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Opportunities, Benefits, and Issues Relating to the Deregulation of the Electric Powei Industry in Alberta, Canada

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Abstract: Deregulation of the electric power industry in the province of Alberta, Canada, has been actively pursued by the Alberta provincial government and has reached the final stages of legislative implementation with the establishment of an active Power Pool and new interconnection guidelines for small generators. This paper examines the potential opportunities, benefits and issues resulting from this new regulatory environment. The paper deals with economic, social and environmental benefits of distributed power generation, including cogeneration, and some of the potential synergy between the various established industries in the province and the power generation industry. The paper includes discussion of the results of recent studies by the Alberta Research Council which further support the environmental benefits which distributed power generation can bring to the province.

Key words: Deregulation, cogeneration, emissions, power

I. INTRODUCTION

The Electric Utilities Act passed in May 1995 in Alberta heralded a new era in the management of the energy industry. The Act created for the first time a Power Pool and separated the generation of electricity from the transmission and distribution functions.

This paper focuses especially on some of the environmental issues which this new free market energy industry can potentially solve for society. Although the learnings and examples are specific to Alberta, they in fact would be applicable anywhere in the world where power is required and where environmental emissions are an issue.

II. DEREGULATION OF THE ELECTRIC POWER INDUSTRY IN ALBERTA

The Alberta Power Pool commenced operation in January 1, 1996. It operated as a real-time spot market for electricity in the province and for all imports and exports to the province. Initially the Power Pool was to be the sole agent for buying and selling all energy within the province. The posted Pool Price reflects the price of the last generator dispatched to meet overall demand.

The Transmission Administrator was given the mandate to set province-wide tariffs for non-discriminatory, open access to the transmission system.

III. COGENERATION POTENTIAL

The key industries served in Alberta include a very substantial oil and gas industry and significant petrochemical industry. The province has very significant discovered bitumen reserves in the "tarsands", estimated at 49 billion cubic meters of recoverable reserves [1], which reputedly exceeds Middle East conventional crude oil reserves. Since approximately 80 percent of these reserves will likely require in-situ steam stimulation or other special process to recover the hydrocarbons, this represents a very significant cogeneration opportunity, potentially in excess of 14 Gigawatt with a value of over $3 billion annually for 100 years. (Assumes 3c/kWh) Since deregulation of the electric power industry has now occurred, such long sought after cogeneration opportunities can now be embarked upon.

To exploit the above cogeneration opportunities, we note that the province also has significant gas reserves, estimated at 56 Tcf discovered recoverable reserves remaining and a further potential estimated 75 Tcf of reserves yet to be proven. [1] These gas reserves can play a significant role in the cogeneration processes as a clean source of fuel. Additionally, the province still has significant conventional crude oil production with remaining reserves of 680 million cubic meters. [1] Conventional crude oil production is in decline and does represent a very significant source of environmental pollution as a result of excess gas flaring as well as inefficient process heating.

IV. ENVIRONMENTAL ISSUES

Currently there are over 5000 wells in Alberta flaring solution gas at any point in time. [2] Approximately 64 billion cubic feet of solution gas is flared annually in Alberta each year. This represents enough energy to power the base load of the city of Calgary. This 64 billion cubic feet represents approximately 2100 thermal MW, and at a 30 percent conversion efficiency, represents approximately 640 MW of electric power. Gas flaring operates at combustion efficiencies which are as low as 66 percent, often emitting black smoke and always emitting numerous toxic pollutants. [3]

According to a recent 1996 study by the Alberta Research Council, over 250 chemical compounds were identified in flare stack emissions. [3] Not only do these stack emissions represent the waste of a valuable resource, they have also been associated with numerous human and animal health problems. The rate of asthma in Alberta is two to three times higher than the published rate of asthma in the U.S. Independent scientific studies on oil and gas production operations have shown that the emission products can migrate over 300 km. [4] It is therefore not hard to imagine how the whole province can therefore be affected by these emissions. Although Alberta is considered to have an above-average asthma rate today, this was not always the case. Alberta used to be considered one of the best places for an asthmatic to live, especially before flaring became prevalent in the province.

The Alberta Energy and Utilities Board, which has the mandate to regulate the energy industry in Alberta, is in the process of mandating emissions reductions. It is expected that a 25 percent reduction from 1996 emission levels will be mandated by the end of year 2001. [5] Utilizing this waste gas for power generation is clearly one of the options to reduce toxic emissions from these gas flares. Since the petroleum industry generally views power generation as non-core to their business, and has displayed a reluctance to invest in power generation opportunities, and since the regulated utilities have in the past expressed reluctance to get involved in this area, this can only open up opportunities for independent power generators.

Some of the pollutants resulting from incomplete flare stack combustion include benzene, benzo(a)pyrene, carbon disulfide, carbon monoxide, sulfur dioxide, methane, hydrogen sulfide, toluene, naphthalene, ethylene, black smoke, numerous other polycyclic aromatic hydrocarbons and many other complex potentially harmful hydrocarbon compounds. [3] The polycyclic aromatic hydrocarbons have long been associated with increased risk of cancer. These include benzene and benzo(a)pyrene. Sulfur dioxide has been associated with asthma.

Benzo(a)pyrene is well studied and is epidemiologically proven to be one of the most potent mutagenic carcinogens of the aromatic hydrocarbons. Further studies at the molecular level have now corroborated the epidemiological studies. In 1996, scientists at the M.D. Anderson cancer center, University of Texas, and in another study at the City of Hope Hospital in Duarte, California, demonstrated how at the molecular and DNA level, benzo(a)pyrene caused cancer. [6] Benzo(a)pyrene is sometimes referred to as soot by the industry, and is a product of incomplete combustion.

Benzo(a)pyrene breaks down in the body to form the metabolite Benzo(a)pyrene diol epoxide (BPDE). They found that BPDE preferentially bonds in the cell to the DNA P 53 gene, at the most common mutagenic sites of human lung cancer. The conclusion is that benzo(a)pyrene and its metabolite BPDE create the DNA mutations that result in human lung cancer.

Noteworthy is the fact that the Alberta Research Council studies have shown that the flare gas emission products have been measured to have thousands of times higher levels and thousands of times higher concentrations of benzo(a)pyrene than cigarette smoke is reported to have in the scientific literature.

Noteworthy also is the fact that even low concentrations of carcinogens are harmful and cancer causing. Sub-lethal levels are mutagenic, especially on growing organisms. [7] The toluene, benzene and carbon disulfide found in flare gas emission products are on the state of California's Proposition 65 list of chemicals known to cause reproductive harm or birth defects. [8]

V. INTERNATIONAL SITUATION

Emissions reductions are fast becoming a global objective. In Kyoto, Canada agreed to a 6 percent greenhouse gas reduction from the 1990 level. In the United States the Environmental Protection Agency (EPA) has been updating its clean air standards. It is believed that these upgraded standards will prevent 15,000 premature deaths, 350 000 cases of aggravated asthma, and one million cases of significantly decreased lung function in children. [9] The United Kingdom, Australia, New Zealand, Chile, Argentina, Columbia, Peru and Bolivia all have embarked on deregulation of their power industries. [10] California appears to be at the forefront of deregulation in the USA. In general, the economic benefits of a deregulated power industry and the need to pursue emissions reductions through improved technologies such as cogeneration are being recognized world wide.

In Japan, over 50 percent of the power comes from cogeneration sources. Corresponding figures are 34 percent in the Netherlands, and 29 percent in Denmark and Finland. [11] In Alberta, the percentage is less than 10% percent, and was reportedly as low as 1% in the period prior to deregulation. Given that we have a relatively cold climate, a good case can be made for the increased use of cogeneration processes in Alberta.

VI. COGENERATION SITUATION IN ALBERTA

Cogeneration, which is regarded as a "green" technology, could not thrive prior to deregulation, and so large cogeneration projects in the oil sands were not initiated until after deregulation. Many significant opportunities to generate revenue from flare gas and greatly reduce toxic emissions were prevented from occurring before deregulation. Significant barriers existed for independent generators to market electricity, wheel electricity, or export electricity. The cogeneration industry could not flourish unless these legal barriers were removed. The oil and gas industry was focused mainly on hydrocarbon production and not on power generation. The result was that more efficient environmentally friendly technologies were not applied.

VII. THE ECONOMICS OF COGENERATION AND SMALL POWER GENERATION

A simple payback calculation for a 4 MW NUG generator with a capital cost of $4 million (Canadian) and utilizing a 3c/kWh contribution margin will pay back the initial capital investment within a 3.8 year time period, excepting tax considerations and attaching no value to the heat. Similarly, a small 75 kilowatt NUG generator with a capital cost of approximately $70,000 (Canadian) will pay back the initial capital investment within 3.6 years.

In evaluating the economics of a cogeneration opportunity, it is necessary to examine the cogenerator economics in the context of some of the host facility's parameters. Important questions are: Which costs are relevant to the cogenerator decision economics, and which costs are irrelevant? How are joint costs to be treated, and how are separable costs to be treated?

An important concept from the field of management accounting is that the only costs that are relevant to a particular product and decisions regarding that product, are the costs that occur beyond the "split-off point" of that product. The decision to incur added costs beyond the split-off point is a matter of comparing the revenue available (if any) at the split-off point with the differential income attainable beyond the split-off point.

Figure 1 is a simplistic diagram of a cogeneration process and compares it to more conventional processes. It shows how the efficiency of the overall cogeneration process greatly exceeds the efficiency of a conventional stand-alone power station in that much of the heat coming off the gas turbine can be utilized in the host facility.

In a cogeneration plant, almost 100% of electrical energy is useable and up to 70% + of the exhaust heat energy is useable, giving it an overall efficiency of 65% to 80% +, as compared to the conventional power station efficiency of 30%.

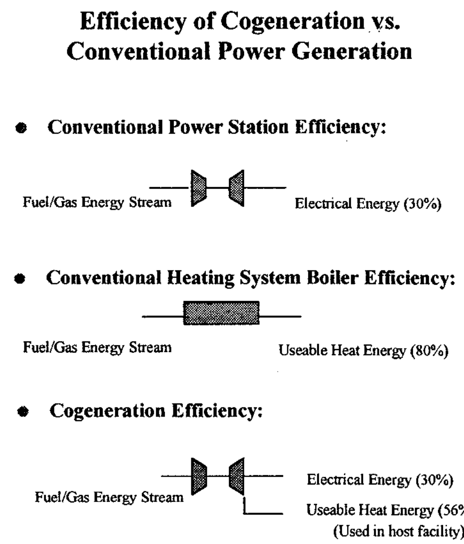

Figure 1

The overall efficiency of the three technologies as illustrated above is:

Conventional Power Station	30%
Conventional Steam Boiler	80%
Cogeneration Facility	86%

It is the high value added characteristic of electricity vs. heat that makes the economics of cogeneration attractive.

For example, if gas costs $1.50/GJ, produced heat has a value of $2.50/GJ and electricity has a value of $0.03/kWh, then 1000 GJ of gas input would produce:

- In a conventional heating system: 800 GJ of heat producing gross revenue of $2000 and a gross profit of $500.
- In a cogeneration system: 560 GJ of heat producing $1400 gross revenue and 300 GJ (= 83,333 kWh) of electricity, producing $2500 gross revenue. Total gross revenue is $3900, and total gross profit is $2400.

VIII. POTENTIAL VALUE ADDED TO GNP (GROSS NATIONAL PRODUCT) IN ALBERTA

Significantly higher levels of GNP are potentially available from cogenerated power in Alberta, especially if exports are pursued. Alberta natural gas production averaged 11.777 billion ft^3/day during 1995. [12] It would take only a 9 percent increase in gas production to add over $1 billion dollars per year to the GNP, if this gas is used for heating and cogenerating export power. (This assumes selling electricity at 3c/kWh, gas costs $1.50/GJ and no value is attached to the heat.) This is approximately a 15 percent increase to the natural gas contribution to GNP before the added benefit of heating value is accounted for. In addition, in practical terms, the benefit will be many times greater than this to the overall Alberta economy because of the multiplier effect economists refer to, which results from the chain of secondary spending this will generate. This multiplier effect is often of the order of 7 to 12 times the initial amount. Other benefits would include a more efficient power generation industry, reduced emissions and reduced health-care costs.

In addition, the cogeneration requirements from tarsands operations have the potential to add very significant values to the GNP, if an export market can be found for the power. Although there is a large requirement for the heat in Alberta, excess power will need to be exported. Incremental GNP values such as $3 billion per year would be imaginable if the entire tarsands resource was developed. However, this would be in the distant future and assumes that petroleum products would still be in significant demand. Given that Alberta has some of the most competitively priced power in North America, and given that research has shown transmission line lengths are feasible and economic at distances of 7000 km, it is not unthinkable for Alberta to become a large power exporter to North America. [13]

IX. ENVIRONMENTAL ADVANTAGE OF COGENERATION

When comparing a gas-fired cogenerator to a stand-alone coal fired power generation facility, we can expect a 60 percent reduction in carbon dioxide emissions, a 95 percent reduction in nitrogen oxide emissions and 100 percent reduction in particulate emissions for the same amount of electrical power generated. [14]

In regard to using solution gas for cogeneration vs. flaring it, cogeneration results in a 99.5% combustion efficiency as compared to a potential 66 percent combustion efficiency when flaring the gas. Instead of 250 plus toxins being emitted into the atmosphere, cogeneration will essentially only be emitting carbon dioxide and water molecules. This is true whether we applied cogeneration or just straight generation with gas that is currently being flared. (The products of ideal 100 percent combustion efficiency are only carbon dioxide and water molecules. Nitrogen oxides can be kept at very low levels using some of the latest technologies discussed further on.)

X. WHERE ARE WE TODAY IN POWER GENERATION AND FLARE GAS ISSUES?

Power generation is seen as a viable alternative to flaring as a means to reduce toxic and greenhouse gas emissions by many. A number of potential new opportunities for independent power generated from flare gas appear likely. Pollution levels from the older coal-fired power stations are seen as an issue. The Alberta Energy and Utilities Board is in the process of substantially upgrading environmental legislation in order to achieve a 25 percent flaring reduction within two years.

The 1999 federal budget allows for projects providing power generation from flare gas to be eligible for a 30 percent annual capital cost allowance. Power generation from flare gas presents an opportunity for diversifying Alberta's economy, reducing emissions of hazardous chemicals in flare gas, reducing green house gas emissions, improving health of all Albertans with respect to respiratory ailments and potentially harmful cancers. Independent power generation initiatives will go a long way toward satisfying a number of significant political pressures within Alberta from respiratory sufferers, from rural constituents, and in Canada federally as well as internationally. This distributed generation reduces the potential for "brown outs" and makes effective use of a "free" resource that currently generates no revenue, only problems.

XI. SOME TECHNOLOGIES AVAILABLE FOR EMISSIONS REDUCTION

Power generation with gas (that would otherwise be flared) can be done with a 99.5 percent plus combustion efficiency, and is obviously a preferred alternative to wasteful flaring. Some necessary refinements, though, to this technology should be discussed. There are a number of technologies which have been developed and which would insure that the gas turbine driving the power generator does not itself cause environmental emissions that are harmful. As indicated, the products of 100 percent combustion of hydrocarbons are essentially water (H_20) and carbon dioxide(CO_2), however, nitrogen oxides (NOx) can also be an unwanted byproduct.

A number of technologies have been developed to ensure that nitrogen oxide levels are within environmentally acceptable standards. Options to reduce NOx emissions include water or steam injection into the gas turbine, catalytic clean up of nitrogen oxides and carbon monoxide's from the turbine exhaust, lean pre-mixed combustion technology or dry low NOx (DLN) technology. [15] With these systems, NOx emissions reductions of below 10 PPM can currently be achieved. It is a essential that nitrogen oxide levels be minimized, as they themselves exacerbate asthma, and in the presence of sunlight and other volatile organic compounds, can degrade into ozone, which is toxic and causes asthma allergic reactions at extremely low concentrations of 0.12 PPM. [16] Ozone in the upper atmosphere is a benefit to reducing ultra-violet ray penetration into the earth's atmosphere, but at ground level it is considered a toxic pollutant.

Turbine emissions can further be reduced by ensuring that the gas being combusted is of the appropriate quality. Ideally, one would prefer to see pipeline specification quality gas being burned in the gas turbine. As this may not always be possible, gas conditioning with molecular membrane technology to remove liquids from the raw gas stream as well as to remove the impurities' such as hydrogen sulfide, prior to combustion, show promise as viable alternatives in situations where pipeline specification gas may not be an available alternative.

Combined cycle power generation using turbine exhaust heat recovery systems [17] are further options to generate more power and simultaneously minimize the amount of emissions generated. Some of the major gas transmission companies have effectively utilized this method on the gas turbines driving the gas compressors on their gas transmission pipelines.

XII. ISSUES/BARRIERS AND RECOMMENDATIONS REQUIRED TO BE ADDRESSED BY REGULATORS

Assuming the Alberta government has the collective desire to bring about a fully deregulated and free enterprise marketplace for power generation in Alberta, which we have no doubt they do, then it should not be too hard to address and resolve the issues of prohibitive standby charges, to make wheeling available at a fee which is not punitive and also to streamline the interconnection requirements, especially where small generators are concerned.

By unbundling transmission and distribution rates, the regulators can further facilitate small power plant development. We would thus recommend that these actions be embarked upon as early as possible to ensure open access to the marketplace at the distribution and transmission levels.

Increased efficiency of the approval process for small power plants and simplification of the royalty relief process and clarification of that process would go a long way to facilitating the transition to a free market, deregulated environment. Customer Choice is close to being announced and is fundamental to a free market place.

Allowing generators to bypass the transmission and distribution system when economic, will allow independents to better serve their clients and take advantage of the many flare gas issues and opportunities in the province. As they exist today, many of these are viewed by the public as a menace and a seriously unaddressed health issue.

As power generation is a non-core business for the oil and gas industry, it is incumbent upon the Alberta government to encourage the development of an independent power generation industry in the interests of more efficient industry, and in order to reduce toxic flare gas emissions. It is also incumbent upon our government to take steps to encourage the development of an export power market in the interest of diversifying our economy and adding value to our product base. By ensuring that we have enough power to export, we will be ensuring security of supply for all Albertans as well.

By providing environmental credits for flare gas power generation and by upgrading environmental regulations and enforcing them, the government can encourage green technology development. This would also encourage further new technology development in the areas of mini-turbines and gas conditioning with molecular membrane technology or other such cost effective methods.

By eliminating the predatory pricing practices of those companies which have an unfair advantage because of market power or guaranteed rate based contracts, the government can insure a fair market place. In practice, this would require some vigilance and corrective action by the regulators, which should include fines or trading restrictions being placed on companies found to be breaking the rules. Further definition of these rules is also required.

The current market mechanisms have established an hourly Pool Price, but no futures market has yet been established which would allow longer term power contracts to be made available. It is essential that a futures market be established in order to attract investment capital to the market place and thereby allowing independent generation to occur.

XIII. CONCLUSION

Deregulation of the electric power industry promises to potentially facilitate resolution of some significant environmental issues for the province, namely the flare gas issue along with many of its toxic emissions and associated adverse ill health effects.

By turning a waste resource into a valuable product, significant improvements can be made to the gross domestic product of the province. Additional economic benefit will be achieved by reducing health care costs.

Deregulation also promises to facilitate more efficient technology and more environmentally acceptable technology through cogeneration for development of the very significant bitumen reserves of the province, and ultimately over 14 Gigawatt of power with a value of over $3 billion annually over a 100 year period can potentially be cogenerated from this resource. Associated with all of the foregoing will also be significant reductions in greenhouse gas emissions.

By fostering power exports, the opportunity exists to further diversify the economy, add significant value to our product base and increase security of supply of electric power for all Albertans.

By facilitating the development of a futures market in or alongside the electrical Power Pool, the regulators can create the type of environment to attract investors to the independent power business in Alberta.

Further evolution, though, by the regulators, of the deregulation process is definitely required to insure that outstanding issues are resolved in the best interests of the citizens of Alberta, and to reap the full benefit of the deregulation process.

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