Blue Fuel Energy Corporation
100 - 9800 McDonald Park Road
Sidney, BC, V8L 5W5 Canada
www.bluefuelenergy.com
T 250.655.0330
C 250.888.2737
F 250.483.1577

# A New Vision for Clean Energy in BC

Major changes in outcome usually require bold strokes. The Government of British Columbia exemplified this when it implemented plans for the WAC Bennett Dam and the Columbia River projects. The following quote from BC Hydro's company history page says it all: (https://www.bchydro.com/about/who_we_are/history.html)

"The '60s and '70s saw BC Hydro take on some of the most ambitious hydroelectric construction projects in the world."

BC's legacy of low-cost, renewable hydropower would not exist were it not for those visionary steps. Today, the WAC Bennett, Peace Canyon, Mica Creek, Revelstoke, and Hugh Keenleyside dams represent close to 10,000 Mw of available capacity and give BC an electricity supply that is more than 90% renewable. There were, however, intense political, economic, and community-level fights over each of these investments.

Turning to current times, one look at greenhouse gas (GHG) emissions in the province and, more broadly, in the country and the world, shows that most emissions are in the transportation and industrial segments of the economy. Outside of BC the electricity generating segment is also a major emitter; in the US, for example, more than 50% of the electricity generated is from coal.

In BC more than 37% of our emissions are from the Transport sector and 39% from the Industrial sector (See Table 1, Source, Discussion Paper, Climate Leadership Plan for BC). The table below shows emissions in BC by sector, and that more than 77% of emissions are from the Transport and Industrial sectors. The most rigorous steps

be taken are in these sectors as the remaining 23%, in Built Environment and Deforestation, cannot mathematically produce the overall 33% reduction committed to for 2020.

Residential emissions are primarily from space heating and water heating, where natural gas is commonly utilized. Similarly, in Commercial buildings, probably more effort is applied to efficiency as it affects the owner's bottom line. Again, most usage is probably for space heating and hot water. These two sub-sectors, accounting for almost 11% of total emissions, should continue to be targets of consumer activism as they are where individuals can make a difference. That said, with our suggestion to promote electricity throughout the province, major reductions would come from refits of existing buildings and regulations around "new builds" that would have a significant medium-term impact.

## Table 1.
## GHG Emissions in BC in 2013

| | % | Million Tonnes / Year |
|---|---|---|
| **Transport** | | |
| Personal Vehicles | 13.3 | 8.5 |
| Commercial | 23.9 | 15.3 |
| **Industry** | | |
| Fossil Fuel Production | 13.4 | 8.6 |
| Forestry/Mining/Other | 24.8 | 15.8 |
| Electricity Generation | 1.3 | 0.8 |
| **Built Environment** | | |
| Residential | 6.8 | 4.4 |
| Commercial | 4.0 | 2.6 |
| Waste | 7.5 | 4.8 |
| **Deforestation** | 4.9 | 3.1 |
| **Total** | 100 | 64.0 |

As far as Deforestation is concerned, a "no-brainer solution" should be the requirement to replant at a rate that ensures balance or in some cases net positive reforestation. We presume the current negative in this sector comes from the concerted effort to remove beetle-killed trees in vast areas of the province over the past few years.

Against the background of actual emissions the province and the nation have enacted targets as well. In BC we are required to reduce total emissions by 33% over 2007 levels by 2020 and by 80% by 2050. As a nation we are signatories along with the rest of the G-7 Group of Countries to a commitment to reduce fossil fuel use to zero by 2100.

These are noble targets, but without far-reaching change in almost everything we do they cannot be achieved. Back in 2007 it may have seemed that a 33% reduction by 2020 was reasonable, but now we see that more than halfway to 2020 we have not achieved a significant reduction (2007 emissions:, 64.3 million tonnes; 2013 emissions: 64.0 million tonnes).

This is not to say that there have been no positive developments or significant progress. The fact of the matter is that population and economic growth in BC are offsetting efficiency improvements throughout the economy. That said, as a province we want the population and economy to continue to grow in order to maintain or enhance our standard of living in the future. Given the above, we conclude that there is now no practical way to achieve the 2020 targets, and that to achieve longer-term targets we need more profound initiatives. We cannot simply throw our hands up and say, "Woe is me". Rising temperatures, melting glaciers, rising sea levels, and more extreme weather events are not acceptable outcomes from our current lack of success. Even attaining a 33% reduction (which is not the target of the G-7 commitment) will require major new initiatives, particularly in the Transport and Industrial sectors, which account for almost 80% of all emissions.

Our recommendations address issues in both the Industrial and Transport sectors.

**In the Industrial sector we propose:**

• Committing to the replacement of fossil fuels with renewable electricity — on a massive scale.

**In the Transport sector we propose:**

• Driving down the carbon intensity of existing motor fuels.

• Aggressively supporting the adoption of electrified vehicles (electric vehicles or fuel cell-powered engine platforms).

The Transport sector requires both of these approaches because of the long life of the existing vehicle fleet, which today is constantly being replaced with similar technology.

We are fortunate that adoption of electrified vehicles in our marketplace is at a much higher rate than global statistics would indicate. That said, jurisdictions like Norway clearly have superior plans in place for adoption of these new cars: Norway's electrified vehicle adoption rate is about 29 times BC's. This is an area where the province can take a major leadership position in all aspects of car ownership. For more details see: http://www.bcsea.org/policy/norway-vs-british-columbia-great-electric-vehicle-race.

The Government of BC has two major tools for implementing change: policy adoption and resulting legislation; and taxation policy. The existing carbon tax is a good example of the latter.

**Why Electrification of British Columbia?**

We have reached the point where industrial activity contributes 39% of our total GHG emissions. Generally, emissions from this sector come from two major sources: generation of power to move or rotate things; and generation of heat to heat things. Man has made major progress in industrial innovation, but most of it has been targeted at product and not process. When it comes to energy we tend to take the easy way out and simply burn whatever is handy to rotate a turbine or to raise steam to turn machines and generate electricity. This is because the direct cost of energy production this way has been cheap and emissions and heat effects on the

environment have not been included in the cost. Often, however, electricity is a far superior form of energy for those activities. In the past electricity was more expensive than other forms so industry tended to go on doing what it had always done and burned coal or natural gas or wood to get the job done. If we want to change the world (and our province, specifically) we should instead focus on changing as many of these energy users over to electricity as possible — and finding ways to make sure that renewable electricity is available where and when it is needed.

BC Hydro has an enviable set of assets that provide the province with electricity, approximately 93% of which is renewable. The corporation has always been driven by the need to demonstrate demand before new capacity is added. This leads to an inevitable chicken or egg situation whereby: because electricity is not available industry plans not to use it; and because industry plans not to use electricity, demand for it is not forecast.

To break this cycle we recommend that BC Hydro be mandated to generate electricity from all renewable sources available, with choices made according to unit cost. Some of this can be done, of course, through Public Private Partnerships or simple supply agreements with third parties. The essential policy feature is that:

- Industries are encouraged and, later in the cycle, directed to use electricity for their prime energy requirement wherever feasible.
- BC Hydro is charged with acquiring and delivering that renewable electricity.

A good example of what happens when this is not done is in BC's rapidly developing LNG segment, where insufficient generating and transmission capacity has resulted in project developers planning to use natural gas-fired turbines to generate their power. If these plans are realized, CO2 and NOX emissions will far exceed those that would occur if electrical drivers were used. Only with excess capacity in both the grid and generation can such outcomes be avoided. Many will argue that this is an inefficient way to run a utility and that we will all end up paying more for our electricity as a result. There's some truth to this, but if you want both economic growth and lower GHG emissions something has to come first.

We believe that a balance can be achieved by developing interim markets in Alberta

in cooperation with the Alberta Government so as to balance out supply and demand. In processing plants, electrical drivers in most cases are more efficient and more reliable, features that help to offset the cost differential between, for example, natural gas and electricity.

**By Way of Example**

In designing our Blue Fuel Energy plant we have the option of adopting a conventional approach that uses waste heat to raise steam and then uses the steam to manage heat loads and power rotating equipment (compressors and pumps, etc.). We are turning our back on this option. We've chosen a new balance of technology that produces very little waste heat and allows us to use all-electrical drivers. As a result, our electricity demand is significant, but our natural gas demand is more than 20% lower than it would be in a conventional plant. Most importantly, our CO2 emissions are reduced by 700 – 800 thousand tonnes / year vs. a conventional approach. The cost of electricity is a new cost, but it is offset by a reduction in total natural gas cost. These two items when compared at about US$4 / mmbtu gas cost are more or less equal. We trade a simplified design and lower capital cost and operating efficiency for a slightly higher variable cost and a lower carbon intensity in our product.

Of course, if that power were not available we would not even consider such a process; it would be nonsensical to generate our own power from fossil fuels to do such a job.

BC has an opportunity to ensure that all new industrial sites and, over time, refits of existing sites, use electricity for their energy requirements rather than less efficient heat, which is accompanied by GHG emissions. However, for this transition to happen, low-cost renewable electricity must be made available through new sources of generation and upgraded grid capacity.

**Beyond Borders**

For a massive electrification plan to bear the most fruit it should also meet the needs of our neighbours, particularly Alberta. Major new interconnects are required to ensure that our provincial grid has full access to Alberta markets as well. The new government in Alberta has announced plans to completely phase out coal-fired

generation in the province by 2050 and to reduce emissions from this sector by 20% by 2017. However, with a growing demand for power in Alberta, something will have to give. This implies that Alberta will embark on a massive investment in natural gas-based power for the future. Surely, at this early stage of the conversion, the option of importing renewable electricity from BC would seem to be part of a simple and GHG-efficient solution. A trans-provincial agreement, and construction of new grid capacity, could see BC's vast potential for renewables electrifying Alberta's industrial base, as well as our own. By such means Alberta's oil sands could transition from being the source of the "dirtiest oil" to the cleanest oil — in terms of GHG emissions. Alberta off-take of renewable electricity from BC balanced by natural gas-based peaking plants in Alberta or BC would give rise to much lower overall emissions than the current independent provincial models, which sub-optimize emissions in favour of provincial autonomy.

When we refer to BC's "vast potential for renewable electricity" we are primarily referring to wind and run of river, although later in the century we might expect the province's very large geothermal resources, particularly those in the northeast, to become a significant contributor.

Such a plan would also open the door for BC Hydro to use its vast water storage capacity in a way that balances intermittent supply alternatives like wind power. Those dams are possibly the world's largest batteries. Probably the most important feature of such a plan would be enhancement of the grid. It is the lack of grid and generating capacity, and provincial policy, that is forcing potential LNG producers on the West Coast to plan for a natural gas-based power supply.

Any expansion of generating and grid capacity cannot be accomplished without compromise between land use and emissions management (grid corridors and generation sites); this issue needs to be tackled first with all stakeholders.

What might this look like in terms of demand over the period to 2100? Taking a simple view that all emissions are from burning fossil fuels at a very conservative rate of 4 Gj / Mwh, our suggestions would predict a demand growth of over 288 million Mwh / year, which is roughly four times existing provincial capacity (not including growth in demand or sharing with Alberta). Clearly, this is the type of major undertaking we know is required if GHG emissions are to be wrestled to the

ground.

**Summary of Key Steps**

- Policy to require electrification of industry in BC wherever possible
- Pre-investment in electricity generation and grid capacity and interconnects with Alberta
- Negotiation of a comprehensive "uni-grid" agreement with Alberta to ensure smooth integration of electricity supply with demand. Such an agreement would grow the available market for BC renewables, balance intermittent new supplies of such electricity, and offset coal use in Alberta. This could provide incentives for oil sands producers to move towards electrification of their processes as well.
- "Sea-change" in the philosophy of BC Hydro whereby it becomes a systems optimizer rather than a dam builder

**Transportation Sector**

The Government of BC should be applauded for developing and implementing the Climate Action Plan in 2008. This plan called for reductions in emissions of GHGs by 33% by 2020 and 80% by 2050. The plans included adoption of a carbon tax, with BC being one of the first jurisdictions in North America to do so. Despite prognostications of doom, the world did not come to an end and industrial activity in BC did not decline.

In 2008 BC also introduced the Greenhouse Gas Reduction Act, which calls for a 10% reduction in the carbon intensity of fuels in BC by 2020. Of the current 37% of total GHG emissions in the province that are derived from the transportation sector, this act should result in a reduction of 10% of fuel emissions and about a 3.7% reduction in total GHG emissions for the province. This would equate to a reduction of GHG emissions by about 2 million tonnes of CO2 equivalent by 2020. Technically this plan will be difficult to achieve given the current slate of low-carbon fuels that are available to replace gasoline and diesel. And if that target is difficult, how will we get to a 33% overall reduction in 2020 when the transportation sector can only achieve 3.7%? Reducing overall emissions by 33% by 2020 would seem to be impossible since fully 30% of the 33% would have to come from the industrial sector, residential and commercial buildings, and balancing deforestation. Achieving the

33% reduction will require more than a 50% reduction in all other sectors of the economy. This is simply not feasible by 2020.

However, it might make sense to take the long view. We need to reduce usage of fossil fuels by a little over 1% / year from now until 2100 to achieve the G-7 goal. This may seem like small steps, but it will not take many years before this target seems hard to achieve as well. There is still some low-hanging fruit that might allow for an acceleration of the pace in the early years, but after that major technological change will be required.

Therefore, the conclusion we draw is that the goal for the transportation sector must be seen as simply an early interim target with much more dramatic reductions to follow. It needs to be at least 33% by 2030 given the growing emissions in other sectors of the economy and the long lead time required for the energy / industrial/ and transportation segments to overhaul themselves. In the transportation segment there is great hope for new technologies like the fuel cell and all-electric cars, but they will take considerable time to make a significant contribution.

Our conclusion is that the penetration rate for fuel cell and all-electric vehicles will follow a path that is hampered more by the lack of hydrogen infrastructure for fuel cells and the need for significant new infrastructure, as well as a supply of electricity for electric cars. This is an area where the province — and BC Hydro in particular — can take a new lead. Otherwise it might be well into the second half of this century before these new technologies represent a majority of the total car park. In the meantime an accelerated reduction in the carbon intensity of fossil fuels will be required after 2020 to make progress until new technologies take over.

As to how to reduce the carbon intensity of fuels, this is an area where Blue Fuel Energy is particularly well informed; our website offers many insights into one of the possible approaches (bluefuelenergy.com). We know that other companies are also heavily engaged in bringing technologies to the commercial stage, but mainly what they need is a policy signal and clear market direction (not choosing technologies) from the government so that needed capital can be made available.

As to the second part of this equation, reducing total transportation-based emissions

by 33% by 2020 seems to be practically impossible (since the current regulations are for a 10% reduction at that time), but adopting that goal for 2030 accompanied by a market-based pricing mechanism, such as the trading of credits, would probably bring a number of low-carbon fuel approaches to market that much sooner. We favour the trading of credits as it does not attempt to put a price on carbon (as the current fine of $200 / tonne for non-achievement in the LCFS does). Any attempt to put a price on failure-to-achieve leaves open the scenario where the fine is simply paid and no progress is made. We do not think it is the intent of the province to collect fines, but rather to reduce emissions. The market is the best place to decide how.

As an example of how that might be achieved, at our proposed plant in Chetwynd, BC, Blue Fuel Energy is planning to produce a "drop-in" gasoline that has about 11% lower carbon intensity than conventional oil-based gasoline. This would meet the 2020 challenge, but what's after that?

Blue Fuel Energy has found a way to combine fully commercial methanol and methanol-to-gasoline (MTG) technology so as to produce a fungible "look-alike" gasoline with a CI about 11% lower than conventional oil-based gasoline. We do this by replacing all the conventional steam-driven machines in the production plant (compressors, large pumps, air cooling etc.) with electrically driven motors utilizing BC's greater than 94% renewable electricity supply. This step alone results in a CI reduction of 10 – 15%. But that is not the only reason we chose this process route. In the longer term the much more compelling feature is that the feedstock for methanol production is syngas (a mixture of carbon monoxide, carbon dioxide and hydrogen) in a ratio that assures high productivity and efficiency. The end steps in this process can be augmented by the addition of extra carbon dioxide and renewable hydrogen (in our case, produced through electrolysis of water) to produce incrementally more and more methanol and consequently more and more gasoline. Every time we add such an increment, the average CI of the resulting gasoline goes down. (At 25% addition, for example, it will approach a CI of 60 g CO2 /MJ for all of the product gasoline. This represents a 30% reduction in carbon intensity of the fuel with no loss in properties and complete fungibility with existing fuels.). The pace of this second phase can be solely determined by market dynamics.

There are no new technologies to be proven, no new infrastructure to be built, and

no stranded capital assets as the incremental additions occur. The incremental capacity can also be achieved at relatively low capital investment in the existing plant.

In this way we are focused on achieving the full 10% reduction in CI in the first investment with conventional gasoline economics, and to continually improving the carbon intensity of the product through a series of much more modest investments in electrolysis capacity and incremental de-bottlenecking of the methanol and MTG plants.

Reducing the carbon intensity of fuels is one area where a major policy / taxation initiative is required. The current low-carbon fuel standard includes a penalty of $200 / tonne of CO2 not attained. At present rates, this represents a penalty of about US$7 / barrel of non-attainment. For a reduction in carbon intensity of 10%, roughly one barrel in 10 must be replaced. This represents a significant reduction in refinery utilization and potential loss of margin. Currently, refinery margins in western Canada are very high at about US$40 / barrel in Edmonton. Therefore, on simple economic grounds, it makes more sense to continue running the refinery flat out and to pay the fine. This points out the weakness of fixing a penalty without respect to market dynamics.

The provincial strategy must not be to become a “fine collector”, but rather to reduce emissions, so a move to a market-based approach like California’s would be more effective. California has similar regulation for the 10% reduction in GHG emissions, except that the reduction must be attained; the seller of fuels must buy credits on the market to make up any shortfalls. This creates a market for credits.

We believe that a California-like regulation would demonstrate that attainment is the target and also provide developers of alternative low-carbon fuels with a clear signal as to the market response to the regulation.

Our Blue Fuel Energy example is just that, an example. There are a number of other technologies that are moving along that promise lower costs. These include new processes to recover CO2 from the atmosphere, as well as from flue gas and other waste streams. The promise of lower costs for electricity from renewables through

economies of scale and technical breakthroughs will also be stimulated by creation of real markets on the scale of energy markets.

**What are the Major Policy Framework Questions?**

First and foremost is to make BC Hydro an enabler of emissions reduction strategies rather than a potential blocker of them. Accomplishing this requires that Hydro management be rewarded for careful stewardship of existing systems and assets, risk-taking in future grid and generation decisions, and willingness to find the way to align plans with Alberta to move both provinces ahead. This is no small undertaking: it will immediately come up against issues with the BC Utilities Commission, mandated to protect consumers from foolish risk-taking. A new government-backed entity might be required to carry out this step.

On the transportation front, strong policy support for new low-carbon transportation technologies and a market-based cost of carbon that will encourage new "low-carbon" sources of carbon-based fuels. This would be supported by an announcement that the reduction target for 2030 will be 33%.

A recognition that consumers will ultimately have to pay for the fight against climate change and resulting global warming. Naturally, they will ultimately pay for the effects of climate change if it is not mitigated. This needs to be made clear throughout the province. This could start with a comprehensive look at the unique cost to BC of doing nothing in terms of rising seawater levels, agricultural water shortages, loss of arable land due to drought, and more extreme weather events causing damage. While our own approach to mitigation will not solve the problem (it is a global problem), we can continue to be leaders in this effort, which will give rise to new technologies and new companies and employment. The effects will be felt directly in items such as fuel pricing and electricity rates, but these could be offset by taxation strategies such as carbon taxes offset by income tax reductions as proposed in BC's existing regulations. To the fullest extent possible, costs should be user-based.

The impact of the electrification strategy will also alleviate emissions from the residential and commercial buildings sector as heating and cooling demands move over to electricity. On the heating and cooling front, we should also encourage

adoption of proven geothermal solutions so the electricity load is not so great.

**Anticipate the Future**

We are only now beginning to see the cost of doing nothing. All of the above-mentioned consequences have measurable costs and must be considered as offsets to the cost of change.

We also need to anticipate that as we base a significant portion of our provincial economic future on LNG that we recognize the CO2 emissions from both the operating plants and the gas sources. Much of our new gas supply will come from basins like the Liard, where the gas commonly has more than 10% CO2 entrained. We must not pretend that that CO2 does not exist. At a future consumption level of 4BCF / day our CO2 emissions will rise by at least 8 mega tonnes / year. Now is the time that we should be making collective investments in innovation to mitigate that specific atmospheric load so that the economic development of those reserves will not be unduly restricted.

The accomplishment of these goals will ruffle more than a few feathers. It is not a time for the fainthearted. These suggestions would be best implemented with the full support of all political parties so that needless scrimmages around policy changes can be managed. It is not too late to accomplish this goal, as it is hard to see what party would want to be on the wrong side of this discussion.