



ADVANCED MATERIALS: A STRATEGIC SECTOR FOR QUEBEC

PRIMA 
Advanced Materials Moving Forward

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INTRODUCTION

Quebec has well-documented expertise in the «research» aspect of the advanced materials sector. The province's universities, college centres for technology transfer (CCTT) and public research centres are already home to a critical mass of hard-working researchers. However, the «industry» aspect of this ecosystem has not yet been clearly defined. To increase the visibility of Quebec's advanced materials expertise among its various potential users, this ecosystem must be inventoried.

The role of the Advanced Materials Research and Innovation Hub (PRIMA Québec) is to coordinate and support the various stakeholders in the ecosystem, so this portrait of the advanced materials ecosystem falls under its mandate.

According to Transparency Market Research,¹ the advanced materials market will be worth over US\$100 billion by the year 2024. This prospect echoes the findings of the McKinsey report² that lists advanced materials among 10 technologies likely to have the highest potential economic impact by 2025.

The advanced materials sector is a strategic one, as these materials have various applications:

- The production, transportation and storage of energy and the creation of alternative fuels that could accelerate the «greening» of transport
- More efficient modes of transportation, thanks to lighter vehicles
- The development of new semiconductors, sensors, and more energy-efficient screens capable of reducing the energy consumption of computers used in data centres

Both the federal and provincial governments are spotlighting advanced materials. Quebec's *Transportation Electrification Action Plan 2015-2020*, *Innovative Manufacturers initiative* and *Research and Innovation Strategy 2017-2022* all feature advanced materials. At the same time, the federal government's expectations of this sector are set forth in its *Innovation Agenda* and *Future Fighter Capability Project (FFCP)*, to name but a few.

1 Transparency Market Research (2017). *Advanced Materials Market*. Retrieved from <https://www.transparencymarketresearch.com/advanced-materials-market.html>.

2 McKinsey Global Institute (2013). *Disruptive technologies: Advances that will transform life, business, and the global economy*. Retrieved from https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx

As a result, PRIMA Québec, in collaboration with the Ministère de l'Économie, de la Science et de l'Innovation (MÉSI) and Innovation, Science and Economic Development (ISED) Canada, asked E&B DATA and Deloitte to draw up a portrait of the Quebec advanced materials ecosystem. Representatives of NRCC-IRAP, Cycle Capital Management and the École Polytechnique de Montréal served as advisors on the project's steering committee (Appendix 1).

Advanced Materials: A Strategic Sector for Quebec is the result of this co-operation. Providing an initial overview of this industrial ecosystem and its potential, it reveals a critical mass of 340 companies that rely on research expertise to become more competitive on the market.

Although this first edition does not claim to be exhaustive, it is nonetheless an essential tool for improving the sector's market position and facilitating the implementation of public policies to better support advanced materials.

PRIMA Québec would like to express its sincere appreciation to all the members of the steering committee for their involvement, with special thanks to Michel Lefèvre (PRIMA Québec), Nicolas Bourque (MÉSI) and René Poirier (ISED) for their invaluable co-operation throughout the process. Finally, thanks as well to all the companies consulted during the production of this portrait; they are, after all, the true beneficiaries of this effort.



Marie-Pierre Ippersiel
President and CEO
PRIMA Québec

BACKGROUND

The global industrial base is changing, both virtually and physically. While the development of advanced materials offers Quebec industry both opportunities and challenges, it must be backed by networks that support research, the dissemination of knowledge, and businesses.

These opportunities and challenges can be found throughout the various value chains:

Downstream, advanced materials will contribute to advances (in innovation and productivity) in traditional Quebec industries like metals, polymers and textiles, transportation equipment, pulp and paper, etc. It is therefore important to stimulate demand in these sectors so local industry can enjoy the benefits of new materials, creating a structural impact on Quebec.

Upstream, new suppliers of products, technologies and processes will help develop the demand for advanced materials in Quebec. These companies face challenges like a high level of uncertainty with regard to technology development deadlines and outcomes (e.g., stabilizing formulas and processes), markets (e.g., new certifications), and financing (e.g., occasional gaps in the funding chain). These upstream activities must therefore be stimulated and equipped to optimize the development of the advanced materials industry and its contribution to the Quebec economy.

METHODOLOGY

1 Demand analysis— International perspective

2 Demand analysis— Local perspective

3 Analysis of local supply

4 Conclusion

A four-step approach was adopted to complete this mandate. This document is thus a summary of this process.

As a preamble, a literature review helped define the term «advanced materials»; this definition was then adapted to Quebec realities.

The first step was to identify a series of international trends likely to strengthen and stimulate demand for advanced materials, followed by a series of needs and end markets for each trend (Figure 1). Although the markets within the advanced materials sector can appear at various levels, these different levels were accepted in the analysis because they refer to different levels of integration in the value chain and are an inherent reality of the sector.

Next, having determined a high potential global demand, a quick analysis of local demand was conducted via a survey of industry associations and research consortia actively working with an industrial clientele. Although by no means exhaustive, this analysis does offer an initial overview of local perceptions with regard to key advanced materials, their impact and barriers to demand.

To document the structure of the industrial ecosystem, a database of companies was created using information gathered from various sources.

Advanced materials are not part of the nomenclature of the North American Industry Classification System (NAICS) and there is no standard classification in the literature so any categories used are approximate.³ Furthermore, the cross-sector nature of advanced materials and their ability to be made into composites presented several challenges, especially given the sometimes fluid borders between different materials and sectors of application and the fact that a company can be catalogued in more than one segment.

To identify the needs of industries and determine Quebec's competitive advantages, a questionnaire was sent to the 340 companies in the database. A stratified sampling approach was used since it was an atypical group of businesses.⁴ Once the definition of the industry was stabilized—in other words, the qualification criteria of companies in the advanced materials industry—the starting point for the quantitative data research was prior knowledge of PRIMA Québec and its partner companies in the Quebec industry.

³ In addition, the definitions and categories used in these ad hoc studies tend to reflect industrial realities and technology industries that are not necessarily found in Quebec. It was difficult to use the conventional criterion of classifying a company on the basis of its «main activity» without running the risk of excluding the many businesses that integrate advanced materials but are primarily involved in other conventional commercial productions.

⁴ In fact, the total population includes a small number of very large companies with many employees, as well as a great number of SMEs with fewer employees.

For the purposes of the study, this database was then enhanced:

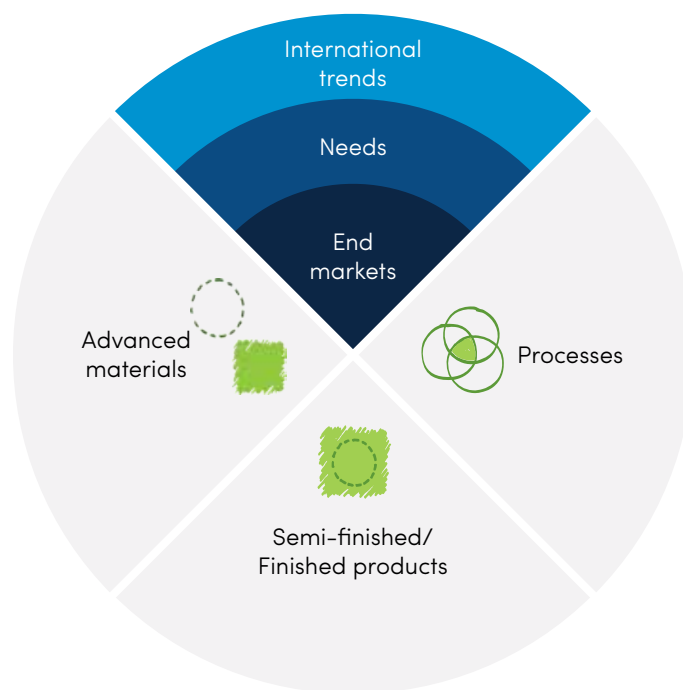
- A survey was sent to these companies (86 responded) with questions about their advanced materials activities, company size and potential (innovation, exports, investment, growth), and whether they faced any barriers to their development.
- In addition, each company's Website was systematically consulted to identify the category or categories of advanced materials and the area or areas of application. Any reference to producing, integrating, or developing a process for an advanced material led to the inclusion of the company in these categories or fields.

However, the companies' activities were not documented in detail so no directory was created.

Likewise, it was impossible to compare the advanced materials industry with any other industries in detail because the activities of those working with advanced materials can overlap with those in other industries.

The approach adopted nonetheless helped create an initial statistical portrait of the types of industrial expertise in Quebec, characterized by either the nature of the advanced materials involved or the sectors of application served by the businesses in Quebec's industry.

Figure 1
General approach



PRIMA QUÉBEC, BY THE NUMBERS - 2015-2018



52

collaborative
innovation research
projects funded

**\$46.3
MILLION**

total value of projects

2

digital intelligence tools
to support innovation

NovaCentris - IRDQ

PRIMA QUÉBEC THE HEART OF THE ECOSYSTEM

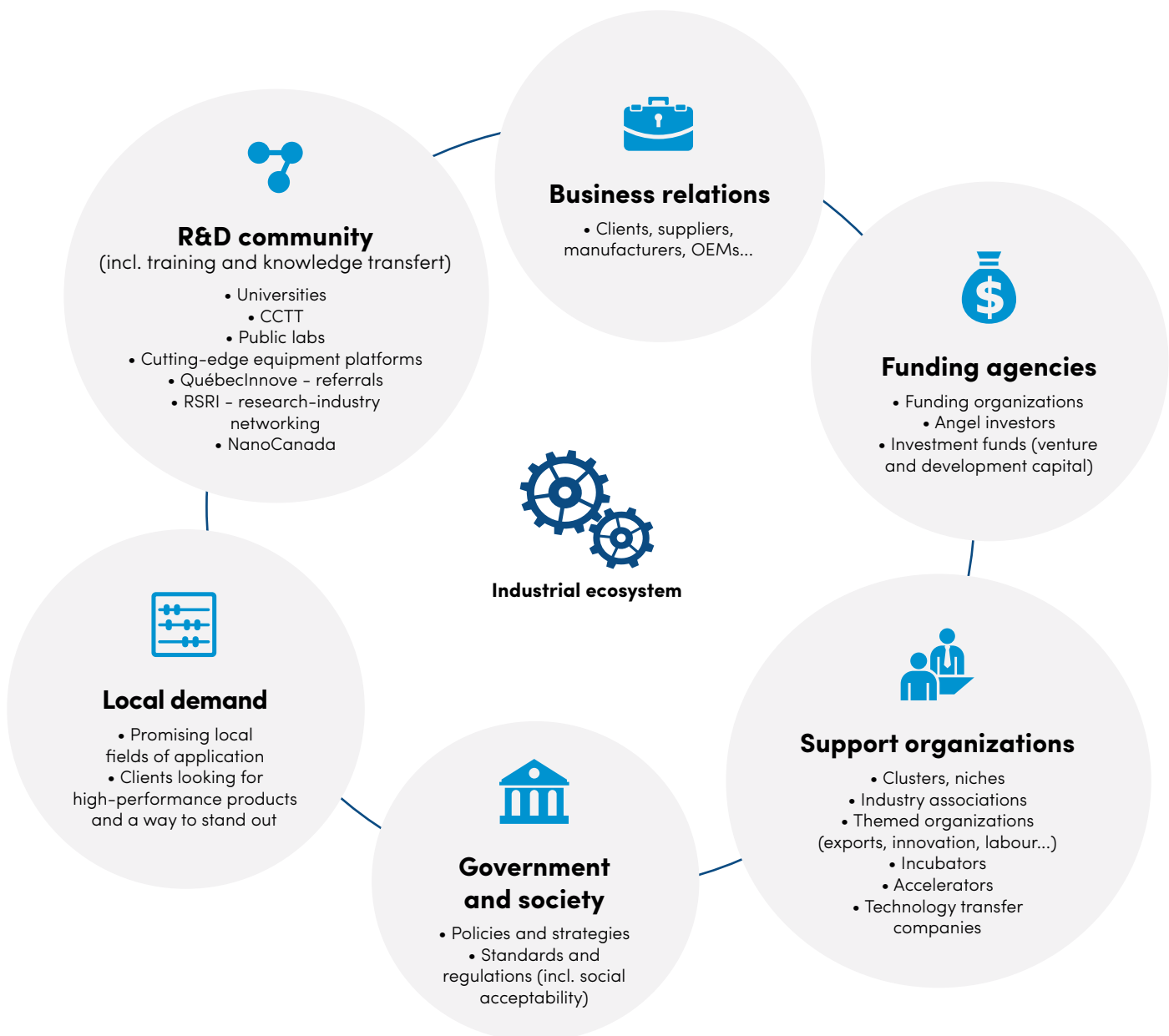
PRIMA Québec, the sector-based association for industrial research, enhances the competitiveness of the advanced materials industry by stimulating collaborative innovation. As the preferred interface for research and development, it helps bring together the various stakeholders in the ecosystem.

Building on advanced expertise, it helps the industry leverage advanced technological knowledge by increasing the number of strategic connections between the field of academic research

and companies of all sizes. Using its vision and expertise, it strengthens the innovation capacity of companies, making this strategic sector one of the most innovative.

Unlike other industries, the advanced materials ecosystem has emerged as a sector strongly influenced by collaborative research.

This spirit of co-creation drives and accentuates the innovation dynamic and promotes the discovery of innovative processes and materials as well as the development of components and their integration into various value chains.



«In terms of government research, research clusters must remain competitive and research infrastructure must offer the required level of quality. Cross-sector and multidisciplinary research can address major societal challenges, but requires access to competitive, adequately funded infrastructure where partnerships are welcomed. International partnerships are the norm today for collaborative projects. To stay competitive, Québec researchers must be connected with the best teams and world-class consortiums.»⁵

5 Ministère de l'Économie, de la Science et de l'Innovation (2017). *Québec Research and Innovation Strategy 2017-2022*. Retrieved from http://collections.banq.qc.ca/ark:/52327/bs2977698_p_15





1

ADVANCED MATERIALS

THE CROSS-SECTOR NATURE OF ADVANCED MATERIALS

Although advanced materials is a strategic industry, there is no recognized definition or single North American Industry Classification System for the sector. The cross-sector nature of advanced materials and their ability to be made into composites make characterizing the sector even more complex. A literature review helped define the term «advanced materials» and then adapt this definition to Quebec realities.

An advanced material can be defined as any new or significantly improved material that provides a distinct performance advantage (physical or functional) in comparison to the commonly used conventional materials it replaces (Figure 2).

Advanced materials can be organized into the following three categories:




-  Basic materials - materials found upstream in the manufacturing chain that have undergone little or no transformation (production of advanced materials).⁶
-  Finished and semi-finished products – products intended for intermediate or end users (integration of advanced materials).⁷
-  Processes and instrumentation – processes involving advanced materials.⁸

Figure 2
Exemples of desired properties

Physical performance	Functional performance
Electrical conductivity	Anti-icing/hydrophobic coating
Thermal conductivity	Self-healing materials
Mechanical resistance	Adjustable polarized lenses
Hardness	Biodegradability
Efficiency	Biocompatibility
Optical properties	Antimicrobial coating
Magnetic properties	Superabsorbent materials and impermeability

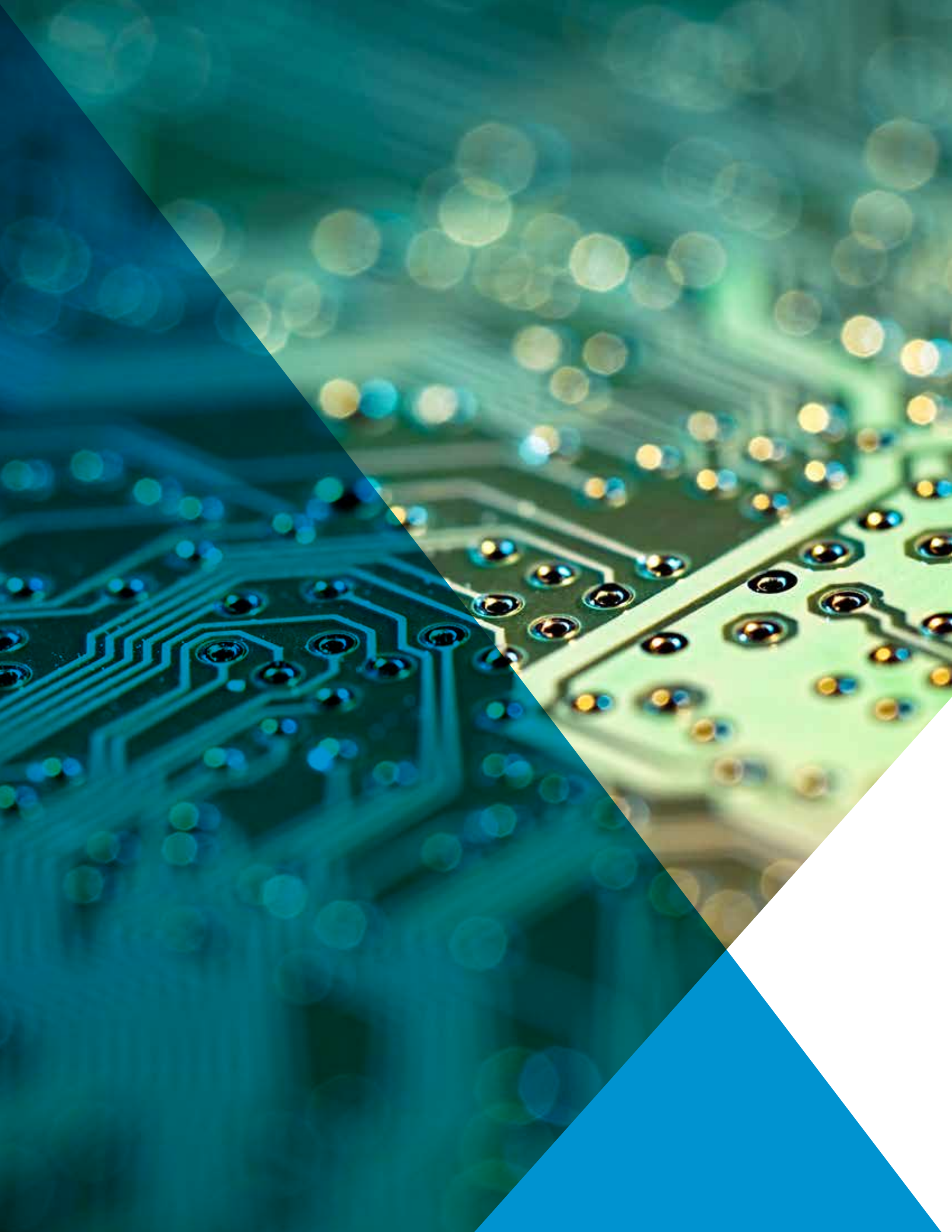
6 Firms active in the development and/or production of advanced materials

7 Firms active in the experimental integration of advanced materials to produce/assemble products manufactured in the firm

8 Firms active in the development (design, development) of processes and/or the manufacture of equipment used to at least partially process these advanced materials

Companies active in the advanced materials sector:

- Any firm that develops, produces or integrates advanced materials on its production line
- Any firm that develops or produces equipment or systems associated with the production and/or characterization of advanced materials





2

LEADING INTERNATIONAL TRENDS

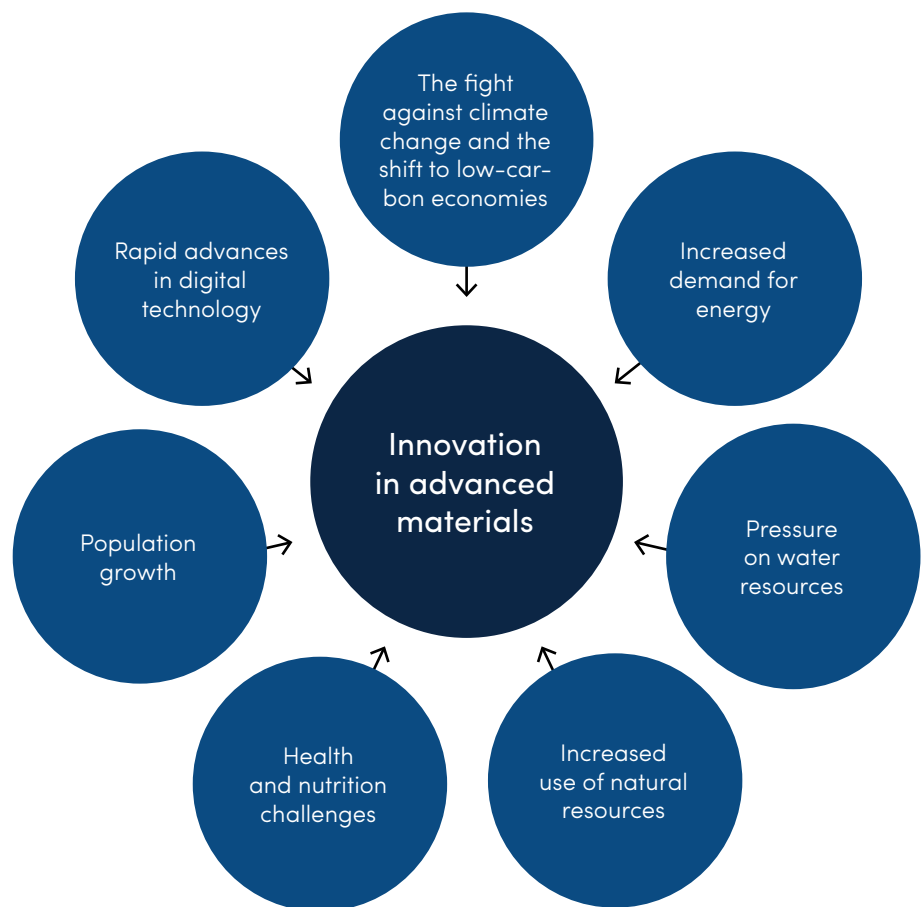
SEVEN GLOBAL TRENDS DRIVING INNOVATION

The fight against climate change and the shift to low-carbon economies, increased demand for energy, pressure on water resources, increased use of natural resources, health and nutrition challenges, population growth and rapid advances in digital technology are among the primary trends likely to have a major impact on the demand for advanced materials (Figure 3).

These very influential trends will upset the dynamic and have a profound effect on needs. They will drive innovation and technological advances in this strategic sector and open new opportunities for growth in Quebec.

Figure 3
Trends stimulating the demand for advanced materials

Source: Deloitte, Portrait of Advanced Materials, phase I, conducted for PRIMA Québec, 2018



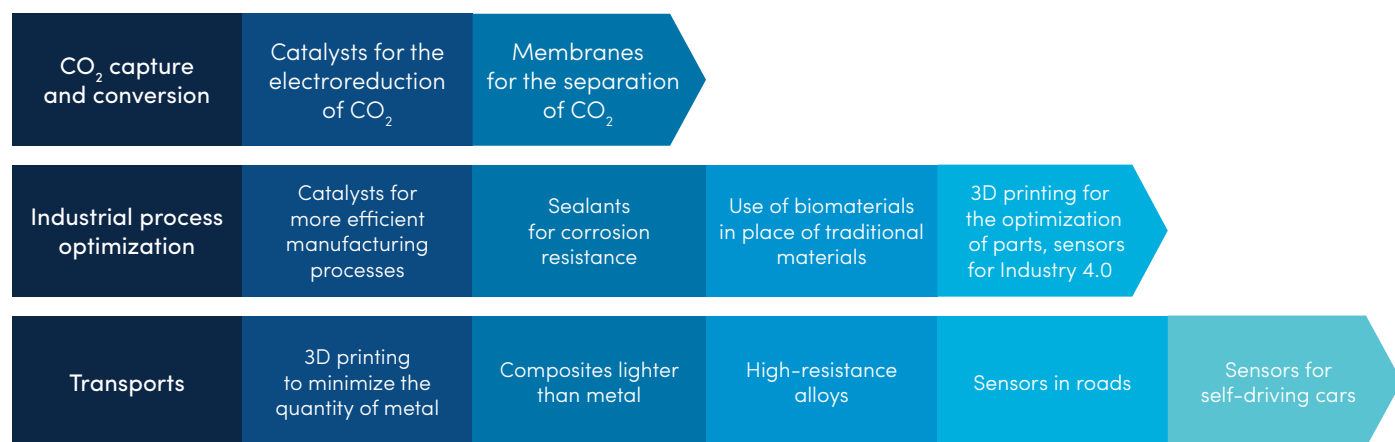
THE FIGHT AGAINST CLIMATE CHANGE AND THE SHIFT TO LOW-CARBON ECONOMIES

The dramatic effects of climate change have led governments to set objectives for reducing greenhouse gases (GHG) to limit their impact and move towards low-carbon economies. To help with this transition, advanced materials offer technological options that will ultimately help manage the GHG emissions produced and adapt infrastructure to climate change, notably in the industrial and transportation sectors.

In industry, the adoption of technologies driven by advanced materials can help optimize the energy efficiency of industrial processes and develop new manufacturing techniques that contribute to environmental protection.

Applications developed in the transportation sector can also have a tremendous impact on reducing greenhouse gases. For example, the production and storage of alternative fuels can help accelerate the conversion of modes of transportation, and the use of alternative materials can reduce the size and weight of vehicles (aircraft, ships, and vehicles used for defence purposes). In short, advanced materials offer a solution to environmental issues.

High-potential markets

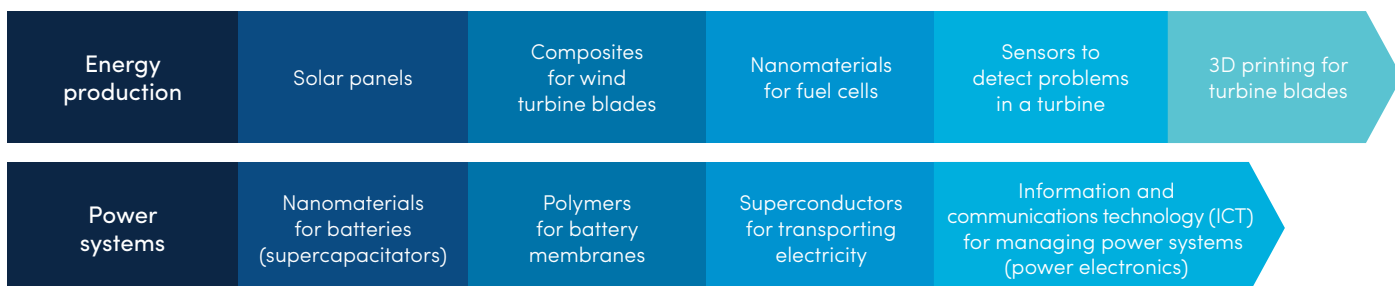


INCREASED DEMAND FOR ENERGY

In light of the growing demand for energy and the need to limit the effects of climate change, improving ways of producing alternative forms of energy and managing energy networks will stimulate the development of advanced materials.

Along with a greater reliance on renewable energies, efforts to optimize and recover energy in the fields of industry, housing and transportation will create greater energy efficiencies and likely have consequences on the development of these markets.

High-potential markets

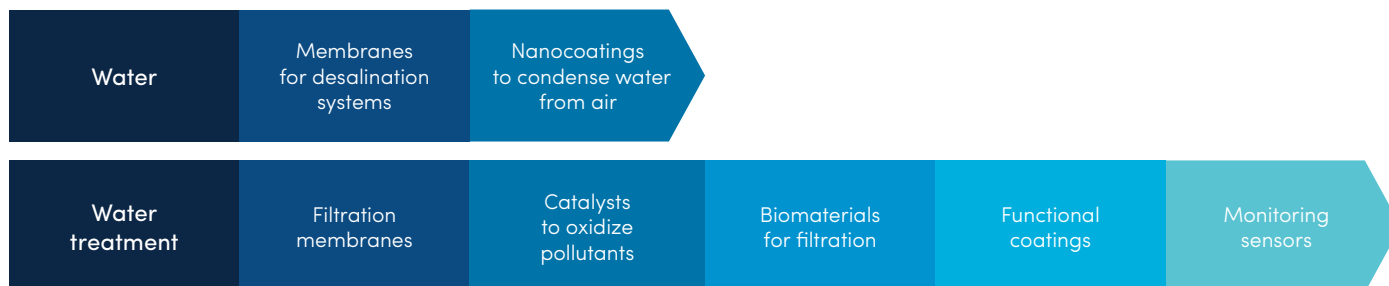


PRESSURE ON WATER RESOURCES

The rising demand for water resources, the quantity and quality of drinking water, urbanization, agriculture and the pressure of industrial activity (waste water) are issues that will require the implementation of innovative practices to ensure sustainable water management.

Advanced materials can support the introduction of new technological options for producing drinking water, treating water for consumption, treating waste water (from industry), and optimizing water resources.

High-potential markets



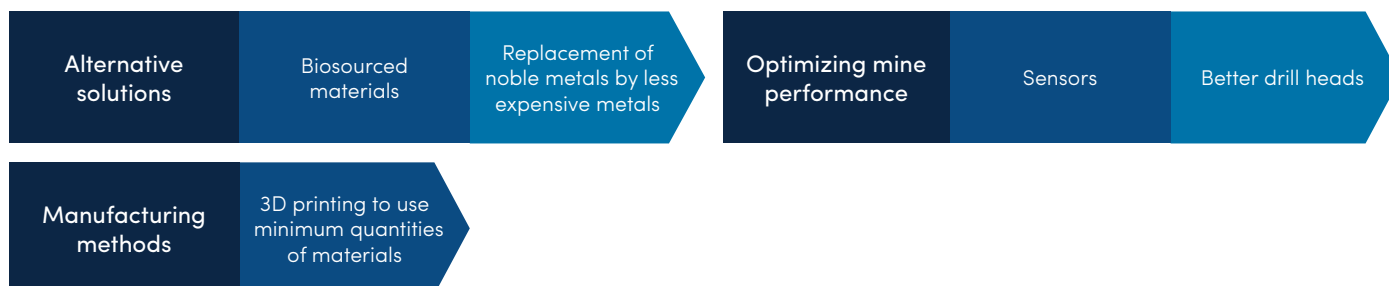
INCREASED USE OF NATURAL RESOURCES AND PRICE VOLATILITY

Given that energy consumption continues to grow, demand is increasing for natural resources, and the limited nature of such resources leads to price volatility, it is crucial to reuse materials and find substitutes for resources. These alternative solutions for traditional materials, which optimize recycling, recovery, reworking and substituting with the help of reinforced materials

or those with enhanced properties, can help reduce the number of inputs needed to manufacture finished and semi-finished products.

In addition to these efforts to reuse and substitute, improving equipment performance and the efficiency of mining and oil extraction processes will help respond to the increased demand for natural resources.

High-potential markets

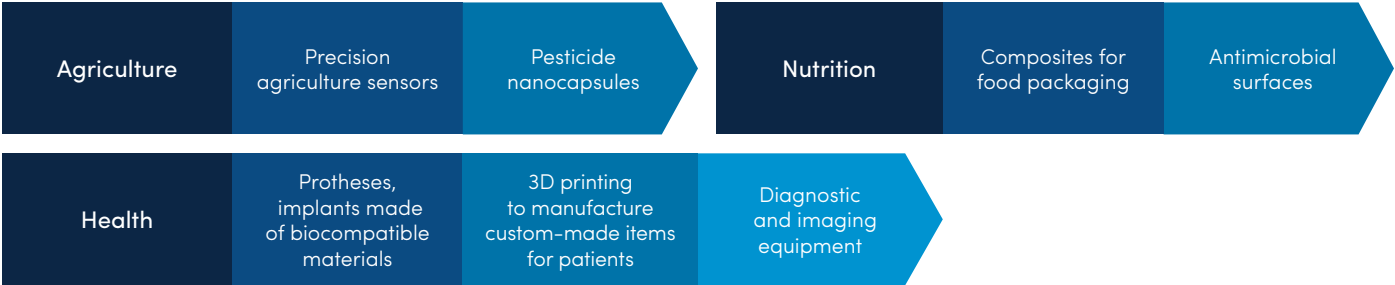


HEALTH AND NUTRITION CHALLENGES

In addition to issues associated with energy, water and natural resources, health and nutrition are also part of the international trends that will have an impact on the industry and for which advanced materials can provide solutions. With the world's population expecting to reach 9.5 billion by the year 2050 and demand for food rising by 60%, the global food and agri-food system will be under intense pressure. Combined with the effects of climate change, this increased demand for agricultural products (food, energy and animal feed) will have an impact on the availability of farmland. To address these issues and reduce the environmental impact of agriculture, improvements in productive harvesting practices (inputs and decision tools for farmers) and the creation of new technologies to improve the assimilation, processing, and preservation of agricultural production and transportation could all help deal with uncertainties.

Alongside the imperative for more efficient agricultural production systems is the growing demand for and complexity of health needs. The links between technology and medicine and the need to find new ways of optimizing research and development (R&D) in the pharmaceutical industry are key issues. Some of the areas with potential for advanced materials are the reduction of side effects (from diagnosis to treatment), performance improvements, the reduction of treatment and drug costs, and the development of new technologies for the pharmaceutical industry.

High-potential markets

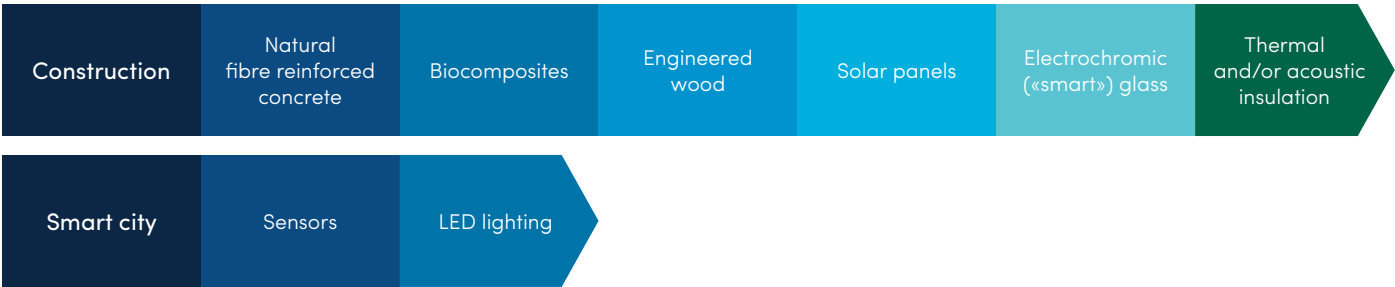


POPULATION GROWTH

The increase in the world’s population will generate a massive shift towards cities. This rapid urbanization will have a significant impact on environmental quality and resource use. Furthermore, a larger global population will affect the construction, maintenance and heating of buildings, which will, in turn, generate greater energy and resource consumption and the production of greenhouse gas emissions.

The acquisition of technologies that can reduce energy consumption (insulation, active/passive solar and air) and increase energy efficiency, along with the emergence of innovative solutions for producing construction materials that control costs and reduce the environmental footprint, will enhance research and innovation capacity in the advanced materials sector.

High-potential markets

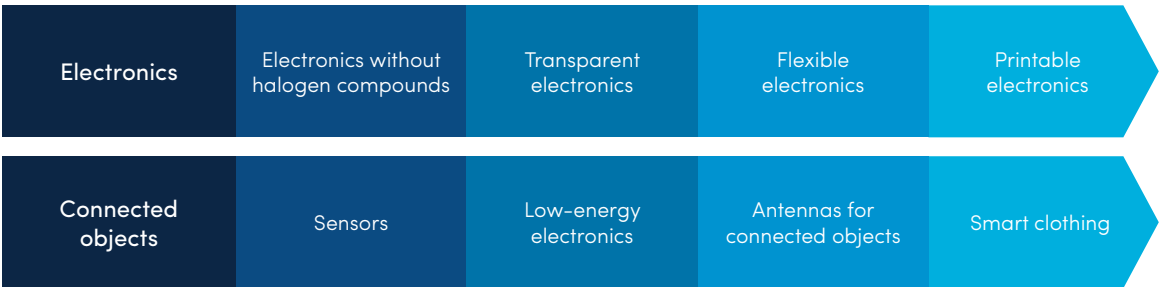


RAPID ADVANCES IN DIGITAL TECHNOLOGY

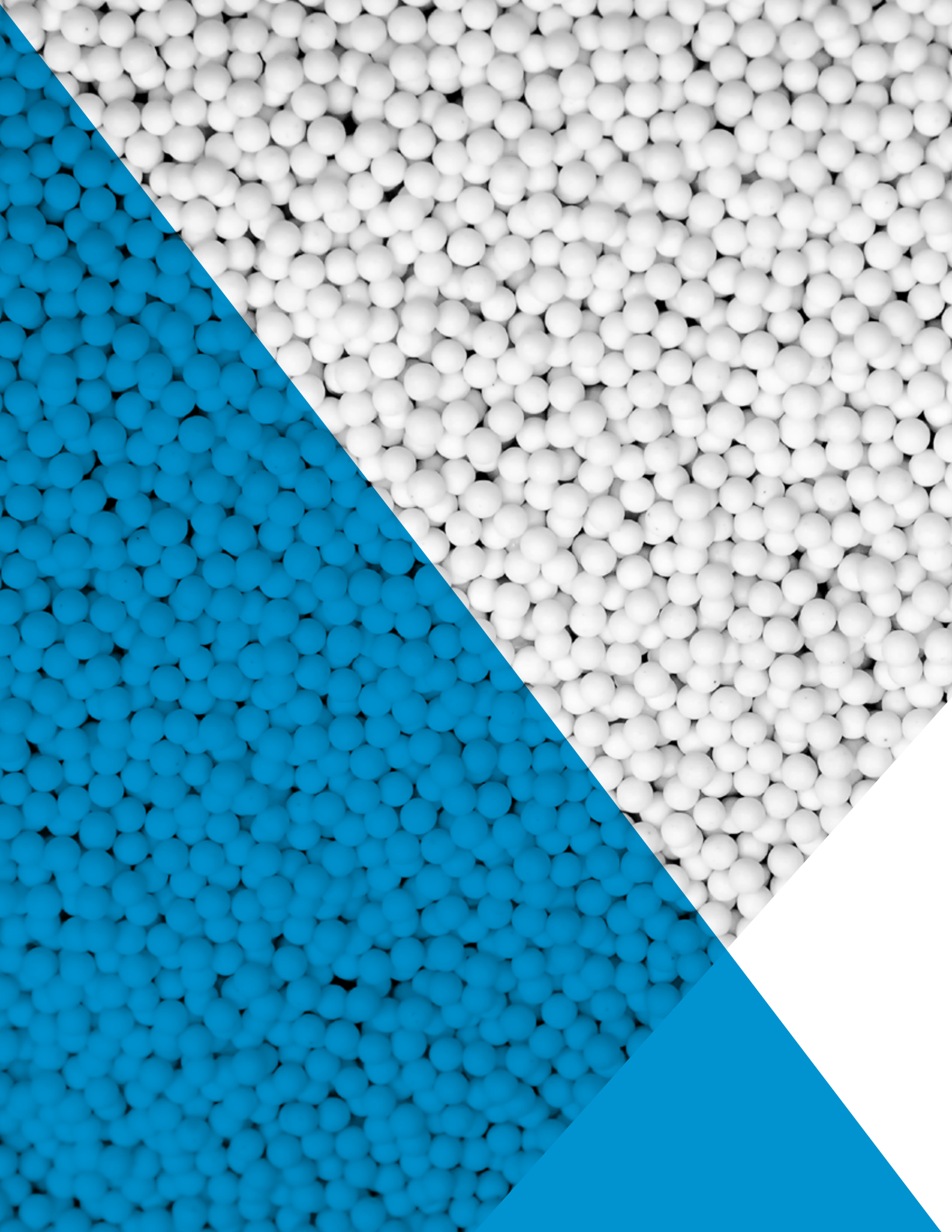
The wide-ranging issues associated with rapid advances in technology will influence the demand for innovation and affect the evolution and opening of new advanced materials markets. With an increasingly connected global population and the multiple challenges facing the industry with regard to the

use of toxic substances and electronic waste, promising new technologies will take shape. This trend will involve creating substitutes for scarce materials, recycling and reusing electronic waste, and developing new products with better connectivity, more powerful features and faster speeds, all with ever-smaller components.

High-potential markets



International
trends will have
an impact on
innovation and
disrupt the
evolution of
technology





3

DEMAND LOCAL PERSPECTIVE

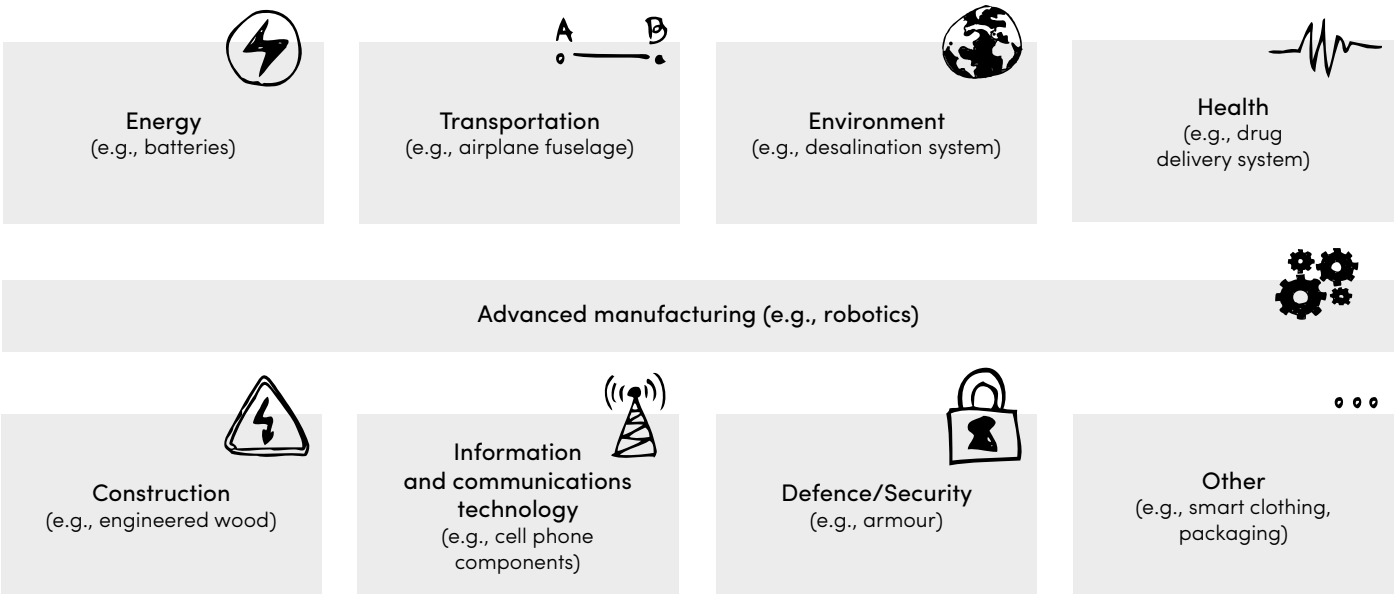
APPLICATIONS THAT WILL DISRUPT THE EVOLUTION OF TECHNOLOGY

Advanced materials generate solutions and build the future in many ways.

International trends affect the demand for innovation and shape the advanced materials markets. While the potential global demand seems strong, there is also potential local demand in Quebec.

Among the sectors that will drive this evolution and capitalize on the changes implemented to respond to global issues are energy, transportation, the environment, health, construction, information and communications technology, and defence and security (Figure 4).

Figure 4
Sectors of application - advanced materials
Source: Deloitte and E&B DATA survey, 2017



Although it is difficult to estimate the overall impact of this evolution, advanced materials do create interactions between sectors and companies tend, on average, to do business in two sectors. The transportation sector will offer the most potential for advanced materials (Table 1).

Identifying the interconnections between sectors will foster the development of new applications that go beyond the conventional scope of Quebec companies. The cross-sector nature of advanced materials will enable companies to multiply connections by joining their respective forces to position themselves in this market (Table 2).

Table 1
Examples of cross-sector connections

Source: Deloitte. Portrait of Advanced Materials, Phase I, conducted for PRIMA Québec, 2018

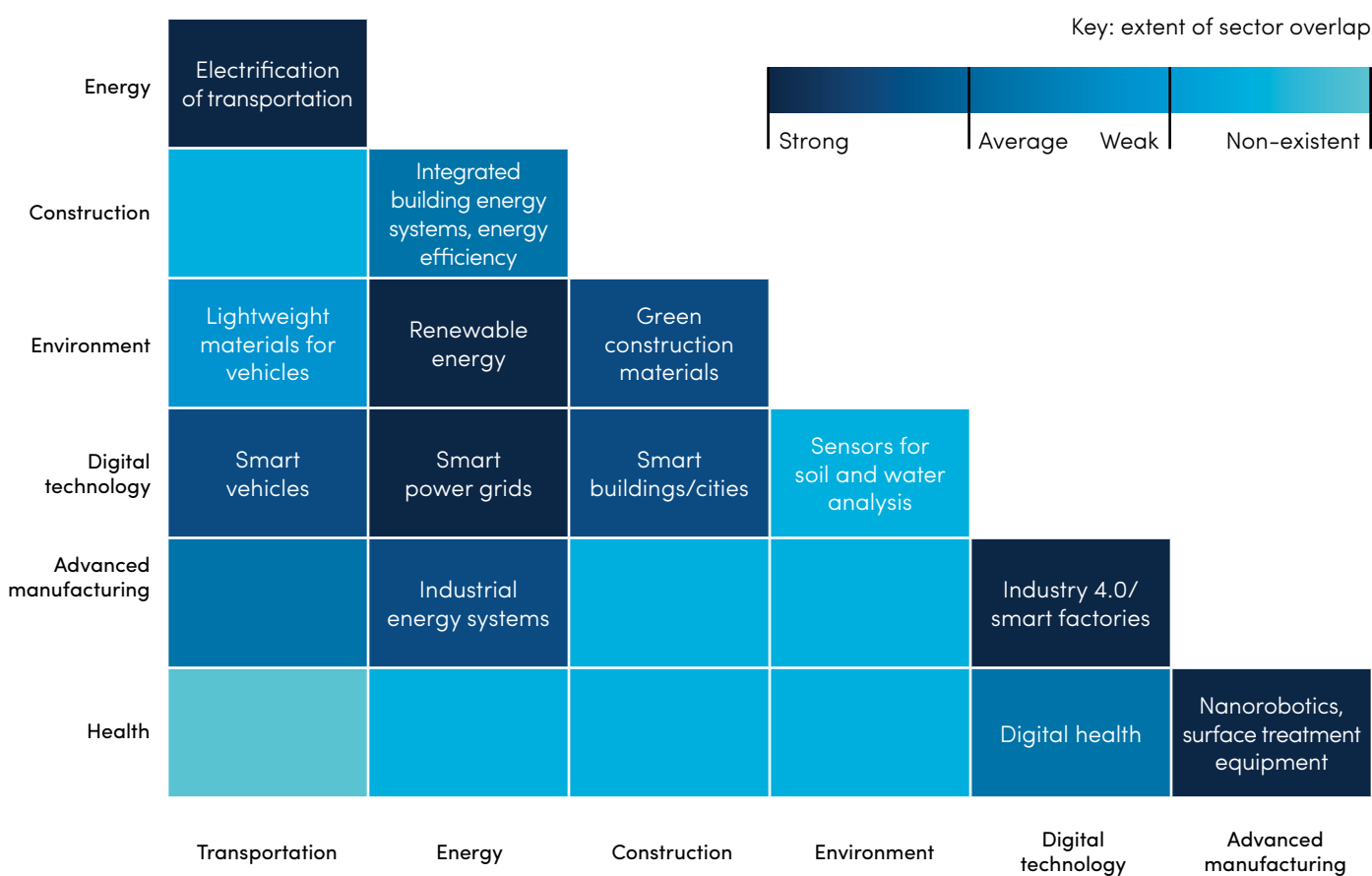









Table 2

Examples of semi-finished/finished products and sector overlap

Source: Deloitte. Portrait of Advanced Materials, Phase IV, conducted for PRIMA Québec, 2018

Examples of markets/semi-finished/finished products							
Sensors	●	●	●	●	●	●	●
• Smart power grids	●	●					
• Smart transportation	●		●				
• Smart buildings	●			●			
• Smart water management	●				●		
• Smart factories	●					●	
• IoT in healthcare (digital health)	●						●
Nanoelectronics	●						
Transparent electronics	●		●	●			
Batteries	●	●	●	●	●	●	●
• Electric/hybrid vehicle batteries		●			●		
Solar panels (photovoltaic cells, materials, etc.)	●	●	●	●	●		
Wind turbines		●			●		
Lightweight materials for transportation			●		●		
Composite panels				●	●		
Green construction materials (cement, etc.)				●	●		
Self-healing materials		●	●	●			
Green chemistry (industrial biotechnology, biosourced products, etc.)		●	●	●	●	●	●
CO ₂ sensors					●		
Water treatment (equipment and chemicals)				●	●	●	
Additive manufacturing			●	●		●	●
Robotics	●					●	
• Nanorobot						●	●
Implants, prostheses, pacemakers, etc.							●
Medical imaging (nanoelectronics, sensors)	●						●

- Primary sector of application
- Secondary sectors of application (sector overlap)

DEMAND

The analysis of the data collected from the heads of organizations and associations in various sectors of activity provides an initial overview of the demand for advanced materials in Quebec.

As was the case on international markets, the local advanced materials market seems to consist largely of sensors. In addition to a marked interest in this product, the evidence obtained indicates that firms are also interested in metals, alloys, and polymers.

In fact, local companies are open to using advanced materials more often, either by purchasing them as is or by incorporating them into semi-finished/finished products.

TARGET MARKETS

Advanced materials are becoming more common in Quebec. According to the survey respondents, the defence, advanced manufacturing and transportation sectors are the most promising potential markets for advanced materials. In addition to offering the most opportunities, these sectors are those in which advanced materials would have the greatest impact on the

features or performance of products (manufactured, integrated or semi-finished/finished).

BARRIERS TO DEMAND

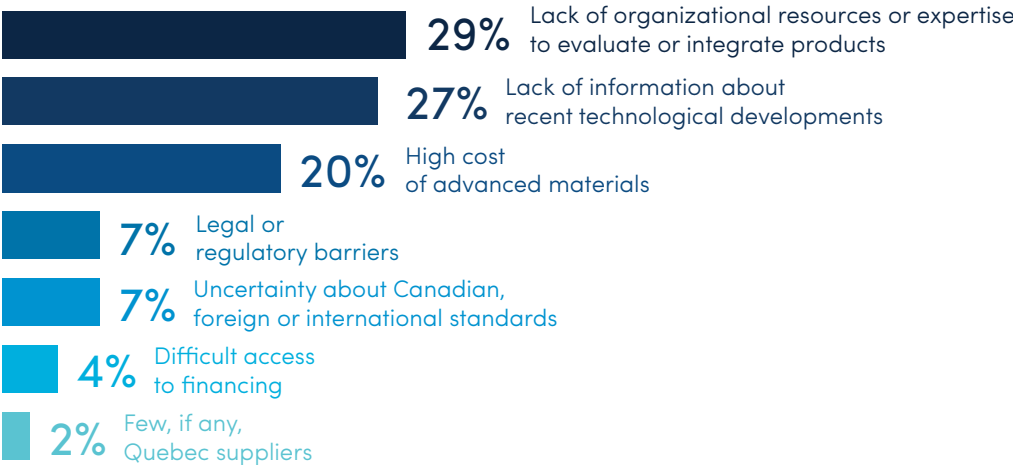
However, to capitalize on this demand and enter the market, companies must address certain concerns.

The question of expertise appears to be a major issue for the associations surveyed. For some companies (29%), a major barrier to demand is definitely the lack of resources or expertise to evaluate advanced materials or integrate them into their products. For others, a lack of information about recent technological developments (27%) and the high cost of advanced materials (20%) also inhibit the growth of demand. Other impediments to demand are regulatory barriers (7%), uncertainty about standards (7%), difficult access to financing (4%) and the small number of Quebec suppliers (2%) (Chart 1).

Chart 1

Primary barriers to demand for advanced materials

Source: E&B DATA survey, 2017 (4% of respondents answered Do not know)







4

QUEBEC'S ADVANCED MATERIALS INDUSTRY

QUEBEC: A FAVOURABLE ENVIRONMENT FOR ADVANCED MATERIALS

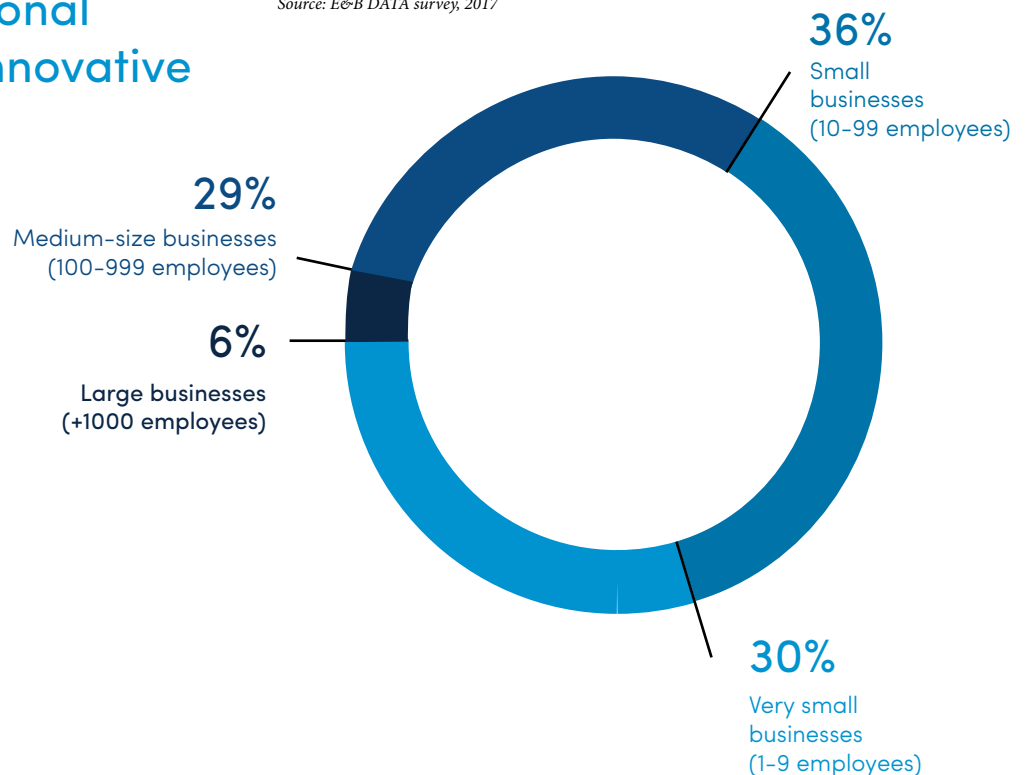
Advanced materials can promote the development of traditional industries. Quebec companies are at the forefront of the shift towards advanced materials, leveraging international trends by offering innovative solutions.

The Quebec advanced materials industry has a critical mass of companies and jobs, as well as a balanced industrial ecosystem.

It includes more than 340 companies that are, for the most part, either very small (30%), small (36%) or medium-size businesses (29%) (Chart 2). Altogether, these SMEs employ over 33,000 people (Chart 3).

Chart 2
The advanced materials industry,
broken down by company size (# of employees)

Source: E&B DATA survey, 2017



EMPLOYMENT

Employment in the entire sampling of companies rose by an annual average of 1% from 2015 to 2017. Among very small, small, and medium-size businesses, it has grown an average of 6% since 2017, according to the estimated change in the level of employment. In the case of the businesses surveyed, this growth could be attributed to an increase in investment.

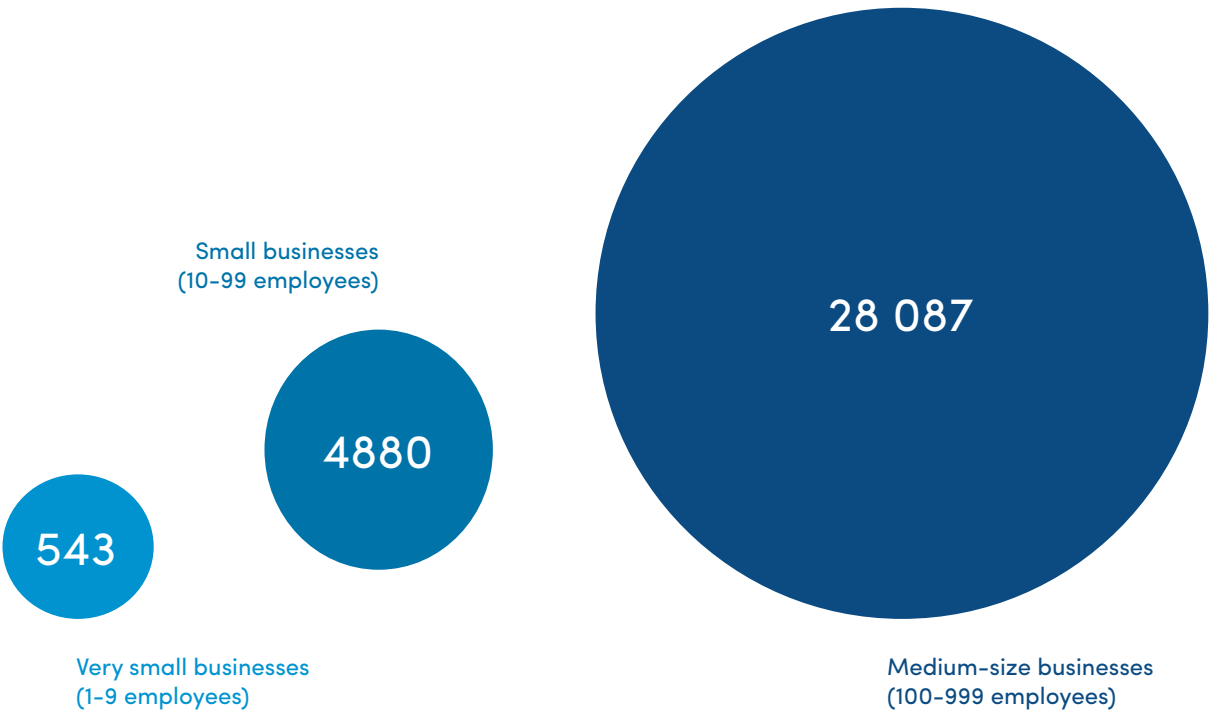
INVESTMENT

In fact, just among the companies sampled (n=86), a total of over \$100 million has been invested since 2015, and this amount should double by the year 2020.

According to the data collected from these businesses, 43% of them have made capital investments of over \$1 million since 2015. The combined value of these projects is more than \$100 million (Chart 4).

Chart 3
**Number of jobs in very small, small,
and medium-size businesses**

Source: E&B DATA survey, 2017



9 Employment has remained stable for the vast majority of the large businesses surveyed (86%). Only 7% of the businesses currently operating in this category experienced a decrease in the number of employees during this period.

+ 340
companies

+ 33 000
employees

+\$10 billion
in annual sales*

+ 500
researchers working
in research centres

* This sales figure is the estimated total sales of these companies, not just the portion of sales associated with advanced materials production.

Chart 4
Value of investments between 2015 and 2017
 Source: E&B DATA survey, 2017

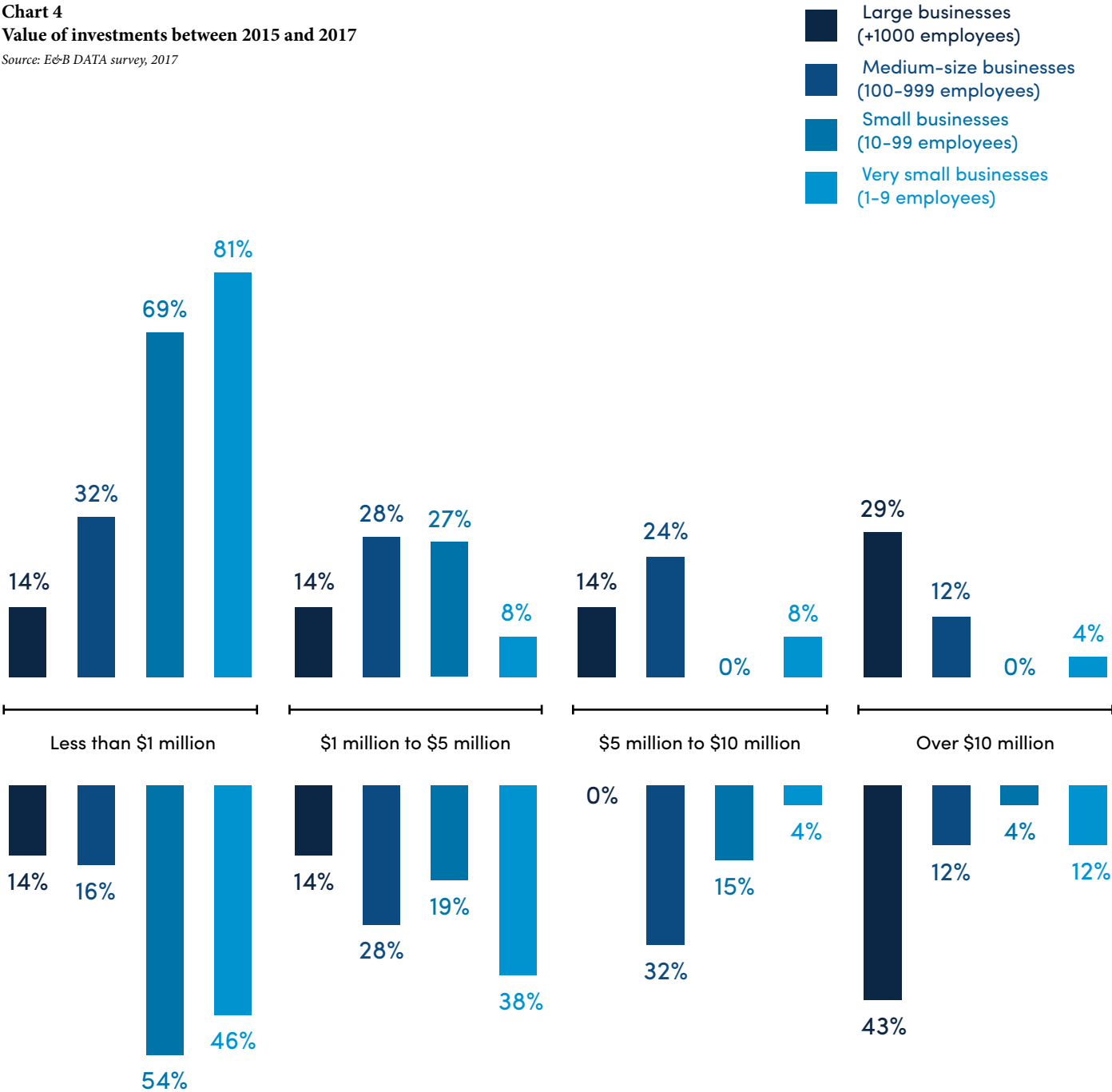


Chart 5
Value of planned investments between 2018 and 2020
 Source: E&B DATA survey, 2017



With regard to projected capital expenditures, it appears that over 63% of the companies surveyed intend to invest over \$1 million by the year 2020, for a total project value that could reach upwards of \$200 million. Furthermore, it is worth noting that these major projects will be undertaken by all sizes of companies, not just the larger ones (Chart 5).

A closer look at the industry reveals that over 33% of the companies surveyed were founded less than 10 years ago. The fact that a strong core of businesses involved in advanced materials has emerged in the last decade illustrates the existence of a favourable entrepreneurial dynamic (Chart 6).

Furthermore, looking at the job growth and strong levels of investment, it is clear that the Quebec advanced materials industry is taking an active role in growing this new global industry.

Chart 6
Number of years in operation (median age),
broken down by company size
Source: E&B DATA survey, 2017



Advanced materials expertise and cutting-edge equipment: Key resources

Although the advanced materials sector is primarily made up of innovative SMEs active in research and development (R&D), these companies do not always have the internal resources needed to conduct characterization tests, synthesize materials, treat surfaces or scale up.

Furthermore, this type of testing and access to cutting-edge equipment is critical to gaining the necessary approval to make the transition from technology to innovation and thus enable companies to access various markets. With the help of cutting-edge equipment platforms, PRIMA Québec surveyed a sample of industrial clients who use these platforms dedicated to advanced materials. Generally speaking, it appears that without this equipment and the associated expertise and support, it would be much more difficult, or indeed impossible, for SMEs to develop their innovations.

More specifically, the SMEs surveyed by PRIMA Québec had to use cutting-edge equipment in public institutions for the following reasons:

- Absence of in-house laboratory (38%)
- Lack of financial resources to fund the purchase of equipment (44%)
- Need to use accurate equipment (71%)
- Need for specific expertise (56%)

Several respondents specified that this equipment was used for its «recognized expertise» or because «an SME cannot afford a \$1 million laser and could not operate without university infrastructure.» Access to this equipment enabled industrial clients to solve a problem (73%), develop a new process (58%) or develop a new product (71%).

Among the benefits identified by this survey was the fact that using cutting-edge equipment definitely affected the innovation capacity of SMEs by enabling them to:

- Acquire a better understanding of their product/process (68%)
- Accelerate the development of their product (53%) or process (32%)
- Get their product to market quickly (21%)

Above all, for half of the respondents, using cutting-edge equipment enabled them to carry out a project that would otherwise have been impossible.

Finally, the support provided by the operators was key because it offered companies expertise and knowledge associated with the equipment. For example, integrating a raw material into a formulated material requires developing a recipe or process. Without the recipes or processes developed by operators, a company trying to integrate new materials into its products could have its innovation process fail and lose precious time and money. Platforms have knowledge and experience in a wide variety of techniques, which means scientific work can be carried out quickly.

10 Between March 24 and 31, 2017, PRIMA Québec surveyed 165 companies that used cutting-edge equipment to determine their level of satisfaction and the benefits they derived.

RESEARCH INTENSITY OF COMPANIES

Research and development (R&D) activity is an indicator of a company's body of knowledge and innovation performance.

According to the data collected from the sample, Quebec companies in the advanced materials sector are very active in R&D. This activity is supported by collaborative public-private research and the existence of in-house scientific and technical knowledge.

In fact, nearly all the companies conduct the same amount of advanced materials research in-house (98%) as they do externally in partnership with university research centres, college centres for technology transfer (CCTT) or private and public labs (99%).

Collaborating on innovation activities, notably the acquisition of R&D services, is as prevalent among small businesses as it is among large businesses, and this co-operation is not solely at the national level.

Many Quebec companies work with international companies and such interactions are conducive to the transfer of knowledge.

As previously mentioned, both in-house and external R&D help stimulate progress in Quebec companies. These routes of knowledge transfer offer Quebec companies new advanced materials market opportunities to develop products that satisfy the requirements of demand. A significant share of the sample estimates that products under development are either in the prototype or proof-of-concept phase. On the other hand, nearly half of the companies surveyed stated that their primary product was at the production and commercialization phase (Table 3).

Table 3
Development phases of advanced materials products
in the companies surveyed

Source: E&B DATA survey, 2017

	Large businesses	Medium-size businesses	Small businesses	Very small businesses
Development plan →	43 %	12 %	27 %	19 %
Market research →	29 %	16 %	31 %	15 %
Idea protection →	43 %	28 %	23 %	15 %
Research and development →	29 %	76 %	58 %	54 %
Prototype and proof of concept →	43 %	64 %	58 %	65 %
Technology showcase →	–	20 %	35 %	42 %
Production →	57 %	56 %	42 %	42 %
Commercialization →	29 %	52 %	38 %	46 %

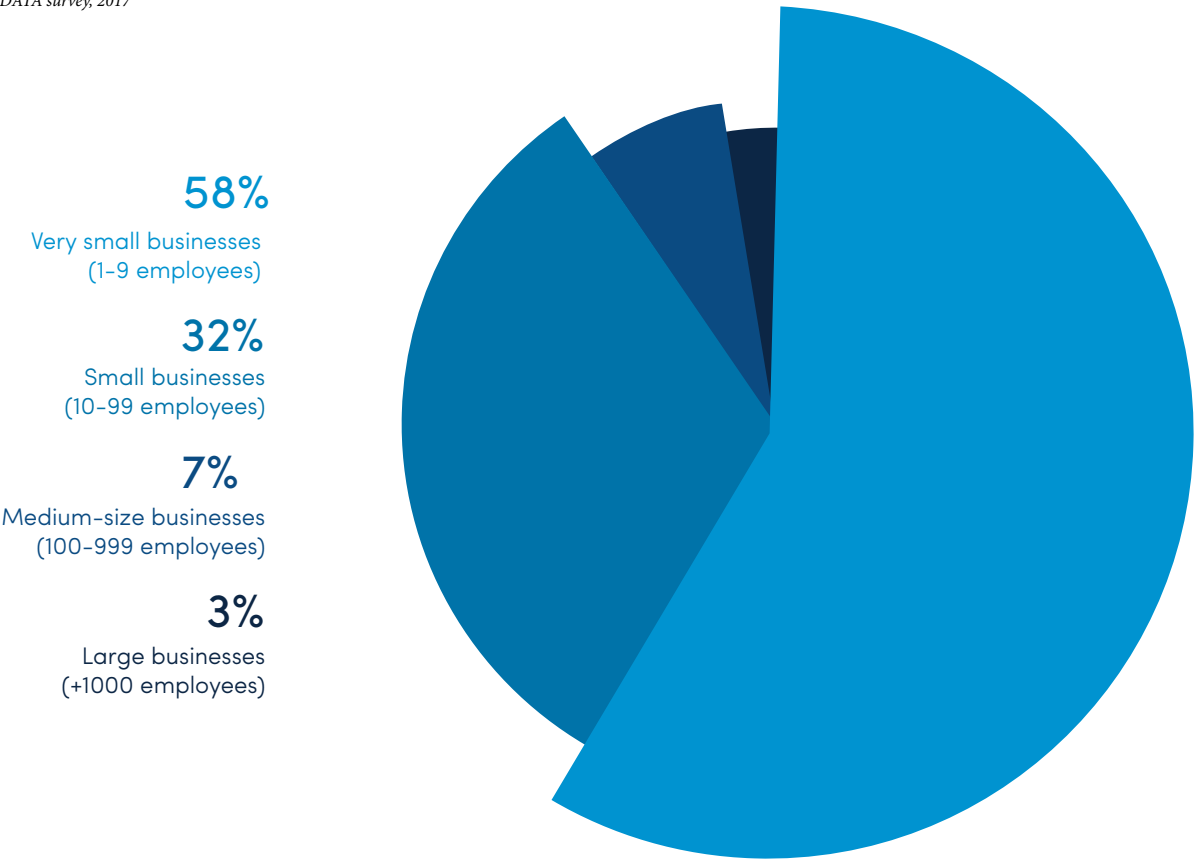
SHARE OF JOBS ASSOCIATED WITH RESEARCH AND DEVELOPMENT

The percentage of jobs devoted to in-house research is nearly 58% in very small businesses and decreases in proportion to the size of the company, reaching 3% in large businesses (Chart 7).

If one excludes large businesses, approximately 10% of jobs in Quebec companies are devoted to the development of new products and processes, which, for the businesses surveyed, is the equivalent of some 2,500 industrial researchers working in R&D.

Chart 7
In-house research

Source: E&B DATA survey, 2017



11 Full-time equivalent.

PUBLIC RESEARCH

Researchers employed by the advanced materials industry are supported by a pool of some 500 researchers working in public research centres.

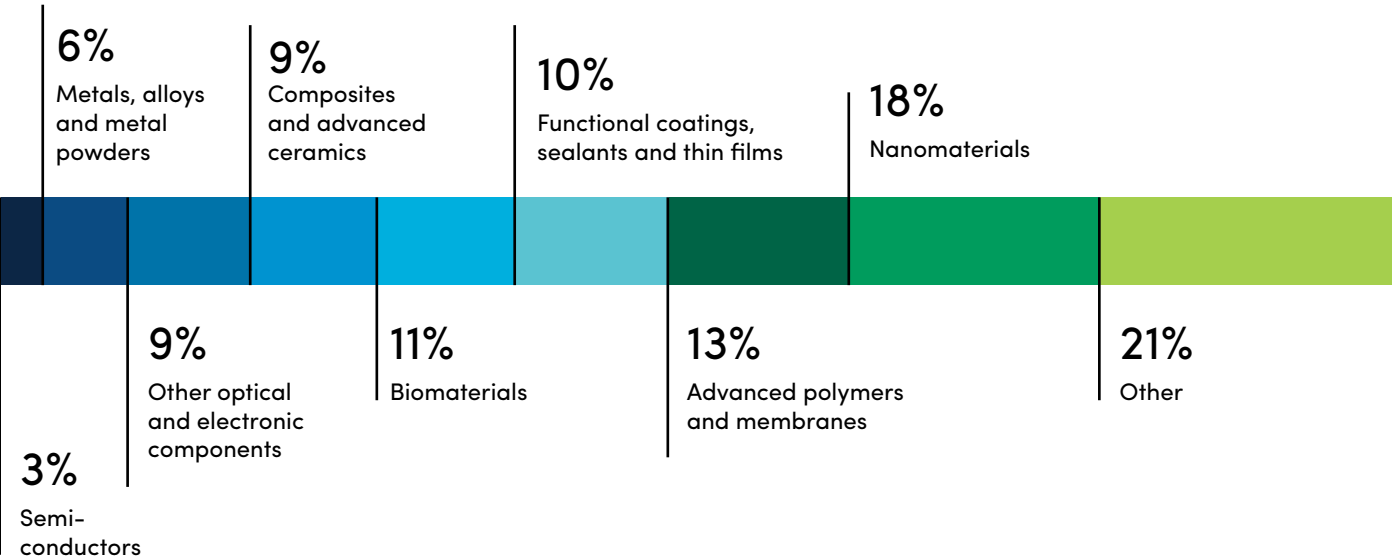
The public sector conducts both basic and applied research, seeming to focus primarily on nanomaterials (18%), advanced polymers and membranes (13%) and biomaterials (11%) (Chart 8).

This intellectual capital, whether it comes from expertise specific to a company or is the result of collaborative public-private research, drives innovation and helps Quebec companies increase their market share.

«Public research plays a key role in innovation systems by providing new knowledge and pushing the knowledge frontier. Universities and public research institutions (PRIs) often undertake longer-term, higher-risk research and complement the research activities of the private sector.»¹²

Chart 8
Sectors in which researchers from public research institutions work with advanced materials

Source: E&B DATA survey, 2017



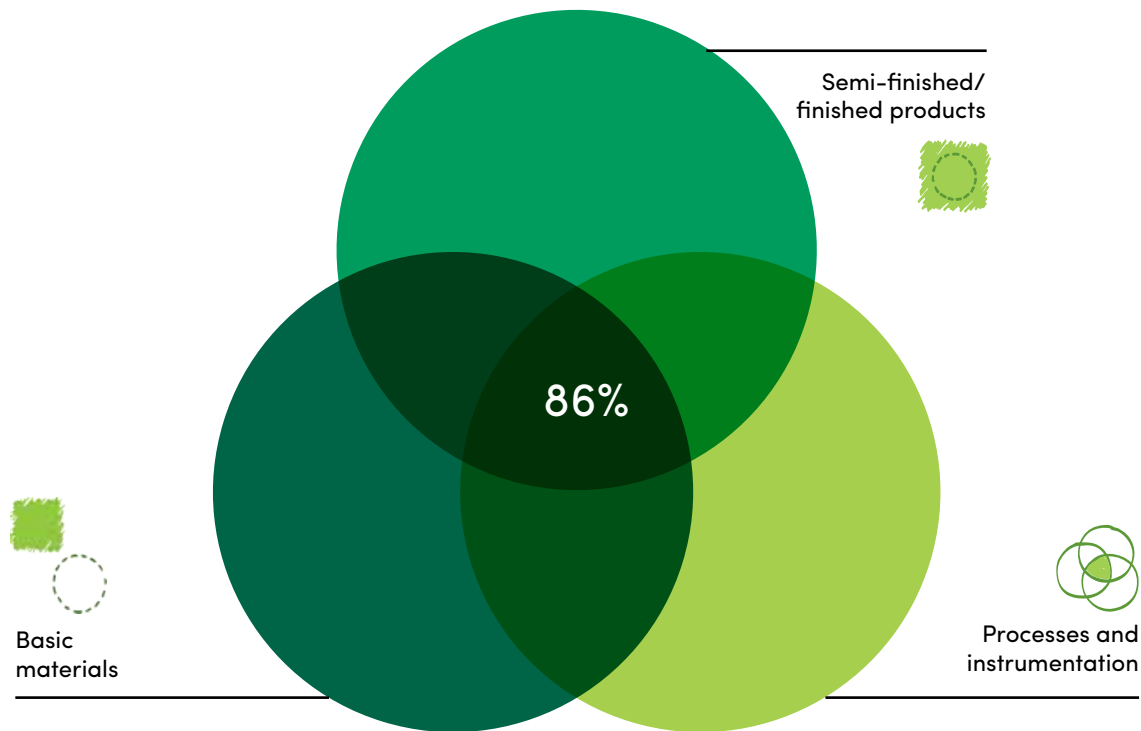
12 OECD. *The Innovation Imperative* (2016). Retrieved from https://read.oecd-ilibrary.org/science-and-technology/the-innovation-imperative_9789264239814-en#page92

COMPANY ACTIVITIES AND CATEGORIES OF ADVANCED MATERIALS

The survey of Quebec advanced materials companies reveals that their R&D activities help transform ideas into products and processes. The advanced materials industry differs from other industries in that most of the businesses surveyed (86%) operate in more than one sector of activity—advanced materials production (basic materials) and/or materials integration (semi-finished/finished products) and/or process development (processes and instrumentation) (Chart 9).

The Quebec advanced materials market seems to be stimulated by the industry’s willingness to diversify its activities in order to better support market demands. It would also appear that the Quebec business environment is conducive to the development of a critical mass of businesses in several major sub-groups (Table 4).

Chart 9
Company activities
Source: E&B DATA survey, 2017



BASIC MATERIALS

In the category of basic materials, the most developed types in the Quebec industrial ecosystem seem to be polymers and membranes (22%), nanomaterials (19%), metals, alloys and metal powders (15%), composites and ceramics (15%), coatings, sealants and thin films (10%), biomaterials (8%) and finally concrete and engineered wood (4%) (Chart 10).

SEMI-FINISHED/FINISHED PRODUCTS

In the category of semi-finished or finished products, that is, products that integrate advanced materials during their production or assembly, transportation components are the most widely manufactured, representing nearly 46% of the total. Another strong trend in Quebec is the search for sustainable global mobility solutions. Since this market is so important, finished products incorporating sensors seem to be very popular

among businesses purchasing advanced materials in Quebec. Electronic, optical and electrical systems are the second most common type of product, making up 19%, followed closely by electronic, optical and electrical components (15%) and finally by biocompatible materials (5%) (Chart 11).

PROCESSES AND INSTRUMENTATION

In the case of processes and instrumentation, additive manufacturing (65%) seems to account for the vast majority of production. Nearly 18% of equipment manufacturing or processes are associated with characterization instruments, while 17% of these designs involve modelling and simulations (Chart 12).

Table 4
Advanced materials produced by Quebec companies

Source: Ec-B DATA survey, 2017




 Basic materials	 Semi-finished/finished products	 Processes and instrumentation
Polymers, elastomers and membranes	Transportation components	Additive manufacturing
Nanomaterials	Electronic, optical and electrical systems and sub-systems	Characterization instruments
Metals, alloys and metal powders	Electronic, optical and electrical components	Modelling and simulations
Composites and ceramics	Biocompatible materials	Nanofabrication
Functional coatings, sealants, thin films	Packaging	
Biomaterials	Smart textiles	
Semiconductors	Other semi-finished/finished products	
Concrete and engineered wood		
Glass		
Natural and high-performance fibres		

Chart 10
Types of basic materials

Source: E&B DATA survey, 2017

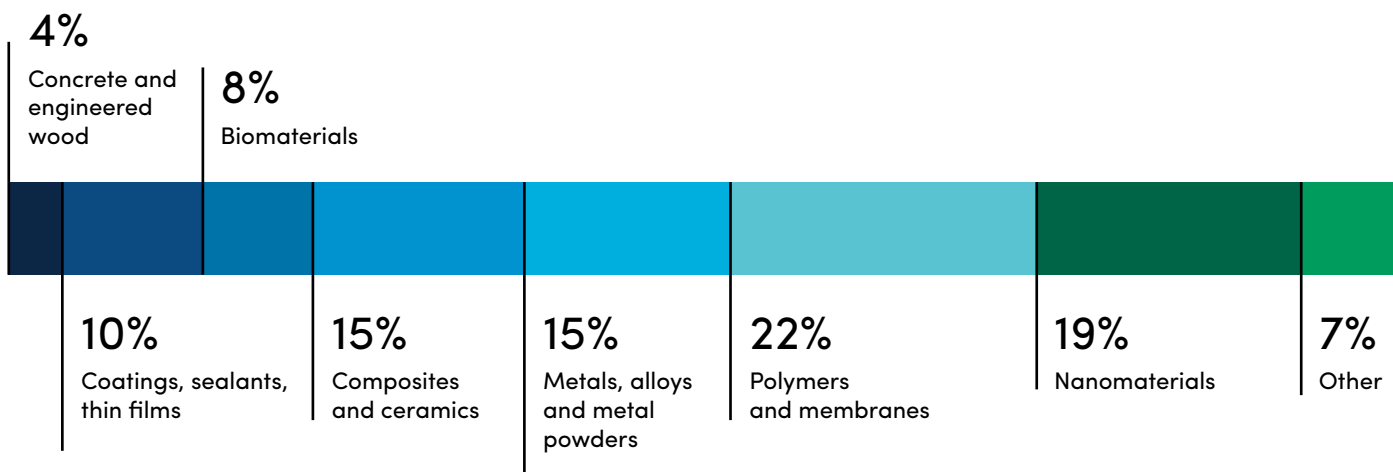


Chart 11
Types of semi-finished/finished products

Source: E&B DATA survey, 2017

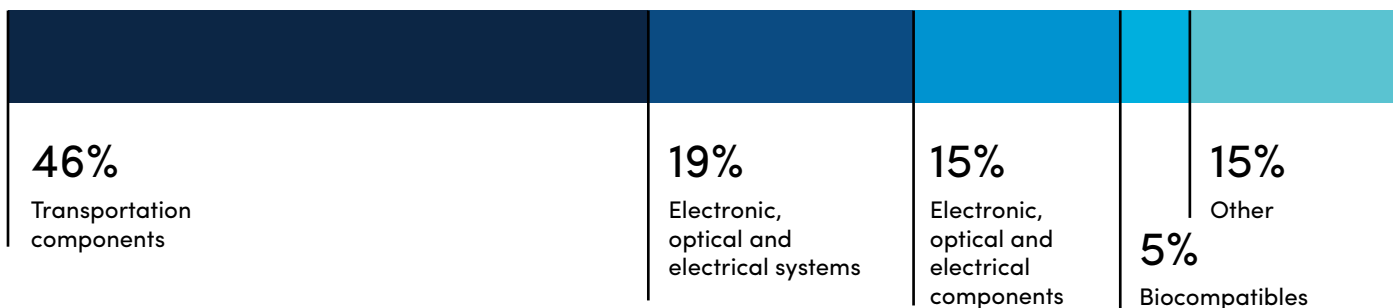


Chart 12
Types of processes and instrumentation

Source: E&B DATA survey, 2017



This exercise helped identify the strategic technologies present in the Quebec advanced materials ecosystem. Although they cover a wide range of fields, these key technological sectors are all helping to promote Quebec as a leader in the industry.

An overview of the products created (Tables 5, 6, 7) also reveals the abundance of innovative solutions developed in Quebec and the many opportunities available to these companies, which provide consumers with products and processes adapted to the challenges of the 21st century.

Table 5
Overview of products in the basic materials category¹³

Source: Database of the companies surveyed by E&B DATA, 2017

Types	Examples of products
Advanced polymers and membranes	Polymeric dyes, recycled plastics, advanced rubber
Nanomaterials (nanopowders, nanocarbons, nanofibres)	Nanocrystalline cellulose, carbon nanopearls, powders for 3D printers
Metals, alloys and metal powders	High-precision machined parts, precision casts
Composites and advanced ceramics	Ceramic composite structures for the transportation industry, ceramic and composite products for construction
Functional coatings, sealants, thin films	Protective metal-ceramic coatings for aerospace and industrial components, coatings for construction
Biomaterials	Bioplastics, bacteriophages and other living materials, products incorporating organic matter (concrete, fibres, composites, etc.)
Concrete and engineered wood	Advanced concrete, timber and engineered wood
Semiconductors	Semiconductors
Glass	Lenses for glasses, windows for buildings and transportation equipment, laboratory materials
Natural and high-performance fibres	Cellulose filaments, natural fibres

¹³ Some of this information comes from the companies that answered the confidential survey (86 out of 340 businesses).

Table 6
Overview of products in the semi-finished/finished products category¹⁴

Source: Database of the companies surveyed by E&B DATA, 2017

Types	Subtypes	Examples of products
	Transportation components	Landing gear, engines, aerostructures
Electronic, optical, and electrical systems and subsystems	Other electronic systems and subsystems	Control systems, GPS, barcode readers
	Imaging	Miniaturized cameras, medical imaging, night-vision cameras, infrared cameras, 3D scanners
	Batteries and fuel cells	Electric vehicle batteries
Electronic, optical and electrical components	Sensors	Motion sensors, optical sensors, distance sensors
	Other electronic and optical components	Lasers, transducers, transceivers, microcircuits, fibre optics
Biocompatible materials (including orthotics and prostheses)		Dentures, prostheses, orthotics, skin diffuser masks, tissue repair devices
Packaging		Food packaging, high-density packaging (electronics)
Smart technical textiles		Uniforms with RFID chips, sensor-equipped clothing (physical metrics), heated coats
Other semi-finished/finished products		Valves, industrial vacuum cleaners, hospital beds

¹⁴ Some of this information comes from the companies that answered the confidential survey (86 out of 340 businesses).

Table 7
Overview of products in the processes and instrumentation category¹⁵
Source: Database of the companies surveyed by E&B DATA, 2017

Types	Examples of products
Additive manufacturing	Transportation components, prototyping, 3D printer manufacturing
Characterization instruments	Forensic technologies, gas, odour and dust monitors, microbiological testing
Modelling and simulations	Flight simulators, 3D modelling

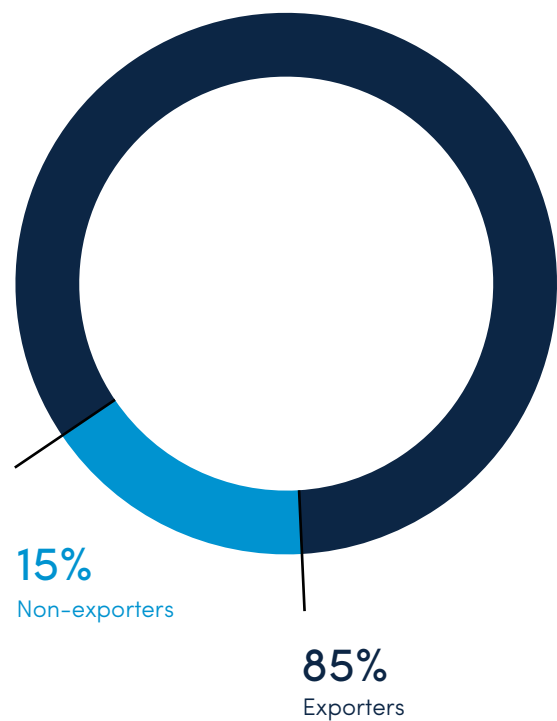
EXPORTS

According to the survey of companies working in the advanced materials sector, the majority (85%) export their products and services (Chart 13). Although the propensity to export is high even among small businesses, those with over 100 employees are more likely to export than smaller businesses. Generally speaking, the proportion of exporters increases along with the size of the company. Among very small businesses, the percentage is 65%, among small businesses it is 85%, while for medium-size and large businesses, it is 100%.

The data gathered indicate that Quebec exporting companies generate over half of their revenues from markets outside Canada. Although Quebec is a marginal player on the international scene, it is nonetheless active in international networks, as its export activities make clear.

In fact, although Quebec lags far behind other industrial powers in terms of inputs (e.g., funding, pools of researchers), it would appear that, in terms of outputs, Quebec’s industry is quite competitive, given its participation in certain international networks (strong exports).

Chart 13
Companies who export
Source: Database of the companies surveyed by E&B DATA, 2017



¹⁵ Some of this information comes from the companies that answered the confidential survey (86 out of 340 businesses).

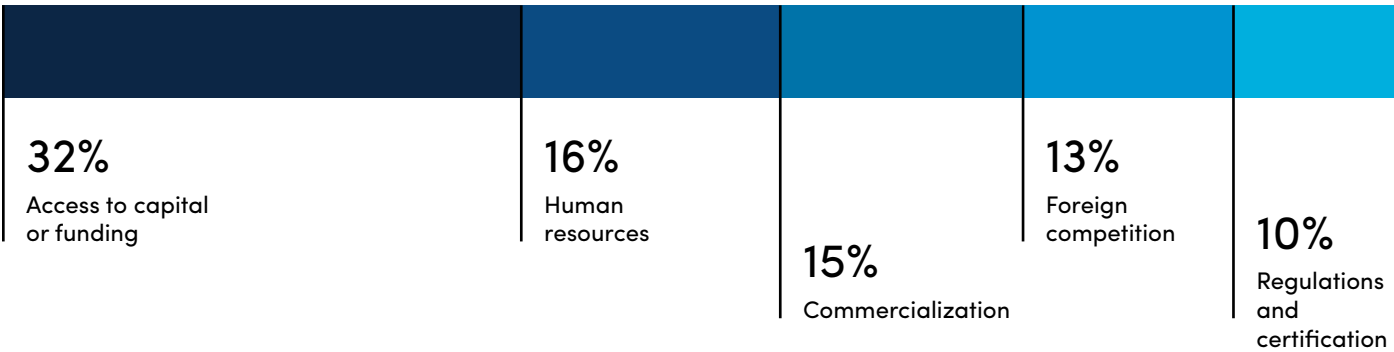
PRIMARY BARRIERS TO GROWTH

Access to funding

Although the industry appears dynamic, there are some barriers impeding the innovation capacity, growth and performance of companies. Generally speaking, finding access to funding is a major challenge for businesses working in the advanced materials sector; it is the top barrier (32%) listed by the companies surveyed (Table 8). The problem is even more prevalent among very small and small businesses, where lack of financing is the primary impediment to development for nearly half (46%) of such companies. Among the major funding constraints experienced by businesses of all sizes are access to financial assistance for investment projects (37%) and the availability of research and development grants (30%). The lack of financial resources to support investment projects illustrates the need for funding dedicated to de-risking technologies and markets.

Table 8
Primary barriers to growth*

Source: E&B DATA survey, 2017



* 14% can be attributed to other obstacles

Recruitment of qualified personnel

The other main problem limiting the growth of companies in the advanced materials sector is the lack of qualified personnel (16%). In fact, nearly 38% of the companies surveyed believe that the inability to recruit production staff is an obstacle to their growth. The difficulty of finding qualified production staff (31%) is also considered a major obstacle. Problems recruiting qualified personnel are most acute among medium-size businesses. This situation underscores the importance of cutting-edge equipment platforms with regard to supporting advanced materials companies in training, staff qualifications and innovation awareness.

Other obstacles

Finally, other obstacles to the development of the industry are commercialization (for 15% of those surveyed), foreign competition (13%), and regulations and certification (10%).





5

CONCLUSION

A BOOMING STRATEGIC INDUSTRY

This portrait provides an initial overview of this booming sector by highlighting international trends that will influence the demand for advanced materials. It reveals the challenges and opportunities present throughout the value chains, while demonstrating the undeniable potential and importance of these materials in the technological development of Quebec industries.

Advanced materials are used in many products and processes, giving Quebec an edge that enables it to stand out from the competition.

DEMAND: QUEBEC'S ADVANTAGES

Quebec has an advantage in several sectors with high potential demand, notably transportation equipment, where companies are investing heavily in industrial research. Another promising sector with a large structural demand is Quebec's energy sector. However, demand in the ICT sector, usually one of the primary markets for advanced materials, is less developed.

THE CROSS-SECTOR NATURE OF ADVANCED MATERIALS

Although some sectors in particular do offer advantages, the cross-sector approach that characterizes advanced materials development in Quebec is a strength that should be leveraged.

That being said, even though it is pertinent to use a non-restrictive, non-compartmentalized approach, the most promising sectors appear to be energy, transportation and advanced manufacturing, given current levels of knowledge, locally and globally, about advanced materials.

BETTER UNDERSTANDING OF INTERNATIONAL MARKETS

This initial analysis has provided context for the international trends that will drive technological advances and affect the advanced materials ecosystem.

¹⁶ Structural demand: demand created by large businesses whose requirements and scope of supply offer suppliers innovation and growth potential.

The purpose of this overview of global issues was to help Quebec companies better understand potential markets. The next step for PRIMA Québec could be a more in-depth look at the international knowledge base to more accurately target certain promising applications.

ADVANCED MATERIALS AND CO-CREATION

In line with the observed rationale for developing new advanced materials, the goal of the innovation approach is to incorporate them directly into complete solutions (Figure 5). This advanced materials development dynamic advocates for a collaborative development approach and co-operation among stakeholders in the field of advanced materials. To this end, PRIMA Québec, a hub of collaborative R&D in Quebec, will play a defining role in establishing these strategic networks.

PUBLICATIONS AND PATENTS

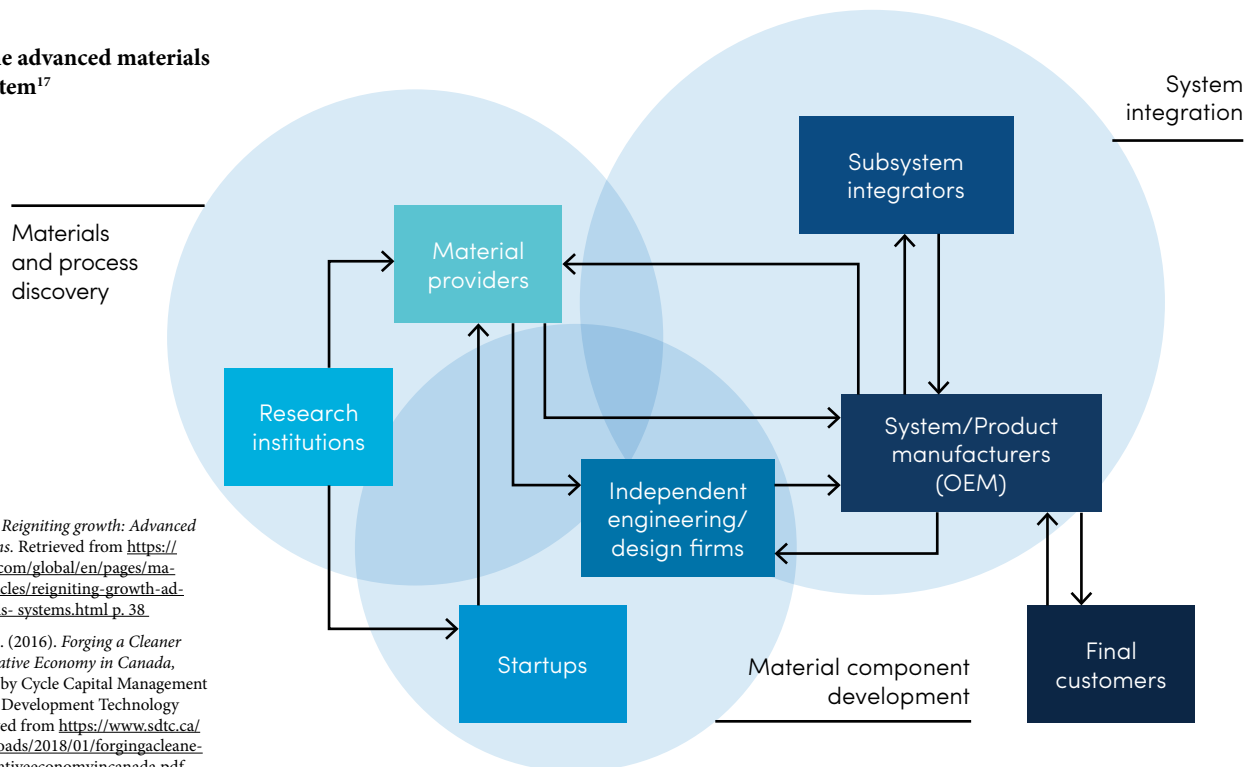
Quebec seems to be one of the few provinces that has specifically targeted advanced materials as a strategic innovation sector and where the government is willing to support the funding of collaborative research between private companies and public research centres. That being said, Quebec would benefit from

a more thorough documentation of certain elements, such as advanced materials publications and patents. Among other benefits, an analysis of publications will provide a clearer picture of research findings and existing partnerships among researchers. An analysis of patents, on the other hand, can help determine whether the inventions created in Quebec benefit Quebec-based companies or foreign businesses, clarifying exactly who profits from the expertise developed in Quebec. Finally, as was done in a recent study on the cleantech sector,¹⁸ it would be interesting to analyze the rate of conversion from publications to patents in the wide-ranging advanced materials sector.

THE FUNDING CHAIN

Access to funding is still the primary barrier noted by companies. To support this key economic sector, financing must be available throughout the innovation chain to help the companies in this industry commercialize their innovations. Quebec has a core of industries that are pushing the boundaries of innovation and taking technological risks. The sector still requires public policies more firmly committed to this industrial ecosystem and a framework that encourages business investment.

Figure 5
Overview of the advanced materials systems ecosystem¹⁷



¹⁷ Deloitte (2013). *Reigniting growth: Advanced Materials Systems*. Retrieved from <https://www2.deloitte.com/global/en/pages/manufacturing/articles/reigniting-growth-advanced-materials-systems.html> p. 38.

¹⁸ Duruflé, G. et al. (2016). *Forging a Cleaner and More Innovative Economy in Canada*, study produced by Cycle Capital Management and Sustainable Development Technology Canada. Retrieved from <https://www.sdtc.ca/wp-content/uploads/2018/01/forgingacleane-randmoreinnovativeconomyincanada.pdf>



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6

APPENDICES

APPENDIX 1

Members of the Steering Committee

Nicolas Bourque

Industrial Development Advisor

Industrial Products Division

Ministère de l'Économie, de la Science et de l'Innovation

Éléna Di Francesco

Industrial Technology Advisor

Industrial Research Assistance Program

National Research Council of Canada

Patrick Desjardins

Full Professor and Director,

Engineering Physics Department

École Polytechnique de Montréal

Martin Doyon

Director

Networking and Industrial

Partnerships Division

Ministère de l'Économie, de la Science et de l'Innovation

Pascal Drouin

Junior Partner

Cycle Capital Management

Marie-Pierre Ippersiel

President and CEO

PRIMA Québec

Michel Lefèvre

Principal Advisor

PRIMA Québec

René Poirier

Senior Economist and Analyst

Strategy and Innovation Policy Sector -

Innovation, Science and Economic

Development Canada

APPENDIX 2

Examples of companies active in the advanced materials sector



5N Plus is a leading producer of special metals and chemicals. The company operates closed-loop recycling facilities and its products are critical precursors and key enablers used in a number of industries such as clean energy, electronics, security and sensing.

www.5nplus.com



ACSYNAM custom manufactures absorbent materials called metal-organic frameworks (MOFs). MOFs are ideal for carbon dioxide sequestration, the storage of clean fuels like hydrogen, as well as the encapsulation and delivery of biologically beneficial molecules.

www.acsynam.com



AddUp offers its customers reliable, complete industrial metal 3D printing solutions.

www.addupsolutions.com



AEPONYX designs and manufactures optical semiconductor chips for cloud computing. It is building the fastest, most affordable and energy-efficient micro-optical switches by combining planar micro-electro-mechanical systems (MEMS) and silicon photonics.

www.aeponyx.com



Alserna conducts R&D and marketing in laser sensors, monitoring, RFID security systems, industrial automation, electronic components, environmental control and devices.



AMEC Usinage machines small and medium-size precision parts for its clients, providing impeccable quality, competitive delivery times, and extraordinary personalized service.

www.amecusinage.com



ANRis Pharmaceuticals has developed a non-liposomal nanoparticle delivery technology that can be tailored to deliver its RNA payload to a variety of tissues and organs other than the liver. The ability to target other tissues and organs is extremely limited and currently not possible with liposomes.



Arkema Canada operates a plant in Bécancour that produces 35%, 50% and 70% hydrogen peroxide solutions. Manufactured using leading-edge technology, these products are used as bleaching or antiseptic agents in a wide variety of industries like pulp and paper, mining, metallurgy, and the environment sector.

www.arkema.ca



AS Composite is dedicated to manufacturing thermoplastic-based composite sandwich panels using a patented innovative automated process. In addition to panel fabrication, the company is actively involved in R&D, prototyping, testing, process design and the manufacturing of inherent machinery.

www.ascomposite.com



Axis Photonique Inc. develops and manufactures scientific instruments for the study of ultrafast events in physics and chemistry. It offers unique tools like ultrafast streak cameras developed for time-resolved spectroscopy and electro-optical systems for the shape-control of ultrashort laser pulses.

www.axis-photon.com



At BASF, we create chemistry for a sustainable future. We combine economic success with environmental protection and social responsibility. Through research and innovation, we support our customers in nearly every industry in meeting the current and future needs of society.

www.basf.com



For over 80 years, Bauer has been supplying innovative hockey equipment, notably sticks, gloves, shin guards, helmets, skates, base layers, bags and clothing.

www.bauer.com



An industry-leading producer of commercial and military vertical-lift aircraft, Bell Helicopter produces the majority of commercial helicopter lines. It has an internationally renowned expertise in airframe design, product development, and composite parts manufacturing.

www.bellhelicopter.com



BHS Composites designs and builds large mid-size parts for the flight simulator, aeronautics, transport, defence and urban furniture markets. The company is recognized for its mastery in combining different materials such as fibreglass, carbon fibre and aluminium in order to create parts with complex shapes.

www.compositesbhs.com



Bombardier is a global leader in the transportation industry, creating innovative and game-changing aircraft and trains. Our products and services provide world-class transportation experiences that set new standards in passenger comfort, energy efficiency, reliability and safety.

www.bombardier.com



BRP is a world leader in the design, development, manufacturing, distribution, and marketing of motorized recreational vehicles.

www.brp.com



Cascades produces, converts and markets packaging and tissue products that are composed mainly of recycled fibres.

www.cascades.com



CelluForce is the world leader in nanocrystalline cellulose (NCC), a material used in various applications like drilling fluids, paints, adhesives and electronics. The company produces high-quality NCC at its plant in Windsor, Quebec.

www.celluforce.com



Euclid Canada is a leader in the field of admixtures and fibres used in concrete. Euclid Canada also produces a full range of products for the construction and repair of concrete structures.

www.euclidchemical.com



Excellence Composites is a composite parts and components manufacturer specializing in simultaneous manual and automated spray-up processes and injection moulding.

www.excellencecomposites.com



Fablab Inc. offers clients 3D printing services on industrial printers, as well as a 3D scanning service.

www.fablabinc.com



FDC Composites Inc. is a manufacturer specialized in value-added built-to-print composite parts and assemblies, primarily for the transportation industry (aviation and rail).

www.fdccomposites.com



Felix Compounds creates and produces thermoplastic elastomers (TPE, TPR, TPO), reinforced thermoplastics, expanded elastomers and engineering plastic compounds.

www.felixcompounds.com



few-cycle Inc. has expertise in the research and development of optical technologies for high-energy, ultrashort pulse lasers, featuring a novel laser amplification scheme. It provides customized upgrade schemes for existing ultrashort pulse lasers and innovative optical systems.

www.few-cycle.com



FPInnovations is a not-for-profit world leader that specializes in the creation of scientific solutions in support of the Canadian forest sector's global competitiveness and responds to the priority needs of its industry members and government partners.

www.fpinnovations.ca



Génik provides complete automated assembly and custom-made robotic solutions with added value to manufacturing industries experiencing multiple production challenges. Its solutions integrate the manipulation of complex forms and the advanced technologies of artificial vision, spectroscopy, and surface laser treatment.

www.genikinc.com



NanoXplore is a graphene company that manufactures and supplies high-volume graphene powder for use in industrial markets. It has extensive expertise in carbon chemistry and the industry experience needed to develop innovative customer solutions.

www.nanoxplore.ca



Zodiac Aerospace is a world leader in aerospace equipment and onboard systems for commercial, regional and business aircraft as well as helicopters. Zodiac Aerospace is also a key player in air safety and teletransmission.

www.zodiacaeospace.com



Gurit Americas Inc. has established itself as a developer and innovator in the composites industry and is now the leading global supplier of composite materials, engineering services, tooling equipment, and select parts and systems.

www.gurit.fr



Hutchinson Aeronautics & Industry is active in the design, industrialization and manufacture of composite and thermoplastic products for applications in aerospace, transportation and industry. It uses low-pressure curing and light RTM for composites as well as thermoforming techniques.

www.hutchinsonna.com



For over 50 years, we, at TIBO, have developed an expertise in plastic injection and compression moulds, particularly in the automotive field. With an established network on several continents, we have technical and industrial expertise in the design, manufacture and maintenance of moulds.

www.tiboglobal.com



In addition to being the largest global IT services and consultancy company, IBM is also a world business and technology leader, innovating in research and development and shaping the future of society at large.

www.ibm.com



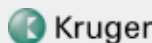
Brilliant Matters is a leader in the design and manufacture of polymer materials for applications in printable electronics. Following a successful first round of investment, the company has been able to continue its growth and increase its competitiveness in the field of solar energy.

www.brilliantmatters.com



Hydro-Québec has the largest research centre (IREQ) of any electric utility in North America. The IREQ team is made up of approximately 500 people who pool their efforts and expertise to support Hydro-Québec in every facet of its operations, from electricity generation to consumption.

<http://www.hydroquebec.com/innovation/en/institut-recherche.html>



Kruger turns renewable resources into sustainable, high-quality essentials made for everyday life.

www.kruger.com



KWI offers a host of polymer solutions, with a catalogue of products that number in the thousands, made from both virgin and recycled materials such as thermoset, thermoplastic, elastomer and rubber polymers.

www.kwipolymers.com



Logistik Unicorp delivers uniform programs to a diverse clientele of corporate and governmental organizations using its innovative «Managed Services» approach.

www.logistikunicorp.com



Lubricor supplies cutting equipment and precision and instrumentation tools to companies in Quebec and the rest of Canada. The company's main areas of expertise are aeronautics and aerospace, and it has developed efficient, sustainable solutions in collaboration with well-known suppliers.

www.lesoutilslubricor.com



MDS Coating Technologies Corporation (MCT) designs and produces metallic-ceramic protective coatings for aerospace and industrial components, including erosion and corrosion resistant coatings for gas turbine compressor parts.

www.mdscoating.com



Metal 7 designs and manufactures high performance equipment that improves processes and increases overall productivity for its international customers. The company stands out in the industry for its unique expertise in material and surface engineering and the enhanced performance of the materials used.

www.metal7.com



M.I. Integration is the ideal partner for global motor vehicle sub-assembly manufacturers searching for world-class suppliers of injected component moulds.

www.mi-integration.com



MPB Technologies develops high tech products in the fields of advanced materials, telecommunications, photonics and optics.

www.mpb-technologies.ca



Nanogrande has developed and manufactures the world's first nanoscale 3D printer using metal powder and its consumables. Its additive manufacturing devices are used for prototyping and the production of complex parts in a wide variety of materials requiring great precision.

www.nanogrande.com



NanoPhyll develops, produces and sells graphene composites for photoactive applications, bringing clean technologies to the energy, construction and transport sectors.

www.nanophyll.ca



OEC is a trusted partner with a deep understanding of photon counting detectors and applications. We supply products from Micro Photon Devices, PicoQuant and Quantum Opus.

www.optoelectronics.com



Ortho Regenerative Technologies Inc. is an orthopaedic biotechnology company that develops novel therapeutic tissue repair devices to dramatically improve the success rate of sports medicine surgeries.

www.orthorti.com



PCM INNOVATION provides fully integrated engineering and tooling solutions to industry. It designs and manufactures assembly lines, fixtures, moulds for advanced composites and high-precision machined parts for customers in the aviation, space and transportation sectors.

www.pcminnovation.com



Performance BioFilaments Inc. optimizes and customizes cellulose filaments, also known as nano-fibrillated cellulose (NFC), to enhance the strength, rheology, and other key properties of polymers and elastomers, concrete and cement, nonwoven materials, and industrial fluids in a variety of specialized applications.

www.performancebiofilaments.com



Photon Etc. produces optical instrumentation using patented fibre Bragg grating (FBG) technology. Its main products are tunable filters, infrared cameras and hyperspectral imaging systems.

www.photonetc.com



PLASMIONIQUE Inc. is a research and development company specialized in developing and commercializing processes and tools with plasma, laser and vacuum based technologies, along with tools for surface engineering, advanced material synthesis and nanotechnology applications.

www.plasmionique.com



A leader in the North American injection moulded plastic industry, Plastiques Moore designs and manufactures small and medium-size high-precision parts for the medical, military, automotive and industrial sectors.

www.plastiquesmoore.com



PO-Laboratories is a modern, multidisciplinary laboratory and contract research organization (CRO) offering a broad spectrum of analytical and consulting services to international industries and government agencies.

www.po-labs.com



Polycontrols specializes in integration, calibration and instrumentation. We are a fully accredited ISO/IEC 17025 fluids testing and calibration laboratory in Canada and have developed advanced expertise in the integration and automation of thermal spray applications.

www.polycontrols.com



Pratt & Whitney Canada (P&WC) is a global aerospace leader, shaping the future of business, helicopter and regional aviation with new generation engines. The company also offers advanced engines for industrial applications.

www.pwc.ca



Pultrusion technique is a major player in the development of fibre-reinforced polymer (FRP) composites. Protected by numerous patents, its products are the most efficient, robust, resistant, durable and cost-efficient in the world, and serve diverse industries (mining, petroleum, transportation, construction and electricity).

www.pultrusiontech.com



QPS Photonics specializes in condition monitoring solutions, like detecting a problem in a wind turbine motor, for example, with the help of its VibroFibre invention. This fibre gratings cavity device is used in its Motor Guard and Turbine Generator Guard solutions to monitor and trend end-winding vibration in large power generators while also monitoring partial discharge events in transformers and circuit breakers.

www.qpscom.com



To take complex projects from the drawing board to real life, one needs close partnerships focussed on recognized injection expertise, moulding processes tailored to the project, and rigorous manufacturing that meets the most stringent quality standards. QUÉPLAST is a trusted partner with the creativity and dedication needed for success.

www.queplast.com



Rackam offers a complete solar energy production solution for industrial and commercial clients. With the help of its parabolic solar concentrators, the company can provide the equivalent of a perfectly autonomous solar kettle capable of generating energy on-demand when the sun is out.

www.rackam.com



Raymor produces very pure and highly graphitized single-wall carbon nanotubes and graphene. Both products can be used in many fields of application like conductive inks, lithium-ion battery anodes, the electronics sector and conductive plastics.

www.raymor.com



RMC is a solutions-driven, client-oriented manufacturer of moulded plastic and composite parts and assemblies. The core of RMC's strategy: avoid direct competition with large, vertically integrated competitors by developing technologies, product designs, and new manufacturing concepts.

www.renecorp.com



Rio Tinto Fer et Titane (a wholly-owned subsidiary of Rio Tinto) is one of the leading manufacturers of raw materials for the titanium dioxide markets and a world leader in the production of high purity metal powders and pig iron.

www.riotinto.com



OEMs operating assembly lines recognize Roski as one of the most reliable quality manufacturers of composite components. For over 50 years, the Roski factory has been true to its reputation for reliability and commitment in the composite industry.

www.roski.com



S.E.C. Papier Masson WW is a member of the White Birch Paper group. Located in Gatineau, Quebec, the Papier Masson mill produces some 250,000 metric tons of newsprint annually. A pulp drying and packaging line is being built to make high-quality, low-cost wood fibre for the production of biocomposites.

www.whitebirchpaper.com



Shawinigan Aluminium Inc. manufactures aluminium alloy billets (2000 to 7000 series), with diameters ranging from 3 to 10 inches. With an annual volume of 50,000 metric tons, the company is active in the primary aluminium processing sector.

www.shawinigan-aluminium.com



Sigma Energy Storage's scalable Hybrid Thermal-Compressed Air Energy Storage (HT-CAES) technology is a clean technology that helps reduce fossil fuel consumption and facilitate the adoption of intermittent renewable energy sources such as wind, solar, and tidal power.

www.sigmaenergystorage.com



Founded in 1995, SiliCycle® Inc. is a world leader in the development, manufacturing and commercialization of high value ultra pure silica gels and specialty products for chromatography and analytical and organic chemistry.

www.silicycle.com



SK Nano specializes in the synthesis of nanoparticles of gold, silver, copper and platinum/palladium for the fields of biotech, medtech, pharma, cosmetics, natural health products, 3D metal printers, textiles, etc.



Soleno's mission is to design, manufacture and distribute high quality, primarily HDPE, products for controlling and managing storm water. Its expert team can solve problems related to collecting, conveying, treating and storing storm water.

www.soleno.com



Soucy Composites is a compression-moulding expert that produces a variety of thermoset composites (BMC & SMC), prepreg sheets and sandwich panels. Soucy Composites also specializes in the polyurethane injection moulding of integral skin components.

www.soucycomposites.com



Soucy Techno Inc. specializes in the production of rubber compounds. The company's facilities can produce up to 30 million kilograms of rubber compounds annually, which are used to manufacture a vast range of rubber products such as conveyor belts, gaskets, automobile parts, and tracks for snowmobiles and industrial vehicles.

www.soucytechno.com



SphèreCo Technologies is a Quebec startup specialized in advanced thermoplastic additive manufacturing to make tools for the manufacturing industry. The company uses 3D printing to provide economic solutions to meet the current challenges facing industry.

www.sphereco.ca



Sport Maska Inc. is one of the world's largest designers, manufacturers and marketers of hockey equipment. CCM Hockey uses cutting-edge innovation to create the highest performance hockey equipment.

www.ccmhockey.com



Stedfast Inc. is a leader in manufacturing value-added laminated and coated textiles. The company offers on-site technical support and laboratory testing for all of its products, which are used for various applications, including chemical and biological weapon resistant textiles.

www.stedfast.com



Tecnar develops, manufactures and markets advanced sensors to manage and optimize industrial processes.

www.tecnar.com



Tekna specializes in the development, manufacture and sale of advanced material powders and integrated plasma systems. The company produces high-quality metal powders that meet the performance criteria of the most demanding applications and are primarily used in the fields of additive manufacturing and microelectronics.

www.tekna.com



Verbom specializes in sheet metal forming using high-performance press tools. The company has developed an aluminium thermoforming technology that offers the transportation sector the ability to manufacture and use very geometrically complex parts and reduce the weight of assemblies while increasing quality.

www.verbom.com



Texonic specializes in the R&D and production of high-performance reinforcement fabrics used for woven composites and ballistics weaves. Natural fibres and specialty fibres of carbon, S2 and E glass, basalt, aramid (Kevlar™), high-modulus polypropylene and liquid crystal polymers are among the fibre reinforcements regularly used.

www.texonic.net



Titan Sécurité is a Quebec-based company founded in 2012 and run by professionals with over 20 years of experience in the field of security. Active in Greater Montreal, the company offers its clients a wide range of customized security solutions.

www.titansecurite.com



Two-Photon Research is shaping the future of III-V materials for industrial and commercial applications by designing, manufacturing and micropackaging micro LEDS, drive electronics and multilevel substrates.

www.twophotonresearch.com



Umano Medical specializes in the production of medical equipment and hospital furniture. The company has extensive expertise in the development of metal-based components and equipment for medical applications.

www.umanomedical.com



Velan is one of the world's leading manufacturers of industrial steel valves, recognized as a standard-bearer in quality and innovation. The company continues to leverage its advanced engineering and innovation capabilities to create hard-working valves that meet critical industrial needs in the areas of power generation, chemicals and petrochemicals, oil and gas, etc.

www.velan.com

Examples of businesses outside Quebec
that are working with Quebec companies
on collaborative innovation projects



Primary research partners



