopi Tribe published the *Hopit Tunatya'at, Hopi Comprehensive Development Plan*. Organized in three parts, the report describes and discusses the Tribe's political boundaries and physical characteristics, tribal organization, tribal goals, population, economy, land tenure, land use, housing, public utilities, public service facilities, transportation, rangeland, wildlife, woodland, agriculture, water resources, mineral resources, recreation, cultural resources, development constraints, and development planning.

In 1995, the Tribe published the *Hopit Potskwaniat, Hopi Tribal Consolidated Strategic Plan of 1995*. This document establishes Hopi Tribal goals in the areas of: tribal governance, law enforcement, justice, economic development and tourism, housing, public utilities, transportation, recreation, preservation and protection of cultural resources, quality human services, conservation and effective use of natural resources. These goals are blended together to produce a tribal vision statement.

The *Hopit Tunatya'at 2000: The Hopi Strategic Land Use and Development Plan* focused more on tribal lands issues, but contains a wealth of other tribal information.

In 2001, the Tribe, in conjunction with the Bureau of Indian Affairs published, *Hopi Tutskwat Makiwa'yta: Soosoy Himu Hopit Tutavoyat ev Hintsaktiwqa Qatsit Oovi Natwaniwa, Hopi Land Stewardship: An Integrated Resources Management Plan for the Hopi Reservation*. This report describes Hopi values about natural resource management, sets out a vision and mission for the Integrated Resources Plan, and details planning regarding water resources, arable land and agricultural practices, plant resources, wildlife, archaeological and cultural resources, and land and mineral resources.

These previous planning documents have been invaluable in our ability to understand the issues described in this report and their context against the broader landscape of Hopi culture and philosophy. In addition to tribal planning documents, the Hopi-EPA Clean Air Partnership team members reviewed other regional reports relevant to this report. Those reports included *Report #2 An Analysis of New Energy-Related Development Opportunities for Northern Arizona Tribes*, by Charles Bensinger and Vernon Maysayesva, presented by The Black Mesa Trust on June 10, 1999 and *Recommendations of the Air Pollution Prevention Forum to Increase the Generation of Electricity From Renewable Resources on Native American Lands*, by Northern Arizona University under contract with the Western Governor's Association for the Western Regional Air Partnership (WRAP), 2001. These sources of information were also invaluable in our creation of this report.

Please allow this information to serve as a tool and resource for your consideration of important issues facing the Hopi Tribe.

# EXECUTIVE SUMMARY

## **1. *Purpose of This Report***

Under Section 103(a) and 103(b) of the Clean Air Act, EPA is authorized and directed to “conduct and promote . . . investigations . . . and studies relating to the . . . effects . . . of air pollution [control]”. Under the Hopi EPA Clean Air Partnership, Hopi is undertaking such a study. Issues related to air pollution control and the Hopi Tribe include the need for the Tribe to manage the:

Near-term consequences of tighter air pollution controls on the Mohave power plant, a key purchaser of Hopi coal.

Long-term consequences of tightening air pollution controls on users of Hopi coal including long-term controls on electric power plant emissions of SO<sub>2</sub>, NO<sub>x</sub>, mercury, and potentially CO<sub>2</sub>.

Long-term implications of tightening air pollution controls on Hopi energy development activities including Hopi’s oil and natural gas and renewable potential.

Air pollution issues associated with energy supply for the Hopi reservation including the heavy reliance on coal for residential heating and the potential for renewables such as solar, wind, and hydro power.

## **2. *The Changing Hopi Economy***

The Tribal economic situation is very depressed. There are significant immediate tribal needs for improvement of the economic situation on the reservation. In addition to the immediate needs, the economy may be worsening due to the potential closure of the Mohave Generating Plant and related local coal mining.

### **Tribal Statistics**

In 1995, the unemployment rates for the Hopi were approximately 8 to 10 times those of the U.S. and Arizona. While the unemployment rate in the U.S. and Arizona was 5.1 and 5.6 percent, respectively, Hopi unemployment was over 50 percent. More recent statistics show that of the number of Hopis available for work on the Hopi reservation, 64 percent are unemployed. Of those who are employed, statistics show that approximately 35 percent earn wages below national poverty guidelines.

The median income earned by employed Hopi people is less than one-half to nearly one-third that earned by their non-Indian counterparts. Median household income on the Hopi Reservation, according to the 2000 U.S. Census, was just over \$21,000 per year. According to a newspaper article published in the Arizona Daily Sun on September 25, 2002, the median family income in northern Arizona was \$46,723. This same article reported that Hopi average family income as only \$17,520.

But these figures do not convey fully the very difficult living conditions found in Hopi reservation communities. According to the 2000 U.S. Census, more than 44 percent of Hopi families with children under 18 years of age subsisted on incomes that were below the national poverty level. The figure rises to more than 50 percent living below the poverty level for families with children younger than 5 years old. A 1997 report by the U.S. Department of Health and Human Services (HHS) found that over 63 percent of Hopi reservation households earned an income that was below the HHS poverty level.

Hopi household infrastructure is also lacking. There is a stark disparity in the basic physical comforts nearly all Americans take for granted, such as a complete kitchen, flush toilets, running water and a telephone. According to the U.S. Census, almost 40 percent of Hopi homes lack complete plumbing facilities, and more than 35 percent lack complete kitchen facilities. In contrast, in the United States generally, only 1.2 percent of homes lacks complete plumbing facilities, and only 1.3 percent lack complete kitchen facilities. In the State of Arizona, less than 2 percent of all homes lack complete plumbing and kitchen facilities. Moreover, according to the Tribal Census Project in 1997, approximately 78 percent of owner-occupied housing units within the categories of “low income” and “very low income” have serious structural deficiencies. Part of the problem is a general lack of adequate water supply. In contrast to non-Indian communities bordering the reservation which use an average of 160 gallons of water per capita per day (gpcpd) for all municipal/industrial uses, (this figure can be as high as 1,000 gpcpd in some urban areas of Phoenix) the Hopi typically use 15-37 gpcpd. Many Hopi must carry their domestic water supplies home from community wells. A 1999 study by Harvard University’s Kennedy School of Government that it will be nearly impossible for the Hopi to develop a sustainable economy that will lift the local living standard without significant improvement in the availability of sufficient quantities of quality water for home uses and business development. Even with improved water supplies, perhaps the most significant challenge will be to diversify the Hopi economy away from its almost exclusive reliance on the Tribe’s coal resource. Like many local economies, on and off reservations, the Hopi economy has far too many of its revenue eggs in one basket.

The Hopi economy is largely a governmental economy with very little private sector development. The major employers on the Hopi reservation are the Hopi Tribe, employing about 500 people, and the United States government, employing an additional 400 in local federal administrative offices, the local IHS hospital and in federally sponsored elementary and secondary schools. Approximately 44 percent of employed Hopi are employed in this public sector governmental economy. There is no industrial development on the reservation, except the mining operation of Peabody, which employs only a handful of Hopi people, with most of the approximately 600 mining jobs going to members of the Navajo tribe. The limited private sector economy consists of small retail outlets, a few service jobs and a cottage production of arts and crafts.

## **Lack of Infrastructure**

The potential for developing additional industrial and service jobs, and thus expanding the economy, is hampered by a serious lack of basic infrastructure-water, sewer, roads, electric distribution- and the isolated nature of the Hopi Reservation. The Hopi Communities are located

approximately 85 miles from the nearest non-Indian economic centers at Flagstaff, Winslow and Holbrook. These non-Indian communities also mark the location of the nearest major transportation corridors, Interstate 40 and the Burlington-Santa Fe railroad which parallels the interstate. There are no major highways traversing the Hopi reservation, only a secondary state route running east and west to connect areas of the Navajo Nation. The Hopi reservation's isolation is made worse by the fact that it is completely surrounded by the expansive Navajo reservation. This geographic fact, created largely by the actions and inactions of the United States government, creates numerous issues concerning rights of way and resource development that contribute to economic stagnation on the Hopi reservation.

There is a need to upgrade and expand the existing infrastructures to meet population growth requirements and provide economic development opportunities. The Hopi Tunatya'at 2000, The Hopi Strategic Land Use and Development Plan, identifies an immediate need for 765 new houses to alleviate structural deficiencies in existing homes and overcrowding. There is an additional need for 90 new houses each year for the next twenty years to keep pace with projected population growth. That is an additional projected 1800 new homes. The Plan therefore calls for five planned Community Development Districts, four on the main Reservation, and one in the Moenkopi District. Development of infrastructure must be consistent with Hopi culture and religion, which requires sustainable protection of land and resources. Development of infrastructure must also reasonably meet the employment, housing, and public service needs of Hopi people.

## **Importance of Coal to the Hopi Economy**

The mine and the power plant are a single economic complex, with Hopi coal and water being the most important component in its overall success. ***Almost 30% of the tribal budget of \$22 million annually is dependent upon revenues derived from the Mohave Generating Station. Coal and water payments relating to Mohave operations in 2001 amounted to approximately \$5 million and \$2.3 million, respectively. In 2001 all coal based revenues accounted for approximately 65% of the Tribe's budget.*** These coal revenues are used to fund the delivery of essential governmental services by the Hopi Tribe and the 12 Hopi villages. Without these revenues it would be difficult to maintain the Health, education, law enforcement and environmental programs and services that Hopi tribal members take for granted as a part of a modern Tribal government.

If the Mohave Generating Station were to cease operation without an economic revenue replacement for the Hopi Tribe, there would be a severe effect on the Tribe's economy. The significant reduction in budget would force the Tribe to eliminate or significantly reduce funding for critical programs like education, elderly and youth service programs, and law enforcement. It is estimated that over 150 tribal employees would be laid off. A relatively small number of Hopi who work at the Black Mesa Mine and the water pipeline would also be laid off. The loss of these jobs would almost certainly send these families spiraling into poverty and onto the welfare rolls. These lost revenues and lay offs would in turn have a ripple effect in the local Hopi economy. The revenues from mining constitute the backbone of the local economy. There would also likely be a loss and attenuation of critical capital and infrastructure programs such as



transportation, water/sewer, electricity delivery, telecommunications, and other basic infrastructures.

## Existing Tribal Lands



Hopi land holdings include tribal trust, or reservation land (77.3% of the land base) within the 1882 Executive order and 1934 Act reservations and the lands within the boundaries of five ranches and associated United States Department of Agriculture Forest Service grazing permits acquired by the Tribe in 1997-98 under authority of the Navajo-Hopi Land dispute Settlement Act of 1996. In addition, the tribe owns in trust a 200 acre parcel of land adjacent to the City of Winslow as well as a number of commercial properties in Flagstaff and Oak Creek Arizona. The

Hopi Reservation is located in eastern Coconino and northern Navajo Counties, Arizona. It encompasses 2,439 square miles, or 1,561,054 acres. The Hopi lands within the 1882 and 1934 Act reservations are bordered on all sides by the Navajo Reservation.

The Tribe's trust lands, or reservation lands, are administered in two different ways. First, there are lands administered by the various villages. These include "District Six", the 650,013 acre area generally surrounding the existing villages, and the Moenkopi Administrative Area. The second category of tribal trust lands includes lands administered by the tribal government. These lands include the Hopi Partitioned Lands which are the reservation lands not in District Six, the Moenkopi District--an island of reservation to the West of the larger Reservation--and the Hopi Winslow property, a residential area and vacant industrial park in the town of Winslow.

A third category of land rights bears mentioning. These are the mineral rights shared with the Navajo Nation in the former "Joint Use Area". The Joint Use Area (JUA) was created by the federal courts as a means of defining the pre-partition rights of the Hopi and Navajo Tribes in certain areas of the Hopi 1882 reservation. Following partition of these lands in 1979, the surface of these lands was given over to the exclusive title and jurisdiction of the Navajo and Hopi Tribes depending on where the partition line was drawn. However, because of the inherent difficulty of equitably dividing subsurface mineral rights, congress ordered and the court found that such rights would continue to be jointly owned by the two tribes and the economic proceeds of these rights would be shared by the tribes on a 50/50 basis.

## **Roads**

The major paved two lane road serving the Reservation is Arizona Highway 264, which traverses the center of the Reservation from East to West and connects most of the villages to each other. The *Hopit Tunatya'at 2000*, The Hopi Strategic Land Use and Development Plan, calls for construction of the Turquoise Trail (Bureau of Indian Affairs Highway 4) as an important link and tourist route between Highway 264 and US 160 at a point just north and west of the Peabody Coal mine lease. At present, approximately one half of the roadway is constructed. The other half is waiting for funding.

## **Telecommunications**

According to the 2000 census, 68% of Hopi homes have telephone service. In contrast, in 1980, the census indicated that only 32% had such service. Only 2% of homes in the US generally were without telephone service in the 2000 census.

Conventional telephone services are provided by CenturyTel of Southwest Inc. throughout all of the reservation's communities with the exception of the Moenkopi/Tuba City area, which obtains its service from Navajo Communication Co. CellularONE provides wireless telephone service to a part of the Reservation through a cell tower located on Antelope Mesa. The Hopi Tribe has recently chartered a telephone company to consider improvements to tribal telephone access.

## **Water and Sewer Facilities Serving the Reservation**

All but three villages: Lower Moenkopi, Old Oraibi and Walpi are served by community water and wastewater systems. All Hopi communities on the main reservation, except Yu Weh Loo Pahki, are dependent on the N-Aquifer (groundwater) as their source of domestic water. Annual water consumption by Hopi communities in 2000 was approximately 300 acre-feet/year. This

aquifer is also supplies Peabody Coal's water slurry, transporting coal from Black Mesa to the Mohave generating station in Nevada.

## **Hopi Ranches**

Beginning in 1997, the Hopi Tribe has pursued a program of reclaiming ownership of some of its aboriginal land base. Under Federal law—the Navajo-Hopi Land Dispute Settlement Act of 1996—the Hopi tribe is authorized to acquire and place into trust status up to 500,000 acres of land in northern Arizona. As part of this program, the Tribe has acquired 5 large ranches, each with accompanying U.S. Forest Service livestock grazing permits, all located south of the main Reservation in the vicinity of Winslow. Formerly known as the Drye Ranch, the Hart Ranch, the Clear Creek Ranch, the Aja Ranch, and the 26-Bar Ranch, these properties are now known as the Hopi Three Canyon Ranch. These lands continue to manage as a working cattle operation. The Hart Ranch may be targeted for closer review as it is closer to major infrastructure than the other ranches. Ranch headquarters is a few miles south of Interstate 40, at the Twin Arrows Exit. A 250 kV transmission line owned by APS crosses the region from the north to the south, approximately 5 miles west of the ranch boundary. A 250 kV substation is located on that line, near I-40. Additionally, near the Sunrise (Leupp) Exit of I-40, about 8 miles from the ranch, there is an NTUA substation and what appears to be a cellular tower.

## **Tribal Laws**

Many factors will influence Hopi air quality, energy use and development, and economic development. These factors include the available resources; the local religion, culture and philosophies; the personal and community customs; internal and external government actions; national and regional economics and markets; and many other factors. One of these factors that is within the control of Hopi government is its legal structure and the laws that impact the likelihood of reaching tribal economic development goals, developing local energy and service infrastructures, and in maintaining and improving air quality. Three categories of Hopi law that were reviewed include the existing policy statements which have been adopted in planning efforts, existing Hopi Tribal Ordinances, and the existing Tribal Council Resolutions. These laws and policies were gathered and reviewed to assist Tribal decision makers in understanding the existing structure of laws and policy and to identify those areas where the laws or policies could be updated or improved to better serve Tribal needs and to be consistent with Tribal policies.

Indian tribes have inherent sovereign authority on their reservations to regulate entities doing business on tribal lands. This is an essential attribute of Indian sovereignty and a necessary instrument of self-government and territorial management. For example, tribes may adopt regulations governing the sales and delivery of goods on the reservation. A Uniform Commercial Code generally establishes such rules. With regards to services, it is customary that the sales and provision of services are regulated by a governmental board or commission that establishes rules for all aspects of service provision. The tribe might choose to regulate utility providers on the reservation. Various other codes may be considered throughout the strategic planning process. The Hopi Tribe protects and exercises its sovereignty by careful consideration and approvals of codes

## **Water Issues**

The water resources on the Hopi Reservation include both surface and ground water resources. Intermittent surface waters occur in five major washes that cross the reservation: Jeddito, Polacca, Oraibi, Dinnebito, and Moenkopi. These washes cut across the Hopi Reservation from a northeast to southwest direction. Except for the occasional spring and seep, the washes are dry most of the year. All of the washes are listed as impaired under the Hopi Tribe's Clean Water Action Plan Unified Watershed Assessment, due to sediment load, chemical contamination, and the presence of coliform bacteria. Ground water resources lay in the aquifers that comprise the various water bearing strata at various depths beneath the reservation's surface. These strata include quaternary alluvial deposits along washes, and the following aquifers: Wepo Sandstone, Toreva Sandstone, Dakota Sandstone, Navajo Sandstone, Coconino Sandstone, and Muav Limestone and Redwall Limestone Aquifer. Many of the aquifers are limited in their extent or storage or for other reasons are not viable sources of water.

The Hopi per-capita water use is estimated at 37 gallons per day. The American average is 160 gallons per day. Water is used at Hopi for social and cultural purposes, traditional subsistence farming, livestock production, wildlife, wastewater, village systems, and for its economic benefit. Water is frequently needed for construction projects, but concern over these uses often slows the projects. By 2040 the annual demand for water at Hopi is estimated to be 36,300 acre-feet per day. Existing water sources will not meet this projected demand.

### **3. *Hopi Reservation Energy Infrastructure and Uses***

#### **Infrastructure Summary**

Reservation electricity infrastructure exists mainly along Arizona Highway 264, serving most of the villages, and is essentially non-existent elsewhere on the Reservation, except two lane paved roads connecting the villages to neighboring communities, numerous dirt roads and trails, and range improvements for livestock. Three of the twelve villages, Lower Moenkopi, Old Oraibi and Walpi have chosen not to allow utilities within their boundaries.

The electrical system serving the Reservation is owned by Arizona Public Service Company (APS), and is now over 40 years old. Electrical service is a radial feed, meaning that the power serving the Reservation comes from one source and extends across the service territory without a back-up interconnection.

As mentioned, there is no domestic gas pipeline distribution system. Much home heating depends on coal. There is a wholesale gas pipeline which traverses the reservation.

#### **Electrical Facilities Serving the Reservation**

The main APS system on the Reservation can be described in three parts, the transmission line bringing bulk power to the Reservation, the substation which steps this power down into lower voltages for local use, and the distribution system that brings the power from the substation to customers. There is one substation at Keams Canyon that serves all Hopi Reservation customers,

except those in the Village of Moenkopi and the Moenkopi District. The distribution system is made up of a main feeder that extends from the substation across the reservation along Highway 264, and wires extending from that main feeder to the villages and to some individual loads, then networking out within each village to serve the loads there. Because the distribution is a radial feed, an outage or interruption of service anywhere along the main feeder may trip the entire feeder line and stop power deliveries to the whole reservation. An outage or interruption initiating in one of the villages may or may not affect power flow outside of that village area.

APS has indicated its willingness to consider the sale of these facilities to the Hopi Tribe. The Navajo Tribal Utility Authority (NTUA) has also indicated an interest in purchasing portions of this APS system. NTUA wishes to purchase the APS system on Navajo lands, including those serving the Village of Moenkopi. APS is willing to sell the system to NTUA, with approval from the Village of Moenkopi that service by NTUA is acceptable.

Reliability statistics were provided by APS for 1998 through 2001. APS has acknowledged that the duration of outages on the distribution feeder is longer than the APS Company average. Distribution system maintenance records, which have not been provided to the Tribe, would indicate likely system replacement requirements. While systems of this age are not uncommon in rural areas, enhanced routine maintenance, including power pole replacements and equipment upgrades and replacements are needed to assure long-term reliability. It was noted that some portions of the system appear very old and some safety issues may exist with some of the drop-lines from feeder poles into homes, which appear quite close to the ground.

It is estimated that the total peak load on the Hopi Reservation is 5 MW. A U.S. Department of Energy report entitled "Energy Consumption and Renewable Energy Development Potential on Indian Lands" published in April of 2000 states that 29% of Hopi households are without electricity.

The NTUA service territory completely surrounds the Hopi Reservation. NTUA maintains service lines and facilities up to the edge of the Hopi Reservation in many places. It is not believed that NTUA facilities exist on Hopi lands outside of the service to Moenkopi. Because standard utility practices call for electrical facilities to be interconnected to neighboring facilities for increased reliability and for coordination, tribal cooperation with NTUA on utility related matters is essential for the development of modern electrical services.

## **Low Cost Hydropower and Tribal Electricity Distribution**

The Hopi Tribe has long considered taking over the delivery of electricity to its membership. With the proposed construction of new communities outside of existing village lands, it makes even more sense to review this option since new infrastructure will be needed where none now exists. Electric service on the Hopi Reservation is substandard, when compared to the reliable service in cities. While better service usually requires paying more money, options exist to address the issue of improved reliability, with or without ownership of the utility system.

Many factors are coming together at this time to reinvigorate the issue of a tribally owned utility. First, the APS system is in need of upgrades. Second, APS has indicated an interest in selling its

distribution system on the Hopi Reservation and in some surrounding Navajo communities. The APS system here is an “island” system, meaning that it is wholly surrounded by the system owned by the NTUA and is fed by one transmission line which crosses through the Navajo Reservation. Third, NTUA has indicated an interest in acquiring and improving the APS system within its boundaries but APS has agreed not to sell the system to NTUA without Hopi approval. Fourth, the Hopi Tribe will, beginning in October, 2004, receive of low-cost federal hydropower from the Western Area Power Administration (WAPA). This lower-cost hydropower will be available to the Hopi Tribe for at least a 20-year period and will provide enough energy to meet almost one half of Hopi’s current electric demand. A method for delivery of this power is being discussed. While the Hopi Tribe now has an interesting, and potentially beneficial opportunity--to form a tribal utility and buy some low-cost hydropower-electricity from WAPA over each of the next 20 years--there are several major obstacles and decisions to be made before the benefit of the opportunity can be realized. These obstacles include: 1) acquisition of the APS distribution system, 2) establishment of internal tribal authorities and structures to operate a utility, and 3) providing the remainder of needed power for a tribal system. Partnerships with NTUA or other regional utility providers may allow the tribe to receive the benefit of the power during the time these obstacles are being resolved.

Other options to improve electrical service, if a tribal utility is not desired, include a regulatory body to oversee existing utilities, or a partnership with the Arizona state regulatory bodies for more careful oversight.

### **Indoor Air Pollution from Home Heating**

Traditional energy sources such as coal and biomass (including wood) are used widely on the reservation for home heating and cooking. The burning of wood and coal, while inexpensive and readily available, releases significant quantities of fine particle soot into the indoor air and pollutes the in-home environment. Indoor air pollution problems arising from coal burning have been identified as significant problems only in the last two to three decades.

Where testing and studies of classic (e.g. particulate, carbon monoxide) and non-classical pollutants, such as fluorine, on indoor air quality have been done in developing or emerging countries, the results have been striking. Those estimates make the health risk/impact of indoor air pollutant exposure larger than that of all but two of the other major preventable risk factors that have been quantified, malnutrition (15 percent) and lack of clean water and sanitation (7 percent).

Many things can be done to reduce indoor air pollution: improve the living environment, use more efficient and cleaner appliances or devices in the home, and foster behavioral changes to reduce exposure and smoke generation. These improvements can be augmented by use of natural gas from a distribution system niche application of solar energy and improved electricity infrastructure. Further, a rise in the standard of living will help address this problem and vice versa.

### **Energy Efficiency**

Energy efficiency can be a cost effective way to yield economic and environmental benefits to the Hopi people. In many cases, the cost to replace inefficient energy using systems (e.g. lighting, appliances, motors, heating/cooling equipment, etc.) with new high efficiency systems can be paid off in relatively short periods of time due to the savings on power bills. Energy efficiency also directly reduces environmental emissions that are either released at the point of use (i.e. in the home or business) or, in the case of electricity, at the power plant. In order to identify and prioritize energy improvement opportunities, a detailed inventory and characterization of buildings on the Reservation is needed. Walkthrough audits of several Hopi communities, medical and school facilities, and community/institutional buildings have already been completed.

#### **4. *Air Quality Regulations on Use of Hopi Coal***

Coal related revenues are the principal source of income for the Hopi Tribe. The largest users of coal in the U.S. are electric power plants and these plants are facing tightening air pollution controls. In order for the Tribe to understand the magnitude and complex overlapping nature of the controls, some features of the regulatory situation are summarized.

U.S. coal power plants have long been controlled for three principal air pollutants: sulfur dioxide (SO<sub>2</sub>), Nitrogen Oxides (NO<sub>x</sub>), and particulate matter. In the case of SO<sub>2</sub>, use of low sulfur coal has been the principal control mechanism, but increasingly flue gas desulfurization systems are being required. In the case of NO<sub>x</sub>, combustion modifications have been the principal control mechanism. However, increasingly selective catalytic reduction (SCR) systems are being required. In the case of particulates, electrostatic precipitator systems have long been required, though baghouses are increasingly being used. All three of these pollutants have technological control solutions that have been fully tested on utility scale U.S. power plants.

In December 2003, EPA announced plans to control mercury (Hg) emissions for U.S. coal power plants. While some technologies exist for Hg controls including activated carbon injection, fuel switching and/or reliance on NO<sub>x</sub> and SO<sub>2</sub> controls to collaterally control Hg emissions, no utility scale Hg specific controls are in place at U.S. coal plants. Also, Hg controls may either involve trading of emission allowances or have more stringent plant specific controls.

In December 2003, the U.S. Senate rejected proposed CO<sub>2</sub> emission controls on coal power plants. CO<sub>2</sub> is considered by some to be a cause of global climate change. Canada and many European countries are in the process of implementing CO<sub>2</sub> controls related to the 1999 Kyoto protocol. There is no economically feasible CO<sub>2</sub> control mechanism for existing coal-fired power plants. Rather, controls are achieved via decreased coal use or decreased emissions at other sources of greenhouse gases. In light of the different nature of CO<sub>2</sub> control, i.e., there is no feasible control system that can be added to existing power plants to decrease emissions; it is an important long-term potential air pollution control issue for coal industry participants.

The number of existing program issues and requirements that can affect coal power plants is large and overlapping. One relevant example is the regulations affecting SO<sub>2</sub> and NO<sub>x</sub>:

- **National Ambient Air Quality Standards (NAAQS)** – Ambient concentrations of pollutants, such as SO<sub>2</sub> and ozone, are controlled both by states and the federal governments. Limits on the maximum ambient concentration of these pollutants are being tightened.
- **Acid Rain** – Total U.S. utility emissions of SO<sub>2</sub> and NO<sub>x</sub> are also controlled by the federal government under Title IV of the Clean Air Act. Hence, maximum allowed emissions can be lower than levels set to meet NAAQS.
- **Prevention of Significant Deterioration (PSD)** – This program can require pollution controls even where NAAQS are not violated and acid rain emission levels are still met.
- **Visibility** – Various programs address visibility impacts of air pollution. Thus, even plants meeting NAAQS, acid rain, and PSD could still have to lower SO<sub>2</sub> and NO<sub>x</sub> emissions due to visibility concerns.
- **Air Toxics** – Regulations requiring MACT (Maximum Achievable Control Technology) on Hg result from the air toxics pollutant program. Since Hg controls are collateral to a degree with controls of SO<sub>2</sub> and NO<sub>x</sub>, plants meeting NAAQS, acid rain, PSD, and visibility regulations could still have incentives to further decrease NO<sub>x</sub> and SO<sub>2</sub> due to Hg regulations.
- **New Source Review (NSR)** – Modifications to existing power plants and change to their status can trigger tighter emission regulations known as BACT (Best Achievable Control Technology). Thus, a power plant in compliance with all of the above regulations could still have to decrease SO<sub>2</sub> and NO<sub>x</sub> if it was modified.

All of these programs can add to the cost of coal generation relative to gas generation, the principal alternative. Further, new programs may also be added such as CO<sub>2</sub> control programs.

Hence, the Hopi Tribe may find its principal source of revenue at risk in the near-term and long-term.

## **5. *The Impact of Air Quality Regulations on the Hopi Economy***

The Hopi EPA Clean Air Partnership was established to help the Hopi Tribe transition to a future compatible with changing environmental air emission regulations and the need for a sustainable economic future for the tribe. The foremost and immediate challenges for the Hopi Tribe in making such a transition derive directly from the Tribe's historic close economic relationship with the Peabody coal mine/Mohave power plant complex.

Potential EPA regulations governing air pollution emissions from coal-fired power plants have significant potential economic implications for the Hopi Tribe. For example, if CO<sub>2</sub> emission controls are implemented in the long-term (e.g., after 2010), the economics of the Tribe's coal resource could deteriorate making it urgent to use coal to transition to a less coal dependent future before regulations make this impossible. More immediate are current EPA regulations including those requiring the installation of a SO<sub>2</sub> scrubber at the Mohave plant. This air pollution control requirement has turned out to be very difficult to implement.



The tribe depends heavily on revenues derived from coal sales to fund its delivery of essential governmental services to its 12,000 members and prepare for a future which may be less coal dependent. The new environmental controls threaten to massively accelerate the Tribe's need to transition away from coal before the Tribe is ready.

In this regard, the Hopi situation vis-à-vis clean air is unique. In most situations, EPA air emissions regulations have only a diffuse effect on U.S. citizens. Both the benefits and costs of cleaner air are usually spread over large numbers of citizens. Accordingly, air emissions policy issues are typically addressed by large governmental entities (e.g., federal and state governments) or large industries. However, the 12,000 Hopi Tribal members and the 7,000 residents of the Hopi reservation homeland are different and bear a disproportionate economic burden under current EPA air quality initiatives. The Hopi own very large coal reserves--estimated at between 4 and 22 billion tons. These coal reserves comprise the single largest economic asset owned by the Hopi and by most estimates these reserves are the only natural resources available to power a Hopi economy. The Tribal government receives a significant portion of its operational revenues from coal leased to Peabody Coal Company which produces 12-13 million tons of coal annually at the Black mesa and Kayenta mines, Arizona's only coal mine complex. Peabody's customers--the Mohave plant in Laughlin Nevada and the Navajo plant at Page Arizona--consume Hopi coal in highly regulated coal fired power plants. Increasing the stringency of emission regulations at these and other coal-fired power plants have been the focal point for a substantial portion of EPA's total clean air program. Hence, under any circumstance, a Clean Air partnership must of necessity focus on and take into account the economic sustainability of the Tribe in a dynamic air emission regulatory environment. Incremental improvements in regional air quality could result in disproportionate and potentially devastating impacts to the local Hopi economy.

This important focus becomes even more critical in light of ongoing and imminent air pollution control developments which may unexpectedly and dramatically compress the period that the Hopi tribe has to transition from its current reliance on coal as set forth in the next section.

## **6.     *The Potential Closure of Mohave Generating Plant***

The Hopi Tribe has a critical 35 year history and economic relationship with the Mohave Generating Station. A significant portion of the tribal budget is derived from coal royalties mined for Mohave and from water revenues from N-Aquifer water that is used to slurry the coal to Laughlin Nevada and in industrial uses at Mohave Generating Station.

If the Mohave Plant ceases operation without an economic revenue replacement for the Tribe, there will be a catastrophic effect on the Tribe's economy. The reduction in budget would force the Tribe to eliminate or significantly reduce funding for critical programs like education, elderly and youth service programs, and law enforcement. It is estimated that over 150 tribal employees would be laid off. A relatively small number of Hopi who work at the Black Mesa Mine and the water pipeline would also be laid off. The loss of these jobs would almost certainly send these families spiraling deeply into poverty and onto the welfare rolls. These lost revenues and layoffs would have a ripple effect in the local Hopi economy. The revenues from mining constitute

the backbone of the local economy. There would also likely be a loss and retardation of critical capital and infrastructure programs such as transportation infrastructure, water/sewer infrastructure, electricity delivery infrastructure, telecommunications infrastructure, and other basic infrastructures.

The potential closure of Mohave is directly related to changes in air quality regulations and subsequent legal agreements that require the power plant to install expensive pollution control devices. The decision whether those devices will be installed is before the California Public Utilities Commission. Even if the California Commission decides to allow the plant owners to install the devices and place the costs of installation in the rate base, it is likely too late to accomplish the necessary work to meet the January 1, 2006 deadline, leading to at least a temporary shut-down. In addition, the water leases needed for the coal slurry expire on January 1, 2006, leaving the plant without a water supply.

There are various policy considerations described in this report for mitigating the economic impacts of the closure of Mohave Generating Station. None of the options are easy, immediate, or certain and it is quite likely that if Mohave closes there will be significant economic reactions to the Hopi Tribe.

## **Water Issues**

The issue of Mohave's future intersects with the future of water supply for the mine power plant complex. The Hopi coal is delivered to the Mohave plant in the nation's only coal water slurry pipeline. This 273-mile line connects the Peabody mine and the Mohave plant which is located in Laughlin, Nevada. The slurry pipeline requires about 4,000 to 5,000 acre-feet of water per year. This water is currently withdrawn from the N-aquifer, a water bearing geologic formation lying largely beneath the Hopi and Navajo reservations. This aquifer produces pure, pristine water and is the Hopi's sole source of drinking water. In addition, N-Aquifer water plays a central role in Hopi life, culture and religion: it supports all life on the Hopi Reservation including subsistence agriculture, culturally significant springs, seeps and washes, wetlands and wildlife as well as many important religious ceremonies. As a matter of official long-term policy, the Hopi Tribal government has declared that the pumping of N-aquifer water for mining purposes must end.

Alternative sources of water for both the coal slurry and for growing local needs are being studied. Without an alternative, the Hopi Tribe wants the coal water slurry pipeline shut down.

A leading alternative water source is the C aquifer. A water pipeline would be needed to be built to pump the water to the mine so that it could be used in the coal water slurry pipeline. Upgrades of the existing coal water slurry pipeline would also be required according to the power plant owners.

The most promising alternative appears to be the use of water drawn from the C-Aquifer, (Coconino Aquifer) south of the Hopi and Navajo Reservations and west of Winslow, Arizona, along U.S. Interstate Highway 40. The C-Aquifer is a significant source of groundwater extending over much of northern Arizona and a portion of New Mexico. Hydrological and

engineering studies indicate that this aquifer can satisfy all of the needs of the mine and slurry line through the expected life of Mohave as well as some of the needs of Hopi and Navajo communities.

Under this alternative, at least 6,000 acre-feet of water would be pumped from the C-Aquifer annually to satisfy Peabody's total demand for mine and slurry water. As much as 4,000 acre-feet of additional pumping would be available to satisfy some of the municipal water needs of the Hopi and Navajo communities. Water quality at this location is good and would likely require no treatment for Peabody's uses, but might require minimal treatment for domestic consumption. The water would be conveyed 117 miles for the well field to the mine via a steel pipeline connected by a series of pump stations. The total estimated capital cost of the 10,000 acre-feet pipeline is \$103 million. The total estimated annual pumping cost, together with annual operation and maintenance costs would be about \$5 million. Peabody and the owners of Mohave would be responsible to pay that part of the pipeline costs attributable to the satisfaction of their needs and the United States would pay that part attributable to the Hopi and Navajo water uses.

Senator Kyle of Arizona and the United States Bureau of Reclamation have conducted separate and recent studies of alternatives to the N-Aquifer. Although both final reports are yet to be released, their preliminary findings appear to give substantial support to the C-Aquifer alternative.

There are other water issues, though they are secondary to the N-Aquifer issue. The most notable is the fact that the Mohave coal power plant also uses water drawn from the Colorado River near the plant to cool the plant. This water is withdrawn on the condition that the plant consumes Hopi and Navajo coal. The authority to use this water ends in 2026. However, options exist to either, purchase replacement Colorado River water, extend the current arrangements or implement dry cooling technology.

## ***7. Options to Transition the Hopi Economy***

Accordingly, there is an important need to help the Tribe develop a transition plan that will allow the Tribe to achieve both its objectives of support for reasonable environmental controls, and the economic viability of its homeland. Options for the EPA and the Tribe include:

**Mohave Modify Consent Decree** – EPA could take a leadership role in providing a delay in the December 31, 2005 deadline – e.g., a one to three year delay to permit the installation of SO<sub>2</sub> controls in combination with a solution to the plant's water supply problem. The lead-time for such equipment installation is significant. This period could be part of a transition to a long-term Mohave (new water supply) or a long-term non-Mohave future.

**Alternative Water to Replace N-Aquifer Use** – The long-term policy of the Tribe is that withdrawal of N-aquifer ground water for use in the pipeline must end to prevent damage to the Aquifer – the Tribe's only water source—and to preserve this important water source for local domestic needs. Thus, EPA or other governmental agencies can help provide an alternative water source – (e.g., C-Aquifer water supply).

**Transitional Financial Assistance** – If efforts to preserve Mohave fail, EPA or other government agencies can provide financial assistance to the Tribe as it transitions from two

customers to one customer for its coal. This is especially important if EPA and other parts of the government cannot help preserve Mohave within an acceptable long-term plan. This could include the ability to issue tax-free bonds for replacement economic activity, loan guarantees, or direct payments, e.g., equal to the overall social benefit from lower emissions. These payments could be recognition of the imbalance between the benefits of EPA's policies and the impacts on such a vulnerable community.

**Alternative Coal Transportation** – In addition to help on an alternative water supply and the coal water slurry pipeline, long-term options also exist to help the Tribe. The construction of a rail line could facilitate sales of coal to alternative customers. Such a line would link the Hopi Reservation with an existing major East/West rail line that roughly parallels Highway 40. Replacement customers would of course be in compliance with EPA emission regulations. This would be especially important as long-term, if current efforts to continue the Mohave plant beyond 2005 fail.

**On-Site Coal-Fired Generation - Clean Coal** – If alternative water supplies are identified (e.g., C-Aquifer), new coal power plants could be built at Hopi to replace the loss of the Mohave power plant. Such a plant could be built to have emissions lower than any other existing coal power plant. This could involve advanced coal technologies. This could be attractive since new coal generation is very attractive at today's record high natural gas prices. This would require a new electricity transmission line to support what would amount to sales of coal by wire.

**Expand Primary Fossil Energy Production** – As noted, there is potential for greater coal use from the Tribe's extensive fully owned (Hopi exclusive) and jointly owned (with the Navajo Nation) coal. Such activity would be based on a proven resource endowment. However, there may also be natural gas (conventional and coal bed methane) or even oil within the Hopi Reservation. Natural gas can further lower plant emissions (e.g., CO<sub>2</sub>) and coal bed methane can prevent methane releases that otherwise would occur during coal mining. Methane, like CO<sub>2</sub> is a greenhouse gas. These resources can be used in EPA regulated facilities, e.g., power plants. This potential has not yet been explored.

**Other Options** – The remaining options involve an even greater jump to alternative economic activities away from the current coal and electricity basis of the Tribe. None of them involve large established businesses or areas of clear economic advantage. One example would be renewables. Another would be non-energy related development such as the Hopi ranches.

A key input into Tribal planning is whether EPA's Clean Air partnership will result in any tangible assistance as it addresses the effects of EPA policy. Once the situation is clarified related to Mohave, the N-Aquifer replacement and transitional support, the Tribe will continue this important planning process.

## **8. *Coal Based Alternatives to Transition the Economy***

### **Background**

Potentially, coal provides the Hopi Tribe with a competitive position that is hard to imagine replacing in a timely manner. Hence, the most logical and economically feasible approach for a non-Mohave transition is still coal based until an alternative can be found.

While there has been some exploration of coal in the area, the coal resource is not fully understood from a commercial perspective. This is especially true for the coal on Hopi exclusive land (other Hopi coal is jointly owned with the Navajo Nation). Assistance in exploration and development of this coal could be helpful to the Hopi Tribe.

As mentioned, when in 1999 it was agreed to install FGD equipment at the Mohave power plant, no one expected this to result in the shutdown of Mohave. Further, in what has been one of the ironies of the current problem facing the Hopi Tribe, the economic attractiveness of coal has never been better. The principal competition for coal is natural gas. Over the last five years, most new power plants in the U.S. and in the Western power grid have been natural gas-fueled power plants. However, ever since these plants have started coming on-line, natural gas prices have been extremely high making coal generation from existing coal plants extremely attractive. Extremely high natural gas prices have also stimulated interest in new coal power plants. These new plants would meet very stringent air pollution control requirements.

#### **Current Natural Gas Prices Are High – Henry Hub Market**

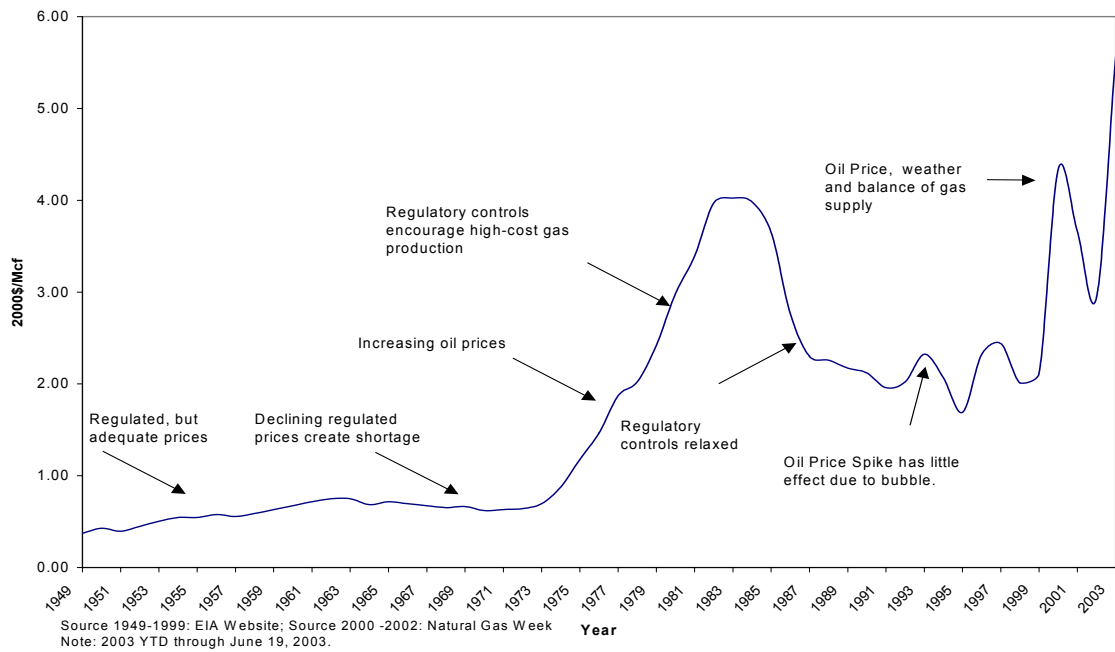
<b>Year</b>	<b>Natural Gas Henry Hub (Nominal\$/MMBtu)</b>
2004 YTD <sup>1</sup>	5.61
2003	5.48
2002	3.05
2001	3.75
2000	4.34
Average 1990 – 1999	2.04

<sup>1</sup>Through March.

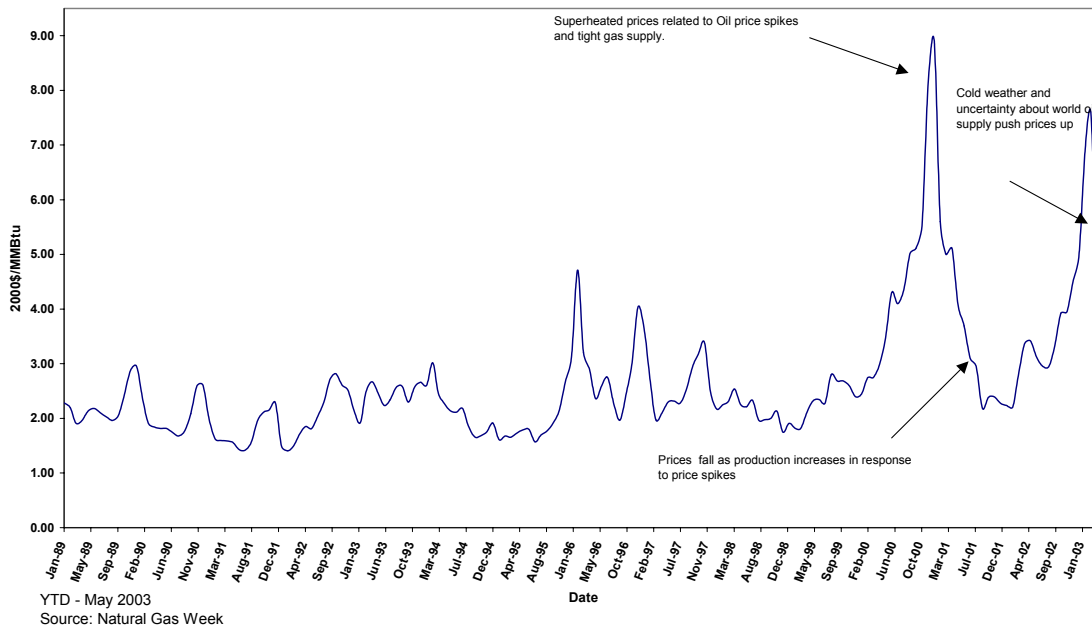
Source: Natural Gas Week

If new coal plants appear attractive, existing ones would be even more attractive due to their low capital investment requirements. The Mohave plant is economic even with the retrofit installation of environmental controls if water could be found to replace the N aquifer water. As shown below, the cost of Mohave including scrubbers is approximately \$28/MWh versus \$44/MWh to \$58/MWh for a new natural gas power plant depending on gas prices. A new coal power plant would cost \$45/MWh. Thus, the Mohave coal power plant would not be shut down were it not for the EPA environmental requirements. Hence, a delay in the January 1, 2006 deadline, combined with a solution to the water problem would be immediately met with continued operation and lower emissions if underlying economics were the only driving factor.

## Annual Historical Annual Natural Gas Wellhead Prices Show Record High Prices in Recent Years (1949 – 2003)

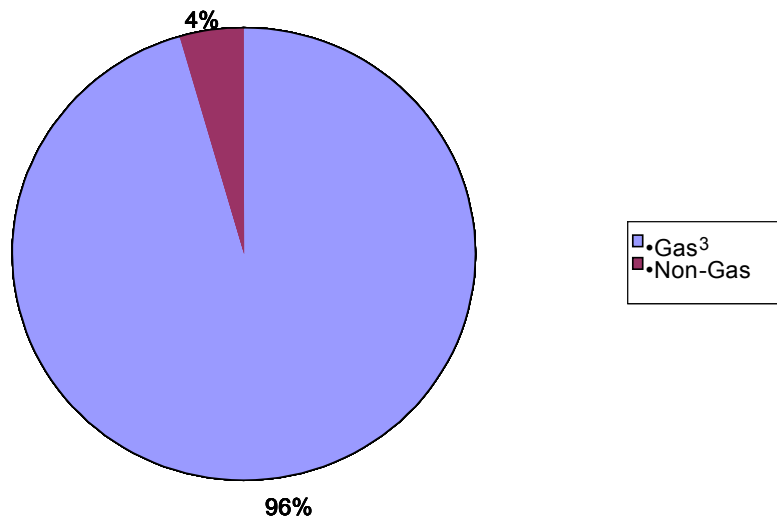


## Recent Monthly Historical Prices at Henry Hub Also Show Record



## High Gas Prices – 1989 - 2004

**Nearly Every New Power Plant Has Been Natural Gas-Fueled, U.S. Natural Gas Prices Have Been Rising**



Capacity Recently Operational and Under Construction<sup>2</sup> in the WECC (MW) 1999 -2004 = 33.2 GW

<sup>1</sup>ICF Estimate

<sup>2</sup>Since 1999.

<sup>3</sup>85 percent of natural gas capacity is combined cycle.

**Power Plant Economics – Upgrading Mohave is Very Competitive (2000\$)**

Item	Mohave With Upgrades – Total Investment Case Including New Scrubber	New Natural Gas Combined Cycle – Lower Gas Prices <sup>1, 2</sup>	New Natural Gas Combined Cycle Current Gas Prices <sup>1, 2</sup>	New Coal Power Plant <sup>1, 2</sup>
Capital Cost <sup>8</sup> (\$/kW)	651 <sup>3</sup>	746 <sup>6</sup>	746 <sup>6</sup>	1,400 <sup>6</sup>
Capacity Factor (%)	85	88	88	85
Levelized Capital Cost (\$/MWh) <sup>2</sup>	9.8	17	17	26
Non-Fuel O&M (\$/MWh)	6 <sup>4</sup>	4 <sup>5</sup>	4 <sup>5</sup>	6 <sup>4</sup>
Delivered Fuel Cost (\$/MWh)	12	23	37	13
Heat Rate (Btu/kWh) <sup>7</sup>	10,000	6,786	6,786	10,000
Total Levelized Cost (\$/MWh)	28	44	58	45

<sup>1</sup> Assuming capital charge rates of 11.7% for coal (based on a 40-yr life) and 12.8% for gas CC (based on a 30-yr life), and 11.2% for MGS upgrades.

<sup>2</sup> Units super controlled for SO<sub>2</sub> and NO<sub>x</sub> for simplicity. Includes transmission costs.

<sup>3</sup> Source: Southern California Edison; for example, in Base Case, Total Investment for Pollution Controls and Planned Retrofit = \$520 MM, plant capacity 1,580 MW; Lake Powell pipeline \$44 MM.

<sup>4</sup> Source: UDI Above National Average

<sup>5</sup> Levelized Henry Hub prices over a 20-year period discounted at a 6.2% real discount rate..

<sup>6</sup> AZ-NM, adjusted for altitude and temperature and local cost conditions.

<sup>7</sup> HHV, Full load. May have modestly understated Mohave heat rate but also modestly overstated new combined cycle heat rate.

<sup>8</sup> Includes interest during construction and interconnection costs.

In spite of the economic advantage of Mohave water issues, the financial problems facing the owners or regulatory problems may nonetheless mean the EPA's environmental controls cause the plant to retire. There are two coal-based alternatives that are considered here that would cushion the economic blow associated with the potential retirement of Mohave. These alternatives would restore Hopi's timeframe for a transition to a less coal dependent future. The first alternative involves finding new coal customers to replace the Mohave plant. The second involves a new Hopi power plant with EPA-approved emission controls.

These coal alternatives are compelling in light in part of the sheer magnitude of the resource. The Black Mesa, a geologic formation extending over large areas of both Navajo and Hopi lands, is rich in coal reserves. Black Mesa is a roughly circular, approximately 65-mile diameter area covering 3,300 square miles at elevations from 6,000 feet to 8,000 feet. Various mining reports have estimated that Black Mesa may contain as much as 21 billion tons of coal. By way of comparison, the Hopi Tribe currently has under contract with Peabody Coal Company only 380 million tons, enough to satisfy the projected needs of the Mohave and Navajo Power Plants from their 1970 start dates through their projected useful life of 2030.

The extent to which the Hopi Tribe's un-contracted for coal can be economically mined is strongly expected to be very large, though uncertainties exist as to the specific mine costs at different locations. A study of the location and economics of the Hopi coal reserves could be



undertaken in order to give the Tribe's leadership a better understanding of the range of local coal development opportunities.

## **Replacement Customers – Accessing Other Coal Power Plants**

Since commercial scale coal mining began at the Peabody mine in the early 1970s, there have essentially been only two customers for Hopi coal. These customers were the Mohave and Navajo coal plant. The Navajo coal power plant is even larger than the Mohave plant. Navajo is a 2,250 MW coal fired power plant located in Page, Arizona near Lake Powell and is operated by the Salt River Project. The coal is delivered from the Peabody Mine by a dedicated rail line, and hence, does not directly involve significant water issues. The Navajo coal plant already is using close to its maximum level of potential coal consumption. There are no other coal plants nearby that could be feasibly served via truck, conveyor or a short dedicated rail line.

The coal mine is not linked to any main stem U.S. rail lines. Hence, in order to find a replacement customer the mine would need to be linked via rail to the existing rail line. The mine is approximately 135 miles from the Santa Fe rail line linking Albuquerque, New Mexico and Los Angeles, California via Winslow and Flagstaff, Arizona.

## **New Coal Power Plant – Clean Coal**

In the event that the Mohave plant is retired, one option would be to build a new coal power plant on site (i.e., on the reservation) to use Hopi coal. This can only be contemplated if a new water source were obtained and if transmission lines were built to carry the electricity. If built, a plant could have much lower emissions of regulated pollutants than the Mohave plant. While new water supply is the critical for success, the amount of water required could be relatively small (e.g., one tenth or less the amount used at Mohave for a similar sized plant, or approximately 2,000 a.f. for a 1,200 MW plant) if advanced dry air cooling technology is used.

Such a hypothetical new coal power plant would comply with the new tighter EPA regulations and have several advantages:

- Jobs and economic improvement at Hopi
- Proximity to Phoenix and California
- High quality coal – surface mineable – proven nearby mine
- Use coal resource with nowhere else to go
- Replacement for loss of Mohave plant
- If not coal, how else can the Tribe develop?
- Siting/permitting/work force
- Accelerated tax depreciation for development on reservation
- Provide customers fuel diversification in light of rising natural gas prices
- Potential for additional government support

**Likely New Jobs from Hopi Reservation Coal Power Plant – 1,200 MW**

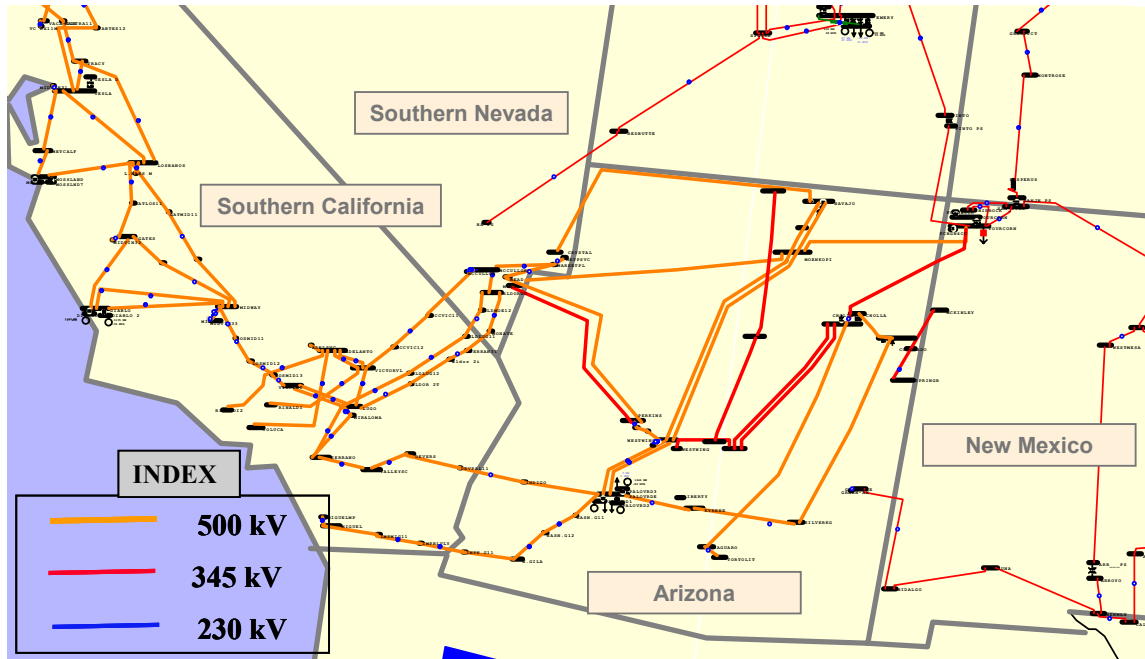
	<b>Low</b>	<b>Base</b>	<b>High</b>
Power Plant	100	200	250
Coal Mine	100	150	200
Total	200	350	450
Average Salary Plus Benefits (\$)	55,000	60,000	65,000
Multiplier	2	2.5	3.0
Total Annual (\$MM)	22	52.5	73
NPV (\$MM) <sup>1</sup>	241	575	802

<sup>1</sup>50 years, 9 percent.

Critical to any proposed large-scale commercial electric generating project on the Hopi Reservation is the ability to move electricity to market. At this time the major markets for any bulk electricity produced on the Reservation are Phoenix, Las Vegas, and California. Existing electrical transmission lines leading from the area of the Hopi Reservation to these markets are all over 25 years old and are owned by utilities. Any proposal to generate electricity for sale off the Reservation to regional markets will require a study of the transmission capacity available and negotiations for use of the facilities. Any use of existing transmission lines will require that an interconnection to the transmission lines be created at a substation. While there are electrical high voltage transmission lines on the Reservation, there are no existing high voltage substations at which the Tribe could access those lines. Capacity may be available at some times on some segments of regional transmission lines, during certain seasons. Information available in the energy industry indicates that there are no large, long term blocks of capacity available between the Hopi Reservation and any market that would support a commercial scale generation facility.

As shown below, there is a large existing transmission line from the Four Corners area to Moenkopi (a Hopi Village) and then to Las Vegas. Building transmission lines of this size generally costs more than \$1 million per mile and requires a 5-10 year planning horizon.

## Existing Arizona and Southern California High Voltage Transmission Grid



The Dine' Power Authority (DPA) of the Navajo Nation is developing a 500 kV transmission line from Four Corners to Marketplace on the California/Nevada border. It is acknowledged that the Navajo Transmission Project is not economically feasible unless new generation capacity is built in the Four Corners area. DPA is therefore actively attempting to develop a large-scale mine-mouth coal fired generation project using Navajo coal in the Four Corners Area. Coal for the project is proposed to be mined at the existing Navajo mine at Four Corners in New Mexico. They have signed an agreement with Steag Power, an independent power generation affiliate of Essen, a German based company. Steag is seeking bank financing to partly fund the development of the \$1.5 billion 1500 MW coal fired power plant. The proposed power plant is projected to have an annual water demand of 20,000 acre feet. DPA is also attempting to develop a 500 MW gas fired power plant in the area of Leupp, Arizona. This gas-fired power plant will use an undisclosed amount of water. The sources of the necessary water are not yet determined for either project; however use of C-Aquifer water has been discussed.

## 9. *Non-Coal Based Options to Transition the Hopi Economy*

### Oil and Natural Gas Development

One of the Hopi Tribe's most promising options for immediate, economically feasible, and lucrative energy development is the exploration and development of oil, conventional natural gas, or coal bed methane (an unconventional source of natural gas). Oil and natural gas

generation can have even lower emissions than coal. There is currently a moratorium, passed by the Hopi Tribal Council, on third party oil and gas exploration or drilling within the Hopi Reservation. Documents now in the public record from early drilling efforts indicate that oil, gas and coal bed methane resources exist on the Hopi Reservation. To date, only six exploratory hydrocarbon wells have been drilled on the entire Hopi Reservation.

As part of a USGS survey, published in 2000 and titled “Geologic Assessment of Coal in the Colorado Plateau: Arizona, Colorado, New Mexico, and Utah”, six wells were drilled to test for coal bed methane. These wells were drilled on Navajo Reservation lands at the very edge of Black Mesa. While the report does not describe any conclusions regarding the likely presence of coal bed methane, the report does state, “Due to depth of burial and the rarity of thick coal beds in the coal bearing strata, only a small portion of Black Mesa coal can be exploited through mining techniques, but the coal-bed methane that may be contained within more deeply buried coal could be produced by standard well-drilling techniques. If present, and if exploration work is allowed, such production might provide a valuable source of energy for local use, and possibly for commercial production.”

In addition, a wholesale natural gas pipeline crosses a corner of the Hopi Reservation and opportunities may exist for oil and gas development on the reservation, making it possible for the siting of a natural gas generation facility. In light of the high gas prices and excess gas generation capacity and transmission problems, a gas power plant is not a priority. This is especially true since there is no clear Hopi competitive advantage here at this time.

## **Utility Scale Renewables**

The Hopi Tribe has substantial solar resources. The solar resource on the Hopi Reservation is considered to be “world class.” The enclosed map (see later) illustrates that the annual average solar resource for the Hopi reservation and most of Arizona is 6 to 7 kWh/m<sup>2</sup>/day, among the highest levels in the US and the world.

Unfortunately large utility scale, grid-connected solar power plants are highly uneconomic even compared to other renewables. Large commercial scale solar projects are relatively rare. The largest solar power plant in the world is in Germany<sup>1</sup>. The 5 MW facility with 33,500 photovoltaic modules covering 21.6 hectares or 53.38 acres was energized on September 8, 2004. The cost of the plant was \$22 million Euro or \$26.5 million US. There have been suggestions that the electricity produced at Mohave could be replaced by solar power. Mohave is a 1580 MW facility. Using the 5 MW facility as a guide, replacing Mohave would require 10,586,000 photovoltaic modules covering 16,868 acres at a cost of \$8,374,000,000. With a price tag of over 8 billion US dollars, financing would be extremely difficult, if not impossible to acquire and the market prices for electricity would be insufficient to provide a repayment of debt.

A new solar power plant is likely to be roughly five times as expensive as a new fossil power plant. An upgraded Mohave plant is one seventh the cost. Without large subsidies, no solar power plant would be viable and in any case new transmission would be very expensive.

<sup>1</sup> As reported by Xinhau News Agency of CEIS on September 9, 2004.

The most common grid-connected renewable power plant being built is wind. Even with a Federal subsidy, a wind power plant needs additional subsidy, e.g., a state renewables mandate. Hopi wind resources are under review; however initial studies do not show commercial levels of wind on the reservation. Information does show a moderate potential for wind generation on some of the Hopi owned ranches. Additional studies, the monitoring of potential wind sites, are being undertaken to more specifically determine the wind energy potential.

The National Renewable Energy Laboratory maintains the US Department of Energy's wind energy resource data base. NREL data and resource maps indicate that there are isolated pockets of land suitable for wind farm development in Arizona. NREL's maps, which are regarded as preliminary until empirical data is taken, indicate that the Hopi Reservation does not have a suitable wind resource for commercial development. An examination of historical wind resource data (at 10 meter elevation) for Winslow, Arizona also indicates that annual average wind speeds are relatively low (Class 1 to Class 2). Wind regimes of Class 4 or higher are typically required to support utility scale projects. Wind is very site specific and until actual data exists there is no assurance that commercial scale wind is available. Again, the report addresses this issue in some detail in the context of non-utility scale applications to help provide for Hopi domestic need.

Other concerns with solar and wind as commercial generation options include the intermittent nature of the resource. Obviously these generators work only when the wind blows or the sun shines. For solar, at least 50% of the time (at night) there is no generation. The amount of time a generator produces electricity is called its "capacity factor". It is also problematic that generation can not be controlled to happen when power is needed. The intermittent nature of these resources therefore makes them less valuable than traditional power. Generation in large quantities also impacts the transmission and utility systems, which must carry and dispatch the resources in conjunction with other resources to make sure loads have the right amount of power when they need it. These utility services can be expensive. Many areas of the country and many utility systems are not set up for large commercial intermittent generation. While the necessary products and services are under development and being used gradually in various places, they may add significant cost to commercial sized renewable energy resources.

## ***10. Non-Energy Options to Transition the Hopi Economy***

Many of these options are designed to take tribal challenges and turn them into economic development engines. Consideration can also be given to the opportunity to participate in federal Small Business Administration programs, such as 8(A) programs, HUB Zone qualification, and other Small or Disadvantaged Business programs. These programs assist businesses with start-up expertise, and qualify them for priorities in obtaining lucrative federal and sometimes state and local government contracts. Hopi members and the Tribe itself are encouraged to consider employment practices that meet tribal needs, not just employment practices that are customary, such as implementation of job sharing practices. For example, where a good paying job may be created, it may be possible to hire two part time employees rather than one full time employee to maximize employment levels and to allow tribal members with traditional and cultural responsibilities time to fulfill those requirements.

# **I. HOPI ECONOMY, LAND AND INFRASTRUCTURE**

## **1. *Hopi Economy*<sup>2</sup>**

According to Tribal enrollment data, the Hopi Tribe has a total membership of approximately 12,000 people. The 2000 U.S. Census reports that approximately 7,000 Hopi people live on the Hopi Reservation. The Hopi have lived in their villages on Black Mesa since prehistoric times. One of the 12 Hopi villages, Oraibi, is referred to by anthropologists as the oldest continuously inhabited settlement in North America, dating to at least 1100 A.D. The Hopi Reservation is entirely surrounded by the larger Navajo Nation and this fact has resulted in circumstances in which Hopi development is somewhat limited due to restricted access to the economic opportunities available in the surrounding communities as well as in the state and national communities.

The pre-European (the time prior to the Spaniards and later the Americans) economy of the Hopi was a subsistence economy—one that provides the very basic means of human survival through the provision of food, clothing and shelter. This fundamental economy was at its heart an agricultural economy that depended on corn, beans and squash as its core products. These basic foodstuffs were supplemented by hunting local game and gathering local plant materials. The production of these basic life-sustaining products constituted the Hopi subsistence economy. The coming of the Europeans introduced sheep, cattle, horses, chickens and goats into the economic mix of the Hopi economy.<sup>3</sup> Many Hopi still live as their ancestors did, planting and harvesting small crops of corn, beans, and squash, and participating in ancient rituals and ceremonies intended to bring peace and prosperity. Much of the reservation is now used for cattle grazing, producing additional supplemental food and income for Hopi family subsistence. Most Hopi have however moved beyond mere subsistence living to a broader participation in the larger cash based economy. It is the rule and not the exception to see Hopi's employed in governmental and private sector jobs that pay a wage/salary in exchange for the service provided. These wages are then traded for the full range of goods and services that one finds in the general American economy. Most Hopi's travel in motor vehicles and many have satellite television reception in their homes. Much of the food consumed by the average Hopi is produced off-reservation and purchased in off-reservation supermarkets. Unfortunately, Hopi participation in the benefits of the larger economy is incomplete and disparate.

On-reservation Indians remain the poorest ethnic group in the nation and suffer from some of the most acute poverty-related socio-economic maladies. Members of the Hopi Tribe have endured a quality of life far lower than that of non-Indian citizens of the United States. Employment, income, and poverty statistics demonstrate that the Hopi are experiencing living conditions considerably worse than the rest of the Nation.

<sup>2</sup> Most of the information in this sub-section is taken from the Testimony of Chairman Wayne Taylor in proceedings before the California Public Utilities Commission regarding Mohave Generating Station, June, 2003.

<sup>3</sup> See for example, Beaglehole, Earnest. 1937 *Notes on Hopi Economic Life*, Yale University Publications in Anthropology 15, New Haven Connecticut.

In 1995, the unemployment rates for the Hopi were approximately 8 to 10 times those of the U.S. and Arizona. While the unemployment rate in the U.S. and Arizona was 5.1 and 5.6 percent, respectively, Hopi unemployment was over 50 percent. More recent statistics show that of the number of Hopis available for work on the Hopi reservation, 64 percent are unemployed. Of those who are employed, statistics show that approximately 35 percent earn wages below national poverty guidelines.

The median income earned by employed Hopi people is less than one-half to nearly one-third that earned by their non-Indian counterparts. Median household income on the Hopi Reservation, according to the 2000 U.S. Census, was just over \$21,000 per year. According to a newspaper article published in the Arizona Daily Sun on September 25, 2002, the median family income in northern Arizona was \$46,723. This same article reported that Hopi average family income as only \$17,520.

But these figures do not convey fully the dire living conditions found in Hopi reservation communities. According to the 2000 U.S. Census, more than 44 percent of Hopi families with children under 18 years of age subsisted on incomes that were below the national poverty level. The figure rises to more than 50 percent living below the poverty level for families with children younger than 5 years old. A 1997 report by the U.S. Department of Health and Human Services (HHS) found that over 63 percent of Hopi reservation households earned an income that was below the HHS poverty level. Hopi household infrastructure is also lacking. There is a stark disparity in the basic physical comforts nearly all Americans take for granted, such as a complete kitchen, flush toilets, running water and a telephone. According to the U.S. Census, almost 40 percent of Hopi homes lack complete plumbing facilities, and more than 35 percent lack complete kitchen facilities. In contrast, in the United States generally, only 1.2 percent of homes lack complete plumbing facilities and only 1.3 percent lack complete kitchen facilities. In the State of Arizona, less than 2 percent of all homes lack complete plumbing and kitchen facilities. Moreover, according to the Tribal Census Project in 1997, approximately 78 percent of owner-occupied housing units within the categories of "low income" and "very low income" have serious structural deficiencies. Part of the problem is a general lack of adequate water supply. In contrast to non-Indian communities bordering the reservation which use an average of 160 gallons of water per capita per day (gpcpd) for all municipal/industrial uses, (this figure can be as high as 1,000 gpcpd in some urban areas of Phoenix) the Hopi typically use 15-35 gpcpd. Many Hopi must carry their domestic water supplies home from community wells.

A 1999 study by Harvard University's Kennedy School of Government that it will be nearly impossible for the Hopi to develop a sustainable economy that will lift the local living standard without significant improvement in the availability of sufficient quantities of quality water for home uses and business development. Even with improved water supplies, perhaps the most significant challenge will be to diversify the Hopi economy away from its almost exclusive reliance on the Tribe's coal resource. Like many local economies, on and off reservations, the Hopi economy has far too many of its revenue eggs in one basket.

The Hopi economy is largely a governmental economy with very little private sector development. The major employers on the Hopi reservation are the Hopi Tribe, employing about

500 people, and the United States government, employing an additional 400 in local federal administrative offices, the local HIS hospital and in federally sponsored elementary and secondary schools. Approximately 44 percent of employed Hopi are employed in this public sector governmental economy. There is no industrial development on the reservation, except the mining operation of Peabody, which employs only a handful of Hopi people, with most of the approximately 600 mining jobs going to members of the Navajo tribe. The limited private sector economy consists of small retail outlets, a few service jobs and a cottage production of arts and crafts.

The potential for developing additional industrial and service jobs, and thus expanding the economy, is hampered by a serious lack of basic infrastructure—water, sewer, roads, electric distribution—and the isolated nature of the Hopi Reservation. The Hopi Communities are located approximately 85 miles from the nearest non-Indian economic centers at Flagstaff, Winslow and Holbrook. These non-Indian communities also mark the location of the nearest major transportation corridors, Interstate 40 and the Burlington-Santa Fe railroad which parallels the interstate. There are no major highways traversing the Hopi reservation, only a secondary state route running east and west to connect arrears of the Navajo Nation. The Hopi reservation's isolation is made worse by the fact that it is completely surrounded by the expansive Navajo reservation. This geographic fact, created largely by the actions and inactions of the United States government, creates numerous issues concerning rights of way and resource development that contribute to economic stagnation on the Hopi reservation.

In addition to the difficult status of the economy on the Hopi Reservation is the potential closure of the Mohave Generating plant on January 1, 2006. The plant uses Hopi coal and water, and contributes significantly to the tribal economy through coal royalties and water revenues. A later discussion of the Mohave issues follows in a later section.

## **2. Hopi Land and Infrastructure**

### **Hopi History**

According to Hopi Tradition, this is the Fourth World of the Hopi. Upon entering this world, the Hopi made covenants with *Maasau*, the guardian of the fourth world. These sacred agreements mark off the boundaries of the Hopi divine plan of life, a living tradition passed on from each generation of the Hopi to the Next. As part of these covenants, the Hopi accepted *Tutavo*--stewardship responsibilities, regarding how the Hopi are to utilize natural resources and act to preserve environmental health. For many hundreds of years these beliefs and practices have guided Hopi life and are now incorporated in tribal natural resource management practices.

A rapidly changing modern world challenges the Hopi Tribe to balance its cultural and spiritual beliefs with the needs of its people who now walk in two worlds—the ancient Hopi tradition and the modern western world of technology. A modern tribal economy that has moved beyond subsistence lifestyles; a growing population and its impact on land and infrastructure; a changing



natural environment; and changes in the energy industry,<sup>4</sup> are all factors that will require careful leadership in setting a course that will seek out the good things in life and at the same time preserve the value of the Hopi way of life.

When Europeans arrived in the area in the mid 1600's they recorded that the Hopi people lived in the mesa-top villages that are still home to the Hopi within the current Hopi Reservation. By the time the Americans took control of the area in the mid 1800's, the Hopi had begun to incorporate non-Hopi innovations and practices into their culture and economy. Already wealthy in agricultural products—principally corn beans and squash-- the Hopi adopted animal husbandry and silver smithing as supplements to their largely agrarian economy. During the late 1800's the Hopi found themselves in growing conflict with their Indian neighbors. Their fields and communities were often raided by thieving Navajos.

Through a long series of federal actions and inactions, the United States government created, and then changed Hopi Reservation boundaries. Navajo people, who are, culturally nomadic shepherds/hunter/gatherers living in small family groups began to squat on the lands previously reserved for the Hopi. The Hopi lived almost exclusively in fixed villages. As a result of this Navajo encroachment, long-standing legal actions were necessary to sort out tribal land boundaries and ownerships and the mineral rights under these lands. Most of the land rights issues have been now resolved as are described in this report.

## **Regional Context**

Modern Hopi Lands consist of a variety of property interests scattered throughout northeastern Arizona. The interests include tribal trust land, most of it within the Hopi reservation established in 1882 (77.3% of the land base) and five recently purchased ranches and associated United States Department of Agriculture Forest Service grazing permits (21.9% of the land base) currently held in fee status but slated to go into trust status in 2004. All of these lands are generally isolated and remote from large population centers.

In addition to its reservation trust lands, the tribe also owns a 200 acre parcel of trust land adjacent to the City of Winslow. Within that property a 25-acre subdivision contains a low income rental project with 33 housing units for tribal families. A manufacturing plant was built on a 15 acre subdivision of the tract in 1968 and operated for more than 20 years. It is now vacant pending redevelopment. The property remains available for additional subdivision.

The Hopi Reservation lands are bordered on all sides by the Navajo Reservation. The Grand Canyon National Park is located approximately 80 miles to the west of the Hopi Reservation.

The city of Flagstaff, Arizona is a two-hour drive to the southwest, and Winslow, Arizona is approximately 90 minutes due south.

<sup>4</sup> Many energy industry changes are directly related to matters of air quality and the regulatory boundaries within which industry must act in order to protect air quality.



## Present Hopi Land Base

The Hopi Reservation is located in eastern Coconino and northern Navajo Counties, Arizona. It encompasses 2,439 square miles, or 1,561,054 acres. These tribal trust lands, or Reservation lands, are administered in two different ways. First, there are lands administered by the various villages. They include “District Six”, the 650 013 acre area generally surrounding the existing villages, and the Moenkopi Administrative Area, west of the 1882 reservation boundary. Most of the existing infrastructure is located in these areas. The Hopi Constitution, Article III, Sections 1 and 2 authorizes the villages and clans to administer the use of farm lands; however, the villages assert almost complete discretion to decide all types of land use issues within these areas.

The second category of tribal trust lands includes lands administered by the tribal government. These lands include the Hopi Partitioned Lands which are the reservation lands not within District Six, the Moenkopi District which is an island of reservation to the West of the larger Reservation, and the Hopi Winslow trust property, a residential area and vacant industrial park in the town of Winslow.

Beginning in 1997, the Hopi Tribe has pursued a program of reclaiming ownership of some of its aboriginal land base. Under Federal law—the Navajo-Hopi Land Dispute Settlement Act of 1996—the Hopi tribe is authorized to acquire and place into trust status up to 500,000 acres of land in northern Arizona. As part of this program, the Tribe has acquired 5 large ranches, each with accompanying U.S. Forest Service livestock grazing permits, all located south of the main Reservation in the vicinity of Winslow. Formerly known as the Drye Ranch, the Hart Ranch, the Clear Creek Ranch, the Aja Ranch, and the 26-Bar Ranch, these properties are now known as the Hopi Three Canyon Ranch. These lands continue to be managed as a working cattle operation. The Hart Ranch may be targeted for closer review as it is closer to major infrastructure than the other ranches. Ranch headquarters is a few miles south of Interstate 40, at the Twin Arrows Exit. A 250 kV transmission line owned by APS crosses the region from the north to the south, approximately 5 miles west of the ranch boundary. A 250 kV substation is located on that line, near I-40. Additionally, near the Sunrise (Leupp) Exit of I-40, about 8 miles from the ranch, there is an NTUA substation and what appears to be a cellular tower.

The Tribe also owns various investment properties in local communities off the Reservation. These properties are managed as investments and were not considered as subjects of this report.

A third category of rights plays a significant role in the Hopi economy.. These are the mineral rights shared with the Navajo Nation in an area of the Hopi reservation referred to in historic case law as the “Joint Use Area”, but now referred to as the “former Joint Use Area,” since all surface ownership rights within that area have now been judicially partitioned among the Hopi and Navajo. The federal courts created the Joint Use Area (JUA) as part of a decades-long legal dispute regarding the Hopi 1882 Reservation Boundary.. Finding that the surface of the lands within the reservation could be more easily divided between competing Hopi and Navajo claimants than could the sub-surface minerals rights, the court determined that all such rights would be held jointly by the Hopi and Navajo and all revenues derived therefrom would be shared on a 50/50 basis. Thus while the Hopi own all lands within the 1882 reservation partitioned to the Tribe by the court, the Hopi Partitioned lands (HPL) and the Navajo own all lands partitioned to that tribe (NPL), the two tribes continue to be linked in an important economic relationship given their continuing joint ownership interest in the subsurface rights of the entire former Joint Use Area.

## **Infrastructure Summary**

The *Hopit Tunatya’at 2000*, The *Hopi Strategic Land Use and Development Plan*, published in 2000 by The Hopi Tribe, and the *Hopit Tunatya’at Hopi Comprehensive Development Plan of 1988* are important planning documents for the Tribe and both discuss the nature and extent of public infrastructure on the Hopi Reservation. Information from these sources is supplemented with additional details that are now available.

Reservation infrastructure—water, sewer, electricity, telephone and roads--exists mainly along Arizona Highway 264, serving most of the villages, and is essentially non-existent elsewhere on the Reservation. Outside of the villages there is little or no infrastructure development except two two-lane paved roads—Indian Route 2 and state highway 264--connecting the villages to neighboring communities, numerous dirt roads and trails, and range improvements for livestock. Three of the twelve villages, Lower Moenkopi, Old Oraibi and Walpi have chosen not to allow utilities—water, sewer, electricity and phones within their boundaries. The other villages, except the Yu Weh Loo Pahki community, which has no waste water system, have community water and wastewater systems. Many of these systems are old, undersized, inefficient and in frequent need of repair.

Infrastructure services to the majority of the villages include electrical, and telephone services. Propane is delivered to villages by three privately owned suppliers. There is no natural gas service to the Reservation; however some discussion is underway regarding the possibility of natural gas service in the Moenkopi area.

The electrical system serving the Reservation is owned by Arizona Public Service Company, and is now over 40 years old. Electrical service is a radial feed, meaning that the power serving the Reservation comes from one source and extends across the service territory without a back-up interconnection. The distribution system has numerous safety and reliability problems, and is not maintained subject to any planned infrastructure replacement or upgrade program. The Navajo Tribal Utility Authority provides electrical service to the village of Moenkopi .

There is very limited capacity on the high voltage transmission system in the area—the 500 kv Eldorado line—for exporting the output of any new commercial electrical projects. However, the Dine' Power Authority of the Navajo Nation is attempting to develop a new high-voltage power line from the Four Corners area to Marketplace Substation, an electrical marketing hub on the California-Nevada border. This line, if built, may provide an opportunity for Hopi generation, however, potential new generation using Navajo coal may fully utilize the new capacity on that line prohibiting its use by the Hopi Tribe.

Telephone services are provided by CenturyTel of Southwest Inc. Navajo Communications provides conventional telephone services in the Moenkopi/Tuba City area. CellularONE provides wireless telephone service to a part of the Reservation, with at least one cell tower located on Antelope Mesa. Internet access is available over conventional telephone lines, at the Hopi Jr./Sr. High School through Northern Arizona University's satellite linked classroom facility, and through a U.S. Department of Commerce funded project at First Mesa.

In late 2000, The Hopi Foundation launched the Hopi FM radio station, KUYI. The broadcast station is sited at the Bureau of Indian Affairs Police/Hopi Courts complex near First Mesa and a 69,000 watt tower is sited on Antelope Mesa.

The *Hopit Tunatya'at 2000*, the Hopi Strategic Land Use and Development Plan, identifies an immediate need for 765 new houses to alleviate structural deficiencies in existing homes and overcrowding. There is an additional need for 90 new houses each year for the next twenty years to keep pace with projected population growth. That is an additional projected 1800 new homes. In addition to these homes, growth in governmental and commercial interests will require additional infrastructure. The Plan also documents the significant barriers to public investment and development of infrastructure within District Six, the area surrounding the existing villages. This area is subject to a complex land tenure system dominated by village and clan interests and which reserves the land for use almost exclusively by their own present and future members. In order to promote development outside of these village restricted areas, the Plan therefore calls for five planned Community Development Districts, four on the main Reservation, and one in the Moenkopi District. All of these planned developments would be located on Hopi Partitioned Lands, lands under the exclusive control of the Tribal government and where streamlined development policy may occur under authority exercised by the Tribe. Two of the projects are tribal initiatives, two are village initiatives, and one stems from a pre-existing concentrated settlement of people in an area. These districts all will require planning and infrastructure development.

There is a need to upgrade the existing infrastructures and to expand existing infrastructure to meet population growth requirements and economic development opportunities. There are many ways to meet these needs. The Vision of Hopi established in the 2000 Plan states:

*Hopi Should be a place where: Hopi culture and religion are strong; Sacred sites are protected; Culturally and environmentally sensitive development occurs; The land is looked after; There are jobs and businesses; Quality infrastructure serves*

*everyone; Everyone has their own quality house; Public service facilities serve all needs.*

Under this statement of values, development of infrastructure should be consistent with Hopi culture and religion, which requires sustainable protection of land and resources. Development of infrastructure should also reasonably meet the employment, housing, and public service needs of Hopi people.

## **Roads**

There are no interstate highways on the Reservation. The major interstate highways in the region are I-40 running east-west about 60 miles south of the Reservation boundary, and I-17 running north-south about 50 miles to the west of the Reservation boundary. No direct paved route connects the Hopi villages to these interstate highways.

The major paved two-lane road serving the Reservation is Arizona Highway 264, which traverses the center of the Reservation from East to West and connects all of the villages to each other. Three paved two lane roads connect to Highway 264 from the south, Arizona Highway 77 on the eastern edge of the Reservation, Arizona Highway 87 connecting between First and Second Mesas, and Bureau of Indian Affairs Highway 2 coming from Leupp and connecting near Kykotsmovi.

No paved roads connect to Highway 264 from the north. There is therefore no direct access from the villages to the coal mines. The Hopit Tunatya'at 2000, The Hopi Strategic Land Use and Development Plan, describes construction and completion of the Turquoise Trail (Bureau of Indian Affairs Highway 4) as an important link between Highway 264 and US 160 just north and west of the Peabody Coal mine lease. At present, one half of the roadway is constructed. It contains a dedicated utility services corridor within the right-of-way. It connects Highway 264 to one of the new community sites identified in the Hopit Tunatya'at, and to the existing tribal landfill. Thirty-nine miles remains to be constructed at an estimated cost of \$50 million.

The 2000 census indicates that a significantly higher percentage of Hopi housing units do not have a vehicle compared to the US population and other Arizona Tribes. Almost 25% of families do not have vehicles. 40% have one vehicle.

## **Telecommunications Facilities Serving the Reservation**

According to the 2000 census, 68% of Hopi homes have telephone service. In contrast, in 1980, the census indicated that 32% of Hopi homes had service. Only 2% of homes in the US generally were without telephone service in the 2000 census. It is unknown how many Hopi homes have internet access. There is no advanced technology service such as digital cable or fiber optic service on the Reservation.

The primary provider of telecommunications service is CenturyTel of Southwest, Inc., a subsidiary of CenturyTel, Inc. of Monroe, Louisiana. Previously, service was provided by Universal Telephone Company. They provide local land line and residential and commercial

telephone hookups. Land lines exist along the Highway 264 corridor into the villages that accept utility services. Microwave technology is used to provide service from a main tower on Second Mesa to transmit signals to and from the Reservation. Navajo Communications provides conventional telephone services in the Moenkopi/Tuba City area.

CellularONE of Show Low, Arizona, is now providing telephone service on the main Reservation. Cell towers provide local service from Antelope Mesa. Northern Arizona University operates a satellite linked classroom facility and internet access at the Hopi Jr./Sr. High School. A United States Department of Commerce Economic Development Administration funded project will provide an internet access point for the Reservation at First Mesa.

The Hopi Tunatya'at 2000 documents the need for improved telecommunications infrastructure and a comprehensive telecommunications plan. It states that the development of a tribal telecommunications system in the near term may be a driver that will promote economic development, the creation of jobs and incomes and a means to achieve *The Hopi Vision*. The Hopi Office of Community Planning is pursuing various telecommunications options that should be considered in conjunction with any activity under this Partnership.

## **Electrical Facilities Serving the Reservation**

The electrical system serving the Reservation is largely owned by Arizona Public Service Company (APS). The APS electrical service to the main part of the Reservation is a radial feed, meaning that the power serving the Reservation is transmitted or wheeled from one source, the Cholla power plant, to one substation on Hopi lands, then one main feeder wire extends from that substation across the entire Hopi service territory without a back-up interconnection. Other wires feed off this main feeder wire to provide service to the villages. The distribution system has numerous safety and reliability problems, and is not maintained subject to any planned infrastructure replacement or upgrade program.

In addition, APS owns distribution facilities on the Hopi Reservation serving the Village of Moenkopi from its 69 kV system running between Page and Tuba City, from the Tuba City Substation, which lies on Navajo lands. The Navajo Tribal Utility Authority (NTUA) provides electrical service to the Moenkopi area and to several Hopi families living south of Jeddito. The NTUA service territory completely surrounds the Hopi Reservation. NTUA maintains service lines and facilities up to the edge of the Hopi Reservation in many places. Because standard utility practices call for electrical facilities to be interconnected to neighboring facilities for increased reliability and for coordination, tribal cooperation with NTUA on utility related matters is essential for modern electrical services. At this time there is no interconnection between NTUA and the APS system serving the Reservation. NTUA wishes to purchase the APS system on Navajo lands, including those serving the Village of Moenkopi. APS is willing to sell the system to NTUA, with approval from the Village of Moenkopi that service by NTUA is acceptable.

The main APS system on the Reservation can be described in three parts: 1) the transmission line bringing bulk power to the Reservation, 2) the substation which steps this power down into lower

voltages for local use, and 3) the distribution system that brings the power from the substation to customers.

The transmission line is a 69 kV transmission line coming from the Cholla power plant at Joseph City, across the NTUA service territory, and crossing the southern part of the Hopi Reservation to the substation at Keams Canyon. It is known as the Cholla-Keams Canyon 69kV line. According to data supplied by APS, the duration of outages on this line is lower than the APS company average; the number of forced outages per hundred-mile year is lower than the APS company average; and the frequency of outages is higher than the APS company average. It appears that the reliability of this line is comparable to two other transmission lines operated under similar conditions by APS. In 2000 and 2001, APS conducted a maintenance program on the 69 kV line that involved inspecting every pole and component on the line. APS reports that any problems found were corrected.

This transmission line is regulated by the Federal Energy Regulatory Commission, and open access to the use of this power line is guaranteed, as long as there is capacity on the line. Therefore, The Hopi Tribe could in the future seek to transport power out of the area, or bring additional power in to the area on this line, subject to its ability to carry more power. Because it is a direct radial line, it is likely there is capacity on the line for other future uses.

There is one substation at Keams Canyon that serves all Hopi Reservation customers, except those in the Village of Moenkopi and the Moenkopi District. This substation also has a second feeder line that takes power out and serves load on the Navajo Reservation. Data provided by APS shows that the peak load of the substation for 2001 was 4622 KVA. The substation transformer is rated at 9380 KVA with fans. The substation transformer at the fan rating could therefore accommodate a doubling of substation load. Outage data on the substation was not available from APS. Information available from APS regarding the substation follows:

#### Transformer:

- MVA rating of Transformer bank is 7.5/9.38 MVA
- Transformer age is 25 years old.
- First energized in 1978 24 years ago.
- What type of cooling Oil & Air/ Forced Air ( Fans)
- Transformer installed at Keams Canyon in 1984
- Transformer Primary and secondary voltages 69KV/ 21.6 KV
- Only Peak load information is available on Transformer from 1989 to 2001.
- Oil containment system is in good shape.

#### Substation Circuit Breakers:

- There is one circuit breaker that feeds the radial system on Hopi.
- This OCR circuit breaker is oil filled.
- This OCR was manufactured by Westinghouse and installed at Keams Canyon in 1961 and there are two of them, one for Hopi feeder and the other for Keams Canyon feeder.

- Each Feeder has 3 over current relays and one ground over current and a PR re-closing relay for protection of the line.
- Control power for the OCR is station service AC power.
- There are no meters at the substation to monitor current voltage and load.

APS has indicated that telephone lines were to be extended to the Keams Canyon Substation in July of 2002 to allow for remote control of the substation.

The distribution system is made up of a main feeder that extends from the substation across the reservation along Highway 264, and wires extending from that main feeder to the villages and to some individual loads, then networking out within each village to serve the loads there. Smaller transformers are placed throughout the system to step power down to usable voltage levels from the main feeder voltage of 21 kV. Other customary electrical equipment includes metering devices at each load, and breakers and fuses that interrupt the flow of power when electrical incidents occur. The Hopi Health Care Center, which has a clear need for reliable power is served by a set of capacitors and voltage regulators. The existing transformer was upgraded from 750 kVA to 1500 kVA. They currently have a diesel powered emergency back-up system. Most of the distribution lines within the villages are 1.2 to 2.4 kV.

Because the distribution is a radial feed, an outage or interruption of service anywhere along the main feeder may trip the entire feeder line and stop power deliveries to the whole reservation. An outage or interruption initiating in one of the villages may or may not affect power flow outside of that village area.

Reliability statistics were provided by APS for 1998 through 2001. APS has acknowledged that the duration of outages on the distribution feeder is longer than the APS Company average. When compared to other rural distribution systems, the frequency and duration of outages was also somewhat higher. APS is installing a remote control device for the substation breaker and relocating and adding remote control devices to other breakers, and is installing additional fuses.

APS has also stated that they are in the process of a complete inventory of the electrical system on the Hopi Reservation. That inventory has not been shared with the Tribe.

Distribution system maintenance records, which have not been provided to the Tribe, would indicate likely system replacement requirements. While systems of this age are not uncommon in rural areas, enhanced routine maintenance, including power pole replacements and equipment upgrades and replacements are needed to assure long-term reliability. APS has indicated it has no routine pole replacement program and no below ground testing program for maintenance of distribution poles for pole replacements. Maintenance is generally done in response to outages and other emergencies.

A visual inspection of the APS distribution system noted that some portions of the system appear very old and some safety issues may exist with some of the drop-lines from feeder poles into homes, which appear quite close to the ground. Additionally the utility feeder lines to the historic home sites in the Second Mesa village are visually very unsightly and potentially out of compliance with industry standards for density and inter-pole line connections. Utility poles



near Keams Canyon were also noted to include some very crooked and bent poles that are usually not acceptable within electric utility quality standards. These observations were noted to support verbal assessments by NTUA of the APS system. Some upgrades would be necessary to bring the APS distribution system into compliance with NTUA's standards. Information available from APS regarding the distribution facilities follows:

**Distribution Lines:**

- There are 50-200 miles of distribution line on Hopi.
- The customer information and fault history was not provided.
- All the customer related information was not provided by APS.
- Maintenance and outage history was not provided.
- Cost to maintain the system was not provided and future projected costs were not provided.

It is estimated that the total peak load on the Hopi Reservation is 5 MW. According to the 1980 census, 53% of Hopi homes had electricity. A U.S. Department of Energy report entitled "Energy Consumption and Renewable Energy Development Potential on Indian Lands" published in April of 2000 states that 29% of Hopi households are without electricity.

**Load Data:**

- Load data on Hopi businesses, institutional buildings, and households was not provided by APS.
- Total number of customers was not provided by APS.

The cost of new service depends on the customer's location and power requirements. All extensions are considered on a case-by-case basis, with APS preparing a cost estimate and both an internal tribal process and often a village or clan process for approval of the new infrastructure and for disturbance of the area. Service extension costs average around \$15,000 per mile in easy topography. In rough topography, service extension costs can increase to \$35,000 per mile, using 1988 numbers.

The APS Reliability group has inspected the distribution lines that feed the area and have identified several strategies that will reduce the duration of outages and reduce the number of customers affected during an outage. APS is currently in the process of implementing the reliability group's recommendations.

7APS has indicated its willingness to consider the sale of these facilities to the Hopi Tribe. NTUA has also indicated an interest in purchasing portions of this APS system. The APS 69 kV Cholla-Keams Canyon system currently feeds the Navajo communities of Nahahtee, Tesihin, and Jeddito, as well as the Hopi villages. The Hopi Tribe is in the process of

negotiating studies and information sharing with APS, and with NTUA regarding the electrical system on the Hopi Reservation.

## **Regional High Voltage Transmission Which Could Support Hopi Generation Projects**

Critical to any large scale commercial electrical energy production on the Hopi Reservation is the ability to move electricity to market. At this time the major markets for electricity produced on the Reservation are Phoenix, Las Vegas, and California. Existing electrical transmission lines leading from the area of the Hopi Reservation to these markets are all over 25 years old and are utilized by the established utility interests. General studies of the capacity available on these transmission lines show that in some seasons capacity exists to take power from the area around the Reservation to Phoenix, but not to Las Vegas or California. In other seasons capacity is limited. Any proposal to generate electricity for sale off the Reservation to regional markets will require a study of the transmission capacity available and negotiations for use of the facilities. Regulatory changes to the way the transmission lines are used will be a consideration for use of existing transmission capacity.

APS owns a major 500 kV electrical transmission line, the El Dorado line, running from Four Corners Power Plant across the central portion of the Hopi Reservation to Arizona and California markets. High-voltage lines are not designed to provide local service, and any suggestion to do so would be cost prohibitive. A gas pipeline owned by Questar Pipeline passes over a corner of the Reservation near Tuba City. A review of the extent of the APS and Questar land rights is needed.

Any use of existing transmission lines will require that an interconnection to the transmission lines be created at a substation. While there are electrical high voltage transmission lines on the Reservation, there are no existing high voltage substations at which the Tribe could access those lines.

Important in this discussion is a review of the Navajo Transmission Project. The Navajo Nation's enterprise Dine' Power Authority (DPA) has been developing a 500 kV alternating current transmission line that will add 1200 to 1800 MW of new transmission capacity from the Four Corners Area to Marketplace, a regional electrical purchasing hub on the California-Nevada border.

An Environmental Impact Study was completed in 1996 with a Record of Decision by Western Area Power Administration in October 1997. An Arizona state Power Plant and Transmission Line Siting Committee was signed October 27, 2000 regarding siting in the State of Arizona. The Hopi Tribe provided cultural resources reviews for the project.

The transmission line is approximately 462 miles long and does not cross the Hopi Reservation, but instead is slated to cross the Navajo owned lands directly north of the Hopi Reservation. The Navajo Nation will provide right of way across the Navajo Nation. Other right-of-way on federal lands and from the Hualapai Tribe are needed. Additionally, private landholdings will need to be crossed on the Western sections of the right-of-way. As part of the project, three

substations will be added: the existing Four Corners Substation will be upgraded, the existing Shiprock substation will be upgraded and a new substation called Red Mesa East will be constructed.

The financing requirement for the transmission line and substations is approximately \$600 million. The Dine' Power Authority has signed an agreement with Trans-Elect, Inc. of Reston Virginia, a utility facility developer for development of the project.

It is acknowledged that the Navajo Transmission Project is not feasible unless new generation capacity is built in the Four Corners area. DPA is therefore actively attempting to develop a large scale coal fired generation project using Navajo coal. They have signed an agreement with Steag Power, an independent power generation affiliate of Essen, a German based company. Steag is seeking bank financing to partly fund the development of the \$1.5 billion 1500 MW coal fired power plant. The proposed power plant is projected to have an annual water demand of 20,000 acre feet. In addition, DPA is also attempting to develop a gas fired power plant in the area of Leupp, Arizona.

## **Hopi Ranches**

In recent years, The Hopi Tribe has purchased 5 ranches, each with accompanying U.S. Forest Service livestock grazing permits, all south of the main Reservation. These include the Drye Ranch, the Hart Ranch, the Clear Creek Ranch, the Aja Ranch, and the 26-Bar Ranch. All ranches are working cattle operations with little infrastructure. Each has a ranch headquarters and some outbuildings served by electricity. Some have telephone service; however some phone service remains a "party line". Water wells are operated for service to headquarters and for livestock grazing. On the Hart ranch alone there are 65 remote diesel generators pumping water for livestock. Converting these wells to solar pumps may be a renewable energy option that could save money and reduce maintenance in the long run.

The Hart Ranch was targeted for closer review as it is closer to major infrastructure than the other ranches. Ranch headquarters is a few miles south of Interstate 40, at the Twin Arrows Exit. A 250 kV transmission line owned by APS crosses the region from the north to the south, approximately 5 miles west of the ranch boundary. A 250 kV substation is located on that line, near I-40. Additionally, near the Sunrise Exit of I-40, about 8 miles from the ranch, there is an NTUA substation and what appears to be a cellular tower.

## **II. HOPI ENERGY RESOURCE OPPORTUNITIES**

The Hopi Tribe may have a number of undeveloped natural resources, including oil and gas, coalbed methane, and some niche renewables. The Reservation's single most important natural resource is its large deposits of high-BTU, low-sulfur bituminous coal. As the Tribe confronts its need to eventually transition away from a coal based future, it must also take advantage of its comparative advantage which, thus far, has been limited to energy. This section discusses both fossil and renewable energy options, though the renewable options are not likely to significantly address energy exports and sales issues.

## 1. Hopi Coal Resources and Coal Mining

### Black Mesa

The Black Mesa, a geologic formation extending over large areas of both Navajo and Hopi lands, is rich in coal reserves. Black Mesa is a roughly circular, approximately 65-mile diameter area covering 3,300 square miles at elevations from 6,000 feet to 8,000 feet. A 1970 Arizona Bureau of Mines study estimated that Black Mesa may contain as much as 21 billion tons of coal. By way of comparison, the Hopi Tribe currently has under contract with Peabody Coal Company only 380 million tons, enough to satisfy the projected needs of the Mohave and Navajo Power Plants from their 1970 start dates through their projected useful life of 2030. The extent to which the Hopi Tribes un-contracted for coal can be economically mined is uncertain. Much of the coal may be contained in seams far too deep for conventional surface mining technology, and much of the coal may be out of reach of even the latest underground technology. A study of the location and economics of the Hopi coal reserves should be undertaken in order to give the Tribe's leadership a better understanding of the range of local coal development opportunities. It is uncertain whether other areas of Hopi lands lying south of Black Mesa contain significant coal reserves.

Coal is generally mined for the purpose of producing electricity. The importance of coal resources, especially for electric power generation has always been acknowledged and is now growing. The United States Department of Energy's Energy Information Administration (EIA), in its "Annual Energy Outlook 2003 With Projections to 2025" states:

*As they have since early in this century, coal-fired power plants are expected to remain the key source of electricity through 2025...In 2001, coal accounted for*

*1,904 billion kilowatt-hours or 51 percent of total generation, including output at combined heat and power plants. Although coal-fired generation is projected to increase to 2,760 billion kilowatt-hours in 2025, increasing gas-fired generation is expected to reduce coal's share to 47 percent.... By 2025 it is projected that 23 gigawatts of coal-fired capacity will be retrofitted with scrubbers to comply with environmental regulations.*

EIA's report also projects that natural gas prices will rise, and coal prices are expected to fall. Falling coal prices have reduced the fuel costs of coal-fired power plants to about 76% of the power plant cost to produce electricity, whereas volatile gas prices have raised the fuel share for gas-fired combined-cycle power plants to 88% of the cost of the power plant to produce electricity.

According to many industry reports, such as a May 31 article in *Electric Perspectives*, a natural gas price "crisis" is also emerging in the Spring of 2003. This "crisis" emerged after the publication of the EIA report and therefore can be seen to further emphasize the reports concerns. This new crisis is a result of an increased use of natural gas as a fuel for new power plants and a reduction in natural gas supply. Natural gas has traditionally been a winter-time fuel, and many underground storage reservoirs were refilled in the summer. With supplies down

after the winter of 2002-2003, and new power plants utilizing summer supplies, and production of gas from North American fields relatively constant, (gas is not traditionally imported from overseas like oil but is piped from fields in the US, Canada and off-shore), storage facilities cannot be quickly refilled, creating an unstable supply. Experts suggest the crisis could last through this decade.

Coal will continue to be a back-bone source of steadily priced electric power that will likely be competitive over natural gas during any period of gas price instability.

## **Early Reviews of Black Mesa Coal**

In 1909, the United States Geological Survey (USGS) gathered data on the Black Mesa coal field and estimated that it contained 8 billion short tons of coal. In 1955 another study estimated the mineable reserves as 2 billion short tons. In 1966 a study estimated 4 billion short tons. In 1970, the Arizona Bureau of Mines estimated that as much as 21 billion short tons of coal lay beneath Black Mesa, including the Wepo coal resource as estimated at 5.65 billion short tons, the Toreva at 6 billion short tons, and the Dakota at 9.6 billion short tons.

To place a *billion tons* of coal in context, according to the USGS in “Monitoring the Effects of Ground-Water Withdrawals from the N-Aquifer in the Black Mesa Area, Northern Arizona” (2001) 11 to 13 *million tons* of coal are extracted each year from the Wepo Formation. At that rate of extraction, and assuming the Arizona Bureau of Mines is correct, the Wepo Formation alone can continue to produce for over 400 years. These figures include all Black Mesa coal, which exists on both the Navajo and Hopi Reservations and in the Joint Use Area.

## **Recent Coal Estimates**

The USGS collects, analyzes and disseminates earth science information regarding the nation’s natural resources. The files of the USGS and other public sources contain general information regarding coal resources on the Hopi Reservation. The USGS has done a study of Black Mesa, in cooperation with the Hopi Tribe and the Navajo Nation. The Black Mesa study spanned lands that are Hopi, Navajo, and Joint Use Area lands. The study outlines the distribution of coal, and determines the geologic controls on coal thickness and distribution, and estimates the amount of coal that is economically recoverable and analyzes the composition of coal. This analysis is not particular to either reservation, but covers all of Black Mesa.

The USGS Study, published in 2000 is titled “Geologic Assessment of Coal in the Colorado Plateau: Arizona, Colorado, New Mexico and Utah. Chapter H is the “Summary of Cretaceous Stratigraphy and Coal Distribution, Black Mesa Basin, Arizona” written by J. Dale Nations, Robert L. Swift and Henry W. Haven, Jr. Despite the scientific sounding titles, however, real data is limited and the report is fairly broad in its estimations of the quantities of coal and coal bed methane.

Coal seams occur in Dakota, Toreva and Wepo formations, or layers within the earth. The Wepo formation is near the surface, and due to erosion is sometimes at the surface. The Toreva Formation is lower, and the Dakota Formation is below that. In addition the Yale Point Sandstone, at the upper surface in some areas contains a minor seam. Coal thickness was interpreted from isopach maps of the cumulative coal thickness for all formations and from 92 measured sections and other data points. In addition, 30 coal analyses were found in the published literature. 14 new coal samples were collected during the course of the study in measured sections and in road cuts around the mesa. Based on the data collected the USGS study reevaluated only the Wepo coal resources and allows the previous studies to stand as the best estimates of coal resources. In 1997 the “Haven study” calculated the original coal resources in the Wepo Formation of Black Mesa at 4 billion short tons. As of 1996, 265 million short tons of coal have been produced from Black Mesa resulting in a remaining resource of about 3.7 billion short tons of coal from the Wepo Formation alone.

The Tribe is currently studying its coal resources in a new study.

### **Coal Bed Methane**

As part of the USGS survey, six wells were drilled to test for coal bed methane, a naturally occurring gas in coal seams. These wells were drilled on Navajo Reservation lands at the very edge of Black Mesa. While the report does not describe any conclusions regarding the likely presence of coal bed methane, the report does state, “Due to depth of burial and the rarity of thick coal beds in the coal bearing strata, only a small portion of Black Mesa coal can be exploited through mining techniques, but the coal-bed methane that may be contained within more deeply buried coal could be produced by standard well-drilling techniques. If present, and if exploration work is allowed, such production might provide a valuable source of energy for local use, and possibly for commercial production.”

### **Coal Mining Regulations for Indian Lands**

The Office of Surface Mining (OSM) is the regulatory authority for coal mining operations that occur on Indian lands in the Western United States. As such, OSM is responsible for the review and decisions on all applications to conduct mining operations and, if a mining permit is issued, OSM is responsible for inspection of the mines to ensure that the public and the environment is protected, and ultimately OSM is responsible for ensuring that mining operations are fully reclaimed before the lands are returned to the tribes.

Other agencies involved with coal mining on Indian lands include the Bureau of Indian Affairs, Bureau of Land Management, U.S. Fish and Wildlife Service, Environmental Protection Agency, and the Corps of Engineers. These agencies coordinate their oversight and management operations through Memorandums of Understanding. These MOUs have made clear the BIA’s role as representative of the Secretary of the Interior in the Federal-Indian Trust relationship and consultation with Tribal mineral owners, and BLM’s role in the administration, exploration, development and production of coal on Indian lands.

## Large Commercial Clean Coal Development

The Hopi Reservation is blessed with a wealth of coal resources. Currently, some of those coal resources are under lease and are actively being mined by Peabody Coal Co. Many coal plants continue to use the same technologies that were used 50 years ago, however with a look to the future; there may be other options for cleaner uses of coal. The federal government has spent billions of dollars on coal research, but very few outstanding options are clearly available except the use of pollution control equipment. Many technologies remain under development, however, and as technology progresses, the coal resource may have new applications.

The Hopi Tribe has ample coal reserves to consider other appropriate uses for coal. This section explores utilizing these reserves in one or more of a large commercial “clean coal” application. Distributed power applications such as fuel cells and residential applications such as home heating are described elsewhere in the report.

The following themes are evident:

- Definition of Clean Coal -- First, the definition of what is considered clean coal is somewhat ambiguous as conventional technology with the appropriate control technology can be considered “clean”; hence, many environmental groups do not support efforts for more research. The differences that we noted as being important for clean coal are (1) the amount of pollution emitted as part of the generation process, and (2) whether the coal waste is being reused in other products (e.g., a plant in West Terra Haute, Indiana generates 99.99 percent pure sulfur, which is sold for agricultural applications, and slag, which has value and application in asphalt and fill projects).
- Importance of Relevant Time Horizon -- A second theme that emerged is that a decision will need to be made whether a near- or longer-term view is to be considered for uses of coal. For example, a near-term technology would include a conventional coal power plant with emissions control technology could be permitted, built, and in place in approximately three to five years. This type of power plant has relatively predictable revenue streams. Currently, there is approximately 11,000 MW of additional coal-fired capacity expected by 2015 and 63 percent of this total is expected to use conventional pulverized coal as the fuel source (Conversation with Jack Ihle from RDI, 2002). A longer-term perspective might include investments in technologies that are currently in the research and development stage but eventually will be considered the mainstay of a sustainable society. These technologies, such as fuel cells that utilize coal, are five to 20 years away from commercialization and do not have predictable revenue streams.

There are many large-scale operation applications that are worth considering. Again, if the desire were to start producing revenue streams in the near-term, conventional technologies with state-of-the-art emissions control would be the present option. If there is more of a desire to explore and assist in technological development, then there are a few technologies that look most

promising and potential funding sources to assist development. The following discussion will further support these recommendations:

- Conventional Commercial Applications
  - It seems that conventional pulverized coal (PC) technology is the primary option for constructing a new plant today. It has the least risk and the lowest costs.
  - However, if construction does not begin for a period of time, it may be best to consider an alternative technology, which may be evolved by that time and may be more economically viable.
  - Most available technologies today are PC technology. They also typically have the lowest installed capital costs (\$1,060 per kW) (Black & Veatch, 2000). RDI gives a range of \$900 to \$1,200 per kW for the capital costs (Jack Ihle, 2002)
  - Low NO<sub>x</sub> burners are now in use in 75 percent of coal burning facilities in the U.S. (EPG, draft report, 8/30/02). While this technology is primarily being used in existing facilities, it is possible to build a new conventional power plant using low NO<sub>x</sub> burners as a clean coal technology.
  - In the U.S. today, 23 of the 25 lowest operating cost electric plants are coal fueled (American Coal Foundation).
- Fluidized Bed Combustion (FBC)
  - Fluidized bed combustion represents another conventional technology that is considered clean, the difference being that the pollution is controlled without the need of installing scrubbers or other back-end technologies. Fluidized bed combustion is a method of burning coal in a bed of heated particles suspended in a gas flow (EPG, draft report, 8/30/02).
  - Currently there are 170 FBC projects in the U.S., and more than 400 around the world (Coalition for Affordable and Reliable Energy). A rough estimate places the capacity of existing plants at 3,800 MW.
  - Fluidized bed combustion is commercially available today. Fluidized bed combustion boilers smaller than 250 MW are considered available conventional technology and have traditionally been marketed as being equivalent, in cost and performance, to small PC boilers fitted with flue gas desulfurization (FGD) and selective catalytic reduction (SCR). Fluidized bed combustion manufacturers express confidence in scaling up units to 500 to 600 MW. Fluidized bed combustion technology is more expensive (\$1,160 per kW) than PC technologies while releasing equal amounts of pollutants (Black & Veatch, 2000). RDI gives a range of \$800 to \$1,200 per kW for the capital costs (Jack Ihle, 2002).
- Integrated Coal Gasification Combined Cycle (IGCC)
  - This technology looks most promising in the mid-term range. The commercialization of IGCC is not seen as near term. It will become more competitive as natural gas prices increase relative to other fuels. This technology is by far the most environmentally friendly and has some of the highest plant efficiency, but has the higher capital costs (\$1,390 per kW) than conventional technologies (Black & Veatch, 2000). RDI gives a range of \$850 to \$1,400 per kW for these capital costs (Jack Ihle, 2002).
  - More than 1,500 MW of IGCC capacity exists in the U.S. today. IGCC facilities currently operate in Tampa, Florida, and West Terra Haute, Indiana. An



additional 1,500 MW plant is planned in Alabama (Coalition for Affordable and Reliable Energy).

- Co-firing gasification uses coal gasification technology combined with co-firing of biomass or wastes. These facilities can generate electricity from coal as well as from biomass and municipal and hazardous wastes. By-products are safe and potentially valuable (EPG, draft report, 8/30/02). Such a facility may provide large benefits to a local community both in terms of the power provided, and the ability to process local wastes more efficiently.
- Different grades of coal are potentially compatible with IGCC; processes are not limited only to high grades (Richter, Chevron Texaco, 2001).
- Gasification seems to be the most effective in terms of reducing SO<sub>x</sub> and NO<sub>x</sub>; its emissions are well below FBC and PC technologies (Black & Veatch, 2000).
- Sulfur is a typical by-product of IGCC as it is removed during the gasification. One plant generates 99.99 percent pure elemental sulfur, which it sells to a broker for agricultural application. The sulfur shipped via train from the plant. Slag is another by-product. Slag is inert and marketed for asphalt, construction backfill, and landfill applications (Amick, Global Energy, 2002). There is another plant in Trapp, Kentucky, in the design and permitting stage, scheduled to open in 2005. This plant and the one in West Terra Haute are part of the U.S. Department of Energy (DOE) Clean Coal Technology Demonstration Program (U.S. DOE Fossil Energy website).
- The West Terra Haute plant is 260 MW, one of only two commercial scale IGCC plants in the U.S. (U.S. DOE Fossil Energy website).

The following are industry contacts and funding sources to assist in pursuing this avenue:

- Research and development funding is available through the U.S. DOE Fossil Energy program:

<b>CCT Program Area</b>	<b>Name</b>	<b>Contact Information</b>
Advanced PC and FBC	Victor Der Product Line Director Advanced Power Systems	Office of Fossil Energy (FE-20) U.S. Department of Energy Washington, DC 20585 Telephone: 301-903-2700

CCT Program Area	Name	Contact Information
		e-mail: <a href="mailto:victor.der@hq.doe.gov">victor.der@hq.doe.gov</a>
Innovations for Existing Plants	Charles Schmidt Product Manager National Energy Technology Laboratory	U.S. Department of Energy PO Box 10940 Pittsburgh, PA 15236- 0940 Telephone: 412-386-6090 e-mail: <a href="mailto:schmidt@netl.doe.gov">schmidt@netl.doe.gov</a>
Low Emission Boilers	Soung-Sik Kim National Energy Technology Laboratory	U.S. Department of Energy PO Box 10940 Pittsburgh, PA 15236- 0940 Telephone: 412-386-6007 e-mail: <a href="mailto:kim@netl.doe.gov">kim@netl.doe.gov</a>
FBC	Donald L. Bonk Product Manager National Energy Technology Laboratory	U.S. Department of Energy PO Box 880 Morgantown, WV 26507- 0880 Telephone: 304-285-4889 e-mail: <a href="mailto:dbonk@netl.doe.gov">dbonk@netl.doe.gov</a>
IGCC	Gary J. Stiegel Product Manager National Energy Technology Laboratory	U.S. Department of Energy PO Box 10940 Pittsburgh, PA 15236- 0940 Telephone: 412-386-4499 e-mail: <a href="mailto:gary.stiegel@netl.doe.gov">gary.stiegel@netl.doe.gov</a>

- University in Ohio applied for grant money from its local utility to build a state of the art coal facility for heating (Elliot, *The Post*, July 3, 2002). This suggests that it may be possible to work with a local utility if they see the advantages in a partnership opportunity for developing a new coal electric plant.
- Coal powered electric plant boiler system manufacturers:
  - Foster Wheeler: [www.fwc.com](http://www.fwc.com), worked with the U.S. DOE on the new Jacksonville, Florida FBC plant.

## **Air Quality Implications of Clean Coal Development**

The federal policies in the past have spent millions of dollars on research and development of clean coal technologies, and those programs continue. No fuel cell based commercial coal plants exist in the U.S. Only one IGCC utility coal plant is operating in the U.S. in the face of record high oil and gas prices. Thus, clean coal has not changed the current U.S. coal industry.

## **2. Oil and Gas Development**

One of the Hopi Tribe's most promising options for immediate, economically feasible, and lucrative energy development is the exploration and development of oil, natural gas, or coal bed methane. There is currently a moratorium, passed by the Hopi Tribal Council, on oil and gas exploration or drilling within the Hopi Reservation lands. The moratorium protects the tribal lands and cultural resources from unwanted geological testing and assures the tribe that any oil and gas or coalbed methane exploration will be done only after due consideration of all options for use of the precious resource. The moratorium also assures that data from any tests will be held and controlled by the tribe and will not be held in the public domain by federal agencies or be sold on the market by private companies. Environmental studies and protections will be required under federal and tribal laws prior to any oil and gas development.

Documents now in the public record from early drilling efforts indicate that oil, gas and coal bed methane resources do exist on the Hopi Reservation. Only six exploratory hydrocarbon wells have been drilled on the entire Hopi Reservation<sup>5</sup>. This is a very limited amount of testing for such a large area that has many positive geological indicators for oil and gas production. Indeed, four of the six exploratory wells contained shows of oil. In addition, United States Geological Survey estimates, based on surface and subsurface evaluations indicate the Black Mesa Basin might contain up to 15 trillion cubic feet (TCF) of coalbed methane reserves at depths that could allow for drilling.

Natural gas has historically and traditionally been a fuel for industrial purposes and for winter heating. It is also now used more and more for electrical generation. The United States Department of Energy's Energy Information Administration (EIA), in its "Annual Energy Outlook 2003 With Projections to 2025" projects the increased use of natural gas as a fuel for electric generation. The report projects that of the new 428 gigawatts of electric generation capacity, 80% is to come from natural gas.

Prices of natural gas spiked in 2000 and 2001 and are once again on the rise. Gas prices to electricity generators are projected by EIA to rise by 1.8% per year in the forecast, from \$3.07 per million Btu in 2002 to \$4.60 in 2025. According to many industry reports, a natural gas shortage is also emerging. Natural gas is not traditionally imported from overseas like oil but is

<sup>5</sup> Public records of well completions on federal lands kept by the U.S. Geological Survey and Bureau of Indian Affairs were reviewed and analyzed by H. Gordon Beamguard of HGB Oil Corporation and HGB Land Services Company, Inc. in a report titled "Coalbed Methane Exploration Hopi Reservation Black Mesa Basin Coconino and Navajo Counties, Arizona". This report was submitted to The Hopi Tribe in 2002 as a proposal for assistance with tribal oil and gas exploration.

pipled from fields in the US, Canada and off-shore. Therefore supplies are local supplies. The article points out that there is mounting evidence that after 20-30 years of intensive development some of the largest gas fields in the United States and Canada are beginning to “tire”. Although the exploration and production companies have been drilling new wells, domestic gas production has only modestly increased. This new crisis is also a result of an increased use of natural gas as a fuel for new power plants. The increase in gas production was less than half of the increase in consumption that occurred over the same period.

Natural gas has traditionally been a winter time fuel, and many underground storage reservoirs were refilled in the summer. With supplies down after the winter of 2002-2003, and new power plants utilizing summer supplies, and production of gas from North American fields relatively constant, storage facilities can not be quickly refilled, providing an unstable supply. Experts suggest the crisis could last through this decade.

This “crisis” emerged after the publication of the EIA report and therefore can be seen to further emphasize the reports concerns over rising gas prices. These rising prices indicate a fortunate outcome for gas or coalbed methane producers.

Many tribes have participated in various ways in the oil and gas industry; some since the 1800s. This participation has taken many forms and has lead to various business models for tribes involved in the oil and gas industry. The different business models have lead to various levels of success in realizing economic development from tribal resources and protection of tribal interests.

As with any development, there are many considerations in the development of oil and gas and CBM resources. Cultural and environmental issues must be clearly considered. Most concerns can be mitigated but most mitigations come at a cost. Oil companies will be most interested in reducing costs and increasing profits and production. Other ways of operating oil fields can protect important tribal culture and the natural environment, while lowering profits or changing development timeframes. All successful development that considers cultural and environmental issues must have a process for community discussion and education. In addition, internal tribal organizations must be in place to coordinate the many concerns of culture, historic preservation, legal mandates, technical matter, land rights, environment, fish and wildlife, taxation, and tribal policy.

## **Types of Hydrocarbon Production**

### **Oil and Gas Production**

Since oil and natural gas are usually found together, exploring for oil and for natural gas is done at the same time using similar methods. Almost all oil production also produces natural gas. In the past, the gas was often treated as a waste product and was “flared” or burned on site. Now, with the advent of pipelines that can transport the gas from the well sites to markets, the gas is a valuable commercial entity. Many developed fields now produce only the gas and leave the small amounts of oil that accompany the gas in the ground. Along with the oil and natural gas, other hydrocarbon products are produced that can be stripped from the usable oil and/or natural

gas and marketed. These other products include condensates such as liquefied natural gas. One key to proper use of the resources is the establishment of marketing systems that most effectively utilize all hydrocarbon products, and accompanying water produced by wells.

Oil and gas is located and produced by the use of wells drilled into areas of rock that hold oil and/or gas. Once oil and/or gas is located using tests on the wells drilled to various depths within the earth, either the oil and gas naturally flow to the surface out of the well, or it is pumped out of the ground using a basic pumping technique. Because hydrocarbon production is pressure driven, most production shows an immediate increase in flow soon after the well is completed then steadily decreases in volume (sometimes over the course of 100+ years) as the hydrocarbon is removed. Pumping uses energy, usually electricity and can therefore be expensive. After wells have produced oil and gas in this primary method of drilling and pumping and production no longer becomes economical, there are secondary, tertiary, and quaternary methods of improving a well's production. Under currently used methods, only about 75% of oil in the ground can be recovered economically. Oil companies cease production of wells when the amount of oil recovered in a given period of time is not enough to cover their costs and overhead. Therefore, a fall in oil prices or a raise in company costs can close down productive wells.

After it is recovered, oil and gas is separated and treated, then placed into storage or pipelines and taken to market. Oil is usually trucked to market and gas is piped to market. Byproducts are also often taken to market by truck.

### **Coalbed Methane Production**

Coalbed methane (CBM) is a natural gas that is produced in coal. It is made up of methane gas and carbon dioxide. Coal acts as both a source for the gas and a reservoir holding the gas. Coal is extremely porous which allows it to hold these gasses. One short ton of coal can produce 1,300 cubic meters of methane. "Cleats" or cracks in the coal, allow the gas to move or migrate out of the coal to the surface.

As the pressure within the coal bed is reduced, methane is produced as the gas flows through the cleat to the well. The CBM is maintained within the coal as long as the water table remains above the gas-saturated coal, causing pressure. As the coal is dewatered, the cleat system progressively opens farther and farther into the coal seams and away from the well. Dewatering reduces the cleat pressure allowing gas to leak out of the coal and flow through the cleats to the surface through the wells that have been drilled. Water production decreases over time which makes the gas production from the well more economical. This process for recovering the oil and gas includes pumping of water out of the saturated coal zone. Pumping of water therefore produces the CBM. The water is a byproduct of CBM production (or vice-versa). Water can be used at the surface or can be pumped back into the earth as the gas is removed. Some water in coal is salt water and is treated as a waste material that is pumped back into deep zones in the earth. Some CBM is already above the water table and is merely trapped in the coal by heavy overburden. Once a well is drilled, the gas can move to the surface.

## **Stages of Hydrocarbon Production**

In determining whether to enter into the oil and gas or CBM business, it is important to understand the process for developing these resources, or the stages of the process. Initial environmental studies under the National Environmental Policy Act are needed prior to any major federal action impacting the environment. Leasing of Indian lands for oil and gas will require an approval by the Department of Interior which will implicate these environmental laws. Assuming environmental obligations are met, the following stages are common.

First there is the Exploration Stage, then Development, then Production/Operation. The last stage is Abandonment.

### **Exploration**

Historically, the Exploration stage has included an oil company suspecting that oil and gas reserves exist in a particular zone under certain lands. This suspicion has been based on existing production on a neighboring property, old public records of previous drill tests showing oil or gas, aerial photographs, or documentary evidence indicating that oil and gas may be found in the area based on geological studies. The presence of coal indicates CBM exists, however, whether it can be recovered economically is still an unknown. On federal and tribal lands there is often federally generated information in the public record that addresses hydrocarbon potential.

Generally, the first agreement requested from a landowner or tribe by an oil company is an agreement to do geological reviews that do not involve drilling and seismic (sound/radio wave) testing using above ground equipment. There is a flat fee paid for the right to test. The agreement may contain an option to enter into leases if the tests show promise. These tests can help confirm suspected underground formations, including those that may be oil and gas producers. These test results are generally the property of the oil-company or seismic company and can be sold as intellectual property. Landowners and tribes can negotiate for the various uses of the information and confidentiality. Tribes can also negotiate for different kinds of tests that could also indicate sand and gravel, water, or other minerals. Tribes can also negotiate for appropriate reclamation of the impacts of testing such as shot holes and roads. While copies of the test results but they are usually technical results requiring special expertise, computer tools, and professional judgment to correctly interpret. If seismic and other testing shows positive results are likely, oil companies have traditionally approached landowners or tribes to enter into lease agreements. Under these lease agreements, the exploration stage continues with the drilling of wildcat or exploration wells.

Landowners such as the Hopi Tribe could contract for the initial exploration of their lands. As long as the tribe paid for the seismic or other studies, the reports would be tribal property and confidential. The more up-front risks that are taken by the tribe, the greater the tribe's bargaining position when seeking energy development partnerships. This testing can be modestly expensive, depending on the extent (coverage and depth) of the testing. In addition, the test results must be interpreted by qualified professionals with a reputation for recognizing geological patterns that indicate oil and gas or the results are simply lines and numbers.

An exploration well into a zone or through zones that appear promising on a seismic test can result in either a producing well, or other “well log” information that can show what other zones above the targeted zone should be tapped to determine if oil can be produced. Drilling of wildcat wells can be very expensive. Generally, the deeper the targeted zone, the more expensive the well will be. If the exploratory wells are surface wells, they may be relatively affordable. Landowners may drill their own exploration wells if the price of the drilling is affordable and a well considered plan is in place to deal with successful, producing wells. Once oil and gas is discovered by drilling a wildcat well, the well is “completed” by providing the appropriate casing pumping, storage, and delivery equipment for the wells.

Tribes seeking oil company partnerships for the exploration of lands can lease only every-other section to an oil company and retain the remaining sections. In that manner, an oil company’s discovery will permit the tribe to capitalize on known reserves. Such a negotiation will likely lead to a smaller leasing bonus paid to the tribe but will likely increase long term profits if reserves of oil and gas are found.

## **Development**

The “discovery” of oil and gas by drilling a successful wildcat well indicates not just one successful well, but a likely underground structure of sediment and rock that contains oil and gas. Development wells can be drilled at strategic areas surrounding the successful wildcat well to provide additional wells to extract oil and gas or CBM from the same underground structure. Or one successful well may show that additional zones above the targeted zone also contain oil and gas. Development wells can be drilled in the area to target those other zones. Each new well and the “logs” that are created during the drilling process lend more information about the underground and unseen layers of rock and minerals. This information can be incorporated into computer databases to extrapolate further information. Most wells drilled are development wells simply because the risk of drilling into a new area is removed and there is a much higher likelihood of finding oil and gas or CBM. Through the drilling of development wells, oil fields are developed.

Another form of development is to re-enter wells that were abandoned by a previous operator. Companies that operate oil and gas wells are driven by profits and when their costs exceed the value of the production, they abandon and cap wells. Other companies with lower costs, a change in production methods, a change in production costs, or use of secondary or tertiary recovery methods can make re-entering old wells very profitable and relative risk free since it is known that oil and gas exist and can be produced.

## **Production/Operation**

The production/operation stage can last for a century or longer for good producing wells. Leases of oil and gas are usually “held by production” meaning that as long as the company is producing the well they have a right to the leased area. An oil company must manage the production of an oil field carefully using proven geological methods. Because many wells may be drawing from one underground reservoir, one well’s activities may impact all other wells. A good understanding of the underground issues is important to producing the reservoir for the best

results. Tribal management of the underground resource can make the difference between a resource that is used up quickly with short term high profits, or used slowly for lower profits but for a longer term. Tribal management of wells will also allow the tribe to determine what is best for byproducts of oil and gas development, such as the use of water from these wells.

Especially in situations involving leases, production and operation also involve issues of accounting, royalty management, environmental issues, water management, safety, and reporting. For federal lands these issues are governed by the Federal Oil and Gas Royalty Management Act of 1982 (FOGMA). The Minerals Management Service (MMS) governs accounting and royalty management issues. Indian tribes may contract for the management of these issues on tribal leases by seeking an agreement with MMS under Section 202 of the Act. The Bureau of Land Management (BLM) governs the operational issues of federal and tribal oil and gas wells. Operational issues include the inspection of the operations during the various stages of development and enforcement of all regulations of the protection of landowners. Again, Indian tribes may seek agreements under Section 205 of FOGMA to oversee the operational aspects of the wells leased on their lands. Very few tribes have both 202 and 205 authorities. Such authorities require a good tribal minerals department that can interface well and quickly with tribal cultural, environmental, safety, water engineering, and lands offices. A good tribal court system is needed to enforce any issues or clear disputes. These human resources must be developed and trained and tribal political systems must encourage an efficient and economical management and coordination of issues.

### **Abandonment**

A well may be abandoned after the cost to operate the well becomes more than the price that can be received for the product. Leases often require certain procedures for capping of wells and mitigation of surrounding lands.

## **Tribal Oil and Gas Development Business Models**

Generally there are two business models for tribal production of hydrocarbons, leasing and joint ventures under the Indian Minerals Development Act of 1982.

### **Leasing**

Leases are the oil and gas industry's traditional method for obtaining access to oil and gas reserves. Under this method, an oil company locates a prospect through public records or by purchased data regarding geological features of areas of land. The oil company then purchases a lease from the landowner (a private individual, a corporation, an Indian allottee, the federal government, or in the case of an Indian Tribe, from the BIA with the Tribe's approval). The purchase usually includes an up-front "bonus" payment, a rental payment, and provisions for the landowner to receive "royalties" or a share of gross profits from any well. Usually, a royalty is around 16%. Some royalties can be taken "in-kind" or in the form of the oil or gas that the landowner can use or sell on his own terms.

### **Tax issues- severance taxes tribal, state, county, schools and services**



The lease provides the oil company the right (or obligation) to do surface testing, seismic testing, or to drill wells to look for oil and gas in areas that appear geologically promising. Leases allow an oil company a period of time in which to drill wells and “prove” the leases. Leases are limited to various depths and underground geologic formations. In that respect, a lease is like a condo purchase in a high-rise building. If you buy a lease you have horizontal or surface boundaries and you also have vertical boundaries to drill to only certain depths.

A new well in a new area is called a “wildcat” well. Wildcat wells are often expensive and are always risky and are the only existing true test of underground geology. Often leases are purchased in areas where other wells have been drilled that show the existence of oil and gas, but no well was completed or no well was previously authorized in that particular underground geological formation. These are called development wells and are less risky because you know that oil and gas exist in the area.

If a well shows oil and/or gas that is proven to exist in quantities that are sufficient to pay for completion and operation of the well under existing and projected oil and gas prices, the lease is deemed “proven” and the oil company has the right to produce the well for as long as it is produced, providing a royalty to the landowner.

In this business model, the oil company takes all the financial risk, is responsible for all technical study, operations, and environmental issues, and the landowner, if he is lucky enough to get a paying well on his land, gets a monthly check. The landowner, however, has no say in the well operation or decisions regarding the lease. The leases could last hundreds of years if the wells continue to produce, with a landowner’s only option to remove the oil company is to buy out their interest in the well. Indian tribes were particularly unhappy with many of the leasing arrangements and were often cheated out of royalties by the oil companies or by BIA mismanagement. Existing litigation (*Cobell v. Norton*) by Indian owners of allotments that have produced oil and gas but very little royalty income has shown that BIA failed to provide royalty income to descendants of original Indian signatories of oil and gas leases.

## **Joint Ventures**

In 1982, Congress passed the Indian Minerals Development Act (IMDA) which allowed Indian Tribes to create other kinds of business arrangements with oil companies for the exploration and development of their lands. The use of IMDA agreements has been limited, but has shown that other models for oil and gas that provide Indian tribes better control of their resource and better economic development options exist.

Congress is currently considering a third option for tribal oil and gas exploration and development. This option, if passed into law, will allow tribes to pass internal regulations that govern all aspects of oil and gas exploration, development, and operations on their lands then after the regulations are approved, the United States (BIA) is removed from further oversight or approvals.

## **Example Tribal Experiences with Oil and Gas or Coalbed Methane Development**

### **Southern Ute Indian Tribe**

The Southern Ute Indian Tribe's reservation is located on the Colorado and New Mexico border in the middle of the San Juan Basin, a major oil and gas and CBM production area. This tribe has become the model for effective, tribally controlled natural resource development. The Southern Ute lands were originally explored for oil and gas under leases to various oil companies. The tribe eventually bought out many of the producers on their lands using royalty monies and they now own their own very successful oil company, the gas pipeline gathering system on their reservation, and are seeking to construct and own an interstate gas pipeline.

The tribe also became the owner of coal reserves formerly held by the United States. CBM was produced from those reserves by a number of companies. The tribe filed suit to determine whether in acquiring the coal, the tribe also acquired the coalbed methane and associated rights. The courts agreed that the coalbed methane was part of the coal and therefore the tribe gained control of CBM production.

### **Arapaho-Shoshone Tribes of the Wind River Reservation**

The Northern Arapahoe and Shoshone Tribes in Wyoming share the Wind River Reservation in west-central Wyoming. This area was originally explored for oil in the 1800s. To date, the tribe has numerous successful productive leases with many companies. Many experiences have been difficult. In the 1980s it was discovered that many oil companies were not fully accounting for the oil produced, so the royalty payments were significantly less than they should have been. This discovery led to the passage of the Federal Oil and Gas Royalty Management Act of 1982 which requires proper accounting of tribal and federal oil and gas interests and management of royalty income.

The Wind River Reservation has many tribally owned lands and many Indian allotments. Issues of regulation and tribal control of oil and gas basins becomes more difficult as the land base ownership is divided among many parties. The BIA administers oil company action on allotments and administers payment of royalties to the many descendants of original allottees that signed oil and gas leases. The Tribe has agreements to do both the Section 202 and 205 Oversight for the wells on tribal lands.

Experiences in the oil and gas industry inspired the tribe to quantify their water rights and to pass tribal regulations governing water interests and uses on the reservation. The Tribes' oil and gas experience also brought up other seemingly unconnected community concerns. Research by the tribe showed that between 1969 and 1987, the County and State collected \$185 million from tribal oil and gas operations. The tribe only benefited with \$85 in services from the State and

County. Much of this tax money was going to school districts not populated by tribal members. The research inspired the tribes to work closely with the state and local government on taxation and spending issues.

The Arapaho and Shoshone tribes do not have a minerals department, which can create issues with continuity. The Joint Business Council monitors oil and gas issues.

### **Jicarilla Apache Nation**

The Jicarilla Apache Nation in New Mexico has also had many years of oil and gas production on their reservation and an extensive portion of the reservation is under lease. This tribe is quite private regarding its business and less is known in energy and tribal circles about its operations. The reservation has a privately owned gas processing facility. The tribe is working to establish an energy company and has a minerals staff of 7 to 8 people.

### **Northern Ute Indian Tribe**

The Northern Ute Indian Tribe in north central Utah has a number of productive leases with oil and gas companies. The tribe does not operate an oil and gas company, but relies on partnerships with existing companies to produce their resources. One option that exists was chosen by this tribe: to turn oil and gas issues over to a private company answerable to the Council for all management rather than have a tribal minerals office.

### **Ft. Peck Reservation**

The tribes of the Ft. Peck Reservation in North Eastern Montana have a number of producing wells on their lands that were covered by leases to various oil companies. This tribe has also leased a large portion of their reservation to a gas production company. This lease is a shallow lease. In the 1990s this tribe was one of the first to sign an agreement under the Indian Mineral Leasing Act of 1982. They agreed on a joint venture with a Canadian oil company to jointly develop certain zones below the shallow gas leases. The Canadian company was to do all the work and take all financial risk and retain 75% of the net profits. The Tribe was to retain 25% of the net profits. Unfortunately, the model was not tested as after drilling the required wildcat wells, no oil or gas in paying quantities was found in that zone. Fort Peck has a minerals department staffed with 4-5 people and is doing Section 202 and 205 Administration of the wells on their lands.

### **Three Affiliated Tribes of the Ft. Berthold Reservation**

Certain oil and gas production operates on this reservation under lease to various oil companies. The reservation has a large presence of allottees. Directly off of the reservation lands significant oil and gas is produced. The Three Affiliated Tribes have recently announced the development of an oil refinery on the reservation to refine local and regional oil production. The tribe is still seeking full financing for the project.

### **Blackfeet Tribe**

Some Blackfeet Tribal lands in Northern Montana are known producers of oil and gas with various test wells and some production. These tribal lands are also checkerboarded with many allottees. The Tribe's boundary with Glacier National Park and the tribal cultural considerations regarding some of the proven oil and gas areas have stopped some oil and gas production and development. Environmental and cultural concerns are very important in the decision whether or not to develop resources. The Blackfeet tribe has authority to do its own Section 202 and 205 reviews of the wells on their lands.

### **Oklahoma Tribes**

Originally the whole state of Oklahoma was reserved for Indian people. After the Indian Allotment Act and other Congressional Acts dealing particularly with Oklahoma tribes, most of the reservation lands were limited and all tribal lands were subject to homesteading and allotment and therefore are now "checkerboarded". Oil was discovered in Oklahoma in the mid 1800s so the various land and leasing rights are quite confused due to the timing of the leases verses the various federal acts regarding tribal lands, and due to the uncertainty by the BIA of the identification and location of many of the parties holding underlying rights to allotted lands with leases. Many of the Oklahoma tribes have been dealing with oil and gas issues almost since their arrival in Oklahoma. Oil and gas certainly was a factor in the Oklahoma "land grabs" experienced by tribes with promised lands there. Oklahoma tribes have not been leaders in the use of joint ventures or the formation of tribally owned oil companies due to the confused legal nature of existing production.

### **Navajo Nation**

The Navajo Nation has some of its lands leased for ongoing oil and gas production. These lands are in the mountain forests near Lukachukai. However, like the Hopi Tribe, the Navajo Nation has been careful about development decisions and much of the reservation remains unexplored.

The Navajo Nation has formed an oil and gas company, however, it is likely not active in producing any of its own oil and gas.

### **Alaska Tribes**

Significant oil and gas production also exists in Alaska on lands controlled by Native Alaskans. Many of the laws governing the resources of the Alaska Natives are different enough from those in the lower 48 states to make a long discussion of Alaska oil and gas issues unwarranted here.

### **Canadian Tribal Oil and Gas Production**

Many Canadian Tribes have ongoing oil and gas production. Under Canadian law, a government agency, Indian Oil and Gas Canada (IOGC) works like the BIA in approving leases and other joint ventures approved by the Canadian First Nations. Most of this production is in Alberta and Saskatchewan. However, more and more oil and gas is now being discovered in far northern reaches of Canada.

## **Gas-Fired Electric Generation**

Electric demand in the United States is growing, and even with the unsure climate of today's energy markets, new power plants will be constructed in the Southwest in the coming years. The Hopi Tribe has considered the option of large scale generation facilities on the Reservation and it is likely that with the resources available to the tribe other opportunities may arise over the coming years. A wholesale gas pipeline crosses a corner of the Hopi Reservation and opportunities may exist for oil and gas development on the reservation, making it possible for the siting of a natural gas generation facility.

Factors needed prior to any successful large scale generation facility include:

- Customers ready, willing and able to purchase plant output, or in the alternative, a tribal willingness to risk that power can be sold on the open market, Arizona already has a glut of gas-fired power plants.
- The ability to transmit electricity to the customer. This requires studies of the high-voltage transmission system to determine capacity. If capacity is available, contracts for the capacity must be signed. With a changing regulatory structure now governing access to and prices of high-voltage transmission, it is very difficult to say whether transmission will be available. In addition, older facilities may be at capacity, and a potential new facility, the Navajo Transmission Project under development by the Navajo Nation may be used by Navajo generating projects. Access to transmission also requires substations, which would need to be constructed for any project on The Hopi properties. The above notwithstanding, transmission is a key obstacle to any commercial plant development on reservation.
- Financing at competitive rates of interest will make or break any project.
- Water is needed for almost all generation options. Some options, especially those with new technologies use less water. A review of any regional project should be considered to watch the local use of aquifer water.
- Altitude is a factor in generation projects. The higher in altitude, the more fuel is necessary to generate the same amounts of electricity. For this reason, higher altitudes are generally not considered for large-scale generation plants.

Consideration of all these factors, and likely other factors, for each particular project will be required by tribal leadership.

## **Air Quality Impacts of Hydrocarbon Development and Gas Generation**

Hydrocarbon development, in and of itself, is not a significant polluter of the air. Depending on the type of development, certain burning of excess gas could take place. In the case of "sour gas" wells, gas content is toxic in high concentrations without proper treatment, and special well procedures are needed to mitigate the concern.

The policy of oil and gas production does contribute to burning of fossil fuels, however, in comparison to coal, burning of gas is much cleaner. For example, when comparing state of the art gas-fired power plant to US fossil fuel fleet, gas fired plants are much cleaner:

98.7% less nitrogen oxides  
99.9% less sulfur dioxide  
65.2% less carbon dioxide  
100% less mercury  
84.4% less particulate matter

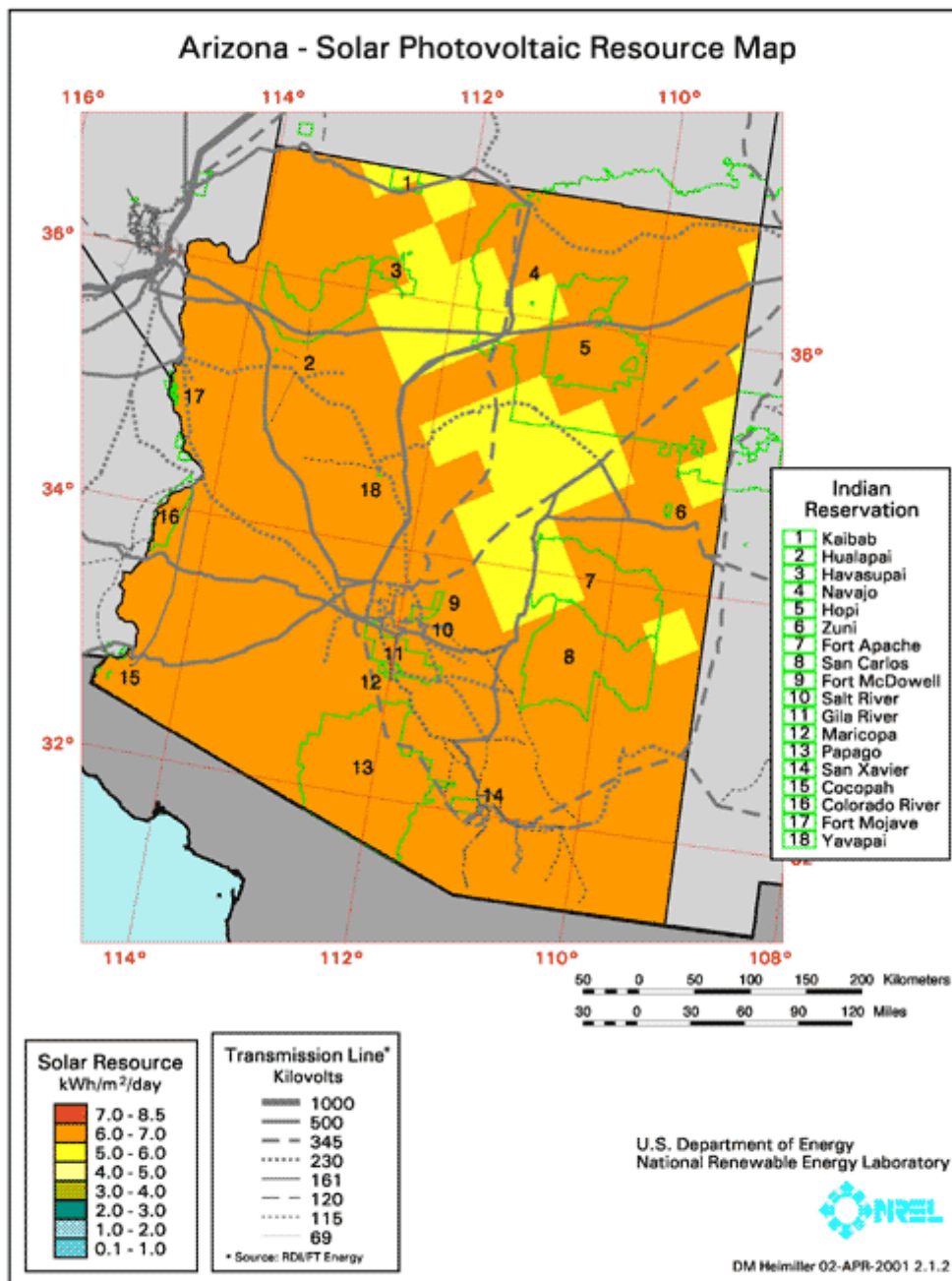
### ***3. Renewable Energy Development***

Renewable energy technologies can be deployed in two ways: for local use (often referred to as distributed generation) or for commercial sale to outside entities. The strategies involved in each type of development are totally different and require different analysis.

Commercial scale renewable developments require a purchaser for the energy, and negotiated agreements for delivery over high-voltage transmission lines. Emerging markets for “green tags” or “green credits” help make the more expensive renewable power competitive in electricity markets. Commercial scale developments usually require significant sums of money, so financing and the cost of money are very important. Rarely is a commercial development done on a small scale because the high cost of infrastructure creates the need for economies of scale. Some federal and state subsidies may make commercial renewable development easier, but often these subsidies do not last the entire life of project finance. These projects require a coming together of many factors, available high-voltage transmission, high-grade natural resource (wind or maybe solar) and local substations. Distributed generation requires coordination only with local electric providers if it is to be grid-connected. There are also certain opportunities for subsidies, rebates, or renewable energy grants. Smaller scale facilities are more reasonably priced and can be added in piece by piece additions over time.

#### **Large Scale Commercial Solar Photovoltaics**

The solar resource on the Hopi Reservation is considered to be “world class.” The enclosed map illustrates that the annual average solar resource for the Hopi reservation and most of Arizona is 7 kW/m<sup>2</sup>/day, among the highest levels in the US and the world.



Photovoltaic modules (also called panels) convert direct sunlight to direct current electricity. There are two basic types of photovoltaic (PV) cells: crystalline silicon and thin film. Crystalline silicon modules have predominated in most installed PV systems to date due to their long life, super high reliability and relative high efficiencies at 14-16%. Single crystal technology however is limited by an inherently high cost of manufacture.

Many large commercial installations are now turning to thin film technology due to its lower cost, mechanical flexibility, and ease of manufacture. Thin film has lower efficiency (8-12%), is

more prone to damage, and has a shorter life span than single crystal cells. But recent advances in manufacturing techniques have overcome some of these obstacles and have made thin film technology competitive.

PV modules typically have a peak power output of 50 to 300 watts. Modules can be assembled into arrays, which can vary from just two modules for a small residential system to hundreds of modules for a utility-scale system of 100 kW or more. The PV modules are the fundamental, but not the only, components of a PV system. Various mounting brackets, supports, and hardware are required to position and hold the modules. An inverter is required to convert the modules' direct current (DC) output to the grid's alternating current (AC) standard. A step-up transformer may be required to increase the voltage to that of the grid. The costs of these non-module, or balance of system (BOS), components are significant. They make up almost half of total system costs.

Unfortunately large utility scale, grid-connected solar power plants are highly uneconomic even compared to other renewables. Large commercial scale solar projects are relatively rare. The largest solar power plant in the world is in Germany<sup>6</sup>. The 5 MW facility with 33,500 photo-voltaic modules covering 21.6 hectares or 53.38 acres was energized on September 8, 2004. The cost of the plant was \$22 million Euro or \$26.5 million US. There have been suggestions that the electricity produced at Mohave could be replaced by solar power.

Mohave is a 1580 MW facility. Using the 5 MW facility as a guide, replacing Mohave would require 10,586,000 photo-voltaic modules covering 16,868 acres at a cost of \$8,374,000,000. With a price tag of over 8 billion US dollars, financing would be extremely difficult, if not impossible to acquire and the market prices for electricity would be insufficient to provide a repayment of debt.

As shown in the table below, a new solar power plant is likely to be roughly five times as expensive as a new fossil power plant. An upgraded Mohave plant is one seventh the cost. Without large subsidies, no solar power plant would be viable and in any case new transmission would be very expensive.

**New Wind and Solar are Even More Costly than New Coal (2000\$) –  
Gas \$3.36/MMBtu<sup>7</sup>, Subsidy, CO<sub>2</sub> and Capacity Penalty**

<b>Cost Parameter</b>	<b>Wind</b>	<b>Coal<sup>1,3</sup></b>	<b>Gas CC<sup>1,3</sup> Low Cost Gas</b>	<b>Solar</b>	<b>Mohave Upgrade<sup>8</sup></b>
Power Plant Capital	982	1400	746	3831	651

<sup>6</sup> As reported by Xinhau News Agency of CEIS on September 9, 2004.



(\$/kW) <sup>5</sup>					
Transmission Costs (\$/kW)	250	250	250	250	0
Capital Costs (\$/MWh) <sup>1</sup>	51	26	17	182	10
Capacity Penalty (\$/MWh) <sup>4</sup>	17	0	0	15	0
O&M (\$/MWh)	9	6	4	4	6
Fuel (\$/MWh) <sup>2</sup>	--	13	23	--	12
Federal Subsidy <sup>6</sup> (\$/MWh)	-11	--	--	--	--
Total (\$/MWh)	66	45	44	201	28
Capacity Factor	32%	85%	88%	30%	85%

Note: Costs represent a national average by type of unit under a status quo case for environmental policies. Capital cost and O&M cost data for nuclear, wind and photovoltaic is from AEO 2002; the rest is from ICF.

<sup>1</sup> Assuming capital charge rates of 11.7% for wind, solar, nuclear and coal (based on a 40-yr life) and 12.8% for gas CC (based on a 30-yr life)

<sup>2</sup> Assumes heat rate of 10,000 Btu/kWh and 6,786 Btu/kWh for scrubbed coal, gas-fired CC, respectively.

<sup>3</sup> Units super controlled for SO<sub>2</sub> and NO<sub>x</sub> for simplicity.

<sup>4</sup> \$60/kW-yr capacity price. Capacity penalty of 80 percent and 65 percent were assumed for wind and solar, respectively.

<sup>5</sup> Excludes interest during construction and interconnection cost for solar, wind and nuclear. These costs are included for coal and gas CC.

<sup>6</sup> Based on an \$18/MWh rate for 10 years levelized over a 20-year lifetime of a renewable project a 6.2% real discount rate.

<sup>7</sup> Levelized Henry Hub prices over a 20-year period discounted at a 6.2% real discount rate.

<sup>8</sup> Capital cost based on \$1,080 MM (2002\$) as the cost of retrofitting Mohave.

A photograph of a 4 MW commercial scale solar project in Arizona is shown below.



With the passage of the Arizona Renewable Portfolio Standard, which is designed to boost the development of renewable energy technologies within the State, a number of large scale solar projects have recently been built or are now under construction. The RPS requires utilities to obtain at least 0.8% (in 2004, ramping up to 1.1% in 2007-2011) of the total retail energy sold from renewable electric technologies, 60% of which must be from solar.

As a result of the Arizona RPS, Tucson Electric and APS both have developed large PV installations in the State. Tucson Electric developed a 4 MW PV facility near Springerville, Arizona and APS has developed large facilities in Flagstaff and Prescott. These facilities were driven in large part by the state requirement for renewables and the proximity to utility transmission lines and interconnect points (i.e. substations).



Tucson Electric Power's 300 KW PV Facility Adjacent to Its TEP Substation

### **Village Sized Solar Photovoltaics**

At the benchmark retail price of \$7,000 to \$10,000 per kilowatt, PV systems yield electricity at a cost of 25 to 40 cents per kilowatt-hour, roughly three to five times the typical price a grid connected Hopi residential customer pays for power. However, PV system can become immediately competitive where utility lines are not available without significant added cost.

PV systems can benefit from economies of scale for multi-family and clustered residential projects. Systems do not necessarily have to be located on the residence for the residence to benefit. Shared systems can offset energy bills of residences sharing infrastructure and utility costs. Costs per kilowatt can be significantly reduced for systems using 10-30 kW compared to the typical 1-2 kW residential system. Larger systems can be located away from residences and ground mounted thereby further reducing costs.

For a 2.0 to 2.5 MW Reservation-wide power scenario, a large PV facility could be located adjacent to and integrated with the Keams Canyon substation. Such a large facility would benefit from economy of scale, would increase the reliability of electric customers downstream from the substation, and could be coordinated with power purchases from APS and WAPA. In fact, APS may be an interested partner in such a facility in order to comply with the State's RPS rule.

For a village power scenario, a single large PV system (or smaller building mounted systems) is a logical candidate power source for the New Town being planned north of the Second Mesa

area. Given the distance of the New Town site to the existing electric grid (12 miles), PV systems may be the most economical power delivery option.

## **Residential Solar Power**

Although there are many applications or uses for remote solar power, this discussion will focus on supplying electrical power to homes in remote areas.

As described below, the cost of PV systems installed by NativeSUN, a local solar electric enterprise on the Hopi reservation, installs systems that may cost \$5,000 to \$15,000, which is far less than the cost to extend the electric grid (nearly \$15,000 to \$35,000 per mile) to serve homes in many Hopi communities. NativeSUN sells its solar electric renewable credits to APS to help the utility meet its goals under the state's renewable portfolio standard (RPS; see discussion below).

Photovoltaic systems convert sunlight directly into electricity. A PV system will not produce any electricity at night or under cloudy conditions, so it is necessary to design a system that will store excess electrical energy in batteries for use when needed.

### **GETTING READY – ENERGY EFFICIENCY AND SYSTEM SIZING**

The motivation for installing a solar electric system on a home in a remote area is based on the cost of extending power lines to the site. If as little as a mile of new power line is required to reach the home, the cost from the utility company would be many times the cost of purchasing a PV system. PV systems are quite expensive to purchase, however, the savings from not having a utility bill recaptures the investment in a few years. The trick to maximizing the return on the investment in a PV system is to size it properly and to use it effectively. If a PV system is too small, there is not enough electricity to supply the family's needs, the batteries are constantly discharged, and the cost of maintaining the system is much greater. If a system is too large, the savings are insufficient to warrant the investment.

The first step in sizing a PV system is to determine how much electricity is needed by adding up the power ratings of lights and appliances and multiplying by the number of hours that each will be on during the day. For example, a 100-watt light bulb that is on for 5 hours will consume 500 watt hours of electricity. Energy efficiency plays a big part in getting the most out of the money invested in a PV system. More energy efficient lights and appliances always pay for themselves in even if they cost more to begin with. For example a typical refrigerator needs 300 to 500 watts compared to 60 watts for an efficient DC model refrigerator. Compact fluorescent light bulbs produce the same amount of illumination with a fraction of the energy required by standard incandescent bulbs.

Below is a table of possible electrical loads for a remote home.

Appliance	How Many	Watts	Hours Used Per Day	Watt Hours Per Day
Compact Fluorescent Lights	4	20	5	400
Refrigerator (efficient)	1	60	24	1440
13"TV VCR Combo	1	100	3	300
Ceiling fans	2	25	12	600
Evaporative Cooler	1	240	8	1920
Computer	1	180	2	360
Total Watt Hour Load				5020

The total electrical needs to be adjusted for system efficiency losses by multiplying the total load by 1.4. The adjusted load is 7028 watt hours per day. The load can be reduced significantly with the use of a propane refrigerator.

## **EQUIPMENT REQUIREMENTS**

### **PV MODULES**

The next thing to do is decide how many solar modules will be needed to provide the number of watt hours necessary. In Arizona, the average number of hours available to collect solar energy each day is 6. A 100-watt module or panel will produce 600 watt hours each day. Divide the total watt hour load by the production of the panel. It will take 12 -100-watt panels to support the load. The total system watts or rating will be 1,200 watts.

### **CHARGE CONTROLLERS**

A charge controller prevents damage to the batteries. Each panel will produce about 8.33 amps of current so a charge controller rated for at least 100 amps will be required. The amount of current in the system can be minimized by changing the system voltage. System voltage is determined by series and parallel connection of the modules. Two 12-volt modules wired in parallel will produce 12 volts and 12 amps. Two 12-volt modules wired in series produce 24 volts and 6 amps. So the system voltage can be selected to suit the desired charging current as follows:

System Voltage	System Amps	System Watts	
12	100	1200	Charge controllers are available that are adjustable for different system voltages.
24	50	1200	
48	25	1200	

### **BATTERIES**

Batteries are rated in Amp Hour capacity. A popular battery used in PV systems is the 6 volt Trojan L16, with a 350 amp hour capacity. The L-16 has a total capacity of 2100 watts (350AH times 6 volts). The battery capacity needs to be adjusted for efficiency and depth of discharge. If batteries are allowed to discharge to 70% of their capacity, the capacity of the L16 is 1470 watts.

Our total daily load is 7028 watt hours so it will take 5 batteries to supply the load for one day. If you want 3 days of storage, 15 batteries will be needed. Since the series parallel wiring of the batteries needs to match that of the modules (system voltage) an additional battery will need to be added. (8 pairs of two batteries for 12 volts, 4 groups of 4 batteries for 24 volts, and 2 groups of 8 batteries for 48 volts.). The total storage capacity of the battery bank will be 23,520 amp hours.

#### **DC / AC CURRENT CONVERSION**

At this point, it would be possible to hook up DC (Direct Current) lights and appliances to the system (PV panels, a charge controller, and batteries). DC lights are like those in a car and operate on 6,12,24,or 48 volts. Direct Current is either on or off with nothing in between, like the light in a flashlight. AC or Alternating Current alternates between on and off over a period of time (60 cycles per second). The spinning of a generator causes the voltage to vary from being fully on, decreasing until fully off and then increasing until fully on again, 60 times each second. The human eye does not see the light going on and off.

There are DC lights, motors and appliances available on the market. However, the vast majority of homes are wired for AC current because that is what the utility produces. PV modules produce only DC current. AC lights and appliances will not work with a DC power system. If conventional AC appliances and lights are going to be used, the battery current needs to be converted from DC to AC using an inverter.

#### **INVERTERS**

Inverters are sized to carry the largest AC load the will be used at one time. If our entire system load was to be operated at once, a 5000 watt inverter would be required. The inverter will convert the DC-Direct Current to AC-Alternating Current, thus allowing the use of standard lights and appliances. Modern inverters also perform a variety of other functions such as back-up generator starting, battery maintenance, utility interface, and system monitoring.

#### **BACK UP GENERATORS**

It is important to have power available without interruption in remote areas. The addition of a back-up generator insures that if there are prolonged periods of cloudy weather or a failure of the PV, the charge on the batteries can be maintained. The backup generator can run on whatever fuel is desired and should be sized to support the entire home load if necessary. The inverter will monitor the battery and allow the generator to provide DC charging current to the batteries if necessary. The backup generator can be used to equalize the batteries which prolong their life. In the event of a battery failure, the inverter will allow the generator to provide AC current directly to household loads.

#### **OPTIONS**

There are a number of options available to make PV systems more efficient, reliable, and adaptable to varying sites and conditions.

#### **TRACKERS**

The PV modules are usually fixed into a framework or array. PV arrays can be positioned in a fixed array tilted to optimize solar collection or on a tracker that follows the sun from east to west. A tracker will increase the output of a fixed array by approximately 30%. The best trackers for remote homes have no moving parts and use a temperature sensitive oil to cause the tracker to move from east to west during the day and back to east in the morning. Trackers that rely on electro-mechanical devices are generally prone to failures.

### **BATTERY ENCLOSURES**

Batteries are sensitive to the environment around them, particularly the outside air temperature. Battery capacity decreases as their temperature increases. Placing batteries in an insulated enclosure reduces the impact of air temperature variations on system performance, increases battery life, and reduces the risks associated with exposed contacts and caustic liquids.

### **WIND GENERATORS**

It is not uncommon for small-scale wind generators to be used in conjunction with PV systems to provide battery charging capacity in addition to the PV array. The use of a wind generator in a remote system will, increase the amount of “free electricity” available by running at night, and reduce the amount fuel needed to support back-up generator run time.

### **GRID TIE**

In areas where there is electrical power available from the utility grid, it is possible to connect PV systems that will replace grid power with “free” solar energy. Grid tied PV systems can serve as uninterruptible power supplies in areas where the utility grid is unreliable or there is poor power quality. A utility connection will eliminate the need for a back-up generator. The inverter will monitor the battery charge level and use grid power to maintain the charge in the event that the PV is unavailable (at night). Grid tied systems can also be configured without batteries so that utility power is displaced when PV power is available. A grid tied PV system can also sell excess PV or wind power back to the utility company through a bi-directional meter.

### **CONFIGURATIONS**

PV systems can be arranged in any number of configurations based on local site conditions. Often, the area behind a fixed PV array will be enclosed to house the batteries, inverter, disconnect switches, and other components. Such a self-contained configuration can be built in one location or factory and delivered to a remote home, ready to hook up to the house wiring.

It is a very common practice for the PV panels to be mounted on the roof of the home and connected to the Balance of System (BOS) components inside the home or in weatherproof enclosures outdoors.

PV system companies manufacture a variety of boxes and enclosures that can contain either the batteries (battery box) or the electric power components such as the inverter, charge controller, and disconnect switches (power center) or both. Battery boxes and power centers are designed

for outdoor use. If there is sufficient space in an indoor room, garage, or shed batteries and power electronics components can be mounted in racks designed for that purpose. Batteries, however, should be ventilated outdoors to prevent the build up of combustible hydrogen gas. It is a common practice to mount the inverter and other components directly on a wall.

### **MISCELLANEOUS PARTS**

We have discussed the major components of a PV system, however there are a number of minor parts that are necessary to connect all of the major components together and provide safety protection.

### **WIRE AND GROUNDING**

Correct wire sizes are very important. If wire is too small, it will heat up under high current conditions. Larger wire diameters can carry more current but can become quite expensive. The connectors used to secure wires to each component of the system are critical to good system performance. Proper connectors will insure good electrical connections and prevent failures caused by wires coming loose.

All electrical systems are required by the National Electrical Code to be grounded. This is accomplished by driving a long copper grounding rod into the earth and making ground connections with heavy-gauge copper wire. All of the system components except the batteries should be connected to the ground rod. Generally the case or frame or chassis of all the components is connected to ground. The frame of each module in the PV array is connected to the array structure and then to the earth ground. This arrangement protects people near the system by providing a path to ground for electrical current that otherwise would pass through a persons body if they were to touch a "hot" connection. The grounding system also protects system components from similar circumstances and lightning.

### **FUSES, CIRCUIT BREAKERS, AND DISCONNECTS**

A fuse is a device that will break the connection in a wire in the event of a short circuit. A "short" causes extremely high current flows which if left un-attended, can heat wires and components to the point of combustion. A fuse will "blow" to prevent fire and damage to components but must be replaced afterwards. A circuit breaker will "trip" to disconnect in the event of a short circuit, but can be reset after the short has been repaired. Disconnect switches are used to isolate or shut off the system during maintenance activities. A typical system will have a disconnect switch between the PV array and the charge controller to isolate the PV array from the rest of the system. There is also a disconnect between the battery bank and the inverter.

The inverter will have a disconnect switch to isolate the AC loads from the entire system. A grid tied system will have a disconnect to isolate the system from the utility grid.

### **COST**

The PV modules are the most expensive part of a PV system and represent about 50% of the cost of an entire system. A small home system with six 80-watt modules, 8 L16 batteries, 2400watt inverter, mounting structure, and BOS (Balance of System) components will cost about \$6,000 without installation. The installation could cost between \$800 and \$1600 depending on the location and site conditions. The medium sized system used as the example in this article, with 12 panels, 16 L16 batteries, a 5000-watt inverter, mounting structures and BOS components will cost about \$14,000 installed. A large system, 2000 watts, with 24 panels, mounting structures, inverter and BOS will cost about \$23,000 installed.

The addition of a backup generator will add between \$2000 and \$6,000 to the cost of the system. Grid tied systems without batteries will be less expensive by about 25%.

### **SUPPLIERS**

There are many companies supplying remote home PV systems in Arizona. PV system companies do not generally distinguish themselves from one another by price. The cost of the system components is usually about the same from one dealer to the next. The cost of installation can vary quite a bit but the important distinction between companies is their history and reputation. A PV reputation for service is the most important element in selecting a system. The length of time that a company has been in the PV business and the prospect that the company will continue to be around to provide the necessary service for a system into the future are two things to look for in selecting a supplier.

It is important to do research on both the components that are included in a system and the background of the supplier. System components are of a good quality, with a proven field record for reliability. The size of the system or the number of appliances that the system can operate should be consistent from one supplier to the next. A system or supplier that says it can provide more power for less money should be carefully checked out. Anyone contemplating the installation of a PV system should talk to people who have similar systems and get their input on the reliability of the system and the company that installed it. Below are few distinguished PV companies in Northern Arizona:

Native Sun	Sun Amp Power Company	EV Solar
P. O. Box 660	2620 Pinnacle Peak Rd.	2655 N. Hwy 89
Kykotsmobi, AZ 86039	Phoenix, AZ 85027	Chino Valley, AZ 86323
928-734-2553	623-580-7700	928-636-2201

## **Other Solar Applications for Remote Areas**

### **SOLAR WATER PUMPING**

Using PV or wind generators to operate a well pump is well proven technology. If the PV system installed on a remote home is large enough, then some of the energy could be used to power the well pump. However, the distance between the house and the well is a significant factor and generally the well pump requires a separate system. A well pumping system usually consists of the solar modules (usually mounted on a tracker), a pump controller to start and stop the pump



based on the available solar energy, a submersible well pump and its drop pipe and wire, and a storage tank. Because PV panels only operate during the day, it is necessary to have a storage tank so that water is available at all times. In addition, it may be necessary to install a pressure pump to produce sufficient water pressure for the home. Depending on the depth of the water in the well and the desired amount of water, the cost of a PV well pumping system can vary widely. The chart below shows some costs without installation or storage tanks.

Vertical Lift in Feet	Gallons Per Day	Cost not Installed
100	500	\$ 1,900
150	1000	\$ 6,000
300	2000	\$ 12,000

A storage tank and pressure pump will cost about \$3,000 for a 1000 gallon system, \$4,000 for 2500 gallons and \$5,000 for 5000 gallons. Installation cost will vary depending on the location and the company doing the work. A well drilling and service company might be required and they cost up to \$1000 for the day. It is possible to install submersible pumps in shallower wells without professional help, however, it is less expensive to have a well driller install the pump than it is to have them retrieve a pump that has been dropped down the well.

Wind turbines are a popular alternative to PV systems in windy locations. There are also wind powered pumps that use compressed air to lift water out of the well. Deep well pumping (over 1000 feet) is possible with solar powered jack pumps. A jack pump has a mechanical shaft that goes down the well and “jacks” the water up the pipe with up and down motion of the shaft, just like the old windmills that were so popular years ago.

### **THERMAL SOLAR**

Solar energy can be used to heat hot water for remote homes. To heat water with an electric hot water heater that runs off of the solar PV would be extremely expensive and inefficient. Panels are available that heat the water directly using solar energy. There are two basic types of solar water heating systems. Active systems use a pump to circulate the water from a hot water heater storage tank through the solar panels. Passive systems heat the water without the need for a pump. There are advantages and disadvantages to both.

#### **ACTIVE SOLAR HOT WATER HEATING SYSTEMS**

Active systems require some electrical energy to operate the circulating pump between the collector and the storage. The advantage of active systems is that by using a heat exchanger, an anti-freeze solution can be used in the collectors to prevent freezing in cold climates. The disadvantage is the use of pumps and controllers increases the chance of failure.

#### **PASSIVE SOLAR HOT WATER HEATING SYSTEMS**

Passive systems do not require any pumps or electrical devices to circulate hot water into storage. By locating the solar panel physically below the storage tank, the cold water in the tank will sink down to the collector where it is heated and rises back to the top of the tank by a

process known as thermosiphoning. Another method is to combine the storage and solar collector into one unit called an integrated collector storage (ICS) unit that is heated directly by the sun's rays. Both passive systems are less susceptible to failures because they have no moving parts or electrical components. However, passive solar water heaters are susceptible to freezing.

### **SOLAR FOR SPACE HEATING**

Solar panels can be used to heat hot water in sufficient quantities for winter home heating. The challenge is to get enough heat into storage during the day, when the energy is available, for use at night, when it is needed. A solar hot water system must heat up at least 500 to 1000 gallons of water to be able to supply a home's needs for a couple of days. This requires several large solar panels and a system of pumps and controls to heat the water and to circulate it through the home. A popular method is to imbed special plastic tubing in a concrete floor and circulate the hot water heat through the slab. This method is called a hydronic radiant floor system. Hot water can also be circulated through a series of radiators, however it is difficult to get the water hot enough for radiators to run effectively, and a small boiler may be required to make up the difference.

There is a type of solar panel that uses hot air to heat up a storage container filled with either rocks or some other material for use at night. Both hot water and hot air systems require a number of electrical components and controls to operate. Solar space heating systems are complex and require a lot of attention from the homeowner.

### **PASSIVE SOLAR HEATING**

Passive solar refers to the practice of allowing the sun's rays to shine directly into the home through south facing windows. Storing the sun's energy for night time use requires thermal mass in the form of concrete, stone, compacted earth, or water tanks. The best way to use passive solar is to design a home specifically for that purpose by including the southern windows and features such as concrete floors, stone or adobe walls and methods that allow the natural circulation of air within the home.

### **SOLAR COOLING**

In the southwest, summer cooling is often more of a concern than winter heating.

### **LOW ENERGY EVAPORATIVE COOLERS**

There are a couple of manufacturers that have developed very low energy use DC and AC evaporative coolers for use with PV systems. These coolers use a fraction of the energy of conventional coolers. Solar evaporative coolers are available from 500 to 3000 cfm and can cool up to 1000 square feet of living space. Southwest Solar from Tucson and Sun Amp Power Company from Phoenix, both carry solar evaporative coolers.

### **LOW ENERGY AIR CONDITIONERS**

The air conditioning industry is just starting to respond to the need for air conditioning units that do not require massive amounts of energy. A prototype air conditioner that can cool up to 1000

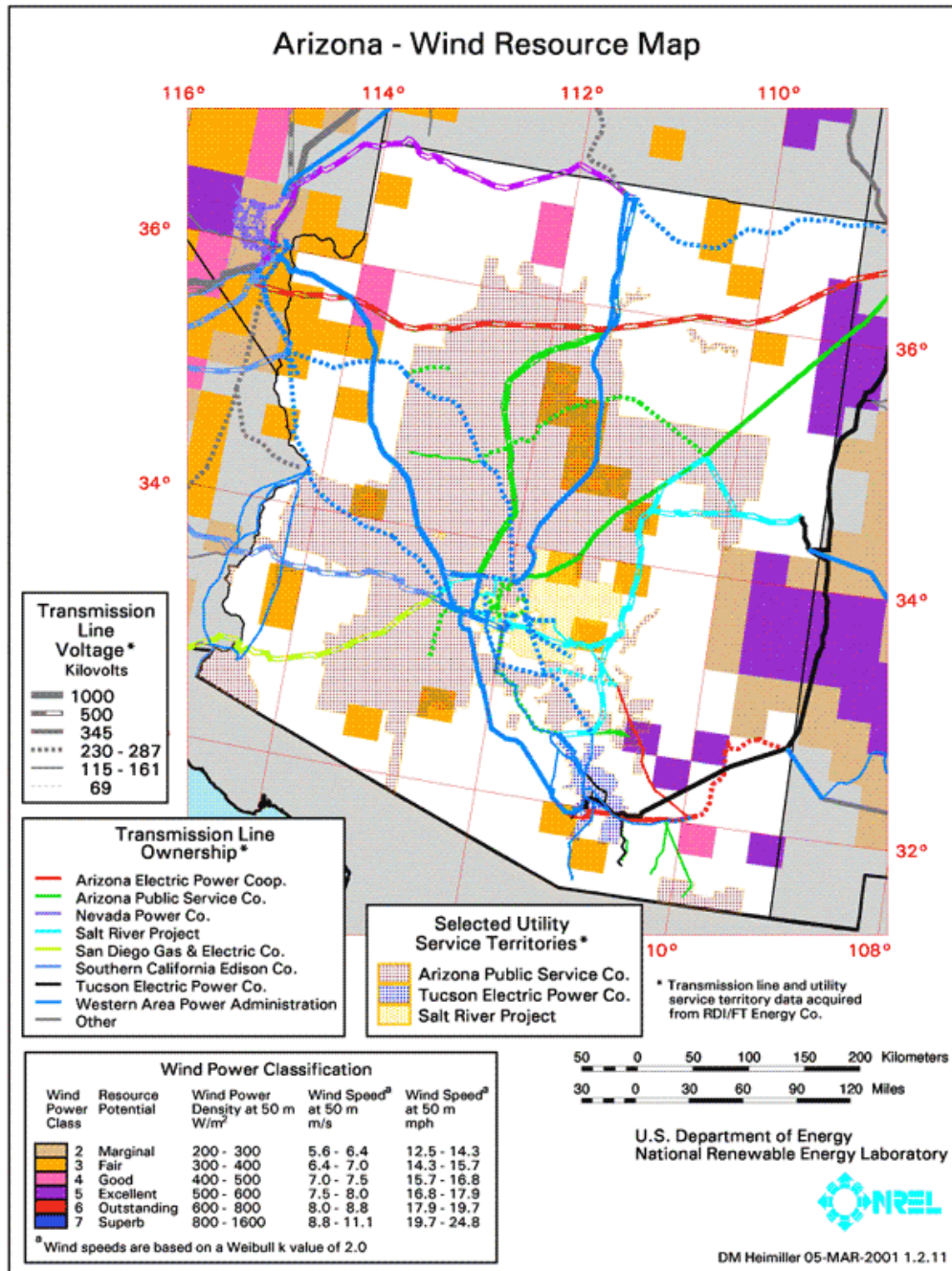
square feet and uses amounts of electricity that are compatible with a solar PV system is being promoted by Sun Amp Power Company from Phoenix.

#### **MAINTENANCE OF SYSTEMS**

Of critical importance is the careful maintenance of these systems. Many tribal programs have shown that placement of remote systems with families often leads to failure if training on upkeep of all facilities is not provided and if routine care is not provided to the systems.

#### **Wind Power Generally**

The National Renewable Energy Laboratory maintains the US Department of Energy's wind energy resource data base. NREL data and resource maps indicate that there are isolated pockets of land suitable for wind farm development in Arizona. NREL's maps, which are regarded as preliminary until empirical data is taken, indicate that the Hopi Reservation does not have a suitable wind resource for commercial development. An examination of historical wind resource data (at 10 meter elevation) for Winslow, Arizona also indicates that annual average wind speeds are relatively low (Class 1 to Class 2). Wind regimes of Class 4 or higher are typically required to support utility scale projects.



However, wind resources are highly site specific and generalizations often overlook promising areas. The Hopi Tribe is installing meteorological towers on two promising wind power locations to gather long-term wind speed and direction data with which an evaluation of wind power potential can be evaluated. Some existing wind data is described below.

Wind Data for Hopi [Winslow Airport 4895 Ft Elevation (@10M)]  
Average Wind Speed (mph) by Month  
1992-2000, WRCC      1961-1990, NOAA      1930-1996, NOAA

Jan                      6.6                      7.1                      7 (SE)

Feb	7.6	8.5	9 (SE)
Mar	8.3	10.6	11 (WSW)
April	9.8	11.3	11 (SW)
May	10.0	10.9	11 (SW)
Jun	9.6	10.6	11 (SW)
Jul	8.5	9.0	9 (WSW)
Aug	7.3	8.4	8 (SW)
Sept	7.2	8.2	8 (SW)
Oct	6.5	7.6	8 (SE)
Nov	6.3	7.3	7 (SE)
Dec	6.1	6.7	7 (SE)
Ann	7.8	8.8	9 (SE)

## Large Commercial Wind Farms

The start up costs for a wind farm are significant, with an estimated turnkey capital cost of approximately \$1,000,000 per MW for a large wind farm (50 MW+) and \$1,500,000 and higher for a smaller wind farm (~ 10 MW). The major cost component of any wind farm is the turbines. A one MW turbine currently costs about \$700,000. Usually the turbines are installed in clusters, or wind farms, that provide more reliability because the generation is spread across several systems. The higher capital cost for installing wind power turbines and their supporting towers is offset by the lack of any fuel cost. Unfortunately, power from a wind turbine or wind farm is not 100% dispatchable, and either a diesel generator or micro gas turbine must back up the wind farm or the power must be firmed by purchased power contracts from a major electricity supplier, like Arizona Public Service or Western Area Power Administration.

Interconnection of the wind farm at a local substation, and transmission to a load along wires with existing capacity is also a requirement for a wind farm. The same issues plaguing other types of generation from Hopi lands are also a problem for wind generation.

The cost of the electricity from wind turbines is highly dependent upon the speed of the wind resource and the size of the wind farm (which effects the amortization of fixed operation and maintenance costs across the generating system size, bigger is better). Assuming a class 3 to 4 wind resource, the cost of electricity is probably going to be in the range of 7 to 10 cents/kWh (APS's generating costs are currently in the 3 cent range). When the cost of firming power by diesel generators or backup power contracts is added the actual comparable costs are more likely in the range of 12 to 15 cents/kWh.

To develop a large wind farm (10 MW or larger) intended primarily for commercial production (and export) of power, the Hopi Tribe and/or its development partners would be required to execute a long term (10-15 years) power purchase agreement with a utility or other marketer of electricity. Further, a wind farm on the Reservation would need to be located near the Keams Canyon substation and the 69 KV line that comes in from the south, or to an NTUA substation, to cost effectively get the power to off-Reservation markets. There are options for wind farms at the Hopi Ranches that are under consideration by the Hopi Tribe.

## **Distributed Wind Power**

Wind power may be an option for the New Town site, subject to available wind resources and the evaluation of environmental impacts at the site. It is not likely that wind farms sited near the New Town site will be connected to APS's nearby 500 kV line as the interconnect costs would be prohibitive. More likely a small cluster of wind turbines (2-3 utility scale turbines) would be located some reasonable distance from the New Town village and the power would be firmed with diesel or micro-turbine backup.

Wind is also a possibility for remote water pumping or for residential applications, however, a proven wind resource is needed prior to investment in the purchase of turbines and other equipment.

## **Air Quality Impacts of Renewable Energy Development**

Renewable energy development generally does not negatively impact air quality. It is likely to displace electricity produced from the burning of fossil fuels. For this reasons, certain "green tag" markets are emerging. Green tag markets, like the one established by the Bonneville Environmental Foundation, match entities that develop renewable systems with entities that wish to support renewable energy development. These markets can be accelerated by federal, state or local "portfolio standards" that mandate regulated entities to have a portion of their electricity provided by renewable energy. If that entity does not develop their own source, they can pay a sum of money to purchase a "tag" from someone who is developing renewables, but is not mandated to do so.

Private negotiations of green tags have been successful. For example, the Rosebud Sioux Tribe's new wind turbine was partially funded with a green tag purchased by Ben and Jerry's Ice Cream Company. The tag helped pay for a turbine that otherwise was more expensive than alternative sources, and it gives Ben and Jerry's the opportunity to claim that renewable energy was used in the making of their ice cream.

## **III. POWER PLANTS AND HOPI COAL/WATER ISSUES**

### ***1. Generation Using Hopi Coal***

Under coal leases entered into in 1966 with Peabody Western Coal Company, coal jointly owned by the Hopi Tribe and the Navajo Nation is mined at the Black Mesa and Kayenta mines. Revenues from coal royalties are shared 50/50 by the tribes. Hopi has objected to the issuance of a permanent mine permit for the Black Mesa Mine by the Office of Surface Mining of the United States Department of the Interior (OSM). Since that objection was logged in 1991, no permanent mine permit has been issued to Peabody by OSM.

## **Navajo Electrical Generating Station**

The Navajo plant, in Page, Arizona, burns 13-14 million tons of tribal coal annually. Transportation of the coal from the Black Mesa to Page is by railroad. The plant produces roughly 25,000 tons of nitrogen oxide and 14,000,000 tons of carbon dioxide every year. Prior to the installation of the scrubbers to remove sulfur dioxide, the plant emitted an average of 72,000 tons of SO<sub>2</sub>. After the scrubbers were installed, that figure dropped to 6,000 tons annually.<sup>7</sup>

Construction and installation of the first scrubber at the Navajo Generating Station began in 1995 and went into service in 1997. The plant's second scrubber was installed in 1998 and the third in 1999. As of November 1, 1999, the cost to remove the pollutants was \$420 million.<sup>8</sup>

## **Mohave Electrical Generating Station**

The Mohave coal fired electrical generating station was built from 1967-1971 and is located 75 miles southwest of the Grand Canyon National Park. Its fuel comes via a 273-mile slurry pipeline from the Black Mesa. The Mohave plant emits over 40,000 tons of sulfur dioxide (SO<sub>2</sub>) a year, 10,000 tons of particulate matter (PM 10), and 20,000 tons of nitrogen oxide.<sup>9</sup>

The Mohave Generating Station coal-fired power plant has been one of two customers for Hopi coal since the power plant came on line in the early 1970s. The plant is a large 1,580 MW coal fired power plant located at Laughlin, Nevada, south of Las Vegas, and supplies power to California, Southern Nevada, and Arizona. The plant currently does not have flue gas desulfurization (FGD) equipment. Even so, because the coal sulfur content is low by US standards, emissions are below average US levels for coal power plants.

The plant is located with direct access to Southern California which is otherwise almost exclusively relying on natural gas generation for incremental electricity supply. Natural gas generation is more costly than generation from the Mohave plant under almost any scenario. Two aspects of this are worth noting. The fuel costs of Mohave have been in the \$1.23/MMBtu to \$1.31/MMBtu range in comparison to recent natural gas prices close to \$6/MMBtu. Non-fuel Operation and Maintenance (O&M) is also low compared to other coal plants.

<sup>7</sup> [www.grandcanyontrust.org/ggc/grcanyon/air/navajo.html](http://www.grandcanyontrust.org/ggc/grcanyon/air/navajo.html)

<sup>8</sup> [www.grandcanyontrust.org/ggc/grcanyon/air/navajo.html](http://www.grandcanyontrust.org/ggc/grcanyon/air/navajo.html)

<sup>9</sup> [www.grandcanyontrust.org/ggc/grcanyon/air/mohave.html](http://www.grandcanyontrust.org/ggc/grcanyon/air/mohave.html)

### Delivered Mohave Coal Costs<sup>1</sup>

Source	Coal Price (\$/MMBtu)
1990 – 2001 Period <sup>1</sup> (Nominal\$)	1.23
2001 (Nominal\$)	1.24
2000 (Nominal\$)	1.24
1999 (Nominal\$)	1.31

<sup>1</sup>FERC 423

### Non-Fuel O&M Costs – Mohave and Other Coal Plants (Nominal \$/MWh)

Year	Mohave	Average of All U.S. Coal Plants
1991	7.0	5.4
1992	5.6	5.3
1993	6.0	5.0
1994	7.0	5.0
1995	5.1	5.0
1996	5.5	4.5
1997	4.8	4.4
1998	4.5	4.8
Average 1991 – 1998	5.7	4.9

Source: UDI

### Potential Closure of Mohave due to Air Pollution Consent Decree

The Clean Air Act was amended in 1990 to create a regional commission charged with protecting and restoring air quality in ‘Class 1’ pristine natural areas located on the Colorado Plateau, including the Grand Canyon National Park. The Visibility Transport Commission<sup>10</sup> recommended monitoring emissions from large stationary sources, including the Mohave and Navajo generating stations and determining if emissions from these plants impaired visibility.<sup>11</sup> A consent decree resolving a lawsuit brought by environmental groups, Southern California Edison pledged to add SO<sub>2</sub> scrubbers that would remove at least 85 percent of the sulfur from Mojave’s stack emissions, and a baghouse to remove 99 percent of the particulates that form the visible plume from the stack. The utility also committed to installing a sophisticated burner system that will reduce NO<sub>x</sub> emissions.

Under the consent decree, the Mohave plant must shut down by January 1, 2006 unless it is scrubbed for SO<sub>2</sub> control. This agreement was reached during a period when it was widely

<sup>10</sup> The Grand Canyon Visibility Transport Commission has been replaced by the Western Regional Air Partnership or WRAP, in which the Hopis participate.

<sup>11</sup> The Grand Canyon Visibility Transport Commission’s broader “policy” recommendations included developing appropriate energy policies to encourage conservation, efficiency and renewable sources; setting regional targets for SO<sub>2</sub> emissions starting in 2000; developing a regulatory program incorporating a market trading approach in the event that regional targets are not achieved; identifying sources of visibility impairment near class one areas, including pollution from urban areas; developing strategies for enhancing data collection and modeling coordinated among tribal, federal, state and local governments, as cited in the Hopi Economic Report of Charles Pace, Ph.D., February 2003 Draft, pages 25-26



expected that the consent decree would be complied with via installation of the required equipment in a timely manner. The consent was agreed to by Southern California Edison, which operates the plant on behalf of itself (the majority owner) and the other three owners, Salt River Project, Nevada Power and the Los Angeles Department of Water and Power. At the time, Southern California Edison already knew it was going to sell its share of the plant to a new owner and the new owner would need to comply with the consent decree. A sale was made to an independent power producer, AES Company, for \$1.1 billion dollars. However, the sale was cancelled by the state of California, which concluded during California's energy crisis that no more power plants should be sold. Current California law continues to prevent the sale of the power plant. SCE has had serious financial and regulatory problems since the sale was canceled.

The scrubbers and improvements are currently under consideration by the California Public Utilities Commission and are in the engineering, design and environmental permitting phase.<sup>12</sup> SCE has been engaged in a process with its regulatory commission regarding the future of the plant. This process has been ongoing for 2 years and has been strongly affected by the uncertainties associated with the State's approach to electric utility deregulation. The Hopi and Navajo Tribes are involved in the regulatory proceedings before the California Public Utilities Commission where it will be determined whether Southern California Edison may include the costs of upgrading the Mohave Generating Station—scrubbers and other improvements—in its rate base.

The Hopi interests in the proceedings are to ensure (a) that the expenditures necessary to prepare Mohave for continued operations beyond 2005 are authorized by the CPUC in order to ensure that continued coal-fired operations of the plant will continue after 2005; (b) that a source of water other than the N-Aquifer is identified and utilized after the year 2005 to supply the coal slurry and industrial needs of Mohave; and (c) that sufficient coal resources be made available to Mohave to permit its continued operation beyond the year 2005 under reasonable terms and conditions.

It is now almost impossible for a SO<sub>2</sub> scrubber to be installed in time for the 2005 deadline. Hence, the plant may need to be closed for at least some period unless some extension of the deadline could be provided via EPA or other parties' intervention in combination with work on an alternative water solution. The extension of the deadline could also prevent NSR (New Source Review) regulations coming into play since the temporary shut down might be considered a change in plant status. This could further worsen the plight of the plant relative to its peers.

It is possible that the California Public Utilities Commission will disapprove the necessary expenditures for installation of the pollution control devices. On December 31, 2005, absent changes in current court-imposed deadlines, the Mohave coal fired generating station would shut down. As described in detail in this report, the circumstances involved in this situation are

<sup>12</sup> [www.edison.com/community/air\\_quality.asp](http://www.edison.com/community/air_quality.asp); [www.sce.com](http://www.sce.com)

complex. Nonetheless, a Mohave shut down on December 31, 2005 would be directly due to the EPA's regulation of the plant's emission of SO<sub>2</sub>, which EPA has sought to lower.

This shutdown will be unusual by EPA and industry standards:

**Only Second Major U.S. Coal Plant Retirement** – When current Mohave air emission requirements were established, all parties expected that these requirements would be met, and that SO<sub>2</sub> scrubbers would be brought on-line in a timely manner. Indeed, this is only the second time EPA regulations could lead directly to the shutdown of a major U.S. coal power plant (greater than 1,000 MW); no other major U.S. coal plant has ever retired for any reason, except the Gannon plant in Florida. Thus, the fate of the Mohave plant will provide an important gauge against which can be measured the viability of the concept of a clean air partnership and the sustainability of economic activity in light of environmental regulation.

**Remaining Useful Life of Mohave and Peabody Mine Complex** – The remaining useful life of the Mohave power plant and Peabody mine is significant and technical lifetime limitations as such are not the cause of the plant's problems. Prior to recent air pollution problems, the Tribe was planning to receive revenues through approximately 2030. The Mohave coal plant's age approximately equals the average age of U.S. coal power plants practically none of which are planning to retire. Coal in the area of the mine is roughly estimated at several billion tons versus extraction currently of 12 – 13 million tons per year.

**Mohave Emissions Are Lower Than Average** – The Mohave plant currently has low SO<sub>2</sub> emission levels by U.S. standards and employs the same means to control SO<sub>2</sub> emissions as the majority of U.S. coal plants – i.e., Mohave uses lower sulfur coal. Thus, when viewed in the broader context of all U.S. coal fired power plants; the Mohave issue involves fundamental fairness issues.

**Unique Coal Resource** - This is the closest major coal-fueled power plant to California and the coal production that will be idled is from the only Arizona coal producing area.

**Coal Economics** - A Mohave closure will occur in the aftermath of the recent California power crisis. Furthermore, the shutdown will ironically occur during a period when the energy industry has been experiencing the highest natural gas prices (the main competition to coal) in U.S. history. Indeed, in 2003, natural gas prices delivered to power plants averaged \$6/MMBtu versus roughly \$1.25/MMBtu for coal. At this fuel price level, if sustained, most U.S. natural gas plants would be effectively shut down and replaced with coal plants, all else being equal. Thus, it is the tightness of the deadline (the 2005 court imposed deadline) and not the underlying economics of the plant that will be directly responsible for the imminent shutdown.

**Economic Technological Solution Exists** - The plant could decrease its emissions by the retrofit installation of scrubbers for SO<sub>2</sub> control, using commercially common technology. The site is not a particularly difficult site for such a retrofit installation. The installation could occur during an extended deadline period during which water issues are also addressed.

A second reason for the potential closure of Mohave at the end of 2005 is the ending of their contract with the Hopi tribe for use of N-Aquifer water.

## **2. Hopi Water Issues**

The Hopi water situation is very acute due to the arid conditions, a long term regional drought, current dependence on one source, the N-Aquifer, competing uses for the N-Aquifer and the religious and cultural significance of local water resources.

## **A Cultural Resource<sup>13</sup>**

The *Hopi Tutskwat Makiwa'yta: Soosoy Himu Hopit Tutavoyat ev Hintsaktiwqa Qatsit Oovi Natwaniwa*, Hopi Land Stewardship: An Integrated Resources Management Plan for the Hopi Reservation describes Paavahu, or the water resources. It emphasizes that paavahu are highly valued by the Hopi as a main source of life in their harsh and arid environment. The central focus of Hopi ceremonial life is the propitiation of moisture in its various forms. Water provides the domestic and agricultural needs of Hopi people as well as the supernatural and spiritual essence of the Hopi indigenous lands. Water must be protected and conserved so that we may all fulfill the stewardship responsibility: the needs of our children and future generations for this life giving resources.

The Southwestern United States has experienced a multi-year drought. For example, the Upper Colorado River Basin is completing its 5<sup>th</sup> year of drought. In July 1999, Lake Power, just north of the Hopi Reservation, was essentially full, with reservoir storage at 97% of capacity. Since that time, inflow volumes have been below average for 5 consecutive years. Unregulated inflow in water years 2000, 2001, 2002, and 2003 was 62, 59, 25 and 51 percent of average, respectively. Total unregulated inflow for water year 2004 is likely to be 51% of average<sup>14</sup>.

Historically Hopis relied on a dense network of springs for their water. However, growing population and modern development have increased the demand for water and Hopis now rely primarily on subsurface aquifers for use.

Many traditional springs are now drying; most believe because of the drastic increased use of the underground aquifers and potentially due to the long term drought. Many growing communities in northeast Arizona use these same aquifers. The coal slurry is a major user of the N-aquifer. Since the constrained water supplies have to support this growing use, there is negotiation and litigation surrounding water use rights. Since aquifers depend on infiltration of surface water for recharge, they are vulnerable for overuse, drought, and contamination.

The water resources on the Hopi Reservation include surface water resources and ground water resources. Surface waters are five major washes, Jeddito, Polacca, Oraibi, Dinnebito, and Moenkopi. These washes traverse the Hopi Reservation from a northeast to southwest direction. The washes are dry many seasons of the year. All of the washes are listed as impaired under the Hopi Tribe's Clean Water Action Plan Unified Watershed Assessment, due to sediment load, chemical contamination, and presence of coliform bacteria. Ground water aquifers include the various water bearing sands at various depths beneath the surface. These sands include

<sup>13</sup> Information for this section has been taken from previous Hopi planning documents, and from the Testimony of Chairman Wayne Taylor before the California Public Utilities Commission regarding the Mohave Generating Station.

<sup>14</sup> See [www.wapa.gov/crsp/operatns/GlenCanyonOperations.htm](http://www.wapa.gov/crsp/operatns/GlenCanyonOperations.htm).

quaternary alluvial deposits along washes, the Wepo Sandstone Aquifer, the Toreva Sandstone Aquifer, Dakota Sandstone Aquifer, Navajo Sandstone Aquifer, Coconino Sandstone Aquifer, and Muav Limestone and Redwall Limestone Aquifer. Many of the aquifers are limited in their extent or storage or for other reasons are not viable sources of water.

Under coal leases with Peabody Western Coal Company, coal jointly owned by the Hopi Tribe and the Navajo Nation is mined at the Black Mesa Mine. This coal fuels the Mohave Generating Station, near Laughlin, Nevada. The coal is transported to Laughlin by means of a 273 mile long coal slurry pipeline. The water used in the slurry transportation process, and water used in the operations at the mine, as well as at Mohave Generating Station for additional purposes, is now pumped from the N-Aquifer. This aquifer is pure, pristine water deposited in the Ice Age, and is the Hopi's sole source of drinking water. In addition, N-Aquifer water plays a central role in Hopi life, culture and religion: it supports all life on the Hopi Reservation including subsistence agriculture, culturally significant springs and washes, and many important religious ceremonies.

The water lease, part of the overall mining arrangements, contributes \$1 million annually for use of the N-aquifer to slurry. This payment is greatly below current values of pure water. The Hopi Tribe has made it clear to Peabody and the operators of the Mohave Generating Station that after 2005 the N-Aquifer cannot continue to be utilized as the source of water needed to slurry coal. An alternative source of slurry water must be found.

The slurry pipeline has been using approximately 4,000 acre-feet of water a year. Converted into gallons, it uses approximately one billion three hundred three million four hundred four thousand (1,303,404,000) gallons of water per year. This is more than 13 times the total annual Hopi domestic consumption from the N-Aquifer. After 2005, it is estimated that 6,000 acre-feet of water per year will be required for coal slurry, mining and Mohave operations.

The Hopi Tribal policy is that ending N-Aquifer pumping for coal slurry purposes takes precedence over the economic benefits received by the Tribe from Mohave. The Tribe has recently stated, however, that if an acceptable alternative water source can be located to supply the mine and slurry, and if that alternative is in the process of implementation, then, subject to obtaining adequate assurances and firm commitments from all interested parties, the Hopi Tribe would extend the 2005 deadline for a limited period of time. Any alternative water supply and associated equipment must be designed and constructed with additional capacity to deliver water for municipal and industrial purposes to Hopi villages.

Various alternatives have been discussed for replacement of the use of N-aquifer water. The Tribe has adjudicated water rights in the Little Colorado River, but access to the water, which is within the Colorado River system and available at Lake Powell is not available until a pipeline is constructed to bring the water to the Reservation. Such a pipeline raises environmental concerns and may conflict with uses of the Grand Canyon National Park. While the Hopi Tribe believes this alternative is superior, it would likely take more time to resolve.

The most promising alternative appears to be the use of water drawn from the C-Aquifer, (Coconino Aquifer) south of the Hopi and Navajo Reservations and west of Winslow Arizona, along U.S. Interstate Highway 40. The C-Aquifer is a significant source of groundwater

extending over much of northern Arizona and a portion of New Mexico. Hydrological and engineering studies indicate that this aquifer can satisfy all of the needs of the mine and slurry line through the expected life of Mohave as well as some of the needs of Hopi and Navajo communities.

Under this alternative, at least 6,000 acre-feet of water would be pumped from the C-Aquifer annually to satisfy Peabody's total demand for mine and slurry water. As much as 4,000 acre-feet of additional pumping would be available to satisfy some of the municipal water needs of the Hopi and Navajo communities. Water quality at this location is good and would likely require no treatment for Peabody's uses, but might require minimal treatment for domestic consumption. The water would be conveyed 117 miles for the well field to the mine via a steel pipeline connected by a series of pump stations. The total estimated capital cost of the 10,000 acre-feet pipeline is \$103 million. The total estimated annual pumping cost, together with annual operation and maintenance costs would be about \$5 million. Peabody and the owners of Mohave would be responsible to pay that part of the pipeline costs attributable to the satisfaction of their needs and the United States would pay that part attributable to the Hopi and Navajo water uses.

Senator Kyle of Arizona and the United States Bureau of Reclamation have conducted separate and recent studies of alternatives to the N-Aquifer. Although both final reports are yet to be released, their preliminary findings appear to give substantial support to the C-Aquifer alternative.

The Mohave issues are bringing important environmental stewardship issues to the forefront of Hopi considerations. Many decisions regarding Hopi concern for the water resources have been made however others are to be made in time.

## **Water and Sewer Facilities Serving the Reservation**

Water issues also impact local uses of water on the Hopi Reservation. The 2000 census states that 27% of housing units on the Hopi Reservation lack complete plumbing facilities, compared to 1% for the United States, generally. 24% lack complete kitchen facilities. All but three villages: Lower Moenkopi, Old Oraibi and Walpi are served by community water and wastewater systems. These systems typically have been engineered by and built with funding from the Indian Health Service. Many of the systems are old, undersized, inefficient, and in frequent need of repair. The Hopi Agency at Keams Canyon, and the Hopi Jr./Sr. High School and Courts/Police area also have community water and wastewater systems. The Yu Weh Loo Pahki community has a water system but. no waste water system.

The Hopi per-capita water use is estimated at 15-37 gallons per day. The American average is 160 gallons per day. By 2040 the annual demand for water at Hopi is estimated to be 36,300 acre feet per day. Existing water sources will not meet this projected demand. Water is used at Hopi for social and cultural purposes, traditional subsistence farming, livestock production, wildlife, wastewater, village systems, and for its economic benefit. Water is frequently needed for construction projects, but concern over these uses often slows the projects.

According to the *Hopit Tunatya'at 2000*, The Hopi Strategic Land Use and Development Plan, published in 2000 by The Hopi Tribe, all Hopi communities on the main reservation, except Yu Weh Loo Pahki, are dependent on the N-Aquifer (groundwater) as their source of domestic water. Annual water consumption by Hopi communities in 2000 was projected in the plan to be 700 acre-feet/year. This aquifer is also the source of Peabody Coal's water slurry that transports coal mined at Black Mesa to the Mohave generating station in Nevada. A priority of the Hopi Tribal government and many Hopi people is the discontinued use of the coal slurry due to its environmental impacts and the importance of water to life. Alternative sources of water for both the coal slurry and for local needs are under exploration.

### **3. Impacts To Hopi Economy from Mohave Closure**

Hopi has been functioning for many years with several implicit or explicit expectations. These include:

**Coal** – Coal operations would continue to provide revenues to the Tribe through the foreseeable remaining useful life of the Peabody mine and associated coal-fired power plants often estimated to be approximately 2030.

**Transition** – Coal revenues would be used to provide essential government services and the basis for a transition to a more diversified, less coal dependent future.

**Environmental Regulations** – Near-term environmental regulations would be implemented in a manner consistent with continued economic activity. Long-term regulations, while uncertain, might make coal use less economic than gas or other alternatives, especially if stringent CO<sub>2</sub> controls were pursued.

**Economic Regulations of Utilities** – Economic regulation of the electric utility sector would provide for recovery of environmental pollution controls from ratepayers as long as the underlying economics of the activity were sound.

As is discussed below, these expectations have been undermined by recent developments. This has created the need for a strategic change for the Tribe, as well as an urgent need for EPA partnership.

This shutdown will also be unusual in the magnitude and concentration of its economic effect:

**Difficult Economic Situation** - The Hopi Tribe already has unemployment levels greater than 50 percent well above the levels of other demographic groups in the nation who benefit most from EPA policies. The Tribe estimates that a minimum of 150 families will lose their primary source of income if the Mohave plant closes.

**Dependence on Coal** - Coal is the only major source of revenue and industrial activity in the Hopi reservation area. (The Tribe is non-gaming). Coal related revenues account for 60 percent of the Tribal government budget and Mohave related revenues account for 30 percent. The Tribe depends on this budget for basic services including law enforcement, health and education. This dependence is not projected to change in the next ten to twenty years, a period of time the Tribe was expecting to use to diversify its economic base.

**Dependence on Two Customers** - Hopi coal is sold only to two coal-fired power plants, the Mohave Generating Station and Navajo Generating Station. The Navajo plant is already using as

much coal as feasible. Thus, one of the two customers will be directly eliminated due to EPA regulations.

**Single Coal Source** - The Mohave power plant only uses coal leased from the Hopi and Navajo Tribes.

**Isolation Complicates Problem** - The Hopi reservation, and hence, Hopi coal is extremely isolated from replacement markets (see map). The reservation is northeast of Flagstaff. There is no rail, barge, economic truck, or conveyor options to other buyers. Coal is delivered to the nearby Page plant via dedicated rail and Mohave receives its coal from a distance of 273 miles via the nation's only coal water slurry pipeline.

**Unique Situation – EPA and Hopi** – The Hopi Tribe supports the attainment of reasonable levels of air quality in the Western U.S. However, the Tribe did not expect such a truncated transition to a new less coal dependent future. It is difficult to imagine a situation in which EPA policy has so directly affected the economic well being of a Native American Homeland, and the economic well being some of the poorest U.S. citizens.

The Hopi Tribe has a critical 35 year history and economic relationship with the Mohave Generating Station. While the Tribe has not been a formal partner of Southern California Edison, one owner of the plant and plant operator, there is no question that the Tribe's economic security is fundamentally tied to the ongoing operation of the plant. The mine and power plant are viewed as a single economic complex, with Hopi coal being an important component in its overall success. Almost 33% of the tribal budget of \$22 million annually is dependent upon Mohave Generating Station derived revenues. This fact impacts a broad range of Hopi economic life. Coal and water payments relating to Mohave operations in 2004 are projected to be approximately \$5 million and \$2.3 million, respectively. In 2004, all coal based revenues will account for approximately 65 percent of the Tribe's budget. These revenues pay the cost of essential governmental services—Health care, education, law enforcement, infrastructure improvement, village services and the like.

If the Mohave Plant ceases operation without an economic revenue replacement for the Tribe, there will be a catastrophic effect on the Tribe's economy. The reduction in budget would force the Tribe to eliminate or significantly reduce funding for critical programs like education, elderly and youth service programs, and law enforcement. It is estimated that over 150 tribal employees would be laid off. A relatively small number of Hopi who work at the Black Mesa Mine and the water pipeline would also be laid off. The loss of these jobs would almost certainly send these families spiraling deeply into poverty and onto the welfare rolls. These lost revenues and lay offs would have a ripple effect in the local Hopi economy. The revenues from mining constitute the backbone of the local economy. There would also likely be a loss and retardation of critical capital and infrastructure programs such as transportation infrastructure, water/sewer infrastructure, electricity delivery infrastructure, telecommunications infrastructure, and other basic infrastructures.

#### **Economic Situation Without Mohave Will be Even More Difficult**

Hopi Budget (\$MM/Year)	
With Mohave	22
Without Mohave	15

Hopi Public Sector Employment %	44
Hopi Tribal Employment	
With Mohave	~ 500
Without Mohave	~ 350 (?)
Hopi Tribal Expenditures Per Capita (\$)	4,800
Arizona Gross State Product Per Capita (\$)	~35,000 <sup>4</sup>
Water Consumption Per Capita (gp cpd)	
Hopi	15.35
Northern Arizona	160
Unemployment	
Hopi	50 <sup>1</sup> – 64 <sup>2</sup>
Arizona	5.6 <sup>1</sup>
U.S.	5.1 <sup>1</sup>
Percent of Families with Children Below Poverty Level	44 – 50 <sup>3</sup>
Percent of Households with Income Below Poverty Level	63
Percent of Homes Lacking Complete Plumbing Facilities	
Hopi	40
U.S.	1
Arizona	1

<sup>1</sup>1995 data

<sup>2</sup>More recent data

<sup>3</sup>Higher number for families with children under 5

Population is from the Census. AZ Gross State Product is derived by taking the AZ 2001 data and increasing at the rate of 5.4% per year (average rate of 2000-01; higher growth at 7.4%/yr for 95-2001).

## IV. SOCIETAL LEVEL ENVIRONMENTAL ISSUES AND THE HOPI TRIBE

The Hopi Tribe is concerned about, and disproportionately affected by environmental issues and regulations, especially air pollution. This section provides additional information about factors which could heavily affect the Tribe's transition from its current coal based condition.

In the *Hopi Tutskwat Makiwa'yta: Soosoy Himu Hopit Tutavoyat ev Hintsaktiwqu Qatsit Oovi Natwaniwa*, Hopi Land Stewardship: An Integrated Resources Management Plan for the Hopi Reservation, described the reaffirmation of the Hopi Stewardship responsibilities, *Tutavo*. These are rules by which the Hopi are to utilize natural resources and provide conservation efforts for environmental health. A consideration of the air quality, water quality and other environmental issues arising from economic development initiatives is important to any strategic planning effort.

Issues of environmental sensitivity, energy resource development and economic development go hand in hand for the Hopi. The sale of the tribe's coal reserves on Black Mesa provides a significant amount of income to the tribe. Tribal coal reserves are strategically located near large western markets, relatively inexpensive to mine because they can be stripped near the surface and are in demand due to their low sulfur content. Mining of the coal creates certain definable impacts to land, such as removal of vegetation and topsoil and resulting impacts to wildlife and



plant life, changes to surface grades, and air quality impacts from dust and particulates. The land's surface is stripped, the coal removed and the land reclaimed. These impacts are observable, measurable and to a large extent, subject to remediation. Slurrying of the coal leads to impacts to tribal ground water, and burning of the coal for electricity generation creates local air quality questions. Local burning of coal for heating creates questions of both indoor and outdoor air quality.

## **1. Global Warming**

The Greenhouse Effect, also referred to as global warming, is generally believed to come from the build up of carbon dioxide gas in the atmosphere. Carbon dioxide is released when organically based fossil-fuels are burned. As part of the process of photosynthesis, living plants convert carbon dioxide back to oxygen, but the release of carbon dioxide from human industrial activities is occurring at rates higher than the world's plant life can process, thereby overloading the system. The situation is made worse since many of the earth's forests are being de-forested as part of the ongoing process of industrialization, and other plants are being damaged by acid rain—another by-product of industrialization. Thus, the net amount of carbon dioxide in the earth's atmosphere is continuing to increase. These carbon dioxide molecules, when present in large quantities, affect the natural ability of the earth to reflect back into space a portion of the heat received from the sun. This effect is thought to act like a blanket and traps heat close to the surface of our earth, raising ocean and surface temperatures, which in turn effect wind and ocean currents and otherwise contributing to global climate changes.

Global climate change has been called “what may be the greatest environmental challenge humanity has ever faced.”<sup>15</sup> A recent report by more than two-dozen climate scientists and engineers from Scripps Institute, the University of Washington, the Department of Energy, and the U.S. Geological Survey, among others, predicts that global warming will have a devastating effect on water resources in the West. The report says that due to an increase in drought conditions brought on by changing weather patterns, reservoir levels along the Colorado River may drop by more than a third and hydropower generation will in turn drop by as much as 40 percent. The report also found that increases in summer temperatures and decreases in summer humidity might cause a "substantial increase in fire danger over much of the West".<sup>16</sup>

According to these reports, even small long term climate changes will drastically impact agricultural practices, wildlife, and many other natural processes.

Solving this complex problem will require fundamental shifts in the way that the world uses and produces energy, which creates both risks and opportunities for the electric sector.<sup>17</sup>

<sup>15</sup> Corporate Governance and Climate Change, Making the Connection, Douglas G. Cogan, June 2003.

<sup>16</sup> Grand Canyon Trust, Jan. 9, 2003 Press Release [Opposing new coal fired power plant near Tucson]; article found at [www.epa.gov](http://www.epa.gov).

<sup>17</sup> *Electric Power, Investors, and Climate Change, A Call to Action*, CERES, Inc. June 2003.

CERES, Inc. an organization working to lessen the negative effects of climate change recently held a dialogue with many electric utility industry players, investors, and environmental groups. The participants in the CERES Electric Power/Investor Dialogue have developed and agreed to the following statement:

*These recommendations are intended to serve as an alert on climate change to leaders and investors in the electricity industry. Climate change is a serious, long-term environmental and financial threat in need of an early, widespread societal response by businesses, governments, and individual citizens. Addressing it could profoundly change the ways in which we use and produce electricity for many decades to come. Indeed, significant action to mitigate climate change will be necessary in many other sectors of the economy, such as transportation and manufacturing. Because the public and private sectors are becoming more concerned about the impacts of climate change on commercial activity, populations and the environment, the issue presents both risks and opportunities to executives and investors.*

Electric companies in the United States emit significant amounts of greenhouse gases through the burning of fossil fuels, including gas, oil and coal. Carbon emissions are a byproduct of the burning of fossil fuels. Emissions from the U.S. electricity sector--the largest system in the world, supporting the largest economy in the world--are growing and currently contribute 40% of U.S. and 10% of worldwide carbon dioxide emissions, the most prevalent greenhouse gas.

Some electric companies believe it is in their shareholders' and the public's interest for them to act now to reduce these emissions. But they confront the problem that financial and electricity markets do not reward, and in some cases punish, proactive efforts that anticipate environmental issues, such as climate change. Because the cost of mitigating greenhouse gas emissions is not a recognized standard business expense across the sector, investments to address climate change are viewed as a cost with a negative impact on the balance sheet. This creates a barrier to proactive efforts and has significant implications. Put simply, it is cheaper to continue burning fossil fuels and releasing greenhouse gases than it is to develop alternatives. The economy rewards goods produced at the lowest possible price and penalizes those produced at higher cost.

The electricity industry and energy investors are also facing a period of uncertainty about the future national and international regulation of greenhouse gases. This uncertainty makes it difficult for all to determine the future economic cost of greenhouse gas emissions or to completely value the assets that emit them. Shifting political policies may call for a reduction in emissions, thereby driving up the cost of producing today's electricity demands. A power Plant producing cheap electricity in today's market may produce marginal value electricity in a future where strict regulatory measures are imposed. This situation of uncertainty will continue until the U.S. government clarifies the future path for regulation through either domestic or international action.

Managing the uncertain policy environment on climate change is one of a number of significant environmental challenges facing electric company executives and investors in the next few years

as well as the decades to come. Compounding the uncertainties, efforts to combat climate change come on top of a series of other pressing issues facing the U.S. electric industry. They include:

- Volatility in fuel prices, especially natural gas, and a growing demand for electricity;
- Dynamic markets and an uncertain future, some states are working on restructuring their energy laws and the federal government is moving from geographic utility monopolies to competitive utility markets;
- Increased pressure to ensure reliability of electricity supply, particularly in the face of recent blackouts in the northeast;
- Local concerns about power plant sitings and expansions, everybody wants electricity but they don't want the plants that produce it, at least not in their backyard;
- Highly competitive capital markets that are distrustful of an energy industry scandalized in recent years by market manipulation and deceptive accounting practices;
- Increasing requirements to reduce emissions of air pollutants; and
- Introduction of new generation technologies such as fuel cells, biomass, geothermal, solar and wind energy and legal requirements for their use.

Unlike other air emissions of concern, climate change cannot be controlled by currently available “end of pipe” technologies. In other words, there is no technology for preventing the release of carbon dioxide or otherwise economically capturing and sequestering the molecules. As such, advanced, highly efficient technologies and low carbon energy sources will have an increasingly important role to play as society gradually forces itself to reduce greenhouse gas emissions. Further, a price signal, or a regulatory cost that is added in order to provide the market a way of seeing the cost of emissions, will likely result in shifts in the value of different forms of energy generation and the potential increase in value of low- and zero-emissions sources and technologies. An example of a price signal is a government surcharge for emitting a dangerous substance, making the cost of the emission a real cost that must be budgeted for by corporations. This will require significant financial and human capital outlays. Even if started today, the transition will take place over a long period of time to enable gradual capital stock turnover by amortization of existing facilities and to minimize the costs to affected companies and communities.

Mitigating greenhouse gases will affect each electric company differently due to their specific energy assets, generation mix and market conditions. For example, companies in regulated markets may have the ability to pass the cost of new regulations and some voluntary environmental programs on to consumers. Companies operating in deregulated markets do not have this ability and thus may have more difficulty taking on investments that may negatively impact their balance sheet. Conversely, these deregulated markets can attract investment in newer, more efficient and lower carbon-intensive generation.

Inconsistent economic regulations in the same market also can impact emissions, such as distinct rules for public power companies (*e.g.* municipal power and rural cooperatives) in certain areas of the country. Further, differing environmental standards such as those based on the age of power plants can create additional challenges.

Despite these hurdles, a growing number of electric companies recognize that climate change is a serious problem and they understand that their sector has a role to play in addressing it, beyond what it is currently doing. By engaging in the issue, they can improve their internal business planning, make better investment decisions with respect to control of other air emissions, perhaps gain competitive advantage and lower the cost of mitigation and investments in new technologies over time.

However, acting before greenhouse gas emissions are regulated has costs that, to some, outweigh the potential benefits. Given the current uncertainty surrounding the timing and structure of regulations, electric companies fear that they might be hurt competitively in the marketplace or lose the confidence of investors.

Presently, the investor community does not widely understand the financial implications of many environmental risks, including global climate change. Climate change is a long-term problem with technical and scientific complexity. Investors are hindered because they lack access to consistent information. Government bodies could do more to ensure that consistent information on climate change risk is provided to investors. For now, however, climate change is especially challenging for the financial community to assess.<sup>18</sup>

Because Global Climate Change is an international problem, The United Nations has formed a “Framework Convention on Climate Change” called UNFCCC. At this time, 111 countries have ratified the Kyoto Protocol, which seeks to slow the process of global warming by limiting greenhouse gas emissions relative to levels emitted in 1990. The 111 countries signing the Protocol represent 44.2% of worldwide emissions.<sup>19</sup>

The United States is the largest emitter of greenhouse gasses. On March 29, 2001, the Bush Administration withdrew the United States from the 1997 Kyoto Protocol on Climate Change. President George W. Bush established a Cabinet-level working group to find a more practical method to work with global climate change. The result of the working group was the Administration’s Energy Policy, released in 2002 and the Clear Skies and Global Climate Change Initiatives. Goals are to be achieved by “market-based approaches.”<sup>20</sup>

Leadership on an international, national, and local level is needed to educate communities about this important issue, and to create policies and plans for these long-term concerns. There have been three International Forums of Indigenous Peoples and Local Communities on Climate Change, which have drawn indigenous peoples from across the world to address these policy issues.

## **2. Outdoor Air Quality**

<sup>18</sup> See [www.CERES.org](http://www.CERES.org)

<sup>19</sup> See <http://unfccc.int/>

<sup>20</sup> See [www.usembassy.at/en/download/pdf/kyoto.pdf](http://www.usembassy.at/en/download/pdf/kyoto.pdf)

This Air Quality section focuses mainly on the sources, health effects and problems associated with outdoor air contaminants and some future strategies that would be useful to monitor and assess the extent of potential air pollution problems and actions the Hopi can take to influence and improve regional and local health and environmental quality.

Clean air is essential to a healthy population, a safe and healthy environment and a healthy economy. There is currently no available data which could be used as a baseline for outdoor air quality on the Hopi Reservation. Due to the Reservation's remote nature and lack of any local industrial pollution, outdoor air quality has not been a complaint of tribal members. Here are, however, many local emissions from non-point and collective sources that warrant scrutiny. Elevated concentrations of carbon monoxide, sulfur dioxide, ozone and particulates may also be generated by non-industrial sources, e.g. residential coal use for heating and cooking, trash burning and fugitive dust from unpaved roads, fire and surface mining.<sup>21</sup>

It's thought that road dust is a large contributor to visibility impairment on the Colorado Plateau. Further attention and study is needed regarding both near-field and distant effects of road dust, prior to taking remedial action. Since this emissions source is potentially such a significant contributor, it deserves high priority attention and, if warranted, additional emissions management actions.

Fire recently played a significant role in reducing the visibility on the Plateau. Prescribed fires and wildfires are expected to increase. The tribe could implement programs to minimize emissions and visibility impacts from prescribed fire, as well as to educate the public. Threats of catastrophic wildfires from overgrown or under-managed forests can also be a threat to air quality. Good forest management can contribute to clean air.

## **General Types of Air Pollution**

Dispersal of outdoor air pollutants depends on geographical location, temperature, wind and weather factors. When conditions are not ideal, pollution can build up to dangerous levels. For example, when air close to the earth is cooler than the air above it, a temperature inversion occurs. Under these conditions the pollution cannot rise and be dispersed. Cities or towns surrounded by mountains also experience trapping of pollution. Winter inversions trap particulate and carbon monoxide particles at unhealthy levels.

Acid rain is formed when sulfuric acid combines with droplets of water in the air, causing the water (or snow) to become acidified. The effects of acid rain on the environment can be very serious. It damages plants by destroying their leaves, it poisons the soil, and it changes the chemistry of lakes and streams (eutrophication). Damage due to acid rain kills trees and harms animals, fish, and other wildlife. This problem is most prevalent in the Eastern US where coal having a high sulfur content is used extensively.

<sup>21</sup> From Executive Summary, Grand Canyon Visibility Transport Commission: Recommendations for Improving Western Vistas to the United States Environmental Protection Agency, dated June 1996, found at [www.westgov.org/wga/publicate/final.doc](http://www.westgov.org/wga/publicate/final.doc)

Black carbon pollution is the release of tiny particles into the air from burning fuel for energy. Air pollution caused by such particulates has been a major problem since the beginning of the industrial revolution and the development of the internal combustion engine. Scientific publications dealing with the analysis of soot (graphitic carbon aerosol)<sup>22</sup> and smoke, date back as early as 1896. Mankind has become so dependent on the burning of fossil fuels (petroleum products, coal, and natural gas) that the sum total of all combustion-related emissions now constitutes a serious and widespread problem, not only to human health, but also to the entire global environment.

## Source Pollution

Generally, air agencies implementing the Clean Air Act have made significant progress in reducing air pollution over the last three decades. Collective emissions of the six “criteria pollutants” from which health-based National Ambient Air Quality Standards (NAAQS) have been established have gone down 29%, while Gross Domestic Product has increased 158% and energy consumption by 45%.<sup>23</sup> But according to the EPA, more than 160 million tons of pollution are still emitted into the air each year and electric utilities are one of the most significant sources of harmful air emissions.

Electric utilities are responsible for 64% of annual sulfur dioxide (SO<sub>2</sub>) emissions, which contribute to acid rain and the formation of fine particulate matter (PM<sub>2.5</sub>), and 26% of oxides of nitrogen (NO<sub>x</sub>) emissions, which not only lead to ground-level ozone formation, but also contribute to public health problems like secondary PM<sub>2.5</sub>, acid rain, eutrophication of water bodies and regional haze.<sup>24</sup>

<sup>22</sup> In 1989, a high school biology teacher spent a summer in the DOE Teacher Research Associate Program (TRAC) at Lawrence Berkeley National Laboratory. He was assigned to work with the inventor of an instrument that measured graphitic carbon aerosols in the earth’s atmosphere. Together, the scientists developed a low tech, affordable instrument, that students could operate, which produced data that were extremely similar to the Lab’s most elaborate equipment. All they needed were simple, commonly available materials such as facial tissue, a vacuum cleaner, a large garbage bag, a light bulb, plastic cups and a \$2.40 photo cell that could be attached to an ammeter.

School children and teachers from 72 schools in Slovenia and Estonia, where soot concentrations are particularly bad, built their own sampling and analysis devices in school shops and laboratories and share data on the Internet. Estonia’s program is the *only* air pollution monitoring network in the country. This work has been reported in the Journal for Chemical Education (Vol. 71, pp. 318-23, 1994) the Bulletin of the World Meteorological Organization (Vol. 43, No. 1 January 1994, pg. 60), and the 5<sup>th</sup> International Conference on Carbonaceous Particles in the Atmosphere found at [www.lbl.gov/education/ELSI/frames/pollution-europe-f.html](http://www.lbl.gov/education/ELSI/frames/pollution-europe-f.html)

<sup>23</sup> Principles for a Multi-Pollutant Strategy for Power Plants, Adopted by the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALPCO), May 7, 2002, found at [www.cleanairworld.org/stappa/comments.html](http://www.cleanairworld.org/stappa/comments.html)

<sup>24</sup> *Id.*, citing EPA’s Latest Findings on National Air Quality: 2000 Status and Trends (Sept. 2001)

Power plants also emit 67 other hazardous air pollutants (HAPs), other than what are listed on the NAAQS, including mercury, arsenic, nickel, hydrogen chloride and dioxins. Electric generators are one of the largest sources of mercury in this county, responsible for more than 1/3 of the nation's mercury emissions. The persistent and bioaccumulative nature of mercury poses a serious threat to humans who consume contaminated species.<sup>25</sup>

## Air Quality Regulations

The Clean Air Act and its amendments have generally succeeded in reducing or eliminating harmful air pollutants. Originally, coal-fired power plants were exempt from the clean-air legislation of the 1970s because legislators assumed that these older coal burning facilities were nearing the end of their economically useful lives and would be replaced by new and cleaner fuels and facilities. It granted this exemption on the condition that if the aging plant rehabilitated or expanded, plant owners would install and update pollution controls at the same time under “new source review”(NSR) provisions.

Recently, however, the Senate considered the new rules proposed under President Bush's “Clear Skies” initiative to allow aging, coal-burning power plants to modernize without installing costly anti-pollution devices.<sup>26</sup> The administration claims that the old NSR rules don't specifically operate to reduce plant emissions, but that the new rules are designed to require the power industry to reduce emissions by capping emissions at specified levels.<sup>27</sup>

Proponents of Clear Skies argue that cleaner air will result in large measure from the use of a market-based, integrated multi-pollutant strategy for power generation. According to the USEPA, Clear Skies requires a 70% decrease in power plant emissions of SO<sub>2</sub> and NO<sub>x</sub>. The administration expects Clear Skies to produce fewer SO<sub>2</sub> and NO<sub>x</sub> emissions [35 million tons] than expected from the current new source review, regional haze (or BART), acid rain programs, and the NO<sub>x</sub> SIP plans. Clear Skies does not change the health-based air quality standards for ozone and fine particles – those standards would still have to be met.<sup>28</sup> Additionally, administrators predict that the new law will decrease power plant emissions of mercury by 70% by placing a cap of 15 tons on power plants (currently at 48 tons).<sup>29</sup>

<sup>25</sup> As of July, 2000 at least 41 states had issued fish consumption advisories for mercury for some or all water bodies within their jurisdiction. *Id.*, citing the EPA's National Air Quality and Emissions Trends Report (1999)

<sup>26</sup> Senate Rebuffs Clean Air Move, San Francisco Chronicle, Jan. 23, 2003, [www.sfgate.com](http://www.sfgate.com)

<sup>27</sup> See the EPA's Frequently Asked Questions about the Clear Skies program and changes to the Clean Air Act at [www.epa.gov/air/clearskies/faqs.html](http://www.epa.gov/air/clearskies/faqs.html). [EPA's disclaimer is that the information presented is EPA's modeling of the Clear Skies Act of 2002. The Agency is in the process of updating this information to reflect modifications included in the Clear Skies Act of 2003].

<sup>28</sup> [www.epa.gov/air/clearskies/faqs.html](http://www.epa.gov/air/clearskies/faqs.html)

<sup>29</sup> *Id.* Using the best available information and the EPA's own analysis, the Western Regional Air Partnership questioned whether the new rules would actually result in less mercury being emitted than under the old rules. See WRAP Tribal Caucus Letter to the President, dated May, 2002, at [www.ntec.org/air/nteccomments/csiletter.html](http://www.ntec.org/air/nteccomments/csiletter.html)

Finally, the administration does not believe that the new rules will cause coal-fired power plants to switch to natural gas. Although they forecast growth in electricity demand over the next twenty years to be met through an increase in gas-fired generation with only limited increases in coal-fired generation, they maintain that Clear Skies will not significantly alter this forecast. Coal will continue to play an important role for energy production through the first half of the 21st century. Supplies of natural gas and petroleum are dwindling. Alternative energy sources are not expected to contribute significantly to the energy needs of the United States in the near future.<sup>30</sup> Thus, the administration and the Congress believe that emissions reductions under Clear Skies will be achieved through the installation of control technologies, not through fuel switching.<sup>31</sup>

Even with these optimistic figures and forecasts, the Clear Skies program has its skeptics and opponents.<sup>32</sup> The Western Regional Air Partnership, staffed by the Western Governors Association and the National Tribal Environmental Council, found that the Clear Skies program does not adequately address transboundary issues within local air sheds or long-range transport of pollution created by West-East airflows. Further, they did not want the older NSR rules scraped because they were necessary to ensure that all utilities played on a level field. Nor did WRAP want any actions taken that would adversely affect the substantive improvements made to local air quality over the past thirty years.<sup>33</sup>

What the EPA's 'Fact Sheet' doesn't highlight is that the new rules will allow utilities to monitor and report their own emissions performance, will not require any reductions in emissions before 2008, and will allow certain utilities to actually increase their pollution output.<sup>34</sup> An analysis by nine environmental groups found that the plan would allow emissions of twice as much SO<sub>2</sub>, one and one-half as much NO<sub>x</sub>, and five times as much mercury for at least a decade as compared to the current law.<sup>35</sup> Many say that any changes permitting the generation of more soot and smog

<sup>30</sup> From USGS report "Understanding Our Planet Through Chemistry," citation found at <http://minerals.cr.usgs.gov/gips/oprevent.htm>

<sup>31</sup> [www.epa.gov/air/clearskies/faqs.html](http://www.epa.gov/air/clearskies/faqs.html) Economic modeling of the utility industry, using EPA's Integrated Planning Model apparently shows that no coal-fired power plants would repower to natural gas in response to Clear Skies. The EPA projects that by 2010, 74% of U.S. coal-fired generation would come from units using advanced SO<sub>2</sub> and/or NO<sub>x</sub> control equipment (such as scrubbers and SCR, which also substantially reduce mercury emissions). By 2020, the percentage is projected to rise to 86%.

<sup>32</sup> The WRAP Tribal Caucus letter, commenting on the 2002 version of Clear Skies legislation, expressed serious concerns, see [www.ntec.org/air/ntecomments/csiletter.html](http://www.ntec.org/air/ntecomments/csiletter.html). Just recently, Attorneys General from 11 states sued US environmental regulators over the 600 pages of Clear Skies rules in November; one senator called on EPA Chief Christine Whitman to resign; newspaper editor opines that "[t]he furor is not likely to subside." San Francisco Chronicle editorial of Nov. 27, 2002, A24; and SF Chronicle article dated Feb. 28, 2003, pg. A6.

<sup>33</sup> WRAP Tribal Caucus Letter at [www.ntec.org/air/ntecomments/csiletter.html](http://www.ntec.org/air/ntecomments/csiletter.html)

<sup>34</sup> Minneapolis Star Tribune, August 11, 2002

<sup>35</sup> Lockyear Sues U.S. EPA Over Looser Federal Pollution Rules, San Francisco Chronicle, Feb. 28, 2003; [www.sfgate.com](http://www.sfgate.com)



will further impair visibility, do nothing to address the greenhouse effect or acid rain problems, and unnecessarily increase asthma and respiratory ailments.<sup>36</sup>

The Clean Air Act explicitly allows state and local air pollution control agencies to adopt programs more stringent than those of the federal government. Specifically, Section 116 of the CAA states that air quality agencies are not precluded from adopting or enforcing any standards, limitations or requirements as long as they are at least as stringent as those required under the federal program. Examples of more stringent measures certain states have taken include bans on wood burning, new source review, particulate matter, visibility, open burning, and more stringent standards for criteria pollutants and control technologies.<sup>37</sup>

No reservation-specific data was found that accurately quantifies or qualifies indoor and outdoor air pollution problems. Those sources that broadly threaten Hopi health and lands (e.g. household heating with coal, open burning, etc) could be addressed on a regional basis. The tribe may also want to address the cumulative effect of minor sources (e.g. unpaved roads). Pollution from existing major sources on Hopi lands without federally enforceable emission limits can be efficiently dealt with by using tribe-specific or region-wide implementation plans.

Standard setting requires the consideration of several questions: Whether or not the national standards really protect human health and the environment, whether the standards are firmly based in scientific principles, and whether or not the standards can be achieved in the short-to medium term with available resources? For example, exposure to indoor air pollutants tends to differ from the outdoor urban air pollutants that have formed the basis for most epidemiological studies. Most particulate matter standards do not differentiate between the chemical compositions of particles, but health effects may vary with differences in particle composition.

Outdoor ambient air quality guidelines for particulate matter may not have adequately considered the concentrations or chemical composition of indoor air particulates when considering health effects.<sup>38</sup>

Considering both health-based and performance based emission studies may be helpful when trying to set standards at realistically attainable levels in the prevailing technical, social,

<sup>36</sup> These claims are not entirely unfounded. According to the California Institute of Technology, this pollutant is implicated in rising death rates from bronchitis, emphysema, and lung cancer, and has been found to interact with particulates synergistically such that when both are present, the combined effect is greater than the sum of effects if each acted on human systems independently. See *Black Mesa, supra*, at 50. Almost 4000 Londoners were killed in 1952 and 100 New Yorkers died in 1967, when temperature inversions prevented the dispersal of sulfuric oxides from coal burning. *Id.*

<sup>37</sup> Restrictions on the Stringency of State and Local Air Quality Programs, Results of a Survey by the STAPPA and ALPCO, Dec. 17, 2002, [www.cleanairworld.org](http://www.cleanairworld.org)

<sup>38</sup> See section 4.2.5 Although some epidemiological studies of particle air pollution were conducted in cities with seasonal wood smoke emissions, there is not enough information to apply air quality guidelines for particulate matter to biomass smoke. [www.who.int/environmental\\_information/Air/Guidelines/#6611](http://www.who.int/environmental_information/Air/Guidelines/#6611)

economic and political climate. Over time, standards can be changed as the health of the population and quality of the environment becomes better understood.

## **Funding to Move Forward**

Air agencies rely on a variety of funding sources, including federal grants that Congress appropriates to agencies under Section 103 and 105 of the CAA. While federal grants represent only a fraction of their budgets, they are essential to most agencies' operations. Air agencies have many responsibilities that are currently unfunded or under funded, due to shortages in federal grants, including compliance, monitoring emission inventory developments other activities that form the foundation of an effective program.<sup>39</sup> Nevertheless, financial assistance will continue to be available under Section 103 for studies and air quality assessments and Section 105 for support of air pollution control programs.<sup>40</sup>

Increases in federal grants are critical to ensure healthful air quality. Last year, the EPA invested \$4 million in grant funds, policy formulation and technical assistance to coalitions of western state governments and Indian tribes.<sup>41</sup> Since 1998, other programs have been expanded to identify sources of pollution, some of which may be 100s of miles from the protected lands.<sup>42</sup> The EPA just published the availability of \$5 million in FY 2002 grant money to be given to states, tribes and intertribal consortia for eliminating pollution, providing source reductions and for technical assistance.<sup>43</sup>

Training must be made available to the community to provide technical expertise and assistance in areas of detailed monitoring and emissions assessment work, emissions inventories, modeling, appliance replacement, etc. The Hopi will need to continue to prioritize and earmark resources necessary to recruit, train and retain environmental professionals, monitor current air quality rules, develop programs and standards of their own, and collaborate with such regional entities such as WRAP.

Clean air is essential to a healthy population, a safe and healthy environment and a healthy economy.<sup>44</sup> To improve both indoor and outdoor air quality for all tribal members, the Hopi will

<sup>39</sup> Funding Needs of State and Local Air Pollution Control Agencies, Results of STAPAA and ALAPCO Survey, June, 2002; [www.cleanairworld.org](http://www.cleanairworld.org)

<sup>40</sup> Fact Sheet, Clean Air Act Final Rule, Indian Tribes: Air Quality Planning and Management at [www.epa.gov/air/tribal/tas\\_indian\\_tribes.html](http://www.epa.gov/air/tribal/tas_indian_tribes.html)

<sup>41</sup> EPA Progress Report 2002, Pacific SW/Region 9, EPA-909-R-02-001, page 13, Jan. 28, 2003, [www.epa.gov/region09/annualreport/02](http://www.epa.gov/region09/annualreport/02)

<sup>42</sup> US Mexico Border XXI Program: Progress Report. 1996-2000, page 46; See also, [www2.nature.nps.gov](http://www2.nature.nps.gov)

<sup>43</sup> 68 Fed.Reg. 11391, March 10, 2003.

<sup>44</sup> There are certain ways that the tribe can influence the speed and impact of coal development which better protect both human health and the environment. See Ruffing, Lorraine, American Indian Energy Resources and Development: The Role of Policy in American Indian Mineral Development, edited by Roxanne Ortiz, Institute for Native American Studies, University of New Mexico, Dvlpt. Series #2, 1980, page 50-59.

build upon their existing partnerships to jointly develop and implement regional air programs, use innovative approaches and strategies to respond to new challenges and emerging issues, and effectively use information to support creative and effective decision making.<sup>45</sup>

The development of an air quality management strategy starts with the development of ambient air quality standards or guidelines. It also involves the collection of data and the preparation and use of an emissions inventory.<sup>46</sup>

Given the existing controversies and uncertainties raised by the new rules, it would be prudent for the tribe's local air quality officials to look beyond the current Clear Skies program and continue to formulate policies and strategies that address all significant emissions from coal burning and electric power generation. Additionally,

## **Emission Control Approaches that Prevent or Reduce Exposure**

Laws and regulations are at the heart of most management strategies. Traditionally, emissions have been regulated by adopting standards, licensing discrete sources, monitoring and reporting emissions, and imposing penalties for exceeding permit conditions or standards.<sup>47</sup> But there are other ways to reduce emissions.

The federal government has recently employed self-regulation of industry as a way to curb emissions. The underlying theory is that industries are familiar with current best practices and can set codes of practice, industrial standards and targets. Individual companies that self-monitor compliance should still be subject to audit.

Another approach involves the use of economic incentives or market oriented systems to encourage compliance. Designed to decrease the operating costs for pollution prevention, examples include adjustments to pricing policies or load-based emission charges, which increase operating costs if pollution discharges increase. Market-based strategies may include provide incentives for adopting the best technologies available, or implementing a 'polluter pays' concept.<sup>48</sup> Where regulating authorities quantify the total amount of emissions permissible and

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<sup>45</sup> See Joint Vision of the Future as envisioned by the USEPA, the National Tribal Environmental Council, the Institute for Tribal Environmental Professions, the Environmental Council of the States, the STAPPA and the ALAPCO.

<sup>46</sup> An essential emissions inventory must include biogenic or natural sources emissions from fire or fugitive dust generated by winds or unpaved dust, and point source measurements of stack emissions (Alternatively, reasonable quantitative estimates can be calculated by knowing the throughput and sulfur content of the fuel used). See Section 6.1.3 at [www.who.int/environmental\\_information/Air/Guidelines/#6611](http://www.who.int/environmental_information/Air/Guidelines/#6611); See also the Emissions Inventory Surveys of the Western Regional Air Partnership, be searching [www.wrapair.org](http://www.wrapair.org)

<sup>47</sup> See Section 6.1.5 at [www.who.int/environmental\\_information/Air/Guidelines/#6611](http://www.who.int/environmental_information/Air/Guidelines/#6611)

<sup>48</sup> See Section 6.1.9 at [www.who.int/environmental\\_information/Air/Guidelines/#6611](http://www.who.int/environmental_information/Air/Guidelines/#6611)

issue emission entitlements, these tradable permits have the potential to achieve policy objectives at the lowest cost to industry, and in some cases governments, too.

Modifying the coal resource before it is used as fuel can also reduce emissions. Significant improvements in coal processing and burning in modern power plants have dramatically reduced pollution. The process has been improved in three ways. First, sophisticated equipment can be added on to significantly reduced fly ash and soot and other specialized equipment has been developed that greatly reduces mercury<sup>49</sup> and sulfur dioxide emissions.

Low-ash and low-sulfur coals can be selected as they pollute less. Detailed chemical analyses of coal prior to mining can be done to determine concentrations of ash, sulfur, and other toxic elements. A new technique can determine over 70 elements at the ppm to ppb levels. By using these techniques to locate low-polluting coal resources, the Hopi will know how much clean coals exists and be able to recover and market these reserves accordingly.

Coal cleaning is the third method for reducing pollution. Sulfur minerals such as pyrite can be removed by using various techniques. Chemical analysis of the coal and identification of mineral inclusions determines what cleaning procedure will be most effective. Understanding the chemistry and mineralogy of coal can significantly prevent or reduce emissions from coal burning.

Controlling widespread sources of pollution, such as caused by open burning, domestic fuel combustion and forest fires, is also possible. Surface mining and overgrazing of land in this semi-arid environment can also lead to high particulate concentrations. Technical strategies involve investigating alternatives to existing polluting activities and implementing cleaner production and pollution prevention technologies and best practices. Regulatory strategies may involve banning open burning during certain periods, controlling fuel quality or encouraging the use of newer types of combustion appliances. Educational strategies involve informing the community about their individual practices and the contribution each makes toward collective and cumulative emissions which may damage their health and the environment.<sup>50</sup>

There are several major coal fueled electrical generating power plants relatively close to the Hopi reservation – the Navajo and Mohave Generating Stations and the Four Corners plant.<sup>51</sup> Fuel for

<sup>49</sup> A mercury emissions control system now used on municipal waste incinerators is being adapted to function on coal fired power plants by Consol, Inc. of Library, Pennsylvania. The system is being developed as a cost effective and efficient way to remove mercury from air emissions. June 26, 2001 Environmental News Network, [www.enn.com](http://www.enn.com).

<sup>50</sup> See Section 6.1.9 at [www.who.int/environmental\\_information/Air/Guidelines/#6611](http://www.who.int/environmental_information/Air/Guidelines/#6611)

<sup>51</sup> The Four Corners plant is fueled with coal from New Mexico.

the Navajo and Mohave generating stations comes from the sacred<sup>52</sup> Black Mesa area. Reserves found on Navajo and Hopi lands cover an area larger than 3,000 square miles.

Black Mesa has the most extensive deposit of coal known in the world. It's soft, bituminous coal is relatively low in sulfur, containing from .05 - .08% sulfur (compared to eastern US coal deposits having up to 3% sulfur content). The coal is strip mined from two large surface mines and provides some of the fuel for the 2250- megawatt Navajo power plant, located near Page, AZ [operated in part by the Salt River Power District], and all of the coal for the 1580-megawatt Mohave plant near Laughlin, NV [operated by Southern California Edison].<sup>53</sup> The Hopi and Navajo tribes receive a coal royalty income of approximately \$19 million annually from their joint ownership of the Black Mesa mines.<sup>54</sup>

### **Tribal Authority Under the Clean Air Act**

Under Section 301(d) of the federal Clean Air Act, the EPA is authorized to treat Indian tribes as States and implement their own tribal air programs. Although the EPA retains permitting authority for all sources of air pollution that are located on tribal lands, it has developed regulations to enable it to transfer permitting authority over to tribal governments on a case-by-case basis.<sup>55</sup>

The rule provides that Tribes are treated in the same manner as States for virtually all Clean Air Act programs and are eligible for treatment in the same manner as States. This means that Tribes have the same authority as States to impose more stringent requirements than federal regulations, and may implement CAA programs that are most relevant to their needs. The Hopi have air quality and planning and management authority over all air resources within the exterior boundaries of their reservation, including non-Indian owned fee lands.<sup>56</sup>

Certain nationally applicable regulations already apply to Indian lands, e.g. the National Emissions Standards for Hazardous Air Pollutants and the Standards of Performance for New Sources.<sup>57</sup> However, certain categories of sources of air pollution, such as open burning or

<sup>52</sup> The sacred and religious significance of the Black Mesa area, as well as the current coal and water resource controversies surrounding it, are highlighted at [www.blackmesatrust.org/news.html](http://www.blackmesatrust.org/news.html)

<sup>53</sup> Arizona State Coal Profiles, Energy Information Administration at [www.eia.doe.cneaf/coal/st\\_coal.pdf](http://www.eia.doe.cneaf/coal/st_coal.pdf) (1992); Gordan, Suzanne, *Black Mesa, the Angel of Death*, John Day Publishers, NY, NY, 1973, pages 12, 48; Hopi Economic Report of Charles Pace, February 2003 Draft, at page 14.

<sup>54</sup> Hopi Economic Report of Charles Pace, February 2003 Draft, page 21.

<sup>55</sup> See 40 C.F.R. Chapter 1, Part 49 Tribal Clean Air Act Authority

<sup>56</sup> See Fact Sheet, Clean Air Act Final Rule, Indian Tribes: Air Quality Planning and Management at [www.epa.gov/air/tribal/tas\\_indian\\_tribes.html](http://www.epa.gov/air/tribal/tas_indian_tribes.html).

<sup>57</sup> 42 U.S.C. 7412 and 40 CFR Part 63; 42 U.S.C. 7411 and 40 CFR Part 60, respectively.

fugitive dust, are not covered by major source regulations. For these categorical sources and other general air quality rules for which EPA has not enacted national rules, a tribal or regional rule could be developed.<sup>58</sup>

### **3. *Land Based Issues from Coal Mining***

Black Mesa coal has been mined and used since prehistoric times. Prior to 1960, when a gas pipeline was extended through areas of Northern Arizona, coal was mined to supply local fuel requirements. Coal programs for local use continue today on the Hopi reservation.

The Black Mesa and Kayenta coal mines, operated by the Peabody Group are located near Kayenta and produce coal from a large reserve leased from the Navajo Nation and the Hopi Tribe. According to USGS, since 1975, coal production from the Black Mesa and Kayenta mines has averaged about 12 million short tons per year. The value for the coal mined in 1996 is estimated at \$300 million. The coal is strip-mined. It is sub bituminous with an average quality of 11,000 Btu/lb, .05% sulfur, and 10 percent ash. The Black Mesa mine was opened in 1970 and produces 4.5 million short tons of steam coal annually. The Kayenta mine began operation in 1973 and produces 7.5 million short tons of steam coal annually.

According to the USGS, the mines are model reclamation projects. Numerous environmental studies exist which describe and analyze the impacts to land from coal mining operations and which describe the mitigation and reclamation of land when coal mining is completed.

### **4. *Other Environmental Issues***

In addition to the issues that directly impact air quality as are raised in this report, additional environmental issues are of interest to The Hopi Tribe. Such issues include clean-up of areas

which had leaking underground tanks; the presence of asbestos in many tribal and BIA buildings; the presence of noxious weeds such as “salt cedar”, a quickly growing shrub that chokes out native plants along washes and other wet areas; erosion due to off-road use of vehicles and other causes; remediation of springs, streams and washes; fire and forest management issues, especially due to the growth of juniper and other spreading plants that displace native grasses; the impact of recent years of drought; water quality; solid waste issues; and others. This report is not meant to be a full analysis of all these issues. The Hopi Department of Natural Resources has programs in place that manage these issues.

## **V. GENERAL ENERGY SECTOR CONDITIONS**

The most important aspects of the energy situation for Hopi exports and bulk energy sales are:

<sup>58</sup>STAPPA/ALAPCO have produced an instructive list of multi-pollutant reduction strategies which would promote more healthful air. Pollution Prevention and Sustainability Principles (adopted April 29, 1997); found via [www.cleanairworld.org](http://www.cleanairworld.org).

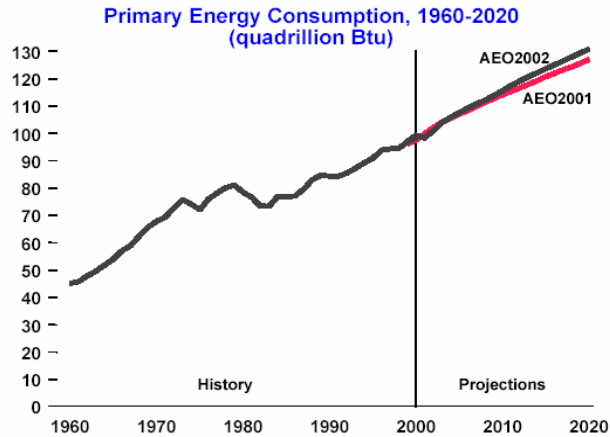
- High Oil and Natural Gas Prices – Currently, the industry is experiencing high oil and natural gas prices. This has been occurring since 2000. Past cycles have lasted about 10 – 12 years (e.g., 1973 – 1985). They are unpredictable. However, coal competes directly with natural gas, and hence, all else equal, coal resources are valuable.
- Isolation – Hopi’s coal resource would generally compete with other coal, and hence, they have not become so valuable so as to connect them to a market. The only exceptions ever have been the Navajo and Hopi coal plants.
- Environmental Regulations – Powerful forces seem to be gaining strength which oppose or want to make coal use economically infeasible. This threat to the coal use is real and creates the need to consider the possibility that the window for coal sales may close. Thus, in the event of falling oil and gas prices, the Tribe may face both economic and regulatory challenges.
- Regulation – Under traditional electric utility regulations, costs are passed through to ratepayers. This favors raising the price of coal. Under deregulation, market forces determine price and this can cap prices for coal. The two customers for Hopi coal have had varying degrees of deregulation. While the current phase of the industry is showing more regulation, this could change back. For example, Mohave could be sold to deregulated or other companies after 2005.
- Renewables – Hopi prospects for renewables as a major replacement for coal sales is challenged by a lack of transmission, the variability of the resource, lack of investment community interest in financing large scale projects, and the cost of proven large scale generation versus the costs of other types of generation.
- Oil and Gas Resources – If these could be found, they are highly valuable.

## **1. Energy Industry Context**

The Hopi Tribe is impacted by the energy industry in many ways. It is a supplier of raw materials, coal and water; and it is a land owner for energy company rights of ways, and it is a consumer. These involvements are not trivial. The energy industry has the largest impact on Hopi economy than any other industry, such as the agricultural industry, the arts and crafts industry, the tourist industry, or providing goods and services. There are opportunities for other participation by the tribe in the energy industry. With the growth of electricity demand new power plants will be built over the coming years. New technologies are inspiring new manufacturing of energy products. Renewable energy development is growing. All these reasons support Hopi Tribal Leadership awareness of energy industry issues.

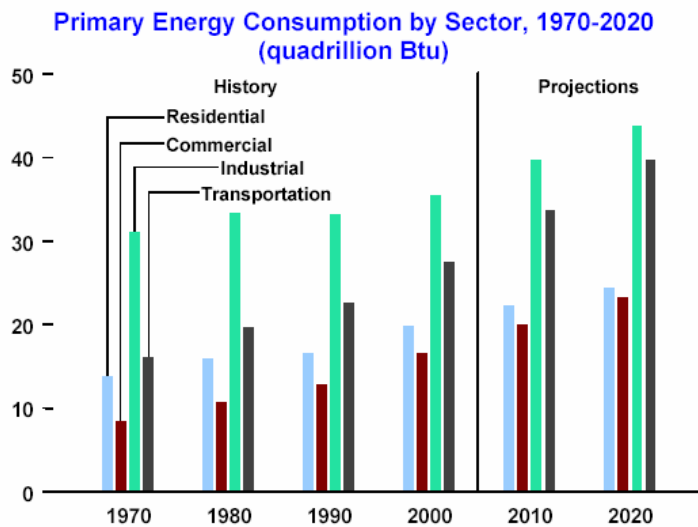
## **2. The U.S. Energy Industry**

The U.S. energy industry is huge, and it is growing. It is already one of the largest industries in the world. Primary energy consumption (including all forms of energy: petroleum, natural gas, electricity, coal) has risen from about 45 quadrillion British Thermal Units (Btus) in 1960 to about 95 quadrillion Btus in 1999. It is projected to go to 130 Btus in 2020 by the United States Energy Information Administration.



Energy Information Administration, Annual Energy Outlook, 2002

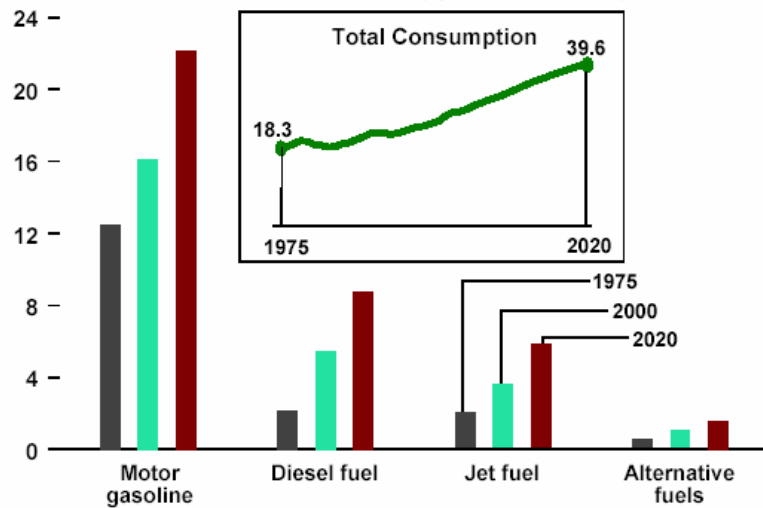
Traditionally, the Industrial users of energy have been the greatest consumers, but the transportation industry is catching up quickly. The transportation sector is already significantly larger than the residential or commercial sectors.



Energy Information Administration, Annual Energy Outlook, 2002



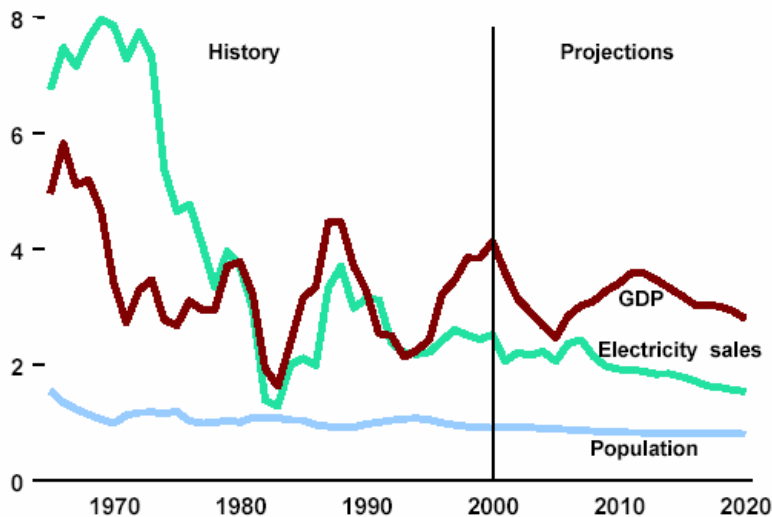
Transportation Energy Consumption by Fuel,  
1975, 2000, and 2020 (quadrillion Btu)



Energy Information Administration, Annual Energy Outlook, 2002

More than one-third of the primary energy in the Nation is used to generate electricity.<sup>59</sup> Use of electricity has gotten less expensive, relative to other products.

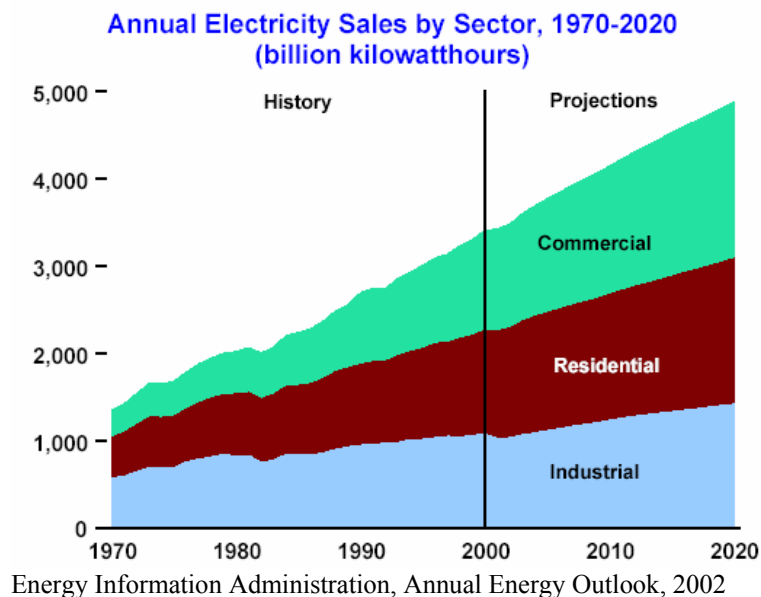
Population, Gross Domestic Product, and Electricity Sales,  
1965-2020 (5-year moving average annual percent growth)



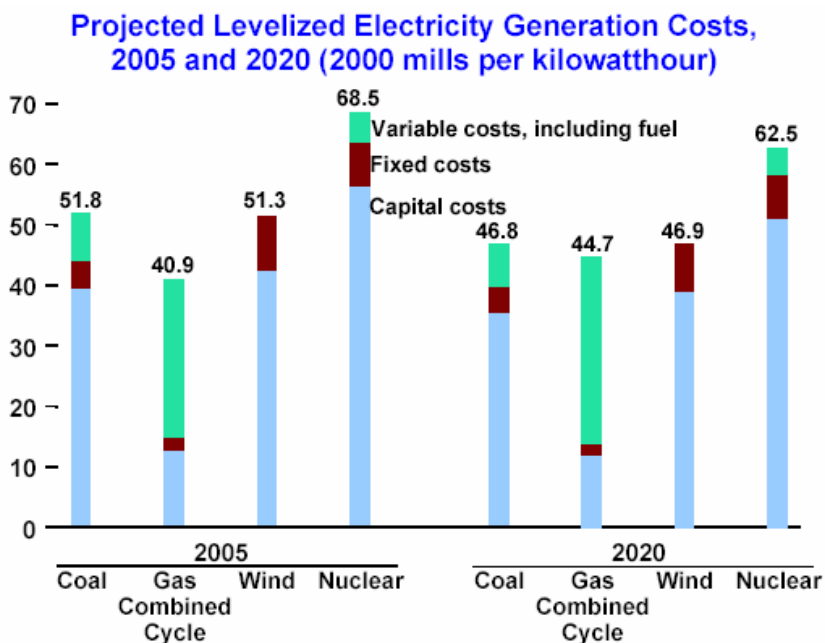
Energy Information Administration, Annual Energy Outlook, 2002

<sup>59</sup> Energy Information Administration, Monthly Energy Review, (Washington DC, March 1999) Table 2.1, p. 23.

United States electricity sales are projected to grow significantly over the next decades.

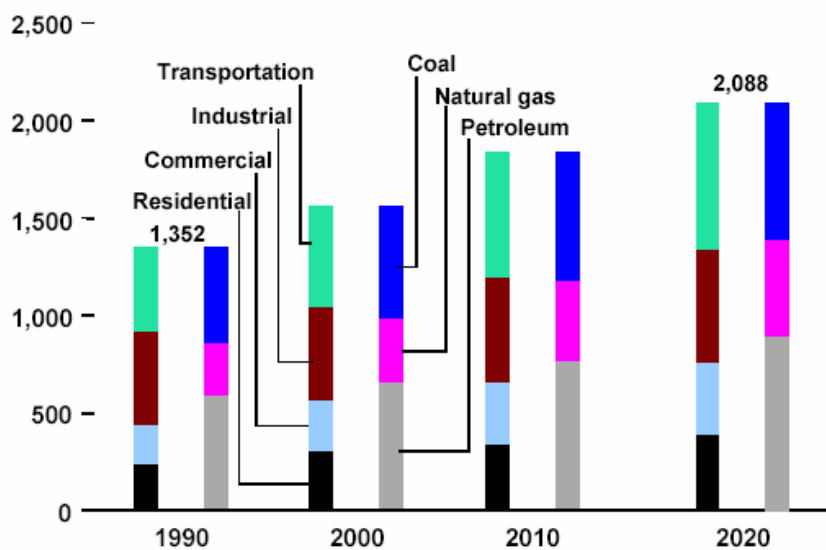


All generation and use of energy has environmental consequences. When fossil fuels are burned in the production of electricity, a variety of gasses and particulates are formed. If these gasses and particulates are not captured by some pollution control equipment, they are released into the atmosphere. Even renewable energy has environmental drawbacks such as the use of lands for facilities, and visual and noise impacts.



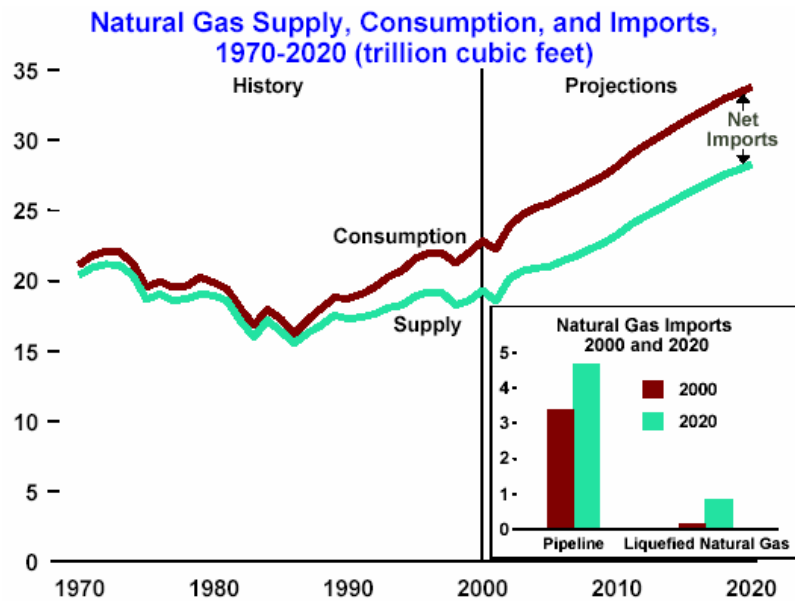
Energy Information Administration, Annual Energy Outlook, 2002

### Projected U.S. Carbon Dioxide Emissions by Sector and Fuel, 1990-2020 (million metric tons carbon equivalent)



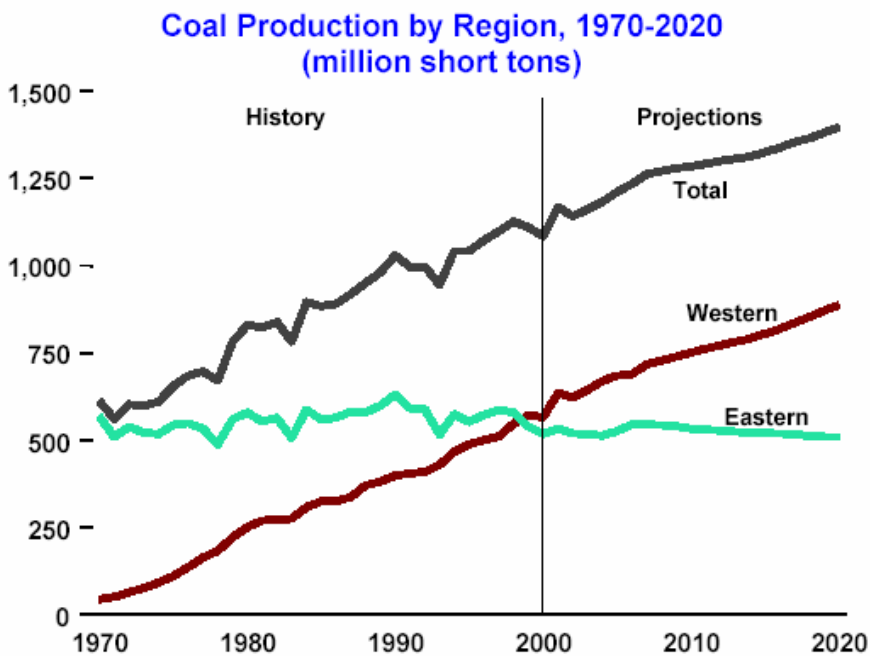
Energy Information Administration, Annual Energy Outlook, 2002

A quarter-century ago, Congress enacted the Power Plant and Industrial Fuel Use Act, which prohibited the use of natural gas as a fuel to generate electricity since this fuel was in short supply and is used to heat half of all homes. Congress has changed its mind. The ban was repealed in 1987 by the Reagan Administration. Three years later, environmental standards were raised which discouraged the burning of coal. Now nearly one-fifth of U.S. electricity is generated with natural gas and most of the new electrical capacity is predicted to be gas driven, even though U.S. production of natural gas has remained stagnant.



Energy Information Administration, Annual Energy Outlook, 2002

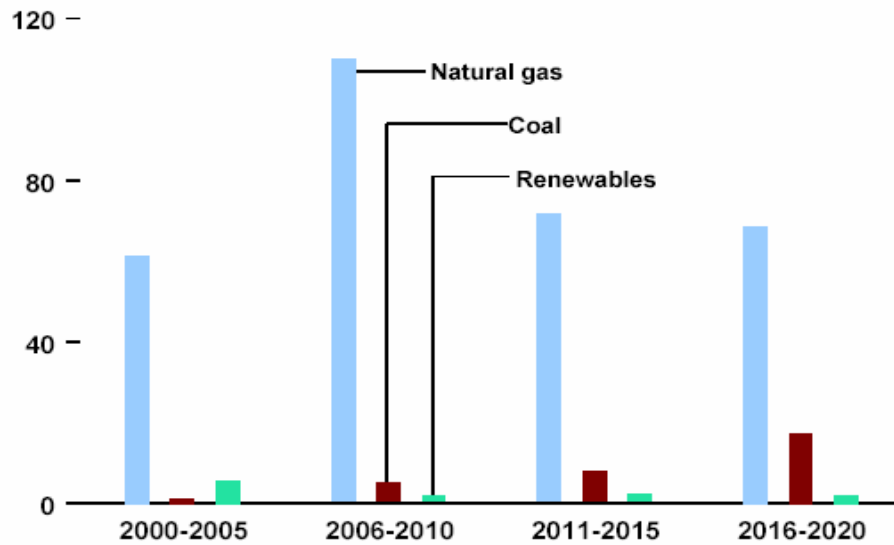
Despite the increase in natural gas generation, there is a predicted increase in use in Western coal, and a decrease in Eastern coal.



Energy Information Administration, Annual Energy Outlook, 2002

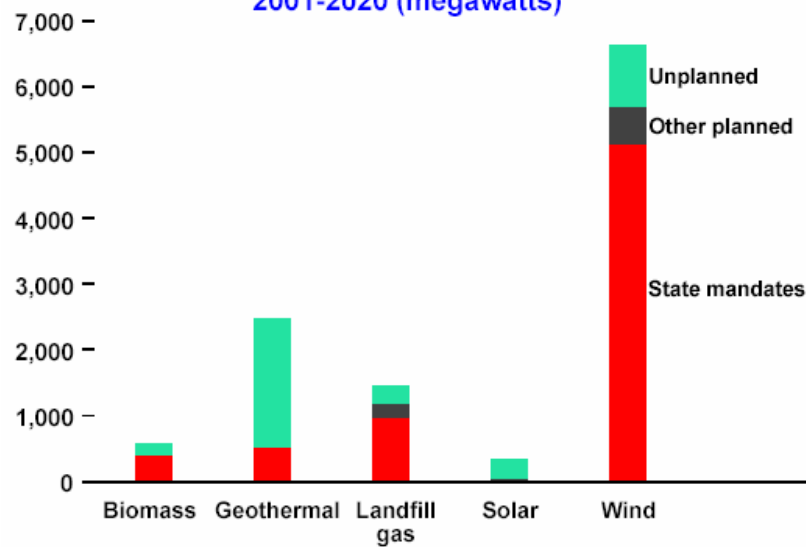
Some growth in renewable energy facilities is projected, with the equalizing of renewable energy costs.

### Projected Electricity Generation Capacity Additions by Fuel Type, Including Cogeneration, 2000-2020 (gigawatts)



Energy Information Administration, Annual Energy Outlook, 2002

### Projected Additions of Renewable Generating Capacity, 2001-2020 (megawatts)



Energy Information Administration, Annual Energy Outlook, 2002

## 3. Energy Regulatory Background

### Electricity Regulation

Under the Commerce Clause of the United States Constitution, federal law applies to transactions that are interstate in nature, or those transactions that cross state lines. State or tribal laws apply when transactions are within a state, unless the federal law says otherwise. This holds true for the energy industry. Federal laws, particularly, the Federal Power Act, and the Energy Policy Act of 1992 apply to larger state-to-state transactions and State, or tribal laws when they exist, apply to the smaller, usually retail transactions that stay within states.

Under the Federal Power Act and the Energy Policy Act, the Federal Energy Regulatory Commission (FERC) is charged with regulating wholesale sales of energy, both electricity and gas. FERC generally has jurisdiction over any company that is a for-profit company, and not over companies that are government owned or consumer owned.

Since their inception, our country's energy delivery systems were a series of geographically established utilities that were responsible for energy supply, transmission and distribution within that geographical territory, or franchise area. These were called "vertically integrated" utilities and were monopolies. Because they were monopolies they were regulated so their prices and terms of sales remained reasonable. FERC was responsible for sales of gas or power from one company to another and states were generally responsible for the actions of these companies to deliver power within the state's geographical territory. FERC approved the rates and tariffs, or prices and conditions, of wholesale energy transactions and governed the movement of electricity or gas on the wholesale transmission systems. States approved the rates and tariffs of the companies in delivering the product to consumers.

With "deregulation", which was blessed by the Energy Policy Act of 1992, companies have been encouraged to separate the functions of their power production, power transmission, and distribution to customers. In many cases companies actually sold the different segments of their business to other companies or to corporate subsidiaries. This corporate segmentation was designed to make sure that companies were treating each other equally, and were not favoring their own assets over other competing companies who may be better able to serve the customers of each utility. The new competition was supposed to open up the energy markets to newcomers and those with a better competitive edge for consumers. In many cases regulations have been poorly designed which has allowed many games on the system and has not resulted in lower costs for consumers or better uses of the energy delivery systems. We are now at a stage where these energy regulatory issues are in question before many policy makers.

### **National Regulatory Issues**

Since passage of the 1992 Energy Policy Act, the federal government has been involved with the introduction of concepts of competition among utility providers. While the Act was not precise in how the utility industry should change, the law has led the FERC to introduce a number of policy initiatives. At the time the Act was passed, most utilities owned generation facilities, transmission lines and distribution systems serving customers; they were "vertically integrated". The FERC regulated utilities were monopolies whose rates were based on their costs of doing business with a State approved profit built into their rates. Independent entities were generally not allowed to play a role in providing electricity.

The first FERC initiatives were introduced in 1998, known as Orders 888 and 889. These Orders required all utilities that own electric transmission that were jurisdictional to FERC to change the way they use their electric transmission lines. The Orders applied generally to those utilities that are for-profit, like Arizona Public Service; and did not apply to entities like the federal power marketing administrations Bonneville and Western Area Power Administration, and did not apply to municipal utilities like Tucson Electric Power, or public power districts or cooperatives such as the Navajo Tribal Utility Authority. The orders required all utilities to share their transmission lines with other utilities, and to charge the same prices to others that they charged themselves for using the wires. These Orders made a lot of sense because the transmission lines are all interconnected as one grid, and by sharing the existing infrastructure, the industry was spared the huge financial and environmental cost of building duplicative lines. While the Orders did not mandate that non-jurisdictional entities participate in the sharing of the grid, most of them have voluntarily complied through the reciprocity provisions of the Order.

The next major FERC initiative was known as Order 2000, which came out in 2000. That Order requires all jurisdictional utilities to turn over the operation of their transmission lines to an independent entity called a Regional Transmission Organization (RTO). That RTO would govern the movement and trading of electricity across the grid. This Order is being implemented in various parts of the country at various speeds. In the West, RTOs are not yet formed and active. Details for forming the various RTOs are under negotiation in each region, with filings being made at FERC to obtain approval of the various proposals.

FERC's third major initiative is known as Standard Market Design (SMD), and has been the subject of substantial industry conflict, and political concern. SMD would require all regions of the United States (and by default, the connected parts of the Canada and Mexico grids) to form market places to buy and sell electricity. Each regional marketplace would have to follow standard rules, have similar pricing structures, and have similar utility planning requirements. While this all sounds lovely in theory, the practical challenges are staggering. Additionally, no proof has been made that the proposed changes will have an ultimate positive impact on consumers. There remains a huge risk that the markets will be designed incorrectly, which may allow for industry gaming and unfair practices, as we saw in the California marketplace. FERC has since backed off of the SMD initiative, allowing regions to determine what may be the best initiation of these concepts.

The industry seems to be divided into two camps: those that believe RTOs and SMD create a substantial risk to consumers and therefore to regional and national economies, and those who believe that a free market competitive industry without regulatory oversight on the price of power will be best.

Prior to these initiatives most electricity rates were based on the utility costs, and in the case of for-profit entities, a state-approved rate of return was added to the costs. (For non-profit entities like municipalities, cooperatives, and governmental utilities, there was no profit added.) In an era of "competition" the price will be as high as the market will bear. In times of high demand,

the prices could be very high. Consumers will pay for these market prices. It is not a coincidence that the supporters of RTOs and SMD are generally those that wish to make money on the huge electrical energy market, like independent power plant developers. Utilities that remain cost based, like public power, and many state public utility commissioners, see the initiatives as the end of cost-based energy services at stable prices.

FERC initiatives also created numerous issues over whether the federal government or states have jurisdiction over the new utility operations. The State of Virginia has passed a law prohibiting its local utilities from participating in the federal initiatives, setting the issue for eventual federal Supreme Court decision on the authorities given to FERC in the Energy Policy Act and the Federal Power Act. To date, the FERC has been losing cases and it appears that state authorities will be upheld.

It is clear that state and federal regulators and industry professionals are still undecided on the appropriate structure for the industry. Should it be regulated or purely competitive? Now the electricity and transmission markets are a little of both. In areas of competition there are price caps set by regulators, and profits are subject to refunds. Regulated utilities are allowed to market power and transmission under market prices. Many ask the question whether prices will be higher tomorrow than they were yesterday, keeping the benchmark of the regulated municipal cooperatives. Others ask whether the rates tomorrow will be lower than they would have been without competition. Until the model is chosen, and implemented correctly, the utility industry will be confused.



## **Energy Industry Financial Issues**

At the same time these initiatives have been under consideration, the national utility industry has seen a financial crisis. The new electricity markets have had serious problems such as the California crisis of 2000 and 2001, the Enron bankruptcy, and increased costs to buy wholesale power in times of high demand while consumer rates are still capped at the lower cost structures. Energy companies stocks used to be known as “widow and orphan stocks” since they were stable and generally paid a dividend. Now those stock prices have fallen, and dividends from energy companies are often a fond memory. Most merchant and wholesale company bond ratings have fallen to the lowest in years, many are junk bond status. The more stable companies are generally those with utility load service responsibility. The capital markets, used to finance the huge capital costs of energy projects such as generation and transmission, have halted many utility investments. Equity and debt investors have lost several hundred billion dollars in the energy industry in 2 years.

Over \$90 billion in energy industry debt is estimated to come due by 2006. Most industry players will not be able to pay this debt, so it is likely to be restructured in many large refinancings. The banking industry is gearing up to negotiate new deals and find opportunities for new loans. Some of this debt will be forced into equity by corporate bankruptcy. The fees and interest rates for these refinanced loans or bankruptcies will eventually be paid for by consumers. It is unlikely banks will want to take over the ownership and operation of the power plants, but many may be sold or deals will require additional security for loans. Some say the industry model for independent power has failed and must be replaced. Of utmost importance is trust and fair dealing when seeking to work in the industry.

The electricity industry is in a time of crisis. However, most crises create opportunity for those in the “right place at the right time.” The energy industry and the financial markets tied to the energy industry will not be through the crisis until we have the following: a stable regulatory environment, energy prices that will support infrastructure improvements and payment of debts, and renewed investment community confidence. Unfortunately, this crisis will likely last for another 3-4 years and will raise electricity rates in certain service territories to a level that could impact the regional economies.

### **Some interesting considerations regarding the Regulatory and Financial Issues**

- Energy consumption is up 4.11% in 2002 over 2001. 6.4% YTD in 2003 over 2002. Residential and commercial uses are up, industrial use is down. Energy is therefore still a long-term growth business.
- Significant cancellation of new generation projects in US – 74,000 MW cancelled, 37,000 MW tabled, and 49,000 delayed.
- There are 50,000 MW of ageing coal facilities in the US. Environmental and air quality issues are in dispute between federal Environmental Protection Agency and States. Many industry professionals believe that these projects will not retire so long as the Bush administration is in power.

- The “Sparks spread” is the difference between the market price of fuel (gas price) and the market price of electricity. When the spread is high, there is a chance to make a profit by selling power. When spread is low, selling power could lose money over selling gas.
- 40% of generation capacity is now owned by independent power producers. 90% of the generation which has been recently built is owned by independent power producers.
- FERC is being asked to cancel market based contracts. The financial community is watching closely to see whether the contracts will be upheld. If not, there is a much higher risk to invest as high profits may not be allowed by regulators.
- Loss of investor confidence in the power sector caused by the confluence of many seemingly unrelated events, such as:
  - Power crisis in California and bankruptcy of Pacific Gas and Electric Utility in 2001
  - Fraud and bankruptcy of Enron in late 2001, rash of misdeeds by others
  - Collapsing power prices arising from excess capacity
  - Slowing of deregulation in midstream, resulting in uneven playing field,
  - Elimination of long-term contracting capability among most power marketers and traders
  - Investors thought they understood the markets, but they didn’t
- Bank issuance of debt for power projects (loans) down 70% in 2002 to \$12.6 billion. Bond issuances for power projects down from \$14.3 billion in 2001 to \$4.3 billion.
- Since 2000, \$130 billion in equity (stock or project ownership) was lost by 8 companies AES, Williams, El Paso, Calpine, Dynegy, Mirant, Aquila & Reliant (This figure does not include Enron.)
- Market value of bonds issued in 2001 and 2002 by six companies (AES, Calpine, Dynegy, El Paso, Mirant and Williams) fell by 42% from a total amount of \$5.2 billion fell by March 2003 to \$3 billion.
- Modeling shows industry will “recover” in 2005-2007, meaning that the wholesale prices for power will increase by then.
- Many believe that 5 top industry players will emerge from the crisis with a second tier of 5-10 other players.

## **Local Electrical Industry Regulations**

The Arizona Corporation Commission (ACC) is regulating electricity service on the Hopi reservation in the absence of any tribal regulatory bodies. The ACC monitors and approves rates or charges for electricity service, handles disputes over service areas between competing electricity companies, and generally tries to protect consumer interests in this regulated monopoly. The State of Arizona has been trying to deregulate this industry, but based on issues with the State of California's deregulation, Arizona has pulled back on any significant changes in the near-term.

The current Hopi reservation electricity provider is Arizona Public Service (APS). Services are provided by one on-reservation APS employee stationed in Keams Canyon. If additional staff or assistance is required, the APS office in Winslow provides support. APS is a for-profit utility company, headquartered in Phoenix. APS operates major electrical generation plants in Arizona

and has a major 500 KVA transmission line that crosses the Hopi reservation. There are no generating stations on the reservation. The APS facilities on the Hopi reservation are sited likely through no cost rights-of-way negotiated with the BIA approximately fifty years ago. Many of these rights-of-way may be expired, or may be expiring soon. The rights-of-way issue is being litigated on other Indian reservations and this issue may provide some leverage in future discussions with APS.

The Navajo Tribal Utility Authority (NTUA), a rural electric cooperative, primarily serves the surrounding Navajo reservation. It is regulated by Navajo law and by an independent Board of Directors. Many of the rural areas of the Hopi reservation are closer to NTUA distribution lines than to APS distribution lines. The proposed new town along the Turquoise Highway is approximately 17 miles from the nearest APS distribution line, but only 3 miles from NTUA service. NTUA is the oldest tribal utility authority in the U.S. NTUA recently expressed interest in purchasing the APS distribution service for the Navajo reservation town of Tuba City. APS was generally pre-disposed to agree to a sale of the distribution assets only if the transaction also included service for the adjacent Hopi village of Moenkopi<sup>60</sup>. This resulted in APS contacts to the Hopi tribal government regarding the willingness of the tribe to agree to a transfer of rights-of-way to NTUA for certain distribution lines on the Hopi reservation. These contacts reportedly led to a verbal expression of interest by APS to sell distribution system assets on the Hopi reservation to the Hopi tribal government.

APS is in the process of conducting an inventory of distribution assets on the Hopi reservation. However, they have not shared that information with the Tribe. Nor has APS provided any good load data for the Hopi reservation service. APS is being contracted through the EPA Clean Air Project to supply more specific operating information about their system on the Hopi reservation.

In general, the Hopi reservation load is a winter peaking load of approximately 5 MW of demand. Approximately one-half of this load is estimated to serve the major reservation loads of the Indian Health Service (IHS) medical center, the Hopi middle and senior high school complex, and the tribal central government offices. A rough estimate of the number of meters on the reservation is approximately 2,000. This estimate includes approximately 25 commercial businesses, 25 government institutional buildings, and the remainder is residences and farm/ranches. There are no industrial customers within the reservation service area.

The APS estimated load of 5 MW is consistent with the Western Area Power Administration calculations in support of the Hopi hydropower allocation of approximately 2.3 MW's to serve the residential load. The total annual electricity consumption is estimated to be in the range of 20 million kWh. Assuming an average cost of 9 cents/kWh<sup>61</sup> for standard rate plans, the annual electricity service cost for the entire reservation is about \$1.8 million and the average monthly residential bill is estimated to be on average about \$75.

<sup>60</sup> Discussion notes from meeting with APS in Winslow by project team, 7-11-02.

<sup>61</sup> APS service rates as posted on website, 7-12-02. Assumes an average residential customer usage of 800 kWh per month.

APS charges the same rates for electricity service throughout its service area of large urban areas and outlying rural communities. Because the customer/line density on the Hopi reservation more closely approximates a rural electric cooperative with about five to eight customers per mile of distribution line, rather than for an urban utility where the density may be 50 customers per mile, the operation and maintenance expense for the distribution system on the Hopi reservation is in essence being subsidized by the urban customers in Phoenix. Operation and maintenance of rural utility distribution systems is by far the largest component of the retail rate. The firm power generation rate component for APS is approximately 3.5 cents/kWh. Administration and maintenance is therefore about 6 cents. Some rural electric cooperatives that receive nearly all of their power from hydropower dams may have a generation cost of only 1.5 cents/kWh and an administrative and maintenance cost of 8 cents. This situation may be part of the reason why APS is trying so hard to reduce maintenance costs by only having one employee on the reservation and by closing the office when the employee is out on a service call. Additionally, this situation may contribute to an attitude of limiting or cutting back on distribution upgrades and replacements in this area and why APS accepts the higher rate of outages in the service area.

The State of California utility regulatory body has also become important to Hopi. The California Public Utilities Commission regulates the rates of utilities in California. Southern California Edison, serving Californians in San Diego and the surrounding areas, must pay for upgrades to the Mohave Generating Station by adding to the rates of its California customers. The CPUC is therefore determining whether certain upgrades necessary to meet California air quality standards and keep the plant in operation are permissible.

## **VI. INDOOR AIR POLLUTION CONCERNS**

### **1. Background**

People spend most of their time indoors - as much as 80-90% of their lives - so our exposure to harmful indoor pollutants can be serious. We work, study, eat, drink and sleep in enclosed environments where air circulation may be restricted. For these reasons, experts feel that people suffer more from the effects of indoor air pollution than outdoor pollution.<sup>62</sup>

There are many sources of indoor air pollution. It can come from tobacco smoke and vapors released from building materials, paints, furniture, etc. Traditional energy sources such as coal and biomass (including wood) are used widely<sup>63</sup> on the reservation for

<sup>62</sup> Indoor air pollutant levels are estimated to be 25-62% greater than outside levels. In 1987, the USEPA ranked indoor air pollution among the 13 top environmental problems analyzed. See "Reducing Indoor Air Pollution: A Serious Public Health Problem" Calif. Air Resources Board, found at [www.arb.ca.gov/research/indoor/rediap.htm](http://www.arb.ca.gov/research/indoor/rediap.htm), updated May 2, 2001.

<sup>63</sup> The US Census shows that 37% of households use wood heat, and 12% use coal. Electricity is used only by 6% to heat their homes and natural gas by 3%. Each Hopi member (or household) is entitled to 4 "loads" of coal annually.

home heating and some cooking. In 1990, twice as many Indian households on reservations used wood, propane or coal for home heating as compared to the use of cleaner burning natural gas and electricity in other U.S. households. Based on 1990 census numbers, the Department of Energy found that 28.6 % of Hopi homes on the reservation lack access to electricity.<sup>64</sup>

Even in households where electricity is available, it is not known what percentage of Hopi homes may also use coal or wood for heating. There is also little information about the types of stoves, furnaces, fireplaces or other ‘combustion appliances’ being used, and their condition and age. Further, little or no air quality sampling or monitoring of Hopi household environments has been done to establish baseline data and whether or not a problem exists.

The burning of wood and coal, while inexpensive and readily available, releases significant quantities of soot into the air<sup>65</sup> and pollutants inside the home. Indoor air pollution problems exist from coal burning, even though it has been scientifically characterized only in the last two to three decades. Worldwide, rising concerns about soot and wood smoke pollution from solid fuel burning<sup>66</sup> lead to epidemiological studies in developed countries where exposures to many of the classical air pollutants, specifically sulfur dioxide, respirable particulate matter, carbon monoxide, and nitrogen dioxide were first monitored.

Where testing and studies of classic (e.g. particulate, carbon monoxide) and non-classical pollutants, such as fluorine, on indoor air quality have been done in developing or emerging countries, the results have been striking.

Today about half the population of the world relies on unprocessed solid fuels for cooking and space heating on simple household stoves in spite of high emission factors which produce a range of health-damaging air pollutants.

There are no natural gas pipelines serving the Reservation, however, a gas transmission line serving wholesale customers crosses the Reservation.

Propane service is provided by three suppliers. They each deliver propane to individual unit tanks from a central distribution center. Propane is the heating source for 39% of the housing units on the Reservation, according to the 2000 census. Wood heats 37% of Hopi homes, and electric heat is used by 6% of homes.

<sup>64</sup> The latest information found was in Table 5, Renewable Option for Indian Lands with High Incidence of Households without Electricity, in DOE’s report “Energy Consumption and Renewable Energy Development Potential on Indian Lands” Energy Information Administration, April 2000, found at [www.eia.doe.gov/cneaf/solar/renewables/ilands](http://www.eia.doe.gov/cneaf/solar/renewables/ilands).

<sup>65</sup> Indoor Air Pollution at a glance, World Health Organization publication, dated March, 2002, found at <http://wblmn0018.worldbank.org/hdnet/hddocs.nsf>

<sup>66</sup> Unprocessed solid fuels produce 10-100 times more respirable particulate matter as the result of low (combustion and heat-transfer) efficiencies than modern cooking and heating fuels, such as kerosene and gas, World Health Organization (WHO) , Air Quality Guidelines, dated 1999, Chapter 4 , Indoor Air Quality, search [www.who.int/environmental\\_information/air/guidelines](http://www.who.int/environmental_information/air/guidelines).

According to the census, 12% of homes are heated by coal. Peabody Coal, through the Hopi Office of Mining and Mineral Resources provides tribal members with free coal supplies as part of its mining agreements. The coal is hauled from the mine to the solid waste site where it is stock-piled and then distributed to individual members by the “pick-up” load. Each family is permitted 4 free loads per year.

In China and India, studies attributed approximately 1 million premature deaths<sup>67</sup> per year to household use of solid fuels (split about 2 to 1 between biomass and coal). Since India and China together account for approximately 60 percent of solid-fuel-using households in the developing world, this implies that, worldwide, about 2 million premature deaths each year could be attributed to household solid fuel use.<sup>68</sup> Depending on the number of young children in the total, indoor exposures account for *4-6 percent of the global burden of disease*.<sup>69</sup>

Those estimates make the health impact of indoor exposure larger than the burden from all but two of the other major preventable risk factors that have been quantified, malnutrition (15 percent) and lack of clean water and sanitation (7 percent).<sup>70</sup> If these estimates are accurate, the global burden of disease from indoor air pollution is larger than for such well-known threats to human health as tuberculosis, AIDS/HIV, malaria, heart disease, cancer, sexually transmitted diseases, tobacco, illicit drugs, hypertension, occupational hazards, alcohol, war, vehicle accidents, or homicide.<sup>71</sup> The economic impacts of indoor pollution, including health care costs,

<sup>67</sup> Indoor burning of coal doesn't always result in premature death, but it can have other serious detrimental effects to teeth and bones. In China, where coal is readily gathered and used for cooking, heating and drying grain, people develop debilitating dental and skeletal fluorosis primarily from burning coal indoors without adequate ventilation. Watanabe, Kondo, Asanuma, et al., *Skeletal Fluorosis from Indoor Burning of Coal in Southwestern China*, *Fluoride* Vol. 3, No. 3, pages 135-139, 2000 at [www.fluoride-journal.com](http://www.fluoride-journal.com).

<sup>68</sup> Murray, Christopher J., and A. D. Lopez, editors. 1996. “The Global Burden of Disease” Cambridge, MA, Harvard School of Public Health on behalf of the World Health Organization and World Bank, at [wbln0018.worldbank.org](http://wbln0018.worldbank.org).

<sup>69</sup> By comparison, urban air pollution is estimated to be responsible for 1-2 percent of the global disease burden. Ostro, Bart, 1996. “A Methodology for Estimating Air Pollution Health Effects.” WHO/EHG/96.5. Geneva: World Health Organization; and *Indoor Air Pollution at a glance*, World Health Organization publication, dated March, 2002, found at <http://wbln0018.worldbank.org/hdnet/hddocs.nsf>.

<sup>70</sup> *Indoor Air Pollution at a glance*, World Health Organization publication, dated March, 2002; Reddy, A. K. N., R. H. Williams, and T. B. Johansson. 1997. “Energy after Rio: Prospects and Challenges.” New York: United Nations Development Program at [wbln0018.worldbank.org](http://wbln0018.worldbank.org).

<sup>71</sup> Smith, Kirk R. 1993. “Fuel Combustion, Air Pollution Exposure, and Health: The Situation in Developing Countries; Annual Review of Energy and Environment 18:529-66 at [wbln0018.worldbank.org](http://wbln0018.worldbank.org).

lost productivity, and human welfare impacts, have been estimated at billions of dollars each year.<sup>72</sup>

Enough research has been done on the subject of indoor air pollution to warrant a look at what is going on inside Hopi homes. One would suspect that households using coal and/or wood for heating purposes have higher concentrations of indoor air pollutants than those using electricity or natural gas for heating.

## **2. Strategies to Reduce Pollution**

Many things can be done to reduce indoor air pollution, but their effectiveness will depend on three considerations: 1) the policy and regulatory context within which changes are introduced; 2) making sure that all relevant sectors and actors are consulted before actions are undertaken to increase fuel efficiency, reduce health risks and improve local ecology; and 3) the local community is educated and involved in technology designs and applications, especially with regard to home heating appliances and ventilation.<sup>73</sup>

Initially, indoor air sampling and monitoring should be done to determine if the air is contaminated, establish the source and severity of the problem, and inform the occupants of any threat to their health and well being. Radon, which is a natural radioactive gas released from the earth, and can be found concentrated in basements or subsurface structures. The Hopi are aware of this problem and have an active radon-testing program for assessing the presence of radon in homes.<sup>74</sup>

Other key monitoring indicators could include particulates (PM10) in the air in homes, carbon monoxide (CO measured in parts per million or ppm), and fluoride levels in food (if the coal contains fluoride). There are devices that can be worn by household members that measure direct exposures to PM10 over a specific period of time (usually 24 hours).<sup>75</sup> Id. Then if warranted, control and improvement of indoor air quality can be achieved by combining several strategies.<sup>76</sup>

<sup>72</sup> See “Reducing Indoor Air Pollution: A Serious Public Health Problem” California Air Resources Board, found at [www.arb.ca.gov/research/indoor/rediap.htm](http://www.arb.ca.gov/research/indoor/rediap.htm), updated May 2, 2001.

<sup>73</sup> Indoor Air Pollution at a glance; expanded versions of the ‘at a glance series’ are available on the World Bank Health-Nutrition-Population web site: [www.worldbank.org/hnp](http://www.worldbank.org/hnp)

<sup>74</sup> See articles re Hopi Indian Radon Project in the Tutuveni archives, October 2, 2002, [www.hopi.nsn.us](http://www.hopi.nsn.us)

<sup>75</sup> Id. These devices are then worn again after corrective measures are taken.

<sup>76</sup> World Health Organization (WHO), Air Quality Guidelines, dated 1999, Chapter 6, Strategies For Indoor Air Quality Management, found at [www.who.int/environmental\\_information/air/guide](http://www.who.int/environmental_information/air/guide)

## Improve the Living Environment

The types and amounts of pollutants generated depend on the type of heating appliance, how well the appliance is installed, maintained and vented, and the kind of fuel it uses. Creosote<sup>77</sup> buildup or leakage causes black stains on the outside of the chimney or flue and can mean that pollutants are leaking into the house. Carbon monoxide poisoning from burning and smoldering fuels can quickly kill.<sup>78</sup> However, most appliances like wood stoves heat a room or two at a time and expel smoke and pollutants through a chimney or vent.

Adequate ventilation is an easy and effective way to maintain good indoor air quality, although it may not completely remove all pollutants. Normally, fresh air enters a home through cracks around doors and windows. A fresh air supply is very important to help carry pollutants up the chimney, stovepipe or flue to the outside. Increase ventilation by opening windows and doors when the weather permits. For effective ventilation while conserving energy during extreme weather, a heat recovery ventilator should be considered.<sup>79</sup>

Properly maintained heating appliances generally burn cleaner and more efficiently. Before each heating season, flues and chimney should be inspected and cleaned. Proper maintenance generally involves checking coal burning central furnaces, fireplaces or stoves for cracked heat exchangers or fireboxes, defective grates, flues blocked by rust or soot, and blocked air intakes such that the fuel is not receiving enough air to burn most efficiently.<sup>80</sup>

New houses or buildings are generally designed airtight so that not enough clean, outside air can enter. As a result, mechanical ventilation is necessary to introduce a satisfactory flow of outside air and to provide adequate dilution and removal of pollutants. Kitchen hood fans, bathroom and whole house exhaust fans are very effective at removing pollutants, although they generally require electricity to run.

Two other types of technologies effectively remove particulates and contaminants from the air - - electrostatic precipitation and negative ion generation - - but are effective only when properly installed and maintained. It is important that filters be changed or cleaned on a regular basis and that leakage around the filters be minimized. These types of air cleaning are most effective when used in conjunction with source control and adequate ventilation. Most air cleaning in large buildings is directed primarily at preventing contaminant accumulation in HVAC equipment and

<sup>77</sup> Creosote is an oily, black tar that sticks to the inside of chimneys and stovepipes. Seasoned hardwoods burn hottest and should be used, if possible, to prevent creosote buildup, "What You Should Know About Combustion Appliances And Indoor Air Pollution," Consumer Product Safety Commission Document #452, found at [www.cpsc.gov/cpscpub/pubs/452.html](http://www.cpsc.gov/cpscpub/pubs/452.html).

<sup>78</sup> Carbon monoxide detectors are now available which warn consumers of harmful levels in the home.

<sup>79</sup> "Reducing Indoor Air Pollution: A Serious Public Health Problem," California Air Resources Board, [www.arb.ca.gov/research/indoor/rediap.htm](http://www.arb.ca.gov/research/indoor/rediap.htm).

<sup>80</sup> Consumer Product Safety Commission, "What You Should Know About Combustion Appliances And Indoor Air Pollution," Document #452, citation above.



enhancing equipment efficiency.<sup>81</sup> Incorporate Technologies Which Aim to Improve the Device, Fuel Or Need Programs which aim to improve heating devices, improve fuels or reduce the need for heating are essential to reducing indoor emissions. Electricity and natural gas provide the cleanest forms of home heat. However, if these cleaner, but more costly fuels are not an option or a preference, new state of the art technology as applied to woodstoves and combustion appliances has been developed since the 1980s that greatly reduce emissions of particles.<sup>82</sup>

Along with better stove designs, coal can be chemically treated to reduce emissions or the size of the fuel pieces can be reduced, e.g. briquettes and pellets burn much more efficiently than large coal lumps. Although costly, stoves are available now that automatically feed rice sized pieces of coal into a blower and can warm a 2,500 square foot house.<sup>83</sup>

Also, home improvements can greatly reduce the need for heat. Less heating is required if walls and ceilings are better insulated, heavily used living areas are partitioned separately from cooler sleeping areas, and alternative energy sources (wind, solar) are used to heat water, dry clothes, etc.

## **Foster Behavioral Changes To Reduce Exposures And Smoke Generation**

All programs need to include components that inform, educate and communicate the health, environmental, energy and financial consequences of indoor air pollution and how improved heating devices, together with behavioral changes, can lead to better health and household finances. Stove design and building, as well as appliance and chimney maintenance can create income-generating opportunities for the local economy. Subsidies can be offered as an incentive to adopt improved heaters.<sup>84</sup> Rural credit schemes can be effective ways to promote demand and finance community-based appliance improvement schemes.<sup>85</sup> Finally, government grants or assistance may be available for larger sampling or monitoring programs or health studies to help defray costs. Further, there may be funding available to low-income households, e.g. utility

World Health Organization (WHO) , Air Quality Guidelines, dated 1999, Chapter 6 , Strategies For Indoor Air Quality Management, found at [www.who.int/environmental\\_information/air/guide](http://www.who.int/environmental_information/air/guide)

<sup>82</sup> J. Houck and P. Tiegs, Residential Wood Combustion Technology Review, Vol. 1, Technical Report No. EPA600/R-98-174a prepared for the USEPA, Office of R&D, Dec. 1998. Note that some electricity is necessary on most newer stoves and furnaces to ignite it or run the blowers and fans.

<sup>83</sup> Top of the line stove cost around \$2,700 but can run as little as \$700, Letter of energy Market Innovations, Inc. to Ms. Margaret Schaff, P.C., dated Dec. 2, 2002, referencing [www.coalstoves.com](http://www.coalstoves.com).

<sup>84</sup> These programs are generally phased out gradually to limit continuous reliance on public funding.

<sup>85</sup> Indoor Air Pollution at a glance, World Health Organization publication, dated March, 2002, found at <http://wblmn0018.worldbank.org/hdnet/hddocs.nsf>.

assistance, stove or heater replacement, etc.<sup>86</sup> Improving Residential Coal Applications. Coal is a significant source for heating for much of the world. However, our research did not uncover many clean coal technology opportunities. Here is what we found during our research:

- Anthracite's low sulfur and high carbon content makes it an extremely clean-burning fuel. It produces virtually no smoke or polluting emissions, a major problem with wood and wood pellet-burning stoves. In fact, it is a good alternative to wood stoves where wood burning is restricted due to air pollution problems. After switching to anthracite, many homeowners report saving up to 50 percent on their heating bills while gaining a more healthful and comfortable home. Even the small quantities of ash left over from burning anthracite can be used. The ash is excellent for aerating soil and as anti-skid material for icy driveways and walkways. In fact, many municipalities collect anthracite ash from industrial users, saving taxpayers thousands of dollars per year (Blaschak Coal website). The nearest anthracite production in the U.S. is near Philadelphia, PA.
- Coal is still one of the least costly and most plentiful energy sources. It was a dominant home heating fuel up until the 1950s. Since then, its use has fallen steadily in all but large-scale industrial heating, and power generation systems. The decline in the use of coal for home heating can be attributed largely to the cost of handling, coal burning equipment, ash disposal, and general maintenance issues. The recent EPA restrictions in the Clean Air Act will further detract from the acceptability of coal as a heating fuel in all but the largest applications (Florida Power and Light website).
- Today, home heating uses anthracite coal, known as hard coal, which has only about one percent sulfur. Stove dealers still advise consumers to buy carbon-monoxide detectors, but Dave Ryan, a spokesman for the Environmental Protection Agency, says that harm to the environment from burning anthracite coal appears to be negligible if stoves operate properly and adequate ventilation is present. Most of the stoves operate like wood stoves, heating a room or two at a time and expelling smoke through a chimney. However, in houses where ductwork is already in place, a forced-air fan or blower system can circulate the heat. Top-of-the-line stoves, which cost about \$2,700, are fully automatic, feeding rice-sized pieces of coal into a blower fan that can warm a 2,500-square-foot house. Then there is the ash factor. A ton of coal produces about a half ton of ashes. Some people bury it. A winter's worth of coal can cost \$200, depending on location
- (Matthews, *Wall Street Journal*, Jan. 7, 2001). Most anthracite is found in northeastern Pennsylvania (American Coal Foundation website).
- Wood and coal stoves, fireplaces, chimneys, chimney connectors, and all other solid-fueled heating equipment need to be inspected annually by a professional and cleaned as often as the inspections indicate (National Fire Protection Association website).
- Coal stoves can cost as low as \$700 ([www.coalstoves.com](http://www.coalstoves.com)).

The following are industry contacts and funding sources to assist in pursuing this avenue:

<sup>86</sup> The U.S. Environmental Protection Agency and Department of Health and Human Services have several programs which may be available to the tribe, See e.g. the low-income home energy assistance program (LIHEAP); the tribal funding of programs via DHHS' National Center for Appropriate Technologies at [www.ncat.org/liheap](http://www.ncat.org/liheap) or [www.epa.gov](http://www.epa.gov)

- Funding exists for those households with low income who need government assistance. Low-income home energy assistance program (LIHEAP), offers subsidies through state offices to those in need (U.S. Department of Health and Human Services, Administration for Children and Families).
- Home heating coal stove manufacturers:

Company	Website	Of Interest
Harmon Stoves	<a href="http://www.harmanstoves.com/coal.htm">www.harmanstoves.com/coal.htm</a>	
Alaska Stove Company	<a href="http://www.alaskastove.com/coal.htm">www.alaskastove.com/coal.htm</a>	
Meyer Manufacturing	<a href="http://www.meyermfg.com/woodchuck.html">www.meyermfg.com/woodchuck.html</a>	The Woodchuck is an add-on stove that burns coal or wood and compliments the current heating system in a house
Transocean Ltd	<a href="http://www.transoceanltd.com/appliances/woodburn.html">www.transoceanltd.com/appliances/woodburn.html</a>	
Krings Stoves	<a href="http://www.kringsonline.com/coalstoves">www.kringsonline.com/coalstoves</a>	

## VII. IMPROVING ELECTRICAL SERVICE ON THE RESERVATION

### 1. *Allocation of Federal Hydroelectric Power*

#### **Western Area Power Administration Power Allocation**

Electricity generated at federal hydroelectric dams throughout the western U.S. provides a significant portion of the total electricity consumed in the west. The relative low cost of this hydropower is a benchmark for cost comparisons for all other electricity generation sources. Many of the federal power rates are up to 75% less than market rates for undelivered power. The low-cost hydropower is limited in quantity and is sold by the federal government to only

non-profit electricity companies (rural electric cooperatives and municipal electric companies) or to a few selected large industrial consumers that have special economic circumstances. While the Corps of Engineers or Bureau of Reclamation generally operates the dams, the electricity from federal dams is managed and sold to qualified buyers by regional power marketing administrations. For the sixteen most western states, the United States Department of Energy, Western Area Power Administration (WAPA) manages the electricity.

WAPA has recently agreed to sell a small amount of its hydropower-generated electricity directly to Indian tribes. This change in policy was the result of a lengthy legal battle conducted by the Mni Sosa Tribal Water Coalition of the northern plains tribes. Beginning in the fall of 2004, the Hopi Tribe will be able to purchase an amount of electricity that is on a month-to-month basis 25%- 50% of the total electricity consumed on the reservation. The specific amount of electricity is defined by a monthly schedule derived by WAPA of estimated actual electricity usage by reservation consumers. The amount of electricity is also dependent upon the ability of the dams to generate an estimated amount of electricity each month that is based on estimated long-term rainfall projections.

However, since the Hopi Tribe does not yet have its own electricity distribution system, the Tribe must enter into a contractual agreement with the existing electricity companies in the area to make beneficial use of the low-cost hydropower. The allocation of electricity to the Hopi Tribe is severely restricted by legislation and administrative policies. For example, the Hopi Tribe cannot simply sell its right to buy the hydropower to some electricity company in direct return for cash.

The Hopi Tribal Council will be asked to sign federal contracts for this power in the near future. Final contract changes are now under consideration by WAPA. The contracting will be done in two stages. First, a "Firm Electric Service Contract" will be presented that will in effect reserve the allocation to the tribe without requiring any tribal commitment. This Firm Electric Service Contract must be signed by April 1, 2004 or the option to become a federal power customer will expire. The second contract will be a contract that describes how the power will be delivered to the Tribe. This contract should be in place by October 1, 2004 or the tribe will lose the benefit of the allocation for the time it is not in effect.

The most common method for allocation delivery that other Indian Tribes have used is a "net bill crediting" agreement with the local electricity distribution company. In simplest terms, the Tribal allocation is given to the local electricity company in return for an agreement that the savings realized by this low-cost electricity that replaces higher cost electricity sources will be passed along to tribally designated families or beneficiaries.

However, the Hopi reservation local electricity company, APS, has firmly stated that they are unwilling to enter into this form of net bill crediting agreement. Since APS does not currently buy any electricity from WAPA (APS is a for-profit company and is not allowed to buy the low-cost hydropower) to now begin this hookup and purchasing agreement with WAPA would require significant technical and administrative changes to the APS accounting system.

## **Delivery of Power Allocation**

The available options for the Hopi Tribe to make beneficial use of this allocation option to buy low-cost hydropower are probably limited to:

1. Form a Hopi Electricity Company that can distribute electricity to reservation consumers
  - a. This option will require a significant amount of time (2 - 3 years) and would probably be based on purchasing the existing APS distribution system

- b. This option would also require the development of a Hopi Utility Regulatory Authority to govern the way utility services are managed on the reservation (the utility authority may include both electricity and telecommunications regulation).
- 2. Develop a creative hydropower transfer agreement with a different off-reservation electricity company that could return some benefit to the Hopi Tribe that is not
- 3. necessarily deemed as a "sales agreement" until a tribal utility is formed or some alternative method can be devised
  - a. A likely neighboring electricity company is the Navajo Tribal Utility Authority (NTUA) that operates all around the Hopi reservation boundaries and whom
  - b.
  - c. would need to be a cooperating and supporting business partner with any Hopi Electricity Company
    - i. NTUA is a non-profit, rural electric cooperative that already buys some electricity from WAPA and has an accounting and business structures already in place that could easily accommodate the usage of the Hopi allocation of hydropower
    - ii. While several options might be possible, one scenario (for illustrative purposes only) might be for NTUA to build the required substation for the proposed new village site at a reduced cost.
    - iii. NTUA has proposed a power pooling system under which it will take other tribal allocations and provide the benefit of the allocation back to the tribe. If WAPA approves this NTUA option, an arrangement for a cooperative acquisition of the APS facilities, or some other cooperative arrangement may be possible.
  - d. Other Arizona tribes served by APS are also struggling with these issues and could form some kind of cooperative effort for delivery of the allocations.

The WAPA hydropower allocation for the Hopi Tribe is 5,951,066 kWh Summer Energy and 6,698,757 kWh Winter Energy. This allocation is to begin in October 2004 and be valid for 20 years<sup>87</sup>. The draft contracts between the Tribe and WAPA assumes a wheeling arrangement with Arizona Public Service on a firm power basis with a not to exceed maximum, depending upon the water levels of the Colorado River dam reservoirs. Because of the unique nature of the draft contracts, the value of the allocation to the electric utility will depend upon the flexibility within the generation system to maximize the cost savings. Coincidentally, if the allocation management is to be accommodated within the generation system, the value of the lower cost hydropower (1.7 cents/kWh for hydropower versus approximately 3.0 cents/kWh for coal based generation) may become trivial. Ostensibly, the savings would be passed along to individual customers by a net credit on the monthly bills. For a typical residential customer using approximately 800 kWh/month the savings might be as high as \$10.40 per month (about 12% of the monthly bill).

Any use of renewable energy will improve air quality because it presumably defrays the need for electricity generated by burning fossil fuels. Federal hydropower also defrays the need for

<sup>87</sup> Federal Register Notice, Final Allocation of the Post-2004 Resource - Salt Lake City Area Integrated projects, Western Area Power Administration, February 4, 2002.

burning. Most renewable forms of generation do rely on conventional fuel generation for back-up due to their intermittent nature.

## ***2. Consideration of a Tribal Utility***

The Hopi Tribe has long considered taking over the delivery of electricity to its membership. With the proposed construction of new towns, it makes even more sense to review this option since new infrastructure will be needed where none now exists. The Hopi Reservation customers spend millions of dollars per year on electricity. All these funds leave the reservation into the hands of APS. This is steady money that is drained from the reservation economy, and if it could be kept on the reservation to circulate, it could create an excellent economic boost. Electricity is a critical infrastructure that will only grow in use over time. Tribal control or regulation of critical infrastructure is an instrument of sovereignty that is not now being exercised.

Electric service on the Hopi Reservation is poor, when compared to the reliable service in cities. While better service usually requires paying more money, options exist to address the issue of improved reliability, with or without ownership of the utility system.

Many factors are coming together at this time to raise the issue of a tribally owned utility. First, the APS system is in need of upgrades. Second, APS has indicated an interest to sell its distribution system on the Hopi Reservation and in some surrounding Navajo communities. The APS system here is an “island” system, meaning that it is wholly surrounded by the system owned by the Navajo Tribal Utility Authority (NTUA) and is fed by one transmission line which crosses through the Navajo Reservation. Third, NTUA has indicated an interest in acquiring and improving the APS system within its boundaries but APS has agreed not to sell the system to NTUA without Hopi approval. Fourth, the Hopi Tribe will, for the first time beginning in October, 2004, be a recipient of low-cost federal hydropower from the Western Area Power Administration. This lower-cost hydropower will be available to the Hopi Tribe for a 20 year period and will be enough energy to meet almost one half of Hopi electric demand. A method for delivery of this power is being discussed.

While the Hopi Tribe now has an interesting, and potentially beneficial option, to form a tribal utility and buy some low-cost hydropower-electricity from WAPA over each of the next 20 years, there are still several major obstacles and decisions to be made before the benefit can be realized. These obstacles include: 1) acquisition of the APS distribution system, 2) establishment of internal tribal authorities and structures to operate a utility, and 3) providing the remainder of needed power for a tribal system.

### **Acquisition of the APS Distribution System**

Review and study of available materials for the APS system and utility codes have been started. APS has not been forthcoming, however, with information necessary for a full analysis. APS has requested non-binding agreements to cover the study period and the confidentiality of its information.

NTUA has also expressed an interest in acquisition of the APS distribution system. Part of the system is on Hopi lands and part is on Navajo lands. The Hopi Tribe is discussing the possibility of working with NTUA to deal jointly with APS in a coordinated strategy.

Initial quality and price evaluations of the APS system on the Hopi reservation have been made and are being kept confidential to protect the Hopi Tribe's negotiation status with APS.

Acquisition of the system will require economic analysis for acquisition and improvement of the existing system, additions to the system for future development, financing reviews, and operations and maintenance options.

## **Providing Remainder of Power to Serve Load**

If the Hopi tribe does not form a utility, APS will continue to provide the remainder of the power not provided by WAPA. The total amount needed to serve the remainder of Hopi loads in the near-term before significant economic development results in electric load growth is approximately 2 to 2.5 MW.

If the Hopi tribe does form a utility and acquires and improves the APS facilities on the Reservation, it will have to generate this additional power, or purchase the power in the open power markets and have it delivered to the tribe over the only existing line into the only existing substation at Hopi. This line is the APS Cholla-Keams Canyon line and it will likely have needed capacity to service the Hopi load since it is now servicing the load. Access to this transmission line is guaranteed by FERC, assuming conditions are met.

Options for generation of the balance of reservation loads in the 2 to 2.5 MW range using existing energy technologies could include:

- ☐ Purchase power from local suppliers
- ☐ Diesel generators (which might be converted to either propane or natural gas)
- ☐ Micro gas turbines (fueled by propane or natural gas)
- ☐ Coal generation
- ☐ Wind power turbines (backed up by diesel generators or micro gas turbines)
- ☐ Photovoltaic (backed up by diesel generators or micro turbines)
- ☐ Fuel cells (future emerging technology)

The most widely used option for this size of generation system would be a diesel generator. Thousands of similar systems are in operation around the world. Because diesel fuel is prone to spillage and is more difficult to transport, many such systems have been converted to run off propane or natural gas that also reduce particulate emissions. The IHS medical center uses a similar diesel generator at its site as a backup for outages of the APS grid. The systems are highly reliable and can be quickly dispatched (turned on and off) to meet load shifts and to complement available power that is incoming from WAPA. Diesel generators are easily purchased or leased from a number of American or international manufacturers or their local

distribution companies. Emissions and fuel storage are highly regulated by environmental agencies.

So-called "micro or mini" gas turbines are also very available in a range of sizes. The recent resurgence of on-site power systems for large industrial or manufacturing facilities has revitalized manufacturing and development of mini gas turbines. The turbines are usually fueled by natural gas or propane. The turbines are easily dispatched and are relatively compact with good emissions characteristics. The natural gas pipeline that crosses the reservation may be a potential fuel source if a cost effective tap can be installed. At this time, no such tap exists, but NTUA is discussing the installation of a tap to serve its Moenkopi customers with natural gas. The efficiency of the gas turbines and lower emissions make this technology very attractive. The biggest drawback is volatile of natural gas prices. Trucking in propane is undoubtedly more expensive, but may be integrated with a Tribal propane business. If the propane can be purchased in bulk during the off-season, the relative cost difference may be significantly less than natural gas.

A review of the material available for distributed generation application suggests that technologies using coal as a fuel source are in the research stage. It appears that no such technologies are available in the commercialization stage (i.e., available for the mass market today). However, if a group with coal resources was interested in getting involved with the research and development stage, many opportunities are available as evident from the following findings:

- By 2010, coal/fuel cell distributed generation applications are expected, which will likely be powered with a fuel gas derived from coal, possibly similar to methods used in IGCC. Fuel cells currently cost about \$1,000 to \$1,500 per kW, a very similar capital cost to a full sized power plant. However, DOE estimates that capital costs for fuel cells will drop to under \$500 per kW by 2015 (U.S. DOE Fossil Energy website).
- A two-MW fuel cell is being built at the Wabash CCT plant in West Terra Haute, Indiana. This will be the largest fuel cell ever powered by gas from coal (U.S. DOE Fossil Energy website).
- Scientific Applications Research Associates, Inc (SARA), a private research and development firm, is currently developing a direct carbon fuel cell (DCFC) which may have little or no pollutants ([www.sara.com](http://www.sara.com)).

According to the DOE Fossil Energy Group, there are no current solicitations for using coal with fuel cell technologies. However, there may be opportunities next year once Congress resolves budget issues for energy programs. There is a process available for submitting unsolicited proposals and the instructions can be found at <http://www.fe.doe.gov/business/>. Research and development funding is available through the U.S. DOE Fossil Energy program.

Wind power turbines of a utility scale are now currently available in a range of sizes from 600 KW to 1.5 MW. Usually the turbines are installed in clusters, or wind farms, that provide more reliability because the generation is spread across several systems. The higher capital cost for installing wind power turbines and their supporting towers is offset by the lack of any fuel cost. Unfortunately, the wind is not 100% dispatchable, and either a diesel generator, micro gas



turbine, must back up the wind farm or by purchased power contracts from a major electricity supplier, like APS. The cost of the electricity from wind turbines is highly dependent upon the speed of the wind resource and the size of the wind farm (which effects the amortization of fixed operation and maintenance costs across the generating system size, bigger is better). The wind resource is being evaluated as a separate part of this study. Assuming a class 3 to 4 wind resource, the cost of electricity is probably going to be in the range of 7 to 10 cents/kWh (APS's generating costs are currently in the 3 cent range). When the cost of firming power by diesel generators or backup power contracts is added in the actual comparable costs are more likely in the range of 12 to 15 cents/kWh.

While this analysis does not appear favorable for considering wind power, an offsetting positive is the potential availability of Federal grants that might reduce the wind power system capital costs by about half. Additional Federal tax credits for wind generation might shave and additional 1 to 2 cents off the electricity cost if a partnership with a for-profit company could be arranged where the tax credits could be of real value. Such a for-profit partner could also take advantage of investment tax credits for economic development on Indian lands, as well as special employment tax credits.

Photovoltaics (solar cells) are another renewable energy technology option that is similar to the wind turbine option. Photovoltaics convert direct sunlight (which is very intense on the Hopi reservation) to direct current electricity. This electricity goes through an inverter to energize the ac or alternating current power lines to homes or businesses. Since sunlight is not always dependable, the photovoltaic power would need backup just like wind. While photovoltaics are basically solid-state electronics, which are more reliable than the rotating machinery in wind turbines, the basic cost of the solar systems, are still many times more expensive. Photovoltaic-based electricity is likely to be in the 20 to 25 cents/kWh range. Similar tax incentives to wind energy may reduce this cost estimate slightly. A Hopi local company, Native Sun, has installed numerous photovoltaic systems on remote homes not connected to the electricity distribution system. The economics of photovoltaics in these small, isolated homes is much more comparable to other alternatives that are also very expensive.

Fuel cells are an emerging energy technology that may provide a cost effective alternative within 5 to 10 years. This technology must be considered in any comparison of energy technologies because some believe it will make many of the above discussed technologies obsolete in the near future. Fuel cells are electro-chemical devices that convert a hydrogen based fuel (such as methane, propane, or natural gas) into electricity with virtual no emissions other than heat and water vapor. Even the waste heat might be utilized by a nearby commercial facility for water heating or space heating. Fuel cells are being developed by a growing number of North American companies in sizes for individual homes, for cars (to replace the internal combustion engine with an electrical power source for electric vehicles), for medium to large scale commercial facilities and for small electric generating stations within the area of interest.

<b>CCT Program Area</b>	<b>Name</b>	<b>Contact Information</b>
Fuel Cell	Mark C. Williams Product Manager National Energy Technology Laboratory	U.S. Department of Energy PO Box 880 Morgantown, WV 26507- 0880 Telephone: 304-285- 4747 e-mail: <a href="mailto:mwilli@netl.doe.gov">mwilli@netl.doe.gov</a>

The most likely near term applications for fuel cell applications on the Hopi Reservation would be building-sited systems that would be fueled by propane. The system economics of fuel cell/propane systems would need to be compared to that of micro-turbine/propane systems, PV systems, and wind systems, but it is believed that once fuel cells production ramps up in the next few years, fuel cells may represent a very important power option for the Hopi Reservation.

- Manufacturers of fuel cells:

<b>Company</b>	<b>Website</b>	<b>Description</b>
Fuel Cell Energy	<a href="http://www.fce.com">www.fce.com</a>	Working with the U.S. DOE to combine a fuel cell with the Wabash IGCC plant
Siemens	<a href="http://www.pg.siemens.com">www.pg.siemens.com</a>	Working with the U.S. DOE on advanced fuel cell technology
UTC Fuel Cells	<a href="http://www.utcfuelcells.com">www.utcfuelcells.com</a>	Major manufacturer of fuel cells

- Carbon fuel cell market expert:
  - John F. Cooper, Lawrence Livermore National Laboratory

With the exception of utilities that receive all federal hydropower, no utility in the United States operates on 100% renewable power. If the Hopi Tribe chose to use it WAPA power hydropower allocation along with a renewable power source to meet its balance of electrical loads, it would be the first such utility. Such a utility would set an example for other utilities, and would contribute to better air quality. While costs would likely be higher than other utilities, the potential for green tags sales to defray costs, and use of other federal grants and programs could, if structured correctly, make the utility successful.

In summary, the technologies pursued will depend on what type of strategy is chosen. Immediate uses for clean coal tend towards conventional technologies as described above while leaving it in the ground for the future would tend towards participating in research and development, and investing in technologies of the future.

### **3. *Establishment of Internal Authorities to Regulate Local Utilities***

An alternative to a tribal utility is a tribal regulatory authority. The merits of a Hopi utility commission to oversee policies and regulatory issues are being discussed. Such a commission could be a first step in establishment of a tribal utility by creating leverage with existing utilities (including telephone service providers) or it could be an ongoing means of gaining control over certain utility functions. It could also provide a training ground for future utility managers. Lastly, it will help establish necessary separation between the business sides of utility matters and political governance of the tribe.

Utility commissions at other tribes have taken a variety of organizational structures depending on the relationships to tribal councils, the integration of electricity services with other utility services such as propane, water, or telecommunications, the relationships with existing state regulatory bodies and electricity providers, and the separation of regulatory and utility service functions.

Regulatory oversight of electric utility operations and facilities on Indian reservations is very clearly within the jurisdiction of Tribal governments<sup>88</sup>. State electric utility regulatory bodies, such as the State of Arizona Corporation Commission, do not have jurisdiction on Indian reservation lands. Their oversight of the electric utilities operating on reservations is only an implicit assignment of oversight through the lack of Tribal activity in this regulatory area. Since land allotments have not been wide spread on the Hopi reservation (only minimal allotments in the Moenkopi area<sup>89</sup>), there is little concern for the Tribal governments' exercising control over non-Indians operating on allotted lands.

Many Tribes throughout the U.S. are investigating the possibility of forming a Tribal electric utility. As a companion to formation of a utility company, Tribes are beginning to define their government role as a regulator. In fact, more tribes are now forming or operating utility regulatory bodies than are actually forming utility companies.

The role of tribal electric utility authorities is some varied, but generally includes:

- Oversight of utility company operations,
- Approval of rates and rate structures,
- Oversight of rights of way,
- Approval of policies for connections and disconnects,
- Granting of service area franchises, and
- Establishment of generation technology portfolios.

In general, tribal utility authorities have the same roles and responsibilities as state utility commissions. The overriding purpose is generally: "Establishment and implementation of public

<sup>88</sup> U.S. Supreme Court and FERC rulings, various, see *State of North Dakota vs. Otter Tail Rural Cooperative*, 1998.

<sup>89</sup> *Tiller's Guide to Indian Country*, Veronica E. Velarde Tiller, BowArrow Publishing Company, 1996.

policies and procedures to provide cost-competitive, reliable electricity service to any consumer requesting service."

Tribal utility authorities usually begin by establishing utility codes of operation and regulation. The name "Tribal Utility Authority" should not be confused with the common name for many tribal utility companies, i.e. Navajo Tribal Utility Authority or Tohono Odom Tribal Utility Authority. The role of regulation and company operations are two distinct purposes that are most usually not confused by combining the roles within one entity. A governing board separately chartered by the tribal government regulates even the above named tribal utility authorities. Tribal utility companies cannot become fully effective, or even operational, unless the issues of tribal regulatory authority are addressed.

Establishing a tribal utility regulatory authority is not an express commitment or obligation to form a tribal utility operating company. Indeed, the establishment of a regulatory framework is an enabling step that may yield policies and procedures that achieve tribal goals without forming a utility company. Tribes that form utility regulatory authorities may find that issues of cost or reliability that were previously experienced by reservation customers are now more rigorously fixed by existing off-reservation utility companies that want to continue operations on the reservation.

Establishing a tribal utility regulatory authority may also be the first step to formation of a utility, if that is the direction a tribe wishes to go. Creation of a decision making body with knowledge of the issues, and authority to move forward is critical to safeguarding important infrastructure facilities and decisions. In many instances, the threat of regulation will be a needed tool to leverage utility cooperation.

However, in the event the Hopi Tribe determined that acquisition of the APS facilities was immediately in their best interest, and APS was cooperative, a utility regulatory authority could be foregone in favor of the immediate establishment of a utility.

#### **4. *Energy Efficiency***

Energy efficiency may be the most cost effective and expedient way to yield economic and environmental benefits to the Hopi people. In many cases, the cost to replace inefficient energy using systems (e.g. lighting, appliances, motors, heating/cooling equipment, etc.) with new high efficiency systems can be paid off in relatively short periods of time due to the savings on power bills. Energy efficiency also directly reduces environmental emissions that are either released at the point of use (i.e. in the home or business) or, in the case of electricity, at the power plant.

In order to identify and prioritize energy improvement opportunities, Hopi Tribe will need to conduct a detailed inventory and characterization of buildings on the Reservation. Walkthrough audits of several Hopi communities, medical and school facilities, and community/institutional buildings have been completed. See Appendix C.

#### **Lighting**

Based on field observations and walk through audits of many buildings on the Hopi Reservation, lighting appears to present the largest and most expedient opportunity for operating cost savings. Lighting is ubiquitous; it is in every building; it is in plain sight; it can be readily evaluated and retrofitted; and it is often inefficient.

*Fluorescent Lighting.* Fluorescent lighting is common in many institutional buildings on the reservations. It is also used in most of the mini-mart/convenience stores, and is often found in kitchens and bathrooms in households. While standard fluorescent lighting is relatively energy efficient (as compared to incandescent lighting), there still are significant energy savings to be garnered by retrofitting light fixtures that use magnetic ballasts and T-12 fluorescent lamps. The typical retrofit involves replacing the magnetic ballast with an electronic ballast, replacing the T-12 lamps with T-8 lamps. The electronic ballast/T8 system yield comparable or higher light levels than the magnetic ballast/T-12 system with a 30-50% reduction in electricity use.

An example of these savings can be demonstrated by comparing the operating requirements of a standard fluorescent light fixture, pre-retrofit and post retrofit. A 2x4 recessed fluorescent fixture with magnetic ballast, 4 T-12 lamps, and an acrylic lens requires about 172 watts to operate. The same fixture retrofitted with an electronic ballast and T-8 lamps will require about 114 watts to operate, or a 34% reduction in electricity requirements. Further, since the electronic ballast/T-8 system typically yields more light output (in lumens) than the magnetic ballast/T-12 system, this type of fixture can often be “delamped” to three lamps (and sometimes 2 lamps) to achieve further savings. For fixtures that operate 10 hours a day/5 days per week (e.g. education center, etc.) or 24 hours a day/7 days per week (e.g. convenience store, etc.), the annual operating cost are shown in the Table X below.

Table X Annual Operating Costs and Retrofit Savings for a 2x4 Fluorescent Fixture

	\$0.075/kWh		\$0.10/kWh	
	10 hrs/day	24 hrs/day	10 hrs/day	24 hrs/day
Existing Fixture				
4 T-12 lamps (w/ magnetic ballast)				
Annual Operating Costs	\$33.54	\$113.00	\$44.72	\$150.67
Retrofitted Fixtures				
4 T-12 lamps replaced with 4 T-8 lamps				
Annual Operating Costs	\$22.23	\$74.89	\$29.64	\$99.86
Annual Operating Savings	\$11.31	\$38.11	\$15.08	\$50.81
4 T-12 lamps replaced with 3 T-8 lamps				
Annual Operating Costs	\$18.53	\$62.41	\$24.70	\$83.22
Annual Operating Savings	\$15.01	\$50.59	\$20.02	\$67.45
4 T-12 lamps replaced with 2 T-8 lamps				
Annual Operating Costs	\$14.04	\$47.30	\$18.72	\$63.07
Annual Operating Savings	\$19.50	\$65.70	\$26.00	\$87.60

Note: A retrofit of the magnetic ballast with an electronic ballast is assumed when using T-8 lamps.

By comparison to these savings numbers, it costs about \$15 for an electronic ballast and \$2 per T-8 lamp to retrofit the fixture, along with about 15 minutes of electrician/technician labor per fixture. Since the Hopi Tribe already has electricians/technicians on the payroll to do routine maintenance, out-of-pocket labor costs for ballast/lamp retrofits may be zero. If so, then all of the scenarios in the table above have an economic payback of 2 years or less. For applications

with higher hours of operation or higher utility costs, economic paybacks may be as short as 2 to 3 months.

*Incandescent Lighting.* Incandescent lighting (such as screw-in “A” lamps, flood lamps, PAR lamps, and decorative and specialty lamps are far less energy efficient than fluorescent lighting (on a lumens per watt basis). Incandescent fixtures can be retrofitted by screwing in a compact fluorescent lamp (with integral electronic ballast) or by retrofitting the fixture with a hard-wire electronic ballast and plug-in compact fluorescent lamp (CFL).

While CFLs typically cost as much as 5-10 times the cost of the incandescent lamps they replace, they typically have lamp lives 5-10 times longer, so there is a direct tradeoff (it’s a push) in equipment cost. CFLs have a very significant advantage in that they typically require 75% less electricity than the incandescent lamps they are designed to replace and, since they operate much cooler, there are additional savings associated with reducing the building’s cooling load. CFLs can be used in a range of building applications, including households and institutional buildings. Comparisons of the operating costs of incandescent and compact fluorescent lamps are shown below for fixtures operating for five hours per day (e.g. household fixtures, certain institutional fixtures, etc.).

**Table X Incandescent vs. Compact Fluorescent Lamps**

				Example Costs to Operate a Fixture Over 5 Years			
Lamp Type	Wattage	Lumens/ Watt	Lamp Life (Hours)	5 Year Lamp Costs (# of lamps)	5 Year Electricity Cost	5 Year Total Cost	CFL Savings Over 5 Years
Incandescent Lamp	40	15-20	750	\$9 (12)	\$27.40	\$36.40	<b>\$20.20</b>
CFL Replacement	9	50-70	10,000	\$10 (1)	\$6.20	\$16.20	
Incandescent Lamp	100	15-20	750	\$9 (12)	\$68.50	\$77.50	<b>\$47.90</b>
CFL Replacement	27	50-70	10,000	\$11 (1)	\$18.60	\$29.60	
Incandescent Lamp	150	15-20	750	\$12 (12)	\$103.20	\$115.20	<b>\$68.20</b>
CFL Replacement	44	50-70	10,000	\$17 (1)	\$30.00	\$47.00	

*Assumptions: Costs based on 5 hours of use per day at an electric rate of \$0.075/kWh.*

## Appliances

Of the various household appliances found in many Hopi households, the refrigerator is often the best candidate for energy efficiency improvement. Virtually every household has a refrigerator or refrigerator/freezer; refrigerators are one of the largest consumers of energy in a household; the efficiency of refrigerators are easily assessed; refrigerators can be readily replaced; and unless a refrigerator is less than 5 years old, it is not likely to be very energy efficient compared to newer models. Table X below indicates the potential energy and operating cost savings by replacing older refrigerator/freezers with “standard” (i.e. units that meet the Federal energy efficiency standard) and “highly efficient” (units that are rated by the US Environmental Protection Agency as *Energy Star*) refrigerator/freezers.

**Table X. A Comparison of Standard and Energy Efficient Refrigerator/Freezers**

Refrigerator with Top-Mounted Freezer (Automatic Defrost)	Example Costs to Operate a Refrigerator/Freezer Over 5 Years			
	kWh per Year	1 Year Electricity Cost	5 Year Electricity Cost	5 Year Savings
<b>12.5 to 14.4 Cubic Feet</b>				
15 to 20 Year Old Refrigerator	996	\$75	\$375	NA
New Standard Refrigerator	623	\$47	\$235	\$140
New <i>Energy Star</i> ® Refrigerator	498	\$37	\$185	\$190
<b>14.5 to 16.4 Cubic Feet</b>				
15 to 20 Year Old Refrigerator	1018	\$76	\$380	NA
New Standard Refrigerator	643	\$48	\$240	\$140
New <i>Energy Star</i> ® Refrigerator	514	\$39	\$195	\$185
<b>16.5 to 18.4 Cubic Feet</b>				
15 to 20 Year Old Refrigerator	1108	\$83	\$415	NA
New Standard Refrigerator	695	\$52	\$260	\$155
New <i>Energy Star</i> ® Refrigerator	554	\$41	\$205	\$210
<b>18.5 to 20.4 Cubic Feet</b>				
15 to 20 Year Old Refrigerator	1190	\$89	\$445	NA
New Standard Refrigerator	745	\$56	\$280	\$165
New <i>Energy Star</i> ® Refrigerator	595	\$45	\$225	\$220
<b>20.5 to 22.4 Cubic Feet</b>				
15 to 20 Year Old Refrigerator	1222	\$92	\$460	NA
New Standard Refrigerator	766	\$58	\$290	\$170
New <i>Energy Star</i> ® Refrigerator	611	\$46	\$230	\$230
<b>22.5 to 24.4 Cubic Feet</b>				
15 to 20 Year Old Refrigerator	1240	\$93	\$465	NA
New Standard Refrigerator	812	\$61	\$305	\$160
New <i>Energy Star</i> ® Refrigerator	620	\$46	\$230	\$235
<b>24.5 Cubic Feet and Above</b>				
15 to 20 Year Old Refrigerator	1260	\$95	\$475	NA
New Standard Refrigerator	845	\$63	\$315	\$160
New <i>Energy Star</i> ® Refrigerator	630	\$47	\$235	\$240

*Assumptions: kWh data from EPA’s Energy Star® refrigerator ratings; electric rate of \$0.075/kWh.*

## Water Heating

Like lighting, water heaters are present in nearly every building application. Water heaters can be readily evaluated and retrofitted (or replaced if needed), and are often inefficient.

A water heater's efficiency is measured by its energy factor (EF). EF is based on recovery efficiency, standby losses and cycling losses. The higher the EF, the more efficient the water heater is. Electric resistance water heaters convert power at 100% efficiency and, as a result, their energy factors are typically higher than gas water heaters. Older electric water heaters have an EF of 0.7 to 0.8. Older gas water heaters may have EF ratings 0.4 to 0.65. New energy efficient electric water heaters have an EF of 0.9 or higher for 80 to 120 gallon tanks, and EF ratings of 0.95 to 0.98 for 30 to 80 gallon units. New energy efficient gas water heaters have an EF of 0.7 to 0.8.

Even if an older water heater is in good shape, a number of relatively simple measures can be pursued that can add up to major energy and operating cost savings. They include adjusting the tank thermostat to a lower setting, installing low flow showerheads and faucet aerators to reduce water consumption, installing water heater blankets, use the energy-saving settings on appliances that consume large amounts of hot water (e.g. dishwasher and clothes washer), and insulating hot water pipes.

## Heating and Air Conditioning

*Residential/Small Non-Residential.* Heating/cooling systems in residential and certain non-residential buildings (e.g. educational facilities) can be readily evaluated and retrofitted (or replaced if needed).

The efficiency of a furnace (natural gas or propane) is measured by its Annual Fuel Utilization Efficiency rating (AFUE). Many older furnaces have AFUE ratings under 60%. The minimum efficiency of a residential furnace that can be manufactured and sold today is 78%. New *Energy Star*® gas furnaces are 30 to 50% more efficient than old furnaces. Many use electronic ignition and automatic flue dampers. Others have advanced “condensing” technology. The AFUEs of mid-efficiency units range from 85% to 90%, and the AFUEs of high efficiency condensing units range between 90 and 95%.

Electric air conditioners and electric heat pumps in the cooling mode are rated according to their Seasonal Energy Efficiency Ratio (SEER), with 10 being the Federal minimum. An air conditioner unit with a SEER of 10 costs 40% less to operate as an air conditioner with a SEER of 6 – the standard found in many older homes today. *Energy Star*® air conditioner units have SEER ratings of 12 to 14 for mid-efficiency units and SEER ratings of 15 to 17 for high efficiency units. For room air conditioners – window mounted or through-the-wall units – energy efficiency is presented as an Energy Efficiency Ratio (EER), with most new standard efficiency room air conditioners offering EERs in the 9.5 to 10.5 range and high efficiency units offering EERs of 11 to 12.

Electric heat pumps are essentially air conditioners that are capable of reversing the refrigeration cycle to provide heating. Electric heat pumps in the heating mode are rated according to their



Heating Seasonal Performance Factor (HSPF), with 6.8 being the federal minimum. Older homes that are heated with either heat pumps or electric resistance furnaces are candidates for new heat pump equipment replacements. *Energy Star*® heat pumps are 20% more efficient than minimum federal standards, and have HSPF ratings in the 7.5 to 10 range and SEER ratings of 12 and above.

*Large, Non-Residential.* Achieving energy efficiency improvements in HVAC systems in larger buildings is considerably more complex than for residential or other small buildings. Part of the difficulty is ascertaining the efficiency of the existing system. Even though the efficiency of a given component of a HVAC system may be known, the overall efficiency of the system may require rigorous field analysis to be determined.

A potential hurdle in achieving multi-Tribe energy savings from HVAC improvements in large non-residential buildings is the requirement to understand the operation of and evaluate a wide range of HVAC systems and components used (e.g. rooftop units, chillers, boilers, heat recovery, etc.). Further, there is likely not much replication of HVAC systems among the large non-residential building stock on the Hopi reservation, so energy efficiency improvements efforts in these buildings would need to be custom evaluated and engineered.

## **Building Envelope**

The thermal integrity of the building envelope (roof, walls, windows, etc.) is very important to the energy performance of residential buildings and certain non-residential buildings (e.g. institutional and educational facilities). Improvement opportunities for these buildings may include adding ceiling, wall, and floor insulation, replacement windows, window treatments (films, blinds, etc.), and caulking and weather stripping.

For buildings with high internal loads such as medical clinics and convenience stores, the relative importance of the thermal characteristics of the building envelope is diminished.

## **Air Quality Impacts of Energy Efficiency**

Real air quality impacts of energy efficiency can be measured by determining what air polluting source is being foregone by *not* using electricity. In the case of existing Hopi power sources, saving electricity directly impacts the generation at the Cholla coal-fired power plant. However, the savings will be small.

## **VIII. OTHER ECONOMIC DEVELOPMENT OPTIONS**

Previous Hopi planning documents have highlighted the need to bring more jobs and economic development to the Hopi Reservation. As part of the initial information gathering for this project, a brainstorming session with the Hopi/EPA Clean Air Partnership project team and Hopi staff members was held. From that session and from the ideas gathered along the way, a list of economic development ideas has been created.

Many Indian Tribes have used gaming as an economic development option. The Hopi people have twice decided not to enter into gaming operations by tribal ballot, most recently in the summer of 2004.

Many of these options are designed to take tribal challenges and turn them into economic development engines. For example, the tribe currently has a number of older buildings that are unusable due to the presence of asbestos. These buildings are in Winslow, Keams Canyon, Kykotsmovi, and other locations around the Reservation. Rather than bringing in outside contractors to do the work and walk away with significant amounts of Hopi money, a tribally sponsored asbestos abatement team could be trained and managed.

Another such example of turning “lemons into lemonade” is the abundance of damaging salt cedar, a quickly growing plant that chokes out other plants. This plant is being used in the creation of furniture and other wood products.

Consideration can also be given to the opportunity to participate in federal Small Business Administration programs, such as 8(A) programs, HUB Zone qualification, and other Small or Disadvantaged Business programs. These programs assist businesses with start-up expertise, and qualify them for priorities in obtaining lucrative federal and sometimes state and local government contracts. Using the asbestos example, significant amounts of government work exists for trained asbestos teams, and tribally owned businesses have competitive advantages for obtaining government work. These are high-paid jobs that require specialized training. Grants and small business opportunities likely exist to begin this kind of a program.

Hopi members and the Tribe itself is encouraged to consider employment practices that meet tribal needs, not just employment practices that are customary. For example, many Hopi members have numerous religious and cultural obligations that restrict them from full-time nine to five jobs. Hopi tribal employers are encouraged to implement programs like job sharing, shorter work weeks, or part time work to accommodate tribal schedules. These strategies would create jobs for more people as each person works fewer hours.

Some of these options are likely more appropriate for individually owned businesses, and some could be considered as tribally owned businesses. In the event the Tribe wishes to establish businesses, it is recommended that a tribal business arm be established which is not under the purview of tribal government. Such a model has been proven successful by other tribes. Such a model requires a carefully chosen board of directors, and excellent management.

Other economic development options that have been identified include the following.

- Tribal propane delivery and development of a fuel cell business in conjunction with propane use
- Asbestos mitigation teams
- Salt cedar furniture construction
- Tribal construction companies to assist with building of new needed housing and infrastructure- roofing, framing, carpentry, paving, etc.
- Use of traditional farming and orchards to begin a quality dried fruit business

- Develop tourism in culturally sensitive manner; improve and create tribal parks which are alternatives for tourists to traditional and often sensitive cultural activities
- Bicycle touring on Hopi ranches
- Telecommunications companies
- Firewood businesses on Hopi ranches which are choked with non-native juniper
- Sand and gravel businesses for provision of raw materials for upcoming needed construction
- Underground storage removal and remediation companies- issues similar to asbestos removal companies
- Long distance telephone by computer access
- Transportation- bus or van lines through reservation and to neighboring towns
- Sale of energy efficient appliances
- Solar refrigeration for diabetics/ bicycle powered generators for batteries
- Wellness centers
- Tribal gas station
- Grocery stores or cooperatives
- Education and job training
- Tomato farming/greenhouses
- Energy efficient building retrofit company
- Traditional housing materials company-adobe bricks
- Manufacturing new technology energy products

In addition to these business ideas, a number of projects to explore have been identified including:

- Airfield resurfacing- could National Guard or Reserves be called upon to assist?
- Keams Canyon- Park and tourism opportunities
- Shopping Centers
- Elderly/Handicapped Persons Care Centers
- Library

Lastly, a number of potential partnerships exist when attempting to implement any of these ideas. Some of the partnerships include:

Sandia National Labs  
 National Renewable Energy Labs  
 Los Alamos National Labs  
 Northern Arizona University  
 Nike Wellness Program  
 Arizona Public Service  
 Telephone Providers  
 Western Area Power Administration  
 Peabody  
 State of Arizona

Energy Efficiency Companies  
Small Business Administration  
Churches  
Charitable Foundations

## **IX. HOPI LEGAL AND POLICY BASELINE**

Many factors will impact Hopi air quality, energy use and development, and economic development. These factors include the available resources; the local religion, culture and philosophies; the personal and community customs; internal and external government actions; national and regional economics and markets; and many other factors. One of these factors that is within the control of Hopi government is its legal structure and the laws that impact the likelihood of reaching tribal economic development goals, developing local energy and service infrastructures, and in maintaining and improving air quality.

A review was therefore made of three different categories of Hopi government law and policy that can impact air quality, energy and economic development. These three categories are the existing policy statements which have been adopted in planning efforts, existing Hopi Tribal Ordinances, and the existing Tribal Council Resolutions. These laws and policies were gathered and reviewed to assist Tribal decision makers in understanding the existing structure of laws and policy and to identify those areas where the laws or policies could be updated or improved to better serve Tribal needs and to be consistent with Tribal policies.

The Hopi Tribe has been an organized government under the existing Constitution and Bylaws since 1936. The Preamble to the Constitution and Bylaws states as follows:

*This Constitution, to be known as the Constitution and Bylaws of the Hopi Tribe, is adopted by the self-governing Hopi and Tewa Villages of Arizona to provide a way of working together for peace and agreement between the villages, and of preserving the good things of Hopi life, and to provide a way of organizing to deal with modern problems, with the United States Government and with the outside world generally.*

Prior to the Constitution and Bylaws, there was no centralized Hopi Tribe. Each village today remains self-governing. Some villages do not send delegates to the Tribal Council, and in that manner they do not recognize the centralized government. The Hopi Tribe is a confederation of village governments. The approved Constitution and Bylaws gives the Tribal Council certain powers, such as the power under Article VI, Section 1(a) to “represent and speak for the Hopi Tribe in all matters for the welfare of the Tribe, and to negotiate with Federal, State, and local governments, and with the councils or governments of other tribes.” As such, the Tribal government has established policies and laws.

### **1. Existing Energy Related Tribal Policy Statements**

As a relatively young and new government, whose job it is to represent a group of villages each of which is much older than the United States of America, and rich in history and culture, the

Hopi Tribal government has embarked on a series of strategic planning efforts to identify the directions for the Tribal government. As described above, various Strategic Planning documents that have been adopted by the Tribal Council and include policy statements regarding Hopi resource use, environmental stewardship, and improvement of modern tribal economies.

These documents each have a particular focus, however, each contains important policy statements that are useful to this effort, which focuses on air quality, energy development and economic development. Some of those statements are as follows:

*Hopit Tunatya 'at*, March 1988:

- Identify the most suitable sites for commercial and industrial development by referring to the commercial and Light Industrial Sites suitability map and other suitability maps and tribal standards as appropriate. Protect these sites from encroachment by residential and other uses that have less critical location requirements.
- Protect the scenic vistas of the Hopi Reservation from roadside clutter that results from scattered, unplanned development.
- Assure that land use on the reservation is consistent with the development plan map.
- Respect those uses of land and resources that sustain religious, subsistence, economic and recreational activities.
- Locate new housing near existing housing where water and other community facilities are available or can be provided. Exceptions are new planned communities or other locations on the HPL designated for housing by the Tribal Council.
- Provide traditional villages with access to a safe water supply.
- Coordinate village, tribal, and Hopi Housing Authority water and sewer needs with the HIS.
- Adopt regulation to enforce the HIS solid waste management.
- Select and secure a site for a centralized sanitary landfill.
- Locate residential communities and commercial development in areas where water and sewer services can be provided; these areas should also be near existing power and telephone lines.
- Consider the possibility of a tribal public works department.
- Work with the villages to develop suitable sites for public facilities.
- Extend public services to the HPL. Give highest priority to law enforcement and medical care.
- Support an ongoing fire safety program, including public education and inspections to make building fire safe.
- Evaluate the local road network. Close unnecessary roads and return them to more productive use.
- Develop standards for installing underground roadside utilities and adopt regulations to enforce them.
- Establish a tribal range department to plan and manage the range.
- Develop management plans for the range units being grazed on the HPL.

- Prepare a wildlife management plan and adopt regulations to enforce it.
- Prepare a woodland management plan and adopt regulations to enforce it.
- Prepare a comprehensive water management plan. Include tribal goals, philosophies, and priorities regarding Hopi water resources-both surface water and groundwater.
- Balance water protection and use between religious and subsistence uses and more consumptive domestic and industrial/commercial uses.
- Develop regulations and administrative procedures for enforcing the Tribe's water management plan.
- Develop a tribal minerals code, including a permit application and review process, and adopt regulations to enforce it.
- Adopt interim mining and reclamation guidelines to control the commercial mining of construction materials. These guidelines will be used until the tribal minerals code is developed.
- Adopt an energy resource development policy.
- Designate suitable areas, such as Blue Canyon, for public recreation, and provide facilities for picnicking, camping and hiking.
- Develop regulations and a tribal review process to protect culturally sensitive areas from new development and land use changes.
- Prohibit structures in areas constrained by steep slopes, easily erodible soils, periodic flooding, or other unsuitable features (as shown on the Development Constraints suitability map.) Consider exceptions where there is no alternative location or where economic benefits outweigh the cost of mitigation.

*Hopit Potskwaniat*, 1995:

- Goal: To plan and construct proper facilities to adequately house the tribal and village and tribal administrative offices.
- Goal: To increase Hopi employment opportunities by supporting small business development and appropriate education and job training programs.
- Goal: To ensure that every Hopi family is provided the opportunity to own or rent a decent, safe and sanitary home according to their needs and income.
- Goal: To ensure that residential homes are constructed and maintained in the manner that assures safety, durability and adherence to the Hopi aesthetic qualities and sensitivity to the environment.
- Goal: To provide public utilities for local residents for purposes of ensuring a safe and healthy environment.
- Goal: To provide affordable and environmentally safe energy (electricity, solar, gas, wood/coal, etc.) for local residents and businesses for the purpose of economic self-sufficiency.
- Goal: Review and make basic recommendations on the relationship between housing, employment and transportation, looking to ways to improve on these issues.
- Goal: To upgrade existing telecommunication system to the state-of-the-art standards for present and future needs.
- Goal: To initiate feasibility studies to determine if the Hopi Tribe should create and establish its own public utilities entities.

- Goal: To develop and adopt an ordinance for the control, use and regulation of all public utilities.
- Goal: To design and construct a new airport facility that meets present and future needs for public and commercial purposes.
- Goal: To preserve the Hopi way of life, and protect sacred places and subsistence gathering areas.
- Goal: Incorporate and address environmental concerns and integrate health and epidemiological data into the GIS or establish a centralized data base that will assist those agencies in appropriately assessing and providing intervention, when needed, as it impacts the health of the Hopi people.
- Goal: To enhance and develop Hopi lands for the benefit of all Hopi people.
- Goal: To ensure the protection and proper management of woodland resources on Hopi lands.
- Goal: To ensure the protection and management of wildlife and wildlife habitats on Hopi land.
- Goal: To reintroduce selected wildlife species.
- Goal: To ensure adequate and quality water supply for present and future needs of the Hopi Tribe.
- Goal: To ensure the protection and proper management of mineral resources on Hopi land.
- Goal: To initiate a comprehensive surface and sub-surface minerals inventory program.
- Goal: To ensure the Preservation and Protection of the natural environment.

*Hopi Tutskwat Makiwa 'yta*, May 2001:

“The Hopi Tribe, in the interest of Hopi values shall re-affirm these stewardship responsibilities, Tutavo, which are rules by which the Hopi are to utilize natural resources and provide conservation efforts for environmental health.”

Objectives:

- To promote by word and example, Hopi stewardship values and practices about land and its resources.
- To restore Hopi Reservation lands to their former bounteous condition.
- To ensure coordinated and efficient Tribal government responses to opportunities and challenges.
- To ensure the Tribal government responses are coordinated with village governments.
- To develop and use surface water and groundwater to meet current needs of Hopi people without compromising the ability of future generations to meet their water needs, and without compromising the sustainability or quality of the resource. This includes protection and rehabilitation of the important wetland environments for their values to the environment and Hopi society.
- To provide a plentiful supply of safe drinking water to the Hopi people through application of best management practices and enforcement of the Hopi Water Code...

- To inventory all water sources on the Hopi Reservation to establish a baseline water quality and availability database.
- To assist the Little Colorado River Multiple Objective Management (LCR-MOM) project in the wise planning of resource utilization to the benefit of all residents of the Little Colorado River Basin.
- To stop the slurrying of coal using N-aquifer water, and develop an alternative method of coal transport, by 2004.
- To promote sustainable environmental management in traditional and non-traditional agriculture.
- To encourage the practice of traditional Hopi farming techniques as a suitable form of sustainable agriculture.
- To promote irrigation opportunities in the reservation that are consistent with the wetlands and water resources management guidelines for the Hopi Reservation.
- To establish a staffed agricultural support program with the Department of Natural Resources.
- To maintain biodiversity in the various native plant ecosystems on the Hopi Reservation.
- To promote land stewardship values and practices amongst the users of plant resources, including ranchers, wood cutters and gatherers.
- To implement the Hopi Environmental Strategic Plan...
- To develop and implement special management and/or conservation strategies for unique environments and wildlife habitat.
- To protect existing wildlife and wildlife habitat.
- To conserve and protect mineral resources of the reservation used for cultural and domestic subsistence purposes.
- To develop industrial minerals such as sand, gravel, and stone to meet local needs and demands for construction and development materials.
- To prevent or minimize mineral exploration and mining practices that may permanently degrade renewable resources.
- To develop and manage energy resources for sustainability while protecting the environment, wildlife, water, and cultural resources.

*Hopit Tunatya 'at 2000:*

This publication contains a “Vision of Reservation Development” that incorporates critical and strategic issues under the topics of Economic Development, Community and Land, Infrastructure, Governance, Housing, and Water. A Preferred Vision was crafted under which most new development would be placed into a limited number of planned community developments located on the HPL, but some development would take place near villages that want to encourage their growth. The scenario would likely use 1,575 acres and would provide a total of 3,200 new dwelling units over the next 20 years. As relating to this report, some of the central implementation concepts and policy impacts identified include:



- Village administrations would be responsible for providing main utility services (water, electricity, wastewater, etc) to District Six new development. The tribal government would be responsible for providing these services to new planned communities in the HPL.
- The planned communities would include the Tawaovi Community, Howell Mesa East, and a new development in the Moenkopi District. More growth would take place in Side Rock Well and Yu Weh Loo Pahki. ... The Tawaovi Community would be the site of building new tribal government administration facilities and possibly a relocation site for the entire tribal government.
- The Turquoise Trail, a road (BIA4) will connect SR 264 a the Hopi Cultural Center to US 160 just north and west of the Peabody Coal mine lease.
- The report also states, “Without a doubt the single most pressing life support issue facing the Hopi people at the turn of the millennium is securing a long term domestic water supply. The strategy that has been proposed to alleviate this looming crisis is for the tribe to obtain an allocation of the Colorado River water from Lake Powell and to construct a water pipeline system to deliver the water to the reservation communities. This strategy should be pursued with vigor. A corollary action envisioned in this strategy is to remove Peabody Coal from the use of the N-aquifer water and to sell them a portion of the allocation as a replacement water supply for the slurry.”
- The electrical supply to the reservation needs to be extended and made more reliable.
- Air transportation landing facilities need to be increased on the reservation.
- Telecommunications infrastructure needs to continue to expand and become more widely available and affordable.

These statements will be important parameters to consider while evaluating and exploring the options presented in the remainder of this report.

## **2. *Existing Tribal Ordinances***

Tribal Ordinances are tribal laws of general application. The Constitution and Bylaws of the Hopi Tribe, at Article VI, Section 1(g) authorizes the Tribal Council to “make ordinances to protect the peace and welfare of the Tribe, and to set up courts for the settlement of claims and disputes, and for the trial and punishment of Indians within the jurisdiction charged with offenses against such ordinances.” Section 2 provides a process for the ordinances to be reviewed and approved or disapproved by the Secretary of the Interior. A minimum of 90 days is required for full approval of an Ordinance. A series of Ordinances is on file with the Tribal Government. The Ordinances that appear to have a direct impact on air quality, energy development, or economic development were reviewed.

Some general information regarding the existing Tribal Ordinances follows:

Ordinance 10 – Ordinance establishing procedures and fees for the issuance of permits for prospecting for oil and gas upon the Hopi Reservation: This Ordinance was passed in 1959 and is no longer current under federal laws governing oil and gas development on Indian lands, such

as the 1982 Indian Mineral Development Act. In addition, the fee and bonding structures are outdated.

Ordinance 14 – Ordinance for establishing procedures and license fees for persons, firms, or corporations desiring to engage in the business of investigating, conducting tests and scientific information and data concerning the natural resources within the Hopi Reservation: This Ordinance was passed in 1963 and is no longer current under federal laws governing oil and gas development on Indian lands, such as the 1982 Indian Mineral Development Act. In addition, the fee and bonding structures are outdated.

Ordinance 23 – Ordinance for the control of new construction on the 1882 reservation outside District 6: The reasons for this Ordinance may no longer exist, with the resolution of lands issues with the Navajo Nation. The Ordinance prohibits any improvement to real property on the 1882 Reservation outside District 6 without a permit issued jointly by the Hopi and Navajo Tribes, with exceptions that Hopi may construct dwellings equal to the number of Navajo dwellings. A later change in the jurisdiction of each existing Ordinance to reflect the creation of the Hopi Partition Lands by Ordinance 28 further confuses Ordinance 23.

Ordinance 38 – Hopi Coal Severance Fee Ordinance: It is unclear whether this Ordinance is in effect. If not, it should be deleted from the list of Ordinances.

Ordinance 39 – Hopi Possessory Interest License Fee Ordinance: This Ordinance requires entities, like utilities and telecommunications companies to file information upon which a license fee on their activities on the Reservation is based. This information may be useful in other forums.

Ordinance 41 – Hopi Partitioned Lands – Land Assignment Ordinance: A land commission is established to oversee uses of the Hopi Partitioned Lands, including home sites, agricultural uses, and special uses. Assigned uses are for the term of the life of the assignee. Some method for terminating these interests, with appropriate compensation would be useful in the event the land assignments conflict with other eventual planned uses of Hopi Partitioned Lands

Ordinance 45 – Ordinance for Governmental Corporations Act: The Tribal Council may create corporations as agencies and instrumentalities of tribal government. This is one method of incorporating tribal entities. A possible expansion of the act to provide a method for tribal members to form corporations under tribal law to assure tax advantages may be appropriate to encourage small business.

Ordinance 52 - Civil Trespass Ordinance: This Ordinance requires strict accordance with terms of real property agreements between third parties and the Tribe, and provides penalties for holding over on real property rights and provides a method of enforcing lease, easement, right-of-way and permit terms.

Ordinance 55 – Hopi Tribal Planning Ordinance

Ordinance – Hopi Tribe Water Code: This Ordinance appears to govern residential and agricultural wells and new water uses on the Reservation, but does not directly address industrial water uses or large scale water uses.

### **3. Current Tribal Council Resolutions**

A number of existing Tribal Council Resolutions are important to a strategic planning discussion. These resolutions include:

- Ban on oil and gas exploratory drilling
- Approval to move forward on improving the telecommunications system
- A Strict control on the use of N-aquifer water for the coal slurry.

### **4. Tribal Legal and Regulatory Options**

Laws can be a structure for societal interaction that keep peace and harmony, and provide protect for humans and the environment. They are also tools that can protect tribal sovereignty and establish opportunities or inspire action.

Tribes have inherent sovereign authority on their reservations to regulate entities doing business on tribal lands as an essential attribute of Indian sovereignty; it is a necessary instrument of self-government and territorial management.<sup>90</sup>

Case law has limited this sovereignty when actions are within reservations, but not on tribal lands, such as on fee owned lands within reservations<sup>91</sup>. The Hopi Reservation has very few non-tribal lands, therefore, this issue is minimized. However, if facilities which the tribe may choose to regulate are on easements or rights-of-ways approved by the Bureau of Indian Affairs, they may be deemed to be on non-tribal lands<sup>92</sup>. A careful review of land rights held by third parties may be important to determining the Tribe's jurisdiction. Such a review is scheduled as a part of this project.

A state's authority to regulate on Indian lands is limited<sup>93</sup>. In litigation between Indians and non-Indians arising out of conduct on an Indian reservation, resolution of conflicts between the jurisdiction of state and tribal courts has depended, absent a governing act of Congress, on

90 See *Montana v. U.S.*, *infra*, and *Merrion v. Jicarilla Apache Tribe*, 455 U.S. 130, 137 (1982).

91 There, absent a treaty or federal law, a tribe has no civil regulatory authority over non-members, with two exceptions:

A tribe may regulate the activities of non-members who enter consensual relationships with a tribe or its members through commercial dealing, contracts, leases, or other arrangements

A tribe may retain inherent power to exercise civil authority over the conduct of nonmembers when that conduct threatens or has some direct effect on the political integrity, the economic security, or the health or welfare of the tribe.

See *Montana v. U.S.*, *infra*. See also *Nevada v. Hicks*, 533 U.S. 353 (2001) Land ownership is one factor to consider when determining whether a state also has jurisdiction. While this ruling has not been interpreted by the Federal Courts as regards jurisdiction over electrical utility matters within a reservation a strong case is made that both exceptions apply. First, utility companies have consensual relationships on the reservation by providing service, and by real and personal property rights agreements with the tribe and tribal members. Second, one can not regulate or exercise authority over utilities serving some parcels of land but not others because the same wires serve power to both. A tribe's economic security, political integrity and health and welfare depend on basic infrastructure and services such as utility services.

92 *Big Horn Elec. Coop. v. Adams*, 219 F.3d 944 (9thCir 2000).

93 See Note 4.

whether the state action infringed on the right of reservation Indians to make their own laws and be ruled by them.<sup>94</sup>

Absent easements or other rights granted to third parties, The Hopi Tribe has clear regulatory jurisdiction over third parties doing business on the reservation, including electric companies, propane companies, telephone companies, construction companies, and other providers of goods and services.

The Hopi Tribe does not have existing regulations for the sales and delivery of goods on the reservation. A Commercial Code generally establishes such rules. A Uniform Commercial Code (UCC) has been adopted by most U.S. states and by many Indian tribes. A UCC is protection for purchasers and sellers of goods and clearly establishes a consistent method of commerce. In the event The Hopi Tribe does not have a UCC in place, it is a candidate for consideration.

With regards to services, it is customary that the sales and provision of services are regulated by a governmental board or commission that establishes rules for all aspects of service provision. The Hopi Tribe does not at this time have a regulatory commission to oversee the third party service providers on the Reservation. Most third parties probably do not even know that the state regulations do not apply on the reservation, and therefore the Arizona Corporation Commission (ACC) is in fact regulating services on the Hopi reservation. The ACC monitors and approves rates or charges for electricity and telephone service, handles disputes over service areas between competing electricity companies, and generally tries to protect consumer interests. The Hopi Tribe may wish to establish rules and regulations for third party provision of services. Such rules and regulations must then be enforced, which may be a large undertaking and will require tribal staff and budgets. An example set of utility regulations has been provided as part of this project and appears at the end of this chapter. The regulations include a prohibition on state taxes, the creation of a utility commission, methods for franchising service providers, rate approval for service providers, and enforcement of the code. A copy of such a code has been drafted pursuant to the Hopi/EPA Partnership and is appended hereto as Appendix A.

Another important code that is often missing from tribal legal statutes is a right of way code. This code established procedures for acquisition of easements and rights of ways on the reservation by third parties, and establishes the method for valuing the rights. An example of this kind of code is also included at the end of this chapter. A copy of such a code has been drafted pursuant to the Hopi/EPA Partnership and is appended hereto as Appendix B.

Various other codes may be considered throughout the strategic planning process. The Hopi Tribe protects and exercises its sovereignty by careful consideration and approvals of codes. Often this consideration will require a public comment process so that the views of tribal members, federal officials, state officials, and parties to be regulated may weigh in on tribal proposals. Regulations can have the effect of improving economic development and service or can have the effect of driving third party businesses away or increasing the cost of service. For

94 *Montana v. United States*, id.; *Strate v. A-1 Contractors*, 520 U.S. 438, 453 (1997).

these reasons, the regulations should be carefully considered with significant input before they are adopted and enacted.

Other potential types of Ordinances the Hopi Tribe may want to consider include:

- Coal Mining Regulations for Hopi Partition Lands: While existing federal regulations address these issues, and some coordination with the Navajo Nation may be in order, such a code may be useful to resolve tribal issues with the existing or future mining efforts.
- Codes protecting watersheds from erosion, such as prohibitions from off-road driving.
- Environmental Codes with Penalties: A discussion with the Hopi Natural Resources Department may uncover areas where tribal laws are needed.
- Water Rights Code: While a domestic water code is on the books, laws may be useful in addressing commercial and industrial uses of Hopi water.
- Condemnation Code: This code may be useful if acquisition of property by the Hopi Tribe is needed pursuant to tribal electrical or telecom utilities, or for other purposes.
- Air Quality Rules: See the air quality discussion above.

## **X. DEVELOPMENT OF A HOPI TRIBAL ECONOMIC TRANSITION PLAN**

This report is intended to be used as a tool and resource for the creation of a Hopi Tribal Economic Transition Plan. The authors of this report hope that the report has been helpful in establishing a context for the legal, regulatory, industry, tribal, growth, and physical issues that impact the Hopi economy. We also hope that the report is helpful to Tribal Leadership in understanding both the short and long term issues impacting the Hopi economy.

The following factors can be considered when forming Tribal policies:

Extremely difficult economic situation

Dependence on tribal government funding which will be cut if Mohave is shut down

Isolation, lack of infrastructure, lack of economic base, lack of water

Non-Gaming status twice affirmed in Hopi referendums including in 2004

Cultural and homeland sustainability in the event of further economic deterioration

The Hopi Tribal Economic Transition Plan is intended to be the creation of the Hopi Tribe. It will seek to address ways to transition the tribal economy to a more diversified, self-sufficient, and sustainable economy. Creation of the Plan will be done by a process established by Tribal Leadership.

The following is a suggested strategy for creation of the Plan once funding is available:

1. A likely first step in creating the Plan will be a careful review of the documentation in this report.

2. Then, a schedule can be established for joint meetings of relevant tribal staff to originate an outline of the Plan or parameters under which the Plan will be created.
3. As soon as sufficient details are firmed up to make the exercise useful, public meetings could be publicized and held to summarize the information available to tribal leaders, and to hear from tribal members and other interested parties.
4. After the public meetings, another round of internal meetings could be held to incorporate the information heard from the public.
5. Then a draft Plan can be published that allows for additional public input.
6. A Final Plan may then be approved and published.

After the publication of the Final Plan, and otherwise as they become available, grants and other financial sources can be sought that can assist in the implementation of the priorities in the Plan.