



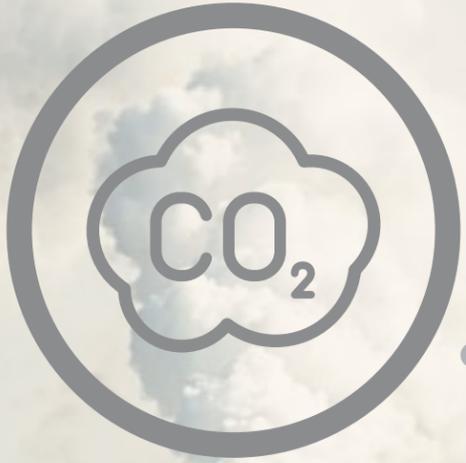
**CO₂ CAPTURE
AND VALORIZATION**

BBA

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ONE SMALL STEP FOR MAN...

A GIANT LEAP FOR MANKIND!



CONTEXT AND INNOVATION

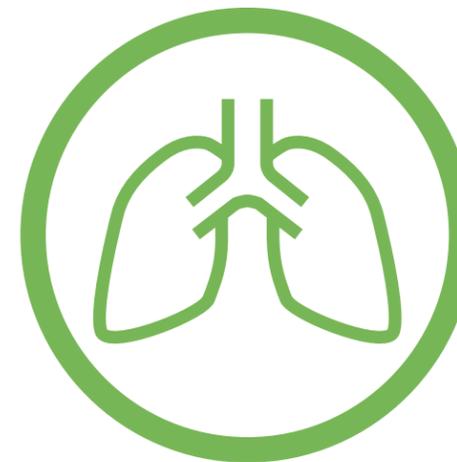
THIS PROJECT IS THE RESULT OF AN AMBITION SHARED BY BBA AND CO₂ SOLUTIONS: TO CREATE PROJECTS THAT ADDRESS THE GLOBAL PROBLEM OF CLIMATE CHANGE.

INNOVATING BY COMBINING ENGINEERING AND BIOLOGY

CO₂ Solutions chose BBA to design and build the first commercial version of its “industrial lung” at the Resolute Forest Products (RFP) plant in Saint-Félicien. The technology captures CO₂ emissions directly from industrial chimneys, purifies them using an enzyme similar to one that is found in our respiratory system and uses them in Les Serres Toundra’s greenhouses that grow cucumbers.

The project process is stable and uses little energy—truly a breath of fresh air. **What sets the project apart?**

- The **FIRST** worldwide commercial plant fitted with a technology that combines chemistry and engineering in CO₂ capture
- Recycles industrial emissions to help produce our food
- Results from close collaboration between pure and applied sciences



WHEN PURIFICATION IS SYNONYMOUS WITH INNOVATION

Plants consume CO₂ during photosynthesis, and they do not tolerate dust and contaminants well. BBA designed all the equipment used in the project: a pretreatment process to condition the CO₂ prior to its capture by the CO₂ Solutions technology, and the equipment that dries and compresses the CO₂ between capture and delivery to the greenhouse, to avoid the need to decontaminate it a second time. Even better, the compressor operates without oil to preserve the high degree of food grade purity of the CO₂ required by the plants.

THE WHOLE IS GREATER THAN THE SUM OF ITS PARTS

The technology used to extract the CO₂ from effluent gases involves the addition of enzymes to a carbon-capture solution. The enzymes must be prepared before being injected into the process. Through the use of applied sciences, particularly chemical engineering, BBA designed the equipment at the heart of this technology—a unique concept—to be integrated into CO₂ Solutions’ patented technology.

KEEPING AN “INDUSTRIAL LUNG” ALIVE

This project, which creates a kind of “industrial lung”, is based on technology developed through 20 years of research, using carbonic anhydrase, an enzyme usually found in the human living respiratory tract. BBA’s challenge was to design equipment that has operating conditions that allow these enzymes to perform. By combining an enzymatic component with a chemical process, the team has clearly pushed back the limits of engineering.

COMPLEXITY

SEEING THE OPPORTUNITY IN EVERY DIFFICULTY

On one side: a pulp and paper plant that continuously produces greenhouse gases (GHGs) and CO₂.

On the other: living plants that follow their natural growth curve, awakening in the morning and gradually increasing their CO₂ consumption before reducing it at sundown.

The challenge: combining these two realities in an optimal manner.

The initial concept called for a carbon-capture facility with a nominal capacity of 15 tonnes per day. Because the CO₂ was only to be used by day, nighttime production was collected in storage tanks.

Foreseeing that the client's needs would increase with time, BBA proposed designing double-capacity facilities. These would operate solely during the day and additional storage tanks would be installed later, in accordance with the client's needs. From a financial point of view, this concept was ideal, but it presented a significant challenge in operational terms: how to handle the daily startup and shutdown of the equipment.

To overcome this challenge, BBA developed a smart monitoring device that interacts bidirectionally between the carbon-capture plant and the greenhouses, thereby combining two very different scientific fields. The facility was designed to start up and shut down each day without the presence of an onsite operator—a solution that was perfected through trials and the development procedures conducted beforehand in a CO₂ Solutions pilot plant.



SOCIAL AND/OR ECONOMIC BENEFITS

INSPIRED BY NATURE, GUIDED BY OUR CONVICTIONS

The notions of economic growth and environmental protection have long been considered antagonistic, but things are changing. The objective of today's industrial players is to develop projects that are both economically and ecologically viable.

This project opens up many possibilities by demonstrating the viability of CO₂ capture and conversion. It reconciles the shared interests of two different industries, agri-food and pulp & paper, and opens the way to a sustainable future for present and future generations.

PAVING THE WAY TO ANOTHER DIMENSION

Generally, to derive a useful product from CO₂, the oxygen in the molecule must be replaced with hydrogen to create hydrogenated carbon chains (an expensive

chemical process). However, in the facilities at Saint-Félicien, this process is carried out naturally by plants through photosynthesis. This means it is now possible to give new life to our GHG emissions, transforming them into valuable material, just as in nature. This project paves the way to a circular economy by creating wealth differently while respecting our planet.

STIMULATING THE QUÉBEC ECONOMY

This project, for the most part completed by workers in the region—from manufacturing purification columns to construction—testifies to entrepreneurial dynamism.

Through uninterrupted year-round production, Les Serres Toundra plans to create over 400 sustainable jobs, thereby reversing a falling regional demographic trend. The country will, as a result, increase production of homegrown produce and reduce vegetable imports.

ENVIRONMENTAL BENEFITS

IMPROVING FOOD PRODUCTION BY RECYCLING WASTE

This project provides an opportunity for RFP to reduce its emissions and for Les Serres Toundra to stop burning methane to produce CO₂. The facilities can capture 30 tonnes per day (5,500 tonnes annually), equivalent to the emissions that 1,750 cars would produce if they each travelled once around the earth (i.e., 21 million kilometres¹).

The idea of recycling our air emissions to grow vegetables opens the door to other projects aimed at reducing our environmental footprint. On top of this comes a reduction in the environmental impact of transporting food, with Les Serres Toundra eventually producing a sufficient quantity of cucumbers to meet the province consumption, bringing the producer ever closer to the consumer.

PRODUCE MORE, CONSUME LESS.

Since the RFP plant was already eco-efficient and integrated in terms of energy, it was important to take existing infrastructure into account and prevent the installation of this new carbon capture project from increasing the company's overall energy consumption.

BBA therefore designed a highly energy-efficient heating system that makes use of energy coming from an intermittent flow of wastewater. RFP, Les Serres Toundra and CO₂ Solutions are now completely integrated, in energy terms, thus minimizing their overall consumption of both water and energy.



¹ <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>

Ville de St-Félicien



MEETING CLIENT NEEDS

ONE SMALL STEP FOR MAN, A GIANT LEAP FOR MANKIND

The success of the project is very largely the result of the teamwork and synergy that developed between CO₂ Solutions, Resolute Forest Products, Les Serres Toundra and BBA.

Keen to design reliable, sustainable and innovative solutions that make sense for its client, BBA succeeded in pushing back the limits of the project and came up with a concept that met its client's current and future needs. The team banked on the quality, speed, profitability and efficiency of its services to maintain long-term business relationships with its clients.

At the end of the project, CO₂ Solutions President Evan Price declared: "This first commercial carbon-capture unit in Québec is truly a major step forward for our company and for our partners: Resolute Forest Products and Les Serres Toundra. Because the same technology can be applied to all the world's sources of combustion gas, this is an achievement that will prove very helpful in the greatest challenge of our time: reducing GHGs."

In summary, to paraphrase the words of Neil Armstrong: *This project may be one small step for humans, but it is surely a giant leap for mankind!*

CO₂
SOLUTIONS



APPENDIX

BROADER THINKING. ON-POINT ENGINEERING.

BBA has been providing a wide range of consulting engineering services for nearly 40 years. Today, its engineering, environmental and commissioning experts team up to quickly and accurately pinpoint the needs of industrial and institutional clients. The firm's expertise is recognized in the fields of energy, mining and metals, biofuels and oil and gas. With 12 offices across Canada to provide clients with local support and field presence, BBA is recognized for providing some of the industry's most innovative, sustainable and reliable solutions.

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Energy



Mining and metals



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