2010 Evaluation of Energy Options

Heat and Power

University of Alaska Fairbanks

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power plant and at the other extreme, minimum investment new energy infrastructure with increasing use of stand alone building heating and reliance on purchased electric power. The comparison between these two diverse approaches slightly favored a more energy efficient centralized combined heat and power approach.

A range of alternatives, options and opportunities exist between the extremes considered in the 2006 Utility Development Plan. Alternative technologies using biomass or municipal solid waste, the potential of less expensive pipe line natural gas, or the possibility of an inexpensive regional source of hydro-electric power were not evaluated at that time.

Factors Influencing Decision Making

Technical factors influencing long term campus utility planning at University of Alaska Fairbanks are primarily thermodynamic, economic, and operational. Atkinson Plant converts purchased fuel into heat and power. The prime mover is a set of coal fired boilers that generate steam at sufficient pressure to expand through a turbine that drives an electric generator. The low pressure steam exhausted from this unit provides heat to campus buildings. Campus loads have begun to outgrow the capacity of the Atkinson Plant combined heat and power system, making supplemental purchase of electric power from the utility grid and operation of a fuel oi0TD-0001Tc[(ther)-6.7(modynami)-5.6(c,)]TJ TT31g68 [fuel dron turbipower comparison

Base Assumptions, Initial Phase

Fuel	Energy costs		Energy Escalation
Coal	$ 3.65	$/MMBTU	0.25 %/yr

Option 4: “Gas Boiler” (STG)- this concept models the performance of the current Atkinson Plant if the coal units were deactivated and current extraction steam turbine operation proceed with addition of a new 100,000 #/hr gas fired boiler. The new and existing gas boilers would generate 600 psi steam for expansion through a steam turbine to campus heat. The unit would operate in a heat following mode. Fuel to steam efficiency for this boiler is modeled at 0.85% and only natural gas is burned.

Option 5: “All CHP Circulating Fluidized Bed” (CFB all CHP) is a circulating fluidized bed boiler and 20 MW steam turbine with new larger condensers and steam plant auxiliaries. This is an all coal- islanded power station solution- requiring no purchase of utility power or supplemental gas or oil (follows the original Atkinson Plant concept). Construction cost (2010 dollars) is on the order of $180 M. This option, along with the CFB option, could be set up to co-fire Biomass with coal for energy cost reduction or to reduce net greenhouse gas emissions. This option would be capable of exporting power to the electric grid if there were an economic incentive to do so but is not currently set up to do so.

<u>Option 6:</u> “50% Gas Turbine Generator” (GTG)- this concept installs and base loads a single gas turbine generator with heat recovery boiler. Supplemental heat is provided by combination of a duct burner on the turbine generator power train and gas fueled boilers. No coal is burned. Supplemental power is purchased from the Utility. This option requires relatively low capital cost and could be expanded to become Option 3.

<u>Option 7:</u> “Coal Gasifier”- this concept uses a pyrolitic gasifier/oxidizer to convert coal and/or coal co-fired with biomass to steam. Fuel-to- steam conversion efficiency is conservatively set to 70% (research ongoing). A backpressure turbine is installed downstream of the 600 psi heat recovery boiler to reduce pressure to campus distribution. This unit is arranged in a similar fashion to the biomass (wood chip) gasifier recently installed at University of South Carolina which generates up to 60,000 lb/hr at 600 psi and expands steam through a backpressure turbine for campus distribution. More information is needed to model the cost ($/MMBTU) of biomass in Fairbanks- at this point coal is used to compute annual energy cost

<u>Option 8:</u> “All Electric”- this models the concept of converting the campus heat and power system to all electric in the event of access to a significant source of inexpensive hydro electric power. With hydro power, this concept would achieve a goal of major reduction in campus greenhouse gas emission. Heat would be produced through 12.47 kV electrode boilers in the Atkinson Plant and routed to campus through the existing distribution system. Capital investment in these 125 psi boilers and operating costs are comparatively low. Existing coal units would be removed and the new units installed in their place. Electric generated steam and building condensate return would be routed to campus through the piping in the existing utilidor system. Electric demand quadruples in this option. From an energy cost perspective, this option becomes comparable to “DND” only if electric power became available at roughly $ 0.035/kWh.

<u>Option 9:</u> “MSW IC Internal Combustion” has reciprocating engines fueled with syngas produced from gasification of Municipal Solid Waste or Refuse Derived Fuel (Reg a roug[illegible]ely #

gas. There are a number of logistical unknowns as this is a developing technology but the promise is that the input fuel cost would be low to free. The model at this point is more speculative than others. Additional research is needed on costs, reliability and efficiency of the gasification process.

Option 10: "MSW Gasifier"- similar technology to the biomass gasifier, this unit would operate with Municipal Solid Waste. This technology has reportedly been used successfully in Canada. The model at this point is more speculative than others. Additional research is needed on environmental issues associated with arctic application and waste handling logistics and costs.

Summary of Results, Initial Phase

The range of estimated annual energy costs is seen in graph below. Given the base assumptions,

options that burn coal or inexpensive biomass/MSW result in less annual expense than those using fuel oil, total annual costs across

Review of Results, Initial Phase

Given the base assumptions, an essential result of this exercise is that overall campus utility costs are projected to more than double over the next twenty years, regardless of which approach is decided (or not) upon. This is driven by a combination of increasing campus load growth, fuel and power costs, and a balance of energy cost, operation and maintenance and bond payment. How much more than double is a function of the decision, and the retrospective quality of the assumptions.

The research to collate data for alternatives demonstrated the relatively narrow range of combined heat and power systems in common use across the United States. Gas turbine cogeneration systems are utilized in a large number of university campus utility systems, coal fired steam cogeneration is typical, particularly in established campuses where access to inexpensive coal made mid 1900 investment in campus scale plants attractive. Use of biomass, either as a primary fuel source or co-fired with coal is less common, but has been in reliable operation at a number of university systems. Beyond these basic technologies, there are few, if any examples of the alternative technologies explored in this study. Municipal Solid Waste as a heat and power production fuel source has had a long history in European utility systems but limited application in the US, particularly on a campus setting. Coal gasification technologies are seeing some application on a larger regional utility scale (the Polk Power Plant in Tampa Fl. Is an example) but

year term, annual costs of the CFB option drop to just energy and operations.   The natural gas fired GTG options require less capital, and lower financing costs, but are hampered by high fuel costs until such time as inexpensive pipeline gas becomes available (modeled here as occurring in 2028, and costing $8/MMBTU in 2009 dollars). Deferring the decision to invest in gas turbines until pipeline gas becomes available pushes the problem forward and does not work to lower annual costs in the next forty years. A cross over point at which the annual projected cost of doing nothing different is comparable to those of a new CFB is seen to occur at about 2022 in this model. From that point on, the CFB is a less expensive proposition.

A summary of Net Present Values of the options (in which the lowest NPV represents the best use of capital) is seen below.

Option	NPV (40 yr)
1-CFB	$386,336,411
2- CFB Steam Cool	$391,226,354
3- GTG	$389,215,447
4- GTG Power Sell	$438,712,711
5- DND	$410,671,130
6- DND/GTG	$392,389,688

Consideration of the life cycle costs for this project lead to a question of the validity of the economic terms of the model. Does the University (or the State) make investment decisions based on the the