



An artist's depiction of a Carbon Engineering 'air contactor slab' that would capture 100,000 tonnes of CO₂ per year and turn it back into fuels like gasoline or diesel in a process called air to fuels (A2F). *Carbon Engineering photo*

It Takes a Country: Innovating Canada's Clean Tech Future

Geoffrey Holmes and Jean-François Béland

With the exception of recent regressive measures in the United States, countries around the world are transitioning toward clean energy, creating enormous economic opportunity for innovators. One of those companies is Squamish, B.C. -based Carbon Engineering, which is capturing carbon directly from the atmosphere and turning it into fuel using technology so promising that Bill Gates is CE's largest private investor.

The Rideau Hall Foundation “gathers, aligns and catalyzes ideas, people and resources to move the Canadian spirit and our shared aspirations forward.” One value that our Canadian spirit has always embodied is innovation, the importance and pace of which have never been greater. Countries around the world are increasingly moving towards clean economies that will produce and use renewable energy,

minimize waste and environmental impact, and continue to deliver better health and lifestyles for their citizens.

Meeting this challenge and making this transition will require innovation. New technologies, ideas, and methods are needed to realize this vision, and this in turn presents a great opportunity to those countries, start-ups, and even individuals that can deliver the best solutions. Canada is enhancing its strength in many of the sectors that will play a critical role in this transition—from healthcare to education to energy and resources—but there is much more to be done. Cultivating and harnessing innovation requires participation from government, the private sector and higher education. Our experience at Carbon Engineering is one example of how these sectors can work together to make progress in developing the technologies and industries of the future.

In December 2015, over 190 nations signed the COP21 agreement in Paris and committed to reducing greenhouse gas emissions and stabilize global warming below 2°C. The COP21 agreement commits nations to reducing emissions to far lower levels to avoid the worst effects and dangers of climate change. In coming decades, nations and economies must eliminate over 80 per cent of the 40 billion tonnes of CO₂ emissions currently produced from the use of fossil fuels, and we must eventually get to net zero. These deep cuts will require far more than displacing fossil power generation with renewable electricity; they will require new industrial technologies, new agricultural practices, and carbon-neutral means of powering transportation.

While the Paris Agreement was an important milestone, the largest challenges remain ahead, as countries decide how to cultivate the changes needed to meet these targets. Here in Canada, the federal and provincial governments are creating policies

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that incentivize clean energy and support innovation, are leveraging existing agencies that support and fund innovative start-up companies, and are enhancing funding for universities and academic institutions to lead the way on research that will produce the clean technologies of tomorrow.

At Carbon Engineering, we’re an example of a private start-up company performing technology development and commercialization. Since we were founded in 2009, our mission has been to develop and market technologies to capture CO₂ from atmospheric air, and use it to produce liquid transportation fuels. We do this with a method we call “Air to Fuels”, or A2F for short. A2F involves capturing CO₂ from the air, using clean electricity to split water and make hydrogen, and then combining the two to directly synthesize liquid hydrocarbon fuels like gasoline, diesel, or jet-A.

Fuels produced this way have several advantages: they’re drop-in compatible with existing engines, produce fewer particulates and less pollution than fossil fuels when they burn, and since they’re made from atmospheric CO₂, when they’re used they simply return their carbon to the atmosphere. Such “closed carbon cycle” fuels can help us displace the need for fossil fuels made from crude oil, and in turn cut our net carbon emissions while still powering our transportation infrastructure.

Technologies like A2F present great opportunities, but also many challenges in order to get them to work and get them into our commercial markets. A2F is a

technology that will eventually have to be deployed at large scale, and in competitive energy markets, in order to help make a difference in reducing emissions. As a result, we must engineer and demonstrate this technology over many years with successive prototypes and pilot plants, all of which takes investment, talent, and innovation.

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These challenges apply to many clean energy technologies, and can make securing private investment in clean tech challenging. Clean energy technologies, especially those that are disruptive, can take longer or require more investment than software-based businesses before they get to market. Further, clean energy technologies that seek to reduce GHG emissions face an evolving and uncertain market landscape in terms of how emissions will be restricted, or what types of cap and trade or carbon taxation schemes will be used to push energy markets towards renewables. As a result of this uncertainty,

often called “market risk”, private investors and large corporations are often hesitant to pursue disruptive clean tech concepts.

But the reward is large for companies and countries that can get it right. Some estimates say the market for low-carbon energy and the technologies that deliver it will be worth several trillion dollars per year in coming decades. Twenty-first century, jobs, innovation, growth, and competitiveness will favour those countries and companies that lead the way on clean tech.

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With challenges to investment in clean tech, but high stakes for success, Canada is fortunate to have a “support system” for companies like Carbon Engineering. At each step of the way on our trajectory—from early lab work to engineering to R&D, and now to demonstration scale—we have found agencies and programs whose support has been critical. First, Carbon Engineering was spun out of Dr. David Keith’s research group at the University of Calgary. The research and work done in that group



CE’s pilot scale air contactor in Squamish, B.C. This device can scrub roughly 1 tonne of CO₂ per day from the air. *Carbon Engineering photo*

was critical in launching Carbon Engineering in the right direction. Second, over our years as a private company, we have utilized support and funding from Canada’s innovation agency in order to attract and leverage private investment. This has given us more runway and the ability to hire top talent in order to reach our goals.

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In each case, agency support has given us the boost we needed to unlock private investment, and to achieve the next milestone on our development path. This system, our private investors, and the hard work of our team and partners has now put us in the position where we’re aiming to build a commercial-scale facility based on our A2F technology to synthesize liquid gasoline and diesel from air, water, and renewable electricity.

Our A2F facility will be the first of its kind anywhere in the world, and will give Canada a lead in an advanced fuels technology. Our vision is to harness Canada’s existing depth of expertise in energy and resources and direct this towards innovative technologies like air to fuels, so that Canada becomes a leader and exporter of clean technology and know-how as other countries tackle the challenge of powering their transportation systems with clean fuels.

Now is the time for Canada to double down on clean energy technology, to take a lead in what will be the largest growth industries of the coming decades, and to continue to enhance and evolve the right set of policies, funding mechanisms, and research institutions to retain our lead in clean energy. **P**

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