Department of Energy
Office of Energy Efficiency and Renewable Energy
Strategic Energy Planning (Area 1)

Consultants Report
to
Citizen Potawatomi Nation
Federally Recognized Indian Tribe

December 1, 2004

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Final Report

Submitted to:

Citizen Potawatomi Nation
Federally Recognized Indian Tribe

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Executive Summary

Vision Elements

The Citizen Potawatomi Nation has a vision of reducing energy usage while providing quality energy services to members and creating revenue-generating energy enterprises.

Present Assets

Consulting teams, while being able to establish proposed directions and multiple options, and provide energy planning guidance, cannot provide the sustained operation of implementation. This requires leadership of the organization to accomplish goals set forth to carry out the vision. From the consulting teams' perspective, we see that Citizen Potawatomi Nation has strong leadership. Chairman John A. Barrett has proven to be a champion for the tribe, a visionary and an achiever. He and his staff have the correct attitude to embark into new directions and make decisions to save and wisely utilize energy sources. Their perception is clear on the concept of accomplishing their goals and they have the commitment of bringing the project to fruition.

Fortunately, their land is abundant with groundwater resources, which is an asset. Water as an energy resource for geothermal heat pump technology can be used in several ways, such as: water improves the transfer of heat energy to vertical or horizontal boreholes; it can be pumped through the heat pump and returned to a reservoir or directed to approved disposal sites; or a closed loop system can be submerged in a body of water fed by the water source.

Prior knowledge of ground source heat pump installation and operation is an asset that gives them an edge in expanding the application to tribal facilities and also the background to begin a new enterprise in ground source heat pump systems. During the current year, their knowledge base has expanded to provide other options for them to apply to both new and retrofit projects.

With the campus-style arrangement containing significant numbers of the CPN buildings, it allows the integration of systems to produce greater efficiency. This is accomplished by transferring energy from one building to another. For example, the FireLake Discount Foods produces heat that can be transferred with fluids across the street to heat the headquarters buildings through convective coils. Every boiler in the complex could be replaced with lines carrying hot water from the refrigeration system in the Foods store.

Sufficient land surrounds the existing buildings to build revenue-producing facilities that can be supplied with energy from the existing buildings. An example is using heat from the FireLake Discount Foods to operate a car wash, a laundry, a greenhouse or other facilities requiring heat. These could be constructed near the Foods store since space is available.

Chairman John Barrett and others with CPN have experience with drilling wells. They also have experienced people in drilling horizontal boreholes. Both of these methods are utilized in installing geothermal heat pump loops to transfer heat to or from fluid circulating through the heat pumps. In addition there is a commitment to expand this experience to installing ground source heat pump systems.

Revenue generating activities that Citizens Potawatomi Nation currently own, provide funding to implement others when cost effective projects are identified.

Present Energy Systems

- Stand Alone Conventional Systems (low to medium efficiency)

A survey of 16 selected CPN facilities has revealed that roof top pack units for heating and cooling are predominant. These are basically low first cost systems but have higher operating costs than alternatives. The highest electric service charge is for the FireLake Discount Foods. It is a large facility and has a large amount of refrigeration systems and air conditioning loads which result in heat rejection of up to 536 tons or 6436 MBtuh. This heat is currently being dissipated through four large evaporative condensers.
To maintain temperature and humidity in the store requires cooling with large capacity HVAC chillers and concurrently heating with gas operated roof top pack units. The four areas that consume the greatest amount of energy are the FireLake Discount Foods store, Casino, Headquarters and Bingo Hall. Costs of the other buildings are significantly smaller than these four areas. There are the 31 heat pumps installed in the Wellness Center at a capacity of 24.3 tons. This is one of the cost saving systems. Because of the type of HVAC systems that exists in the majority of the buildings, they are the most viable potential for saving energy and costs. Most buildings have florescent lights so lighting is not a high potential for reducing costs.

- Some GSHP Systems and others under construction

There are some ground source heat pumps that have been installed to yield cost reduction and energy savings, and more are being planned for installation. Systems currently exist in the Clinic and the Wellness Center. More are planned, and in the near future they will be installed in the Heritage Center and the housing project.

- Utility purchasing rates being studied

Currently, the CPN is receiving service on Service Level 5, which is a more expensive billing rate for both the energy charge and the demand rate. In addition, there are not any current combinations of primary meters to reduce rates by diversification of loads.

- Initial commitment to wind energy program participation

CPN has made a Subscription Agreement with OG&E to purchase electricity produced by wind power up to 16,000 kWh per month at an additional cost of 2 cents per kWh. This agreement is in support of using renewable energy. This agreement is for one account only, which is the Casino and Off Track Betting meter.

Future Economic Opportunities

Near Future Implementation

Diversification of Electric Loads and Changing Service Levels to Lower Electric Costs

Utility purchasing rates and service levels are being considered to determine the more economic approach to reducing the monthly bill. A "CAR" or combined aggregate rate is being studied to see if the combination of primary meters will produce the lower rates when usage exceeds one million kWh per month. In addition, changing from service level 5 to service level 3 would lower the demand rates and the energy charges. Economics of changing to level 3 and operating under the responsibility of maintaining the equipment on the load side of the primary meter will help resolve the issue.

Heat Recovery from Grocery Store and Casino as Energy Source

The Fire Lake Grocery Store and Casino generate sufficient waste heat on an annual basis to support existing heating and cooling loads as well as additional business growth. Depending on market analysis of local and area needs, business such as vehicle washing, laundry facilities, greenhouse capacity for specialized winter products, are but a few of the available options. Also, space heating for the Fire Lake Grocery Store should come from the refrigeration and/or air-conditioning equipment waste heat that is presently being discharged by cooling towers.

- Car Wash
  Approximately 3 million BTU/hr of heat is wasted from the CPN Grocery Store. If this waste heat is recovered and used for heating water, a vehicle wash system can be supplied with enough warm water, and the excess heat can be used to reduce icing on the ground for customers of the Grocery Store and Casino. A vehicle wash system will not only save money by washing the fleet of 100 vehicles operated by the CPN, but will also be a major source of income if used for washing school buses, public works vehicles, vehicles of nearby businesses such as Central Plastics, trucks on highways, and cars of the customers of the Grocery Store and Casino.

- Laundry
  Laundry facilities must be considered based on available thermal energy at the site. Decisions on whether to enter the laundry business should be made based on the local need and market and not whether there is sufficient available energy for the enterprise.

- Green Houses
  A 22 x 96 foot greenhouse at the CPN headquarters would require about 300,000 Btu/hr to maintain a 65 to 70°F degree indoor temperature at design conditions. Facilities for holding plants at dormant conditions (35 to 40°F) require about half that amount of thermal energy.

- Preheating Ventilation Air for Adjacent Buildings
  There is sufficient thermal energy for preheating ventilation air at the site for adjacent buildings. Latent and sensible cooling energy wheels in combination with water source heat pumps are the most efficient system for the complex for pre-cooling ventilation air.

Ground Water Development for Water Source Heat Pumps

The process of energy auditing revealed there is a water well that runs all but a few weeks in the winter and pumps water into a pond near the new CPN Heritage Cultural Center. A design has been made for the geothermal heat pump loop field scheduled to be installed in the Center. Pond loops are known to be cost efficient. After viewing a map of ponds relative to the Center, it was concluded that a pond loop design be conducted. Using the data showing, 55 gpm is being pumped into the third pond from the Center, and determining it is about 0.67 acres in size, and by deepening it to 8 ft. would provide excellent loop performance with 18 each 5-ton copper loops (300 ft of 1 inch copper per 5-ton loop) and a reverse return header system. An estimate of the cost of the two loop designs, show that the pond loops for this project will be about 23% of the vertical borehole loop field costs.

Geothermal Heat Pump Installation/Distribution Company

A geothermal heat pump installation company has been started using several ongoing construction projects at or near the CPN Headquarters. The CPN Cultural Center and housing duplex projects are underway. The hiring of an experienced geothermal heat pump engineer demonstrates their commitment to the technology and their energy saving vision. Installation equipment for both projects is available for their use.

A distribution company will naturally evolve from their component requirements on the two aforementioned projects. As facilities for stockpiling necessary components for their present jobs is made available, distribution to a larger customer base can start small and build to a developing market. Early stock piling should consist of standard components used in the industry (pipe, fittings, fusion equipment, etc.) Participation of the present engineering staff in actual construction of multiple heat pump systems will identify company needs.

Integration or Sharing of HVAC Loads

The thermal energy loads of the Fire Lack Grocery Store, Fire Lake Casino and CPN Tribal Headquarters could be combined into a district heating and cooling system by taking advantage of load diversity. An auxiliary (standby or emergency) electric power generation unit should be added to this district system. This auxiliary system should be configured as a Combined Heat and Power (CHP) system and incorporated into the district system to meet both peak electric demand issues, emergency power for the casino and additional heat energy during high demand periods. The integrating component should be a water based system consisting of a combination of ponds, water feature, water supplies, vertical boreholes, cooling towers, etc. Fuel costs of the auxiliary power generation unit will determine its usage in circumstances other than emergency power needs.

Future Implementation—Beyond 5 Years

Growing, Harvesting and Transporting Biomass to Gasification-Fermentation Plants Being Developed by OSU Researchers

Within the next several years, a pilot facility may demonstrate a process for converting Oklahoma grasses and crop residues to ethanol and other useful products. The proposed pilot plant uses a process being developed by a research group at Oklahoma State University. Potentially this process can make ethanol, which could be blended with retail gasoline sold by the Citizen Potawatomi Nation. Perhaps the Nation could get involved in selling feedstock to a biomass facility. A commercial facility to produce ethanol with this process will require a large investment of 60 to 170 million dollars. If such a facility is planned or built within 50 miles of Shawnee, the Nation should look into growing and providing biomass for the facility.

Integrated Energy Systems (IES)/Combined Heat and Power (CHP)/Cogeneration Type System Producing Electricity and Heat to Support a Business to be Identified

Any electric power generation process rejects energy that cannot be converted to electrical power. Typically, a large centralized power plant at a utility company rejects more than half of the input energy from fossil fuels. The rejected energy is heat, which often goes into a nearby body of water. If end-users instead have localized, on-site electrical production facilities, the end-users may recover and use this otherwise wasted energy to heat nearby buildings or for other uses. By using this heat, the user has a thermodynamic efficiency advantage over utility's central power plant, which may become an economic advantage. Such systems [2, 3] are called combined heat and power (CHP) systems or Integrated Energy Systems (IES).

The near-term opportunities listed earlier in this summary use excess thermal energy from current equipment and systems. These will be more cost effective than a new CPN system with on-site production of electricity. If, after five years or more, the implementation of near-term opportunities has taken advantage of all the excess thermal energy, then the Citizen Potawatomi Nation may investigate the feasibility of CHP systems.

Baseline utility electrical power costs are relatively low in Oklahoma due to coal-fired power plants. Furthermore, the price of coal is stable compared to other fuels such as natural gas or crude oil. A CHP system with on-site production of electricity would likely use natural gas. The relatively large price fluctuations for natural gas relative to coal, add a significant hurdle for the economics of CHP systems for the Citizen Potawatomi Nation

CPN Strategic Energy Plan

The CPN Strategic Energy Plan has three major components in support of their Energy Vision. These components are:

- CPN Major Building Baseline Energy Assessment and Plans
- Geothermal Energy Business Plan
- Plans for Waste Heat Utilization Businesses

The CPN Major Building Baseline Energy Assessment component identifies energy savings that can occur by energy efficiencies that can be made to reduce energy costs in the operation of the physical plant. The key element is to reclaim thermal energy from heat rejected by the refrigeration units of the FireLake Discount Food (FDF) grocery store. This energy will be used to replace natural gas that is presently used in the grocery store and other buildings located at the physical plant by using an energy bank that integrates HVAC loads into a common or pooling location.

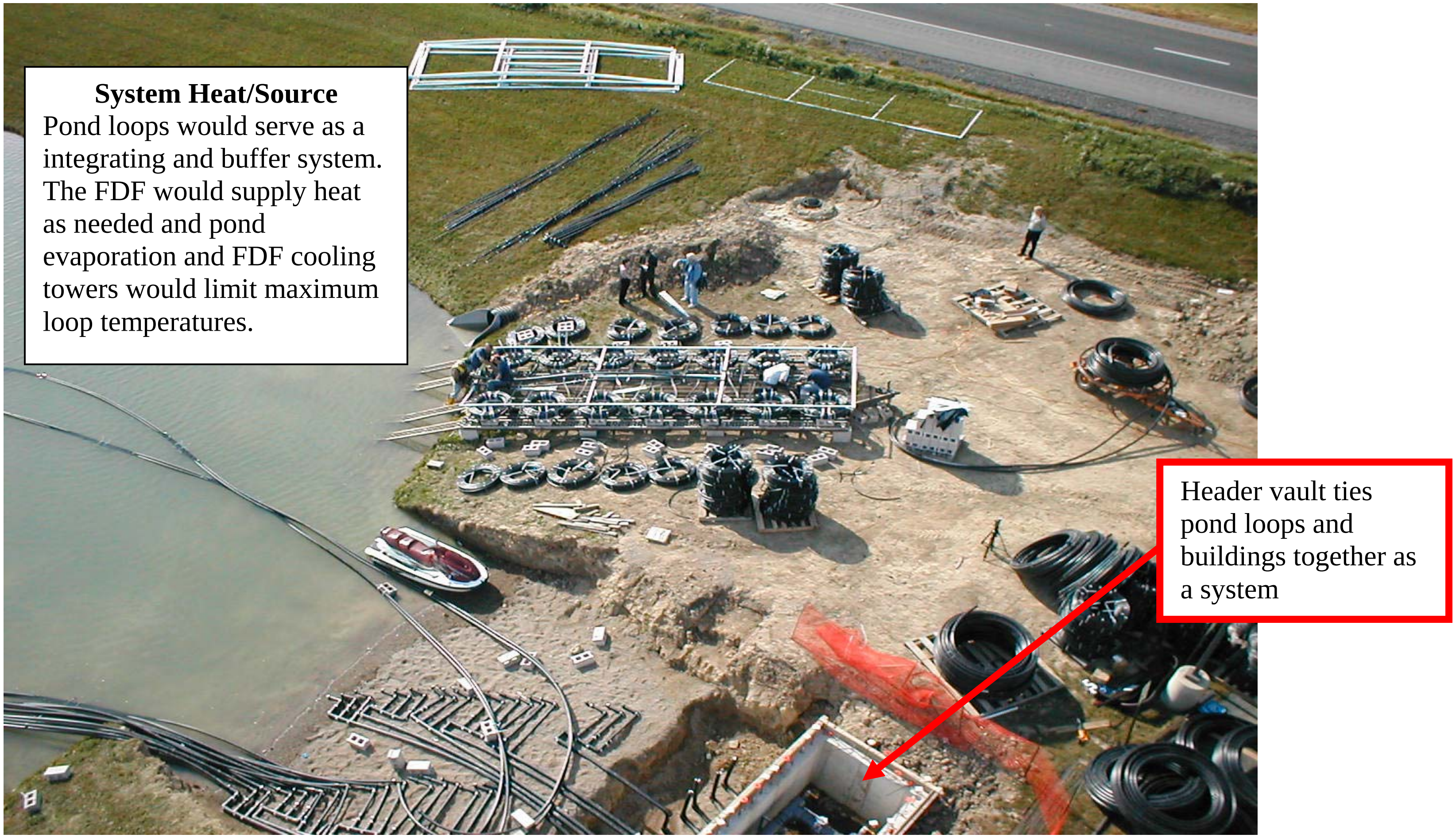
The Geothermal Energy Business Plan identifies business opportunities that are well within the expertise of the present technical staff and CPN work force.

The Waste Heat Utilization Businesses identifies typical economic energy consuming activities that could be developed by the CPN and thus create revenue streams using a work force of tribal members. Businesses could be either internal to CPN or leased to others as appropriate.

Energy Plan
CPN Major Building Baseline Energy Assessment and Plans

Building	General Equipment Type	Implementation/Recommendations
Fire Discount Food Grocery Store	• Water-based food refrigeration (freezers, coolers, display units, etc.) system with multiple chillers and external (outdoor) evaporative condensers • Multiple space fan coil cooling units (9 units, 288 tons) supplied from central chiller. Each unit has electric heating (140 kW total connected load)	• Waste heat recovery from refrigeration and air conditioning should be utilized to replace gas fired heating. • Load diversity with the Casino, Administration Building Complex, and Bingo hall should be analyzed to determine what additional loading should be considered with the waste heat from the FDF grocery store. • The control strategy for the HVAC system at the FDF needs to be analyzed to see if energy improvements can be made. • The ancillary businesses (WIC, Dollar Store, etc.) appear to operate independently. Improvements could be made by replacing the resistance heating with heat recovery from the FDF Grocery Store or water source heat pumps from a central energy field.
Casino	• Conventional roof type gas fired heating and electric cooling • Heat recovery using an energy wheel.	• Excess heat now being rejected from the grocery store could be utilized during a portion of the year to increase desired additional ventilation loads for smoke dilution. • Standby electrical generation power unit should be considered for emergency use and as a Combined Heating and Power (CHP) unit for electrical power generation and heating • Operation and/or maintenance of the energy wheel needs to be evaluated.

Administration Building Complex	• Roof type gas fired heating and electric air-conditioning units • Thru-the-wall air-conditioning and electric heating.	• There appears that sufficient heat energy is available to integrate this load with the FDF grocery store and Casino into a Closed Loop Ground Source (CLGS) district HVAC system • Devise a transition plan for replacing roof top units with GSHPs as replacement units are required.
Bingo Hall	• Conventional roof type gas fired heating and electric cooling	• Potential to integrate this load with the FDF grocery store and Casino into a district system • Devise a transition plan for replacing roof top units with GSHPs as replacement units are required
Heritage Center	• GSHPs using a pond loop utilizing existing water resources available on the adjacent golf course	• The tribal water sources are adequate to replace a more expensive proposed closed loop ground source vertical ground heat exchanger
Clinic Complex	Some GSHPs and conventional HVAC	• As present HVAC systems are replaced, develop a transition plan for new GSHPs • The clinic is close to the water resources available making the transition an economic easy decision
Restaurant	Conventional HVAC equipment	• Replace some conventional HVAC equipment with water source cooling for water heating or • Install a water to water heat pump using ground water as the energy source for potable water heating
I40 Development	GSHP proposed with truck stop and cultural center as a district system	Develop a GSHPs as a district system
Tribal Housing	Existing older units use conventional gas heating and electric cooling. New duplex units are being designed using GSHPs	New duplexes will use GSHPs. CPN should assume engineering design of the HVAC system, construction management, oversight and installation using tribal employees.



Analyze the cost/benefit of constructing an integrated water-based energy field with capacity to handle heating and cooling supplemental requirements of the Casino, bingo Hall, Administration building and proposed new businesses. The energy field would consist of a pond as shown as well as ground heat exchangers and water features. Construction of this type of system would eliminate drilling of boreholes at any of the connected buildings.

Geothermal Energy Business Plan

The CPN should consider the following two business opportunities:
Geothermal Heat Pumps
Businesses that can use waste heat available at the site.

Geothermal Business	Implementation Plan
Form a fabrication, manufacturing and distribution company: • Fabrication of specialty and unique components (flushing and purging, • manufacturing of specially developed service equipment (plastic and copper pond loops, pumping modules. Etc.) • distribution of geothermal components	• Start by providing components for CPN installations • Manufacture header systems • Identify standardized system installation and sell packaged components
Form a geothermal company drilling company and provide: • drilling services (vertical, horizontal, pond loops) • Piping installation • Startup and checkout (commissioning)	• Develop a business plan based on present installation needs at the CPN • Define level of activity to start and allow growth • Define a timeline of activities for meeting CPN goals
Form a borehole thermal testing service • Turnkey testing • Rental units • Analysis of data	• Hire an experienced thermal testing operator(s) or train a CPN employee • Manufacture or have thermal testing units manufactured per CPN specifications. • Become expert in state-of-the-art analysis

Plans for Waste Heat Utilization Businesses

The following are types of businesses that are suitable to take advantage of the energy assets and requirements that are unique to the CPN physical plant. Simply stated, the CPN physical plant with the FDF grocery store has an abundance of thermal heat energy which if managed properly can be used to generate additional income and jobs.

Waste Heat Utilization Businesses

Typical Businesses	Implementation Plan
Vehicle Wash • Automobiles • School Busses • Commercial fleet owners • CPN vehicles	• Survey local area and determine potential businesses that could use such a service • Identify and survey local vehicle wash locations to determine how vehicles are presently being serviced
Greenhouses • Local off-season vegetable production • Exotic plants • Herbs (food and medicinal)	Identify available resource entities • OSU • Local and state-wide growers
Laundry • Coin operated • Commercial	• Survey local area and determine level of competition • Write a business plan or advertise business opportunity at the CPN physical plant

In addition to the three major components described above in support of the CPN strategic energy plan, the following opportunities have merit but will require further study and research before implementation. CPN should monitor the development of biomass processes and any construction of nearby facilities over the next five to ten years. Perhaps CPN could become a supplier of biomass to a nearby processing facility that converts biomass to ethanol or other fuels. In the interim, careful attention to the on-going biomass project at Oklahoma State University should be made.

Biomass Business Development	Implementation/Monitoring Plan
Monitor progress of biomass processes being developed at Oklahoma State University in the College of Engineering, Architecture and Technology and the School of Biosystems and Agricultural Engineering	• Attend conferences at local, state and national level in regards to the OSU progress. • Monitor progress and activities of the DOE/NREL programs.
Be proactive in steering potential biomass pilot plants to the CPN agricultural area	• Attend conferences and gauge level of activity.

- If all the currently excess thermal energy is put to use within the next five years, CPN may want to investigate the potential of combined heat and power systems with on-site electrical power generation. An emergency diesel powered unit such as described in Appendix 6.6 may be considered.

Recommendation: This should be a high priority with significant economic benefit to the CPN. It is well within their economic means, well within their technical expertise, and well within their mission.

- Underground geothermal resources of steam and hot water are not viable geothermal energy sources in Oklahoma. Geothermal heat pumps discussed in this report show much greater promise and have a history in this area of being economically viable.

Recommendation: In the long term, an underground heat store may be viable. It has not been proven to be economically viable.

- The cost of electricity from hydrogen and fuel cell technologies is substantially greater today than the cost of power from electrical power utilities. Until research reduces these costs, these technologies are not attractive to CPN.

  Recommendation: Adopt a wait and see attitude. Conventional fuel sources and energy conversion devices are national agendas with long term research requirements

Table of Contents

Executive Summary .... **i**

CPN Strategic Plan .... **vi**

1. Introduction **1**
1.1 Background of Project 1
1.2 Project Description 1
1.3 Project Goals 1
1.3.1 Create long-term energy strategies to explore development of tribal utility options and analyze renewable energy and energy efficiency options. 2
1.3.2 Explore energy efficiency and renewable economic development projects: 2

2. Primary Technology Options **3**
2.1 Near Future Implementation 3
2.1.1 Diversification of electric loads and changing service levels to lower electric costs. 3
2.1.2 Heat recovery from grocery store and casino as energy source for: 6
2.1.3 Ground water development for water source heat pumps. 7
2.1.4 Geothermal heat pump business models. 10
2.1.5 Integration or sharing of HVAC loads. 31
2.2 Future Implementation—Beyond 5 Years 31
2.2.1 Growing, harvesting and transporting biomass to gasification-fermentation plants being developed by OSU researchers. 31
2.2.2 Integrated energy systems (IES)/combined heat and power (CHP)/cogeneration type system producing electricity and heat to support a business to be identified. 33

3. Response to Proposal Objectives **37**
3.1 Objective One 37
3.1.1 Baseline assessment of where tribe is now. 37
3.1.2 Create an energy vision of where tribe wants to be. 37
3.2 Objective Two 37
3.2.1 Baseline energy assessment of CPN facilities. 37
3.2.2 Identification of energy efficiency devices that could be implemented in CPN facilities 44
3.2.3 Preparation of cost benefit analysis of energy efficiency practices and technologies proposed for implementation. 44
3.3 Objective Three 45
3.3.1 Baseline assessment of biomass, geothermal, hydrogen/fuel cell resources, propane and natural gas distribution systems on CPN lands. 45
3.3.2 Baseline assessment of microturbine. 49
3.3.3 Initial feasibility analysis, production potential, and identification of biomass plant operators and waste brokers of biomass fuels. 55

3.3.4 Cost benefit analysis and feasibility of installing geothermal heat pumps in all new tribal facilities and housing projects. 55
3.3.5 Feasibility of creating a geothermal tribal enterprise. 55
3.3.6 Research involvement in Freedom CAR, Fuel Initiative, and Presidents' Hydrogen Fuel Initiative. 55
3.3.7 Analyze manufacturing and production technologies in the areas of hydrogen/fuel cells, natural gas and propane distribution. 56
3.3.8 Develop action plan into CPN strategic energy plan. 58
3.4 Objective Four 58
3.4.1 Analyze feasibility of creating a tribal utility. 58
3.4.2 Microturbines. 59
3.4.3 Determine the feasibility to purchase or generate electricity for distribution. 59
3.4.4 Analysis of selling generated power. 59
3.4.5 Action plan. 59

4. Conclusions 60

5. References 62

6. Appendices 65
6.1 GHP Planning Guide A-1
6.2 Interclean. A-6
6.3 Chula Vista. A-39
6.4 Car Wash. A-42
6.5 Propane Distribution A-64
6.6 Small Municipal Power Distribution Company A-66

1. Introduction

1.1 Background of Project

The Citizen Potawatomi Nation is the ninth largest tribe in the United States. Headquarters are in Shawnee, Oklahoma where the majority of the facilities are located. It was recognized by the leaders of the tribe that their economic prosperity will directly depend on sources for affordable and reliable energy. In addition, a need for the development of enterprises to provide employment for tribal members was a related opportunity that is to be pursued. Creating innovative partnerships with Indian tribes and private sectors is considered one approach to provide economic viability. Opportunities to pursue these plans were provided through financial assistance from the Department of Energy.

1.2 Project Description

The assets that Citizen Potawatomi Nation holds were evaluated to help define the strengths and weaknesses to be used in pursuing economic prosperity. With this baseline assessment, a Planning Team will create a vision for the tribe to integrate into long-term energy and business strategies. Identification of energy efficiency devices, systems and technologies was made, and an estimation of cost benefits of the more promising ideas is submitted for possible inclusion into the final energy plan. Multiple energy resources and sources were identified and their attributes were assessed to determine the appropriateness of each. Methods of saving energy were evaluated and reported on and potential revenue-generating sources that specifically fit the tribe were identified and reported.

1.3 Project Goals

A primary goal is to create long-term energy strategies to explore development of tribal utility options and analyze renewable energy and energy efficiency options. Associated goals are to consider exploring energy efficiency and renewable economic development projects involving the following topics:

- <u>Home-scale projects</u> may include construction of a home with energy efficiency or renewable energy features and retrofitting an existing home to add energy efficiency or renewable energy features.

- <u>Community-scale projects</u> may include medium to large scale energy efficiency building construction, retrofit project, or installation of community renewable energy systems.

- <u>Small business development</u> may include the creation of a tribal enterprise that would manufacture and distribute solar and wind powered equipment for ranches and farms or create a contracting business to include energy efficiency and renewable retrofits such as geothermal heat pumps.

- <u>Commercial-scale energy projects</u> may include at a larger scale, the formation of a tribal utility formed to sell power to the commercial grid, or to transmit and distribute power throughout the tribal community, or hydrogen production, and propane and natural-gas distribution systems.

1.3.1 Create long-term energy strategies to explore development of tribal utility options and analyze renewable energy and energy efficiency options.

1.3.2 Explore energy efficiency and renewable economic development projects:

- Home-scale projects may include construction of a home with energy efficiency or renewable energy features and retrofitting an existing home to add energy efficiency or renewable energy features.
- Community-scale projects may include medium to large scale energy efficiency building construction, retrofit project, or installation of community renewable energy systems.
- Small business development may include the creation of a tribal enterprise that would manufacture and distribute solar and wind powered equipment for ranches and farms or create a contracting business to include energy efficiency and renewable retrofits such as geothermal heat pumps.
- Commercial-scale energy projects may include at a larger scale, the formation of a tribal utility formed to sell power to the commercial grid, or to transmit and distribute power throughout the tribal community, or hydrogen production, and propane and natural-gas distribution systems.

2. Primary Technology Options

2.1 Near Future Implementation

2.1.1 Diversification of electric loads and changing service levels to lower electric costs.

Conclusions

Two options for changing from Service Level 5 and to Service Level 3 are viable, but the final benefits are not known because operating costs of the equipment acquired are not known. Diversification of combinations of loads would automatically occur if Option 2 of changing from Service Level 5 to Service Level 3 were implemented. First estimates of aggregating loads under the "CAR" method by combining the current CPN facilities primary meters and the new one at Grand Casino is projected to qualify for the cost reduction of going over 1,000,000 kWh per month and save about $3000 per month.

Discussion

Two areas that have the potential to lower electric costs with OG&E are changing from Service Level 5 to Service Level 3, and instituting an aggregate rate by combining primary meters.

Service Levels 3 and 5 are primarily different with the customer owning and maintaining the equipment on the load side of the primary meter in Level 3 and the demand and energy charge being at lower rates, whereas with Level 5, OG&E owns the equipment on both the source and load side of the primary meter and the demand rate and energy charge are higher. Currently CPN is operating on Service Level 5.

A technique called "Diversification" or averaging of demand loads with use of primary meters will reduce demand charges. Diversification or averaging of demand loads can provide a reduced demand charge only if the combined primary meters do not have the demand occur at the same time for each of the combined primary meters. If you have several primary meters that have maximum capacities of say 100, 1000, 2000 and 5,000 kW then each would have their separate demand load. If for a 15-minute period all had enough of the energy-consuming units turned on at the same time to use 90% of the maximum, then the demand would be 90% of the maximum capacity. For this example then, a demand load of 90, 900, 1800 and 4500 kW would be seen. If they had occurred all at the same time then the demand load would be 7290 kW. But if they did not occur at the same time, the rate would be less than that by some amount. Thus diversification would reduce the demand costs.

In order to diversify, the primary metering would be a single one to encompass all the sources that would use electricity and that single meter would be used to determine the peak load for a 15 minute period of time for a given month.

Service Level Changes: Two Options

Two options are being considered in changing to Service Level 3. One is to place the FireLake Wholesale Foods, the Casino, CPN Headquarters and the new Heritage Center on Service Level 3. The other is to add to the first option, that of installing a primary meter to close the primary loop. The main switch on the inside of the primary meter that closes the primary loop would provide the option of shutting down the whole system and change the source of power. This option is at the request of Chairman John A. Barrett, Jr.

Costs associated with changing to Service Level 3 are listed in Table 2.1 for both Options 1 and 2. Values for the separate primary meters are listed with the name of the facility being served by it and the cost. As seen from the table, the total cost of Option 1 is $153,690.90 and the total cost for Option 2 is $214,539.90. Option 2 has the cost of installing a primary meter added to the Option 1 costs.

Table 2.1. Cost of purchasing primary on load side of primary meter.

Primary Serving:	**Cost for CPN to Purchase the Primary**	**Estimated Current Electric Usage kWh/month**
FireLake Wholesale Foods	$79,285.00	1000
FireLake Casino	$44,574.40	650
CPN Headquarters	$19,924.50	280
New Heritage Center + Pow Wow	$9,907.00	200 60 to 70
Option 1 Total	$153,690.90	2190 to 2200
Primary meter to close loop	$60,849.00	
Option 2 Total	$214,539.90	

Regarding costs shown in Table 2.1, it is suggested by Herron [4] that the relative short run to put in the primary meter to cover the whole system for Option 2 was high at $60,849. He thought it would be of value to get an estimate from an Edmond or Oklahoma City electric contractor to put the meter in place. It is not required that OG&E put the meter in; but a licensed high voltage electrician is required. Installing the cable would be roughly $10.00/ft and electricians charge about $50.00 hr. Switches would cost about $25,000 for the CPN system.

Herron also suggested that it would be better to put two meters in, one at the NE location of the CPN system and one at the SE location of the CPN system, and connect each end to the overhead line so that CPN could feed the system either direction with the loop created in the proposed design.

Herron further suggested it would cost less to go directly east, across the street to tie into the other line and add a $25,000 switch rather than to add a line going north and then across to the Heritage Center. At a cost of approximately $10.00/ft for underground cable, going directly east would cost less and also result in less line to maintain.

Data for cost of operating in Service Levels 3 and 5 are obtained from [1]. The information is summarized in Table 2.2. According to [4] going from level 5 to level 3 would change rates but the costs would not be changing much for the energy charge rates because the customer would be paying for the transformer losses which would bring the effective rate back up to about the level 5 rate.

Table 2.2. Oklahoma Gas and Electric Company
Standard Pricing Schedule, Code No.39.

Service Level	Customer Charge	Capacity Charge		Energy Charge	
		Summer Max. Demand	Winter Max. Demand	1st 1,000,000 kWh per mo.	All additional kWh per mo.
3	$135.00/bill/mo.	$10.79/kW/mo	$5.19/kW/mo.	$0.0264	$0.0234
5	$73.00/bill/mo.	$11.73/kW/mo	$5.63/kW/mo.	$0.0271	$0.0241

Note: Summer season is defined by the five months of June through October and the winter season is defined as the seven months of November through May of the succeeding year.

To get a cost comparison for capacity charges and energy charges of Service Level 3 versus 5, it would require the monthly information from each meter for kWh usage, kW demand and power cost adjustment. These charges could be determined on a spread sheet for the previous 12-month period for the current level, which is Service Level 5. Doing this for the Level 5 and making sure the results came out to match OG&E's cost would be the first step. And then to directly change the inputs on rates from Level 5 to Level 3 and rerun the results would be the last step. The results of these costs would have added to them the customer charges for each level to give the total costs. Obtaining the difference in the total costs would provide the electricity cost difference but it does not account for the costs that could occur for maintaining the acquired equipment in Service Level 3. Another factor is that in changing Service Levels and diversifying the loads along with it, could change the demand and these calculations do not account for that.

Load Diversification and Aggregation

Diversification of the loads in the existing system is being studied to determine potential electric cost savings. To make an estimate of the potential savings by reducing demand would require some measurements. Only if the kW used for a 15-minute period of time was recorded for all the systems to be diversified would there be a way to determine beforehand how much savings could be realized from diversification. Taking the data and adding the 15-minute kW loads per time would provide an estimate of the demand load to be expected after aggregation. This is beyond the scope of this project.

A "CAR" or combined aggregate rate is being studied to see if certain combinations of primary meters will produce the lower rates. The CAR would allow the current CPN system to be included with the new CPN Grand Casino allowing the rate reduction by going over one million kWh/mo. Savings would be about $3000 per month from this approach.

2.1.2 Heat recovery from grocery store and casino as energy source for:

- Car Wash

Conclusions

The waste heat that can be recovered from the CPN Grocery Store is eight times the minimum requirement of the heat for a large-vehicle wash system. One viable option of vehicle wash is a touchless (no brush), fully-automated, large-vehicle wash system that recycles the water. Important factors that affect the costs of installment include the range of type and size of vehicles to be washed and the number of vehicles per hour.

Discussion

The heat from the refrigeration and cooling systems of the CPN Grocery Store and Casino is dissipated to the air. The waste heat of the Grocery Store alone is approximately 3.24 million BTU/hr (12,000 BTU/(hr-ton) x 67.5 tons x 4). The heat recovered from the Grocery Store and Casino can be used for several applications including vehicle wash. There are many types of vehicle wash systems ranging from a small-size, manually-operated machine to a fully-automated system for trailer trucks.

A vehicle wash system that can effectively wash public works vehicles, school buses and all smaller vehicles is discussed here. The information is from phone conversations, a quote, and technical specifications (Touchless Public Works Vehicle Wash - Technical Specifications, www.interclean.com). Some of the highlights of the system include the following:

- The capacity of the water heater should be at least 199,000 BTU/hr, which is less than 1/8 of the heat that can be recovered from the grocery store.
- If water is to be warmed by recovered heat, make sure the water temperature does not exceed 110 F.
- Public works trucks and buses require 400 to 500 gallons of water per vehicle, while commercial trucks require 1600 to 2000 gallons each.
- A standard recycling unit operates at 300 gpm or 18000 gallons per hour. It recycles over 90% of all water used in the wash process.
- The wash system is capable of washing vehicles up to 14-feet in height including cars, pickups, vans, buses, trucks, flatbeds, tankers, tractors, sanitation trucks, waste haulers, vacuum trucks, utility trucks with or without attached ladders.

A car wash business in Stillwater has manual systems in eleven bays. Operational costs include $400 to $600 per month for electricity and $300 for gas for heating water at 110 to 130 F. Hot water is used only with soap and wax. Waste water goes into sanitary sewer. Each working bay consumes 3.5 gpm of water. Daily maintenance includes cleaning the pits and hoses.

Appendices related to vehicle wash systems include:

- InterClean Vehicle Wash System (Pictures)
- Drawings of truck wash facility at Chula Vista Co. Yard, Chula Vista, CA
- Touchless Public Works Vehicle Wash - Technical Specifications

- Laundry

Discussed under "Heat Recovery from Grocery Store and Casino as Energy Source" section of Executive Summary.

- Green Houses

Discussed under "Heat Recovery from Grocery Store and Casino as Energy Source" section of Executive Summary.

- Preheating Ventilation Air for Adjacent Buildings

Discussed under "Heat Recovery from Grocery Store and Casino as Energy Source" section of Executive Summary.

2.1.3 Ground water development for water source heat pumps.

Conclusions

Installing a pond loop field in the pond near the Heritage Center where the well water discharges will provide the best operating characteristics and be the least cost installation to provide source energy for the ground source heat pumps in the Heritage Center.

Discussion

A review of the CPN assets and current systems revealed that well water is currently being pumped into the ponds at the golf course at a rate of 55 gpm, 24 hours per day and 7 days a week except for a few weeks in the winter. This cost can be made into an energy producer by connecting this source of energy to the heat pumps in the Heritage Center, which is being constructed adjacent to the golf course. By having the option of exchanging heat with water, the efficiency increases and the cost decreases.

The common improvements that water makes in applications of ground source heat pumps are: water improves the transfer of heat energy to or from vertical or horizontal boreholes; it can be pumped directly through the heat pump and returned to a reservoir or directed to approved disposal sites; or a closed loop system can be submerged in a body of water fed by the water source. Direct pumping of the well water through the heat pumps was not pursued because there is a concern that the artifacts stored in the Heritage Center would not be held in the proper climate if the well were needing repair and the source of energy exchange would not be available to help provide the heating and cooling required. The best choice is to maintain the current pumping system to the pond. The well water discharges to the third pond away from the Heritage Center which is the largest pond. Using aerial photographs, the surface area of this pond was measured to be 0.67 acres. Placing closed loop heat exchangers in the pond and connecting them to the heat pumps in the building with headers to and from the pond provide an efficient system that is not highly sensitive to the few days that it would take to repair the pump system if it failed. Therefore the protection of the artifacts would be satisfied.

We were provided monthly building loads for the Heritage Center, building drawings, aerial photographs and well water flow rate, which gave us the background to do the analysis. The pond size and depth depends upon the flow of water into the pond. With the current rate of 55 gpm and loops being installed in the pond, there will be no changes in piping and pumping required from the well to the pond. Although it is recommended that the discharge from the well supply be modified to distribute the water more evenly in the vicinity of the heat exchangers.

In the design process, the building loads were input to a software package along with a configuration of 9 each pairs of 5 ton Trane water to air heat pumps, which produces 90 tons peak cooling load. This is not what is currently in the design, but the predicted loop size would not change enough to matter with the size heat pumps shown in the drawings, because the same peak load exists for either case. In the design process a modification to the input was made to allow for the 55 gpm water influx from the well.

The three ponds closest to the Heritage Center were measured from the aerial photographs to determine the acres covered by them and the approximate distance from the Center to each pond. The largest pond was estimated to be 0.67 acres. Based on the results of the analysis the one 0.67 acre pond will handle the 90 ton load if it is taken to a depth of 8 ft with water coming from the well at 55 gpm. There would be 18 each, closed loop 5- ton copper coils (1 inch pipe, 300 ft long) and each heat exchanger would have two 150 ft long coils placed in parallel. These are of the configuration that is shown in Figure 2.1. The heat exchangers can be positioned in pairs on each side of the header pipe at a distance of 15 feet on each side. These branch lines would be 40 feet apart down the header to connect the 9 pairs of heat exchangers. A reverse return header would be installed to provide evenly distributed flow. This is shown schematically in Figure 2.2.

Figure 2.1. A 5-ton copper coil pond loop being installed in a pond.

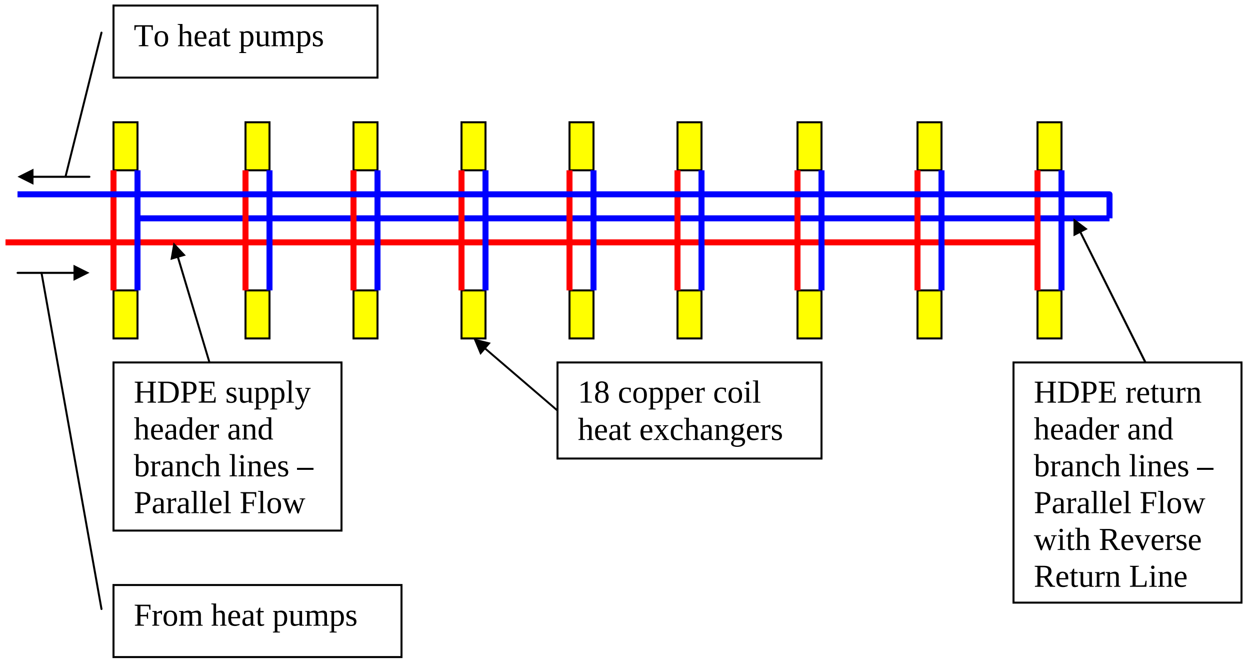


Figure 2.2. Schematic of pond loop system for the Heritage Center.

By having the closed loop system in the pond, the well could be down for repair and cooling and heating would continue in the building. After having the pump down for several days, the efficiency would begin to reduce but the temperature in the building would be maintained.

It is recommended that a larger number of smaller heat pumps be used in the building and individual circulating pumps be placed at each heat pump to reduce cost of operation and also provide redundancy in case one pump went down the other heat pumps would run for longer periods of time to maintain the load.

Cost estimation indicates the pond loop costs for 9 loops will be approximately 23% of the cost of the proposed 98 vertical boreholes that are in the original drawings. There will also be costs for the supply and return lines to the pond and the pond header pipe, but the vertical borehole field also requires header lines and more of them. It is estimated that the total pond loop system will be the least first cost and provide excellent operation characteristics. It will also, with the closed loop flow, be able to operate without the well water for short periods (several days) of time and maintain high efficiency. Therefore the artifacts in the building will be protected.

The Heritage Center is an example of utilizing well water and pond water to couple with ground source heat pumps to reduce first costs and provide excellent HVAC performance. Other facilities, such as the Headquarters, are candidates for using this source of energy to heat and cool the building and produce hot water.

2.1.4 Geothermal heat pump business models.

Conclusion: Business Management Skills of the CPN Team

The management of the CPN is uniquely qualified to take a leadership position in an accelerated ground source heat pump business. This supposition is based on their experience with the technology and its requirements, the can-do attitude of their personnel and a ready market driven by increasing energy costs.

GSHP Business Structure Strengthening – On CPN Properties

The geothermal heat pump business is an integrated and structured set of professional and trade organizations working together with an architect/engineer to provide the building owner/Board a high performance and cost effective HVAC system. Figure 2.3 is a flow diagram which describes in a general way how present geothermal business is conducted.

The owner, in this case CPN, will initiate the idea of using geothermal heat pumps in a new building project. It is important that aggressive leadership occurs at this time in order to prevent unnecessary resources being expended on alternative HVAC systems. If the GSHP becomes an alternate, then reworking and submitting fees for additional work can occur. Any time aggressive leadership is taken, it is critical that costs are known in advance. The CPN leadership is positioned and is experienced to assume this role. Also, the leadership has demonstrated their willingness to evaluate alternative GSHP design, seek professional help if needed and proceed in a timely manner.

The selection of the architect/engineer team must be based on knowledge that they either have had successful experiences in the GSHP business or that they are willing to undergo training from a host of providers. In many cases, submitted drawings will be nothing more than rule-of-thumb designs that do not reflect the latest thinking.

The owner must take a lead role if the architect/engineer team is not experienced in the geothermal heat pump technology. The architect selects or uses a previously used engineering firm to design the system. If the engineer does not have experience with geothermal heat pumps, the engineer then has as a resource base of Technology Specialists (see Figure 2.3) who have expertise in critical areas that will result in a successful design and system operation. The CPN has access to these specialists within a 60 mile radius of their headquarters. Within 100 miles, the International Ground Source Heat Pump Association is located, giving the CPN access to training, engineering and design support, and project monitoring. Within the State of Oklahoma, there is a major heat pump manufacturer, plastic pipe extrusion, heat fusion equipment manufacturing, HDPE fittings manufacturer, drilling machine manufacturers, trencher manufacturer, horizontal boring machine manufacturing all the valves and fittings necessary to deliver systems with life expectancies greater than 30 years. Within a 100 mile radius there are numerous companies each with continual growing businesses over the last 10 to 15 years. Five of these companies were surveyed as to size and market share. The results of this survey are given in the next section in support of a new CPN business(s) development.

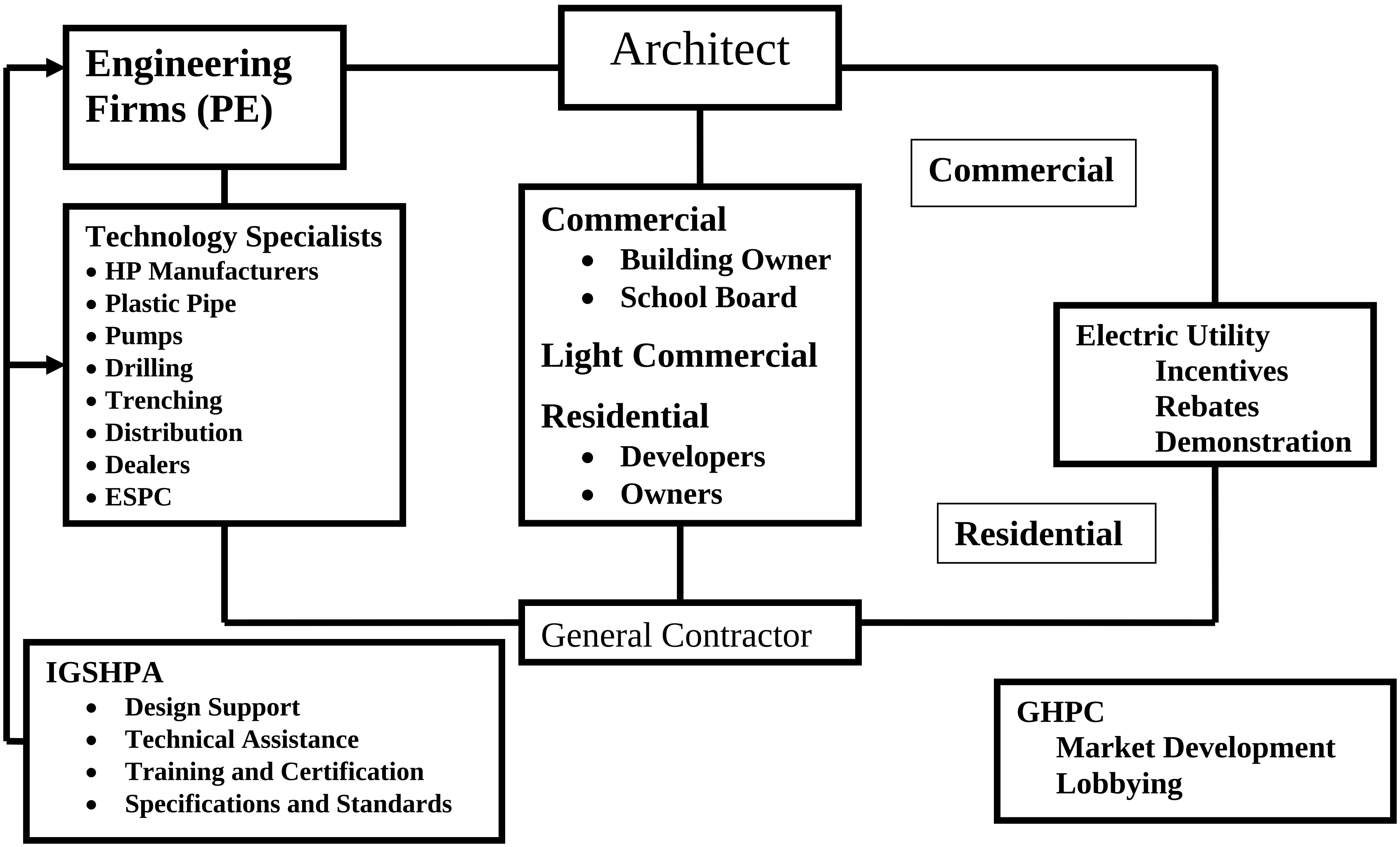


Figure 2.3. Flow diagram of how geothermal is conducted.

New CPN Business Development

Five successful geothermal heat pump companies were surveyed to determine trends that led to their present business operation. The gross annual revenue ranged from 1 to 27 million dollars with employee numbers ranging from 4 to 50. The businesses are described as Companies A through E.

Company A

Company A has the following characteristics:

- Geothermal sales and installation of residential and light commercial systems
- Owners are a husband (driller) and wife (office/accounting) team with over 20 years experience in the geothermal heat pump business
- Eight employees
- Gross annual sales $1,000,000
- Equipment
  - Two drilling rigs – 5 inch bore holes
  - No thermal grout used – extra bore hole length drilled to compensate
  - Two tractors with front end loaders to remove drill cuttings, etc.
  - Duct work trailer to support full system support
  - Two backhoes (Kubota) for headering
  - Five trucks
  - Heat fusion up to 3 inches
- Carrier geothermal heat pumps
- Typical or most desired job – 1,000 feet of borehole per day – single job
- Some manufacturers' training, but mostly on-the-job training by the owner/operator
- Advertising by word-of-mouth
- Largest job – Oklahoma State Capital Building – approximately 400 bore holes
- Personal comment – "shouldn't have been so conservative"

Company B

Company B has many of the same characteristics as Company A, but also includes sales and service of conventional HVAC equipment. Characteristics include:

- Geothermal sales and installation of residential and light commercial systems
- Owners are a husband (equipment operator) and wife (office manager) team with over 20 years of experience
- Eleven employees (4 geothermal, 7 conventional HVAC equipment)
- Equipment
  - Trenchers - 2
  - Backhoes – 1
  - Plastic pipe heat fusion equipment up to 6 inches
  - Service trucks - 5
- Gross annual sales
  - $1,000,000 geothermal sales and installation
  - $1,000,000 conventional HVAC sales and service
  - System types installed
  - Horizontal trenches and horizontal bores
  - Vertical bore holes
  - Hybrid light-commercial
  - Lake/pond loops
- Territory covered – Oklahoma, Dallas/Ft Worth, Southern Kansas
- Capital investment
  - Geothermal - $300,000
  - Conventional HVAC - $150,000

Company C

Company C is managed and operated by a former solar energy system installation person. The downturn in the solar market (tax incentives) resulted in getting involved in the geothermal heat pump business. The business has progressed from single family residences to major university campus buildings. The company prides itself in professional-looking installations with a great amount of care to appearance.

- Geothermal sales and installation of residential and light commercial systems
- Owner was an Engineer in the aerospace field
- Gross sales - $5 ½ to 6 million per year
- Number of employees
  - GSHP – 43
  - Conventional HVAC and service – 4
- Two drilling rigs for residential activity
- 80% of all commercial drilling projects are subbed out for hole drilling and pipe loop insertion
  - Company personnel header the bore holes and other plastic pipe fusion
  - Grouting is by the company using a commercially built machine
  - Plastic pipe is either manufactured by Chevron Phillips or Centennial
- Owner claims that there is **no money in drilling –** very competitive business
- Conventional grout (not thermally enhanced) is recommended with additional bore if enhanced performance is required
- Company C has three divisions
  - Geothermal sales and installation
  - Energy products and supply
  - Geothermal Heat Pump System-loop services

Company D

Company D is headed up by an Engineering Technologist (electronics and computers) and a Business graduate. Both owners have worked for several major heat pump manufacturers in their areas of professional training. In addition, both members of the company started as hourly laborers in the geothermal heat pump industry and gradually worked up through the ranks to their present positions. Their work activities includes in-the-trench experience, heat fusion joining, heat pump selection and sizing, customer service with a major heat pump manufacturer and large commercial project involvement.

- Number of employees – 5
  - Temperature and controls – building automation systems
  - Former contractor – sales, applications engineer
  - Electronics project management
- Total Sales $2,500,000 of which $1,000,000 is for system controls (most profitable component of the company)
- They are state-wide distributors of a major heat pump manufacturer's equipment.
- All ground heat exchanger work is contracted out for in-house projects. All other work is through mechanical contractors.
- Thermal testing is provided as a service with project funding usually by the electric utility. Annual sales for thermal testing is $60,000 which includes drilling and borehole completion (pipe loop installation and grouting.)

Company operates on a Three Question Approach to any potential sales opportunity:

- What is the profitability potential of the opportunity
- Probability of closure of the project
- Pay-ability potential of the customer

Company E

Company E is the largest of all studied. The operation consists of two distinct operations or divisions: 1) Goods and Service and 2) a Professional Division that provides design support, installation and commissioning.

The sales and services division supports a dealer network of installers and mechanical contractors serving residential and light commercial projects. As part of this division's activities, training and design methodologies are provided and supported. Product lines are offered, installation equipment is developed and marketed and specialized components are developed and/or manufactured.

The professional division's primary business includes schools, large commercial and governmental projects. They team with TRANE Corporation as a governmental pre-qualified Energy Service Provided Company (ESCP.) Their design professionals (not Professional Engineers) are experienced in geothermal piping (includes indoor HDPE piping), specialized header vaults, unique valving and fittings, manufacturing of specialized components, filtering equipment, flushing and purging systems and commissioning equipment.

The Goods and Services Division has:

- Annual gross sales of over $10,000,000
- Eight employees
- Associated installation and service equipment (trucks, trailers, skid loaders, backhoes, fusion equipment

The Professional Division has:

- Annual gross sales $17,000,000
- Forty six (46) employees
- Drilling company
- Thermal bore hole testing service
- Manufacturing capability that includes
    - Header vaults
    - Service trailers
    - Flushing and purging equipment
    - Piping systems

The company presently operates in the US, Japan and Korea.

Conclusions on Business Types

The authors have the advantage of personally knowing the principals in all of the six companies and were able to support and learn from them during their company development. There are many statistics that may be calculated based on this limited study such as dollars generated per employee, capital investment per million dollars of business, etc. But the one thing that stands out is that the businesses are an outgrowth of their family business background and/or academic training. All of these business leaders would have been successful no matter what business they entered into. The technology didn't make them better, they made the technology better. They did this through their own efforts of being in the business, participating in technology development and recognizing very early that getting started in a technology that has a strong science base would make sense.

Conclusion Number 1

The size of operation of the individual company depends strongly on how well the business owner is able to delegate work tasks. Both Companys A and B have the business owner taking an active part in the actual installation. For example, one is a licensed driller and does all the drilling personally and the other operates a trencher. Each individual can do every job and do it exceedingly well. Both companies have businesses that are stalled out at about $1,000,000 per year (2004 dollars).

There is very little difference in what kind and size of equipment is required in their operation. It is as if they were all trained by the same person, company or manufacturer. Both companies own equipment to heat fuse pipe up to 3-inches in diameter.

Conclusion Number 2

In order to enter into the light commercial geothermal heat pump business, a working relationship with a professional is generally required. A PE will be required if a design must be stamped. If the client/owner has sufficient confidence and capitol to fund the project, then small commercial businesses such as service centers, etc. can progress without the services of a PE. Repetitive and established designs fit this type of installation contractor. A number of residences for "Stars" fall into this category.

Conclusion Number 3

Large commercial installation companies will operate much like that detailed in Figure 2.3. Professional Engineers will contact known and experienced technology specialists that have a number of successful projects that developed under their tutelage. The role of the large installation companies is to trim the fat and bring the project into budget! This ability comes from successful experience.

Companies that fall into the large government programs will team with a major electric utility that has a subsidiary company or a major heat pump manufacturer to form a government pre-qualified Energy Services Provider Company (ESCP). Individual projects will be in the multi-million dollar range (Ft. Polk, Ft. Sill, Oceania Naval Air Base, etc.)

Potential Business Opportunities

Form or purchase a geothermal heat pump business like one of the aforementioned companies (A through E.) Each one of these companies started small because of the limited knowledge base at the time of their beginning. Each person involved in the start-up was experienced in the technical side of a business (not necessarily geothermal.) The hiring of a broad based and experienced geothermal engineer/technologist is advised.

One or more of the following allied businesses have developed and are potential options for the CPN.

1. Form a geothermal heat pump business to provide fabrication of specialty components, manufacturing of specially developed service equipment and distribution of products as illustrated in the attached photos.

2. Get key persons trained and become an on-the-job training group using IGSHPA type materials. Included would be persons trained as Accredited Installer, Certified GeoExchange Designer (CGD), etc.).

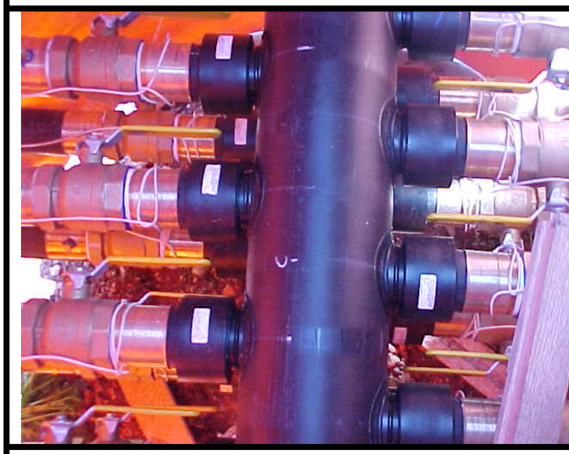
3. Form a geothermal drilling, installation and commissioning company.

4. Provide a borehole thermal testing service and a machine manufacturing business company.

1. Geothermal Heat Pump Business (Fabrication-Manufacturing-Distribution)

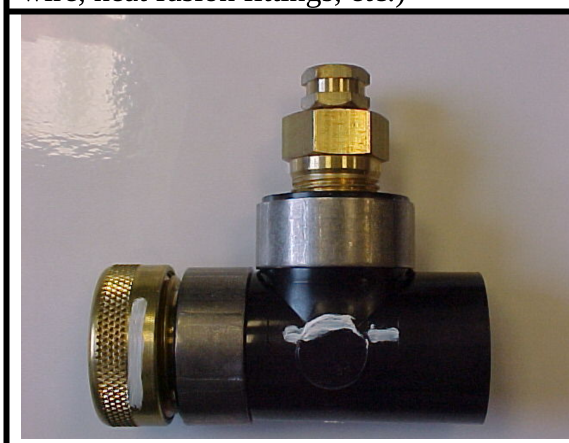
Flushing and Purging Equipment – Manufacturing opportunity, distribution and sales

Prefabricated Header Vault – Manufacturing, distribution and sales



Prefabricated Vault - Interior View (valves, pressure temperature ports, tracer wire, heat fusion fittings, etc.)

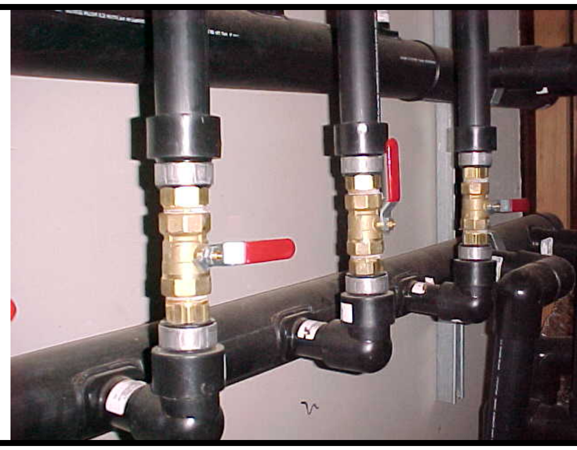
Prefabricated Vault -Interior View



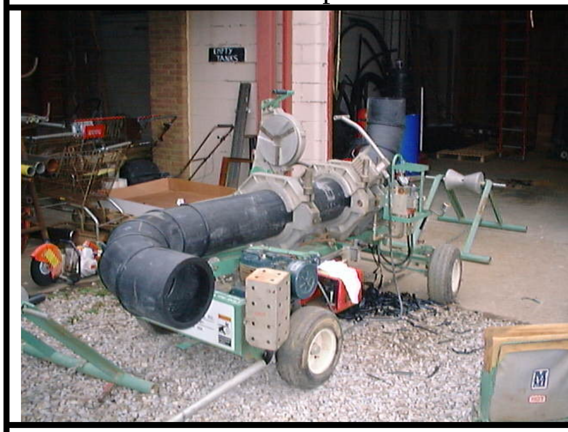
Product Distribution – PT Ports

Distribution - Electro-Fusion Fitting

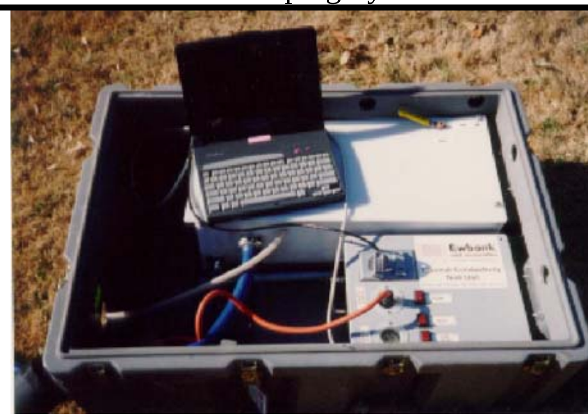
Distribution - Plastic Pipe HDPE 3408



Fabricated Interior Piping Systems



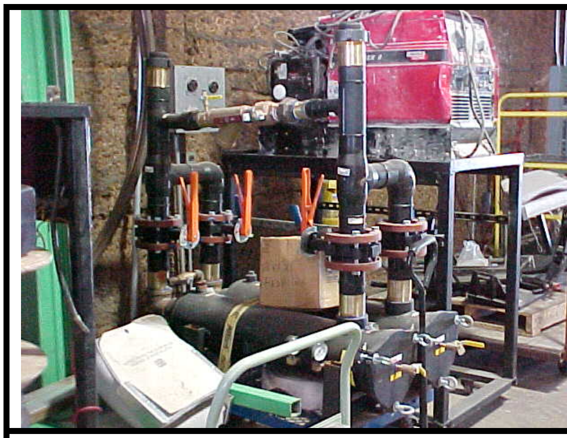
Large Diameter Heat Fusion Equipment



Manufacturing, Thermal Borehole Testing Service

Eight- Inch Heat Fusion Machine

Geothermal Drill Rigs



Filtering Assembly – Manufacturing and System Commissioning

Specialized Service Equipment - Interior View of Service Trailer

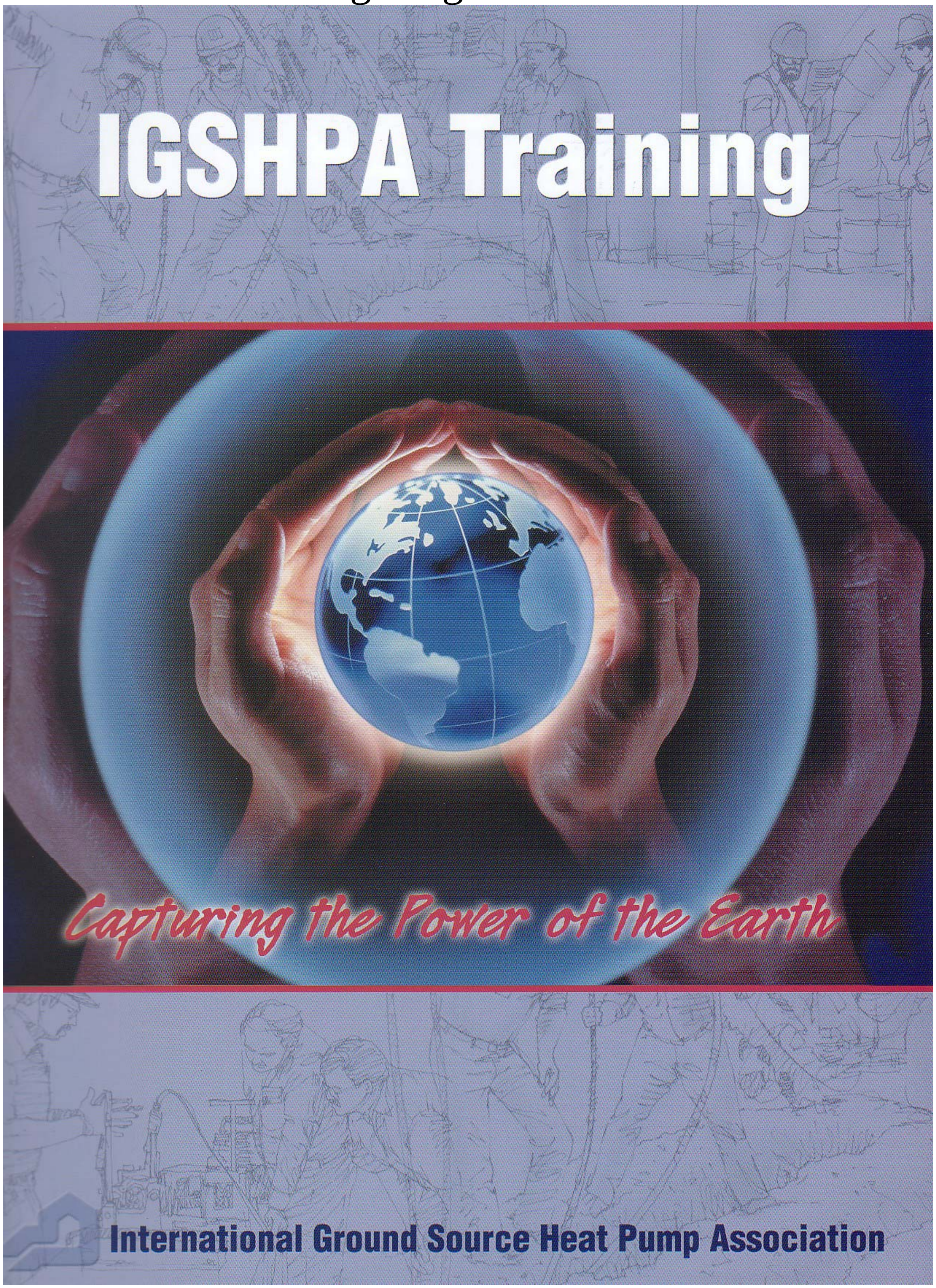
Commissioning Equipment

Field Service Trailer – Manufacturing

Fabrication of Large Pipe Fabrication

Cast Header Vault - Installation

2. IGSHPA Training Programs



Certified GeoExchange Designer Training

As an architect or engineer, you have specific questions about GSHP systems that you want answered. IGSHPA has designed a program to offer advanced training towards certification as a GeoExchange Designer (CGD). From an introduction to the technology to a complete review of the design process, participants learn the specific information they need to know. IGSHPA has entered into a cooperative endeavor with the Association of Energy Engineers (AEE) and the Geothermal Heat Pump Consortium (GHPC) to provide training for the Certified GeoExchange Designer Program. Participants will receive a copy of the *Closed-Loop/ Ground-Source Heat Pump Systems Installation Guide*, as well as other manuals in the CGD Notebook.

Who should attend?

The Certified GeoExchange Designer course is designed for professional engineers, registered architects, installers, and contractors. This course is essential for individuals wanting advanced training and experience in designing GSHPs, and required for experienced individuals who wish to earn certification.

Topics

- Ground Source Heat Pump Design
- Loop Systems, Open Systems
- Soil/Rock Classification and Conductivity
- Grouting Procedures
- Commercial Ground Loop Heat Exchanger Software
- Performance of Ground Source Heat Pumps in Housing Units

Registration information

After you register, a confirmation letter, hotel listings, an agenda, and a necessary course supplies list will be sent to you. If you pay when you register, you will also be sent a reading list and your manuals.

Cancellation policy

The full tuition fee may not be refunded unless you notify IGSHPA a minimum number of days in advance. Please refer to the registration form for specifics.

Certification Process

Certification is accomplished by application to AEE. To become certified the candidate must:

1. Determine if eligible under the Eligibility Requirements listed.
2. Register for and attend the IGSHPA CGD Workshop.
3. Pass the IGSHPA CGD exam.
4. Complete a separate application with additional fee to AEE, initiating the certification process.
5. Certification will be awarded by AEE after their evaluation of the candidate's qualifications.

Attending the CGD Workshop and passing the CGD exam are only a part of the certification process and will not automatically lead to certification. Contact AEE at 1-770-447-5083, ext. 223 for an application and fee information.

Eligibility requirements

Each candidate for certification must meet one of the following four sets of criteria:

- Be an engineering graduate and/or Professional Engineer or Registered Architect with three years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning.
- Have a four-year, non-technical degree with five years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning.
- Have a two-year technical degree with eight years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning.
- Have ten years or more verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning.

1-800-626-4747

Accredited Installer Training

Learning to install

GSHP systems will keep you competitive in a market forced to deal with rising energy costs and resource depletion. Installer accreditation enables you to open new markets and offer customers a low-maintenance, economical, and environmentally friendly alternative for their space conditioning needs.

With over fifteen years of experience teaching these workshops, accrediting thousands of installers, and setting the industry standard, IGSHPA has maintained close ties with Oklahoma State University, and pioneered training in GSHP installation

Who should attend?

The three day comprehensive Installation Workshops are designed for GSHP developers, architects, manufacturers, distributors, dealers, installers, HVAC contractors, trenching/drilling contractors, and anyone who desires a working knowledge of this innovative technology.

Representatives from public utilities, private utilities, and rural electric cooperatives can also benefit from training. Information gathered from the workshops can help utility representatives serve as a source of information regarding money-saving concepts.

Accreditation

Upon successful completion of the workshop and passing the IGSHPA installer's exam, you will be issued IGSHPA accreditation as an installer of GSHP systems. You will receive an installer's card and a certificate.

In most instances, you will receive a membership with IGSHPA after you have completed the Installation Workshop. Membership in IGSHPA is required to be an Accredited Installer and maintain accreditation.

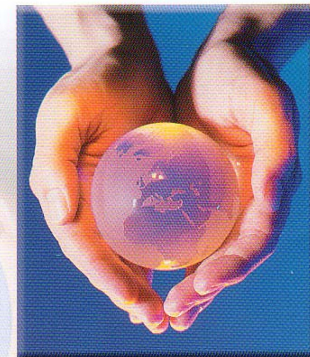
Topics

- Design and Material Options
- System Layout
- Pipe Joining Techniques
- Trenching/Drilling Processes
- Air and Debris Purging
- Pressure Drop Calculations
- Pump and Fluid Selection
- Thermal Conductivity

Group discounts and on-location training

A group discount is available if five or more people attend from your company or organization.

For an additional fee, IGSHPA offers its Installation Workshops on location. Call 800-626-4747 for more information.



Registration information

After you register, a confirmation letter, hotel listings, and an agenda will be sent to you. Before securing travel arrangements, please check the agenda for class times. If you pay when you register, you will also be sent a reading list and your manuals.

Cancellation policy

The full tuition fee may not be refunded unless you notify IGSHPA a minimum number of days in advance. Please refer to the registration form for specifics. You may designate another individual as your substitute at any time.

1-800-626-4747

Train-the-Trainer

As ground source heat pumps capture more of the HVAC market, the need for competent installers increases as an integral part of the growing geothermal industry. Regional trainers are essential if the industry is to provide the necessary GSHP installation workshops for people interested in becoming IGSHPA-accredited installers.

In IGSHPA's Train-the-Trainer Workshop, participants review all the skills involved in GSHP system installation and learn how to teach these skills to others. The five day comprehensive course is taught in conjunction with an Installers' Workshop. The first and second days of the course will cover adult education principles, and program and lesson planning. During the remaining days, trainees will practice presenting lesson plans, and will present a lesson in an actual installation workshop. Participants are taught how to use IGSHPA training aids, such as manuals, videos, sample curriculum, and transparencies used in IGSHPA workshops. With successful completion of the program, participants will receive IGSHPA training accreditation and be able to instruct installation workshops in their home areas.

Courses are taught by industry professionals with expertise ranging from GSHP system design to research. Each instructor is IGSHPA-accredited with years of teaching experience to share. Each participant will also receive a copy of the *Closed-Loop/ Ground-Source Heat Pump Systems Installation Guide*, a presentation manual, and handouts.

Who should attend?

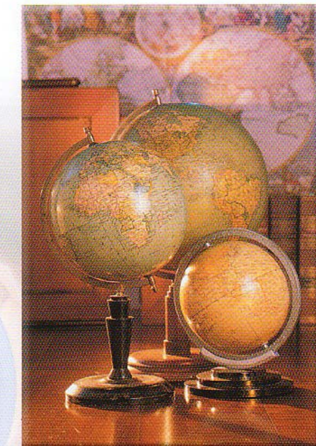
The Train-the-Trainer Program is designed for individuals who are already IGSHPA accredited installers, familiar with GSHP technology, and experienced in its installation and maintenance. Prospective trainers must be confident enough of their knowledge and skills to teach them to others.

Topics

- Training Methods
- Adult Education Processes
- Design and Material Options
- Ground Heat Exchanger Design
- System Layout
- Pipe Joining Techniques
- Air and Debris Purging
- Soils and Rock Identification
- Pump and Fluid Selection

Registration information

You must be an IGSHPA accredited installer to take the course. When you apply, your application will be sent to committee for review. If you are selected to be a course member, you will receive a letter of confirmation with agenda and hotel listings. Before securing travel arrangements, please check the agenda for class times. You will not be charged for registration until your application has been accepted.



Accreditation

Upon successful completion of the training program and passing the IGSHPA Installer's exam, you will be issued IGSHPA accreditation as a trainer of IGSHPA installation workshops. You will receive a trainer's card and a certificate.

Cancellation policy

The full tuition fee may not be refunded unless you notify IGSHPA a minimum number of days in advance. Please refer to the registration form for specifics.

1-800-626-4747

3. Geothermal Drilling/Installation/Commissioning Company

Large project drilling capability

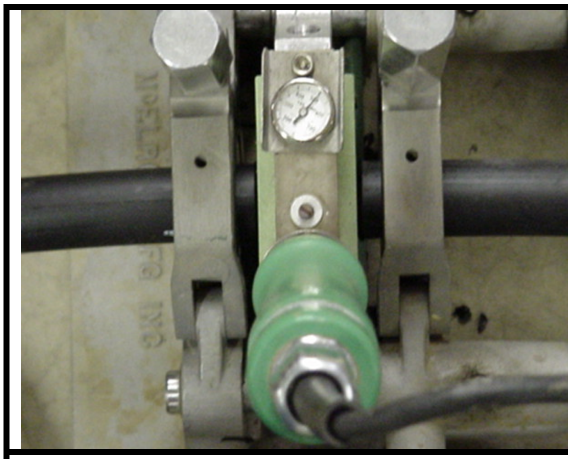
Pipe sales and installation

Large Pipe Heat Fusion

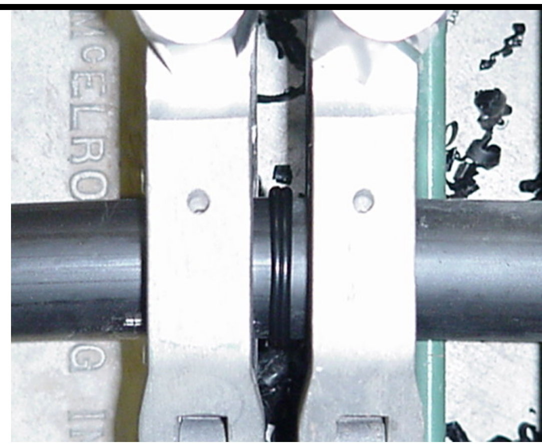
Large Pipe Fabrication

Borehole heat exchanger completion – grouting, spacing

Bore hole thermal testing service



Heating Pipe Ends - Service



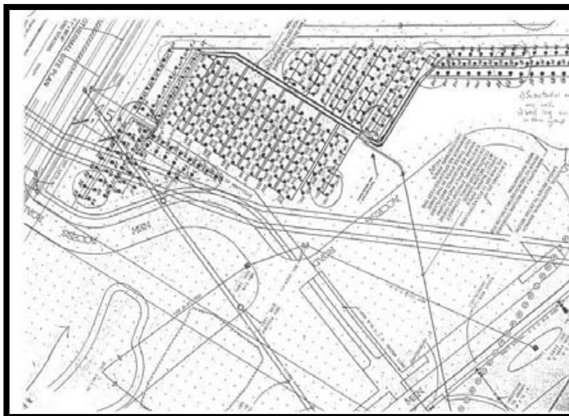
Pipe Heat Fusion Joining

Pipe / Borehole Headering

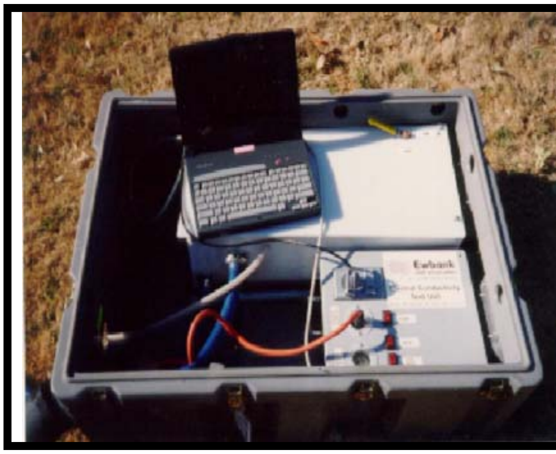
Pressure Testing Service

Filling and Pressurization Equipment – Fabrication and Service

Hookup and Commissioning – Integration with Indoor System

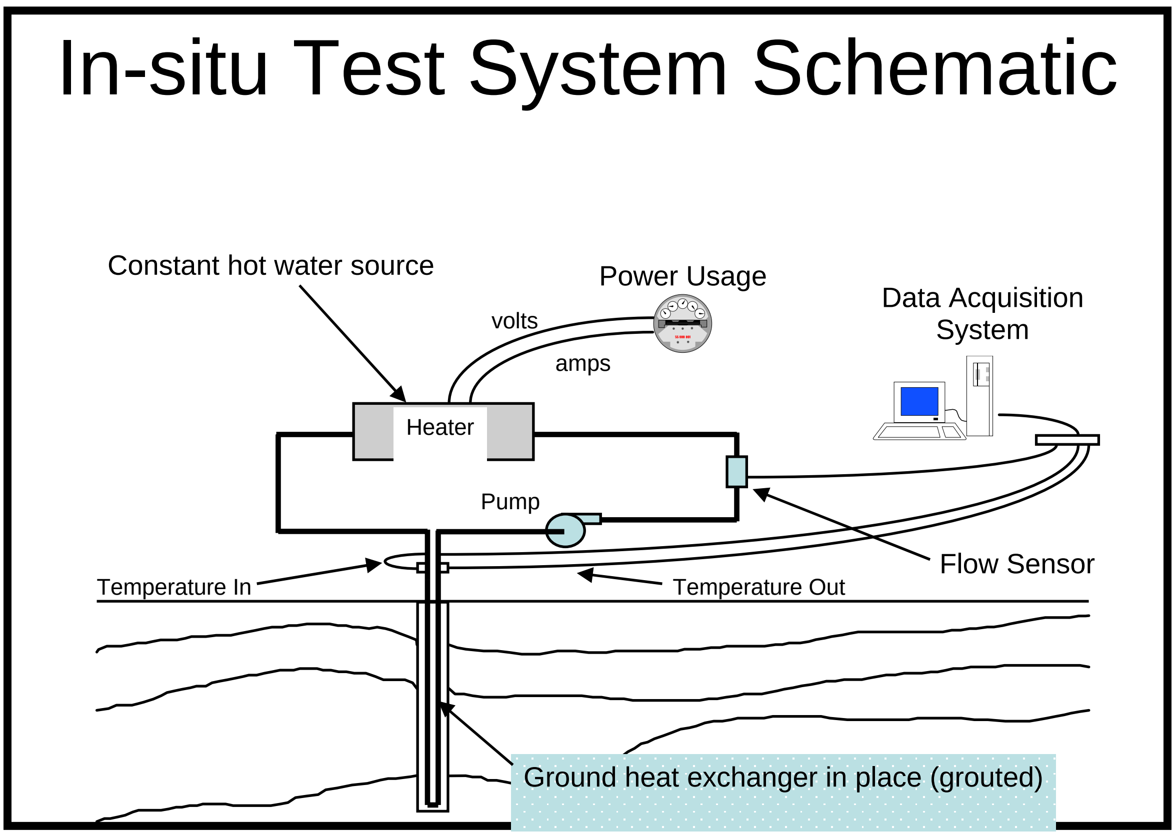
	
Project Management and Installation	Landscaping Restoration

4. Borehole Thermal Testing Service and Manufacturing Business



Shown on the left is a borehole thermal testing unit developed at Oklahoma State University. The unit was fabricated with OSU personnel. Research was by Dr. Marvin Smith, Dr. Richard Beier and others. Research results have been published.

Below is a schematic diagram on the basic operation of the unit.



2.1.5 Integration or sharing of HVAC loads.

Discussed in Integration or Sharing of HVAC Loads under Near Future Implementation in the Executive Summary.

2.2 Future Implementation—Beyond 5 Years

2.2.1 Growing, harvesting and transporting biomass to gasification-fermentation plants being developed by OSU researchers.

Conclusions

Biomass in the form of grasses and crop residues can potentially be converted to ethanol and other fuels. Although a biomass facility will require a large investment of 60 to 170 million dollars, CPN may want to participate by being a supplier of feedstock (grasses or crop residues), if such a facility is constructed nearby.

Background

Biomass, in the form of wood, supplied the majority of the world's energy needs [5] up to the late 1800's. Then the industrialize countries adopted fossil fuels first in the form of coal, and later as oil and natural gas. After the "oil shocks" in the 1970's, governments started to fund research into biomass energy sources. By the late 1970's biomass energy was about 2% of the total US energy consumption or 850,000 BOE/day. The abbreviation BOE stands for Barrel of Oil Equivalent, which is an energy unit representing a barrel of crude oil.

In 1990, biomass energy production increased to 1.4 million BOE/day, or about 3.3% of the US energy consumption rate. Klass [5] compiled the sources of biomass energy in the United States as listed in Table 2.3 for the year 1990. Projections are given for the year 2000. Commercial and residential energy use from wood and wood wastes made up nearly 84% of the total biomass energy consumption. Municipal solid wastes made up about 10%. Agricultural wastes and landfill gases each make up about 1%.

Table 2.3. Biomass energy in the United States in 1990 and projected for 2000 [6].

Resource	Biomass Energy in 1990 BOE/day	Biomass Energy in 2000 BOE/day
Wood and wood wastes	763,000	1,021,000
Municipal solid wastes	141,100	292,400
Agricultural and industrial wastes	18,600	37,100
Methane (mostly gas from landfills)	17,200	49,200
Ethanol & other biofuels (transportation fuel)	29,200	92,800
Total	1,371,000	2,026,200
Percent of energy consumption	.3	4.8

All of the sources of biomass energy (Table 2.3) are related to waste material except for ethanol for transportation fuels. Ethanol contributed only about 2% to the total US biomass energy production in 1990, but has increased in the last decade. Corn is the source for ethanol, which is blended with gasoline to increase its octane rating.

The growth of ethanol use in the 1990's was triggered by the Clean Air Act Amendments [7, 8]. These laws require oxygen-containing molecules in gasoline additives in specific regions to improve air quality. Ethanol competes with Methyl tertiary-butyl ether (MTBE), which is derived from petroleum and is the most widely used oxygenate. But the growing environmental concern of MTBE leaking from tanks and polluting groundwater may restrict its future use and increase the demand for ethanol. The federal government and some states subsidize the use of ethanol for transportation fuels.

Fuel from Grasslands

For the Citizen Potawatomi Nation, the most attractive biomass project would be based on plants that thrive in Oklahoma. Because much of the state was originally grasslands, biofuels from grasses are a logical focus. An active research program [7 – 9] at Oklahoma State University is studying the use of grasses to produce ethanol or other fuels. One possible source crop is switchgrass, which can grow on land poorly suited for cultivated crops. Other sources include native grasses and crop residues. The OSU group hopes to have a pilot plant operating in about three years.

The process used by the OSU group is quite different from the grain-fermentation process of making ethanol from corn. The grain-fermentation process uses only the corn seed leaving the rest of the plant behind. The OSU group is using a gasification-fermentation process, which can use a wide variety of feedstocks such as grasses and crop residues, including the corn stocks not used in the grain-fermentation process. The ability to use a variety of feedstocks gives flexibility by taking advantage of the different harvest periods of various crops. Also, land that is unsuitable for commercial crops in Oklahoma can still be used for growing grasses as a feedstock.

In the OSU process (Figure 2.4), the feedstock is cut into pieces before going into a fluidized bed, which produces a synthetic gas consisting of mainly CO, CO_2, and H_2. This synthetic gas then enters a bioreactor, which contains organisms. These organisms are selected from naturally occurring bacteria. The bacteria convert the synthetic gas to ethanol or other useful liquid products.

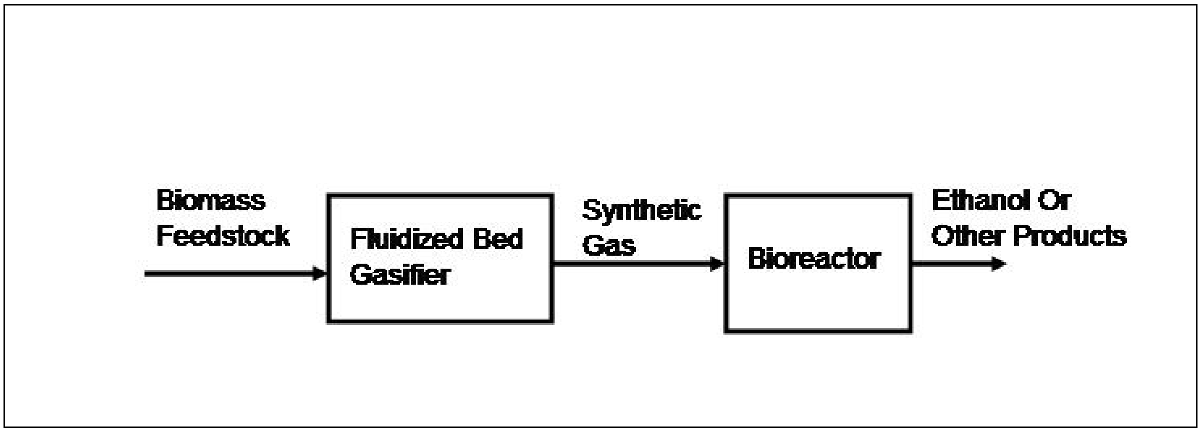


Figure 2.4. Diagram of gasification-fermentation process.

The gasification/bioreactor process is significantly more energy efficient than the grain-fermentation process currently used to transform corn seed to ethanol. The ethanol product from corn contains 30% more energy than was used to produce the ethanol fuel. On the other hand, the gasification/bioreactor process may increase the energy content by 200% to over 300%. Thus, the net energy added in the process may be a factor of 10 over the energy added by the grain-fermentation process.

With the more efficient process comes cost savings. The typical price for fuel-grade ethanol is about $1.40 per gallon, which includes a $0.50 per gallon government subsidy. A projected cost for producing ethanol by the gasification/bioreactor process is $0.76 per gallon [8], which represents a substantial savings. A typical round bale of hay (1100 pounds) would be converted into about one barrel (42 gallons) of ethanol.

The above economics are projected for facilities each producing 25 to 100 million gallons of ethanol per year [8]. To produce 100 million gallons per year would require 224 truckloads of 17 dry tons of biomass per day. To control transportation costs the feedstock would be harvested within 25 miles of a facility.

The initial investment for a biorefinery is estimated to be $59 million, $100 million, or $170 million for 25, 50, and 100 million gallons per year facilities, respectively. If such a facility is planned or built within 50 miles of the Citizen Potawatomi Nation, the Nation may look into providing biomass for the facility.

2.2.2 Integrated energy systems (IES)/combined heat and power (CHP)/cogeneration type system producing electricity and heat to support a business to be identified.

Conclusions

If after five or more years, CPN is using all the current excess thermal energy, the Nation should explore combined heat and power systems. In these systems, excess thermal energy from in-situ electric power generation could be used to heat buildings or perform other uses.

Discussion

A byproduct of on-site electrical power generation is thermal energy for heating (or cooling) nearby buildings. Such systems [2, 3] are referred to as combined heat and power (CHP) systems or Integrated Energy Systems (IES). Potentially 80 percent or more of the energy from a fuel can be converted to useful energy. Such energy efficiency is much greater than typical efficiency at large central power plants operated by electrical power companies. This increased efficiency may turn into an economic advantage, depending on the utilities price schedule and on-site fuel costs. Currently most CHP systems are located at college campuses or health care facilities. In both cases nearby buildings and operations put otherwise wasted thermal energy from on-site electrical power generation to use.

LeMar [3] illustrates CHP options for multiple buildings in Figure 2.5, along with a conventional non-CHP system. In the diagram of the conventional system natural gas is supplied to a boiler, which generates steam or hot water for space heating. A chiller operating on electricity provides cold water for air conditioning and ventilating needs. The CHP system generates not only electricity but steam or hot water for nearby buildings. The uses of the hot water/steam include space heating, domestic hot water, or an energy source for an absorption unit and chiller. The absorption unit and chiller supply chilled water for air conditioning.

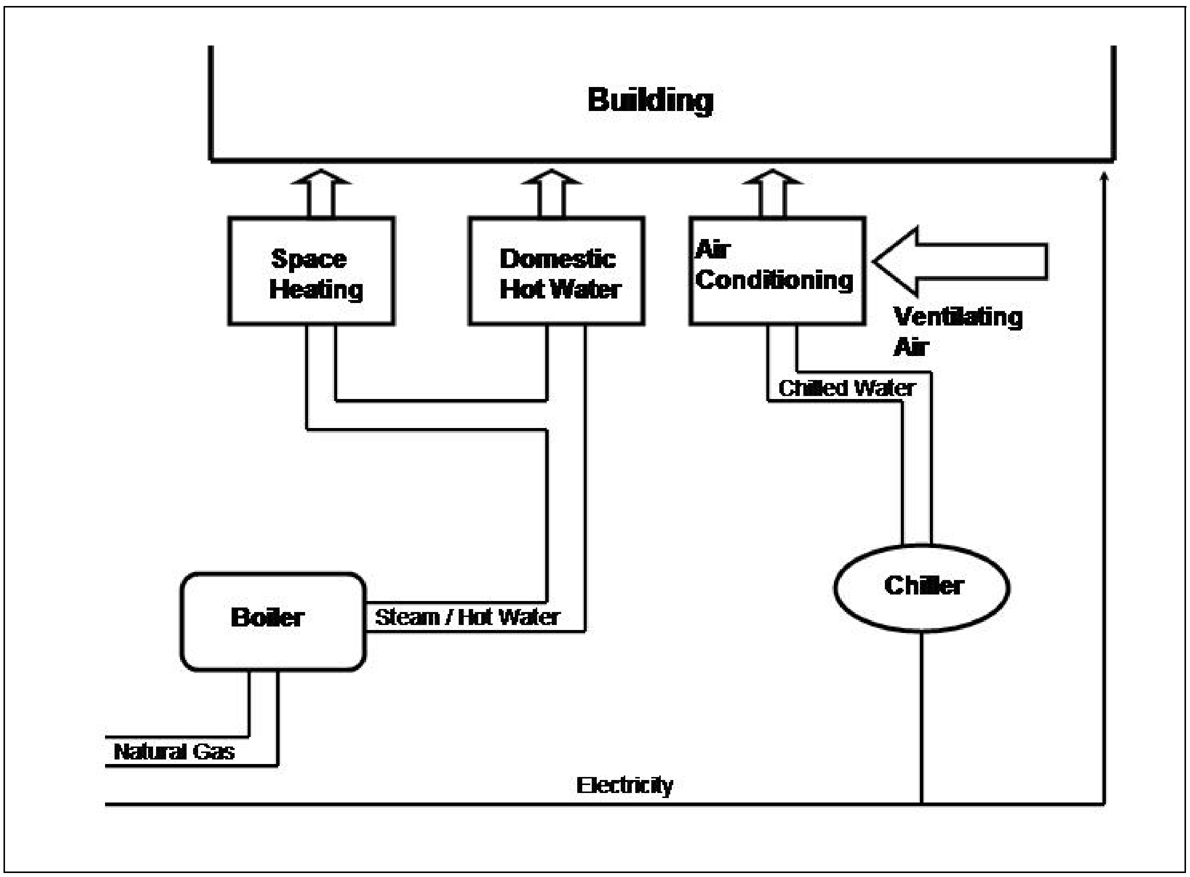


Figure 2.5. Diagram of conventional system for building (Modified from LeMar, 2000).

CHP systems may use reciprocating engines (pistons moving back and forth), turbines, or fuel cells in the generation of electricity. Each of these installations discharge thermal energy as illustrated in Figure 2.6. Table 2.4 (from LeMar [3]) lists cost and performance information for each alternative.

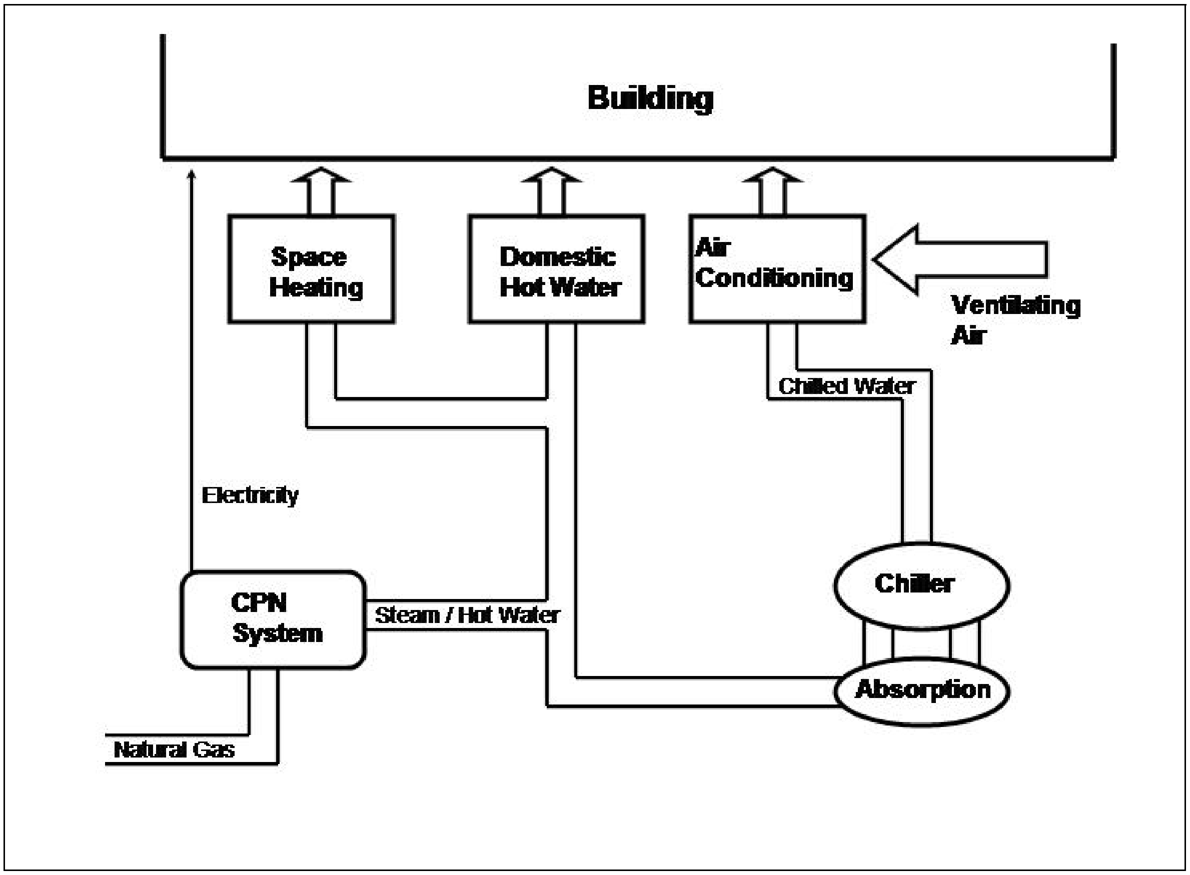


Figure 2.6. Diagram of CPN system for building (Modified from LeMar, 2000).

Table 2.4. Costs and performance of types of CHP systems (from LeMar, 2002).

Technology	Engine	Turbine and Microturbine	Fuel Cell
Size	30 kw – 8 MW	30 kW – 20+ MW	100 – 3000 kW
Installed Cost	300 - 1500	350 - 1500	2000 - 5000
Elec. Efficiency	28 – 42%	14 – 40 %	40 – 57%
Overall Efficiency (With CPN)	~80 -85%	~85 – 90%	~80 -85%
Variable Operating and Maintenance ($ / kWh)	0.0075 – 0.02	0.004 – 0.01	0.002 – 0.05
Footprint (sqft / kW)	0.22 – 0.31	0.15 – 0.35	0.9
Fuels	Diesel, natural gas, digester gas, biomass gas	Natural gas, diesel, kerosene, naphtha, methanol, ethanol	Natural gas, propane, digester gas, biomass gas

Although both diesel engines and natural gas (spark ignition) reciprocating engines are in use, natural gas engines are able to more easily satisfy revised emission regulations. In urban areas, reciprocating engines are sometimes placed in sound enclosures because the generated noise becomes an issue. Installed costs generally exceed the corresponding costs for turbines but fall below the current costs of fuel cells. Installed costs vary significantly based on size, configurations, and other parameters related to a particular site.

Combustion turbines offer lower emissions and maintenance costs. These turbines are generally used to produce a continuous supply of electrical power and steam/hot water. With longer startup times compared to reciprocation engines, turbines are generally not used for emergency or intermittent peak power demand.

Fuel cell costs are the highest of the three above choices. As explained elsewhere in this report, current and future research in fuel cell technology may make them more attractive in the future.

CHP systems are more economically feasible where electric utility rates are high and the price of natural gas is low. Coal-fired plants in Oklahoma make electric utility rates relatively low, and the price of coal is very stable compared to other fuels such as natural gas. This situation makes CPN systems less attractive in Oklahoma than some other areas in the United States.

3. Response to Proposal Objectives

3.1 Objective One

Set a baseline assessment for the Citizen Potawatomi Nation and create an energy vision.

3.1.1 Baseline assessment of where tribe is now.

CPN is transitioning into active procedures to implement methods of reducing energy usage and costs. Plans are to install energy-saving geothermal heat pumps into tribal housing projects and in the new Heritage Center. In addition, the tribe is actively pursuing the reduction of energy costs through possibly changing electric service levels of operation (ownership levels).

This DOE grant testifies that an energy plan is needed and desired by the CPN. A vision and energy strategic plan is required to efficiently proceed, and this grant provides the funds to move from where they are to where they want to be.

Section 3.2.1 of this report contains information regarding the current facilities assessment.

3.1.2 Create an energy vision of where tribe wants to be.

Considerable planning and evaluation is required to proceed to the point of creating an energy vision. Some techniques are available to assist in having a broad window from which to view the options. A method was found in [10] that was applied to land and minerals which was modified to apply to this project. It is included in Appendix 6.1. In this Appendix is an example of evaluating geothermal heat pump characteristics and applications as a potential part of planning, leading to creating a vision for the Citizen Potawatomi Nation.

As energy options are presented, then the assets are weighed to determine the vision that satisfies the characteristics and resources available to the CPN. Even though the vision encompasses breadth of activities, it is focused on a direction that can be accomplished. With respect to CPN, we see the leadership, the desires and the resources being aligned with a vision of reducing energy and creating energy related businesses.

3.2 Objective Two

Perform energy efficiency analysis on opportunities which exist to reduce overhead and increase the efficiency of energy consuming devices, improving the design of the overall system, switching to a more efficient system, improving control of the system, improving maintenance, and reducing demand of CPN buildings.

3.2.1 Baseline energy assessment of CPN facilities.

Information has been gathered for some of the facilities that have potential for improved energy savings and cost reduction. These facilities are listed in Table 3.1 along with some of the systems that relate to energy consumption. Entries in the tables are with the higher energy consumers listed first and descending to the lower consumers. The first four are the greater consumers by a significant amount. CPN HVAC systems are dominated by Pack units, which normally have a low first cost, but a high operating cost. Other conventional systems, such as through wall air conditioning units and gas furnaces are found in the facilities. None of these are high efficiency systems so there is a potential to reduce energy consumption. Since the lights are primarily florescent bulbs the potential to make significant energy changes with lights is very small relative to the changes that can be made with HVAC systems.

Table 3.1. List of building systems and features for key CPN facilities.

CPN Facility Summary of Key Systems												
Building Name	**Building Area**	**Pack Units Gas/Elect.**		**Furnaces**		**Chillers or A/C Units**		**Heat Pumps**		**Cooling Towers**	
	Sq. Feet	Total No.of Units	Cumulative Capacity	Total No.of Units	Cumulative Capacity	Total No.of Units	Cumulative Capacity	Total No.of Units	Cumulative Capacity	Total No.of Units	Cumulative Capacity
FireLake Disc. Foods	82,000	12	clg, 204 tons htg 3088 MBtuh	9	Electric Fan Coil Unit 478 MBtuh	4	270 tons	0		4	765 tons
Casino Bingo Hall	 80,000	11 14	168.5 tons 115.5 tons	2 1	60000 Btuh 36000 Btuh	2 3	5 tons 9 tons	0 0		0 0	
Headquarters	60,600	22	196.5 tons	0		47	58 tons	0		0	
Wellness Center, Title VI- Wellness Ctr.	21,000	0		1	Boiler, 1058 MBtuh	0		31	24.3 tons	1	?
Clinic	25,700			2	240000 Btuh	4	20 tons	?	?	0	
Clubhouse/Restaur.	?	0		3	300000 Btuh	3	15 tons	0		0	
Kickapoo St. Warehse	?	0		4	1400 MBtuh	0		0		0	
Taj/Engr.	11,400	0		9	1088 MBtuh	9	60.7 tons	0		0	
Golf-1 Water Well	Water Well-Only a pump and motor (7.5 HP motor, pumps 55 gpm)										
Police Station	3,000	3	11.5 tons	0		0		0		0	
Pow-Wow Grds. Reunion Hall-N Reunion Hall-S	 6,255 4,817	 0, 0		 1, 1	 24,000 Btuh 24,000 Btuh	 1, 1	 2 tons, 2 tons	 0, 0		 0, 0	
Former Grocery Store	All equipment was being removed from the store--therefore no evaluation										

Table 3.1. List of building systems and features for key CPN facilities continued.

CPN Facility Summary of Key Systems											
Building Name	**Energy Recovery Wheels**		**Hot Water Units**			**Food Preservation /Preparation**		**Lights**	**Other**		**Observations**
	Total No.of Units	Cumulative Capacity	Total No.of Units	type	Cumulative Capacity	Total No.of Units	Cumulative Capacity	Type			
FireLake Disc. Foods	0		1	gas	100g 199MBtuh	64	106.5 tons	mercury v.			
Casino	1	?	5	elec	3ea/50gal	2	0.65 tons	florescent		slot mach.	
Bingo Hall	1	?	4	?	2ea/20 gal	1	0.52 tons	florescent	750 ea.	30.7 tons	
Headquarters	0		?			0		florescent			
Wellness Center, Title VI- Wellness Ctr.	0		1	gas	725,000 Btuh	2	Walk-ins, 18,000 Btuh	florescent			
Clinic	0		1	gas	75,100Btuh 68.3 gal	0		florescent			Dryvit walls need repair
Clubhouse/Restaur.	0		1	gas	75,100Btuh 68.3 gal	Freezers, walk-ins, ovens, etc.	Unknown	florescent			
Kickapoo St. Warehse	0		0			2 walk-in C 3 walk-in F	5.8 tons 19.6 tons	mercury v.			
Taj/Engr.	0		2		34 MBtuh 40g 72 MBtuh 75g	0		florescent			
Golf-1 Water Well	Water Well-Only a pump and motor										
Police Station	0		1	elec.	1500 Watts	0		florescent			
Pow-Wow Grds. Reunion Hall-N Reunion Hall-S	0, 0		2, 2	elec. elec.	11000 Watts 11000 Watts	residential Refrig & Rng	Unknown, Unknown	florescent, florescent			
Former Grocery Store	All equipment was being removed from the store--therefore no evaluation										

To enable a quantitative comparison of the area systems, the electric data will be used from 11 buildings. Figure 3.1 shows the total electric service costs for a month related to the electric usage for eleven facilities at CPN. As seen in the figure, the four greatest electric consumers are FireLake Discount Foods, Casino, Headquarters and the Bingo Hall. The energy costs for Firelake Discount Foods is about twice as high as the Casino, and over three times as high as the Headquarters. The remaining seven are grouped at less than about one-tenth of the Foods store. The significance of this figure is two-fold, one it shows the facilities with the highest absolute total electric costs, and the other is that the seven facilities increase in cost with an increase in kWh usage at a higher rate than the four with the greatest total electric costs. This information implies that even though CPN pays a higher rate for facilities with lower electric consumption, it is more important to focus on the high electric consumers.

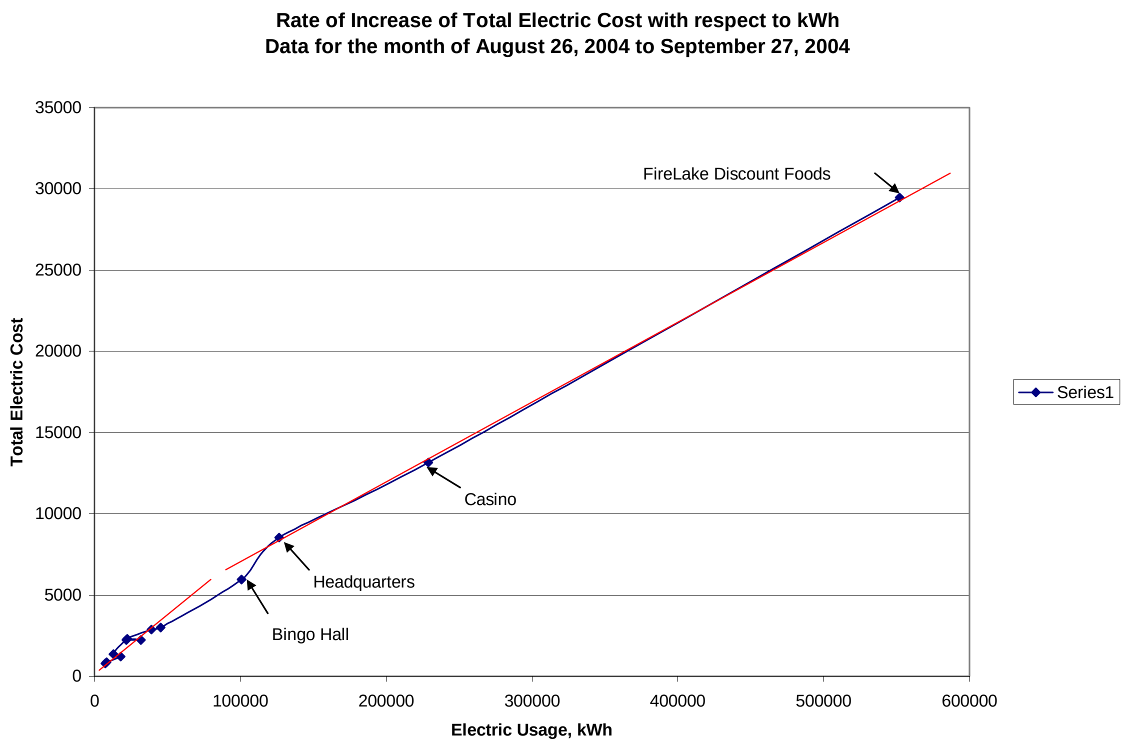


Figure 3.1. Electric consumption relative rate costs for eleven CPN facilities.

It is helpful to know the seasonal effect associated with the facilities. Figure 3.2 is a graph of total electric service cost for a 13-month period for the four highest energy consumers. It shows that all the facilities have a higher cost in the summer. This is deceiving in some respects since other features can cause this rate change other than electric usage. Demand charges and fuel adjustment charges both have a significant effect on the cost. Reviewing Figure 3.2 shows the costs for FireLake Discount Foods facility increases by about $13,000, from lowest to highest costs, which appears to be seasonal. But by reviewing Figure 3.3, it is seen that about $8000 of that could come from an increase in demand and fuel adjustment costs, so the difference is not all seasonal. Also, by looking at Figure 3.3, the variation in the usage, which is read off the right axis, shows about a 25% variance between winter and summer. This information is indicative of systems that are governed by internal gain, not so much seasonal. On the contrary, by viewing Figure 3.2, it is seen that the summer cost for the Casino is almost 8.7 times higher than the winter costs, showing a strong seasonal dependence. These features help direct attention to source of influence.

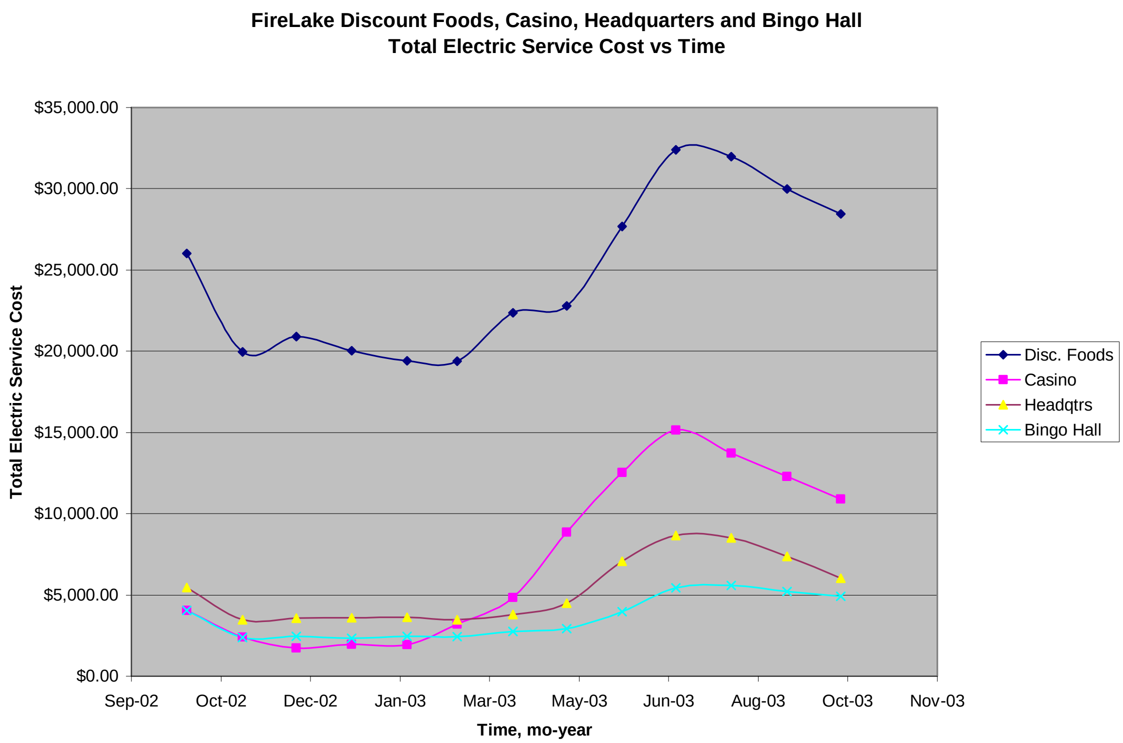


Figure 3.2. Total electric service costs for a period of 13 months for CPN's four highest consumers.

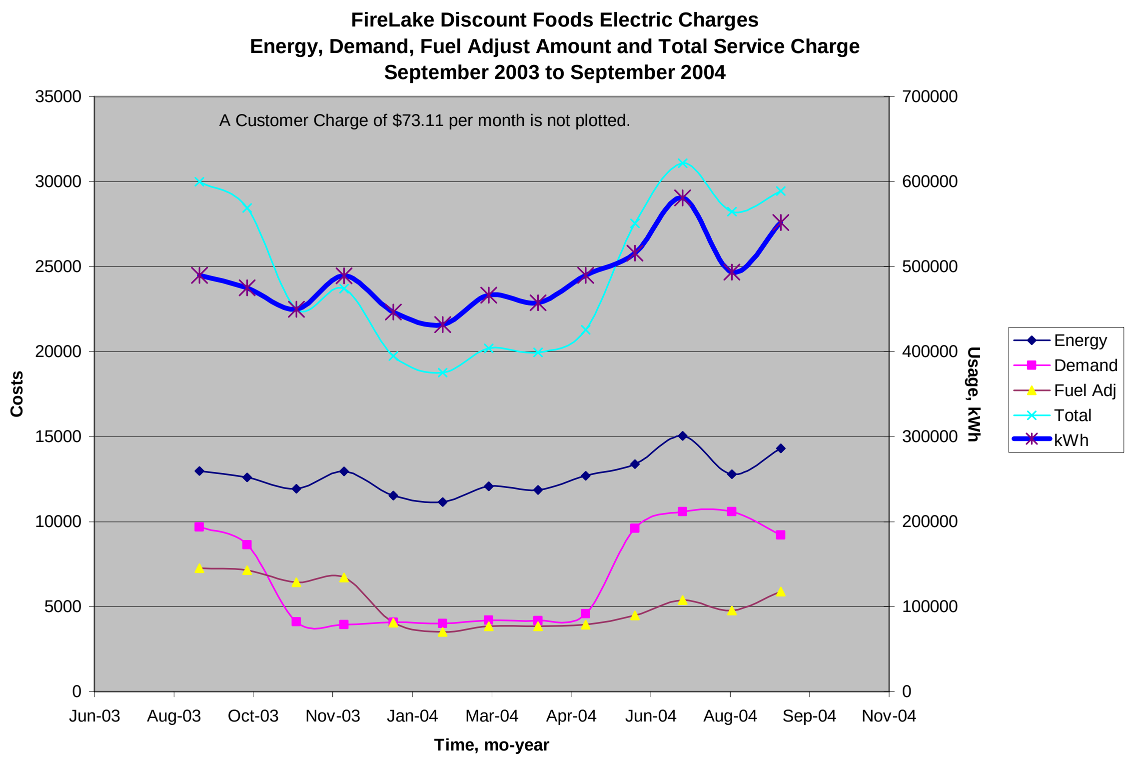


Figure 3.3. Costs and Usage relationships for FireLake Discount Foods' electric, 2003 and 2004.

Knowing the FireLake Discount Foods facility is primarily from internal gain, leads to the conclusion that any energy leaving the building is from system operation. By reviewing the system in the FireLake Discount Foods shows there are four evaporative condensers and these would be continually venting heat energy to the atmosphere. A relative constant supply could be counted upon to provide heat to another building or some process that required heat for a profitable enterprise. It is profitable to save energy, and one way to do it would be to replace the gas heat with heat that would be vented by the evaporative condensers. Gas consumption is plotted in Figure 3.4 and FireLake Discount Foods' consumption for the winter of 2002 and 2003 is sufficiently high to save on the order of $40,000 a year.

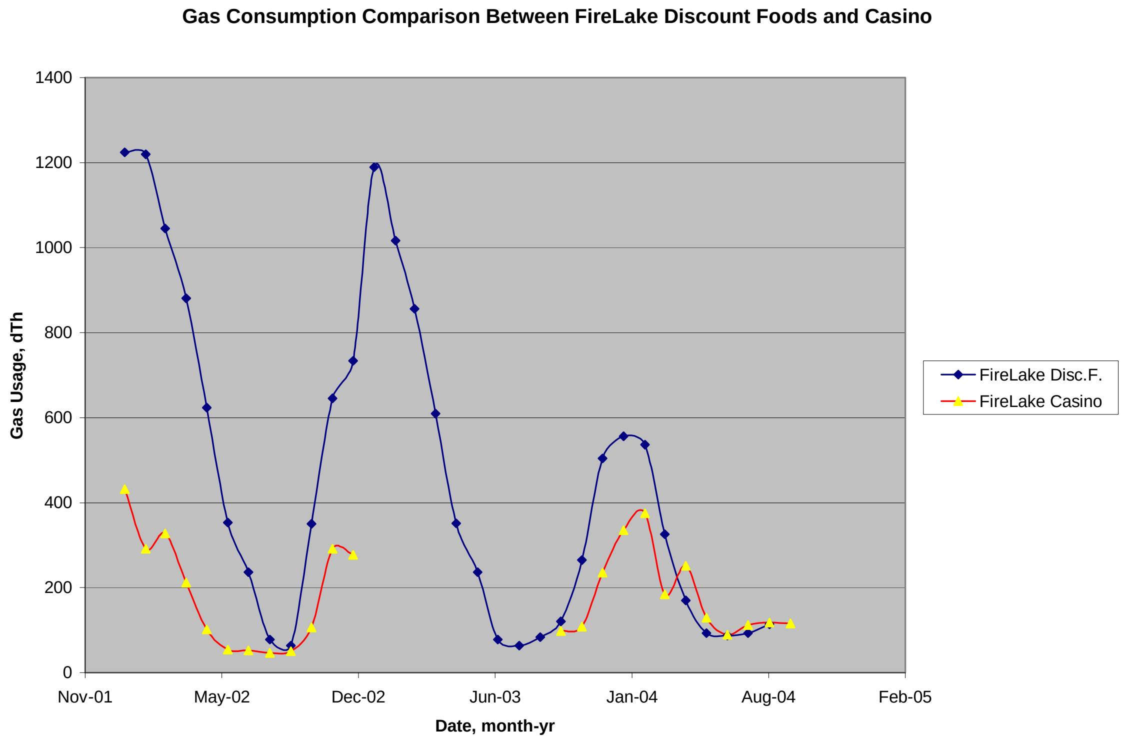


Figure 3.4. Gas consumption as a function of time for FireLake Discount Foods and the casino.

3.2.2 Identification of energy efficiency devices that could be implemented in CPN facilities.

The introduction of energy efficient lighting should be explored in the CPN buildings. Newer fluorescent light systems may potentially have energy savings of up to 44% compared with conventional fluorescent systems [11].

The removal of cigarette smoke in then Casino requires ventilation with outside air. The most current engineering information should be reviewed for designing such ventilation requirements [12, 13].

3.2.3 Preparation of cost benefit analysis of energy efficiency practices and technologies proposed for implementation.

Cost benefits are dependent upon the resources available and the maturity of the practices and technologies to be considered. Examples are the current tribal housing project, the new Heritage Center, the concept of an energy bank with the energy from FireLake Discount Foods, and the biomass plants. All these topics are covered in more detail in other sections of the report.

The tribal housing project leaders found that changing from conventional HVAC units for the housing and replacing them with geothermal heat pump units would save operation costs on the order of 35%. Initial plans were to use vertical boreholes and the source side energy for the heat pumps. Then becoming knowledgeable of horizontal boring and eliminating or reducing grout costs gave them another approach that could be done with CPN personnel and equipment, which reduced the installation cost significantly.

The new Heritage Center was planned with geothermal heat pumps to heat and cool the building. Again, the plan was to use vertical boreholes to provide energy to the source side of the heat pumps. Subsequently, it was determined that with the ponds in the golf course and well water being pumped into them continuously provided a large savings by changing to pond loops. The difference in costs between vertical boreholes and pond loops was estimated to be more than 75% savings.

The concept of an energy bank, energy going in and energy being taken out, would take advantage of the excess heat being rejected from FireLake Discount Foods A/C chiller racks and refrigeration racks. Rather than waste the heat into the atmosphere, as is currently being done, the heat would be directed to an energy bank; in this case a pond and or businesses that use heat energy. The four racks have a capacity to reject 6,437 MBtuh of energy to a process that is beneficial. Whenever a waste is turned into an asset, it can be assured that considerable profits are highly possible. The combinations of the waste heat being available, a water source on site, space to place a pond or a business or both and the technology to do it is what makes this viable.

A biomass plant to convert Oklahoma grasses and crop residues to ethanol and other useful products at a cost between $60,000,000 and $170,000,000, is too large an investment, and the process is still in its development stage. In maybe 7 to 10 years this process developed by Okalahoma State University researchers will be in the production phase. The economics projected are promising, and an opportunity exists in the future for the nation to consider growing and trucking the biomass to a local commercial facility. In this example, it is seen that the technology is not yet available, but it is a potential for CPN to be in a business associated with biomass conversion.

3.3 Objective Three

Conduct an analysis and evaluate feasibility of biomass resources, geothermal resources, propane gas and natural gas distribution systems, and the future of hydrogen and fuel cells in the areas of production, transportation, and storage of large quantities.

3.3.1 Baseline assessment of biomass, geothermal, hydrogen/fuel cell resources, propane and natural gas distribution systems on CPN lands.

- Biomass

Discussed in 2.2.1 Growing, harvesting and transporting biomass to gasification-fermentation plants being developed by OSU researchers.

- Geothermal Energy

Conclusions

The potential for using underground resources of steam or hot water exists in western states but not Oklahoma. Ground-source heat pumps (sometimes called geothermal heat pumps) are a viable technology in Oklahoma.

Discussion

Developments of geothermal resources can be placed into three categories [6, 14] based on the temperature of underground resources of steam, hot water, or rocks:

1. electric power production with high temperatures greater than 300 ºF.
2. intermediate to low temperature applications using underground temperatures less than 300 ºF.
3. ground-source heat pump applications with underground temperatures below 90 ºF.

In the first category, electric power is produced using underground steam or hot water taken from wells. The steam flows through turbines above ground to generate electricity. Historically, electric generation generally required underground resources above 300 ºF. Under favorable circumstances, however, some power plants have generated electricity economically with underground temperatures above 230 ºF.

In the second category, underground hot water is used directly for spatial heating in greenhouses, spas, commercial buildings, or homes. The underground water may also serve for other domestic uses.

Finally, geothermal heat pumps (in the third category) use the near-surface soil and rocks as a heat sink or source for space heating and cooling.

As illustrated in Figure 3.5, the hottest geothermal resources are in the western states, as well as Alaska and Hawaii. None of the resources identified by Lineau et al [15] are located in Oklahoma. Therefore, the potential for geothermal energy in Oklahoma is limited to ground-source heat pumps in category three. These applications are discussed in other sections of the present report.

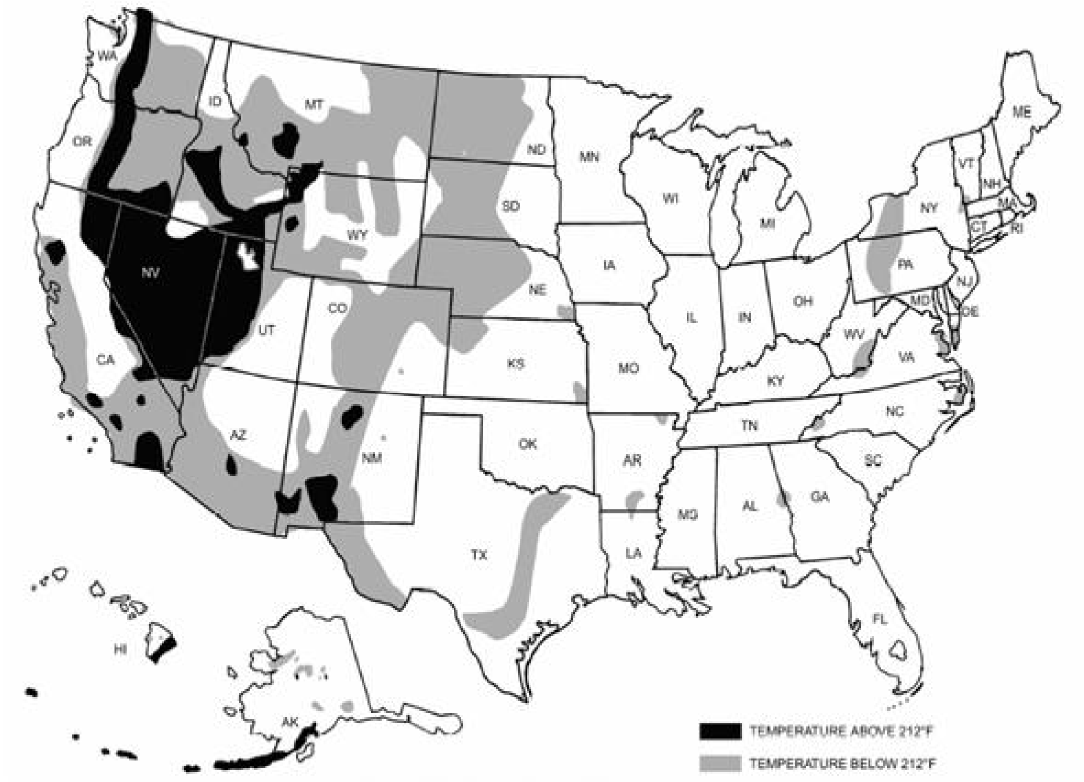


Figure 3.5. Geothermal resource areas in the United States (Lineau et al, 1995).

- Hydrogen/Fuel Cell Resources

Discussed in 3.3.7 Analyze Manufacturing and Production Technologies in the Areas of Hydrogen/Fuel Cells, Natural Gas and Propane Distribution.

- Propane Distribution Systems

<u>Conclusion</u>

A potential exists to become involved in a propane distribution company but for the level of investment required and the trend to replace the high priced fuel with geothermal heat pump systems it would be risky.

<u>Discussion</u>

The following is an excerpt from a report to the New Jersey Propane Research & Education Foundation [16].

“The propane distribution and retail sales business in New Jersey has a significant number of small firms, essentially "mom & pop" operations. Many of these have 15 or fewer employees. At the same time, other propane distribution and retail sales businesses employ hundreds. This makes the creation of a general description of the entire industry difficult. Our sample covers 42% of all businesses in the industry, excellent coverage, but the extreme variations in firm size present several complications”

This gives the picture that often propane distribution is for small firms that can prosper from this type of business. They also quoted the following:

"Wholesale and Retail activities in this region have strong forward and backward linkages. Each $1 million spent on propane goods, materials and services at the wholesale level, will create 3.3 direct jobs, and each $1 million spent at the retail level will create 19.9 direct jobs. Because of the nature of the propane industry, distribution methods, capital intensity, etc. it is very logical that wholesale-related activities will generate fewer jobs than retail related activities. This is true across the board for all businesses in New Jersey and the region."

Therefore, implying that for CPN, it would create approximately 19.9 direct jobs for each $1 million spent on propane goods, materials and services at the retail level. This is a good multiplier but it is not unique to propane distribution.

Appendix 6.5 contains an advertising article that shows that a franchise can be purchased for the distribution of propane [17]. It gives general information regarding the cost of starting a business which includes a franchise fee of $34,900 and total capital investment of between $64,000 and $174,400. With this type of investment and for the cost of propane increasing it would cause caution to become involved in this type of endeavor.

- Natural Gas Distribution Systems

<u>Conclusions</u>

An enterprise to install natural gas distribution systems would possibly have merit if the activity were focused upon the housing development area.

<u>Discussion</u>

A natural gas distribution system requires a range of talents to design, build and maintain and some companies do this as a turnkey operation. An example of a turnkey company is found in reference [18]. Design of the system would require a professional engineer to stamp the drawings. A design of the route, the pipe and compressor stations requires engineering applications of design equations. Accompanying these activities are surveying, easement acquisition and permit procurement. Detailed drawings and as-built drawings are required to convey the design to the construction team.

Keeping the project on schedule and procuring the materials in a timely manner is some of the duties of the construction team. Supervisors, equipment operators and pipe crews work together to complete the installation of the systems. Front end loaders and backhoes, dozers, cranes, horizontal boring equipment, pipe fusion equipment are some of the equipment required to do the job. Installations of metering systems, performing leak detection and repairs before placing the system in operation are required.

Maintenance of the systems requires being on call day and night in the event of an emergency. The personnel must be qualified to detect leaks and repair the system to keep the public safe. Additions to the piping system sometimes require hot taps to minimize downtime.

Citizen Potawatomi Nation could benefit in applying the following approach to installing pipelines and utilities. A technique to install natural gas systems in housing development projects is called a joint trench [19]. Joint trench is putting five utilities in one trench. Water is the deepest, and then at about four feet, there are pipe laid or cable laid for electric, cable TV, and telephone. These three utilities are at a lateral separation in the trench. At about two feet deep is the natural gas line centered above the utilities. Planning for this takes a coordinated effort. After the right away is defined and the distribution of the utilities has been made, then the material is warehoused so it will be on hand for timely and efficient installation of the utilities. From the main and branch joint trenches the utilities are pulled into the house/buildings and connected without cutting through other lines.

Considerable equipment and talent are required to embark on an enterprise to design, install and natural gas distribution systems. A study has not been done to determine the number of systems is installed over a year's time to estimate if the potential exists to pursue this large of commitment. Visual observations indicate that the potential to install gas lines in housing developments might be done sufficiently frequent to merit some consideration.

3.3.2 Baseline assessment of microturbine.

Conclusions

The benefit of using microturbines is the greatest when waste gas is used as energy source and the hot exhaust gas is used for heating water or other purposes. Microturbines can also be very effective for shaving peaks. A few microturbine models are available, and the specifications of five models are listed in this report. The reasonable range of capital investment for installation of microturbines is $1200-$1400 per kW. The efficiency of microturbines decreases when the ambient temperature increases or when the load is less than the design value.

Background

The term "microturbines" indicates gas turbines in the range of 5 - 200 kW [20] or 20-500 kW [21], though these definitions are arbitrary. Development of small gas turbine generators began in the 1960s mainly for ground transportation. A successful example was the Allison GT404 turbine engines installed in six Greyhound buses and operated from 1971 to 1978 (www.shomepower.com/dict/m/microturbine.htm). But it was in the late 1990s when microturbines emerged as a new on-site power generation technology [22]. A schematic of a typical microturbine system is shown in Figure 3.6. Essential elements of a gas turbine generator include a compressor, combustion chamber, turbine, and generator. It is a common practice to include a recuperator in order to increase thermal efficiency of the system. A few highlights of microturbines include:

- Efficiency: Thermal efficiencies of microturbines approach 30%.
- Reliability: Maintenance intervals are 8000 hours or longer.
- Success stories: There are numerous success case stories. In a metal plating facility, for example, the projected payback period is only four years.
- Distributed power: Microturbines can shave peaks economically and provide power in emergencies.

- Cogeneration applications: Both heat and power can be utilized for maximum efficiency in a variety of facilities such as restaurants, hotels, residential care facilities, and small factories.

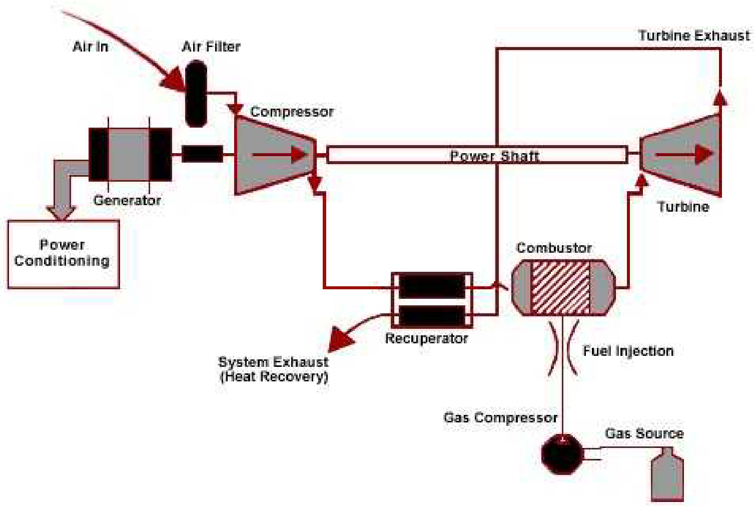


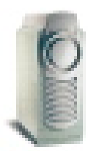
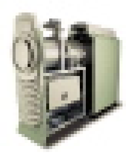
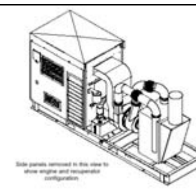
Figure 3.6. Schematic of microturbine system (www.globalmicroturbine.com).

Available models and prices

Based on web search, it appears that there are three major brands of microturbines: Capstone (C30 and C60), Elliott Power (TA80R), and Ingersoll-Rand (IR 70 and IR250). Shown below in Table 3.2 is the comparison of five models. The prices of the first three models (C30, C60, TA80R) do not include the costs of the gas compressor ($10,000+) or the heat recovery units ($15,000+) for cogeneration. Each Ingersoll-Rand unit includes a gas compressor and a built-in integral hot water recovery unit. Basic units are configured as grid-connected, and stand-alone units cost more. Yearly (8,000 hr) maintenance requires simple changes of air and gas filters. Some additional specifications of TA80R are listed in Table 3.3.

Table 3.2. Comparison of microturbines (www.globalmicroturbine.com, www.gensets.com/magturbo11.htm).

Unit	Capstone C30	Capstone C60	TA80R	Ingersoll-Rand IR70	Ingersoll-Rand IR250
Output (kW)	30	60	80	70	250
Fuel consump. (cf/hr)	411	804	976	949	2980
Fuel consump. (BTU/hr)	411,000	804,000	976,000	949,000	2,980,000
Exhaust energy (BTU/hr)	310,000	541,000	716,000	689,000	2,170,000

Design life (hrs)	50,000 (or 80,000)	50,000 (or 80,000)		80,000	80,000
Unit Cost	$35,500	$55,500	$71,000	$100,000	$300,000
Cost per unit life per kW	$0.0173	$0.0167		$0.0143	$0.0125
Overhaul cost at end of life	$5,000	$15,000		$15,000	$60,000
Picture					
H x W x D (in)	75 x 28 x 53	82 x 30 x 76	52 x 32 x 110	69 x 42 x 87	126 x 76 x 79
Weight (lb)	1050	1340	1890	4850	11,700
Availability/ Uptime	> 95%	> 95%			
Efficiency with heat utilization	70 - 90%	70 - 90%			
Heated water				Max. 30 gpm, max. 180 F	Max. 100 gpm, max. 180 F
Voltage output	400-480 VAC, 50/60 Hz	400-480 VAC, 50/60 Hz	480 VAC, 50/60 Hz		
Fuel pressure	75-80 psi	5-55 psi	78	< 75	< 200
Start up	2 minutes	2 minutes			
NOx emissions	<9 ppm at 15% O_2	<9 ppmV at 15% O_2	< 25 ppm		
Noise	65 dBA @ 10 m (with optional silencer)	58 dBA @ 10 m (with optional silencer)		58 dBA @ 10 m	58 dBA @ 10 m
Maintenance	Filter change @ 8,000 hrs; temp. sensor & igniter @ 16,000 hrs	Filter change @ 8,000 hrs; temp. sensor & igniter @ 16,000 hrs			
Warranty service	1 yr; 8,000 hours	1 yr; 8,000 hours			
Gas compressor & heat recovery unit	Optional	Optional	Optional	All inclusive	All inclusive

Note: 1 Therm = 10^5 BTU, 1 ft^3 of gas = 10^3 BTU

Table 3.3. Additional specifications of TA80R (www.gensets.com/magturbo11.htm).

Item	Description
Standard Equipment	80 kW Gas Turbine 4 Pole Permanent Magnet Generator 80 kW Synchronous Output Inverter Push Button Start/Stop Automatic Voltage Regulation 24 VDC Stand Alone Start System 24 VDC Electrical System Battery Charger
Main Stator	The Stator is a conventional copper wound design which is oil cooled and mounted into a common casing with the turbine and compressor assembly.
Main Rotor	The Alternator Rotor is a permanent magnet four pole design which is pressed onto the rotor assembly. A carbon fiber sleeve is used to retain the rotor magnets.
Inverter	The Inverter rectifies the 2267 Hz AC voltage produced by the alternator into 550 - 650 VDC unregulated . It then converts the DC voltage into 50Hz or 60 Hz 480 VAC
Exhaust Gas	550°F, 1410 scfm
Exhaust Emissions, Natural Gas	CO: < 30 ppm, NOx: < 25 ppm
Batteries	(qty. 2) 12V min. 850 (CCA)

Effect of Ambient Temperature on Performance

Microturbines are rated at the ISO condition (sea level, 15 deg. C). At elevated temperature conditions, the power factor, defined as the ratio of the power to the rated power, degrades. An example study indicates that the power factor starts to decrease when the ambient temperature reaches approximately 30 deg. C (Figure 3.7). The same figure shows that the turbine efficiency monotonically decreases with temperature. The reduced density of air and that of fuel are the main causes of reduced performance at high temperatures [22]. The performance characteristics of Ingersoll-Rand models in regard to the change in the ambient air temperature are shown in Figure 3.8 and Figure 3.9. Note that during hot summer days, both the maximum power and the efficiency can be substantially lower than manufacturer's specifications.

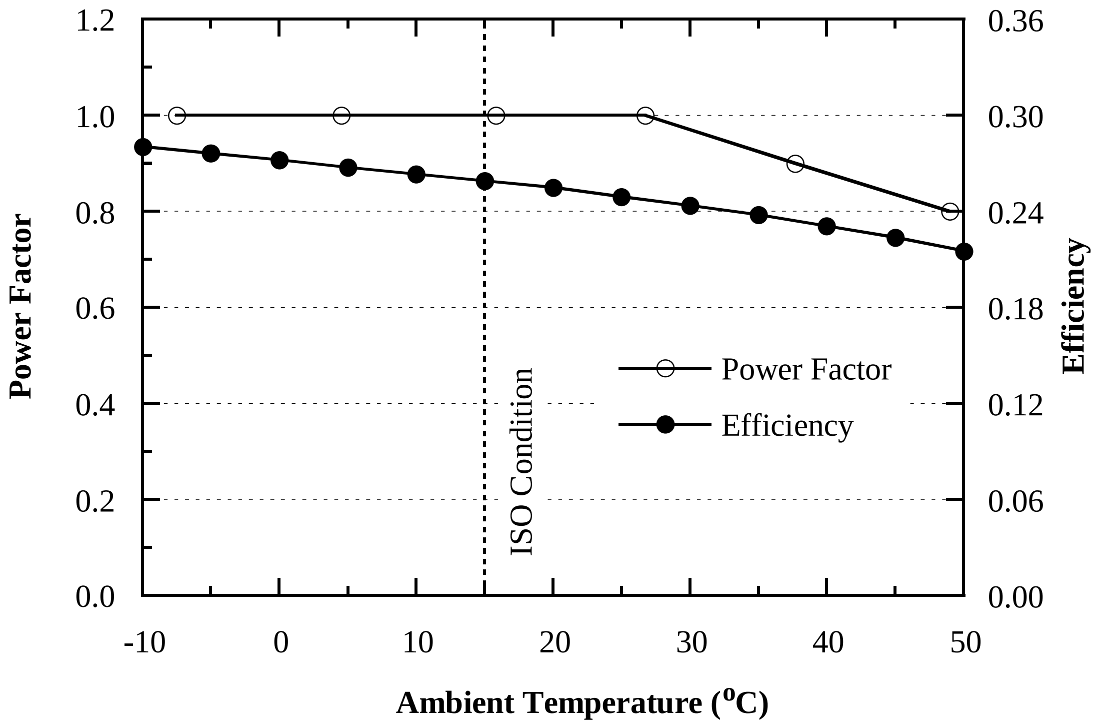


Figure 3.7. Effect of ambient temperature on power factor and efficiency (reproduced from Cowie, Liao, & Radermacher (2003)) [23].

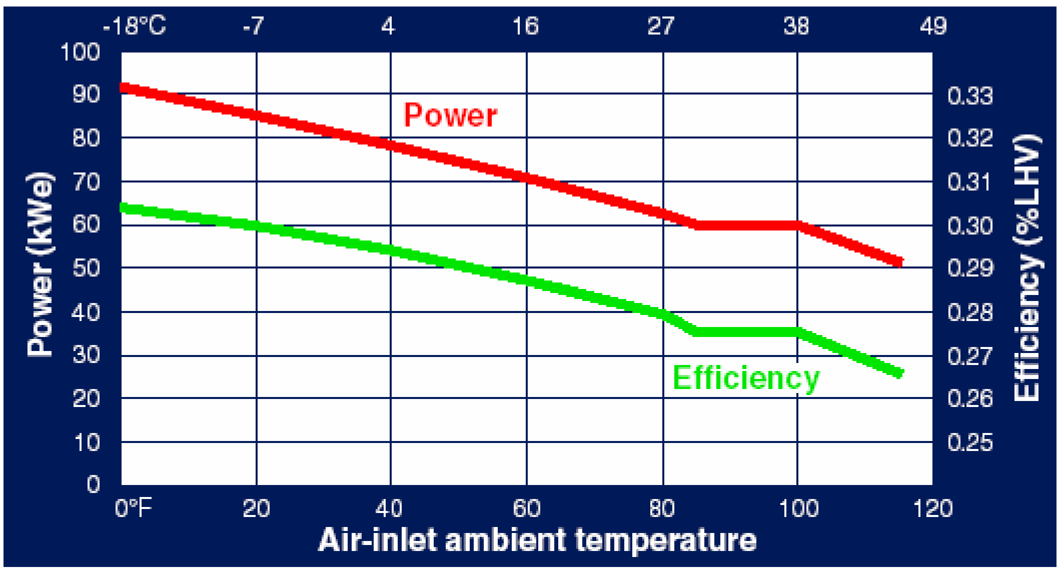


Figure 3.8. Electric output and efficiency of IR70.

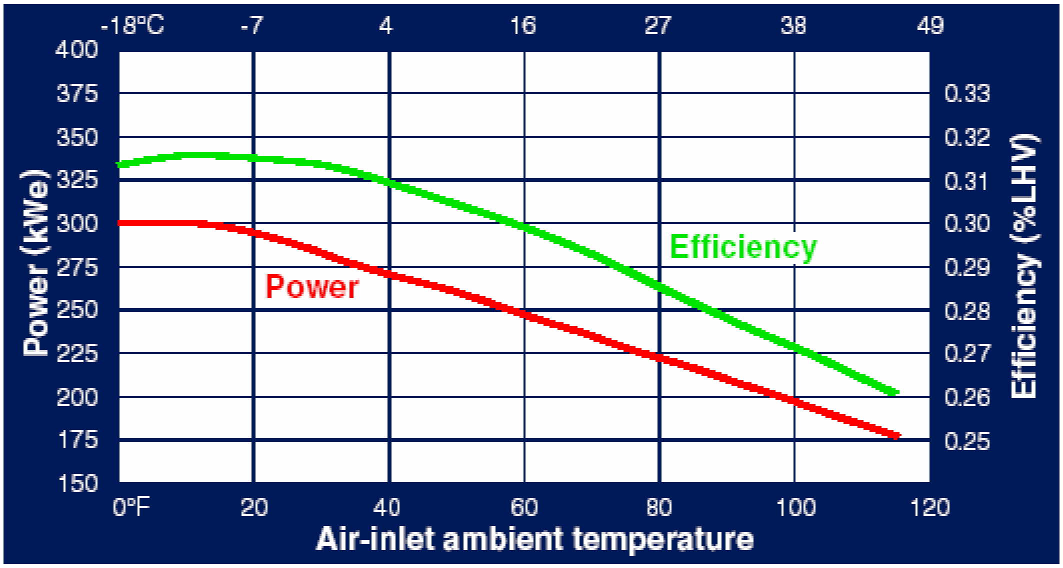


Figure 3.9. Electric output and efficiency of IR250.

<u>Effect of Load Condition on Performance</u>

The efficiency of a microturbine decreases when the load is less than the design value. A study shows that the efficiency ratio (efficiency at lower load divided by the efficiency at full load) stays above 0.9 when the load is higher than 50% of the full load, but it degrades dramatically when the load drops further. It is important, therefore, to properly size the microturbine so that the load factor is always higher than 0.5.

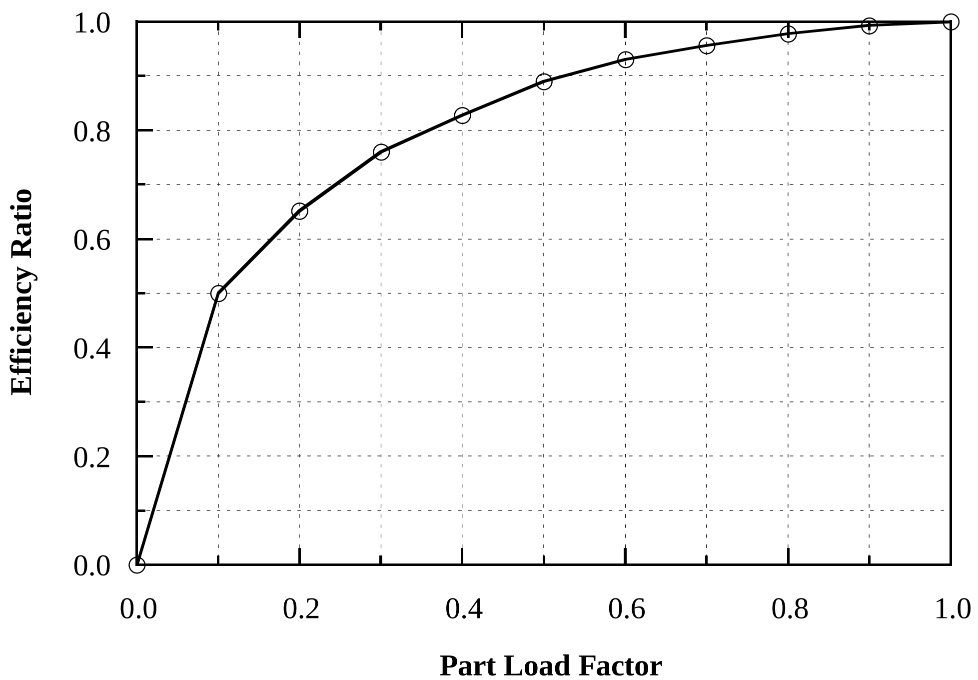


Figure 3.10. Effect of part-load condition on efficiency (reproduced from Fairchild, Labinov, Zaltash, & Rizy (2001)) [24].

3.3.3 Initial feasibility analysis, production potential, and identification of biomass plant operators and waste brokers of biomass fuels.

Discussed in 2.2.1 Growing, harvesting and transporting biomass to gasification-fermentation plants being developed by OSU researchers.

3.3.4 Cost benefit analysis and feasibility of installing geothermal heat pumps in all new tribal facilities and housing projects.

Savings are higher now than ever before with geothermal heat pump systems because of the continued increase in efficiency of the units and the very high cost of energy. Technology and present economics indicate that even the retrofit systems into existing buildings are very favorable. In addition, the high potential of CPN having, owning, and operating a geothermal heat pump business would provide a basis for saving even more on costs and also provideg tribe members with jobs. With technology, equipment and personnel available and training to show the tremendous options CPN has because of their natural resources, there would be no reason not to become actively involved in installing systems that can save from 20 to 50 percent in cost.

A business plan is presented in this report to develop a CPN geothermal heat pump business. Included are requirements to accomplish the plan.

3.3.5 Feasibility of creating a geothermal tribal enterprise.

See New CPN Business Development discussion in 2.1.4 Geothermal heat pump business models.

3.3.6 Research involvement in Freedom CAR, Fuel Initiative, and Presidents' Hydrogen Fuel Initiative.

Conclusions

Hydrogen technologies offer no viable near-term economic opportunities for the Citizen Potawatomi Nation. The technologies need substantial changes to become economically competitive. Such changes will make current technologies obsolete.

Discussion

President Bush proposed a $1.2 billion Hydrogen Fuel Initiative during his 2003 State of the Union address. The initiative's goal is the development of cost-effective hydrogen fuel technology as a power source for vehicles, homes, and businesses. Anticipated benefits are reversing our growing dependence on foreign fossil fuels and using a clean energy source. The initiative encourages joint research projects among government and private groups.

The National Research Council appointed a committee [25] of scientists and engineers to assess the current and potential technologies that may lead to a "hydrogen economy." The name of the committee is Committee on Alternatives and Strategies for Future Hydrogen Production and Use.

This committee identified many technical problems, which need to be solved before the development of the "hydrogen economy." Significant cost reductions in fuel cells are required in addition to cost-effective methods to produce hydrogen. The committee anticipates a long transition period during which fuel cells in vehicles will not be economically competitive with conventional vehicles. The transition period may cover decades and require large amounts of investment. Thus near term opportunities for the Citizen Potawatomi Nation are very limited for hydrogen technology.

3.3.7 Analyze manufacturing and production technologies in the areas of hydrogen/fuel cells, natural gas and propane distribution.

Hydrogen/Fuel Cell Resources

Conclusions

If the initial cost of fuel cell systems continues to decrease in the future, they may warrant further study. Currently, the cost of electricity from fuel cells is substantially greater than electricity from utilities. The efficiency of a fuel cell system increases substantially if the generated heat is also used. A ground-source heat pump should be a good partner to take advantage of the generated heat.

Discussion

A fuel cell is generally defined as an electrochemical device that converts a supplied fuel to electricity and heat [26]. William Grove was the first to demonstrate a fuel cell in 1839. His hydrogen fuel cell produced a small electrical current by combining hydrogen and water to form water. The process is the reverse of electrolysis of water, in which a supplied electric current separates water into hydrogen and oxygen. NASA has used fuel cells for decades in their space program. During the last few decades research efforts have produced many different types of fuel cells [26]. The emphasis in this report is on light commercial and residential use of fuel cells to produce electricity, which is consistent with the needs of the Citizen Potawatomi Nation.

The major disadvantage of fuel cells has always been cost, which remains high relative to conventional utility costs for electricity. Still, the cost has dropped considerably in the last few decades. Currently, some demonstration projects for home use are underway. In particular, Delta-Montrose Electric Association [27, 28] has set up demonstration projects in western Colorado for some homeowners in rural areas, where the cost of running utility lines is significant. In this approach the electric utility's traditional customer generates electricity at their site.

The advantages of fuel cells include simplicity, low emissions, and low-noise level. Fuel cells have few if any moving parts, which leads to simple and potentially reliable systems. The main fuel cell reaction produces water, but the process of producing hydrogen from an available fuel (such as natural gas or propane) generates emissions of CO_2. Thus, the fuel cell system is not completely emission free. Fuel cells are very quiet, which is an important advantage for local power generation at homes.

The block drawing of a fuel cell system in Figure 3.11 includes several components. The fuel reformer extracts hydrogen from fuel such as natural gas, propane, methanol, ethanol, or some other fuel containing hydrogen. This hydrogen goes into a fuel cell stack along with air as an oxygen supply. The hydrogen and oxygen are combined in the fuel cell stack with electricity, water and heat as products. The generated direct current

(DC) electric power must be converted to AC power for use in the building. An electric power conditioner does the conversion.

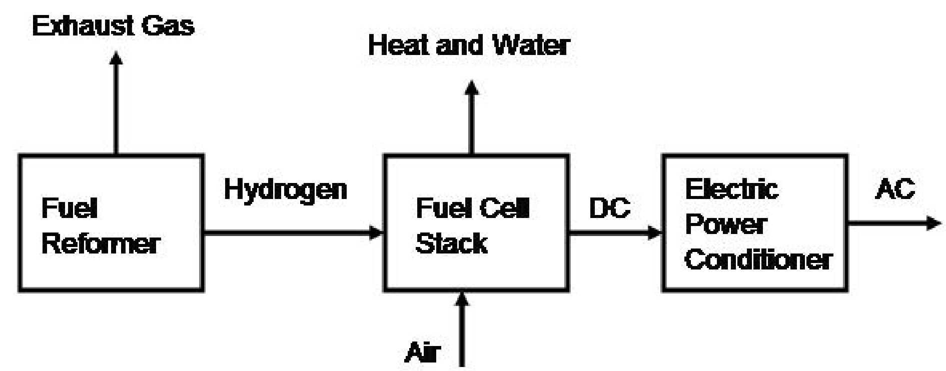


Figure 3.11. Diagram of fuel cell system.

Demonstration projects set up by Delta-Montrose Electric Association [27, 28] use fuel cell systems about the size of a 4-foot by 4-foot storage shed. The system contains all the components to convert natural gas or propane to electricity. The fuel cells use a polymer exchange membrane (PEM) technology [26].

Bony [28] gives some cost estimates for electric power for residential systems in Table 3.4. Because the initial cost of the fuel cell system is an important component and changing, Bony gives two different values. For the lower initial cost, the fuel cell produces electricity at $0.277 / kWh, which is still well above current utility cost. If the residence is at a location without electric lines, Bony argues the actual utility cost becomes higher.

Table 3.4. Cost of electricity from fuel cell system (Bony, 2004).

Fuel Cell 1st Cost	DMEA $/kWh (800 kWh)	Fuel Cell $/kWh (800 kWh)	Fuel Cell $/kWh (1,200 kWh)	California $/kWh Pre-Summer
$17,000	$.081	$.427	$.326	$.12-.20
$ 8,500		$.277	$.226	

Utilizing the heat produced by the fuel cell is essential in order to obtain high energy efficiency. For this reason studies are underway for combined heat and power usage in buildings [28 – 30]. The fuel cell is approximately 30% efficient in the conversion of energy to electricity. If the generated heat is also effectively used, the energy efficiency can jump to 70 %.

Fuel cells run continuously as long as the reactants (hydrogen and oxygen) are supplied to the cells. Unfortunately, the demands for heat in a residence do not match the time for electrical loads. For instance, in the middle of a night in winter, the residence has minimal electrical needs, but the need for heat is at its peak. Thus, some thermal storage medium is required to take full advantage of the discharged heat. Bony [27, 28] claims the earth is a suitable storage medium, and ground-source heat pumps are a good partner for fuel cells.

3.3.8 Develop action plan into CPN strategic energy plan.

3.4 Objective Four

3.4.1 Analyze feasibility of creating a tribal utility.

The most critical element to be determined before any action is taken should be if there is a supply of low cost fuel available for power generation. Coal, hydropower, natural gas, and nuclear are the primary non-renewables, while wind, biomass, and photo voltaics are the renewable forms. The following Table 3.5 of electric energy costs puts things into perspective:

Table 3.5. Costs of electricity with and without external costs
New generation in cents/kWh
Worldwatch: State of the World 2003.

Electricity Source	Generating Costs	External Costs	Total Costs
hydropower	2.4 – 7.7	0-1	2.4-8.7
wind	4.0-6.0	0.05-0.25	4.05-6.25
natural gas	3.4-5.0	1-4	4.4-9.0
coal/lignite	4.3-4.8	2-15	6.3-19.9
biomass	7-9	1-3	8-12
nuclear	10-14	0.2-0.7	10.2-14.7
photovoltaics	25-50	0.6	25.6-50.6

Note: The price of natural gas went from $2-3/MMBtu in 2002 to $5-6/MMBtu in 2004. The current price is $6.60/MMBtu.

Non-Renewable Energy

First, the non-renewable sources are led by coal which for all its problems is a fundamental and abundant fuel in the US. Coal is unavailable at the site without significant infrastructure and environmental issues that would have to be overcome. Natural gas prices are high and extremely volatile and have doubled in the last five years. Nuclear will come at a later time.

Renewable Energy

Almost all of the renewable energy options require a backup/supporting (during periods of no wind or sunlight) technology that brings with it peaking power costs. Special niche markets for PV arrays (remote access, etc.) will continue to exist and with strong tribal support can add to the energy sources and support a spirit of tribal independence.

Hydropower is not available at the site but may be available from GRDA. Bio-mass, when coupled with other economic opportunities (waste disposal from feedlots, chicken manure, etc.), can be cost justified if sufficient quantities are available. In most cases, considerable government incentives will be required to bring renewable energy to its potential.

3.4.2 Microturbines.

Major factors that determine the feasibility of utilizing microturbines include load variation, peak time usage of electricity, waste gas, water heating or other use of hot exhaust gas, and tax credit. Detailed feasibility analyses can be done by companies that sell and install microturbines. For example, Global Energy (608-238-6001) offers a microturbine feasibility study at $5000 for single installation or at $10,000 for multiple installations. Their feasibility study includes the evaluation of natural gas and electrical usage history, calculation of thermal loads and sizing the microturbine as a "peak-shaving" or "primary" power producer, system optimization and process integration, and estimation of initial and operational costs along with potential savings.

3.4.3 Determine the feasibility to purchase or generate electricity for distribution.

The Stillwater, Oklahoma municipal electric utility, serving a residential population of approximately 41,320, had gross annual revenues of $30,000,000. They turned a profit of $5,000,000, paid $3,500,000 in wages, and were using their peaking units to supply peak/backup power back to their supplier. Key to their success was their low-cost, long-term electric power contracts. The major power supplier is GRDA (hydropower), which the City of Stillwater paid between 13 and 14 million dollars for electric power.

During the summer of 2004, the Stillwater, Oklahoma electric power generation units did not operate. They were on standby and leased to the GRDA.

See Appendix 6.6 for an example of a small municipal power plant and operation.

3.4.4 Analysis of selling generated power.

Unless a low cost fuel is available to the site for generating purposes, the CPN should take an alternate route. A goal would be to secure a low cost base source and provide peaking power units to reduce demand charges.

3.4.5 Action plan.

- Seek a low cost power contract for base load service.
- Evaluate the economics of purchasing diesel engine powered generator sets for known peaking loads (such as the casino) to reduce demand charges and recover costs of generator sets.
- Install water source heat pumps (closed loop, groundwater, etc.) to reduce demand.

4. Conclusions

The consulting team took very seriously the work and National Perspective as presented by Roger Taylor at the Oklahoma Tribal Energy Summit in Oklahoma City June 27-28, 2004. The approach taken was to evaluate the options available and recommend economically viable approaches to the CPN administration that are embedded in the options. The following table summarizes the conclusions:

Renewable Technology	Comments
Solar • Resource Assessment • Solar Electric – PV • Solar Thermal - Heat	• Maps are available showing good resources at CPN location • Costs are high except for remote locations • Costs are high compared to waste heat and geothermal heat pumps
Wind • Resource Assessment • Technology Development	• Under study at CPN – not encouraging • Well developed in State with growing interest and participation by CPN
Biomass • Resource Assessment • Technology Overview	• Activity at OSU. Pilot plants being studied and possible locations identified • Strong support at OSU and Federal level
Geothermal • Resource Assessment • Power • Low Temperature – Heat • Heat Pumps	• Resource maps are available and applications exist around the State/Nation • Insufficient resources at CPN location for Geothermal Electric Power generation • Marginal at best. Have not been considered • High priority with major efficiency and peak demand improvements for CPN
Hydropower	Not available on the CPN site(s)
Efficiency • Building Design • State Weatherization • Appliances	• Technology is well know to the technical staff at CPN • In-place • High efficient lighting has a high ROI and lowers cooling loads

Concluding Remarks Regarding GSHP

Implementation of a GSHP program reduces the number of challenges faced by the CPN when compared with other renewable energy technologies. For example:

- Tribal Human and Financial Resource Development

Volatility of fuel prices seek actions that support technology that is within the tribal human and financial resources of the CPN. The ground source heat pump technology clearly meets these requirements with job development and energy reductions. Businesses that are unable to control energy costs will be at a disadvantage. New business opportunities that employee tribal members that have contributions to energy control will be a premium.

- Tribal Renewable Resource Quantification

Geothermal heat pumps have a non-exhaustible supply of solar energy in the earths surface. Other renewables such as wind, surface solar are intermittent, have a higher first cost, require backup or storage and higher maintenance costs.

- Private Investment versus Private Developer Regulations

CPN tribal investment is sufficient for GSHPs. Leasing arrangements are an option but should be carefully evaluated.

- Tribal Utility Policies and Tribal Utility Formation

Not required for GSHPs

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6. Appendices

6.1 GHP Planning Guide
6.2 InterClean
6.3 Chula Vista
6.4 Car Wash
6.5 Propane Distribution

Appendix 6.1
GHP Planning Guide

Appendix 6.2
Interclean

Appendix 6.3
Chula Vista

Appendix 6.4
Car Wash

Appendix 6.5
Propane Distribution

Appendix 6.6
Small Municipal Power Distribution Company