Site C and the Future of Energy in British Columbia

by Chris Aikman

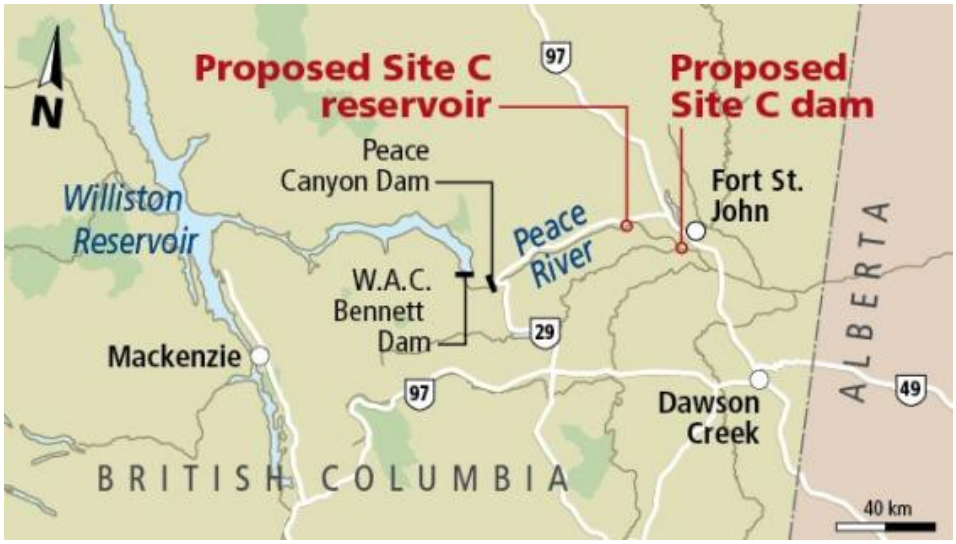
Summary

The Site C project now under construction on the Peace River near Fort St. John, BC is all about providing ***secure*** capacity in British Columbia's sustainable energy supply. For a transition from fossil hydrocarbon energy to a blend of sustainable sources from solar photovoltaic, wind, run-of-river and tidal sources, we face the severe problem that all of these are intermittent. The development of Site C on the Peace would create three sequential reservoirs to offer an as-needed supply of power, manageable on all time scales from minutes to months. Only the Columbia River system, which already consists of a comparable sequence of reservoirs, offers this degree of freedom to top up intermittent sources with hydro power. If we truly envision a future in which all (or at least 80%) of our primary energy comes from sustainable sources, Site C is an essential element to that goal. Without a reliable backup supply, the green energy revolution will be stillborn. It's really that simple.

Introduction

In the 1950s, the British Columbia government of W.A.C. Bennett proposed a series of three reservoirs with dams on the Peace River where it flows through the Rocky Mountains and onto the Canadian prairie. The first of these projects ('Site A'), the Bennett Dam and Williston Reservoir, was commissioned in 1968, and has been the largest generator of electrical power in the province since that time. Although overwhelmingly a success, the project made some environmental and planning errors due to the rapid pace of the project. In retrospect, some of these issues, particularly the project's effect on aboriginal communities, and the methyl-mercury contamination of the water due to not removing biomass from flooded areas, could have been and should have been avoided. Wikipedia offers a nuanced view half a century after its completion.

The Peace Canyon Dam, with a much smaller reservoir, was completed at Site B in 1980. Around that time, plans to begin the Site C project were actively advocated. However, in the fossil-fuel era, it was deemed the further development of hydroelectric power was deemed unnecessary. The Site C project was closely reviewed by the British Columbia Utilities Commission between 1981 and 1983 and deemed unnecessary at that time. In fact, no large hydroelectric projects have been built in British Columbia since 1984. Even though Site C never fell far 'off the radar' since that time, it never came to foreground again for 30 years.



In 2014-15, the BC government announced its intention to proceed with the Site C. Unfortunately, they made this decision for the most bizarre of reasons: the energy of Site C would be used to promote fossil fuel production, specifically for a non-existent LNG (liquified natural gas) industry. This incredibly stupid rationale has muddied the waters ever since. Once actual construction began in early 2016, the Site C project has seen endless controversy over its merits.

It is important to acknowledge cultural bias relating to hydroelectric projects. Since the 1980s at least, there exists a strong antipathy toward such projects. Many reasons exist for this, one being the corporate culture of the global petroleum industry, which has actively and subversively campaigned against the competition of electrical energy. Another is an aversion to flooding valley-bottom agricultural lands, a particularly sensitive issue west of the Rockies where such land is the only rich farmland to be found. This argument is not very meaningful east of the Rockies, where agricultural soils abound, and the limits to agriculture are climatological. Political manipulation is not without a role in the drama as well. In British Columbia, political bias has meant electricity has never been allowed to present as the alternative to fossil energy, the very role it **must** play if we are to avert climate catastrophe. BC Hydro has spent a great deal of money promoting the idea that not using their product will somehow save the environment, when actually the reverse is true!

Today, the era of fossil fuels is necessarily and rapidly reaching its end. Either that, or civilization will end. We already see the enhanced extremes of flood and drought arising from human-caused climate change. We already see tens of millions of climate refugees destabilizing the world's political systems.

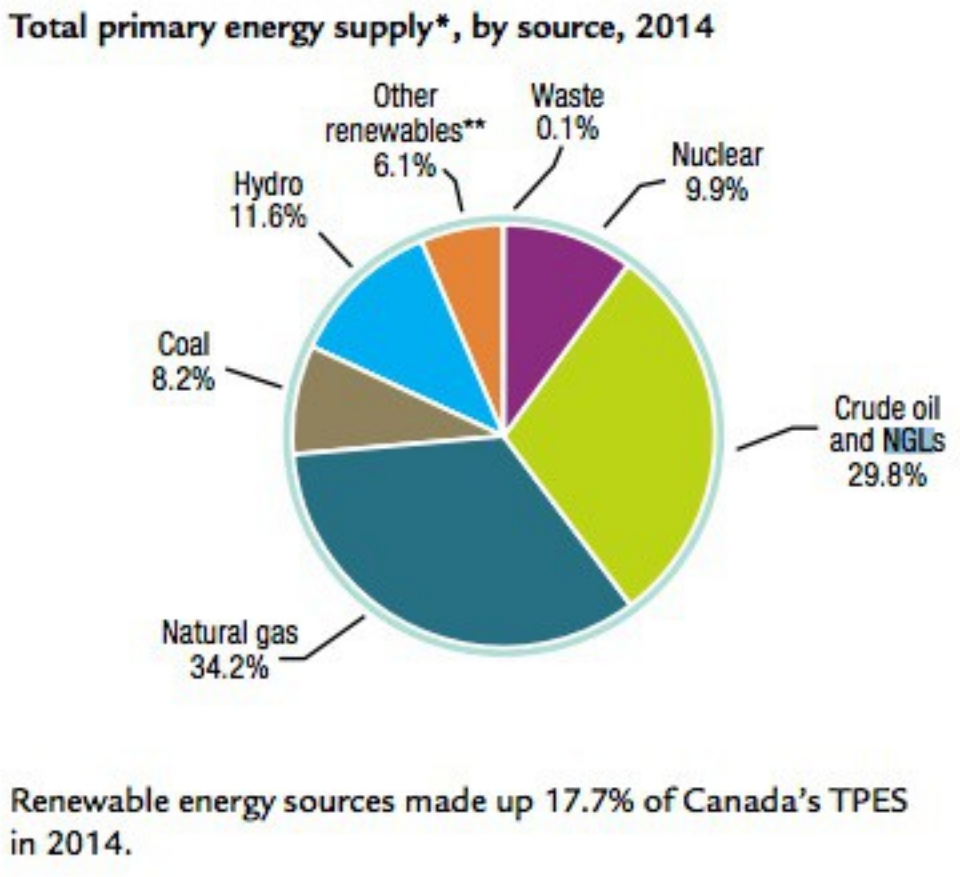
By this year of 2017, the future of energy is becoming pretty clear. Almost certainly, the majority of our primary energy will come from the Sun as solar photovoltaic, supplemented by wind generation. This leaves the problem of their intermittency, for which we must have some source of stored energy. A false view held by many is that super-batteries will fill this need. This view overlooks the fundamentals of chemistry. Carbon is the only element in the periodic table with the electronic structure to densely store chemical energy in such an easy-to-access form. But the combustion of hydrocarbons necessarily produces carbon dioxide, which is precisely what we need to avoid if humans are to survive and prosper on this planet.

We need also to recognize what might be called “the greatest cultural myth of our time”. By this, I mean that when the word “energy” is spoken, most of us conjure up images of petroleum and natural gas production and use. 'Energy' has become a placeholder word for 'fossil energy'. We tend to forget that constantly the sun directs to Earth more than 10,000 times more solar energy than humans use in all of our daily activities. A very small amount of the planet's surface is required to capture enough solar energy to completely replace fossil energy, everywhere. And now we have the technology to do just that. Solar energy presents in many forms: heat of course, yet mostly it powers the movement of air and water around the surface of the planet.

The largest source of energy in the universe is NOT chemical energy. It is NOT fusion energy. It is gravity. Gravity powers the universe. On earth, we can harvest gravitational energy as rainfall. Solar energy lifts each water molecule into the atmosphere, giving it gravitational energy. Each gram of water will release its stored gravitational energy in amount dependent solely on the height it falls in its descent to sea level. Fortunately, British Columbia is endowed with abundant rainfall, and high elevations. We can store that energy of water descending for times when the sun has set and the wind is not blowing. Storage is best done in multi-sequential reservoirs, so that the final discharge of water downstream is more or less constant. Alternatively, hydro projects that discharge directly to tidewater are also free of downstream effects. British Columbia's ability **to store and harvest the gravitational energy of rainfall as needed** is without peer anywhere on Earth. We should welcome the chance to utilize this natural advantage.

Why Site C is a vital part of the energy & climate solution

First, let's take an overview of the energy situation we are facing:



Canada only gets 17.7% of its Total Primary Energy Supply from renewable sources at present, and less than 12% is truly sustainable. 'Sustainable' is a better descriptor of solar and water energy than 'renewable', since we need do nothing to renew the supply. Biomass, on the other hand is renewable but not sustainable, because it does require renewing, and involves massive defoliation of the planet in order to be a major energy source.

- The above pie chart depicts the magnitude of the task if we are to replace fossil energy with sustainable energy.
- To stop the rise of atmospheric CO2, we need to increase the amount of sustainable energy from 12% to at least 80% of our **total primary energy supply** (some would say to 100%).
- British Columbia gets a higher percentage of primary energy from sustainables than the national average, because 93-98% of our **electrical** energy comes from hydro. An exception occurs on Vancouver Island, where up to one third of the Island's electricity can sometimes be supplied from Capital Energy's gas-fired generator at Campbell River.
- Regardless of the exact figures for BC, we still get roughly 4/5th of our total energy needs from fossil sources. That is the real problem that we must address if we want to reduce carbon emissions.

- That last 20% of our primary energy from fossil sources will be hard to replace for uses such as aviation, and steel & cement manufacturing. What we need to focus on now is reducing fossil energy from 80% of primary energy to 20% of primary energy.
- That is to say, we need something more than a fourfold increase in sustainable energy to displace fossil power, while maintaining current economic activity levels.
- BC Hydro has rarely (if ever) acknowledged a role to displace fossil power.
- We have rarely (if ever) put numbers to the magnitude of the supply challenge we face to displace fossil power.
- Unlike fossil energy, sustainably-generated electricity (from all sources, but especially true for solar photovoltaic) does not incur discovery costs. It is universally accessible. It is uniformly distributed over the whole globe, as sunlight or wind or flowing water. It is not capital-intensive to develop. It is royalty-free. It is highly scalable, from single households to communities or countries, without loss of efficiency. It is easily to transport via electrical grids. These are **immense inherent advantages** and they assure a bright future for sustainable energy, and for a viable climate-change solution. It has already become obvious that fossil energy cannot remain cost-competitive against these advantages. In almost every corner of the world, solarPV provides the cheapest source of new energy
- Any statement that we don't need additional electrical power is clearly a falsehood. Sustainably generated electricity is the only significant choice we have to replace fossil energy.
- Since sun and wind are intermittent sources of electricity, we clearly need to increase discretionary (reserve) hydro capacity in order to offset the interruptibility of solar and wind power.
- We cannot forecast with certainty which mix of photovoltaic, wind, run-of-river, etc will prove optimal in the coming decades. For example, few could have accurately predicted the astounding drop in the cost of photovoltaic cells. But given that this has happened, it is driving a dramatic rise in the attractiveness of photovoltaic electricity at this time.
- So it's becoming a fair bet that solar photovoltaic electricity is poised to dominate the sustainability revolution. Its advantages are that it is cheap, easily installed & integrated, and scalable in application from single households to vast arrays powering a whole state or jurisdiction.
- Theoretically the USA could meet all its energy needs in daylight hours from photovoltaic. Many regions of Canada could meet their needs from photovoltaic, the exceptions being mostly in the polar regions, which experience long periods of darkness.
- The salient question is: how far can solar photovoltaic generation grow before hitting a limit? An obvious limit is set by the fact that the sun doesn't shine at night.
- What happens when the sun goes down? The glib answer, that we'll get it from other places were the sun is shining, is nonsense for us on the west coast of North America. When the sun goes down here, it has set over all the Americas. We won't get photovoltaic electricity from the Pacific Ocean nor from Japan. We can't rely on wind to blow every evening (when it usually calms down, and when demand for electricity peaks) to fill the gap. So the solar photovoltaic revolution will be stopped dead in its tracks unless we build an always-available backup supply of electricity.
- The idea that this backup will come from super-batteries is a myth, because chemistry has its limits. The best source of chemical energy (that is, with a high energy density value) is from hydrocarbons, which we're trying to get away from. For example, a rechargeable lithium-ion battery typically has about 100 times the mass of gasoline to deliver the same amount of energy. Also, lithium, which delivers the best electrochemical storage, is a rare and very expensive element. There simply isn't enough of it to power the world. Batteries can supply single homes and small operations, but simply can't be scaled in an environmentally responsible and economically viable way to supply whole cities.
- The gravitational energy of water at elevation, that is hydro, is and always will be the only safe, natural, convenient and efficient way to store vast amounts of energy for use when needed.

- Reservoir-to-reservoir hydro generation is the natural solution to intermittency problems. It allows power to be generated as needed, without causing severe downstream effects.
- The three Peace Dams (Bennett, Peace Canyon, and Site C) can be major contributors to the nighttime supply, if properly engineered to maximize their capacity.
- The Columbia River reservoirs can also fulfil this function. Additional capacity being installed at the Mica and Revelstoke dams will provide some of this.
- An alternative or additional step would be to nationalize back the Nechako reservoir, which could provide1.6 GW power during the hours of darkness, within the allotted water rights. The second penstock tunnel to reach this capacity is already built, but sits unused, since Alcan (now Rio Tinto Alcan) abandoned its project in the 1990s.
- The argument that we already have sufficient hydroelectric capacity is not true. BC Hydro's reserve capacity is typically around 5%, or 3 GW. For 100% sustainable energy, we will need many times more than this. Hopefully, geothermal generation could and will fulfil a constant base load component.
- The only other option to deal with intermittency is to build 1 MW of gas-fired generation for every 1 MW of intermittent generation. If we choose that route, we are clearly abandoning any hope of carbon-free energy. The result of this choice is certain: catastrophic climate change will ensue.

A comparison of fossil energy and non-fossil sustainable energy

We have to remember what made fossil power so wonderful in the first place:

1. It's energy-dense
2. It's easily transportable
3. It's there whenever you need it, once huge barriers of discovery and capitalization are met.

Now consider hydroelectric power:

1. It's not energy-dense, but the supply is vast
2. Even easier to transport than fuel, because it travels over wires
3. If it's always available when you need it, and cheap enough, it will naturally displace fossil energy on its merits.
4. It's virtually carbon emissions-free, and generally environmentally neutral.

Solar photovoltaic power is a natural partner with hydroelectricty because it is:

1. Abundant whenever the sun is shining, ample even in cloudy daylight
2. Being electricity, also easily transportable via electrical grids
3. Universally accessible during daylight, uniformly distributed except for polar regions
4. It's non-proprietary, not capital-intensive to develop, & royalty-free,
5. Totally scalable, so as to serve single households, communities or whole countries

To replace fossil energy, both solarPV and stored hydro are both required.

So why is there so much opposition to Site C?

Many false statements have made by the vocal opponents of the Site C project. Here we examine 20 of the most frequently cited arguments against the project, and counter with a more accurate representation.

1. "We don't need the electricity. Efficiency and conservation will reduce the need for additional generation."

   This seems to imply that we don't need additional electrical generation.

   How then do we replace fossil energy, which still supplies four-fifths of our primary energy

supply? Simply cutting back on our total primary energy supply will put us all back in the stone age.

2. "Electrical demand in British Columbia has plateaued."

   Sadly, this is true. Through its 'Power Smart' program, BC Hydro has has always campaigned to limit electrical use. The fact is that most of the changes they suggest to limit your electrical use actually increase your fossil fuel use. If you do the environmentally wise thing, and heat your dwelling with a heat pump, you will be immediately punished by a 50% increase in your hydro rate per kilowatt-hour as you move from Tier 1 to Tier 2 rates. BC Hydro's Integrated Resource Plan (IRP) makes no real goal or consideration to displace fossil energy – which is our most urgent task! It seems obvious that BC Hydro has been run for the benefit of the fossil fuel industry, rather than serving as the replacement for it. BC Hydro needs to plan ahead of the market, and beyond provincial borders. It has clearly not done this yet. In that sense, a new IRP is needed. Electrical energy has been depicted as the problem, **while in fact it is the only viable solution to our energy & climate problems.**

   In BC, the Hydro rate policy, plus the lack of long-term planning, represent a political problem. They require a political solution. Unfortunately, no political party in BC is presently offering a solution.

3. "It will create an immediate oversupply of electricity".

   Once again the myth of too much electricity is repeated. Electricity can displace fossil fuels for all building heating and operations: it can replace fossil fuels for most transportation purposes. These uses alone account for about two-thirds of our present carbon emissions. Solar/hydro-produced electricity will be cheap enough to displace fossil energy by market forces alone. No contrived taxes or regulation will be required for this transformation.

4. "The electricity from Site C will only be used to process LNG, or to increase our fossil fuel extraction."

   Well, the Christy Clark government really muddied the political waters with its plan to use Site C electricity to liquify natural gas. In that case, its energy would be entirely consumed in cooling natural gas to -160 Celsius in order to liquify it; that energy is 100% wasted and unrecoverable. Fortunately the mad schemes of politicians are no match for physical law and the realities of market economics. We all know that the massive LNG projects talked about will never happen in British Columbia. The power from Site C can be 100% used to displace fossil fuels from our primary energy supply.

5. "Demand-side Management will solve the intermittency problem of sustainable energy."

   It is impossible to make the case that demand-side management is superior to supply-side management. The big advantage that fossil energy has enjoyed is that it's there when you need it. Once electricity is always there when you need it, its other advantages (cost, ease of transmission, scalability, environmentally cleanliness) will allow it to displace fossil power.

   Demand-side management is simply not an issue when you have over two years supply of water behind the W.A.C. Bennett dam. Doesn't it make more sense to use this relatively unique advantage we have in BC? We can deliver electrical power anytime, at a fixed rate. Other jurisdictions can't. This is a huge advantage we should be using to draw investment into our province.

Demand-side management is the reality faced by jurisdictions without a backup power generation capacity. To put it very bluntly, demand-side management is for losers.

6. "Energy storage is a rapidly advancing field of research”

   This suggests that some magic of chemistry or physics will somehow emerge to solve intermittency of supply. That simply won't happen. The truth is there is only one method of energy storage that is almost 100% efficient and totally scalable: water at elevation. The technology we already have is the best there ever will be. We need to expand stored capacity if we are to make progress in sustainable use of energy.

7. "Super-batteries will solve the energy storage problem."

   We've been developing batteries for centuries. The limits of chemistry and chemical energy storage should be pretty clear by now. Batteries typically require about fifty times the mass of fossil fuels to store the same amount of chemical energy.

   There will be progress in battery technology, but it won't be spectacular, and it is incapable of solving the energy storage problem on a societal scale.

8. "Site C is a gigantic mega-project.”

   Is there something wrong with that? Isn't it precisely mega-projects that make the plethora of smaller projects possible? This is especially true when it comes to the question of energy. It seems obvious our energy future requires a mix of large and small facilities: the large enable the small to happen, wherever they are needed.

9. "Gas-fired generation can solve the intermittency problem."

   Yes, but you'll need a gigawatt of gas-fired generation for each gigawatt of wind or solar generation. That hardly leads to CO2 reduction and a climate solution.

10. "Solar photovoltaic electricity is already cheaper, and getting cheaper everyday."

    Yes, but solarPV cannot deliver a stand-alone solution, because the sun sets. In fact the spectacular rise of solarPV puts increased urgency of the need for nighttime power generation that Site C could supply. The cheaper solarPV power gets, the more we need Site C to complement it. That's the reality.

11. "Wind generation will solve our electrical needs."

    BC Hydro estimates that it can currently integrate 3,000 MW of wind capacity onto its system”. This represents only 5% of generating capacity, so BC Hydro is effectively saying they will limit wind generation to 5% of the electrical supply. Compare that with what Denmark and Germany are already doing with wind: at times it suffices for all their electrical needs. With the ability to store power in reservoirs such as Site C, we essentially erase the limits to how much wind-generated electricity we can handle.

12. "Geothermal electrical generation could supply all our energy needs."

    This is almost certainly true. But so far, we do not have a single large-scale geothermal power plant in Canada to demonstrate that it can deliver energy in a cost-efficient manner. It's unrealistic to believe that geothermal can power Canada cost-efficiently when no proof-of-concept power station has yet been built in this country.

13. "Treaty rights have been violated."

    BC Hydro has consulted Treaty 8 and other First Nations groups for a decade, and some settlement of claim has been made. First nations' rights are indeed important. They must be suitably consulted and accommodated. But we do not grant an absolute veto to any citizen group, aboriginal or otherwise, against the common good. Actually, optimization of the power system with its existing grid capacity from Treaty 8 lands offers these communities an incredible opportunity to lead the sustainability revolution with solarPV and

wind generation from their lands. The manageability of Site C's generation capacity is what makes the those power sources viable in the first place. The most-cost effective wind resource in BC is found in the Peace River region. First nations have already become leaders in run-of-river and wind power projects. We can do this together.

14."The environmental impacts will be hugely negative."

We need to acknowledge that that the natural flow of the Peace River has already been disrupted by the two existing power dams. With a third dam and three reservoirs, there is far more freedom to operate reservoir-to-reservoir release to produce more desirable downstream effects, including a restoration of the natural river flow. Site C potentially can have a very positive environmental impact, especially on water levels in the vast freshwater delta of Lake Athabaska.

15."Hydro dams consume so much water."

Hydro dams do not consume water: every drop is conserved: what goes in comes out. What the hydro generators do is harvest the gravitational energy of the water, which was imparted to it by the sun, via the hydrologic cycle.

16."Reservoirs are huge sources of carbon dioxide and methane."

This statement is a total misrepresentation of the carbon cycle. Bodies of water do not create carbon dioxide or methane, but they can absorb, transport and release them. Biomass will create those gases with or without water reservoirs.

17."Hydroelectric dams and reservoirs are not clean sources of carbon-free energy."

Well, actually they are very clean and carbon-free. Their advantage is huge:

Lifecycle greenhouse gas emissions by electricity source

18."The flooded farmland could feed a million people."

This widely quoted claim has no quantitative basis. At present, only about one quarter of the land to be flooded at Site C is actually under cultivation. Most of that farmland is used to grow animal fodder, not human food. Agricultural productivity of the Peace River region is now limited by the extreme temperatures, which produce a very short growing season from last frost to first frost. Large bodies of water do mitigate such temperature extremes. The Site C reservoir might actually increase agricultural productivity of the Peace region by moderating temperatures, and lengthening the growing season.

19."The soils in the valley are the best agricultural soils."

The valley contains a mix of soils; some are poor. Actually, the best agricultural soils in Canada would be found underwater on the bottoms of freshwater lakes and rivers that cover about 9% of Canada. No one is proposing that we drain all those bodies of water in order to farm them.

20."The Peace Valley is too precious and beautiful to flood."

It's one thing to argue against flooding valleys when the remaining land is entirely rock and mountaintop. That is simply not the case in the deep soils east of the Rockies. There the surrounding terrain is all flat, rich, fertile agricultural land.

The Peace Valley is indeed beautiful. Yet, there will always remain hundreds of kilometers of the Peace Valley just as beautiful. There are many other beautiful rivers flowing from the Rockies onto the prairies. And remember, the lake formed by the new reservoir will be pretty awesome sight to behold.

A natural, market-driven solution to catastrophic climate change:

It has often been stated that in order to address the real and present dangers of climate change from CO2, that we need to react in much the same way as did the Allies at the outbreak of World War II. That is, we need to mobilize all our efforts towards achieving a necessary goal. In 1939, the goal was the preservation of freedom and democracy. Today it is the preservation of a stable climate environment on our planet. Then as now there wasn't a perfect master plan of how the goal might be achieved. It just requires a total commitment to get it done.

The climate war is truly underway. And we are losing.
What we need to do to stop catastrophic global warming is simple enough: stop burning carbon! We do know there will be huge intermittency problems as we eliminate fossil fuels, and the **only** large scale solution to intermittency of supply will be water stored at elevation (that is to say hydro reservoirs). In short we very much will need Site C in any plausible scenario to eliminate our hydrocarbon dependence.

The answer to the energy/climate crisis is available right now.

Today, it is clear that solar photovoltaic power, coupled with hydro storage, will provide the most viable solution to climate change. It can be achieved safely and rapidly. We cannot afford to delay on this most important challenge/opportunity. Site C electrical power is a vital component of that solution.

Further reading:

Light and water are the future of energy.

Electricity from sunlight is Einstein's greatest legacy.

Are hydroelectric reservoirs sources of greenhouse gases?

Twenty arguments surrouding the Site C project.

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