



The Road to 2050

Bridging the Gap Between Challenges
& Solutions in the Energy Sector.

Energy

Bridging the Gap Between Challenges and Solutions in the Energy Sector

The Province of British Columbia, through their progressive CleanBC program, has set province-wide GHG emissions reduction targets of 40%, 60% and 80% for 2030, 2040, and 2050. While BC produces clean energy in the form of hydroelectricity, 68% of energy demand in BC is being met through refined petroleum products and natural gas.¹

In order to meet the CleanBC targets, the province will have to transition away from using fossil fuels for transportation, industry, and housing into cleaner alternatives with low or zero GHG emissions. This transition is not only necessary to meet these legislated goals, it is being driven by global economic conditions that has put Canada's oil and gas industry in dire straits.²

The pathway to 2050 does not lie in a single technology solution or sub-sector of the energy industry. While it's clear that as a leader in renewable hydro-electricity, BC should pursue electrification of many sectors of the economy, it is also clear that electrification will not be enough on its own to achieve the 2030-2050 policy objectives of the provincial government.

What's At Stake

- The consumption of energy produces the largest amount of greenhouse gas emissions in British Columbia. (~81%).³
- The sector contributes \$9.4 billion to BC's GDP.⁴
- BC's energy sector directly employs 20,400 people, and nearly twice that many indirectly in drilling, maintenance, supply, construction, and corporate and transportation industries.⁵
- The size of the potential hydrogen export market for BC is significant. In 2030 and 2050, respectively, the total market size of four combined target markets of China, Japan, Korea and California is expected to be \$87 billion and \$305 billion, respectively.⁶



New technologies will have to be developed and deployed (at significant scale) to create more pathways for energy decarbonization, energy transmission, renewable energy conversion and storage, low cost carbon & methane capture, and grid optimization. New markets and market mechanisms will also have to evolve.

Most importantly, decisions must be made, and action must be taken. There is a massive opportunity for BC to leverage its clean energy expertise, its natural resources and its geographic advantages to capture a significant share of a growing global market in liquid and gaseous energy.

CORE Cleantech Cluster and Foresight are producing a series of roadmap landscapes in the six sectors of CORE's focus. The intent is to provide a snapshot of the roadmaps that exist in each, and how they are being used. This will help identify gaps in the required elements, as well as places where roadmaps either don't exist or are insufficient to achieve the government's targets.

This introductory document is meant to provide a snapshot of the roadmaps in use in the energy sector in BC, to provide a strategic overview of the path to the targets for 2030-2050, and to identify areas where the industry would benefit from further support in order to achieve the targets.



Energy: Established & Emerging Markets

Decarbonizing the energy sector in BC requires a market-driven approach guided by the end user and what they will adapt and use most efficiently and economically. Interviews with a cross-section of industry players revealed a number of low carbon technologies, fuels and energy sources under consideration as major contributors to the energy transition.

ENERGY SOURCE	SUPPLY CONSIDERATIONS	DEMAND CONSIDERATIONS	GHG CONSIDERATIONS
Renewable Electricity	BC is an exporter of hydroelectric power and has clean power generation expertise.	Growing demand, uncertainty re: infrastructure requirements and future economy needs	No emission at end use. Most electricity in BC comes from clean hydroelectric.
Natural Gas	Large supply in BC, export market growing.	Demand is growing. However, long term demand is uncertain as competing fuels become more available and cost effective.	Can support global markets in energy transitions as it emits approx 24% less CO ₂ than oil, 56% less than coal. ⁷ Still a significant source of GHGs.
Hydrogen	Can be made from a range of resources that are abundant in BC	Demand growing, both in BC, Canada and globally	No emissions at point of use. CO ₂ emissions in the production of hydrogen vary by technology.
Bioenergy	Limited/uncertain supply of feedstock	Uncertain, price is significantly higher than LNG	Considered carbon neutral as emissions are offset by growing feedstock. Amounts of CO ₂ emitted at point of use vary by production method.

Roadmaps: Competing Visions

While the CleanBC Plan, the Low Carbon Fuel Standard and Renewable Gas targets are driving change throughout all energy-related sectors, there are a number of roadmaps in use in BC to guide the energy transition that are focused on particular technologies and energy sources.

TECHNOLOGY	ROADMAP OR STRATEGY	PUBLISHED BY
Electricity	BC Hydro Review (Phase 2)	BC Hydro
Natural Gas	Renewable Natural Gas Technology Roadmap for Canada FortisBC - Clean Growth Pathway to 2050	Canadian Gas Association Project Sponsor: Govt of Canada FortisBC
Hydrogen	British Columbia Hydrogen Study	Zen and the Art of Clean Energy Solutions, The Institute for Breakthrough Energy and Emission Technologies, G&S Budd Consulting Services. Project Sponsors: BC Ministry of Energy, Mines and Petroleum Resources, BC Bioenergy Network, and FortisBC
Bioenergy	BC Bioenergy Strategy Canada's Bioeconomy Strategy	BC Bioenergy Network Bioindustrial Innovation Canada Project Sponsors: Agriculture and Agri-food Canada; BIOTEC Canada, the Forest Products Association of Canada, and FP Innovations



In addition to these energy source/technology based roadmaps and strategies, there are regional and stakeholder groups such as economic development officers, municipalities, First Nations and regional organizations across the province active in preparing roadmaps and economic actions plans focused on meeting climate goals through energy-related projects and initiatives.

Significant efforts are underway by Indigenous communities in BC for clean energy and efficiency projects. Some of this work is carried out by The New Relationship Trust who implement the British Columbia Indigenous Clean Energy Initiative (BCICEI) to provide support and capacity-building funds to Indigenous communities working on the development of new projects.⁸

Producers want to know there is demand,
equipment to use H2, pipelines to carry it.

- Interview participant

Observations

Electricity

- As the default clean energy provider in BC, BC Hydro has a huge impact and influence on the future energy path in BC. As their mandate is electricity, they are primarily focused on promoting clean electricity and not connected into or engaging with discussions around alternative fuels such as biofuels and hydrogen. This leads to a communication gap in the industry, as future planning around the energy infrastructure, which impacts the entire sector, often happens within BC Hydro.
- Future growth and market development relies on expanding transmission infrastructure. An expanded transmission network would ensure more of the country benefits with economic opportunities as well as the ability to transition to cleaner energy.

Natural Gas

- FortisBC has presented a clean growth pathway showing they are working on expanding their focus on natural gas into renewable natural gas and blue/green hydrogen to align with the CleanBC Plan.
- There is a large initiative underway to export LNG and to create the least carbon intensive operation as possible. However, there is concern that the long term economics and falling prices of competitive options could leave an LNG-only solution a stranded asset in the coming decades.

Hydrogen

- There is a growing demand for hydrogen as an energy source to help in the decarbonization of hard-to-abate sectors of the economy, for example, steel-making, fertilizers, and other industrial uses.
- Transportation demand is currently unclear, but thermodynamics and number of available vehicles in the market both suggest Battery Electric Vehicles (BEV) will win the light-duty car market as well as medium and short-haul trucking in BC.
- In order to transition to hydrogen as a substantial energy source in BC, there will need to be a means to transport hydrogen within and out of the province, which likely means the use of pipelines. While hydrogen can safely be injected into natural gas pipelines, there is a maximum concentration of 5-10% for major transmission lines, meaning that this would only be a short-term solution. Given that the design, permitting, and construction of a major pipeline will take many years, if the provincial government decides to commit to a long-term hydrogen pathway for BC, it will need to move forward quickly with policies and action plans for building a dedicated hydrogen pipeline network.

Bioenergy

- Low carbon liquid fuels and renewable natural gas have a role to play in replacing conventional natural gas for applications where conversion to electricity is not practical or cost effective.
- There is a limited quantity of feedstock in both forestry and agriculture, and economics may favour the conversion of biomass into higher value products rather than large scale conversion into energy.
- Price is currently significantly higher than regular natural gas, and that will have to be addressed in the economics and business modelling for future projects and large scale sector planning.
- Renewable diesel and/or aviation fuel also has pricing concerns, though in some cases the price differential is less dramatic. (For example, the Port of Seattle, in partnership with Washington State University, recently published a study looking at the potential production of sustainable aviation fuel and concluded that pricing/economics were the key challenges rather than technology or feedstock supply.)⁹

Everyone is watching federal and international signals, but provincial direction is what it comes down to.

- Interview participant

Recommendations

As a large contributor to the GHG emissions in the province, and a significant economic driver, decisions must be made regarding the future direction of the energy sector. While it is clear that the path to 2050 in this sector will require both local/regional technological adoption and export market development, the path forward is not fully defined.

As noted above, there are competing strategies, roadmaps and visions for the energy future in BC. CleanBC has told the players where the goalposts are, the players are gathering, but there's no coach on the field telling them what positions to play and they are fighting over the ball rather than working together.

Access to the global market is critical to the growth of the sector, and hinges on the development of pipeline projects, transmission infrastructure and fuel processing facilities. However, the uncertainty around pricing, local and global demand, technology readiness, environmental impact, and costs may be causing paralysis and an unwillingness to move forward in the decisive way that is required.

We believe that a provincially-led decision tree must be developed that provides guidance around key issues and major technology pathways. This should outline the path ahead around big picture decisions and infrastructure investments, particularly in transmission plans, the capacity of electricity, feedstock supply, role of biofuels, and the path toward developing an export market in hydrogen.

BC is a known hub of hydrogen expertise and a global leader in clean hydroelectric energy. We have natural resources and feedstock supply, geographic advantages in the Cascadia corridor and into Asia, and progressive, world-leading carbon policies. A decision tree that catalyzes this province into action would allow us to be leaders in the changing energy landscape and break the uncertainty that has arisen from competing visions and roadmaps.





HYDROGEN - A Critical Decision that Needs to Be Made Quickly

In order to achieve CleanBC goals, there is an immediate urgency to decarbonize BC's energy supply across all industry sectors. Major industry players in the province are responding to that need and supporting the government's CleanBC plan by developing strategies reports and roadmaps, as we outline in this report:

- In Sept 2019, the BC Hydrogen Study's top recommendation was to "identify and communicate hydrogen as priority sector for the Province."
- In March 2020, BC Hydro published the interim report from Phase 2 of their review stating they will support the government's CleanBC plan by "expanding the electrification of the economy and powering more activities from electricity".
- In 2018, Fortis BC recommended "ramping up Renewable Natural Gas (RNG) and hydrogen deployment" and "positioning BC as a vital domestic and international Liquefied Natural Gas (LNG) provider" as pathways to support CleanBC.

The purpose of this report is not to discuss the merits of any of these three major pathways, only to highlight that given the costs and timelines, the full picture inherent in all these plans can not all happen at the same time, and a decision made in one sector impacts the planning on the other sectors. And, that the opportunities to work together will only come to full fruition with government guidance regarding priorities.

That said, one of the pivot points in these big decisions is the nature and scope of the hydrogen economy that should be developed in BC. The BC Hydrogen Study identified the following pathways as worth considering:

- 'Green Hydrogen' produced from clean and renewable electricity,
- 'Blue Hydrogen' produced from natural gas or biomass coupled with carbon capture and storage (CCS).

Blue hydrogen is under consideration as both a domestic and export pathway for energy production due to its lower cost and the abundance of natural gas resources in BC. However, it is still relying on natural gas, which is a significant source of GHG emissions.

The BC Hydrogen Study sees the pathway toward a hydrogen economy as a transition from blue to green over time:

"Our policies should set BC as the global leader in hydrogen production with a clear understanding of how their inherent cost structure will drive market adoption of the lower cost natural gas sourced hydrogen to the more expensive fully renewable hydrogen as the finite hydrocarbon sources are depleted over time."

However, it is worth noting that while fully renewable 'green' hydrogen is more expensive, there is some notable research coming out showing that the costs of producing green hydrogen is dropping more rapidly than expected. Not only are renewable electricity costs dropping rapidly, so are the costs of manufacturing electrolysis equipment. A new report from the Hydrogen Council predicts that the cost of green hydrogen production will fall by up to 60% in the next decade.¹⁰ Wood Mackenzie identified 2030 as the year when green hydrogen would reach cost parity in some markets.¹¹

The first decision will be to identify whether hydrogen will be a priority sector, and then, if so, what technology pathways (blue or green) should be prioritized (and when). This will be dependent on another key decision - whether the markets to be developed should be local only, or local and export.

These decisions will impact technology development, investment and infrastructure planning for all major industry players in the energy production and delivery sector in BC. In order to meet CleanBC goals, these decisions should be made in a very short time frame.

Electricity

- Transmission is the biggest constraint to further electrification of the province, as it is highly capital intensive. BC should align with the federal government in the creation of a national grid strategy. Multiple synergies and innovative partnerships could be created between the provinces, and the country as a whole would benefit from a more efficient and resilient electrical grid.
- There should be future opportunities for more power generation through a revised and renewed independent power producer program. Decisions regarding power generation should come from the decision tree for the sector, as future power and distribution needs will be dependent on the outlined pathway for technology and market development.
- Distributed power and ownership of infrastructure should be addressed as part of the economic development planning around the energy sector, as this is of interest to First Nations communities and rural areas who currently depend on off-grid diesel power.
- BC Hydro future demand modelling should be reviewed once decisions are made concerning the hydrogen and LNG opportunities.

Natural Gas

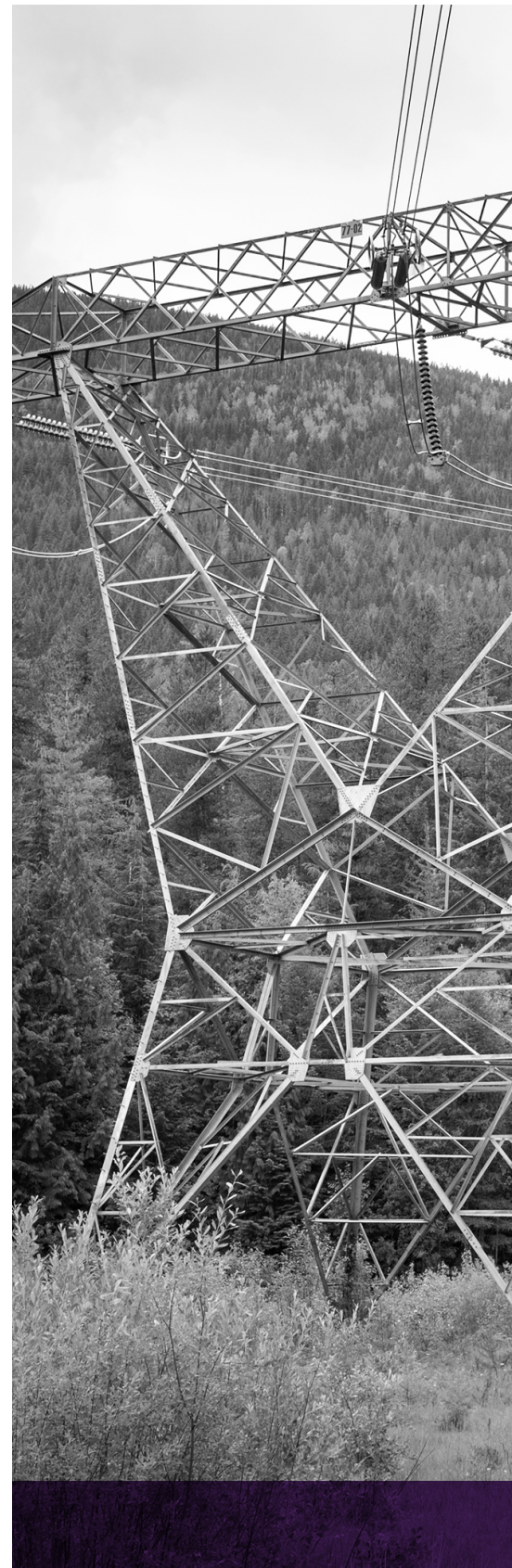
- The opportunity to produce blue hydrogen from natural gas and export it should be further explored. The planning around the use and transport of LNG in the province should be considered in tandem with the decision whether or not to develop the hydrogen sector. If the economics prove favourable, the opportunity inherent in LNG may be more fully realized as not only a short/medium term opportunity but also a pathway to a cleaner hydrogen economy. (see previous page).
- An LNG roadmap project should be undertaken as quickly as possible to define the pathway to this opportunity, develop buy-in and engagement, and create a collaborative vision for the industry to work towards.

Hydrogen

- A decision must be made regarding the pathway to a hydrogen economy in BC. The 2019 BC Hydrogen study provided a series of action steps. As part of the overall decision tree for the province, there needs to be a decision regarding which aspects of this opportunity we will pursue.

Bioenergy

- The 'elephant in the room' is the overall economics of renewable natural gas and other biofuels. These fuels are more expensive to produce, and there are uncertainties around feedstock supply and whether biomass-energy is the best use of our renewable forests. Nevertheless, bioenergy has a role to play in various industries. The best applications of biofuels and bioenergy should be included in the energy decision tree we are recommending be developed.





High Priority Recommendation

The high priority recommendation of this report is to develop a top-level decision tree regarding the future direction of this province with regards to energy pathways. The decision tree should be developed in a short time frame (within 3-6 months), and should be communicated to industry and followed up by action steps for upgrades or additions to the province's infrastructure.

Key decisions include:

- 1** Is BC going to support hydrogen as a major energy source and fuel?
- 2** If yes, will the strategy be to focus on internal use, developing an export market, or both?

Then, once these decisions are made, a number of follow-up decisions will need to be made such as:

- 3** How much more electricity production and transmission will be required?
- 4** How much bioenergy would be needed (and in what form)?

Without these decisions made and clearly communicated to all, the province will be unable to move forward toward CleanBC goals. As these are long term and capital intensive projects, they require an 'all hands on deck' approach and a clear strategy. The decisions made at this point also impact technology development, investment, and project planning choices in multiple industries over potentially decades.

With regards to the energy sector, TeamBC is on the field, suited up and ready to go - but they need direction from the Province on how to work together.

An aerial photograph of a large solar dish collector, which is a parabolic mirror reflecting sunlight. The dish is surrounded by various pieces of equipment, including solar panels, cables, and structural supports. The background shows a mix of greenery and industrial infrastructure.

About the Project

The CORE Cleantech Cluster is driving economic development goals of job growth, company growth, investment attraction and trade opportunities in British Columbia by activating, coordinating and developing collaboration opportunities and energizing an innovation ecosystem centred around cleantech and sustainability.

A more detailed analysis of the Energy Sector and its role in the cleantech innovation ecosystem is available in the report [Accelerating British Columbia's Clean Economy: A Cleantech Cluster Strategy for the Province of British Columbia.](#)

Foresight

About Foresight Cleantech Accelerator Centre

This roadmap landscape report is funded through [Foresight Cleantech Accelerator Centre](#). Foresight is Western Canada's Cleantech Innovation Centre which supports the identification and validation of cleantech opportunities and the successful commercialization of solutions.

¹ https://www2.gov.bc.ca/assets/gov/government/ministries-organizations/zen-bc-bn-hydrogen-study-final-v6_executivesummary.pdf

² <https://www.petroleum-economist.com/articles/upstream/exploration-production/2020/canadian-oil-industry-in-dire-straits>

³ <http://www.env.gov.bc.ca/soe/indicators/sustainability/ghg-emissions.html#:~:text=Greenhouse%20Gas%20Emissions%20by%20Sector,gas%20emissions%20in%20British%20Columbia>

⁴ https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf

⁵ https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf

⁶ <https://www2.gov.bc.ca/assets/gov/government/ministries-organizations/zen-bc-bn-hydrogen-study-final-v6.pdf>

⁷ <https://www.eia.gov/tools/faqs/faq.php?id=73&t=11>

⁸ <https://www.newrelationshiptrust.ca/initiatives/bcicej/>

⁹ https://www.portseattle.org/sites/default/files/2020-07/PofSeattleWSU2019_final.pdf

¹⁰ <https://www.pv-magazine.com/2020/01/28/green-hydrogen-costs-projected-to-decrease-by-up-to-60-by-2030/>

¹¹ <https://www.pv-magazine.com/2019/11/15/green-hydrogen-to-reach-cost-parity-by-2030/>