

PERSPECTIVE

Welcome to the 21st Century: Industrial Bioproducts



A lot of attention is often paid to things that aren't working and to problems because they require immediate action. Nonetheless, it's interesting to look at the other end of the spectrum and see the solutions. Industrial bioproducts¹ are one part of the answers we are looking for to solve the challenges of the modern world. They are booming, and roughly 200 businesses are active in this industry in Quebec. It's an area driven by imagination and a requisite openness. A sense of imagination is a must for those who develop these products. It also has to spur those who advise the businesses developing industrial bioproducts if their efforts are to bear fruit.

Answers to Very Real Problems

There are a number of concerns relating to human life and population growth. Uninterrupted population growth worldwide brings with it its share of challenges. Hygiene, food safety, and water, soil and air—even noise—pollution are but a few. And climate change and its extremes affect both nature and humans.

On another note, the race for energy is raising questions. Demand is increasing sharply because some economies are industrializing, new, everyday objects are being introduced that have to be “connected” (e.g., cellphones, tablets, voice assistants, computers), and industrial automation is on the rise. This brings to the forefront the issues of energy production and efficiency, and material conductivity, among others.

The solutions must not have an impact that only adds to the challenges that already exist. Industrial bioproducts, for their part, are an attempt to provide sustainable, eco-friendly answers to the problems mentioned earlier. They're not new, but their numbers, their importance and their prospects are rapidly growing.

Innovative Solutions

According to the sources consulted, industrial bioproducts are classified according to three or four categories. The classification used here is that of the Quebec consortium for industrial bioprocess research and innovation or

CRIBIQ (Consortium de recherche et innovations en bioprocédés industriels au Québec). There are three groups: bioenergy, biosourced chemicals and biosourced materials. Each of these streams will be discussed later. Some organizations identify four groups by creating a category specifically for biofuels, while others categorize them under bioenergy.

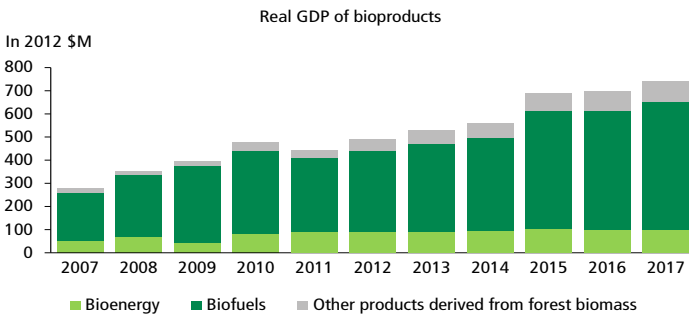
This is a fairly new sector with consequences for many economic areas; for many companies the production of bioproducts is just one part of their operations, resulting in few indicators to accurately determine how significant it actually is. Still, Statistics Canada has developed a way of measuring the real GDP (excluding the impact of inflation) of bioproducts in Canada. As a result, we can see that significant progress has been made over the last ten years (graph 1 on page 2). From 2007 to 2017, real GDP reportedly grew from \$287M to \$678M, or 136.2%, compare to 14.6% for Quebec's economy. In fact, this figure largely includes biofuels. Some of the lesser-known industrial bioproducts recently developed may have been missed in this calculation.

A Vast Range of Applications

What kinds of bioproducts are there? Table 1 on page 2 provides an overview of the possibilities. The examples are presented according to major streams. For example, in the bioenergy stream, there are fuels made from agricultural biomass (corn, canola, agricultural waste), lignocellulosic biomass (wood

¹ According to the [Office québécois de la langue française](#), a bioproduct is a product made primarily from renewable plant-based or animal-based raw materials.

GRAPH 1
According to Statistics Canada, the real GDP of bioproducts may have grown 136.2% between 2007 and 2017 in Canada



Sources: Statistics Canada and Desjardins, Economic Studies

and even municipal waste), and biogas produced using cattle dung and the waste from food processing, to name but a few.

Biosourced chemicals include biosolvents, detergents, bioadhesives and biopesticides. Specifically, these are biodegradable paints and inks, vegetable-based acids, animal-based bandages for the skin, or biopesticides based on micro-algae, fungi, or even plant extracts and insect pheromones. This by no means exhaustive list is nothing more than a sampling of the ideas that businesses are proposing.

Bioplastics, biocomposites and wood polymer composites belong to the third category, that of biosourced materials. They are offered in a variety of forms, such as soy-based foam for stuffing furniture. There are also bioplastics that incorporate agricultural- or wood-based fibres. Some bioplastics are used in the interior trim of motor vehicles. People are looking for solutions to the longevity of plastics in the environment, but bioplastic does not necessarily mean biodegradable. Still, contrary

to conventional, oil-based plastics, bioplastics are produced from renewable resources.

Some applications spur the imagination more than others due, in particular, to their everyday use. One of the developments that comes to mind are food-based containers for storing food that also happen to be edible! This is quite a feat as the container has to be airtight and it can't change the taste of or interact with the food it is meant to protect. And it has to be cost competitive. Yet, this was achieved in [Quebec](#). Still, it's important to ensure that this idea does not lead to more food waste. It's a real challenge at a time when overwrap is condemned and waste management is a headache.

Other examples of daily use include hemp-based insulating panels (thermal and acoustic) for the construction industry. It's a local, renewable material that is used to produce structural components for less than the cost of polyurethane and it can be reused at the end of its life. These panels are not limited to a few people in the know; they can be bought in hardware stores and at big box building supply vendors.

Businesses from Different Backgrounds

There are an estimated 200 businesses associated with bioproducts in Quebec, and they are active in very different areas. Some are developing lighting systems to disinfect surfaces, an application that is especially valued in the food industry. Others are concentrating their efforts on producing fast-growing trees to provide a stable, uniform and renewable supply of biomass to produce biofuels and bioproducts.

Still others are salvaging and processing sawmill by-products. Sawmill residues and forest biomass are thus being converted into biocarbon products that can be used to replace coal

TABLE 1
Bioproducts classified according to CRIBIQ

STREAM	CATEGORY	EXAMPLES (NON-EXHAUSTIVE)
Bioenergy	Solid, liquid or gaseous biofuels	- Fuel extracted from agricultural biomass (corn, canola, agricultural waste) - Fuel extracted from lignocellulosic biomass (from wood, municipal waste, etc.) - Biogas made from cattle dung, food processing waste
Biosourced chemicals	Chemical intermediates, extractable biosolvents, biosurfactants (detergents), bioadhesives, biosourced inks, biopesticides, biosourced agrochemicals, etc.	- Biodegradable paints and inks - Sugar beet- or corn-based acids, for example - Skin bandages made from animal components - Biopesticides based on micro-algae, fungi, plant extracts and insect pheromones, etc.
Biosourced materials	Bioplastics, biocomposites, wood polymer composites	- Soy-based foams for stuffing furniture - Bioplastics incorporating agricultural or wood fibres - Bioplastics used in motor vehicle interior trims

CRIBIQ: Consortium de recherche et innovations en bioprocédés industriels au Québec
 Source: CRIBIQ and Desjardins, Economic Studies

(in thermal power stations and cement factories), or even help improve soil conditions for growing crops. Even roasted wood flour is being produced, a material that is especially useful in manufacturing plastic wood.

Some businesses have developed natural health products, such as food supplements. Businesses are also active in the healthcare field, but in the development of antimicrobials for use in the food and personal care industries. Some are perfecting products that improve plant yields.

Other examples demonstrate that the businesses designing bioproducts come from a variety of backgrounds. One that comes to mind has developed a compostable bioplastic from a renewable raw material used in the paper industry!

It's difficult to paint an overall picture when one of the characteristics of these businesses is their openness. They are offshoots of the energy, food, health care, forestry and agriculture industries, to name but a few. Interdisciplinarity is also at the heart of the development of all of these products and will be discussed in the next section.

Decomartmentalizing Is Key

Product development is often the result of collaboration. Many businesses therefore turn to specialized services and public research centres. Unique to the Cegep network are the roughly 15 Centres collégiaux de transfert technologique, or college technology transfer centres, associated with bioproduct development in Quebec (table 2). They specialize in a number of fields (agriculture, water, wood, the sea, industrial waste, etc.) and are located throughout Quebec, from Gaspé to Rouyn-Noranda, by way of Amqui, Thetford Mines and Montreal.

Other research centres are providing support, especially those based in universities, such as Université de Montréal, Laval, McGill and Sherbrooke, as well as the Université du Québec campuses located in Chicoutimi, Rimouski, Trois-Rivières, Abitibi-Témiscamingue and Ottawa-Gatineau. They also include some of the departments at the Institut national de la recherche scientifique and Polytechnique Montréal. They are joined by the Centre de recherche sur les biotechnologies marines (Rimouski), the Centre de recherche en sciences animales de Deschambault and the Centre de recherche industrielle du Québec (Quebec and Montreal).

The activity surrounding the development and production of industrial biomaterials is highly organized. There are clusters (CRIBIQ, in particular), a niche ACCORD² sur les [bio-industries environnementales](#) (Eastern Townships), and government points of contact for assistance programs. The federal and provincial governments have recognized the importance of this emerging industry and would like to see it flourish.

A Few Pitfalls All the Same

In terms of the difficulties encountered by innovative bioproducts businesses, the transition from research and development to commercialization is known to be challenging. There is a lot to do, and it goes beyond simply believing in something, although this step may be the most important one. It takes time and money to get through the commercialization phase.

² *The ACCORD initiative*, Ministère de l'Économie et de l'Innovation, Benefits and goals. (Viewed on May 15, 2019): "The ACCORD initiative was launched following a decision by the Quebec Cabinet in April 2002 [...] this initiative rests on uniting and mobilizing the business community, is based on regional strengths and the search for excellence in Quebec's key sectors, and relies on participants in the same economic sector forming alliances and industry networks."

TABLE 2
List of college technology transfer centres associated with the field of industrial bioproducts

NAME	LOCATION	PREFERRED SECTOR
Agrinova - Agricultural research and innovation	Alma	Biofood
Biopterre - Bioproduct development centre	La Pocatière	Bioproducts
CTE - Hydrotechnology centre	Montreal	Environment
CÉPROCQ - Centre d'études des procédés chimiques du Québec	Montreal	Bioproducts
Cintech Agroalimentaire - Centre d'innovation technologique en agroalimentaire	Saint-Hyacinthe	Bioproducts
CIRADD - Centre d'initiation à la recherche et d'aide au développement durable	Carleton-sur-mer	Sustainable development
CNETE - Centre national en électrochimie et en technologies environnementales	Shawinigan	Environment
CTRI - Centre technologique des résidus industriels	Rouyn-Noranda	Bioproducts
CTTÉI - Centre de transfert technologique en écologie industrielle	Sorel-Tracy	Bioproducts
Innofibre - Cellulosic fibre innovation centre	Trois-Rivières	Bioproducts
Merinov - Aquaculture innovation and fishery centre	Gaspé	Biofood
Oleotek - College technology transfer centre in industrial oleochemistry	Thetford Mines	Bioproducts
SEREX - Service de recherche et d'expertise en transformation des produits forestiers	Amqui	Bioproducts
TransBIOTech - College technology transfer centre in biotechnology	Lévis	Biofood

Sources: Consortium de recherche et innovations en bioprocédés industriels au Québec and Desjardins, Economic Studies

Furthermore, given that a large part of the wealth of the businesses developing bioproducts resides in their know-how, their industrial secrets and their patents, they need to be able to manage this intangible capital carefully. It is important to be surrounded by people who are capable of securing intangible assets, in this case, data, computer programs and research agreements. For some, this also involves access to the workplace and the integrity of the people associated with the development projects (confidentiality, in particular). It is conceivable that, with artificial intelligence and all the opportunities for increasing and spreading information that it offers, the issue of information security will become increasingly important.

As mentioned earlier, working in silos is less productive than in an open environment. This also suggests a certain vulnerability due to information sharing. However, collaborating helps to focus energy on one's own strengths and benefit from the strengths of others.

On the other hand, businesses that decide to develop and use industrial bioproducts are not always faced with pitfalls. Canada and Quebec have everything they need to promote their development and attract investment and foreign companies. With its vast forest cover and agricultural land, Quebec can count on impressive and renewable reserves of raw material. In addition to the more conventional forest and agricultural resources (conifers, deciduous trees, grains and oilseeds), there are resources that are less familiar to the general public, such as algae, switchgrass and miscanthus (grasses).

Moreover, as previously mentioned, there are many diverse research centres spread out over the entire province. And they have a skilled and educated work force, which is an undeniable asset. Lastly, the developments in recent years seem to suggest that Quebecers' reputation for inventiveness and creativity is genuine.

Driving Factors

The production of industrial bioproducts needs to be developed and expanded. Finding answers to the long-term demographic, ecological and energy problems alluded to earlier is a matter of urgency. Industrial bioproducts offer solutions that are in keeping with the times: people around the world are demanding action that is respectful of the environment. It has to be able to ensure that living species and natural environments can be sustained.

Like a growing number of economic sectors and industries, businesses cannot work in a vacuum. They need help to continue their work (research and testing, in particular) and to market their discoveries. While the outlook for growth may look promising, it has to be acknowledged that business success also depends on decompartmentalizing. They have to be open to the ideas of their business partners from different backgrounds. At the same time, openness and an appetite for novelty must drive those who advise businesses developing industrial bioproducts.

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