Introduction

The change in millennium has brought with it urgency amongst the socially conscious citizens of the world to reverse, or at the very least abate the environmental footprint of mankind. It is a sad fact that very few of the growing number of environmental advocates fully understand the economic consequences and for that matter, the impact of making many of the radical changes they propagate. Be careful what you wish for. Significantly altering our environmental footprint involves a lot of science and technology, a lot of money and a lot of sacrifice.

We have an energy economy. Our very way of life is energy dependent and our socioeconomic standing is in many ways dictated by how much energy we can afford. We drive our cars, we heat our homes, we watch our televisions late at night. Access to affordable and reliably available energy is the stalwart parameter of our economy and it facilitates everything from food production and transportation**,** to heavy industry. Energy is power and the most powerful nations have the most energy at their disposal.

Energy from hydrocarbon sources has facilitated our growth. Even though North American oil production peaked long ago, the demand has continued to rise. North American oil requirements approach a mind-boggling 20 million barrels per day and buying this oil from overseas sources has a dramatic impact on our economy and our world. In 2008 world oil demand hovered near 85 million barrels per day. Adding to this ocean of oil, we have an ever-increasing demand for coal and natural gas. It seems that the more we talk about alternative sources of energy, such as geothermal, wind, solar, or hydroelectric and nuclear, the more hydrocarbons we seem to use. It appears to be all talk and little action? Why do all of the potential solutions seem to come with their own set of problems?

What is new in the public conscience is that now most people are aware that their hydrocarbon energy consumption has a significant environmental impact. Man-made carbon dioxide emissions are cited as a primary contributor to global warming and oceanic acidification. Sulfur dioxide emissions from coal fired power plants cause acid rain. What is not new is that the more we talk about the problem, the more emissions we seem to produce. In a study released in March of 2008 and published in the Geological Research Letters Journal, co-author Ken Caldeira of the Carnegie Institution stated that, "The answer implies a much more radical change to our energy system than people are thinking about." Emissions are rising and they will continue to rise. Even if we take dramatic action, the technology for which has yet to be developed, overall emission reduction is still many, many years away.

Al Gore is a world famous former politician though most of his accolades have accrued subsequent to his American vice-presidency and failed Whitehouse bid. He has championed the cause of global warming. The documentary "The Inconvenient Truth" which was narrated by Mr. Gore did an extensive job of articulating the problems, but was conspicuously short on solutions. There is now a global awareness of the problem, and we should move forward toward a global focus on the solutions. We cannot simply turn off the switch. We will not stop driving our cars and take up mass transit, we will not stop heating our homes and certainly will not stop producing food in order to reduce our carbon footprint. As much as we would like to improve the environment, most people are not really looking for a change in lifestyle. This would imply that although we would like to help, we are going to need a lot of energy from environmentally friendly sources. Most of us are not looking to cut our individual energy consumption in the face of environmental challenges; rather, we would like the energy we use to come from cleaner sources. These sources must be affordable and abundant before we are likely to make any contribution to emissions reduction. We would like to supplement greener energy for hydrocarbon energy, but it must be affordable and widely available, neither of which is presently true.

The Alberta Oilsands is the fastest growing industry in Canada with capital in-flows approaching US$200 billion. The oilsands developments near Ft. McMurray, Alberta are the largest industrial developments in Canadian history. In 2006, oilsands production surpassed 1 million barrels per day with a massive expansion aimed at tripling production by 2019. Further production capacity will be developed in the years ahead with some 200 billion barrels of *recoverable*[1] reserve. Development will cross the Alberta/Saskatchewan border and tens of thousands of jobs will be created to bring this vital oil to an ever growing world market. The primary market destination for raw bitumen and Canadian synthetic crude oil is currently the United States where diversification of oil supply is a matter of national security.

The growth in oil demand is a dimension of the overall growth in global energy requirements. This demand grows exponentially on a worldwide basis. The rapid increase in global population is the primary driving force for this growth. Access to energy is the single largest facilitator of modern civilization and the degree to which any nation succeeds economically, is determined by its access to energy in any or all of its forms. Ready access to affordable energy has an enormously significant impact upon every element of humanity including health, social stability, employment and economic prosperity.

As we become increasingly aware of the growing negative impact that the quest for and development of the world's energy reserves is having on the global environment. Though the production and consumption of global energy reserves has a positive economic impact on the fortunes of producer nations, much of it is at the expense of a negative impact upon the global environment. The earth's atmosphere has long been a sink for emissions. Energy consumption throughout the world has increased and so too has the negative effect upon global environmental conditions. In order to accommodate increases in energy demands relative to the growth in population, it is imperative that more environmentally efficient methods of energy production be developed. This applies to the oilsands as well.

The unique process of extracting bitumen from oilsands and upgrading it to synthetic crude oil using thermal recovery, has a carbon footprint larger than any other method of

[1] "recoverable" in this context means economically recoverable, a quantity that varies with oil and gas prices.

oil production. Current exploitation methods use massive quantities of natural gas and accordingly, produce mega tonnes of carbon dioxide (“CO2”) emissions. Significant volumes of CO_2 emissions are generated just to produce the oil, which of course produces further CO_2 after in is refined into fuel and burned. The collective CO_2 emissions resultant from oilsands production, are greater in magnitude than those that produced burning coal. The economics of the process make sense with high value oil and relatively inexpensive natural gas, as long as there is no cost associated with the corresponding CO_2 emissions. This is now changing. The probability of a carbon tax and/or other regulatory changes that affects the oilsands industry can no longer be ignored.

Sir Nicholas Stern, former Chief Economist of the World Bank has described climate change as “the greatest market failure in history”. He asserts that the real economic cost of fossil fuel consumption will be borne by future generations rather than the present day consumers to whom the dramatic increase in global emissions can be attributed. In the words of the Waterkeeper Alliance’s R.F. Kennedy JR., “global warming from excessive CO_2 emmissions is a form of deficit spending, the cost of which will be borne by future generations in the form of denuded landscapes, unpotable water, and unbreathable air.”

As the issue of global warming has mushroomed into the public conscience, a paradigm shift is occurring on the acceptability of civilian nuclear power. In what is now referred to as a “nuclear renaissance”, a long dormant industry is alive again and public attitudes are changing. In the last 5 years, approximately 20 gigawatts (“GW”) have come on line worldwide. At present, dozens of new plants are in the application, approval and development stages. The development of civilian nuclear power installations throughout the world is in major expansion mode and billions of tonnes of carbon dioxide emissions will be prevented. Nuclear power development is the only solution that addresses the scale of the demand and this solution will apply to the oilsands as well.

The nuclear power industry in North America was stopped in its tracks when public support for nuclear development evaporated after the incident at Three Mile Island, Pennsylvania (1979), followed by the accident at Chernobyl, Ukraine (1986). In the United States all of the projects planned for the 1980’s were mothballed or cancelled. No nuclear reactors have been built anywhere in North America since 1979. However, in the absence of new reactors, nuclear power continued to be an important energy source in both Canada and the United States with existing plants operating near capacity. The nuclear share of the North American power market has grown to 20%, though many of the old reactors are now in need of refurbishment. Many new reactors have been proposed and at least three reactor complexes in the United States are in the application and licensing stages. Ontario has also commenced a $26 billion upgrade to its existing facilities.

It is not simply the passage of time that has contributed to waning public apathy regarding nuclear power. What happened at Chernobyl could not happen with a CANDU reactor or the more common PWR reactor designs. What actually happened at Three Mile Island was more an incident than accident, as catastrophe was avoided due to well-designed containment and safety systems. Just as the industry learned from these experiences, so did the public. There have been no other accidents and the world's 442 nuclear power reactors continue to operate safely, effectively and efficiently. At the same time, every other method of non-renewable energy production has found public scrutiny. The environmental efficiency of all forms of energy production is now weighed on the scale of public opinion. In 1979, there was little concern with how much CO_2 was emitted from power production or any other industrial process, but today that has changed. The 21st century will be the era of nuclear development on an unprecedented scale and producing oilsands process energy is an emminently practical application for this technology.

Climate change is the instantly recognizable issue that now moves science, government, industry and the public to remedial action. The Kyoto Protocol established a new regulatory regime for the signatory nations. Although the United States is not a signatory to the Kyoto Protocol, it has also recently established new emission standards. The public conscience has opened up to a wider view of our collective impact upon the environment. Climate change is the hot button issue of the western popular culture and it pervades our conscience with seemingly endless descriptions of the problem and its potential outcomes. Descriptions of the problem abound. Solutions to these problems are being developed but no overall decrease in greenhouse gas has yet been achieved. The rate of growth in CO_2 emissions is increasing and global warming and oceanic acidification continue.

The Kyoto Protocol established a timetable for reducing man made atmospheric CO_2 emissions according to a timetable. The 1997 target set by the Kyoto agreement called for reductions to 6% below 1990 levels by the year 2012. This international treaty entered into force in 2005. Canada was originally a signatory nation but has subsequently abrogated her commitment citing the technical impossibility of compliance to the levels established. The federal government is establishing its own standards to limit growth in CO_2 emissions and the Canadian public has made climate change a political issue. The Canadian and Alberta governments have embraced "Intensity Based Targets" for reductions to allay public concerns about CO_2 emissions. Intensity Based Targets allow overall emissions to rise with increased oilsands production.

It is a sobering reality that CO_2 emissions have increased by 40% since a previous Canadian government ratified the Kyoto Protocol but Canadians certainly can learn from this experience. Practically speaking, the impact of CO_2 reductions upon our very way of life is not well understood. It is not useful to blame governments for the problem, but governments can, and do contribute to the public misunderstanding. These misunderstandings have gotten in the way of solutions. Talk is cheap and actions really do speak louder than words. There was no direct benefit to the Canadian public in having a previous government sign on to an international convention for which there was no plan for, or reasonable prospect of compliance. Unachievable election promises in the form of international undertakings do nothing more than contribute to public confusion and in the case of the promised CO_2 emissions reductions, did nothing but damage Canada's reputation internationally.

When it comes to solutions, public misunderstanding is not an asset. In the Canadian context, the Kyoto targets were unachievable at the time they were ratified and even more unachievable when the Canadian opposition parties in their minority government voted to force compliance in February of 2007. In order to comply with the targeted reductions, Canada would have to shut down half of its industry or alternatively, spend tens of $billions to purchase emission credits. This too would shut down half of the industry by making it unprofitable. The politics of the proposal are complicated. There is a fear in western Canada, Alberta and Saskatchewan in particular, that such a plan would induce penalties on the oil production industries in the form of emission taxes in order to raise money to subsidize the hydroelectric industry in Quebec or the nuclear industry in Ontario. This is plausible based on the historical relationship between Alberta and the past Canadian governments as it pertains to energy. Many Albertans view the prospect of new federal regulation as a potential new *National Energy Program*[2] that would undermine national unity by alienating Alberta and threatening trade relations with the United States. Oilsands exports to the United States potentially diminished by Canadian regulatory changes could face a NAFTA challenge, and a new national energy program could foment a Canadian constitutional crisis.

CO_2 emissions from Alberta's oilsands mega projects are the fastest growing source of greenhouse gases in Canada. They presently account for approximately 1/3 of the country's total emissions. Almost $200 billion has been spent on these mega projects to help alleviate American dependence on oil from the middle-east. Relaxing American dependence on middle-eastern oil imports has become an international security issue. Tens of thousands of Canadian jobs have been created. Tens of $billions worth of production upgrades are planned and the industry as a whole has become the economic engine of the nation. Oil production in Alberta and Saskatchewan could surpass Saudi Arabian production by 2020, but present oilsands production techniques are CO_2 emissions intensive. With present technology, increased production and emission reductions are mutually exclusive outcomes. It does not have to be this way. In light of the Kyoto based regulations, it would be an opportune time to turn the problem into a new opportunity.

As the oilsands continue to evolve into a primary source of world oil, Saskatchewan has more quietly become an energy superpower unto itself. When we talk about Canadian energy exports, we are generally talking about hydroelectric power, oil and other hydrocarbon products. However, the fact is that Saskatchewan is Canada's leading energy exporter, primarily in the form of raw uranium oxide. Saskatchewan has the world's largest high-grade reserves of this nuclear fuel and presently supplies more than one-third of the world's demand. This industry is rapidly growing. Saskatchewan uranium supplies nuclear power reactors in eastern Canada, China, Japan, India, South Korea and other countries. While the Canadian development of nuclear power plants went dormant in the 1970's, it has grown dramatically throughout Asia. New plants are under construction all over the world and more are planned. Saskatchewan uranium has already averted billions of tonnes of CO_2 emissions and promises to do much more.

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[2] National Energy Program – A Trudeau era (1970's) tax regime that saw 10's of $billions in Alberta energy revenues flow to Ottawa, until the legislation was rescinded by the Mulroney government in 1982.

Why is it then that we have not found a way to use Saskatchewan uranium to fuel the oilsands? Nuclear reactors for the oilsands have been proposed for thirty years with no development. A large part of the reason is due to our changing attitude toward CO^2 emissions. If investors would readily ante up hundreds of billions of dollars to develop oilsands production, why would they not invest in nuclear power to facilitate it? Why would they not hedge against the potential for costly regulation, by committing their resources to cleaning up the oilsands and increasing production at the same time? I believe they will and it is not a question of if, but when and how.

The Opportunity

The oilsands production industry in Alberta is the fastest growing process energy market in the world today. Unlike conventional oil production, the extraction of bitumen from oilsands to produce synthetic crude oil process energy intensive, and emission intensive where this process energy is supplied using fossil fuels. At present, natural gas is the feedstock fuel and vast quantities are required. By 2008, the requisite gas volumes approached one million gigajoules per day and will escalate with increased production. Canada, nor Alberta are particularly well endowed with gas reserves and this versatile commodity has many valuable applications unrelated to the oilsands industry. Gas reserves are worth preserving as long as there is an alternative.

The application of natural gas in the oilsands industry extends beyond its use as a feedstock fuel used to produce steam for extraction purposes. It is also an important source of hydrogen used to upgrade the raw bitumen in order to manufacture synthetic crude oil that meets the export requirements and adds value. In either case, whether the gas is used as a fuel in thermal recovery or as a source of hydrogen, enormous quantities of CO_2 are produced. For every million gigajoules of gas consumed, approximately 63,500 tonnes of CO_2 are produced and presently emitted into the atmosphere. These emissions are the primary Achilles' heel of the oilsands and have drawn the ire of the industry's growing list of detractors. Overall reductions in these emissions are directly dependent upon this industry's ability to develop more environmentally efficient production methods.

In light of growing criticism respecting the emissions from oilsands exploitation, the Alberta government has come to the defense of this vital industry by proposing that the answer to the emissions problem lies in Carbon Capture and Sequestration ("CCS"). This practice involves collecting the CO_2 from the process and pumping it into geologic underground storage vaults where it would ideally be stored indefinitely. Various pilot projects have been undertaken and the viability of the solution, has to a degree, been empirically validated. A project at Weyburn, Saskatchewan undertaken jointly by ENCANA Corp. and the Petroleum Technology Research Centre at the University of Regina demonstrated the viability of the practice up to a capacity of 5,000 tonnes per day. This was the highest sequestration capacity ever achieved in Canada and although the technology shows promise, it is unlikely that it would be a practical solution for the enormous CO_2 volumes of the oilsands. Even if it were possible to capture and sequester tens of thousands of tonnes of CO_2 daily, it is unlikely that the process would be more efficient economically than not having produced the CO_2 in the first place. As much talk as we have heard about the potential of CCS, we cannot afford to expect that the technology will solve the emission problems of the oilsands. In the short term it makes sense to apply CCS techniques to coal-fired power generation, where the emissions are more noxious, and the point sources are less voluminous than the oilsands.

There is only one way that the oilsands industry can grow or even maintain its existing level of production while decreasing its production of CO_2. Only by adding nuclear power to the process can we accomplish this. Only the advent of nuclear energy can improve the environmental efficiency of the oilsands without curtailing production and growth. However, this should not be seen as a problem because it represents a logical opportunity. Although Canada and the companies operating in Alberta are major players in the world's oil export market, Canada, and the companies operating in Saskatchewan are already the world's preeminent suppliers of uranium for nuclear power production. Saskatchewan's high-grade uranium reserves are the world's largest and this enormous resource should be developed to supply the process energy requirements of the oilsands, rather than fuelling the expansion of exports.

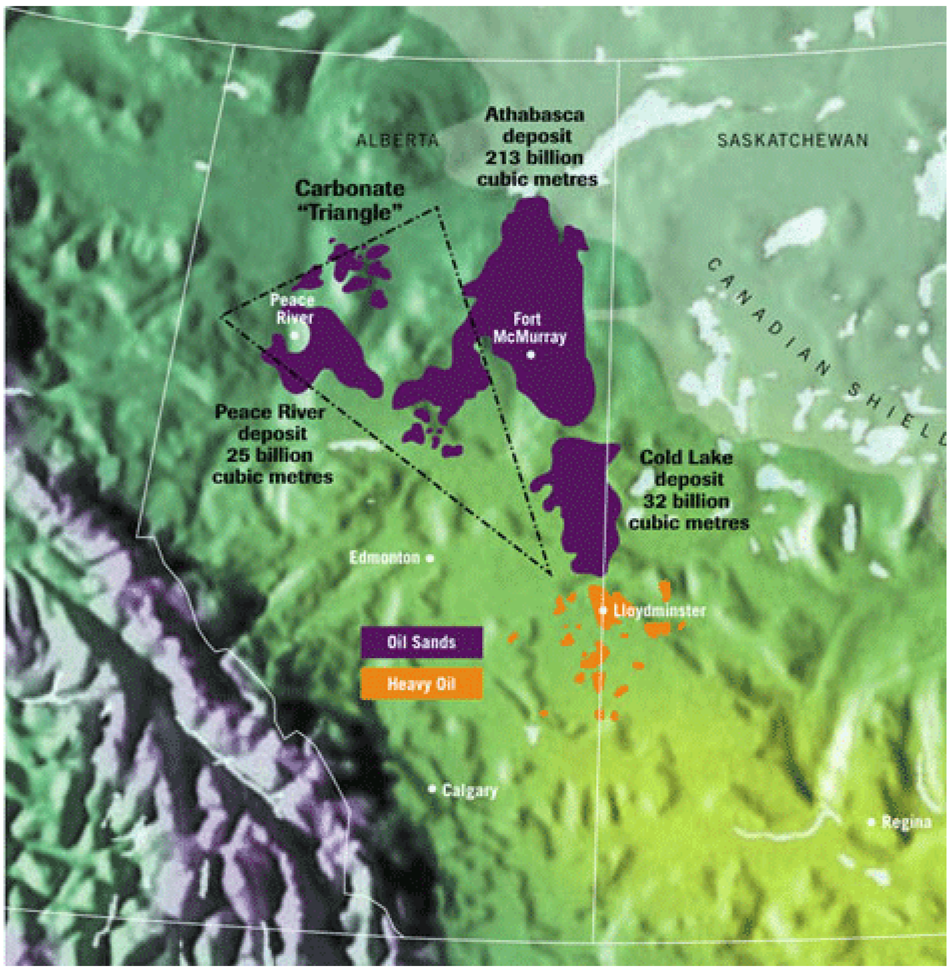
A rudimentarty hypothetical can shed light of the potential: Given the natural gas demands of the oilsands presently approaching one million gigajoules ("GJ") per day and using a market price of $10 per GJ, the oilsands industry is would already be spending $10 million per day on its process energy requirements. As gas supplies diminish in light of increased demand, it is certainly plausible that these costs could rise. Indeed, $10 per GJ is cheap energy, but even at that price, the oilsands process energy market would already be $3.65 billion per year and rising with production upgrades. Add to this cost any future compliance costs respecting CO_2 emissions, or the costs of CCS, and the capital costs of nuclear reactor development begin to look very competitive. This is an opportunity that we cannot ignore. This is an opportunity to facilitate the growth of the proven oilsands industry, while at the same time giving birth to a new one. This is an opportunity to create tens of thousands of new jobs, while simultaneously facilitating dramatic reductions in our CO_2 emissions.

The Oilsands

The Carbonate Triangle of northern Alberta includes three major oilsands deposits that represent one of the largest oil reserves in the world. These reserves are second only to Saudi Arabia's liquid oil reserve. The oilsands reserves have trillions of barrels of oil in the form of bitumen which is much more difficult to produce than conventional oil. The thick, tar-like bitumen is thoroughly mixed into the sand and various extraction methods ranging from open-pit mining to thermal recovery are employed to produce the product. Compared to conventional oil production, bitumen recovery is presently cumbersome, expensive, and environmentally inefficient. Once the bitumen is recovered and separated from the sand, it can be pipelined to an upgrader where hydrogen is added to "lighten" the substance into a form of high-grade synthetic crude oil, or alternatively, it can be exported in its raw form.

The complex and tedious process of exploiting this resource has given rise to the term "presently recoverable oil". This term is used to describe what portion of this multi-trillion barrel reserve is thought to be economically recoverable using present technology. It would be more precise to change the term "presently recoverable oil" to "economically recoverable oil" because that would better accommodate the fluctuation one would expect along the cycle of oil prices. In short, the amount of economically recoverable oil is considerably higher with $100/barrel oil than what would be practical at $50/barrel oil, which is the expected break-even price at the end of 2008. Within this price range the economically recoverable reserve fluctuates from a low of 150 billion barrels to a high of 250 billion barrels given a static price for the process energy used in production and present recovery techniques. Better recovery techniques and technologies may well be developed in the future, but even the present reserve estimates are mind boggling.

The Carbonate Triangle/Oilsands Deposits



www.centreforenergy.com/silos/ong/oilsands/AOSD.asp

There is a lot of non-OPEC oil in the oilsands of the Athabasca Region, and the importance of the resource has great significance to the North American economy and our security. Given the capital that has been invested and the future potential for oil shortages, it is irrational to expect that oilsands production will do anything but increase.

The distinctive characteristics of oilsands production are many and it is the case that conventional oil production is much less expensive to develop. The break-even production price for synthetic crude oil has spiraled upward and new regulations governing CO_2 emissions are a threat to production and economic viability. The per unit energy cost difference between natural gas prices and oil prices has benefited oilsands producers relevant to the 2008 spot prices that featured at times the most expensive crude oil in history, coupled with relatively cheap gas prices. There are many factors governing production costs, but given the huge process energy requirements of thermal recovery, the ratio of oil price to gas price is extremely important to the bottom line.

	Oil Barrel $US	**Oil GJ $CAN**	**Gas Mbtu $US**	**Gas GJ $CAN**	**Ratio $Oil/$Gas**	**$CAN/$US**
January 1, 2008	92.93	16.19	7.6	7.2	2.25	1
July 1, 2008	137.11	24.28	11.63	11.2	2.17	0.984
December 1, 2008	58.66	13.1	5.74	6.97	1.88	0.78

http://tonto.eia.doe.gov
US Dept. of Energy

The $Oil/$Gas ratio benefits oilsands profitability when it ranges higher, though diminishing gas supplies make it unlikely that relatively inexpensive gas will remain a production constant.

Labour costs, materials costs, regulatory costs, emission management costs, royalties and taxes are all key parameters governing the profitability of oilsands production. Many inducements have been provided along the path to multi-million barrel per day production. In 2008, the average production cost of synthetic crude oil was near US$50 per barrel. Thermal recovery of bitumen is more expensive and more emissions intensive than surface mining, but Steam Assisted Gravity Drainage (“SAGD”) is a fast growing thermal recovery technique and will be heavily relied on for production increases in the future.

SAGD involves using energy from burning natural gas to heat steam which is piped in copious quantities deep into the oilsands. This steam reduces bitumen viscocity causing it to flow into wells where it can be pumped to the surface and shipped to a refinery. Though other production techniques are being developed, most of the growth in production accrues to SAGD so that deeper bitumen deposits may be exploited. Every barrel of SAGD production uses on average 1.18 GJ of natural gas and produces 63.5 kg of CO_2. To produce 1 million barrels per day by SAGD, the daily natural gas requirements will be 1.2 Pitajoules (“PJ”) and daily CO_2 production will 63,500 tonnes. In order to produce 5 million barrels of oil per day, the production would require 3 to 4 PJ of natural gas and North American gas reserves would be consumed in less than 25 years. If this happens we will be forced to become dependent upon liquefied natural gas (“LNG”) imports from abroad, primarily the Middle East.

Making North America dependent upon LNG supplies from the Middle East is very questionable logic. That quandary is exacerbated by potentially making the oilsands dependent upon the same LNG supplies. Add to these possibilities the rapidly growing public distress over CO_2 emissions, the tremendous technological challenge of yet undeveloped means of CCS, and it is clear that the industry must pursue a different course in terms of its process energy. If the oilsands industry does not develop an environmentally responsible alternative process energy supply, its growth will not continue, and the current economic engine of the nation will sputter.

Emission Problems

In the last five years the CO2 emission issue has moved from relative obscurity to the forefront of human obsession. It is a “global emergency” in the words of Al Gore. “The greatest market failure in history,” as described by former World Bank chairman Sir Nicholas Stern. There is omnipresent conjuring of imminent disaster, a roadmap to our own Armageddon. We are inundated with the never-ending articulation of the problem.

It is most useful in any discussion of the global warming phenomenon to divide the discussion of the issue into two factors: 1) environmental factors and; 2) economic factors. It is popular in the contemporary sense to merge these two sets of factors into an ambiguous division of pseudo facts, ambiguous figures that promulgate unachievable and prohibitively expensive ambitions. We should do something, we cannot do everything, but we should do what we can. Where capital is invested to address the problem of global warming, the spending should be targeted in a way to maximize the positive outcomes.

<u>Environmental Factors</u>: The hypothesis is that man-made greenhouse gas emissions, predominantly CO_2 from fossil fuel consumption, have tipped the environmental atmospheric balance and that this is rapidly changing our climate. It is further alleged that precipitous oceanic concentrations of CO_2 are causing acidification that destroys coral and more importantly kills phytoplankton that are themselves natural CO_2 processors, again on a man-made basis. There has been much argument and discussion, and though it remains a scientific uncertainty that man-made emissions have caused climate change, the evidence suppoting that conclusion is mounting.
It has been demonstrated that atmospheric CO_2 concentrations are now at their highest level since man evolved as a species. However this is quite recent in geologic time. In the last 100 million years there have been two other occasions where CO_2 levels were higher than they are now. Indeed, the fossil fuels at the root of the emission argument were formed at a time when there was greater atmospheric CO_2 concentrations than there are now, when the growth of vegetation was uninhibited by cold temperatures or the availability of CO_2. Our globe has been warmed several times.

In 1997 the government of Canada ratified the Kyoto Protocol which imposed CO_2 reductions upon its signatories to 6% below 1990 levels by 2012. These signatories did not include the United States, China, India or Russia. Canada has since abrogated her commitment to the Protocol, first by non-performance and officially since the government changed in 2006.

Economic Factors: If Canada were to reduce its CO_2 emissions to 6% below 1990 levels by 2012, it would result in gross domestic production losses of $37.5 billion per year and tax losses of $14.5 billion per year. This would result in the loss of 350,000 jobs and to add insult to injury, it would have virtually no impact upon global atmospheric CO_2 levels. Two provinces account for almost half of Canada's CO_2 emissions with Alberta leading at 233 megatonnes per year and Ontario with 207 megatonnes per year. Canada's total CO_2 emissions are 850 megatonnes per year. The Kyoto Protocol would mandate reductions from these levels to a total of 600 megatonnes per year, approximately the same amount of CO_2 that is emitted by human respiration in China.

The two major sources of CO_2 emissions are energy production/consumption and food production. Food production is in itself energy intensive and the notion that CO_2 emissions can be reduced in the short term without negatively affecting food production is absurd and clearly unachievable. We may reduce atmospheric CO_2 levels but it will not matter if one-half of the world's population risks famine. At present, China, India and the United States account for 10,000 megatonnes annually, yet none of them were signatories to the Kyoto Protocol and all have increasing emissions. This is why Canada cannot make a difference even if making a difference actually made a difference, which it may not

One major caveat on the continued development of this abundant oilsands resource is the troubling emissions resultant of the energy intensive processes of bitumen extraction. In the aftermath of Canada's abrogation of its commitments under the Kyoto Protocol, CO_2 emissions are set to triple by 2018, excepting where they may be sequestered, reduced by alternative processes, or eliminated by the introduction of an alternative non-emitting process energy source. The present Canadian government was left with no option but to abrogate its commitments to the Protocol, since the previous government had signed on for political reasons with no strategy or prospect for compliance. In the last five years Canada's CO_2 emissions have risen 40% mostly due to oilsands activity.

Although surface mining of oilsands is much less emission intensive than thermal recovery, it is an unfortunate reality that only 20% of the reserve is accessible using this technique. Whether the bitumen is harvested using surface mining or by thermal recovery processes like SAGD, further emissions accrue in removing the bitumen from the sand and clay and also by upgrading the tar-like substance recovered into more easily refined grades of synthetic crude.

The fastest growing methods of recovery facilitating the massive ongoing expansion of production are known as in-situation ("IN-SITU") recovery. This includes the previously mentioned SAGD, as well as Cyclic Steam Stimulation ("CSS"), vapour extraction process ("VAPEX"), and fire-flooding. The emissions resultant of these recovery techniques vary according to the energy input requirements. SAGD and CSS are steam assisted cycles and accordingly, require large energy inputs, whereas VAPEX and fire-flooding are not steam cycles and require much less energy. Oilsands producers are working diligently to improve upon the environmental footprint of their processes in terms of CO_2 emissions but they are a long way from where they need to be to allay the public disdain for emissions and satisfy the regulatory requirements of the future.

Irrespective of the recovery technique, the upgrading of the bitumen requires the addition of hydrogen and natural gas has historically been the feedstock. Separating hydrogen from the carbon in gas is a simple process but CO_2 is produced as a waste product of the reaction[3].

There are only two viable sources of hydrogen for upgrading purposes, either from hydrocarbon fuels or from water[4]. Electrolysis of water does not produce CO_2 as using gas does, but it uses a lot more energy and vast quantities of water which is in short supply throughout the Athabasca Region. Less than 10% of the overall CO_2 emissions resultant of oilsands exploitation accrue from hydrogen production, but if nuclear process energy were abundant and cheap, electrolysis of tailings water might be useful for hydrogen production and there is a lot of hydrogen in the oilsands tailings ponds.

Environment Canada has predicted that the CO_2 emissions resultant of oilsands activities will triple to 75 million tonnes per year by 2018. The projected magnitude of these emissions are well beyond any presently known capacity for sequestration and any government commitments to reduce overall emissions are rendered unachievable in the face of these facts. This refers to the Canadian government's commitment to stem the rise in greenhouse gas emissions by 2013 and the counter-proposal by the Alberta government to accomplish the same objective by 2020. Unless and until alternative non-emitting process energy sources are developed, these objectives are clearly unachievable.

The propensity for governments to make commitments for which they have no viable path to realization is not novel, but it is understandable given the nature of politics and the present public concern regarding global warming. Populist politicians feel a need to tell the public what they want to hear and their very electability may be tied to these promises. A February 2008 survey conducted by McAllister Opinion Research which was commissioned by the Environmental Defense Organization and reported in the Calgary Herald, found that 79% of Canadians thought that greenhouse gas emissions from the oilsands should be "capped at current levels and then reduced." The survey also found that only 12% of those surveyed believed that emissions from the oilsands sector should be "allowed to exceed current levels." This underscores a grand divergence between what is acceptable in terms of public opinion and what will sustain the economy and economic growth. The survey results also demonstrate why politicians and governments are inclined to make promises that they cannot keep. This has happened before and it will likely happen again.

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[3] CH4 + O2 → 2H2 + CO2

[4] 2H2O→ 2H2 + O2

As previously stated, since the Canadian government's ratification and subsequent abrogation of the Kyoto Protocol, CO_2 emissions have risen approximately 40%. This trend will continue to the extent that oilsands production will increase without the development of an alternative non-emitting process energy source. Only nuclear energy can address the scale of this demand and accommodate increased oilsands production. There is no other way. Capping oilsands production is not an option where tens of thousands of jobs are at stake and the security of North America is threatened. The challenge clearly is to accommodate the expansion of oilsands production with a simultaneous decrease in CO_2 emissions. Again, the advent of nuclear process energy is the only option. With increased public awareness and scrutiny, as well as the long lead times required for nuclear development, the time to act is now.

A Sobering Look at Carbon Management

The last decade has given rise to an ambition by some to tax carbon emissions in order to facilitate overall reductions in man-made emissions by means of economic disincentives. For industrial emitters of $CO_{2,}$ the disincentives are even greater where the associated compliance costs are coupled with the capital costs of the industrial infrastructure necessary to achieve any reduction and/or sequestration of the enormous volumes of CO_2 produced by their processes. There is a disconnect between the public's understanding of the challenges associated with the solutions to the problem and what solutions are presently achievable for economic and technological reasons.

The economics of carbon management ultimately do not favour the consumer and carbon taxes will filter down to the end user of every conceivable product and service that we buy. Carbon credit trading schemes will allow non CO_2 producing countries to tax consumers indirectly, where industries like power production, fertilizer manufacturing and the oilsands are forced to buy credits to offset their emissions. There is not necessarily any economic benefit toward the environmental optimization of any industry respecting the carbon credits they are compelled to purchase as a cost of production, rather the funds will be used to subsidize "green energy" in places that don't manufacture fertilizer, don't produce synthetic oil from bitumen and in places where the primary energy production comes from nuclear and renewables as opposed to coal and natural gas. This is the future that we face as consumers of energy.

The technological challenge of sequestering the immense CO_2 emission volumes of industry in the masses that they are presently produced has not yet been addressed in any way that as of yet promises to be the answer to a reduction in overall emissions. The pilot projects that have been developed have managed tonnages in the range of 5000 tonnes per day, while in Canada, the overall emissions are 850,000 tonnes per day, primarily from coal-fired electric power generation and oilsands exploitation. Despite the Canadian and Alberta government's plan to subsidize the carbon capture and sequestration (CCS) industry, the ambition to achieve 100,000 tonnes per day sequestration remains empirically un-proven. The long-term environmental impact of massive sequestration needs a lot more study before we can accept the CCS practice as a solution. As much as we would like to embrace "inverting the stack" as the saviour to facilitate the growth of industry, employment, and energy stability, while simultaneously reducing CO_2 emissions, we cannot afford to put all of our stock in the potential of CCS. Currently there are simply too many unknowns.

To simply discount entirely the potential for CCS implementation would not be prudent as in all likelihood, it is part of the solution to emissions reduction. The $billions that have been spent on research and development have produced results. Clean coal technology of which CCS is a fundamental component, is imperative considering the abundance of coal resources worldwide and the extent to which they are now exploited. It is expected that coal-fired energy production will continue long into the future until all of the coal resources throughout the world are gone. In addition to massive CO_2 production in the combustion process, there are several other air quality issues inherent in coal usage where the molecules involved also warrant capture and sequestration. Coal is a very noxious substance to burn and its emissions become more noxious as the quality of the coal diminishes.

The historical precedent is that the diminishing quality of coal has no impact on our propensity for its use. From the perspective of environmental management, it is reasonable to expect that the CO_2 volumes produced from coal use will continue to grow at the same time that CO_2 emissions are supposed to decrease in accordance with international conventions such as the Kyoto protocol. For this reason alone, we will continue to expand the development of the CCS industry and the environmental ramifications of this technology will be better understood in the not too distant future.

Though coal fired generation produces most of the CO_2 emissions in Canada, oilsands exploitation is the fastest growing mode of production. Oilsands presently accounts for roughly one-third of the total emissions and have concentrated point sources at the bitumen production facilities near Ft. McMurray, Alberta as well as the refineries at Edmonton, Alberta. Carbon management from concentrated point sources would seem to lend itself to CCS, however, the massive volumes of CO_2 produced are already well beyond the planned but as yet undeveloped capacity for sequestration. As thermal oilsands recovery techniques accelerate, so too does CO_2 production. In the near future oilsands activity will account for 63,000 tonnes per day of CO_2. The public should not be encouraged to expect that this quantity of CO_2 could ever be sequestered at any point over the next century of oilsands production as we do not have in place the technology, the capital, or the will. The viability of the oilsands industry hangs in the balance.

The conundrum of carbon management has a different face in Canada. There are complicated reasons for this including but not limited, to the fact that only Canada has an oilsands industry. Moreover it is of further consequence that the fruits of this industry, raw bitumen and synthetic crude oil are primarily export commodities destined for the United States. This compels Canada to incur the CO_2 emissions of the export production industry where competing conventional oil producers do not have the same CO_2 problem. Carbon management has a lot more significance to the oilsands industry in terms of costs than conventional oil production anywhere else.

It is not a premise of this writing that CCS or the clean coal technology that employs it is fundamentally the wrong pursuit, rather this technology seems well designed and well suited for deployment to the coal fired electric power industry. There will be problems in its implementation, there will be adverse environmental ramifications, but any measure toward overall reduction in CO_2 emissions should be developed. Specifically, CCS may provide an answer to the use of coal for energy production and the related emission stream. CCS development may at some point be capable of handling the emission volumes of individual or small collections of coal fired power plants, but it is not now nor will it ever be the answer to the enormous CO_2 volumes produced by the oilsands. The tonnages are simply too great and the only solution therefore is to proceed with the nuclear option.

Production Upgrades

It is important to make the connection between the physical security of North America and energy independence for obvious reasons that are beyond the scope and purpose of this writing. Suffice it to say that we cannot curb North American oil production in any way in the face of increased demand. Conventional oil production is in decline on the continent and new discoveries show little promise of addressing the shortfall. North America will continue to develop and utilize all of its energy resources, renewable and non-renewable, hydrocarbon, hydroelectric, tidal, geothermal and of course nuclear. Our way of life and our socioeconomic standing are at stake.

The role of oilsands development in the equation of North America's energy future cannot be underestimated. Production upgrades throughout the oilsands are necessary to accommodate the present demand, let alone what we might expect in the future. This is why global investment has poured into the resource and will continue. Capital has historically been available for energy developments, and the diversification of supplies in the North American energy market will continue to be popular with investors.

Though estimates of recoverable oil in the oilsands vary and technology will be developed to enhance this recovery, most industry experts would agree that approximately 150-200 billion barrels of oil are economically recoverable using present technology. This fact is what has prompted the interest of the world's capital markets and this interest continues.

Long term energy planning is always in the best interest of nations, and some rudimentary math is required to put oilsands production into context.

150-200 Billion Barrels / 5 Million Barrels per Day = 82 -110 Years of Supply

That is many years of supply at the 5 million bbl production level which is 5 times the 2008 production, using existing production techniques and technology. This is obviously a long-term resource, and oil will be flowing from the oilsands long after the supplies of Saudi Arabia are tapped out. Of course, such a vast resource is better exploited using effective long-term management. This long-term management involves acceptance of public concern regarding the environmental ramifications of production, and more specifically the omnipresent contemporary concern respecting CO_2 emissions. Increased production will not only be facilitated by capital in-flow, but by increased environmental efficiency as well. Embracing this reality is just good business.

What would be necessary to allay the public concern is to proceed with an ambition to expand the oilsands production and dramatically reduce emissions at the same time. This is not only achievable using nuclear energy but it makes good economic sense. By doing so, the industry commits to an environmentally pro-active expansion agenda and gives birth to a new industry at the same time. Unlike the Canadian nuclear developments of the past, this new industry could take flight without public money, without government subsidy and with strong public support.

The opportunity cost of replacing natural gas with nuclear energy as the process energy of the oilsands, would be that domestic demand for natural gas would decrease dramatically. Though natural gas would still be required for upgrading, the burning of gas would decrease by more than 90% and gas supplies would be conserved and/or preserved. There is nothing wrong with preserving our own natural gas supplies or decreasing our future dependence upon liquefied natural gas imports. This is also good business and sustains the prospect of North American energy independence.

Nuclear Canada

Canada was quick to join the group of nations embracing nuclear energy for civilian purposes and enjoys a sixty year history of research, experimentation, development and reactor operation. The Chalk River reactor which was constructed in the late 1940's was built primarily as a research reactor. To this day it remains the world's preeminent supplier of medical isotopes, though the reliability of such an antiquated facility has recently become a problem. Canada has eighteen nuclear power reactors, sixteen in Ontario, and one each in of Quebec and New Brunswick. All of the Canadian reactors are of the "CANDU" variety. CANDU is an acronym which describes the Canadian Deuterium Reactor. The CANDU differs significantly from the more common PWR reactors which are used in most nuclear nations. The primary difference is that the CANDU is moderated by heavy water and has a simplified fuel cycle.

The Atomic Energy of Canada Ltd. and the CANDU

Canada was once a world leader in terms of nuclear plant design. This was accomplished through the sixty year old crown corporation, the Atomic Energy of Canada Ltd. ("AECL"). The development of its CANDU reactor ranks as one of the greatest Canadian engineering achievements of all time. The AECL and CANDU technology have an impeccable safety and reliability record based on decades of operational validation and more than a half century of research. This technology and these reactors have been exported to Pakistan, Argentina, Romania, South Korea, India and China.

All of the CANDU reactors built in the last fifteen years have been built in Asia. There are presently 450 nuclear power reactors in operation around the world, 32 of which are CANDU reactors. The distinct feature of the CANDU is its heavy water moderation which gives the reactor the advantage of using naturally occurring uranium fuel with little enrichment. Additionally, Advanced CANDU Reactors ("ACR") utilize on-power refueling, eliminating scheduled shut-downs and productivity interruptions.

In 1973 when the last reactor of the first four units at Pickering Ontario went active, Canada had built the world's largest nuclear power complex. In Ontario throughout the 1980's the AECL maintained a torrid pace for development completing the Pickering B facility, the Bruce A & B facilities and the Darlington facility. The total capacity of the Ontario reactor fleet is almost 14 gigawatts, but the now antiquated reactors are engaged in comprehensive re-fits that have diminished their overall productivity. This energy is vital to the Province of Ontario as it has few options available in dealing with its large growth in provincial energy demands. The AECL has also built smaller power reactor complexes at Gentilly, Quebec and Pt. Lapreau, New Brunswick.

Over the last thirty years the development of reactors in Canada remains at a standstill although the AECL has continued its reactor building in South Korea and China. Indeed, the 1979 incident at Three Mile Island and the accident at Chernobyl in 1986 destroyed public acceptance of the industry throughout the western industrialized world and the AECL suffered a prolonged period of undeserved dormancy. However, these unrelated events were not the only problem that contributed to the dormancy of the Canadian nuclear industry. Much of the problem must be shouldered by the AECL itself.

Historically when it came to the deployment of this world class CANDU technology, the AECL has long demonstrated that it will neither be on time, nor on budget. Because the AECL is a crown corporation, the cost overruns have been borne by taxpayers. These cost overruns were so significant that all of the reactors built in Canada were late in their completion, they went operational at double or triple their original budgets and this resulted in taxpayer reluctance for any further development. This reluctance was well stated by the Executive Director of Energy Probe, Lawrence Solomon, who wrote in the National Post "*Nuclear is the single biggest business disaster in the history of the world. No other technology has failed so big, so often, and so spectacularly. No other technology has needed so much help from so many governments over so long a period of time. Because of its sorry record, almost all nuclear nations decades ago scrapped their nuclear-expansion plans.*" Fortunately for the AECL, the world nuclear industry, the global environment and the people of the planet, Mr. Solomon is dead wrong.

Despite the astronomic cost overruns that have affected the world's nuclear industry and the AECL in particular, the fact is that almost all of the world's 450 nuclear power reactors now operate profitably, even in Canada. Not only are they profitable, but they facilitate energy independence for many nations that would otherwise face grim prospects in that regard, and they do so with negligible impact on the global environment. A nuclear renaissance is afoot and worldwide, dozens of new plants are in the planning and construction phases. The rush to nuclear energy involves many nations including China, the United States, Britain, Italy, Canada and many others. It is anticipated that hundreds of new nuclear power plants will be built worldwide in the next century. Nuclear power is the only way known to address the scale of the global energy demand without degrading our environment and/or disrupting the global economy.

The Canadian Nuclear Industry

The Canadian nuclear industry is comprised of uranium mining operations in Saskatchewan as well as a large nuclear power industry primarily in Ontario. Additionally, facilities for enrichment, conversion and fuel fabrication are also located in Ontario. The mining operations in Saskatchewan, as well as the uranium processing industries in Ontario, are the domain of the private sector. The power generation industry is partially private (Bruce Nuclear Inc.) but primarily public through the provincial crown corporation, Ontario Power Generation. All of the CANDU reactors in the Canadian fleet are presently owned and operated by crown corporations, though the Bruce, Ontario facility is privately operated.

CAMECO is the largest corporation involved extensively in the Canadian nuclear industry. It is publicly traded and is listed on both the Toronto and New York Stock Exchanges. Before being privatized, CAMECO was a Saskatchewan crown corporation. It is vertically integrated with uranium mining interests, enrichment facilities, fuel conversion and fabrication facilities. It also has a one-third stake in Bruce Nuclear Inc. which is Canada’s largest private nuclear reactor operator. CAMECO is the world’s largest uranium company and is headquartered in Saskatoon, Saskatchewan. In 2007, it produced more than 30 million pounds of uranium representing approximately 25% of the world’s supply. Of this Saskatchewan uranium, 80% was exported either as lightly enriched uranium or as fuel bundles fabricated to fuel the 14 CANDU reactors located outside of Canada. CAMECO has a market capitalization of US$11.4 billion and present annual profits of US$360 million. In March of 2008, CAMECO controlled economically mineable Saskatchewan uranium reserves of 750 million pounds(worth approximately US$45 billion using 2008 closing spot prixes for uranium oxide)..

Bruce Nuclear Inc. operates a nuclear power complex in Bruce County, Ontario with 6.8 gigawatts of capacity. The company is presently engaged in a multi-billion dollar refit of its first two reactors and is expected to run at maximum capacity in 2009. The company presently supplies one fifth of Ontario’s electrical power. In March of 2008, Bruce Nuclear announced plans to build nuclear reactors in the Peace River Region of Alberta. This move would see the first new nuclear power reactors built in Canada in the last thirty years. Bruce Nuclear Inc. has submitted a proposal to the Canadian Nuclear Safety Commission to build 4,000 megawatts of capacity near Grimshaw, Alberta.

The Bruce Nuclear proposal relating to the Grimshaw, Alberta area originated from Energy Alberta Inc. It had originally proposed a reactor for the oilsands near Ft. McMurray but then moved the proposed reactor site to Whitecourt, Alberta, before ultimately deciding on Grimshaw. Energy Alberta Inc. was acquired by Bruce Nuclear Inc. in late 2007. Of greater significance than the site of the proposed reactors is the purpose for the reactors. The purpose was changed from delivering oilsands process energy to supplying nuclear power to the provincial grid system. Though this would reduce emissions of CO_2 related to the Alberta power generation industry, it would not improve oilsands emissions at all. Alberta's power market is fast growing and massive upgrades in electric generation capacity are required. Even more recently, Bruce Nuclear has introduced the idea of locating this plant facility in Saskatchewan along the shores of Diefenbaker Lake in the South Saskatchewan River system.

The economics of nuclear power generation for the Alberta grid compare favourably versus nuclear process energy for oilsands. This is probably the reason why Energy Alberta Inc. abandoned its earlier plan for oilsands based reactors and why Bruce Nuclear has subsequently named Grimshaw as its proposed site. However, the need to reduce CO_2emissions, is just as important, if not more important to oilsands operators.

The new Bruce Nuclear Inc. proposal differentiated itself from Alberta nuclear proposals of the past, because it was not directly related to oilsands activity. It also seems to have opened the door to prime contractors other than the AECL. AREVA, the largest reactor operator in the world was among other companies named as potential developers by Bruce Nuclear Inc.'s CEO Duncan Hawthorne. At $10 billion ($2.5 billion per GW_e), the latest proposal is also the most inexpensive compared to those made previously by Energy Alberta Inc. The proposal is in its earliest stages and approval is not yet certain.

In June of 2008 the Province of Ontario announced its plans for a $26 billion upgrade to its Darlington facilities to bolster the Toronto and area power supply with an additional 10 GW_e of nuclear generated electricity. At the time of this writing the details of the proposal are sketchy. However, news reports have indicated that the AECL is uncompetitive and that AREVA may be the prime contractor. With the involvement of AREVA comes a measure of cost certainty and competitiveness that has never been achieved by the AECL in Canada. This move would almost certainly speed up the capitalization and development of the project.

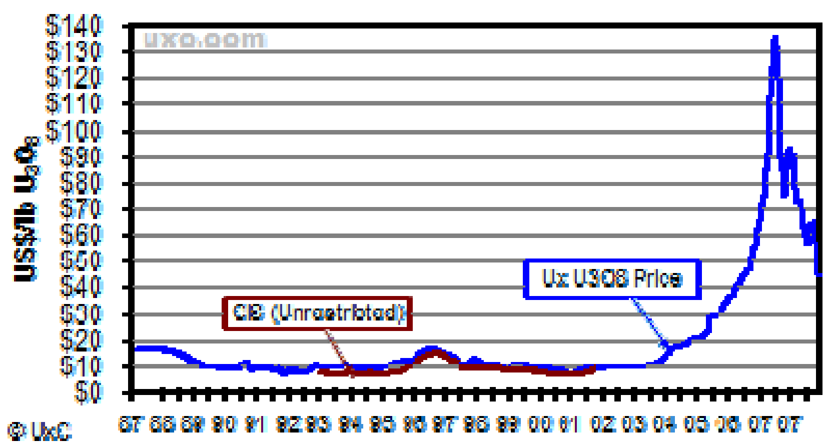
The Uranium Cartel

To accomplish any reduction in man-made atmospheric CO_2, the only established technology that can address the scale of the present energy demand and its anticipated growth into the future is nuclear energy. At this point it is arbitrary that there will be a boom in the building of nuclear power reactors, as that boom is well underway. In the not too distant future, hundreds or thousands of nuclear power plants will be built.

Since the 1970's all of the new reactors have been built in Asia. However, in 2008 new nuclear power plants have been planned for the United States, as well, Italy has announced its plans to build a dozen nuclear power reactors. Canada has plans for a $26 billion expansion and re-fit of the existing complex at the Darlington, Ontario facility, rather than a new plant. In light of this, the demand for uranium reactor fuel is rising with world prices doubling to what they were in 2006. Demand will continue to grow in proportion to the number of reactors operational worldwide.

The Province of Saskatchewan is the world's largest uranium producer. The production of 30 million pounds in 2008 constitutes 25-30% of the world's mined, non-recycled supply. Other source nations include Namibia, Australia and Kazakhstan all of which are upgrading their production capacity. None of these source countries have a nuclear weapons program, although they supply approximately 90% of the raw uranium used to make reactor fuel. Declining uranium production in the former Soviet Union and elsewhere in Africa has been offset by increased Canadian and Namibian production. However, it is expected that increased demand for reactor fuel will outstrip supply-side production upgrades within the decade. This is due to the dramatic increase in new power reactor construction. This "nuclear renaissance" is resultant of changing societal attitudes toward civilian nuclear power and the related conclusion that the nuclear option may well be the most environmentally responsible technology to address the scale of modern power demands.

World Uranium (U3O8) Price History



www.uxc.com/review/uxc_g_price.html

With Canada's status as the predominant global supplier of uranium, there is a lack of public discussion relating to the Canadian uranium export industry. Canada is among those nations that have not established a long-term energy plan, although Canadian energy exports presently include bitumen, oil, gas, coal, uranium as well as hydroelectricity. These resources are vast and production far exceeds the demand of the domestic market. Canada is in the export business. Unlike the petroleum sector, the United States is not presently the primary destination for Saskatchewan uranium. Unlike the Athabasca oilsands that could sustain a 200 year supply for export of 2 million barrels per day, the Saskatchewan 750 million pound uranium reserves will be totally depleted by 2030 based on present export levels. When it's gone, it's gone, and it is going fast. This gives rise to the strategic question, what about Canada's energy future? Is it in the best interests of Canadians to deplete our entire uranium supply primarily for present day exports? Would it not be in Canada's best economic interest to stop the growth of uranium exports while we determine what our own energy requirements will be? To whom should we be selling our resources and what trade agreements do we as Canadians want to be committed to?

It was intriguing to read recently that the United States had proposed a form of a nuclear cartel called the Global Nuclear Energy Partnership ("GNEP"), to facilitate the sale of American nuclear power technology. This proposal was unveiled by the Bush administration in early 2006. The GNEP would promote a system in which developing nations would receive nuclear power plants and fuel from the West, in exchange for agreeing not to develop their own nuclear technology. What I found most interesting was that this plan includes the supply of fuel (uranium). The United States does not have any excess fuel to sell, and as recently as 2008 it had been receiving a significant supply of reactor fuel from the Russians under the *Megatonnes to Megawatts* program entered into between the US and the Russian Federation in the early 1980's under President's Gorbachev and Reagan. Under this program, Soviet era nuclear weapons are recycled into United States reactor fuel. This program is set to expire in 2013, and in all probability will not be renewed. The United States does not have a sufficient supply of domestic uranium to sustain its own growing nuclear power industry for the longer term, unless and until new reserves are found. This would seem to diminish America's potential as a reliable exporter of the resource. Indeed, in the coming century most of America's nuclear weapons will be recycled to produce fuel for the next generation of civilian power reactors. Saskatchewan uranium currently fuels many of the world's largest cities including Seoul, Tokyo, Delhi, Paris and Toronto but not any city in the United States.

We Canadians do not relish our role as being part of a North American energy resource union. This role, under the auspices of NAFTA, requires that we cede control over the volume of our energy exports to the United States. In the face of worldwide fuel shortages, it may be an untested truth that Canadians would be compelled to export most of our fuel to the United States, even if we didn't have enough for ourselves. This applies to all forms of fuel including, coal, oil, gas and uranium. Would it not make sense to develop a long-term energy plan for Canada before we export all of our fuel resources? What will our long-term fuel requirements be and what sort of supply are we going to rely on?

For a uranium cartel to be established, precedent would indicate that the producer nations would need a controlling reserve of in order to function successfully as a cartel. In other words, the world's uranium producers would need representation on such a cartel to a similar degree as the petroleum producing nations are represented by OPEC. For the foreseeable future OPEC nations will continue to supply the lion's share of the world's oil exports, with Saudi Arabia as the leading exporter Saskatchewan is the "Saudi Arabia" of the world's uranium exports, and the province's impact on world energy markets will grow in the future.

Why would Canada, the non-OPEC primary supplier of oil to the United States, find it useful to promote and establish a uranium cartel? Why would anyone think that a uranium cartel would be a good thing? Who among the producing nations would be interested in such a concept and for what reasons? The answers can be found in the collective souls of Canadians and people of all nations. Nuclear energy for civilian energy supply is a widely accepted application, and the world is already dependent on a sustained supply of nuclear fuel. Reactors are being built by the dozens but new sources of uranium are not keeping pace. Only two new uranium mines have been established worldwide in the last 10 years. The Canadian public generally appreciates the civilian application of our nuclear fuel and clearly understands the difference between fuelling production of nuclear power and nuclear weapons programs. Canada, like all of the major uranium supplier nations, does not now, nor has it ever had a weapons program and we collectively wish that no other county did either. Some of the nations that buy Canadian uranium do have weapons programs and it might be a good idea to tell those particular nations that Canada no longer wishes to supply them with nuclear fuel unless and until they commit to eliminating their nuclear weapons. Better still, we should encourage Australia, Namibia and Kazakhstan to join us in this effort which would quickly shut-off access to 90% of the world's uranium supply to the countries that maintain nuclear weapons programs, and/or refuse to re-cycle their stockpiled weapons materials into civilian nuclear power.

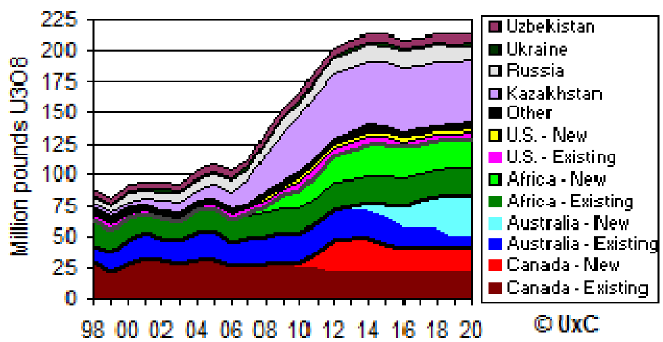
The United States, Russia, China, India, Pakistan and France are good examples of countries that have nuclear weapons programs and to varying degrees, these countries are also dependent upon civilian nuclear power. As bold as it might seem, it is in the best interest of humanity that the world's uranium exporters cooperate in refusing supply contracts to these nations unless they renounce their weapons programs.

Furthermore, it is in the best interest of humanity that the uranium producing nations cooperate with the International Atomic Energy Agency ("IAEA") in enforcing a high standard of facilities and operating procedures at the 450 plus power reactors throughout the world. If any particular program falls short of a requisite standard, sourcing uranium fuel would become much more difficult. At present, there is no means by which a country can be forced to decommission or refurbish an old power reactor, even if it operates beyond its design life at increasing peril to local populations, the global environment and the nuclear power industry. There is no mechanism by which a particular program can be held accountable for poor management practices as they pertain to the handling of spent fuel, or worse yet, the diversion of spent materials into weapons programs.

It is true that an international convention such as a uranium cartel, would in the short term, have little impact upon the wayward programs that provoke the ire of the international community. It takes only minute quantities of nuclear material to make a bomb, and such quantities are already available to these nations. In the case of the United States and Russia, each has enough domestic supply of raw uranium and spent fuel to maintain a weapons program long into the future. However, the same cannot be said about the raw uranium that will be required to produce reactor fuel over the long term. This is especially the case when the inevitable expansion of their nuclear power programs is considered. Sooner or later, all of the nations that presently engage in weapons programs or rogue management of their nuclear power industries will have to come to the market for fuel. A uranium cartel could curtail their access in the interest of the international community and make the world a safer place. It will also protect the industry from the public's apathy and outright disdain which was so strong in the wake of the Chernobyl accident. At the same time it could engage in the safe expansion of nuclear power programs that will reduce our dependence on fossil fuel consumption. Nuclear power is here to stay. It will continue to expand long into the future, and the uranium producing nations of the world have a role to play in insuring public safety.

It is reasonable to assume that those nations engaged in the proliferation of nuclear weapons would not like the idea of a uranium cartel that would refuse supply to them for their domestic power industries. Indeed, it would present them with a decision to make; to proceed with a weapons program and risk supply shortages of uranium fuel for their power plants, or alternatively to join the majority of nations where nuclear energy is limited to civilian applications. To the list of potential cartel detractors we could add those nations engaged in unsafe power programs, where their reactor technology is antiquated, or their operating regimes are not up to the international standard.

Uranium Production by Nation



http://www.uxc.com/products/rpt_usa.html

It should be understood that the primary ambition of such a plan is not to spike uranium prices but rather to enhance public safety and thwart the proliferation of nuclear weapons. It is in the long term interest of the uranium supply industry that there are no more Chernobyl type accidents and no nuclear weapons developments in rogue nations. It is inevitable that support for a uranium cartel would outstrip opposition, especially in those nations that presently supply uranium to the industry. Public safety and security are powerful motivations and this is something that can be done where the energy options are limited and nuclear power development is essential.

The Cree Lake Proposal

The Cree Lake proposal would one of the largest industrial developments in Canadian history second only to the cumulative oilsands developments near Ft. McMurray, Alberta, commencing with capital costs of $10 billion by 2015, $50 billion by 2025, and $100 billion by 2040. Moving forward, the project will become the world's largest nuclear complex and the largest power plant. It will result in the only significant reduction of manmade greenhouse gas emissions in the history of our world. In the future, nuclear power developments will form the heart of Canada's undeveloped plan for its energy future. It is expected that tens of $billions more will be spent to upgrade the capacity of the Ontario nuclear industry. Amonia fertilizers will one day be produced with nuclear power (probably at Churchill, Manitoba) for export to the world The Canadian nuclear renaissance is about to begin.

Over the 60 year design life of the project this nuclear super-complex will generate more than $1 trillion in economic return to the province of Saskatchewan, Canada and to institutional and private investors. Tens of thousands of jobs will be created. Hundreds of $billions will be paid in wages, royalties and taxes and the project will happen without a dime of public funding. The world and the United States in particular, needs the oil from the oilsands and bitumin cannot be produced without enormous quantities of process energy. Natural gas supplies will continue to diminish and there is no energy option other than nuclear, that can address the scale of the demand. The day is fast approaching when the socioeconomic benefit of oilsand's bitumen extraction using precious domestic natural gas supplies is not feasible or sustainable and We must plan and develop in advance.

With ongoing oilsands expansion using present techniques, the gas required for bitumen extraction processes will exhaust known North American domestic gas reserves in 25 years, leaving the continent void of this precious resource. This would entail that every industry and every citizen would become reliant upon liquefied natural gas imports from Iran or Russia. This is not the right direction for Canadians to proceed where our long-term energy security is at stake. At the same time, Canada is exporting her uranium resources at a rate that will exhaust our 750 million pound reserves in 25 years and that too undermines our long-term energy security.

When one accepts the premise that nuclear power is the only long-term viable option that sustains growth in the oilsands sector while dramatically reducing emissions, the question as to where the nuclear plants should be located should be discussed first. Plants have been modeled, researched and even proposed in the past. All of these proposals featured oilsands nuclear reactors located within 15 km of the bitumen deposits near Ft. McMurray. The locations in these instances were selected based on the thermodynamic limitations of steam transport through pipes to the specific area of bitumen extraction. The logic is that bitumen producing nuclear steam generators that could also produce some electrical power, would ultimately be more efficient than using nuclear generated electrical power and transmission over a distance.

One problem with the proposal to employ nuclear reactors like those modeled in 2003 by the Canadian Energy Research Institute ("CERI") is that more than two dozen plants would be required before natural gas could be replaced as the process energy fuel. 700 MW_e plants are small by modern standards, but larger reactor capacity would not be practical given the steam transport constraints. This would result in a significant loss in the economy of scale and all of the CANDUs modeled for Ft. McMurray were prohibitively expensive. The design of the plant for the dual functions of steam generation and power generation contributed strongly to the high cost estimates. More recent cost estimates provided by Energy Alberta Inc. were uncompetitive with 2008 natural gas fired process energy prices. Another major issue regarding the oilsands nuclear models and proposals is that historically, it has been the AECL doing the cost estimations which cannot be taken at face value.

The latest proposal by Bruce Nuclear Inc. for a 4 GW reactor complex in the Peace River Region would see the proposed reactors located in the westernmost area of the carbonate triangle, in proximity to some 25 billion barrels of bitumen deposits. If the entire plant capacity were dedicated to SAGD steam processes, this plant would supply sufficient energy to extract almost 300 thousand barrels per day, though it is probable that the plant would supply some of its power to the grid as well.

By proposing that reactors should be located within the oilsands region, the efficiency of the plant process was the primary parameter in the selection of the plant location. It is well known that nuclear power can be transmitted over a grid, but the cost of this transmission and the infrastructure necessary to provide it, are seen as a costly option compared to having an open-loop steam generation cycle at a nuclear reactor close by.

It is certainly my opinion that we need to re-think the type of reactors that could energize the oilsands as well as any proposed locations. Rather than a matrix of twelve or thirteen nuclear plants that populate the Athabasca Region, it is more prudent to have a high-voltage, high-capacity power grid running through the Region. If that were the case, we not only have a more comprehensive set of options as to where the plants should be located, but we can also realize the economy of scale by building one nuclear super-complex in a single location. The cost savings inherent in this proposal would more than likely surpass the cost of transmission. By going to a system of nuclear power generation and transmission, we are working with well established reactor types and known reliability. In using nuclear steam generators, we are working with reactor systems that are unprecedented in the nuclear industry.

Modern nuclear power plants can be designed to last sixty years. This life span is important given that the oilsands supply of bitumen will last one hundred years once daily production escalates to five million barrels per day. A cerebral approach to the long-term management of the industry would accommodate the anticipated longevity of the oilsands reserve with a plan to supply the required process energy. As logical as this may sound, it is not the present policy. Our natural gas supply is being used up at an alarmingly rapid rate and will not last anywhere near as long as the bitumen harvested from the oilsands. Canadian consumers and other critical industries will at some point become dependent upon LNG imports from Russian or the Middle East. Given the enormous uranium reserves in Saskatchewan and the growing concern over CO_2emissions, using natural gas for oilsands process energy is unsustainable and the use of nuclear power should be viewed as inevitable

Locating the Nuclear Super-Complex

The predication of a safe, long term operation of a nuclear mega-complex necessitates the availability of enormous water resources. There are three river systems in the broader geographic area of the oilsands projects, namely, the Athabasca Basin, the Saskatchewan Basin and the Churchill Basin. It is the Churchill Basin that has a large volume of water and is underutilized. In the past all of the proposed nuclear power developments were to be located in the Athabasca system close to the oilsands projects, where water supplies are already taxed heavily by oilsands recovery activity. In the case of the 4,000 megawatt proposal scheduled for Diefenbaker Lake, it is in the South Saskatchewan River system.

As we move away from the notion that plant efficiency should be the primary parameter in deciding a suitable nuclear plant location, it is necessary to establish the criteria upon which the location decision should be made. Once these criteria are established, their order of priority is also relevant to the decision. The success of any valid proposal is dependent upon public support, investor acceptance, as well as a practical design. These parameters are prioritized as follows:

1) Public Safety
2) Environmental Efficiency
3) Economic Feasibility
4) Sustainability

The issue of public safety is paramount. Though the safety of the nuclear industry is well-established and has been validated over the long term, the propensity for the public to be impressed with the argument of the devil’s advocate cannot be underestimated. The public must be convinced that the proposed project is safe before any acceptable level of support can be expected. The accident at Chernobyl and the incident at Three Mile Island are more prominent in the public attitude toward nuclear power than are the continued outstanding performance of the world’s 450 other nuclear power reactors combined. This is unfortunate, but true.

Since 1986 there have been no other known incidents that have threatened the public’s safety anywhere in the world. In the interest of public safety, nuclear energy operations throughout the world operate in a hyper-regulated environment and their continued successes can now be measured by a shift in public opinion.
Unlike other forms of energy production, nuclear energy has a global watchdog in the IAEA. The IAEA`s mandate is to insure that the regulatory regimes in any particular nation are up to world standards and that national nuclear energy programs do not become instruments of weapon production. When the North American industry went into

dormancy, civilian nuclear power was just getting started elsewhere in the world. More than 80% of the 300 plus nuclear reactors operating outside of North America began operating after 1979 when the newest of the North American fleet went active. Since 2000 another 57 international plants have come on-line or are presently under construction.

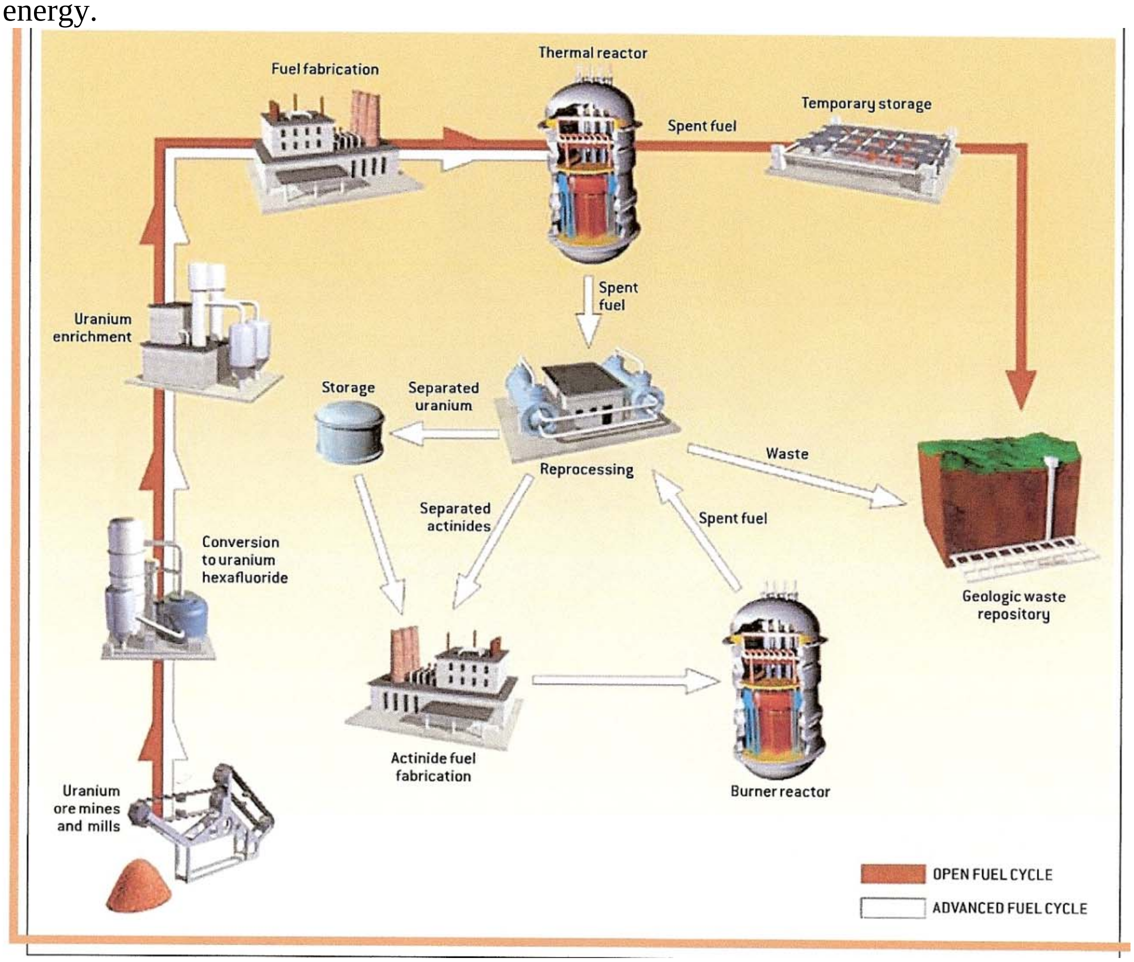
Public acceptance for the civilian nuclear industry is growing. The reason for the change in societal attitude toward nuclear power is partially due to the safe operational validation that comes from decades of service, but the primary draw is the environmental efficiency of the industry. The public is genuinely concerned about CO_2 emissions so much so that oilsands development proposals face regulatory scrutiny based on their potential emissions and this is a threat to the future of that vital industry. In early 2008 in response to a lawsuit launched by the Sierra Club, the Federal Court of Canada rejected Shell Oil's Kearl Oilsands Proposal for development precisely because of the emissions potential and public concern over global warming. Though the project eventually was approved, the new focus on emissions was a departure from the past.

However, the potential for emissions reduction is not the only public consideration respecting the acceptance of nuclear power. It is well known at this point that the public is also concerned about nuclear waste and specifically spent fuel waste. This is unfortunately one area that the Canadian nuclear industry has not managed effectively. Any present sampling of public opinion would demonstrate that concern for the management of nuclear waste material is very strong indeed. Fortunately, there is precedent in the industry for more effective and efficient means of dealing with this spent fuel. We in Canada have something to learn from the examples set by the British, Finnish, Japanese, French and others. As the new technologies are proven, making nuclear power less waste intensive is practical and commercially viable. Commitment and investment are all that is required.

When the primary parameters of public safety and environmental efficiency are addressed, the availability of water is also important to the viability of a nuclear proposal. This is certainly the weakness of prior proposals that would have located reactors within the oilsands deposits. It is noteworthy that all of the CANDU reactors in Canada are located on or adjacent to large bodies of water, as are most reactors throughout the world. However, in France power reactors were built inland without open access to water. Ambient air temperatures are often too warm for adequate cooling, thus reducing the output capacity of the reactors and causing the French to re-think the practice of building the complexes inland. Unlimited access to cooling water is primarily a redundant safety feature, but it would not be practical anywhere in the Athabasca drainage basin.

The issues of public safety and environmental efficiency are very important with respect to determining where the nuclear reactors should be located. In the case of nuclear energy for the oilsands, making the decision to embrace nuclear electrical power and transmission over a distance, as opposed to nuclear steam generation within the oilsands deposits, opens up a wide range of possible locations for a nuclear super-complex. Though it is true that high-capacity transmission is expensive, it is not cost prohibitive over a reasonable distance. Using available high-voltage DC transmission technology, transmission over very long distances is practical. Transmission can accommodate the "base-load" effectiveness of a nuclear power complex and tie-ins with TransAlta's Northern Lights grid interconnect.

If high-capacity nuclear power generation for oilsands process energy is the primary industry to be initialized, there are secondary industries to be considered as well. There is already a large uranium mining industry in Saskatchewan that can readily supply the demands of a power industry but there are other stages to the fuel cycle that would be practical on location as well. Specifically, it is eminently practical and not overly ambitious to propose that the entire fuel cycle should be considered for the region. It simply does not make sense to mine the uranium in Saskatchewan, ship the yellow-cake ore to Ontario to be processed and fabricated into reactor fuel, and then ship the fuel bundles back to Saskatchewan to fuel the reactors for the required electrical process energy.



Scientific American – August 30, 2006

The functions of spent fuel storage, reprocessing and disposal are not pertinent to the open fuel cycle. Unfortunately, in the Canadian nuclear industry, only the storage of spent fuel has so far has been utilized and any long-term solutions that have been proposed have never been undertaken. If Canada's nuclear industry is going to expand in order to energize the oilsands, then the long-term waste management details will have to be explained to the public.

As time has moved forward in the long shadow of the Chernobyl accident, public concern regarding the operation of nuclear power facilities has shifted from the possibility of a similar catastrophic event, to the issue of nuclear waste management and disposal. In many recent surveys, public forums and related press articles the issue of waste management and disposal has demonstrated itself to be an over-riding public concern. The issue is particularly problematic because unlike the British, Finish, Japanese and French nuclear energy programs, there has been no implementation of those solutions widely regarded as the safest and most promising in North America. Canada's Nuclear Waste Management Organization ("NWMO") has developed permanent disposal techniques and has successfully built upon the research and development of its predecessor, the AECL's Waste Technology Business Unit, but their cost estimates for repository development are in the tens of billions of dollars. Though the research has continued for many decades in Canada, the programs of other nations have proceeded to implementation of fuel reprocessing, as well as safe and permanent disposal. The Finish are now constructing the Posiva Project, a facility designed for the reprocessing, short and long term storage, and permanent trans-millennial deep geologic disposal of fully processed spent fuel that their program produces. The "once-through" fuel cycle of the Canadian CANDU is an incomplete process, but Canadian operators have always preferred it given the capital costs associated with reprocessing and repository development. It has always been cheaper to make new fuel from raw uranium and store the spent fuel on site indefinitely.

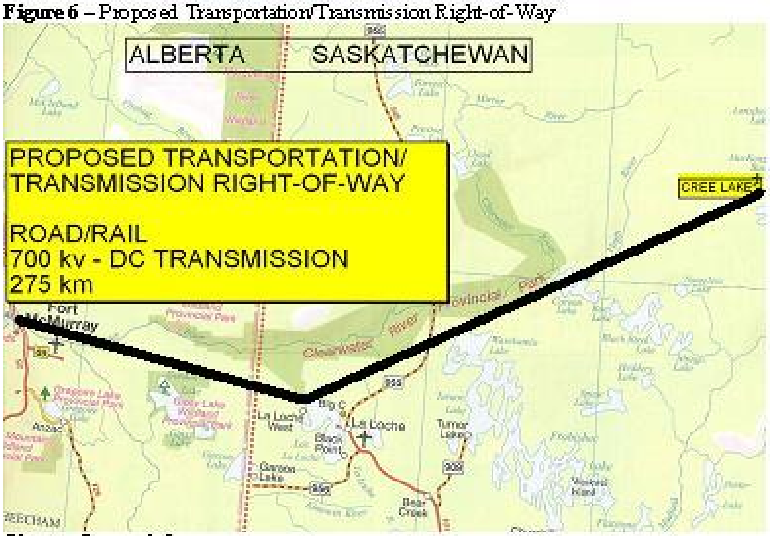
When a nuclear plant location is considered to supply process energy to the oilsands, it makes sense to address the issue of waste management at the same time. What will this super-complex do with the high-level waste that it generates? If this question is answered in advance of any development, the potential for more widespread public support is strong. What if this proposal included the full fuel cycle? What if we could build a nuclear energy facility to fuel the oilsands and reduce emissions by 90% using Saskatchewan uranium? What if we could build a facility that converted and fabricated its own fuel and reprocessed its own waste using state of the art waste management and permanent disposal? The answer is: We can!

If we want to build a nuclear facility that has full cycle operations including a repository, we would need to find a more stable geology than that which is found throughout the Athabasca Basin. According to research, we would need to move east to the Canadian Shield. When we do that we can simultaneously address the availability of water resources by situating the complex in the Churchill Basin. In this location water is ample and water usage is virtually non-existent. This takes us back to the very region where the uranium is being mined; back to Saskatchewan.

The proposed project is the construction of a multi-gigawatt nuclear generating station near Cree Lake, Saskatchewan, approximately 250 km north-east of Ft. McMurray, Alberta. This remote location is on the western edge of the Churchill River basin 550 km north of Saskatoon, Saskatchewan and 850 km north of the Montana border. The site is just east of the Athabasca Basin on the western edge of the Canadian Shield. The project should be scalable, commencing with the Phase 1 construction of a 3.6 MW, two reactor complex with suitable turbine capacity and 700kV – DC transmission lines west into the carbonate triangle near Fort McMurray. The transmission right of way would run north of Clearwater Provincial Park though to the Alberta oilsands. Scalable in this context implies that further reactors generating capacity and transmission lines, should be added over time as revenues will accommodate, the demand will justify and transmission infrastructure will allow.

I really don`t want you to use the following one!!!

Figure 6 – Proposed Transportation/Transmission Right-of-Way



Phoenix Research Inc.

Why Cree Lake? Why 275 km from Ft. McMurray as opposed to something closer? The real cost of nuclear power includes not only uranium, enrichment, conversion, fabrication costs, in addition to facility capital but the cost of disposing of spent fuel. The answer in the case of this proposed project, is to establish a state-of-the-art disposal repository and reprocessing facility on site. This will provide great safety and environmental benefits in addition to excellent economic return.

Geologically speaking, Cree Lake is located on the Athabascan group of Precambrian rock. The sub-Athabasca basement is comprised of very stable Achaean gneissic granitoid rock. Using this location to construct the nuclear plant minimizes the potential for earthquake damage, the effects of volcanism or any natural weather phenomena.

Cree Lake is a good place within a fixed geographic area the size of Lake Athabasca that a facility could be developed which would integrate the functions of uranium mining, milling, fuel fabrication, nuclear power production and transmission as well as safe reprocessing and permanent disposal of spent fuel. At this location there is virtually an unlimited potential to deliver the power given the transmission capacity.

Though nuclear reactors supply less than 8% of the North American energy market, that share of the electrical power market has risen from 11% to 20% over the last 25 years. The added production is the result of plant efficiencies and operation near capacity of existing plants. Worldwide, nuclear power supplies 17% of the total energy market. When you consider that Saskatchewan already supplies approximately 33% of all the uranium oxide produced in the world, that would also indicate that Saskatchewan supplies 33% of 17% of the world's energy, or almost 6% of the world's total energy output. When you compare that with Alberta's oil production of approximately one million barrels per day, or 1% of world production, you can see that Saskatchewan already exports a lot more energy than Alberta. The difference is in the revenue generated and the economic return. When Saskatchewan's $50 billion in uranium reserves (2008 closing spot prices) are viewed in the context of the economic potential of nuclear power generation there is a potential for $trillions in total economy, and longer term viability.

Worldwide uranium production over the last fifteen years has fallen some 20%, though Canadian production had remained consistent. Why is this the case? Obviously global energy demands have not diminished, so what is going on? Half of the world's nuclear fuel is presently produced from decommissioned weapons, but this supply will not last. Canada already has a large nuclear power industry that relies on Saskatchewan uranium but even older reactors can be made more efficient. In other words, greater depletion of the fuel means less fuel is required. Scheduled shut-downs of power reactors for refurbishment including Canadian reactors also diminish the need for uranium production.

The modern era has introduced us to a new realm of security concerns. This is especially true with regard to the nuclear power industry as it has become a serious concern that a reactor site would become a terrorist target. The events of September 11, 2001 introduced the plausibility that nuclear facilities could be attacked in a similar way.
Security initiatives surrounding existing North American reactor sites have made them less vulnerable, but no amount of vigilance can guarantee that terrorists will not attempt to attack a reactor site. However, given the logistical challenges to its access and the absence of a target population, it is extremely improbable that the most remote reactor site in the world would be considered a practical terrorist target. The Cree Lake Project would be the world's most remote and secure reactor site.

There are other reasons why Cree Lake is the ideal location for such a project. There is a strong potential for vertical integration within the industry. CAMECO is a world powerhouse in uranium production and could be a valuable partner in a development of this scale. Bruce Nuclear Inc. which is one-third owned by CAMECO has already proposed a similar reactor development for the Peace River Region of Alberta. The oilsands producers have large reserves of cash in the face of US$100 per barrel oil. The process energy market is already in place. The labour force developing at Ft. McMurray would be a valuable asset to this project, as opposed to any attempt to develop the necessary workforce starting from nothing.

From a public safety perspective there is no question that a remote plant location is preferable, as is the case in this proposed development. The population within a 200 km radius is less than 400 people, many of whom are employees of the various uranium mining operations. This regional population density is among the lowest found anywhere in the world. No other nuclear plant features such an extensive natural population buffer.

The issue of available water resources cannot be understated. Nuclear power generation is a closed-loop process that does not pollute its cooling water, but the availability of large water resources can and does facilitate greater production of power. Abundant water is an important safety consideration, which is why all of the power reactors in Canada are located on, or adjacent to large bodies of water. Oilsands production upgrades are significantly taxing the flow of the Athabasca River for use in the thermal recovery of bitumen, especially with winter flows. Establishing nuclear reactors within the Athabasca Basin potentially exposes the industry to water constraints that would reduce output. Alternatively, the Churchill River is underutilized and ultimately flows into Hudson Bay.

An economy of scale can be realized by building larger reactor capacity. This fact was previously mentioned as a caveat upon prior proposals to locate the reactors within the bitumen deposits. In the contemporary realm of reactor construction, larger is better for this reason. The growth of the oilsands industry will require a vast quantity of process energy (presently nearing one million GJ per day. It is estimated that it could be three million gigajoules per day by 2025 if production were to reach five million barrels per day. In order to eliminate 90% of the total CO_2 emissions from oilsands operations attributed to the thermal recovery of bitumen, we would need to plan for three million GJ per day of electrical energy production.

3,000,000 GJ per day = 34.7 GJ/s = 34.7 GW

This is an enormous energy requirement. The plant would be many times larger than the largest nuclear plants that have been constructed anywhere in the world to date, but the size represents the demand potential. We have to start somewhere, and indeed it will be necessary to start with much smaller capacity than that which will eventually be required.

Based upon the 2010 demand of 1 million GJ per day, 12 GW of reactor capacity are required with an estimated 2008 capital cost of $24 billion.

Nuclear Energy for Wastewater Processing

To legions of environmentalists, the oilsands tailings ponds represent the other Achilles' heel of oilsands production. The process water requirements are enormous, and most of that water ends up in massive tailings ponds. These tailings ponds constitute some of the world's largest man-made structures and collectively contain billions of cubic meters of contaminated water. In its present state this water cannot be reintroduced into the Athabasca River system or even recycled to the process. This water is a murky, salty mix of Athabasca River water, suspended clay, sand particles, hydrocarbon residues, cyanide, arsenic, sulfur and numerous other compounds.

The tailings pond is a long-established method of dealing with contaminated process water from industry. Historically these structures have remained a toxic mess long after the mining operations that created them have moved on. The economic reality is that there are few options for industrial wastewater that are cost-competitive with tailings ponds. That is the reason why the oilsands industry has not reprocessed this water, electing instead to draw fresh water from the Athabasca River. The cost of reprocessing contaminated wastewater varies according to the level and type of contaminants, and reprocessing this wastewater takes a lot of energy that someone has to pay for.

When 90% of the process water used in oilsands exploitation ends up in tailings ponds, the sheer size of these structures and their contained volumes of contaminated water challenge the imagination. For more than four decades, this water has accumulated in these ponds and collectively comprises more than 150 hectares or 24 square miles of area behind dikes at tall as 100 metres or 330 feet. To these toxic reservoirs we are presently adding an additional 1.6 billion litres of wastewater per day and the rate of effluent water production rises with production. Some oilsands producers are working hard on the problem, and the recycling of wastewater is an active pursuit. However, as of 2008 there is no practical method or long range plan to deal with the problem.

Bitumen recovery processes like SAGD, enable the recovery of most of the water that has been injected as steam, yet even this water is not suitable for re-use and ultimately ends up in the tailings ponds. Oilsands producers are working and developing ways to recycle the process water to facilitate growth in production. Cleaning up the water is an energy intensive process and the economic practicality of doing so is diminished by high energy prices as a component of production costs. Any environmental benefit of cleaning up the water would be diminished by CO_2 emissions produced if the required energy that was produced comes from gas or bitumen. However, nuclear energy could be used extensively for this purpose.

Whether the contaminated water is filtered, distilled, centrifuged, electrolyzed to produce hydrogen or processed in some other way, the energy input requirements will be significant and therefore impractical where gas is in short supply or is prohibitively expensive relative to bitumen prices. This does not diminish the need for water reprocessing where the tailings ponds are unsustainable due to their massive contained volumes and the rate of increase in those volumes. If one or more of the mammoth dikes that contain this contaminated water were to fail, it could represent an environmental catastrophe downstream all the way to the McKenzie delta. The advent of nuclear powered water re-processing is essential and ultimately will be well worth the associated costs. The Athabasca Basin is critically short of fresh water and the need for reprocessing climbs with increased oilsands production.

We already have carbon filtration technologies capable of handling high volumes of dirty water and the need for a solution for oilsands waste matter has never been greater. Cleaning up the water will not be as cost effective as dumping it in tailings ponds, but the advent of nuclear process power will go a long way towards insuring cost certainty and improving upon the environmental consequences of this vital industry. With increased environmental efficiency, the public attitude toward industrial expansion in the oilsands sector will be enhanced. Jobs will be created and the sustainability of local water resources will be insured.

The world price for crude oil has a major influence on what may or not be practical in terms of cleaning up the oilsands. The divergence between oil and gas prices has a capacity to undermine the economic practicality of nuclear process energy, for both waste water processing and bitumen recovery. Given the capital costs of a nuclear development, gas at $10/ gigajoule is impossible to compete with when bitumen prices are greater than US $50 per barrel. However, it is reasonable to expect, that the price for gas will go up as world supplies are depleted. Not only does this potentially make nuclear energy cost competitive for bitumen recovery, but in the case of high gas prices it may well make the electrolysis of water competitive for hydrogen production. The industry needs a lot of hydrogen for upgrading the bitumen, and making it from wastewater cannot be discounted given the value added by the upgrading process and the rapidly diminishing supply of gas.

The electrolysis of water to produce hydrogen is energy intensive and at present prices not competitive with producing hydrogen from natural gas. However, using nuclear energy to produce hydrogen from effluent does not produce CO_2 as is the case when gas is used. Instead, the electrolysis of water would produce pure oxygen in addition to hydrogen along with a precipitate of contaminated residues that would ultimately be far easier to manage and contain than holding contaminated water in tailings ponds indefinitely. This process would also enable the recovery of copious quantities of bitumen from the waste water, as well as other usable organic compounds such as polycyclic aromatic hydrocarbons and naphthenic acids that are extremely toxic to the environment and presently abundant in the tailings ponds. Producing hydrogen in this manner also relaxes the requirement for natural gas and preserves supply of this valuable energy source.

No new regime of waste water management for the oilsands would be complete without some discussion about negative prospects of returning processed water to the Athabasca River system. Some oilsands companies are increasing their use of brackish water drawn from deep aquifers, which has a capacity to change the water table levels with corollary and incidental impact to the broader environment. This practice also adds to the salinity of the wastewater and accordingly, to the cost of reprocessing as the salt must be removed before the water is suitably clean re-use in the process. Desalination of water is energy intensive and creates a lot of surface-stored dry salt waste concentrated brine water being pumped back into the aquifers.

When the cost of desalination of the effluent is considered rather than the less expensive, but environmentally dreadful tailings pond concept, the economic feasibility relating to the utilization of brackish water is questionable. The economic motivation to use it in the first instance relates to the regional shortage of fresh water that would otherwise be preferred for the industrial processes. The amount of bitumen that can be produced by the oilsands producers is proportional to the amount of water available and more growth in the industry means more water is required.

By using nuclear energy to power water purification on the scale needed to address the process water requirements of the oilsands industry, the use of brackish or fresh water could be discontinued by replacing it with recycled process water from the tailings ponds. The natural flow volume of the Athabasca River could be partially or even fully restored, and the tailings pond environmental problem would have a long-term solution. Nuclear power is the only way by which these ambitions could be realized, where the energy demands would be huge and energy cost certainty essential. When you have one of the world’s most productive oil installations making the world’s biggest tailings ponds, the world’s largest nuclear complex will be very important to the long-term viability of the industry.

21st Century Nuclear Safety

From a public safety perspective there is no question that a remote nuclear plant location is preferable. As a remote and isolated location, Cree Lake would be an ideal place to develop what would become the world’s largest nuclear power complex. With a very sparse regional population, many of whom are employees of the various surrounding uranium mining operations, the population density is among the lowest found anywhere in the world. No other nuclear plant would have such a population buffer and in the extremely unlikely event of a radiation leak, no other complex would be as safe.

The events at Three Mile Island and Chernobyl have cast a dark cloud over the civilian nuclear industry and strongly contributed to the long dormancy of a vital energy industry in North America. Nuclear development can become a political issue and the consistency of government policies is essential given the long lead times, the high capital costs and life spans of nuclear reactors. More importantly, public support is essential and for the first time in more than 25 years, there appears to be a majority of citizens onside.

All of the CANDU nuclear reactors in Canada are adjacent to large bodies of water, most of them on the shores of Lake Huron. This provides for excellent safety owing to infinite cooling capacity. Cree Lake, Saskatchewan is also a suitable body of water on which to locate a large nuclear reactor complex. It is possible to situate a nuclear plant without a large body of water in close proximity but that is something we have yet to do in Canada.

The safety logic in locating a power reactor near abundant water, is that in the event of a major malfunction affecting the dedicated supply of cooling water, a secondary and ideally unlimited supply of water would be available. It should be stressed that this coolant water is cycled outside of the radiation loop and is therefore not subject to radiation contamination. Though secondary cooling options are redundant, they nevertheless contribute to the design safety factor which must be higher for nuclear reactors than for any other type of industrial installation. In all probability, the availability of water resources is the primary reason why none of the reactors that have been modeled for the oilsands have ever been developed. There is simply not enough water in the Athabasca River to satisfy the requirements of a new nuclear industry in addition to the drawdown of the oilsands industry. With lower winter flows and the propensity for draught affecting the region, the Athabaska River is a limited resource incabable of sustaining any other industrial expansion..

One reason to locate a nuclear complex in a remote and virtually uninhabited geographic area is to provide an enhanced measure of safety. Another good reason is that Cree Lake is an ideal place for a repository development to accommodate the spent fuel produced by the plant. The management and reprocessing of spent nuclear fuel bundles needs a lot of improvement in the Canadian context and it makes sense to address this public concern in advance of any development. The major weakness of the Ontario nuclear power industry is its method of nuclear waste management which accumulates in onsite storage tanks for an indefinite period of time. However, the transporting of these highly radioactive spent fuel bundles to another location is not worth the risk in the interest of public safety.

The long term plan for the Cree Lake development would include a small, secondary burner reactor that functions to reprocess old fuel into new fuel. An integrated complex that incorporates fuel fabrication and reprocessing with an adjacent repository will be the gold standard of safe nuclear power production.

Canada has done much research on the design and operation of nuclear repositories. The AECL built a research repository at Pinawa, Manitoba which they subsequently decommissioned in 1998 after 4 decades of operation. The successor manager of Canada's spent fuel materials is another crown corporation, the Nuclear Waste Management Organization (NWMO). The NWMO has presented plans for a repository to be located somewhere in the Canadian Shield, to accommodate the volume of spent nuclear fuel that Canada has produced in her first half-century of nuclear power production. This plan would cost more than $20 billion to realize and for this reason will remain unfunded and perpetually on the drawing board. The use of onsite storage tanks at Canada's existing nuclear power complexes will continue to be a major safety and security concern.

To secure public support, waste management in the 21st century must be improved upon. For the first time in Canada, the spent fuel regime at any new development should close the loop of the nuclear fuel cycle and stop producing high-level waste. This method is not new and extensive programs are already employed in other nuclear nations such as Japan and France, where fuel is recycled and re-used to effect complete depletion. Spent materials may be stored for long periods of time before reprocessing, but the concept of "permanent disposal" should be replaced by "permanent reprocessing." This will require new reactors and significant investment but will be well worth the cost. The best solution to the nuclear waste problem is not to create any, or at the very least, produce such small quantities as to enable easier management.

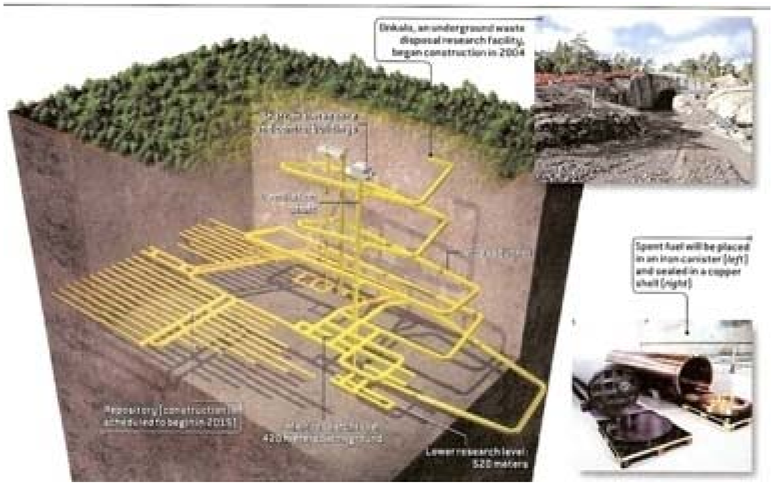
The use of a secondary burner reactor enables the fission of the uranium 238 isotope, or 99% more of the uranium oxide (U_3O_8) used as fuel; plutonium is produced which is then manufactured into new reactor fuel. The short, intermediate and long term storage of spent fuel can be integrated into the Cree Lake reactor complex by locating it underground in stable granitoid rock formations. This highly secure repository and secondary reactor would be self-contained and insure that radioactive materials would never leave the site. This program will enhance public safety to a degree which will be unprecedented in the annals of nuclear development. Continual reprocessing with no permanent waste[5] is the new path to public support.

One proposal from the past suggested that Saskatchewan's ideal geology made it a good candidate for a commercial nuclear repository, where spent fuel materials from far and wide would be concentrated and disposed of on permanent basis. Though the geology is indeed conducive, transporting such materials to this proposed repository would ultimately be too dangerous and the idea was not well received. It should be clearly understood that the repository design featured in the Cree Lake proposal, involves the storage and reprocessing of waste material created by the Cree Lake complex only. It is certainly the opinion of the author that other programs should pursue their own waste solutions. Saskatchewan will never become a nuclear waste dump for any other program and the design of the reprocessing loop at the Cree Lake facility, would have the capacity to handle only those quantities of waste material locally produced.

To put things in perspective, the expected volume of spent material produced over time and in need of storage and reprocessing must be stated. Even if enough reactor capacity were developed to accommodate the total process energy supply of the oilsands industry in 2015 (1.5 million GJ/day), the amount of high-level nuclear waste produced over the next 50 years would be less than 100 tonnes. That is the equivalent of two full railroad cars. In exchange for this small amount of high-level nuclear waste to be reprocessed, we will have eliminated the production of 95 thousand tonnes of CO_2 on a daily basis.

The small repository at Cree Lake will be a state of the art facility featuring a design based on the extensive research of the AECL, the NWMO as well as the larger Posiva ONKALO commercial repository design under construction at Olkiluoto, Finland.

[5] The expected volume of high-level nuclear waste material produced by a family of four over a 20-year period would be approximately 50 cc, about the size of a roll of nickels.



http://www.posiva.fi/englanti/tutkimus_esittely.html

The functions of wet staging and long term spent fuel storage will take place hundreds of metres below ground. The research would indicate that there is no known nuclear waste management method safer than this and correspondingly, Cree Lake is an ideal place to employ the practice.

The novelty of a nuclear power plant with integrated waste reprocessing and a repository provides enhanced worker and public safety by eliminating the transportation of high-level nuclear waste material. Such a facility will feature full-automation in the handling of spent nuclear fuel with an Automated Storage and Retrieval System that transports spent fuel from the re-fuelling process underground into the repository for storage. The Cree Lake project will be the safest nuclear plant in the world, bar none.

State of the art safety must include 21st century security as well. The events of September 11, 2001 heightened public awareness toward the protection of nuclear plants. Keeping this in mind, security has been improved throughout the continent. A strong measure of security is realized by locating the plant in such a remote area and after the initial construction phase, access to the complex will be restricted. There will be no town at Cree Lake and there will be no road in. The plant will be operated by a rotating work force resident in a camp facility. Transportation to and from the project will be by air or by rail from Ft. McMurray.

On the periphery of the Canadian Shield where it meets the Athabasca Basin, the geology is remarkably stable and the probability of any significant earthquake is very low. In this regard, the Cree Lake complex will be better situated than any other North American plant. Risk of damage to the plant facility or the transmission infrastructure from forest fires which may pass through the area from time to time can be minimized by maintaining a vegetation free buffer in proximity to the required structures.

Megaproject Economics

The omnipresent fear of the nuclear economic “white elephant” stirs considerable apprehension among Canadians, particularly those old enough to remember the taxpayers’ exposure to the astronomic cost overruns associated with the CANDU developments in Ontario throughout the 1970’s. Critics of nuclear power development often seize upon this economic history and use this past budgetary performance to admonish its future. Canadians are not alone in this regard as the nuclear industry has grappled with budgetary fiascos throughout the world. In most cases, the taxpayers were made to foot the bill. In the case of government owned and/or operated nuclear power facilities, there was little distinction between taxpayers and ratepayers or for that matter, a tax increase and a utility rate increase.

The AECL’s performance relative to budgets and deadlines remains the poorest among the world’s nuclear reactor developers. Alternatively, AREVA, Westinghouse and Hitachi have shown dramatic improvement in their respective economic performances, the AECL has gone on to demonstrate that even the tiny Maple research reactors at Chalk River, Ontario were too much for the crown corporation to handle. After going over budget in multiples of the original cost estimates, and being more than a decade late, the project was mothballed by the Canadian government in 2008. The AECL continues its work on the $multi-billion Bruce A refurbishment, as well as the proposed $multi-billion expansion at Darlington, neither of which is likely to be on time or on budget. This is a sorry legacy and has done considerable damage to the industry as far as the Canadian public is concerned.

For a project as large and complex as the Cree Lake proposal to get off the ground, the public fears of repetitive history must be put to rest. The best measure in this regard is to ditch the idea of taxpayer participation for the capitalization of the plants and put these capital costs upon the equity markets and private investors. If the necessary capital cannot be raised there, then the project simply is not viable. The government does have a role to play, not as an investor, but as a regulator and facilitator. The project must stand on its own for the raising of the capital costs, or for that matter, cost over runs. This is the only way that this megaproject will materialize and although this is a daunting challenge, the reality of our future energy requirements encourages much optimism.

Government can help initialize the industry by minimizing royalties and taxes. The Alberta boom set the precedent with more than hundreds of $billions in oilsands developments, all of it funded through private investment and energy revenues. If enough capital could be raised on the markets to fund 100’s of $billions in oilsands developments, why would they not also favour spending tens of $billions for the nuclear facilities necessary to facilitate production and sustain growth? If the oilsands production will last 100 years, why should we not build nuclear power plants that will last more than a half century to fuel that production? Why should we not conserve or preserve billions of GJ of gas and at the same time dramatically reduce CO_2 emissions? When these questions are put to investors, the project begins to look quite attractive. Investors seek a stable rate of return and the Cree Lake proposal shows great promise.

The Alberta government provided a royalty holiday to megaproject developers so that $billions could be raised from investors all over the world and the impact of that inducement should not be underestimated. Raising the oilsands capital would not have been possible without this tax concession and there is no good reason why the Saskatchewan government would not appropriate the same provisions to create their own megaproject economy. Accelerating the capital cost allowance for megaproject developers requires federal government co-operation, and here too there are excellent reasons for favourable legislative co-operation. Investors expect a rate of return, and governments, on behalf of the people, want jobs, energy security, and better environmental practices.

If the Saskatchewan and Federal governments were to provide the same tax incentives to industry that facilitated the Alberta oilsands boom, the Saskatchewan nuclear power industry would attract money from the capital markets just as readily as did the oilsands companies. It did not happen overnight. The original Syncrude/Suncor oilsands projects started with $2 billion in the 1970's, but worldwide demand coupled with scarcity of oil resources eventually drove price levels high enough to reward the investors and expand the industry. The oilsands projects turned out to be the biggest energy development in the history of our continent, and no one predicted this phenomenon thirty years ago. The development of Saskatchewan's nuclear power industry will happen in a similar fashion, likely in the amount of $10 billion first, then $20 billion, then $30 billion and so on. Based on the present and projected energy demands, the number of nuclear reactors necessary to accommodate those demands and the requisite transmission infrastructure, a lot of capital investment will be required.

With the ongoing worldwide expansion in the nuclear power sector comes a very useful practical validation of construction costs for new reactors. Commercially available large reactor complexes have a 2008 market cost of US$2.5 billion/ GW_e capacity with an economy of scale favouring the larger developments. The largest nuclear power plant presently under construction at Olikualo, Finland (AREVA/Siemens) had an original budget of $4.5 billion for 1.6$GW_e$, but is 50% over budget and will not be ready until 2009, two-years late. That implies that the actual EPR reactor cost is $4.2 billion/$GW_e$ for a pilot single reactor, though an economy of scale and the experience of construction should lower that price dramatically. For the multiple 1.6GW_e EPR reactor complex it may be possible to lower that price below US$2.5 billion per GW_e. Pricing nuclear reactors is the domain of the reactor builders, not energy writers, and those costs fluctuate with market conditions. For purposes of raising money on the capital markets, any form of cost certainty is a powerful promoter.

After spending $10 billion to finance the first 3.2 GW_e of power production, such a plant would have annual revenues of $1.01 billion operating at capacity, using $10 per GJ as the benchmark sale price for the energy produced. The proposed complex would have no operating revenues during the 5 year construction phase when the initial $10 billion in capital would be spent. It has long been a feature of energy developments that conventional fossil fuel fired power production is very sensitive to fuel costs, whereas nuclear developments are more sensitive to interest rates. The lower the interest rate, the more competitive nuclear energy becomes.

Transmission infrastructure must also be capitalized to accommodate the large nuclear power reactors are that are built. Overland transmission lines supplying the power from the Cree Lake nuclear complex to oilsands facilities throughout the Athabasca Region will cost $billions more on an incremental basis. Transmission infrastructure developments are far more cost effective when they stretch over unoccupied, undeveloped Crown land than they are when private property must be acquired for the easement. When the capital can be spent on developing transmission capacity as opposed to acquiring or leasing private property on which to locate the transmission lines, there will be a significant cost benefit to investors. As more nuclear reactors are added over time, proportional upgrades to the transmission infrastructure will also be necessary. As is the case with the Cree Lake complex, the development of the necessary transmission capacity should also be capitalized by private investors.

Using rudimentary economic analysis[6] to annualize nuclear plant capital costs over the design life of the proposed Cree Lake project (per GW_e) we arrive at a yearly capital cost of $186 million per GW_e. Adding fuel and operating costs of 10%, the total annual costs to the plant gate are $204 million per GW_e, or $6.48 per GJ. Adding a 15% rate of return brings us to $7.45 per GJ. Adding another 15% for transmission costs and line losses gives us a figure of $8.57 per GJ. This figure is close enough to get the project off the ground. What is needed next is a public commitment to proceed.

Who Should Build the Cree Lake Reactors?

With all things considered relative to the construction of what will become the largest nuclear complex in the world, it is plausible that there will be considerable work for all of the nuclear plant developers in the world. The AECL, Bruce Power, Unistar Nuclear, AREVA, Hitachi, Siemens, Westinghouse, General Electric and others should be invited to submit proposals. Just as the oilsands have thus far been developed in most cases by the world's largest oil companies, the process energy nuclear complex to supply continued production of bitumen should be developed by the world’s largest nuclear companies.

AREVA, an atomic energy giant which is 96% owned by the French government, appears to be better positioned than any of its competitors to benefit from capital spending in the oilsands nuclear sector.

With 59,000 employees, facilities in 40 countries, operations in more than 100 countries and annual revenue of more than $13 billion, AREVA is the only corporation active in every stage of the nuclear cycle. It has divisions that cover uranium mining and fuel fabrication, reactor construction, recycling high-level waste and operating repositories.

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[6] A=P(A/P, i%, n) for the capital recovery factor : $i(1+i)^n/(1+i)^n -1$ where P= present capital cost of US$2.5 billion(CAN$3 billion), i = interest at 6% and n = design life of 60 years.

They are also the designer/developer of the world's largest, safest, and most technologically advanced EPR power reactor.

In late 2005, AREVA incarnated itself as a North American company in a partnership with Constellation Energy, the Baltimore, Maryland based consumer energy giant. The partnership operates under the name UniStar Nuclear LLC. This company also based in Baltimore, intends to standardize the North American nuclear reactor fleet moving forward by constructing new AREVA EPR 1.6GWe, the same type of reactor presently under construction by AREVA at Olukuoto, Finland. In 2008, UniStar was preparing several license applications for the United States, and has completed phase one design certification application with the Nuclear Regulatory Commission in Washington. It is already an approved design under construction in Europe where safety standards are higher than current regulations in the United States. The AREVA EPR is widely regarded as the safest reactor design ever built with several new design advents to enhance safety. Several EPR reactors will be under construction in the United States by 2013.

Constellation Energy is a Fortune 125 electricity producer that was acquired in 2008 by Omaha Nebraska based conglomerate Berkshire Hathaway. Berkshire Hathaway's CEO Warren Buffet, has quickly become a principle player in America's nuclear renaissance. In the formation of UniStar, the Oracle of Omaha controls the United States vendor, developer and operator of the world's largest nuclear power reactors. Owning utility companies appears to be an integral part of Berkshire Hathaway's future investment strategy. Owning nuclear power plants and being a major player in the insurance business brings a new measure of efficiency in planning and developing new reactors where the availability and cost of insurance has long been a problem. Berkshire Hathaway is arguably the most well capitalized company in America.

In order to produce substantially all of the process energy requirements of the oilsands, the nuclear power requirement would be unprecedented in scale. More than $30GW_e$ of load potential transmitted over 250 km. That is twenty 1.6 GW_e AREVA EPR[7] nuclear power plants over the next 50 years, each with a design life of 60 years. The economics are staggering. In order to facilitate the production of 50 billion barrels of synthetic crude oil from the oilsands based on the projected output by 2015 (worth more than $2.5 trillion at $50/bbl), it will be necessary to build $70 billion in nuclear reactors and nuclear fuel processing facilities, with $5 billion in transmission infrastructure. An oilsands grid system will have revenues of more than $25 million per day at $10/GJ, or more than $9 billion annually for providing clean electrical power from Cree Lake, Saskatchewan to the oilsands operations in northern Alberta. It will be the world's largest nuclear power plant complex, the world's biggest construction project and the world's most productive enterprise.

The facility will eliminate the production of trillions of tonnes of CO_2 over the life of the plant where the clean power it produces, lessens the requirement for the burning of gas or other fossil fuels. By substantially eliminating most of the present CO_2 emissions from

[7] Evolutionary Pressurized Water Reactor

the oilsands industry, the development will result in the largest man-made reduction of CO_2 in history and will allow Canada to achieve the reductions of 6% below 1990 levels, specified under its original commitment to the Kyoto Protocol. Tens of thousands of jobs will be created. Tens of thousands of jobs will be preserved and a dirty industry will be cleaned up. Saskatchewan will become an economic powerhouse and Canada can conserve its gas supply and ultimately, its uranium supply[8] as well. Tens of $billions in wages, taxes and royalties will be generated and Canada will have developed energy certainty for the North American continent.

Bruce Power Inc.'s plan for a Saskatchewan reactor remains long-term and somewhat ambiguous. However a company feasibility study released in November of 2008 indicated that they propose to build 2-1GW_e plants at a cost of $8 to $10 billion somewhere between Prince Albert and Lloydminster on the North Saskatchewan River. That is $4 to $5 billion per GW_e which, in late 2008, is nowhere near competitive with fossil fuel fired energy production. The oilsands producers cannot presently afford process energy at the price level that would be necessary given the November 2008 capital costs of $20 per GJ unless and until oil prices recover to the $100 per bbl mark. The possibility that enough capital can be raised in the markets to build nuclear reactors at $4 to $5 billion per GW_e remains, but the probability is remote.

Bruce Power Inc**.** is Canada's largest private nuclear operator. It is responsible for the operation of the 6 GWe CANDU complex comprising 8 reactors in Bruce County, Ontario. It is a partnership which includes pipeline operator TransCanada Corp., uranium giant CAMECO, as well as the Ontario Municipal Employees Retirement System (OMERS), the Power Worker's Union (PWU) and the Society of Energy Professionals (SEP). Bruce Power is the parent of recently incorporated and wholly owned subsidiaries in Alberta and Saskatchewan that have proposed developments to be located on the Athabaska River, the Peace River and the North and South Saskatchewan rivers respectively. Bruce Power is presently engaged in a multi-$billion refit of its Bruce A Ontario facility. Though their development proposals in Alberta and Saskatchewan are fundamentally good ideas, the capital costs in all cases are prohibitively high.

The only way that a nuclear development can significantly decrease CO_2 production by oilsands operators, is if it is large enough to accommodate the scale of the demand. This demand is estimated to be more than 1 million GJ per day (11.6GW_e) by 2015 and could even be larger. The oilsands producers in turn, cannot outgrow their process energy supply and their maximum output will always be proportionate to the quantity of process energy available. In the absence of available nuclear power, a lot of natural gas will be required.

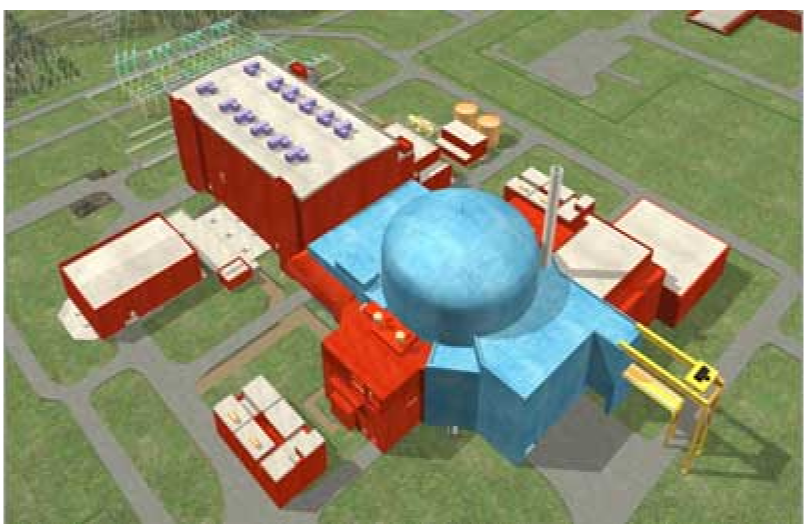
There is a significant economy of scale governing the capital cost of nuclear plants. As the design output capacity of the complex goes up, the capital cost per unit of production goes down. For this reason it simply does not make sense to consider "starting small" given the present demand and the increased demand expected in the future. It is a question of how much capital can be raised in order to build on a much larger scale than

[8] Where using uranium to produce power replaces the export of raw uranium

previously proposed. It must be large enough to significantly decrease the capital costs per unit of production as well as the production of CO_2. . Unistar Nuclear's proposal to standardize the North American reactor fleet will quickly optimize and economize construction where many identical plants will be built on the continent.

Tens of $billions must be raised on the capital markets to move this project forward and much of that money will be needed well in advance of any revenues received from plant operations. This becomes less of a capitalization constraint when US prime interest rates hover near 1%. The reactor design must be large and the capital costs per unit of production must be lowered by building on an unprecedented scale. The reactor demand for high-capacity reactors and the expected economy of scale encourages AREVA/Unistar to take the role as principle developer. Its 1997 EPR design is the largest commercially available reactor in the world. The pilot plant is under construction at Olkiluoto, Finland and will ramp-up to full production in 2009. Unistar/Constellation will soon have the first American plant under construction. Subsequent projects will benefit strongly from the learning curve and budgetary cost-estimation will improve dramatically. In Finland the project is 50% over budget and two-years late. Unistar/Constellation's performance in America will soon be known. The AREVA – EPR is the largest reactor ever built at 1.6 GW_e.

Unlike the large reactors planned by competitors such as the AECL and Westinghouse, the AREVA EPR reactor includes some improvements that make it particularly desirable for producing oilsands process energy. In addition to a long list of state-of-the-art safety enhancements, this reactor is the most fuel efficient of any design. The EPR can also use plutonium oxide fuel which fits well with the Cree Lake plan for spent fuel reprocessing. It is especially important that the prototype for the EPR has been built which should minimize the cost over-runs that have plagued the AECL, whose prototype ACR-1000 CANDU is more expensive and still conceptual at this point in time.



Computer model showing the AREVA –EPR reactor under construction at Olkiluoto, Finland.
http://www.epr-reactor.co.uk

Notwithstanding the potential for AREVA to be the designer, developer and prime contractor for the power reactors at Cree Lake, Bruce Power may have a role to play as well. Bruce Power is a Canadian company and its partners are among the most well capitalized corporate and pension fund entities in the country. They are also an experienced nuclear power plant operator and have demonstrated considerable interest in the geographic diversification of their operations within Canada. Their direct and indirect access to the capital markets could be important as this project moves forward.

In recent years, Bruce Power has made a variety of proposals in western Canada including the aforementioned proposals for Whitecourt and Grimshaw, Alberta, as well as the Saskatchewan proposals for Diefenbaker Lake and somewhere between Lloydminster and Prince Albert on the North Saskatchewan River. In all cases, they profiled the preliminary concept of a two 1-GW_e complex. It is unknown at this point as to whether each proposal succeeds and replaces the previous proposal or if multiple sites would be developed. The original proposals for Whitecourt and Grimshaw featured ACR-1000 CANDUs, but the latest feasibility study for the proposed Saskatchewan reactors also included Westinghouse and AREVA reactors as well. Keeping the design options open is a major step forward from the proposals of the past.

Bruce Power partner CAMECO may also have a large role to play, not only for the supply of raw uranium, but also from their considerable experience and expertise on the supply side of the fuel cycle. They are already involved in fuel conversion for light water reactors such as the AREVA EPR, although the fuel cycle differs from the CANDU.

However, the AECL may not have a role to play in the Cree Lake megaproject. As one of Canada’s oldest crown corporations, their economic performance has been lacklustre with regard to construction of the CANDU reactor. The heavy water moderation feature of the CANDU adds to its capital cost and although the fuel cycle is somewhat simplified by this empirically validated technology, the depletion of the fuel and overall efficiency of the reactor pales in comparison to its competitors. The AECL is extensively involved in the $multi-billion refurbishment at Bruce A, as well as the proposed expansion at Darlington, both in Ontario. These are long-term commitments and the AECL simply does not have the capacity to facilitate the birth of the western Canadian nuclear industry as well. Raising tens of $billions on the capital markets would be very challenging with the AECL doing the capital cost estimations or managing the reactor construction.

In the future, the design and construction of a secondary burner reactor for fuel reprocessing opens the door to Hitachi Corp. which has developed highly efficient reprocessing technologies of their own. They are also world leaders in nuclear safety and have substantial experience in the very large civilian nuclear power industry in Japan where they design and build nuclear power reactors. Like the Posiva development in Finland, the Rokkasho development in Japan virtually closes the loop on the nuclear fuel cycle and permanently addresses the high-level waste problem. A project as large as the Cree Lake proposal will draw on all of the available design and operational expertise of the world`s nuclear industry to insure maximized public safety and economic viability.

The Devil's Advocate Will Be heard

Proposing a new nuclear development for northern Saskatchewan will no doubt ignite the passions of those that would classify themselves as "anti-nuclear power". We have heard some of their arguments recently with respect to Bruce Power's proposals for Saskatchewan. The detractors of such a development typically focus on two key areas of discussion, safety and the environment. Though safety and environmental concerns are related as they pertain to nuclear power plants, they are separate issues from a development and operational perspective. The primary operational safety concern is the possibility of an accident resulting in a radiation release. The primary environmental concern is nuclear waste management. Though the public has demonstrated much concern over both of these areas, the statistically predominant concern relates to waste management. This has not always been the case, but it is thought by many that the continued operational vigilance and safe operation of existing nuclear plants throughout the world, has relaxed the public's concerns of a "Chernobyl" type catastrophe. However, the conspicuous lack of a permanent waste management solution remains a powerful issue.

The repository debacle in Yuka Mountain, Nevada underscores the public's apathy toward permanent waste dumping. It is therefore incumbent upon anyone proposing a new nuclear development that such a proposal should include an effective long term or permanent waste management strategy that meets with widespread public approval. In the case of the Cree Lake proposal, that has been done. The Cree lake complex will reprocess all of its waste and will incorporate long term storage in its integrated repository. The strategy is to fully deplete all of the nuclear fuel that the plant uses and though that may take a long time for all of the material to be reprocessed, it will be stored in the safest way known, in the safest possible place, based upon all of the research that has been done throughout the world's nuclear industry.

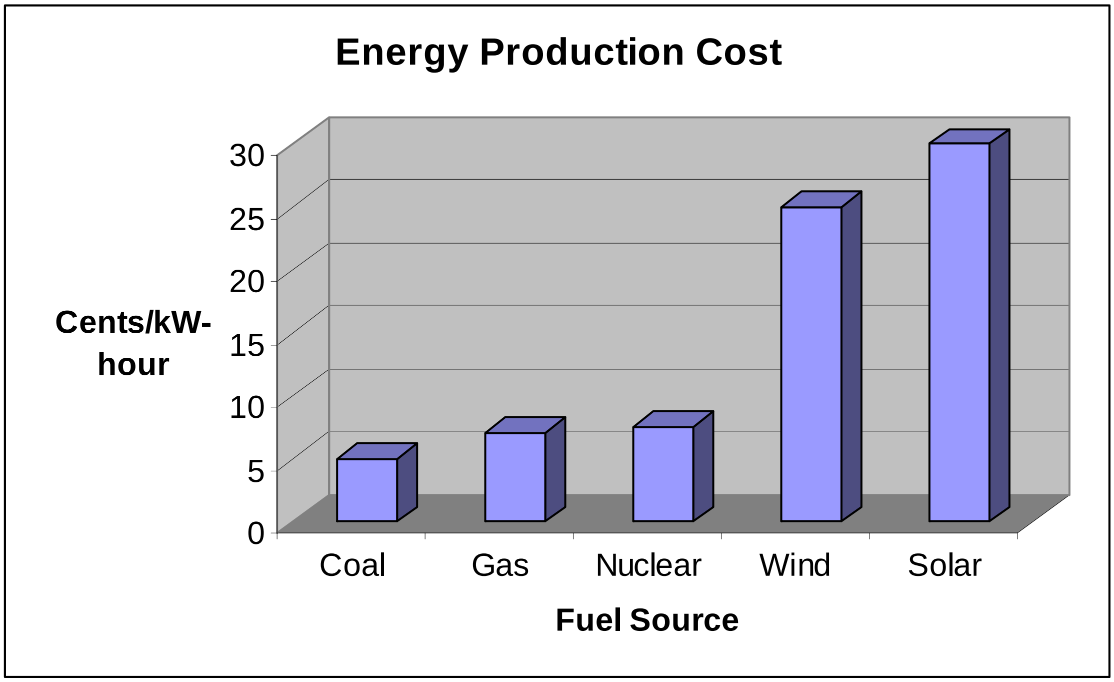
Nuclear energy detractors who would impugn this model for waste management should first look at the empirically validated successes of the French and Japanese. They can make new fuel from old fuel and the ambition of their programs is to eliminate the production of permanent high-level waste. We have not yet incorporated these processes into the Canadian industry but in the case of the Cree Lake project, we will. It is good business to calm the fears of the public and sound long-term environmentally responsible waste management makes good business sense as well. Storage, reprocessing and re-utilizing spent fuel materials at their place of origin eliminates the need to transport these highly toxic materials and further enhances public safety. This is a new feature that will be unique to the Cree Lake project. This practice will help to make it the safest nuclear facility anywhere.

In 2006 at Regina, Saskatchewan, I attended a symposium on Saskatchewan nuclear development. At that time I had the opportunity to listen to the presentation of Ann Coxworth of the Saskatchewan Environmental Society. Ms. Coxworth, an ardent detractor of nuclear development, spoke at length about the nuclear waste problem. The points she made were appreciated as she is an experienced scientist and has worked in the nuclear industry. She usually defends her predispositions with fact based descriptions of the problem which is helpful because fact based descriptions lend themselves to fact based solutions, and dealing effectively with the high level waste problem is key to initializing the Cree Lake development. When it comes to nuclear industry critics the facts are not always readily disseminated. There are better solutions for waste management than those we have historically employed in Canada and any new development proposal should address this from the outset. It has been our tenancy to focus on the problems, now it is time to embrace the solutions.

I mention Ms. Coxworth not only for her able articulation of the high-level nuclear waste problem, but because of a November, 2008 Saskatoon Star Phoenix article where she furnished an argument specifically targeting Bruce Power's proposal to build a complex on the North Saskatchewan River between Lloydminster and Prince Albert. In that article Ms. Coxworth stated:
"There are lots of things that we need to bear in mind, but one of them is the disastrous economics of nuclear power. The cost of electricity from a new nuclear plant is now double the cost from wind energy and that does not include the additional nuclear costs for waste disposal and insuring against accidents and decommissioning. The only way that nuclear power works now is when there is huge public subsidization for it."

She went on to express reservations about the use of water from the North Saskatchewan River. This would seem to imply that she also has issues with the location of the proposed plant. It would have been more appropriate for Ms. Coxworth to stick to her more plausible arguments on the subjects of waste management and water use. Her description of nuclear power economics as "disastrous" is misrepresentative and I can only assume that Ms. Coxworth was caught off guard for her to misrepresent the facts this way. Every nuclear power plant in North America is making substantial profits at present, enough so that owners and operators have the capital necessary to build new plants. The nuclear power industry has not been subsidized in decades and in fact now heavily subsidizes governments through utility sales and tax revenues. At present, every nuclear power plant in Ontario is making significant sums of money so much so that $multi-billion upgrades and refurbishments are now ongoing.

Her assertion that "*The cost of electricity from a new nuclear plant is now double the cost from wind energy...*" is a misstatement as well. Wind energy costs at least 5 times as much to produce as nuclear energy, and while wind energy may supplement the demand, it cannot provide enough wind powered power generation to address the present scale of demand let alone what we might expect in the future. There is not enough real estate in Canada to contain all of the windmills that would be required to meet our demand for energy. Wind power is also more heavily subsidized than nuclear power ever was and there is little prospect that it will ever be commercially viable. Due to the fact that there have been no new nuclear plants built in the last three decades anywhere in North America, any estimate from Ms. Coxworth regarding the cost of electricity from a new nuclear plant is highly speculative. If we choose to use the current operational statistics relating to the cost of nuclear power from existing power plants vs. the cost of wind power, the audacity of her assertions becomes apparent. Nuclear power production costs per unit of power produced are the lowest of any non-CO_2 emitting method of power production. Alternatively, wind and solar power production costs are the highest. It is not even close.



Source: Scientific American August 2006

Her argument that locating a nuclear plant on the North Saskatchewan River is unwise is worthy of some discussion. In Canada, we have historically located our nuclear power plants on the shores of the Great Lakes as well as the Bay of Fundy and one on the St. Lawrence River. It is thought that an unlimited supply of cooling water provides an enhanced safety measure in the event of a system failure or event affecting the cooling water reservoir.

The St. Lawrence River is a much larger river than the North Saskatchewan River in terms of its flow volumes and the reactor located there is only a quarter of the size of each of the reactors proposed by Bruce Power for the North Saskatchewan River. From an operational point of view, this implies that the minimum expected flow volumes of the North Saskatchewan River are well below the minimum expected flow volumes of the St. Lawrence River, though they are still in excess of the maximum requirements for the nuclear power facility proposed by Bruce Power. In either case, the cooling water circulates outside the radiation loop and therefore the water is not exposed to contamination.

Locating a large plant on a smaller river necessitates an examination of the plausibility, probability or possibility of water shortages caused by drought within the headwater region of the North Saskatchewan River. Such water shortages can cause productivity interruptions affecting economic viability, though the impact of those shortages would not threaten the safe operation of the plant, which would have the capability of slowing production or shutting down, if the need arose. If the availability of water was a key factor in selecting a site for the proposed Bruce Power project, it is worthy of mention that there are a number of sites in Saskatchewan that have a more abundant water supply. Cree Lake is one of them. Cree Lake is a vast glacial deposit of water outside the North Saskatchewan River basin.

For the people of Saskatchewan to sanction the commencement of a nuclear power industry they must be satisfied that such a project will be developed in a way that puts public safety and environmental concerns ahead of the economic motivations. In the run-up to approval, it is a certainty that the safe design and operation of the plant facility will be the focal point of public concern. It is eminently practical that the location of nuclear power reactors should be selected putting the safety and environmental concerns first. When the availability of water is also considered, the proposal to locate nuclear power plants on the North Saskatchewan River is questionable. Moving the proposed site to a district with a larger more reliable water source, improves the long term plant safety and reduces the environmental footprint.