

Clean Future Forum

Identifying challenges and solutions
for B.C.'s clean energy transition

Brianne Riehl, Karen Tam Wu, and Maximillian Kniewasser

July 2019

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The Pembina Institute is a national, non-partisan think tank that advocates for strong, effective policies to support Canada's clean energy transition. We employ multi-faceted and highly collaborative approaches to change. Producing credible, evidence-based research and analysis, we consult directly with organizations to design and implement clean energy solutions, and convene diverse sets of stakeholders to identify and move toward common solutions.

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Clean Future Forum

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Executive summary

The stated objective of British Columbia's CleanBC plan is to shift B.C. from an economy powered by oil and gas to one increasingly powered by clean energy. To discuss the expected implications of this commitment for B.C.'s energy system, the Clean Future Forum brought together a diverse group of thought leaders on B.C.'s clean energy future. The forum aimed to identify and stimulate discussion of the challenges and opportunities associated with developing clean energy sources and technology at the pace and scale necessary to make B.C.'s clean energy transition a reality.

Broad agreement emerged among participants around three key findings:

- the importance of increased engagement among B.C.'s climate and energy thought leaders to enable collective problem-solving
- support for the economic opportunity in embracing clean energy options and transitioning to a clean economy
- the need for a diversity of clean energy solutions to reduce fossil fuel dependence across B.C.'s economy.

Key challenges to achieving B.C.'s clean energy transition were identified, including the need for:

- **Clarity** on B.C.'s clean energy resource potential, future demand, matching best-suited energy supply with demand, and the role of utilities in supporting B.C.'s clean energy transition
- **Certainty** in infrastructure development and utilization, and in policy that allows for long-term planning and investment in infrastructure and research and development
- **Support** for overcoming the cost differential between gas and electricity in sectors of the economy that rely on natural gas; for research and development initiatives in the clean tech sector; and for leveraging B.C.'s clean tech leadership to maximize economic benefits
- **Capacity building** to increase awareness and to successfully develop B.C.'s clean energy resources.

Discussion between experts at the forum also raised several potential solutions that could be pursued to overcome these challenges. The identified solutions fall under five key themes:

- resources, infrastructure, and technology
- policy and regulation

- utility design and rates
- community engagement
- research.

Based on these areas of strong agreement or consensus, we recommend the creation of a clean energy plan for B.C. This plan should:

- be the foundation for implementing the vision described in CleanBC
- bring together the work and studies currently underway (such as the B.C. Hydro Phase 2 transformational review, update of the bioenergy strategy, and hydrogen roadmap)
- provide clear policy guidance for regulators, utilities, and energy developers
- provide certainty to investors and businesses about B.C.'s clean energy future
- make use of the wide range of policy levers, technologies, clean fuels and solutions available
- maintain a flexible and reliable energy sector in the province.

In order to outline a pathway for B.C. to power its 2030 economy in line with our climate targets, and set ourselves up for long-term success beyond 2030, we recommend that the clean energy plan:

1. Clarify future energy demand and its alignment with best-suited energy resources
2. Focus on capacity building, especially in rural areas, to increase the province's clean energy development potential and foster economic opportunity
3. Leverage existing infrastructure and plan and build local support for new low-carbon infrastructure
4. Define and update the role that utilities play in supporting B.C.'s stated objective to transition to a clean energy economy
5. Outline how made-in-B.C. technology can help achieve our climate targets and serve as a testing opportunity to prove technology readiness to global markets.

1. Introduction

In British Columbia's new and ambitious climate strategy, *CleanBC*, released December 2018, the province commits to many policies to get on track to achieving its 2030 climate target (of a 40 per cent reduction in emissions from 2007 levels). The stated objective of this plan is to shift B.C. from an economy powered by oil and gas to one increasingly powered by clean energy. This objective will have many implications for B.C.'s energy system, including increased demand for electricity and alternative energy sources such as biofuels.

To discuss the implications of these commitments, the Pembina Institute hosted the Clean Future Forum on Feb. 28, 2019. The forum brought together a diverse group of thought leaders on B.C.'s clean energy future to explore specific questions around the decarbonization of B.C.'s energy system: what kinds of clean energy are needed, and the challenges and opportunities associated with developing clean energy sources at the pace and scale necessary. The event was run under the Chatham House Rule, meaning conversations and ideas exchanged at the forum can be shared, but not attributed. The sole exception was presenters, who agreed to share their materials.

1.1 Gaining insight, building understanding, and generating discussion

Achieving the transition necessary to reduce carbon pollution in line with the goals and the objectives laid out in *CleanBC* is an ambitious task. Although B.C. is a clean electricity powerhouse, with more than 98 per cent of electricity coming from renewable sources, fossil fuels still satisfy the majority of B.C.'s overall energy needs. B.C. uses four times as much energy from fossil fuels as from clean electricity, including to fuel cars, trucks, ferries and airplanes, heat homes and power industry.

To realize the commitments made in *CleanBC*, transform how B.C. powers its economy in just over a decade, and, ultimately, to meet its carbon reduction goals, the province needs to shift away from this reliance on fossil fuels.

Government analysis demonstrates that current *CleanBC* policies, when implemented, will achieve 75 per cent (18.9 Mt of the 25 Mt required; see Figure 1) of the needed emissions reductions to reach the province's 2030 target. Initial government projections suggest that clean energy consumption will increase by about 40 per cent by 2030 under

this plan, while fossil fuel use will decrease by about 15 per cent. Fossil fuels will still account for the majority of B.C.'s energy consumption in 2030. If we are to meet our objectives, greater progress in reducing emissions and scaling up clean energy alternatives in just over a decade is necessary — a challenge that should not be underestimated.

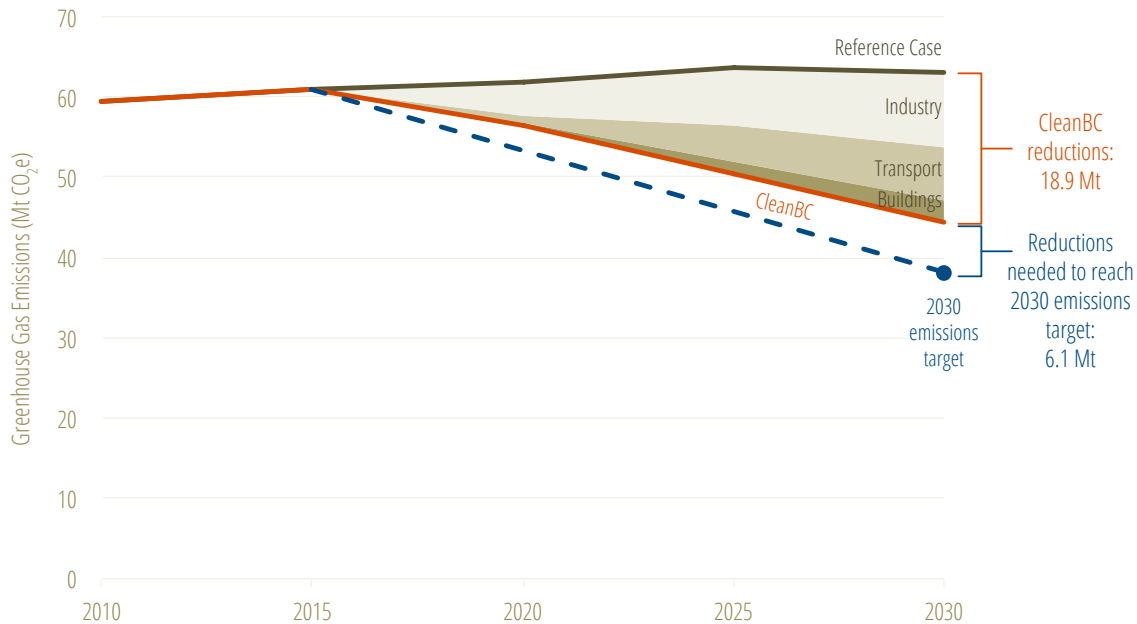


Figure 1. CleanBC commits to achieving 18.9 Mt of emissions reductions by 2030

Additional mechanisms will be needed to fill the 6.1 Mt emissions gap to B.C.'s 2030 target of 38.2 Mt.

CleanBC makes it clear that a significant shift needs to take place, and a key first step is gaining deeper understanding of the challenges that will be faced across B.C.'s economy throughout this transition, in order to identify common solutions across key stakeholders.

As such, the key objectives of the Clean Future Forum include:

- **Gain insight** into various stakeholders' perspectives
- **Build a common understanding** across diverse stakeholders of what B.C.'s energy future will look like — and of the bold action needed to get there
- **Identify challenges** to transitioning our energy system, acting on solutions, and meeting our 2030 climate target.
- **Generate discussion** of and **build support** for potential solutions to overcome challenges to the build-out of B.C.'s clean energy system

1.2 Convening B.C.'s climate and energy thought leaders

CleanBC marks an important first step, and is the first climate strategy since the 2008 Climate Action Plan that gets B.C. back on track to achieve its climate targets. However, further details are needed to make implementation of this strategy a reality.

Climate and energy stakeholders across B.C.'s economy will be impacted differently by the policies and regulations necessary to achieve the clean energy transition and carbon reduction goals. It is therefore important to create dialogue amongst these stakeholders to share their unique views and experiences, helping to build trust across sectors, to identify key challenges that need to be addressed to achieve objectives, and to create buy-in for possible solutions.

The Clean Future Forum was an effort to broaden the conversation and foster contributions from a diverse set of stakeholders, with 83 thought leaders representing 52 different businesses, associations, governments, utilities, organizations and academic institutions in attendance. A summary of participants is provided in Appendix A.

1.3 Exploring electrification and beyond

The Clean Future Forum consisted of two sessions: *Electrification* and *Beyond Electrification*.

Two opening presentations set the context for the day. Tim Lesiuk, former executive director of clean growth strategy for the Climate Action Secretariat, shared insight into B.C.'s recently developed climate strategy and the role of clean energy in this strategy. Nick Bridge, special representative for climate change for the U.K. government, shared lessons learned from the U.K.'s experience with decarbonization and clean energy development.

The morning session, *Electrification: The key to B.C.'s clean energy system*, included a panel discussion about the role that electrification will play in B.C.'s clean energy future with five experts representing industry, First Nations, utilities, and environmental non-governmental organizations. A facilitated table discussion of the key challenges and potential solutions to electrification of B.C.'s energy system was followed by a question-and-answer session with the panel.

The afternoon session, *Beyond Electrification: Opportunities for other sources of low-carbon energy*, also included a panel discussion about the role of alternative energy solutions, aside from electrification, in B.C.'s clean energy future, and how these sources can fill gaps in electrification capacity and build resiliency. The panel consisted of five experts representing industry, academia, utilities, and local government. A facilitated table discussion of the key challenges and potential solutions for the expanded use of these alternative energy sources in B.C. was followed by a question-and-answer session with the panel.

The day's discussions wrapped up with an opportunity for participants to share closing reflections.

A full agenda of the event is in Appendix B.

2. Summary of findings

Key findings that were identified by forum participants are explored and synthesized in section 2.1. More specific challenges and potential solutions identified during the facilitated table discussions are summarized in sections 2.2 and 2.3. These key findings represent areas where there was broad agreement and/or support among stakeholders.

2.1 Synthesis of key findings

More engagement is needed

Participants of the Clean Future Forum appreciated the opportunity to engage and connect with others. Further convening of B.C.'s climate and energy thought leaders is critical to enable the collective problem-solving needed to create support for energy development. Broad input is also critical on the design, development, and implementation of the clean energy system needed to make the transition from a fossil fuel-based energy system to one powered mostly by clean and renewable energy a success.

Participants also highlighted a particular need to engage B.C.'s rural communities and First Nations, which are currently underrepresented in the discussions but are critical to the success of B.C.'s clean energy transition as those whose communities and lands will be directly impacted by energy development.

Support for a clean economy and more clean energy

There is significant economic opportunity for B.C. in embracing a clean economy, participants agreed. B.C. was highlighted as a natural leader in the clean energy transition due to its high-quality and diverse clean energy resource base, its early leadership on climate action, and its role as an important clean tech development hub.

Numerous participants highlighted that greater adoption of “made-in-B.C.” clean tech solutions could help overcome remaining challenges in decarbonizing our energy system. CleanBC offers an important testing and scaling opportunity to prove their technologies to the world, which could help the sector become more globally competitive in this rapidly growing, trillion-dollar industry.

There was overwhelming consensus in the room that to transition away from fossil fuels and to hit our climate commitments, including commitments made in CleanBC, B.C.

needs to develop substantially more clean and renewable energy supplies. There was also consensus that the government has an important role to play, through policy, regulation, incentives and providing long-term funding certainty, in making this build-out of renewable energy a reality.

Diverse energy options should be pursued

There was broad support that no single clean energy solution is best suited to meet the entirety of the energy needs of B.C.'s economy. Therefore, most participants agreed that a diversity of clean energy solutions is needed to reduce fossil fuel dependence across all sectors of the economy, thereby increasing the chance of meeting our climate commitments.

Developing more clean electricity to enable electrification of the economy is widely supported and well understood. However, clean energy options beyond renewable electricity, including biofuels (both liquid and gaseous), synthetic fuels, hydrogen, and fossil fuel with carbon capture and storage (CCS), are still relatively new, and their potential is not yet widely understood. Participants were interested to learn more about these clean energy alternatives. For example, numerous participants expressed interest in research shared by Dr. Chris Bataille on the diverse clean energy alternatives needed to decarbonize sectors across the economy, including sectors that are currently difficult or impossible to electrify.¹ Furthermore, participants' support for seeing such clean energy alternatives play a substantial role in B.C.'s clean energy future increased as their understanding of these technologies increased.²

CleanBC acknowledges the need to maximize known and explore new clean energy options, including electrification, increasing supply of biofuels, the potential role for hydrogen and carbon capture and storage for managing carbon pollution from upstream natural gas development, among others. However, there are several clean energy options that participants felt were missed in the plan, including geothermal energy for providing heating services.

¹ Bataille's research shows 50 per cent of global greenhouse gas emissions are easily electrifiable, while the other 50 per cent are hard to electrify. These hard-to-electrify sectors represent approximately half of the global energy system and rely on a variety of the other clean energy alternatives.

² A survey of the participants after the forum showed increased excitement and interest in clean energy alternatives compared to before the forum.

2.2 Ten key challenges

More clarity and focus is needed on the following ten issues to enable a successful transition to clean energy in B.C. Potential solutions to these challenges identified by participants are explored in section 2.3.

1. B.C.'s clean energy resource base

B.C. has a substantial supply of high-quality clean energy resources including renewable electricity (wind, biomass, hydro, solar), feedstock for liquid and gaseous biofuels, synthetic fuels, hydrogen³, and more. However, there is a lack of clarity on how large each resource is and how cost-competitive they are. This lack of understanding of the available resource base is greatest for energy alternatives beyond clean electricity, due in large part to the relative newness and immaturity of the technologies. Answering these questions is critical because of the potential carbon reductions associated with pursuing the low-carbon fuel standard and renewable natural gas requirement.⁴ Considering that fossil fuels still provide the vast majority of our current energy needs, a successful transition will likely require a significant build-out of a variety of clean energy resources in order to be timely, cost-effective and flexible. A clear understanding of what the available resources are, where they are located, and what technologies are needed to develop them is needed.

2. The clean energy sources best suited for certain activities

Different energy sources have different strengths and weaknesses, with no single energy source perfectly suited to meet all the diverse needs of an economy like B.C.'s.⁵ This explains why today's energy needs are met by a variety of sources across sectors and across the province. As we transition away from the vast amounts of fossil fuel energy used today, it will be important to better understand how to use our clean energy resources most efficiently and effectively in order to build an optimal and flexible energy system.

³ Includes hydrolysis and steam methane reforming plus carbon capture and storage.

⁴ The low-carbon fuel standard and renewable natural gas standard are the two policies outlined in the CleanBC plan that are expected to lead to the biggest emissions reductions.

⁵ Some activities require heat, others motor force; some sectors of the economy require constant power, while others are seasonal or intermittent in nature. B.C.'s various clean energy options each offer different strengths and weaknesses in meeting these energy needs.

3. Future demand for clean energy sources

The future demand of clean energy will depend on variables such as population and economic growth, development of energy intensive industries, efficiency improvements, and climate and energy policies. With so many variables, it is difficult for investors to plan ahead for where and when opportunities may arise to ensure sufficient clean energy is developed in time.

4. Infrastructure certainty

New infrastructure will be needed to develop, transport, and use the incremental clean energy that is needed to meet our climate commitments. However, the type of infrastructure needed will depend on the clean energy pathway the province decides to take, and timing of infrastructure development will be critical to ensure both that demand is met, but also that specific solutions are not prematurely locked in. Also, building infrastructure has multiple challenges, which increase with project complexity. For example, successfully building new high-voltage transmission infrastructure requires consideration of certainty and timing of electricity supply and demand, financing certainty, regulatory approvals, local support for development, and more. Certainty regarding the development of critical infrastructure will be imperative to ensure clean energy development can happen in the required time frame.

5. Economic challenges to commitments made

Several clean energy options that are meant to play an important role in the transition to clean energy face economic challenges under the policies outlined in CleanBC. One key obstacle highlighted at the forum is the continued cost differential between clean electricity and natural gas. This cost differential is currently exacerbated by record low natural gas prices. The cost differential applies to all sectors of the economy that rely on natural gas, but was identified as a particular challenge for natural gas producers. Supporting and incentivizing natural gas producers to choose clean electricity as their primary power source is important to making a successful transition, given the opportunity that electrification in this sector presents for reducing emissions, and given increasing pressures to develop liquefied natural gas (LNG).

6. The role of utilities

The role of utilities in supporting B.C.'s clean energy transition is not well-defined, for example, given current rate design, regulations, and competing interests of the

current incentive structure. Clarifying their role into the future and providing certainty will enable utilities to make strategic business decisions that support development of B.C.'s clean energy resources.

7. Strategies to leverage clean tech leadership

B.C. is home to some of the most innovative clean tech companies in the world, representing an enormous economic opportunity. But B.C. lacks a strategy on how to leverage this technology leadership to maximize economic benefits for the province. The clean tech sector is currently a multitrillion-dollar global industry, and forecasted to continue to grow quickly as the world increasingly embraces the clean energy future. This represents a once-in-a-generation opportunity for B.C. to be at the forefront of a globally significant technology solution. Moving to a low-carbon economy is an important opportunity to support and trial many of these technologies and create export opportunities, and will require a comprehensive strategy.

8. Research and development priorities

In addition to a strategy for leveraging B.C.'s already impressive clean tech sector, the province lacks a strategy to support critical R&D initiatives that are needed to overcome current challenges around decarbonization. There is also a technology gap on several current commitments, such as the renewable fuel standard, that will make it challenging to meet some of the commitments in CleanBC with current technologies. More targeted research and development support is needed to help meet these commitments.

9. Policy certainty

In order to invest in clean energy infrastructure or necessary research and development, investors need better long-term policy certainty. For example, B.C.'s clean energy procurement policies have not had the consistency to encourage investment and capacity building to enable clean energy development.

10. Capacity building

More education and capacity building to successfully develop clean energy resources is needed on a variety of fronts (including increased awareness of clean energy potential and development of the skills needed to realize that potential). Rural capacity to develop clean energy must be increased, as rural B.C. will likely play a significant role in delivering a range of clean energy sources to the province.

While participants outlined numerous challenges that must be addressed, there was a sentiment that none are insurmountable barriers. B.C. has a strong foundation to build on through early action on climate and initiatives to develop clean energy. Participants were supportive of the direction and ambition of the CleanBC plan and see this as a building block and opportunity for B.C. to demonstrate a successful transition to a low-carbon economy.

2.3 Potential solutions identified

Common opportunities and solutions for electrification and alternative clean energy sources identified by participants emerged in five key themes: resources, infrastructure, and technology; policy and regulation; utility design and rates; community engagement; and research. This is not a complete synthesis, but rather, reflects the key points that were repeated throughout the forum. A full summary of the potential solutions identified by participants is provided in Appendix C (Electrification) and Appendix D (Beyond Electrification).

Resources, infrastructure, and technology

B.C.'s current resource base represents a significant opportunity; it includes our clean electricity grid, high-quality renewable resources (especially wind), surplus of electricity generation, and increasing support for electrification as technologies become more viable, cost effective, and desirable. To support expansion of electricity in the province, participants suggested developing local capacity markets as more intermittent renewables become available, and developing a power-to-gas strategy for using hydrogen as a cheap electricity storage option (to help ensure electricity is available to meet demand, while also helping to comply with the renewable natural gas mandate).

B.C.'s supply of alternative clean energy resources, including biomass, biofuels, and synthetic fuels, was identified as an opportunity to provide capacity, cheap storage, and energy density, as well as an energy grid with the potential for hydrogen production. To take advantage of these opportunities, low-carbon fuel standard credits could be used to fund alternative clean energy projects and infrastructure. B.C. has a culture of innovation and a history of demonstrating leadership in the clean tech sector, such as the use of biomass in the pulp and paper industry. This culture could be built upon by replicating current successes, such as Surrey's biofuel facility across other B.C. communities.

Policy and regulation

The expansion of electrification and clean energy alternatives could be supported through various policy and regulatory mechanisms. These could include government-backed incentives and regulation/legislation that complement policy and encourage electrification and the use of renewable fuels; an increase in the low-carbon fuel supply mandate; and an increase in research and development funding, such as the current Innovative Clean Energy Fund, for alternative clean energy technologies. It was suggested that government focus on technology-neutral performance-based regulations to incentivize innovation and allow the best competing technologies to emerge; assign clear responsibility to entities responsible for developing clean energy options and reducing emissions; and maintain flexibility in the energy system and not lock in specific technologies, energy sources, or pathways. Policy certainty is also important in driving long-term planning for utilities and attracting investment for low-carbon energy options. The development of an energy roadmap for the province arose as a key priority, as well as the establishment of an agency responsible for overseeing it.

Utility design, regulation and rates

The declining price of renewable power was identified as a key opportunity for the expansion of electrification in B.C., while carbon tax revenue could be used to help overcome the cost differential between gas and electricity in industry and other sectors that still rely on natural gas. Current utility and rate design could be updated to be consistent with objectives, including electrification and emissions reduction. This will require co-operation between the utilities and government. Modernization of utilities (and their regulations) as clean energy service providers through improved policy direction was highlighted repeatedly as a key opportunity to guide utility planning and avoid competing business interests. For example, regulations could allow utilities to use a portion of their revenue to support research and development and innovation.

Community engagement

Dialogue and alignment among stakeholders, First Nations, and rural communities on renewable energy as an important component of B.C.'s energy and economic future was discussed as a key opportunity. Renewable fuels are a major employment opportunity in rural B.C. and the transition to a low-carbon economy is a key economic opportunity. Outreach to rural and First Nations communities on potential electricity generation, electricity transmission, and bioenergy projects — and the associated economic development — is therefore important for a successful transition. Development of partnerships with these communities on clean energy projects was highlighted as a key

solution to be pursued, and could be considered through the upcoming work of the Labour Readiness Taskforce.

Research

Clean energy alternatives, particularly hydrogen technology, are a growing global interest and research area, demonstrating that B.C. does not exist in a vacuum in pursuing these solutions. Participants suggested developing a deeper understanding of the clean energy alternatives to electricity, including through a cost-benefit analysis by sector and a life-cycle analysis of alternative energy sources, in order to inform this transition and policy development, and to educate stakeholders and the public.

3. Recommendations

Discussion between experts present at the Clean Future Forum raised several key challenges to achieving a clean energy transition in line with B.C.'s climate objectives, as well as many potential solutions to be pursued. The identified solutions fall under five key themes: resources, infrastructure, and technology; policy and regulation; utility design and rates; community engagement; and research (see section 2.3).

Based on these areas of strong agreement or consensus, we recommend a clean energy plan be created for B.C. This plan should be the foundation for implementing the vision described in CleanBC — an increase in clean energy consumption by about 40 per cent by 2030 and a decrease in fossil fuel consumption by about 15 per cent by 2030. However, CleanBC is projected to get us only 75 per cent of the way to our 2030 climate target. To achieve our full commitments it will be critical to increase the absolute clean energy mix and decrease the use of fossil fuels even further. Furthermore, keeping B.C.'s longer-term 2040 and 2050 climate targets in mind will be crucial while making decisions about the 2030 energy system in order to avoid prematurely locking the province into certain energy or policy pathways.

The clean energy plan should bring together the work and studies currently underway (e.g.: B.C. Hydro Phase 2 transformational review, utility long-term resource planning, update of the bioenergy strategy, hydrogen roadmap, labour readiness study, plus recommendations of the Climate Solutions and Clean Growth Advisory Council). It should provide clear policy guidance for regulators, utilities, and energy developers, and provide certainty to investors and businesses about B.C.'s clean energy future. The plan should make use of the wide range of policy levers, technologies, clean fuels and solutions available to maintain a flexible and reliable energy sector in the province as it transitions to low-carbon energy supply. In order to outline a pathway for B.C. to power its 2030 economy in line with our climate targets, and set ourselves up for long-term success beyond 2030, we recommend that this plan:

1. Clarify future energy demand and its alignment with best-suited energy resources.

Both future clean energy demand and the associated available supply must be well understood in order to ensure the best use of B.C.'s low-carbon energy resources. The plan should indicate what future energy demand will be (how much and where), and what types of clean energy will be needed to fill the demand (how much and in what

sectors). A comprehensive understanding of B.C.'s resource base, including local energy supply potential, options for development of these resources, cost and efficiency of potential fuels, and alignment with expected future demand is needed. Identification of what clean energy sources are best suited for which activities is also needed, in order to best align development of B.C.'s clean energy supply with expected future demand.

2. Focus on capacity building, especially in rural areas, to increase the province's clean energy development potential and foster economic opportunity.

There is a need for increased awareness of the opportunities available for clean energy development and capacity to realize these opportunities. This is particularly true in rural areas, which will play an important role in the clean energy transition given their large resource base. We recommend the Labour Readiness Taskforce consider how to improve awareness and capacity in rural communities to foster acceptance and leverage the clean energy opportunity.

3. Leverage existing infrastructure and plan and build local support for new low-carbon infrastructure.

Once energy demand and sources are identified, it will be essential to leverage existing infrastructure and to identify and plan for key infrastructure that is needed for the energy transition (e.g.: transmission lines and renewable energy developments). Infrastructure development should be co-ordinated with energy supply and demand, and project timelines set to ensure development coincides with expected increases in demand. Engaging local and Indigenous communities early in this planning process will be important to build local support for clean energy projects and associated infrastructure, as will discussing local benefits (e.g. through community partnerships).

4. Define and update the role that utilities play in supporting B.C.'s stated objective to transition to a clean energy economy.

We recommend the plan include policies that orient utilities toward clean energy production and use in line with B.C.'s 2030 and 2050 emissions targets. Policy shifts needed include improved rate design, modernization of utility regulations, and power procurement policies that incentivize clean energy production. We recommend that the B.C. Hydro Phase 2 review address these needs and that outcomes of this review be made applicable to other utilities in the province.

5. Outline how made-in-B.C. technology can help achieve our climate targets and serve as a testing opportunity to prove technology readiness to global markets.

We recommend using B.C.'s transition to a low-carbon economy to leverage our clean tech leadership into an export advantage and maximize economic opportunities. The clean energy plan should outline how B.C.-made technology can be integrated locally to transition our energy system, but also how to use B.C. as a pilot to develop and prove technology that can be exported elsewhere.

Appendix A. Summary of participants

Stakeholder group	Number of participants	Organizations
Industry: upstream producer, mining, associations	8	Canadian Association of Petroleum Producers, Cement Association of Canada, Mining Association of BC, Petronas Canada, Shell Canada, Teck Resources
Industry: independent power producers, clean technology, associations	15	Advanced Biofuels Canada, Bullfrog Power, Carbon Cure Technologies, Carbon Engineering, Clean Energy BC, Enbala Power Networks, Enercon Canada, Engie Canada, Foresight, Greenlane Biogas, Innergex Renewable Power, Sea Breeze Power
Business, business associations	3	Diversification Canada, HSBC, Vancouver Economic Commission, Western Economic
Local government	3	City of Surrey, Tsílhqot'in National Government
Provincial government	5	Climate Action Secretariat, Ministry of Energy, Mines and Petroleum Resources, Ministry of Jobs, Trade & Technology
Utility	7	BC Hydro, BC Utilities Commissions, FortisBC
Academic, research, consulting	8	BC Bioenergy Network, Dawson Strategic, Energy and Materials Research Group, Geothermal Canada, Navius Research, Nexii, University of British Columbia
Environmental non-governmental organizations	9	BC Sustainable Energy Association, Canadian Centre for Policy Alternatives, Clean Energy Canada, David Suzuki Foundation, EcoSmart Foundation, Georgia Strait Alliance, Sierra Club BC
Other	4	British Consulate General Vancouver, National Observer, U.K. Government, Vail Resorts
Facilitator and note-taker	21	Pembina Institute, Renewable Cities, Simon Fraser University, University of British Columbia, University of Toronto
TOTAL	83	52

Appendix B. Agenda

Time	Session
8:00 a.m.	Registration & breakfast
8:30 a.m.	Opening remarks <i>Speakers:</i> Karen Tam Wu, B.C. director, Pembina Institute Tim Lesiuk, executive director, clean growth strategy, Climate Action Secretariat Nick Bridge, special representative for climate change, U.K. Government
9:20 a.m.	Panel discussion: Electrification <i>Speakers:</i> Brendan Galloway, senior external affairs advisor, PETRONAS Canada Dolly Kershaw, economic development sub-table co-manager, Tsílhqot'in National Government Julia Balabanowicz, manager, government relations, Innergex Renewable Energy Siobhan Jackson, senior manager, key accounts, BC Hydro <i>Moderator:</i> Dan Woynillowicz, policy director, Clean Energy Canada
10:20 a.m.	Morning break
10:40 a.m.	Table discussion: Electrification
12:00 p.m.	Lunch
1:00 p.m.	Panel discussion: Beyond Electrification <i>Speakers:</i> Anna Stukas, business development lead, Carbon Engineering Chris Bataille, associate researcher, IDDRI Scott Stanners, executive director, BC Bioenergy Network Tyler Bryant, public policy manager, FortisBC <i>Moderator:</i> Anna Mathewson, manager, sustainability, City of Surrey
2:00 p.m.	Table discussion: Beyond Electrification
3:20 p.m.	Afternoon break
3:40 p.m.	Closing exercise <i>Rapporteurs:</i> Jackie Ashley, senior regulatory analyst, BC Utilities Commission Patricia Lightburn, science & policy manager, David Suzuki Foundation
4:30 p.m.	End of forum
5:00 p.m.	Cocktail reception <i>Speaker:</i> Josha MacNab, national director of policy & strategy, Pembina Institute

Appendix C. Key themes of *Electrification* session

Theme 1: Resources, infrastructure, and technology	
Opportunities	<ul style="list-style-type: none"> • B.C. has a clean electricity grid and a high quality resource base (especially wind). • B.C.'s best wind is located adjacent to the Montney Formation, which is B.C.'s largest source of industrial pollution. • There is currently a surplus of electricity generation in B.C. • It's an exciting time to be working on this given the strong expertise that exists in B.C., as well as the leaders in other jurisdictions that we can learn from. • There is increasing support for renewable electricity and electrification (e.g.: personal transport) as technologies become more viable, cost effective, and desirable.
Challenges	<ul style="list-style-type: none"> • Transmission projects face multiple complex barriers (timing, local support, certainty of demand, etc.). • The needed electricity infrastructure takes a long time to build, meaning projects may fall behind required implementation. There is also a need for timing certainty in order to electrify major new industrial development (e.g.: upstream natural gas, LNG). • There is a risk of brain drain of renewable energy development in the absence of short- to medium-term opportunities. • Building infrastructure too far in advance increases the cost differential between natural gas and electricity.
Solutions	<ul style="list-style-type: none"> • Develop local capacity markets as more intermittent renewables are brought online. • Focus surplus electricity generation domestically to help accelerate electrification of B.C.'s economy. • Develop a power-to-gas strategy to help comply with the RNG mandate and ensure that the electricity generated can be used when there is demand (using hydrogen as a cheap storage option).
Theme 2: Policy and regulation	
Opportunities	<ul style="list-style-type: none"> • Electrification provides effective protection against future carbon liabilities (such as high carbon taxes).
Challenges	<ul style="list-style-type: none"> • The political will to expand electrification and continue decarbonization is not guaranteed. • There has been inconsistent messaging from the B.C. government on the need for more clean energy.
Solutions	<ul style="list-style-type: none"> • Government-backed incentives. • Regulatory reform/legislated solutions to complement policy.

Theme 3: Utility design, regulation and rates	
Opportunities	<ul style="list-style-type: none"> • The price of renewable power is declining.
Challenges	<ul style="list-style-type: none"> • There is a large cost differential between gas and electricity. • B.C.'s current rate design does not encourage electrification or conservation at peak times. • B.C.'s current utility design inhibits innovation (by valuing all supply the same way and not incentivizing important aspects like capacity markets). • There is uncertainty in power prices, especially for long-lived industrial equipment.
Solutions	<ul style="list-style-type: none"> • Use carbon tax and/or royalty rebates for industry to overcome the cost differential. • Update rate design to be consistent with objectives (electrification, peak hours, etc.). • Require co-operation between utilities and government to deliver on B.C.'s climate and clean energy targets. • Develop mechanisms to ensure greater price predictability and provide credible long-term forecasts on power rates to address uncertainty.
Theme 4: Community engagement	
Opportunities	<ul style="list-style-type: none"> • There is a willingness among stakeholders to have dialogue about the barriers and opportunities for electrification. • There is alignment across environmental non-governmental organizations, industry, First Nations, and others on electrification as a key opportunity to decarbonize B.C.'s energy system. • Indigenous and rural communities are largely supportive of renewable energy developments such as wind, solar, and biomass generation.
Challenges	None identified
Solutions	<ul style="list-style-type: none"> • Local and First Nations partnerships for generation and transmission projects. • Labour Readiness Taskforce could consider community engagement opportunities in their work.

Appendix D. Key themes of *Beyond Electrification* session

Theme 1: Resources, infrastructure, and technology	
Opportunities	<ul style="list-style-type: none"> • The diverse fuels available in B.C. are well placed to meet the energy needs of specific activities. • Biofuels/synthetic fuels can provide capacity, cheap storage, and energy density. • B.C. is home to world-leading clean tech companies working on several of these clean energy alternatives. • B.C. has abundant biomass resources and B.C.'s forests are well managed for sustainability. • The ocean is an understudied and undervalued resource base. Bioenergy from algae and seaweed holds a lot of potential for B.C. • B.C.'s grid has an opportunity for hydrogen production, especially in this current period of surplus supply. • Drop-in fuels allow continued use of existing valuable infrastructure. • No change in consumer behaviour is required to use alternative fuels. • There are waste-stream synergies, as bioenergy and waste recycling go hand in hand. • B.C. has demonstrated leadership that we can continue to build on (e.g.: regulatory success, Surrey bio-energy facility, use in the pulp-and-paper industry).
Challenges	<ul style="list-style-type: none"> • The availability of feedstock at scale is questionable. There appears to be a supply-side constraint. • Current technology is too immature to make use of B.C.'s large biomass feedstock resource. • There is risk of placing too much hope in unproven technologies (e.g.: hydrogen). • There are associated risks of alternative energy sources to biosystems and agricultural land/soil. • 2030 isn't far away and scaling up clean energy to meet the LCFS and RNG targets will be very challenging. There is risk of failure to achieve this in time and ensuing backlash as a result. • Exporting B.C. feedstock is profitable, reducing the supply available for B.C. objectives.
Solutions	<ul style="list-style-type: none"> • Learn from and replicate the Surrey biofuel facility across B.C. communities. • Embrace the culture of innovation and failure in the expansion of new technologies. • Use LCFS credits to fund alternative clean energy projects/infrastructure.

Theme 2: Policy and regulation	
Opportunities	None identified
Challenges	<ul style="list-style-type: none"> • B.C.'s carbon tax is not reduced for liquid biofuels compared to liquid fossil fuels. • Mechanisms for introducing innovative alternative energy projects are lacking. • There is a lack of alignment in policy prescriptions in CleanBC, and a lack of support for clean tech companies that will deliver some of this clean energy. • There is a risk of picking winners with policy design. • There is a risk of locking in specific solutions and losing the flexibility needed to most efficiently meet B.C.'s long-term targets. • Getting beyond the Valley of Death is a challenge for new clean technology.
Solutions	<ul style="list-style-type: none"> • Increase the low-carbon fuel supply mandate. • Provide government incentives for the use of renewable fuels. • Develop an energy roadmap for the province and establish an agency responsible for overseeing it. • Increase research and development funding generally. • Focus on technology-neutral performance-based regulations on fuel greenhouse gas (GHG) intensity to avoid picking winners. • Implement border tax adjustments to protect B.C. businesses and industry and continue to encourage innovation. • Assign responsibility for achieving clean energy development and emissions reductions (to utilities, for example).
Theme 3: Utility design, regulation and rates	
Opportunities	None identified
Challenges	<ul style="list-style-type: none"> • It's challenging for utilities to justify innovation expenses to the regulator.
Solutions	<ul style="list-style-type: none"> • Allow utilities to use a portion of their revenue to support research and development/innovation.
Theme 4: Community engagement	
Opportunities	<ul style="list-style-type: none"> • Renewable fuels are a major employment opportunity in rural B.C.
Challenges	<ul style="list-style-type: none"> • There is a lack of knowledge of the diverse bioenergy opportunities in rural and First Nations communities. • There is a lack of training on alternative energy options in B.C.
Solutions	<ul style="list-style-type: none"> • Outreach to rural and First Nations communities on bioenergy potential and economic development opportunities.
Theme 5: Research	
Opportunities	<ul style="list-style-type: none"> • There is growing global interest and research in hydrogen. The broad research backdrop on these technologies is promising and B.C. does not exist in a vacuum.
Challenges	<ul style="list-style-type: none"> • The GHG benefits of biofuels is still uncertain.
Solutions	<ul style="list-style-type: none"> • Develop more research/ understanding of clean energy alternatives, including a cost-benefit analysis by sector. • Undertake a comprehensive life-cycle analysis of bioenergy sources/other clean energy alternatives (e.g.: green and blue hydrogen, CCS) that can be used to inform policy development and educate the public.