A Re-evaluation of the Need for the Site C Project

Submitted to the British Columbia Utilities Commission's Inquiry into BC Hydro's Site C Project

by
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1. Introduction

The Government British Columbia by Order-in-Council (OIC) on August 2, 2017 has directed the British Columbia Utilities Commission to assess whether the Government should complete, suspend or terminate the Site C hydroelectric project currently underway on the Peace River. Specifically, the BCUC has been tasked to answer a number of specific questions about the costs, timetable, market viability and long-term energy objectives of the Site C project in formulating their answer.

It is easy to postulate numbers to answer these questions of energy costs and demand, but numbers alone can be meaningless unless we understand the assumptions used in formulating them. We ought to comprehend the reasons which have lead us to this point, and sense why the project has become so controversial. We need also to consider the scenarios that might flow as consequence of a decision to complete, suspend or terminate the project.

In May 1983, after many years of study and many months of pubic hearings, the BCUC issued in a 314-page report which concluded that Site C construction should not proceed at that time. The report stated "The evidence does not demonstrate that construction must or should start immediately or that Site C is the best project to meet the anticipated supply deficiency." Many parts of that report have been quoted, often taken out of context. The energy and climate choices we face today must be made in a very different situation than was apparent 34 years ago.

Complicating matters is the fact that when the government announced on December 16, 2014 that it would proceed with Site C construction, it came hard on the heels of the government's plan to develop a huge LNG industry in the province. Site C was seen as the source for the immense amount of (wasted) energy needed to cool and compress natural gas to a liquid form. The LNG plan never made sense from the standpoints of physics and chemistry, nor from any economic, environmental or climate policy, but it entangled the idea that the site C power would be used to promote fossil fuel development. In fact, Site C's overwhelming strength is that it is part of a rapid exit strategy from fossil fuel dependence. To this day, very few leaders have recognized or embraced that realization. We need to free ourselves from this mental obfuscation, and look anew at the project as a pathway to a sustainable energy economy.

Every major hydroelectric project in history has been born amidst controversy. The great dam-building era of the 1930's in the USA came about from the troubles of the great depression, as detailed in David Billington and Donald Jackson's book. In the 1950s & 60s, the government of W.A.C. Bennett in BC championed the "two rivers" policy to develop the hydroelectric resources of the Columbia and Peace Rivers, in the face of considerable opposition. What would our standard of living look like today if such projects had not been forged by visionaries?

A central issue before us at this time is estimating the future demand for site C power. The future is always uncertain, because it hasn't happened yet. Technical developments foreseen and unforeseen will always arise to change the direction we believe to be optimal. Let's look at one example of how this has played out regarding electrical power over the last 120 years.

Thomas Edison (1847-1931) and George Westinghouse (1846-1914) were the co-pioneers of the electrical industry, who formed how we use electricity in our lives today, yet they were bitter opponents on what that future would be. Edison favoured the use of direct current, while Westinghouse championed alternating current. On the surface it looks like Westinghouse won the debate, since overwhelmingly the electricity used today is

alternating current. But the debate is not over. AC power had the advantage of being easily transformable to high voltage to reduce conductive (I^2R) losses over long distance transmission, then transformed down to low voltage for safe local use. But today, direct current can also be similarly transformed, so this advantage has been lost. AC and DC can be efficiently interchanged today, and DC is advantageous for transmission by underwater cables over long distances. The ability to efficiently transmit electrical power underseas in this way has altered the AC/DC debate. Much of our required electricity can be generated locally as DC from solar photovoltaic and used for daily energy requirements to heat homes and water. In that case the advantages of AC are neither needed nor useful. We can easily imagine that in future homes will get (say) three-quarters of their electrical energy from nearby DC solar panels, with the balance as AC from the grid, to power motors and perhaps provide lighting. One might add that the company founded by DC advocate Edison still prospers, while Westinghouse's company has vanished. As noted, predicting the future is risky.

Whatever the future, this can be said with certainty: Energy is the most important resource for humanity and solar energy is the ultimate energy source. Energy is the primary resource: without energy, nothing happens. All human activity involves, in some way or another, the use of an energy supply.

Virtually all energy on Earth comes from three sources: the Sun, the Moon, and the interior of the Earth. In principle, we could extract a great deal of energy from tidal flows caused by the moon's pull on the oceans, but the practicalities of this remain elusive. Even more so, heat from radioactive processes deep within the Earth offers us a huge energy supply, but the cost-effectiveness of this source is a long way from being demonstrated. Solar energy presents as fossil energy and as sustainable energy. Fossil energy comprises hydrocarbons (coal, petroleum, natural gas liquids and natural gas), but these are the sources from which we must drastically reduce our dependency. Fossil energy is energy dense and convenient to store, but is proprietary, capital-intensive to find, extract and transport, and is environmentally catastrophic. Direct sustainable solar energy, while not being energy-dense, is superabundant and well distributed over the face of the planet. It is non-proprietary, easy to capture on any scale, easy to transport as electricity, and relatively benign environmentally.

Continuously, the sun provides one hemisphere of the Earth with an energy supply about 10,000 times greater than is used for all human activity. This real-time solar energy heats our environment, and moves air and water around on the surface of the Earth. Solar photovoltaic panels can easily and efficiently convert sunlight into electricity. A relatively small area covered by solar panels is sufficient to provide the energy needs of a household, province or country, or the whole planet. Wind power can also be converted into electricity in a cost-efficient manner.

Thanks to Einstein (who identified the photoelectric effect) and a century of technological progress, solarPV has become the cheapest form of new energy supply today. Just as Moore's Law has defined the computer revolution that has altered how we do everything, solar power costs seen to be following Swanson's Law and getting cheaper as production grows. Swanson's Law is empirical, but because the materials of solar panels are abundant, cheap and durable we may expect the cost-effectiveness of solarPV to increase for some time yet. Solar costs have dropped so much that today it's possible to generate all or most of a home's electricity in perpetuity for about the amount that a typical household pays in current hydro rates over a decade or less. Yet today, we still hear claims that the returned energy for energy invested of solar panels is disadvantageous; these claims are totally false in the present reality.

Indeed, the cost advantages of solarPV electricity are so great, that they have created their own falsehood: that other sources of generation such as site C are unnecessary. Solar power has a great future, but the sun sets. Unless we have another source of non-fossil energy to power us reliably after sunset, the solar revolution will be stopped dead in its tracks. Reliability of supply is paramount: it is & was, after all, fossil fuel's great advantage.

Of course every living person on Earth is aware that the sun sets, but in an era when common experience is that electricity is something that comes out out a little hole in the wall, we tend to overlook this little fact that whatever generates that electricity might not always be available. I am constantly reminded of this limitation to solar availability ever since1970, when I wrote the computer code that calculates sunrise and sunset times for any date and any location on Earth, for National Research Council of Canada. This code is still in use today. Of course, sunrise-sunset times have become widely available from a plethora of sources since then. The relevant fact is this: most of British Columbia experiences over 16 hours of darkness at the winter solstice. When the sun sets in BC, all of North America is in darkness. We won't be buying solar power from anywhere else at that time. We must have hydro power dispatch-able for periods of hours, days weeks & months as backup to carry us through night and winter.

Here's where the Peace River holds an unsurpassed advantage. It is the only watershed in North America which straddles the Rocky Mountains. Its flow from Williston Lake descends onto the great plains with incredible power. Behind W.A.C. Bennett Dam (Site A) is impounded two years of river flow, enough to provide almost unlimited power for very long periods of time, if generation capacity is added for that purpose. That isn't possible at present, because Dinosaur Lake above the Peace Canyon Dam (Site B) holds only 2 days of river flow. The Site C reservoir will hold about 22 days of river flow, enough to absorb rapid surge flows from upstream and still deliver a smoothed flow to points downstream from the new dam. Anyone who doesn't recognize the immense advantage this 3-reservoir system can offer really hasn't thought about it very much.

2. The Climate/Energy Imperative

The realities of climate change (as evidenced by flood, fire & drought in many parts of the world) are upon us. The reasons behind it are basic. Since the start of the industrial revolution, we have chosen to believe that we could dig up most or all of the hydrocarbons trapped in the crust of the Earth, and combust them to free carbon dioxide into the atmosphere, all without serious consequence. That idea is false. For a long time, the hypothesis was credible because of nature's great capacity to recycle carbon dioxide, via the oceans and other carbon sinks. But at least since Keeling Curve began to be monitored in the 1950s, we know the “no consequences” idea is dangerously untrue. Now that CO2 levels in the atmosphere have exceeded the levels known to exist since our first pre-human ancestors walked the Earth, we are seeing the consequences of climate change. The good news is that this human activity has precluded the return of the ice ages. The bad news is that we face a near future where global temperatures will exceed by 2 to 6 Celsius the temperatures experienced by our species. The consequences of climate change include: overall planetary warming, altered atmospheric and oceanic circulation, increased atmospheric convection, more extremes of flood and drought, the general movement of climate zones from the equator to the poles, the altering of hydrological cycles, the shifting of agricultural regions, greater extinction threats to many species, human population displacement. Those are merely the first-order effects; it is difficult to conceptualize what the second order or subsequent consequences might be. It is not an overstatement to say these effects pose a threat to civilization itself.

The only solution to this threat is a conceptually a simple one: stop, or greatly reduce, the combustion of hydrocarbons into the atmosphere. The combustion of hydrocarbons has been the overwhelming source of energy for all human activity, and accounts for about 80% of global primary energy supply to the present day.

For the last few years, it is abundantly clear to anyone who has been paying attention that solarPV and wind offer an almost complete answer to our need for carbon emissions-free, lost cost, abundant energy. The only barriers to them rapidly (within years, not decades) displacing fossil energy in the majority of applications are these two:

1. the ability to store energy for periods of darkness (when solarPV is unavailable) and calm (no wind generation).
2. The political will and legislative foresight to enable a smooth and rapid transition.

SolarPV and wind energy often called 'renewable energy' but should be called 'sustainable energy', because we need do nothing to renew them. Once the installations are in place to harvest sun and wind as electricity, they self-supply, and will last as long as the installation remains intact, which in most cases is many decades. Hereafter, I will refer to the need to make the transition described in this and the preceding paragraph as the “Climate/Energy Imperative”.

Biofuels are 'renewable energy' since we would need to renew them with each growing season. Photosynthesis, the process by which plants capture solar energy, is typically 10 to 30 times less efficient than solarPV in energy capture. To power the world with biofuels, we would need to strip the planet of a considerable fraction of its vegetation each year. For this reason, the role of biofuels will be limited to narrow applications, such as aviation fuel. Biofuels, plus unproven energy sources such tidal, wave, and geothermal energy seem unlikely to provide viable solutions, at least not on the magnitude and timescale that is needed to avert a climate catastrophe. For this reason, they are not discussed further here.

3. Counterarguments against Site C

Many words have been spilled attacking the Site C project, and most of the arguments are clearly false, or else do not address the urgency of the Climate/Energy Imperative we face.

A full rebuttal of the most common arguments used to oppose Site C can be found here, here & here. Rather than repeat these tedious arguments, I ask the reader to review those documents.

A more serious set of statements is found in the 24-page submission to the BCUC by Marc Eliesen. His submission of August 16, 2017 commands our attention and demands a response because the author has successively served as Chairman and CEO of Manitoba Hydro, Ontario Hydro and BC Hydro. His submission speaks strongly against continuing the Site C project.

In his submission, Eliesen states five precepts. I have taken the liberty to paraphrase his 5 points from his text, and to add an interpretation of what is actually being said. In what follows, ***the words in italics are my own comments which reflect on what is implicit in his statements.***

1. There could not possibly be a market for power at the rates under which we might expect site C to deliver power. In fact BC Hydro's own load forecast (conducted in part under his watch) suffers from systematic bias that exaggerates demand for electrical power. ***But BCHydro has been constrained so as to never consider any scenario which would lead to fossil energy being displaced by sustainable energy.***

2. If other electrical demand should emerge, it should be met by alternatives responsive to market demand, ***such as gas-fired electrical generation. This will require that 1 megawatt of fossil-fired power be added to capacity for every 1 megawatt of sustainable but interruptible energy generation that anyone (company or individual adds to the grid), to ensure dispatchability. Alternatively, we could manage electrical demand (charge exorbitant rates at peak times, or shut off power altogether).***

3. Even if Site C were to be completed on time and on budget, BC Hydro customers could not afford it. ***Perhaps this is meant to imply that all future generation capacity to the system should be put in the hands of private capital, rather than with the Crown Corporation.***

4. Of course everyone knows that public agencies such as crown corporations cannot do anything within their time and budgetary constraints, ***which is why private capital is the best provider of energy solutions.***

5. In the author's (i.e. Marc Eliesen's) terms as Chairman and CEO of Manitoba Hydro, Ontario Hydro and BC Hydro, no major project was completed within budget. So Site C won't be completed within budget either. The high electrical prices that ensue will ruin the BC economy.

These statements by Marc Eliesen are rather astonishing. In fact, the statements could not have been more blunt and forceful had they been written by a council of fossil fuel executives. A point to consider: Marc Eliesen also served on the Board of Suncor for part of his time he sat as a Hydro CEO. He was certainly not alone on the BC Hydro Boards of the past decade as a person with direct ties to the fossil fuel industry.

Do you see there might be a problem here?

Would the chair of Ford Motor Company or General Motors advocate that automobiles are a big mistake and we should not manufacture them? Would the CEO of Microsoft or Apple suggest there is no future for personal computers and we should leave it all to IBM? Yet here we have Marc Eliesen, who makes no direct reference to solarPV or wind generation, but suggests in his submission that any shortfalls in electrical generation be met with gas-fired plants.

Because of his career as CEO of Manitoba Hydro, Ontario Hydro and BC Hydro, Marc Eliesen's comments might seen to carry great weight. But it might be noted that those were not happy times at any of these Crown

Corporations. To be fair, the urgency to reduce fossil fuel emissions was not as apparent then is it is today. But to sweep away the need for sustainable energy today and suggest topping it up with fossil generation is certainly not 'fair and balanced'.

It might be noted that the words 'solar' and 'wind' do not appear in Mr. Eliesen's submission. It might be noted that to ensure dispatchabilty of electricity with a combination of solar, wind and fossil sources would require building 1 megawatt of fossil generation for each megawatt of wind and solar.

There is clearly a conflict here. Is this conflict reflected in BC Hydro practice up to this point? Consider this:

1. BC Hydro has never done any load forecast that foresees electricity displacing fossil energy in domestic use, industry and transportation. Yet this is absolutely the task which we must undertake if we hope to avert climate catastrophe.

2. BC Hydro has locked in high rates for run-of-river generation. This has had multiple negative effects, by limiting the opportunities for other intermittent sustainables and by requiring fossil backup (such as the Capital Power's Island Generation plant at Campbell River to remain on standby).

3. BC has become unfriendly to wind generating projects. The current three wind farms in BC are, in some measure, token projects. Ironically, many have blamed SiteC for the extirpation of new wind projects in BC, even though wind and SiteC generation are inherently complementary.

4. Even though the John Hart renewal project could easily have been built with the capacity to complement wind energy as needed, it was instead built so that its generation is locked steady at 130 MW, with little possibility of variation. Incidentally, the John Hart project provided an ideal circumstance for variable reservoir-to-sea-level generation, but BC Hydro chose to preclude that possibility. A cynic might discern this to be an attempt to preempt wind energy from having any great role in BC's energy future.

5. In Germany, well over 1 million homes generate their own solarPV electricity which is shared/balanced over the grid. British Columbia has comparable solar potential to Germany, but very few homes here are integrated with the public grid because the regulatory environment is discouraging. Typically, BC Hydro buys electricity at half the rate that homeowners must pay to buy their electricity back. This translates to a payback of many decades which is very unattractive for the homeowner.

6. BC Hydro has changed its slogan to “Power Smart”, and spends millions of advertising dollars each year telling citizens how not to use their product. This is rather bizarre corporate behaviour, especially since electricity is is not the root problem of our climate and energy challenges: it is in fact the solution to them.

7. Consciousness citizens, under the influence of the 'Power Smart' program would replace their tungsten bulbs with more efficient LED lamps, admittedly a good move. Yet unless the thermal performance of the building is improved, this means they will use more fossil energy to heat their homes as a result of this swap. More carbon emissions are the result.

8. Consciousness citizens might replace their furnaces with a heat pump (which is everywhere advantageous in BC, and typically heats with ~400% efficiency). BC Hydro will immediately 'reward' them with 50% higher electricity rates, since the heat pump will almost certainly subject them to Tier 2 rates. Is this Power Smart?

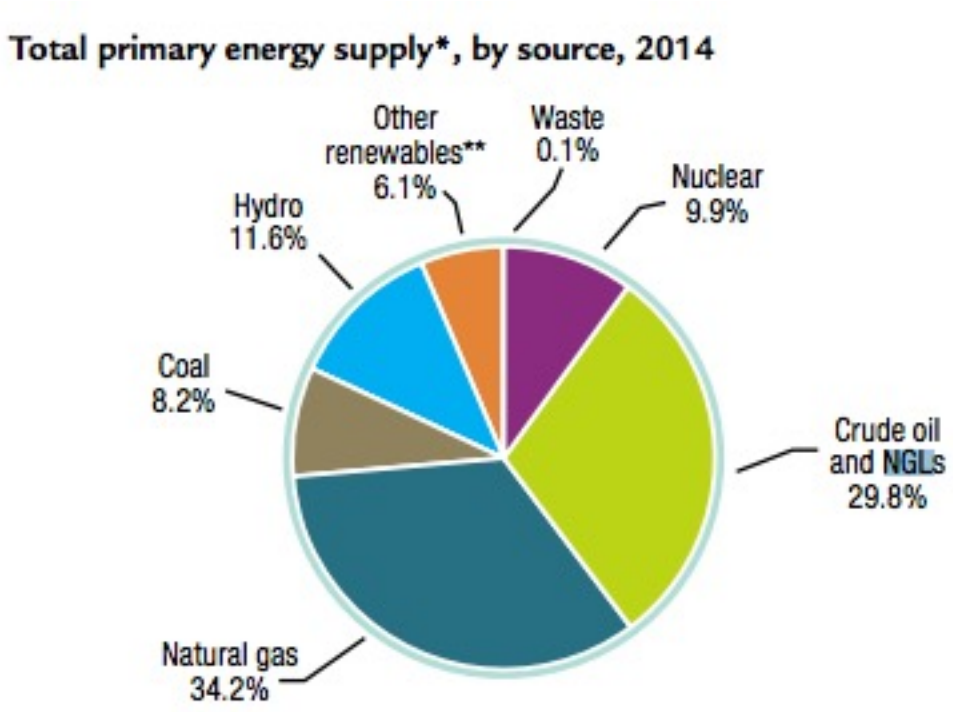
In summary, we have a serious culture problem in BC Hydro's recent past. It needs to be reoriented if we are to have a responsible energy future.

4. The Road Ahead

Under the Paris Accord, the specific Canadian target — the same one set by Stephen Harper’s Conservative government in May 2015 — is to reduce greenhouse gas emissions by 30% below 2005 levels by 2030. In 2005, Canada's CO2 emissions were were at 738 megatons. These dropped to 727 megatons by 2014 and to 722 megatons in 2015. These reductions came about largely because of the phaseout of coal-fired generation in Ontario, plus the economic recession.To meet our Paris Accord commitments, targets, they’d need to drop to

523 megatons by 2030, that is to 72.4% of 2015 levels. It is clear we are not on track to meet this goal. To do so will require much more fundamental changes in our energy budget.

It is also clear, that even if the Paris goals are met by Canada and other nations, that atmospheric CO2 levels will still continue to rise. To stabilize the atmospheric CO2 levels will also certainly require returning our global emissions to 1950s levels. That is to say we need 65 to 75% reductions in fossil fuel use. Many have argued that we need a 90% reduction in fossil fuel use.



Renewable energy sources made up 17.7% of Canada's TPES in 2014.

Canada only gets 17.7 % of its Total Primary Energy Supply from renewable sources at present, and less than 12% is truly sustainable. 72.2% of our primary energy comes from fossil sources.

To grasp the magnitude of the problem, consider this. If the above figures for Canada are representative of BC, to meet our Paris commitment while maintaining the same standards for energy supply, we will need to bring the 72.2% of primary energy from fossil sources down to 52.2% of total primary energy. That 20% of TPES to be replaced by sustainable electricity means our current electrical supply must increase to 2.7 times its current amount. **We must almost triple our generating capacity to meet the lowest goal we have set for ourselves.**

To meet a more necessary goal of (say) 75% fossil reduction will require increasing electrical supply by a factor of 4.7.

It should be apparent that we cannot achieve anything like the reductions of CO2 that are required without massive storage capability, since the sun is in the sky only half the time. Some energy can be stored thermally: with good building codes we could heat our buildings and water during the daylight hours, conserving enough to carry through periods of nighttime.

Now look at some misconceptions surrounding energy storage:

1. “We'll store energy chemically, with batteries.” **Specific energy** is energy per unit mass. The specific energy of chemical batteries is at least 50 times less, but more typically 100 times less, that that of hydrocarbon fuels. No great improvements in battery technology will change this: the difference arises because of the tight chemical electronic bonds of the carbon atom itself. It is not without reason that the human body, which contains 60 elements of the periodic table, is composed 93% of three elements: oxygen, carbon and hydrogen. Carbon forms very energetic chemical bonds, especially with oxygen. No miracle of chemistry can alter this. Lithium batteries are where the best advances in chemical storage have occurred in recent years, but lithium, is a very rare and expensive element (lithium is destroyed in stellar processes). All batteries pose horrendous environmental problems in their resource extraction and manufacturing. Batteries will have a place in future energy schemes, but they cannot solve energy storage on a societal scale.
2. “We'll pump water uphill to store energy.” Indeed hydro storage is very reliable and efficient, reflecting the fact that gravity is the main repository of energy in the Universe. Almost all the energy used to pump water to a higher reservoir can be released on an as-needed basis for later use. By why would you pump water uphill if it's already there? Also, that upper reservoir will cover no less land area than (say) the Site C reservoir. So this turns into an argument that actually shows the logical necessity of the Site C infrastructure. Incidentally, the largest experiment ever in pumped hydro storage began at the Grand Coulee dam with its completion in 1942. Power generated at the dam was used to pump water up to the Grand Coulee, which is an ancient river bed on the Columbia Plateau created during the Pliocene Epoch, to form what is now known as Banks Lake. This pump-generating plant still exists, but is now rarely used since the completion of the third power plant in 1980. This is because it is more efficient to simply harvest the electricity directly from the river reservoir itself, as needed.

5. Answering the questions

To respond to the questions posed in the Inquiry's Terms of Reference, which the BCUC has specifically been charged with answering:

1. I am not aware of any credible accounts that the Site C project is seriously not on schedule and not on budget. That said, any project of this magnitude will likely encounter unforeseen problems: the role of the engineers is to solve such problems. To state that the project cannot be completed on time and within budget is simply irresponsible. Though it was a long time ago, the Grand Coulee dam project in Washington (the start of which was delayed by claims the electricity would never be needed) was, once it was started, completed on time and within budget.
2. All delays are costly to projects. Indecision is always costly to projects. By BC Hydro's account, a one year delay in Site C construction might add $630 million to its final cost. A far greater cost would be the environmental cost incurred by failing to meet our climate goals for carbon emission reduction. That is a unbearably harsh outcome to contemplate.
3. Likewise, the costs of cancelling the project boggle the mind. Since there are no other clear paths to meeting our carbon reduction goals, the cost of cancelling is surrender to defeat. We will have abandoned decades of discussion and negotiation to try to avoid climate chaos. What then?
4. When we can see a path to resolve our energy challenges with supply management, why would we choose to rely on demand management? Demand management was the hallmark of the Soviet era. It failed.

Finally, any figures about future electricity capacity and demand that do not take into account the issues raised in §4 are essentially meaningless. That BC Hydro has never seriously undertaken to assess these needs, though they have been apparent for years, is astonishing.

Conclusion

There is no simpler path to containing our carbon dioxide emissions than can be found by the completion and expeditious use of Site C. However, to realize the immense potential it offers to solving our energy and climate goals, it should be linked to and coupled with regulatory changes to encourage electrical generation from sun and wind.

Completion of a three-reservoir system on the Peace River should be used to protect the climate and the environment, to promote beneficial choices on sustainable energy at the household and local level, and to build a strong economy for generations to come. There is no better choice.

Respectfully submitted,
Chris Aikman
[redacted]
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Further Reading:

http://www.huffingtonpost.ca/blair-king/site-c-dam-myths_b_16568258.html

https://www.bchydro.com/energy-in-bc/our_system/generation/our_facilities/peace/powering-bc-from-north-infographic.html

https://www.weforum.org/agenda/2017/05/solar-has-brightest-sustainable-energy-future?utm_content=buffer44f6a&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

http://dreamgreen.ca/futureenergy.pdf

http://dreamgreen.ca/lightandwater.pdf

http://www.dreamgreen.ca/20reasons.html

http://dreamgreen.ca/einsteinslegacy.html

http://www.dreamgreen.ca/sourceorsink.html

http://www.dreamgreen.ca/kelowna.html (2005)