

**NRC-CNRC**

# FROM DIALOGUE TO ACTION, EXCELLENCE TO IMPACT

●●● NRC Strategic Plan 2019-2024



National Research  
Council Canada

Conseil national de  
recherches Canada

Canada

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**A BETTER  
CANADA  
AND WORLD  
THROUGH  
EXCELLENCE  
IN RESEARCH  
AND  
INNOVATION**



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## EXECUTIVE SUMMARY

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For more than a century, the NRC has evolved continually to build and maintain a leadership role in the Canadian science, technology, and innovation ecosystem in three core areas: advancing scientific and technical knowledge; supporting business innovation; and providing science-based policy solutions for government.

Today, operating within the broad frame of the Government of Canada's Innovation and Skills Plan we are working as Canada's largest federal research and development organization to adapt our approach to tackle the world's most pressing challenges, such as climate change, aging populations and economic crises, and to capitalize on the opportunities presented by the digital economy and disruptive technologies. Leveraging the NRC's excellence in research and innovation will result in our continued contributions to national prosperity and the well-being of all Canadians.

As we move towards 2020, we are presenting a new five-year strategic plan that builds on the extensive community consultations we undertook in the NRC Dialogue process in 2016 and the resulting "reimagining" of the NRC as an organization. Our plan is firmly grounded in a range of strategic platforms that enhance our three core roles, reinforce our research strengths, and better position us as a partner for new forms of collaboration with government, industry, and academia. Recent investments in these platforms are beginning to bear fruit and propel us forward:

**Infrastructure to support research excellence** • establishing the President's Research Excellence Advisory Committee and the Ideation Fund, and appointing the President's Science Advisor, Chief Science Officer, and Departmental Science Advisors.

**New collaborative R&D programs** • launching NRC Challenge Programs and various initiatives to support the industry-led superclusters.

**New collaboration centres** • various centres that co-locate researchers and equipment with universities, polytechnic institutions, and colleges to create hubs anchored in areas of emerging and leading-edge research.

**Revitalized facilities** • conducting a Facilities Review and working with federal partners on Laboratories Canada (LC).

**Better support for digital research** • appointing a Chief Digital Research Officer to manage the NRC's Digital Technologies Research Centre and creating a blended NRC-university digital research network.

**International partnerships** • developing an international strategy and delivering Canada's associate membership in EUREKA.

**A scaled-up Industrial Research and Assistance Program (IRAP)** • increasing funding to small and medium-sized enterprises (SMEs), launching a process for large value contributions up to \$10 million, and streamlining the service delivery system.

In developing this strategic plan, we asked experts across the NRC's broad mandate — our 14 research centres, IRAP, and the 13 corporate branches — to develop individual five-year strategic plans that adhere to assigned funding profiles and set realistic priorities and goals. Through this inclusive, bottom-up process, we have identified five overarching areas that will define the NRC's strategic focus for the next five years:

### Enabling a more sustainable economy •

Like the rest of the world, Canada must transition to a more sustainable economy to reverse the strains that modern life has placed on the environment. The NRC is well-positioned to support this shift with research on energy and the environment, natural resources, buildings and infrastructure, food, and transportation.

**Supporting a healthier future •** Canada faces similar health-related pressures to the rest of the world, including an aging population, re-emergence of infectious diseases, and food security. However, it must also address other issues such as health care in rural and remote areas and the unique needs of Indigenous communities. With a strong reputation for global scientific leadership in biologics and vaccine development, medical devices, and food production, the NRC is well-equipped to address these challenges.

**Innovating the everyday •** Digitalization and artificial intelligence, robotics and automation, sensors and Wi-Fi are changing the everyday lives of Canadians, unlocking economic opportunity, and bringing faster communications links and the features of networked electronic life to remote communities. The NRC has significant expertise in digital and other technologies that touch the daily lives of Canadians.

**Creating Canadian wealth through innovation •** Despite their importance to the Canadian economy, SMEs face an uphill battle to grow and thrive and, in some cases, to survive. With active support for SMEs through IRAP programs and other initiatives, the NRC will continue to be a driver of economic growth, jobs, and opportunities.

**Understanding our world •** Home to about 2,200 scientists, engineers, and technicians who contribute to science and engineering breakthroughs around

the world, the NRC brings deep and diverse expertise to bear on many of the fundamental questions and enabling technologies that will spur Canadian innovation in the future.

For each priority area, we have set two high-level goals and envisioned outcomes for the next five years, delivered through integrated, cross-NRC initiatives, mission-specific initiatives for our research centres, and a visionary “moonshot” that sets an ambitious but attainable goal for the future. We have also established a set of performance indicators to measure the impact of our work according to our three core roles, and to track and regularly report on our progress towards the 10 goals.

As a research and development organization, our compass should rightfully be calibrated with clear direction from the NRC’s greatest resource: the scientists, engineers, and technical experts who generate the cutting-edge work and the staff in our corporate branches who enable their successes. The successful implementation of our ambitious agenda also requires a strong emphasis on our people. To this end, we have also developed a new Strategic Human Resources Plan focused on talent development, transition, and attraction, and employee diversity and wellness. A highly-tuned capable organization allows us to push boundaries and maintain excellence in research and innovation.

We are confident that this comprehensive, bottom-up strategic plan strongly positions the NRC to help Canada effectively address global and national challenges over the next five years and beyond.

# STRATEGIC PLAN AT A GLANCE



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## ENABLING A MORE SUSTAINABLE ECONOMY

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### GOAL 1

Contribute to a cleaner future by reducing Canada's reliance on fossil fuel

### GOAL 2

Support R&D that encourages sustainability and protects against threats to our environment

### OUTCOMES

Alternative low-carbon sources of energy to fuel Canada's way of life while reducing greenhouse gas emissions

New technologies and approaches that lead to a more sustainable and environmentally friendly economic future for Canada



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## SUPPORTING A HEALTHIER FUTURE

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### GOAL 1

Adopt and advance leading-edge health technologies to create a healthier future

### GOAL 2

Develop innovative, affordable and sustainable approaches to food production

### OUTCOMES

Advances and insights that improve Canadians' health outcomes and well-being

Smart solutions to improve the efficiency and productivity of agriculture, aquaculture and bioresource development in Canada





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## INNOVATING THE EVERYDAY

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### GOAL 1

Achieve breakthroughs to bring greater efficiency to Canadian homes, workplaces and transportation networks

### GOAL 2

Develop and deploy next-generation solutions to everyday challenges

### OUTCOMES

More efficient homes, workplaces and transportation networks that improve Canadians' quality of life

Innovations that keep pace with the rapid technological change impacting our daily lives



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## CREATING CANADIAN WEALTH THROUGH INNOVATION

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### GOAL 1

Accelerate the start-up and commercialization of SMEs in Canada and help them to become the next generation of global multi-national enterprises (MNEs)

### GOAL 2

Supercharge Canadian SMEs to help them seize opportunities and expand their global reach

### OUTCOMES

More SMEs and better support for scale-up, leading to improved job creation and prosperity for Canada

More SMEs tied to global value chains, leading to a strengthened, diversified, Canadian economy



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## UNDERSTANDING OUR WORLD

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### GOAL 1

Dig deep into questions of fundamental science to spur Canadian innovation

### GOAL 2

Fuel the next generation of fast, secure communication networks

### OUTCOMES

Advanced knowledge from breakthroughs leading to a better, safer, more prosperous future for Canada

Fast, affordable, reliable internet connections throughout Canada, from coast to coast to coast

## MESSAGE FROM OUR PRESIDENT

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We are pleased to present you with the five-year strategic plan for the National Research Council of Canada (NRC). Guided by the Government of Canada's Innovation and Skills Plan, the NRC's leadership and staff developed this document, beginning with a comprehensive process of reflection on what the NRC should be doing within each part of the organization and ending with an integrated strategic agenda.

This process unfolded as it should have. As a research and development organization, our compass should rightfully be calibrated with clear input from the scientists, engineers, and technical experts who generate our cutting-edge work, and the staff in our corporate divisions who enable our successes.



It also rightfully builds on the foundation of a two-year internal consultation at the NRC called NRC Dialogue, which resulted in a range of actions to enhance

research excellence, improve collaboration and engagement, and renew our tools and processes.

Together, these two crucial pieces create the “how” of how the NRC conducts research and supports innovators — and makes a difference in Canada and the lives of Canadians.

The five-year integrated strategic plan that resulted from these complementary processes now turns to the “what” of our research and efforts to support business innovation in Canada. This work is guided by the NRC vision of a better Canada and world through excellence in these areas. Our plan sets out clear goals and actions to advance knowledge and apply leading-edge technologies in partnership with others to provide creative, relevant, and sustainable solutions to Canada's current and future economic, social, and environmental challenges.

In June 2019, I presented this strategic plan to the NRC's Council, distinguished representatives of Canada's industry and academic sectors charged with reviewing our strategic directions, overseeing our performance and providing a challenge function to our senior management. They endorsed the plan so that we could move forward with our budgets and operations, and I will go back to them in the months ahead on how we move forward as part of an evergreen process to ensure that the NRC continues to respond to the most pressing of Canada's evolving needs.

Canadians will feel the impact of the NRC's work in advances in key emerging technologies, progress against government challenges, and support for thousands of clients for their business innovation and technology objectives. These results, in turn, will allow us to focus further out on the NRC's evolving place in the innovation ecosystem and how best we can maximize our research excellence and impact over the longer term.

As my parting thoughts on this plan, I would like to acknowledge the many minds, ideas and hands it took to bring such a large and encompassing strategic plan to fruition. I offer a tremendous thank you to the NRC leaders, researchers and industrial technology advisers who gave their time and effort to this project. And along the same lines, I owe a great deal of recognition to the leadership of the NRC's Secretary General and his team for their great work in bringing the many parts of this plan into one cohesive strategy.

A handwritten signature in black ink, appearing to read "Iain Stewart".

**Iain Stewart**

President  
National Research Council Canada

## INTRODUCTION

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As Canada's largest federal research and development (R&D) organization, it is vital that the NRC plays a leadership role within the Canadian science, technology, and innovation (STI) ecosystem in key areas — advancing scientific and technical knowledge, supporting business innovation, and providing science-based policy solutions for government. For more than a century the NRC has been delivering in these areas, working collaboratively to face challenges and explore the possibilities they present — from economic opportunities to critical, societal needs — all the while focused on the well-being of Canadians.

Once again, the NRC is determining how best to tackle an evolving context, including challenges such as climate change, aging populations, and global economic crises, mixed with the opportunities presented by the digital economy and disruptive technologies. Emerging science and cutting edge innovations are rapidly redefining industry business models, research, lifestyles, community obligations, and societal needs, and the NRC must adapt to ensure the well-being of Canada and Canadians.

Tackling these challenges and leveraging these opportunities will require the NRC to build on its competencies and capabilities to ensure we keep pace with ever-changing environments and the advances in science and innovation around the world.

To inform strategic planning exercises across the NRC, we undertook a strategic environment scan of emerging research and development trends. This work pointed to five megatrends that will require particular attention in the coming years: climate change and other environmental pressures; changing demographics and health needs; rapid technological change; productivity, innovation and globalization pressures; and support for fundamental research.

This five-year strategic plan is an articulation of how we will leverage our resources to deliver on our key

roles within the Canadian STI ecosystem while helping Canada meet the challenges of our time.

It builds on the success of NRC Dialogue, which began in 2016 as a bottom-up, inclusive consultation aimed at re-imagining the NRC and ultimately involved external partners, key stakeholders and more than 3,000 NRC employees in advancing a bold agenda for change. This consultation led to a historic infusion of funding for the NRC and the development of new strategic platforms to drive research and innovation excellence, and position us as a partner for new forms of collaboration, nationally and internationally, to help address the challenges being faced by Canada and the global community.

However, where Dialogue sought to re-imagine the NRC, this strategic plan seeks to advance an action agenda that will leverage the NRC's excellence in research and innovation to deliver targeted impact for Canadians.

To determine the best areas for our efforts, we asked our own experts across the NRC's broad mandate — our 14 research centres, the Industrial Research and Assistance Program (IRAP) and the 13 corporate branches — to develop individual five-year strategic plans that adhere to assigned funding profiles, and set realistic priorities and goals. Through an inclusive, bottom-up process, these goals and priorities were used to develop five overarching areas that will comprise the NRC's strategic focus for the next five years.

The goals, actions and envisioned outcomes outlined for each of these areas of strategic focus set a robust plan for the NRC over the next five years — and one that should contribute greatly to Canada and the world. As we advance this plan, we will track our progress and measure our success against the NRC's three core roles: advancing scientific and technical knowledge, supporting business innovation, and providing science-based policy solutions for the federal government.



# THE NRC AT A GLANCE

## VISION

A better Canada  
and world through  
excellence in research  
and innovation.

## MISSION

To have an impact by advancing  
knowledge, applying leading-edge  
technologies, and working with other  
innovators to find creative, relevant,  
and sustainable solutions to Canada’s  
current and future economic, social,  
and environmental challenges.

## VALUES

Integrity  
Excellence  
Respect  
Creativity

## ORGANIZATIONAL STRUCTURE

NRC Council		President		Senior Executive Committee			
Chief Science Officer		President's Research Excellence Advisory Committee		President's Science Advisor		Chief Digital Research Officer	
Vice-Presidents Research				Vice-Presidents Corporate			
Transportation and Manufacturing		Engineering		Secretary General		Human Resources	
Life Sciences		Emerging Technologies		Business and Professional Services		Corporate Services and Chief Financial Officer	
Digital Technologies							
Vice-President Industrial Research Assistance Program (IRAP)							
IRAP							



# THE EVOLVING CONTEXT FOR THE NRC



Testing at the OCRE  
Research Centre helps  
design new coastal  
infrastructure to ensure  
sustainability, durability  
and improved resilience  
in future storm conditions,  
made worse by the  
effects of climate  
change on sea levels  
and weather patterns.





For more than a century, the NRC has actively advanced innovative scientific and technological solutions to address Canadian and global challenges. Through adaptation to Canada's harsh climate, the need for support during two world wars, the challenges of space exploration, and the ever-changing need for new medical treatments, the NRC has fulfilled its role to solve complex issues for Canada and the world.

A large part of the NRC's success in this role is due to the organization's strength in building teams and facilities around the areas of expertise needed to meet Canada's current scientific and technological needs. Historically, the NRC has then been able to deploy these teams and their resources to address the nation's challenges.

Now, as Canada and the world face increasing upheaval from emerging pressures, called megatrends, including climate change, growing population, urbanization, changing demographics, disruptive technologies, and increasing global business competition, the NRC is again poised to meet the challenges of environmental, social, technological, economic, and innovation change that will reshape how communities live, work, and plan for the future.

This strategic plan is intended to guide the NRC in the continuing evolution of our capabilities and expertise against the evolving context in which we find ourselves and the challenges we feel we can best address over the next five years. These challenges include creating a more sustainable economy, supporting a healthier future, innovating to improve the everyday, creating Canadian wealth, and understanding our world.

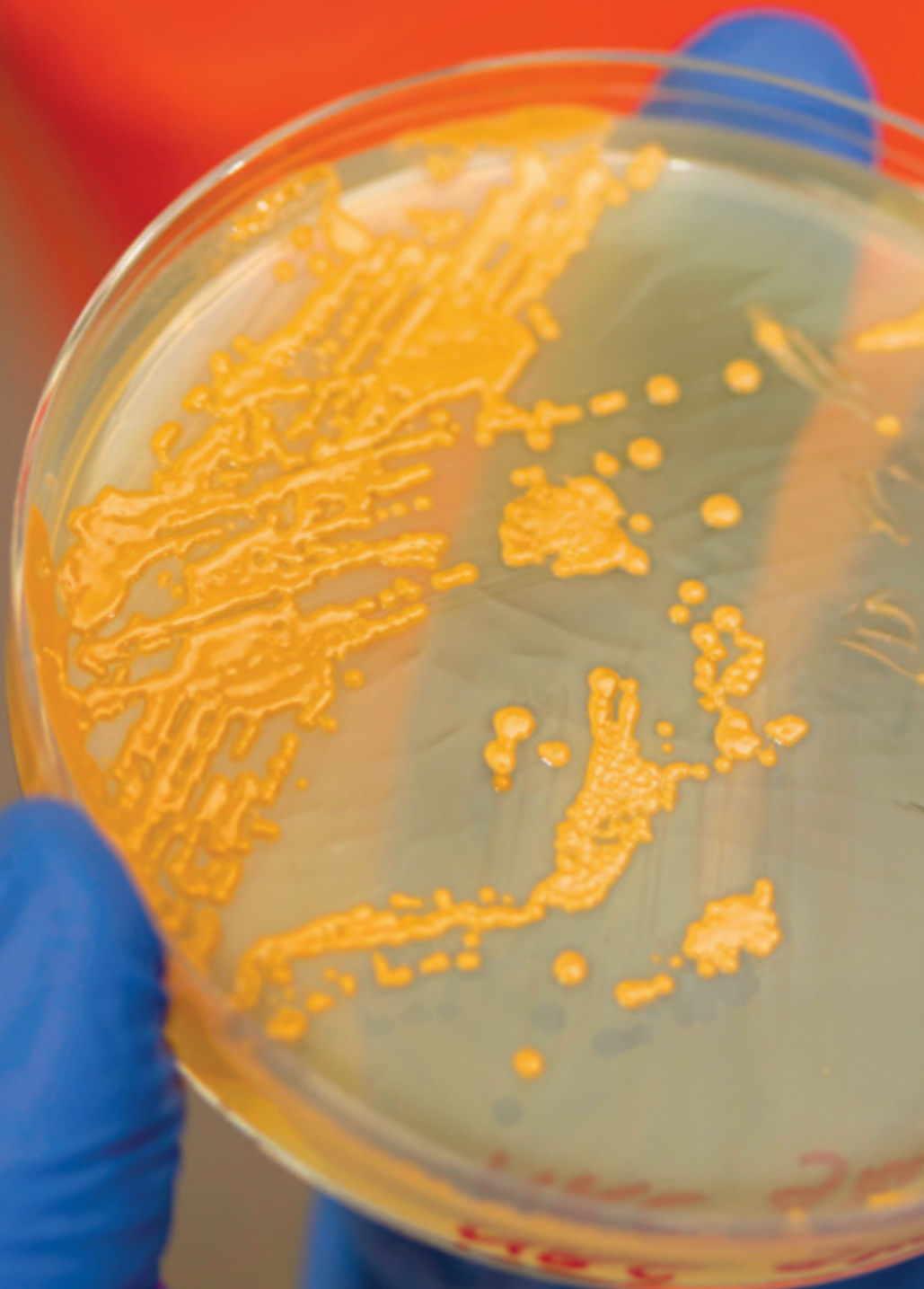
## **CLIMATE CHANGE AND OTHER ENVIRONMENTAL PRESSURES**

Climate change is a formidable challenge, with continuing documentation of links between greenhouse gases, rising temperatures and sea levels, extreme weather events, droughts, floods, wild-fires, and changes to biodiversity.<sup>1,2,3</sup> The World Economic Forum cites extreme weather events and the failure of climate change mitigation and adaptation measures in its top five 2019 risks in terms of both likelihood and impact to the economy.<sup>4</sup> To mitigate these effects, the Paris Agreement brings nations<sup>5</sup> together in a common cause to keep this century's global temperature gain below two degrees Celsius.<sup>6</sup> In Canada, the Pan Canadian Framework on Clean Growth and Climate Change sets a plan to meet the Paris commitments by reducing greenhouse gas emissions by 80 percent by 2050 (relative to 2005 levels) while also growing the economy and building resilience to adapt to a changing climate.<sup>7</sup>

In addition, the world's population is expected to reach almost 10 billion people by 2050,<sup>8</sup> of which about 50 percent will live in urban areas.<sup>9</sup> This shift is placing additional demand on natural resources and the environment well beyond city limits.<sup>10</sup> This challenge presents opportunity as demand has also increased for more sustainable products, less waste and pollution, and better natural resource management.

Dealing with these environmental pressures will mean using clean energy to power homes, workplaces, transportation, and industries. It will also mean building healthier and more comfortable homes that can generate as much power as they use or more; planning for more resilient infrastructure and ecosystems that can better withstand climatic changes; finding new ways to meet resource needs through re-use and recycling; and developing new approaches to cleaning up the legacy of past pollution.

Schizochytrium, a microalgae strain that is a rich source docosahexaenoic acid (DHA). DHA is widely used in the food and pharmaceutical industries because of its benefits to human health. In infants, DHA promotes visual and cognitive development. In adults, it helps prevent cardiovascular diseases and neuropsychiatric disorders. NRC research evaluated the use of inexpensive sources of carbon for strain growth and DHA formation to help reduce production costs.



## CHANGING DEMOGRAPHICS AND HEALTH NEEDS

The world is entering uncharted demographic territory as the aging population triggers a significant social transformation. By 2050, 10 percent of the world's population will be aged 80 and over.<sup>11</sup> In Canada, the proportion of seniors is expected to increase rapidly into the 2030s, when seniors could represent approximately 25 percent of the total population.<sup>12</sup>

The challenges created by this demographic shift will be felt across many sectors of the economy, affecting demand for goods and services including health care, food, housing, and transportation. Emerging science and technological innovations will be critical to how the world adjusts to the economic and social shifts associated with the impacts of the ever-increasing aging population.

At the same time, the world faces other threats to human health and well-being, including anti-microbial resistance, the spread of infectious disease, and diminished access to healthy food and clean water caused by poverty, conflict, urbanization, and climate change.<sup>13 14</sup> The promotion of food security and agricultural diversification, and the development of more resilient crop variants is becoming increasingly important.<sup>15</sup>

Technological advances can offer solutions to meet or manage these challenges. Robotics and neurosciences can help the elderly live longer, more autonomous lives. Smart vaccines can offer targeted protection against emerging and re-emerging diseases. Precision agriculture can maximize yields with less space, and food sensing technologies can extend shelf life while assuring food's quality.

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## Understanding the impacts of climate change



The Intergovernmental Panel on Climate Change (IPCC), the United Nations body that provides the world with an objective, scientific view of climate change, says the world can expect a two-degree (Celsius) increase in global average temperature before the end of the century, and further increase if carbon dioxide emissions are not substantially reduced.

With a two-degree increase, the world can expect more erratic and extreme weather events, pronounced impacts on ecosystems, changes in arable land and crop productivity due to pests and diseases, and a new imperative to manage other challenges such as higher summer temperatures, drought, and rising sea levels.

The NRC needs to better understand these possible major transitions and what they mean for Canada, specifically our built environments, food sources, health and management of disease, and management of water.

Over the next five years, the NRC will strengthen our research efforts to assist Canadians in reducing carbon emissions and preparing mitigations against the negative impacts of climate change. We will determine how to expand our knowledge of specific anticipated climate-related changes and focus our expertise and research on helping Canadians to address climate change related issues and risks.

Our current work for Infrastructure Canada on updating the National Building Codes in anticipation of more extreme weather and our work on new drought resistant wheat are two excellent examples of how the NRC can help Canada prepare.

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## New federal government funding and expectations for the NRC in 2018



When the federal government announced an additional \$258 million in ongoing annual funding for the NRC in Budget 2018, it envisaged the organization as the centre of research excellence and collaboration in Canada. This boost in financial support includes investments of \$108 million per year in the NRC's research and development capacity and \$150 million per year in IRAP.

This unprecedented investment in the NRC helped solidify the organization's foundation and provided new opportunities to support the government's Innovation and Skills Plan. In specific budget allocations and directions from federal ministers through mandate letters, the NRC was directed to be active in three areas: building science and technology (S&T) ecosystems, growing innovative small and medium-sized enterprises (SMEs), and investing in people and skills.

To build S&T ecosystems, the NRC was asked to provide support for the government's Superclusters Program; mobilize teams of NRC researchers, industry, and other collaborators to tackle large challenges facing the nation; and institute small teams of NRC and university researchers to work on smaller challenges in disruptive research areas. The NRC was also tasked with creating collaboration centres with leading university teams in areas of emerging and cutting-edge research through internal reallocation and co-location of NRC researchers and equipment.

To grow innovative SMEs, Budget 2018 included IRAP as one of the four flagship platforms of the Canadian innovation ecosystem (IRAP, the Strategic Innovation Fund, the Trade Commissioners Service and the regional development agencies). The NRC was also directed to increase the maximum IRAP contribution up to \$10M per project to support firms with high growth potential.

To invest in people and skills, the NRC was included as an active partner in four of five science clusters under Laboratories Canada (LC). The NRC was also asked to increase efforts to promote a diverse workforce, and to provide S&T training to students, including a reinvigorated program to hire post-doctoral fellows.

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## RAPID TECHNOLOGICAL CHANGE

Digital transformation is fueled by disruptive technologies such as AI, data analytics, and the Internet of Things (the interconnection via the internet of computing devices embedded in everyday objects, enabling them to generate and analyse data) which are changing the way the world manufactures, travels, shops, accesses information, and spends leisure time. They are also creating new jobs and new approaches to completing work and improving productivity that have not yet been imagined.<sup>16</sup>

As the Internet of Things accelerates, more and more devices are being created with sensors, computing devices, and Wi-Fi capabilities, and by 2030, it could add \$14 trillion to the global economy and revolutionize everyday life. For Canada, this potential is particularly relevant, given that Canada spends the most time online of any country on a per capita basis, and the number of Internet of Things home devices in Canada is forecast to grow by almost 60 percent between 2017 and 2021 alone.<sup>17 18</sup>

Digitization in all sectors is also accelerating product and service development, and changing how offerings are designed and delivered.<sup>19</sup> Business models are evolving, embracing open science and innovation, pay-per-use models over technology acquisition, and services as industries in themselves. New needs for digital currencies and heightened cybersecurity are also opening up new industries that keep pace with new threats.

As digital technologies drive future economic growth, regulatory environments will struggle to keep up with the pace of change. These lags will affect the application of artificial intelligence (AI), digital economies, and genetic modification in particular, and may ultimately restrain technology adoption and business opportunities.<sup>20</sup>

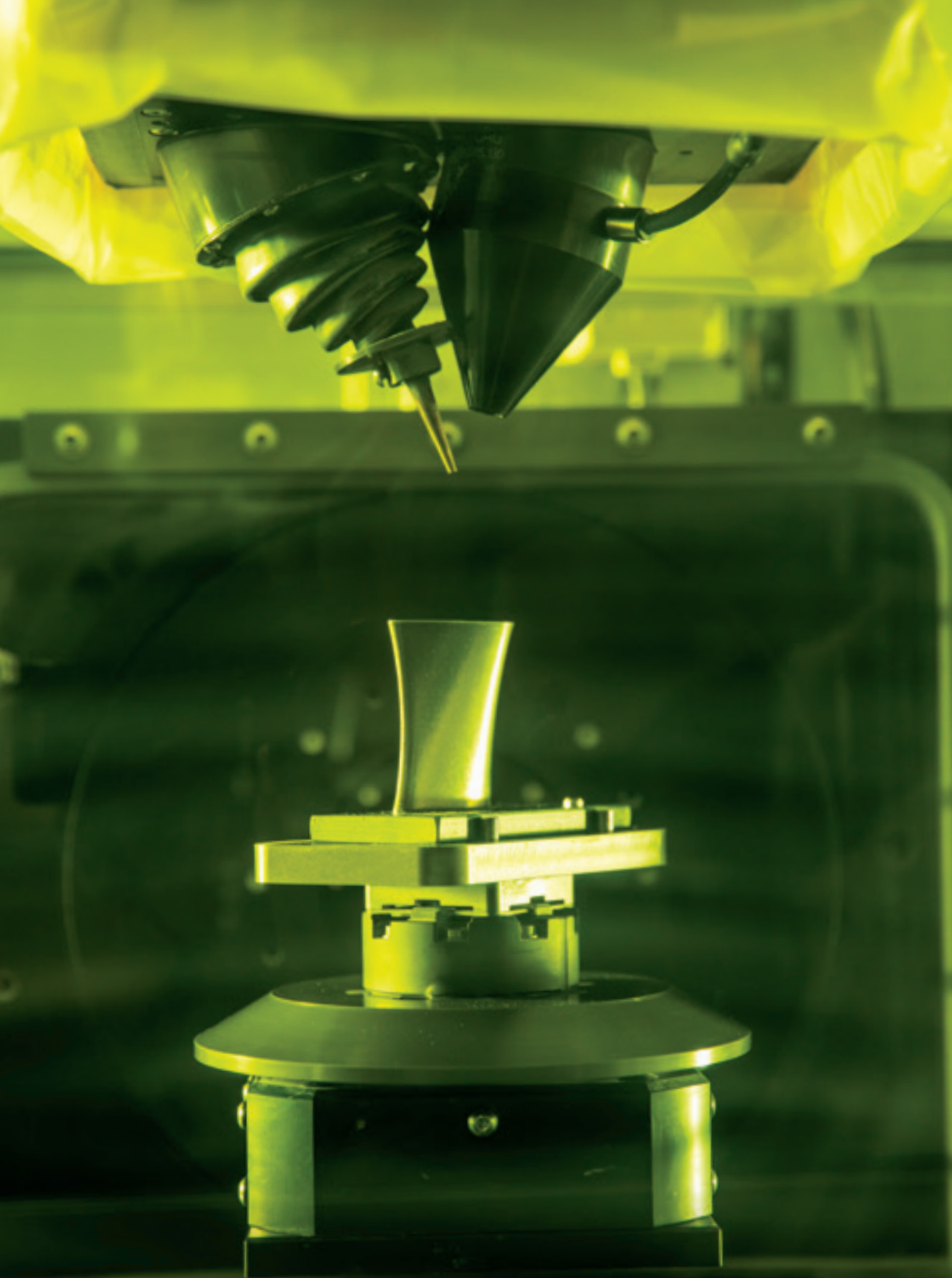
## PRODUCTIVITY, INNOVATION AND GLOBALIZATION

For many years, Canada has been perceived to be struggling to live up to its potential as an innovation world-leader. Generally high levels of education, competitive levels of skilled immigration, and an emerging and lively entrepreneurial sector create the expectation that Canada should be among the most innovative countries in the world. The World Economic Forum ranks countries in terms of “innovativeness,” placing Canada near the bottom of its peer group, a ranking echoed in comparable innovation indicators, such as the Global Innovation Index.<sup>21</sup> These rankings are based on business investment in R&D.

However, innovation as a product of business R&D spending is just one factor in determining a country’s prosperity. In terms of business productivity growth, Canada has been outperforming the US significantly and the rate of growth of Canada’s per capita gross domestic product (GDP) matches that of the US, and has done so historically.<sup>22</sup> So the ingredients for innovation are present in Canada, but perhaps the impetus to innovate has been missing because of Canada’s relatively strong performance in other areas.

Canada’s innovation challenge is about to be magnified by the megatrends that are creating the current economic, social and environmental challenges the world is facing, including environmental sustainability, changing demographics and technology, as well as globalization.<sup>23</sup> In this changing world, it is expected that innovation will play a greater role in enhancing Canada’s competitiveness.





Airfoil being produced with a laser consolidation system. Conventional machining processes create shapes by removing material. This computer-aided manufacturing (CAM) technology adds material to enhance an existing component or build wholly new ones. This technology opens up possibilities for Canadian companies looking for efficient and creative solutions to manufacturing challenges.

Changing world trading patterns present particular innovation challenges for the Canadian economy. Canadian companies generally do not engage in exporting beyond North America, which increasingly limits growth potential as opportunities and markets emerge around the world that could benefit Canadian firms. Canadian firms also face additional pressures, including capital and financing, talent acquisition and management depth, and export market access and knowledge. Accordingly, very few Canadian SMEs make the transition to global competitor.

Similarly, Canada has experienced a steady decline in the number of large scale, homegrown enterprises since the early 1990s. Only about half of new firms survive for more than five years as many new Canadian businesses initially flourish but either fade or are scooped up by international competitors — particularly from the US — before they have a chance to expand and compete internationally.<sup>24</sup> Canadian entrepreneurs cite access to financing, advice, global talent, markets, and growth opportunities as barriers to scaling up.<sup>25</sup> The federal government has done much to address these concerns by increasing access to venture capital, providing more funding to universities and colleges to develop more talent, easing immigration for highly skilled workers, and creating demand for innovation through superclusters and other government programs, but ongoing attention to the needs of firms to scale up will be required.

From a science and technology perspective, Canada has performed well in science but has been weaker in translating ground-breaking research into market-dominating applications. This is particularly true in areas such as genomics, in which Canadian researchers made foundational discoveries and came up with exciting applications in the health and life sciences sectors, but were less successful in the marketplace. Similarly, Canada has been at the forefront of artificial intelligence due to strong

bottom-up research funding programs, and is now facing the challenge of turning research excellence into new product or process innovations. The federal government is supporting this process with programs like IRAP and the superclusters, but ultimately, Canadian businesses have to pull these innovations into their activity. Canada is also an early leader in quantum technology, but a sustained focus to move great science into beneficial applications and advances will be needed to maintain this lead.

In the resource sector, Canada's economy has historically been tied to its bounty of natural resources. These industries continue to serve as a pillar of the Canadian economy, but their dominance is being challenged. Increasing awareness of the environmental impact of natural resource exploitation has created a trend toward cleaner, more sustainable technologies, but Canada has been slow to pivot and is losing ground to countries embracing environmentally-sound solutions. There is tremendous opportunity for Canadian business to reinvent the use of natural resources in oceans, forests, and hydrocarbon reserves to provide economic opportunities and to support a low carbon economy.

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### What else is driving change?



**Wicked problems** (e.g., environment, scarce resources) and accelerated change are driving the collaboration imperative.

**The global race for highly qualified personnel (HQP) and the national imperative to grow firms to scale and gain international brands** are putting added pressure on SMEs.

**Renewed and rethought science infrastructure and innovation programs** are optimizing economic and social benefits for the next generation.

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Augmented reality hip surgery training simulation on a mannequin. Combining virtual reality simulation with technologies such as magnetic resonance imaging (MRI) will enable the realistic rehearsal of patient-specific surgical procedures prior to actual surgery.





## SUPPORT FOR FUNDAMENTAL RESEARCH

The quest to understand underlying foundations of phenomena and observable facts is essential to innovation. This kind of fundamental research is undertaken without any particular application or use in view, while applied research sets out to solve a defined problem. Although fundamental research may not immediately solve problems, it is grounded in traditions of scientific inquiry that have transformed the world for the better in recent centuries. Its impacts have often been unpredictable, and diverse discoveries have been forged into inventions that catalyzed the creation of whole new economic sectors.<sup>26</sup>

This is why fundamental research is important — it generates the foundational science that, in turn, feeds the technological breakthroughs that result from applied research. Fundamental research is essential for innovation. The two are inextricably bound together in a creative process that propels science, technology, and innovation in new and often unexpected directions.

Canada has all the ingredients to contribute successfully to fundamental science, both domestically and abroad: a world-class post-secondary education sector, scientists and engineers who receive international recognition for their research excellence, an enviable record in research citations, and patents and publications in areas of strategic importance to future innovation, such as AI, quantum and neuroscience.<sup>27</sup> These accomplishments demonstrate a high level of research excellence and position Canada to collaborate with the best in the world.

In Budget 2018, the federal government made a historic \$3.9 billion investment over five years in scientific and technical research, researchers, and the equipment researchers need to succeed. This increase in funding is intended to at least partially address the fact that Canada's research intensity has fallen consistently since 2001, while other countries have intensified their R&D efforts over the last decade. The NRC benefitted from this additional funding for ideation and deeper ties with universities to address a shift in focus at the NRC away from fundamental research in recent years, evident in a drop in the number of the organization's publications.

Much like the NRC, Canada's challenge lies in striking the right balance between fundamental and applied research, funding the two appropriately, and ensuring that researchers have time and space to pursue their curiosity in a world that is always hungry for the next big innovation. And, because science doesn't happen in a vacuum, it is also important to keep pace with how the rest of the world finds this balance.



# HOW THE NRC ADDS VALUE



HHT researcher preparing DNA sequencing reactions to help decode the composition of diseased human genomes in lung cancer patients.

As Canada’s largest public sector organization dedicated to research and innovation, the NRC has a particular responsibility to engage with the 21<sup>st</sup> century challenges facing Canadians. Our role is to apply our scientific and technological know-how to help create a better Canada, improve the quality of life of Canadians, and help make the world a better place.

We work with other innovators, including other federal science-based departments and agencies, leading Canadian academics and entrepreneurs and scientists from around the world, building on and supporting them in transforming our world. We add scientific and technical knowledge, expertise, and capacity to their efforts, helping uncover solutions to the sticky problems that get in the way of a more sustainable and prosperous future.

In the end, we are in pursuit of excellence and impact, which we exhibit through the NRC’s three core roles within the Canadian STI ecosystem: supporting business innovation, providing science-based policy solutions to government, and advancing scientific and technical knowledge.

**OUR CORE ROLES AND COMPETITIVE ADVANTAGE**

**To support business innovation,** the NRC harnesses the collective experience, expertise, and advanced technical skills of our scientists, engineers, and technicians to explore new ideas and de-risk innovation. We invest strategically in competencies and technology platforms that enable our research staff to remain ahead of the curve in providing technical services, testing, evaluating, and prototyping. We provide cost-effective support to industries to de-risk commercializing technologies, including meeting regulatory requirements and scaling up industry capacity. By providing guidance and financial support to small and medium enterprises, we help them scale up and compete.

**To provide science-based policy solutions to government,** the NRC supplies Canada with insights into emerging technologies and advice to government and industry on their disruptive potential. We exchange

strategic science and technology information, intelligence, and connections to advanced research centres around the world. Working with other government departments and agencies, we provide scientific knowledge and technological insights that contribute to the effectiveness and efficiency of regulation, stewardship, national security, and defence. We also integrate different fields quickly to address major issues of concern to society.

**To advance scientific and technical knowledge,** the NRC’s teams include researchers making advances at the forefront of their disciplines and running state-of-the-art facilities. Additionally, we work with leading-edge collaborators, including co-location of researchers and equipment with strong partners in government, academia, and industry. We join with private and public organizations to build on each other’s expertise and turn innovative ideas into real products and solutions through joint research and real-life demonstrations. We explore new ideas and access new capabilities through national and international partnerships, while maintaining a strong global presence and reputation. We also make new investments in science as part of new collaborative arrangements with government, academia, and business to encourage development, testing, and validation of transformative research ideas.

# THE NRC'S IMPACT

## ON THE CANADIAN STI ECOSYSTEM

### AS A RESEARCH ORGANIZATION



**\$430 million of  
expenditures on our  
research centres**



**Specialized facilities  
at 179 buildings  
located on 22 sites**



**1,030  
peer reviewed  
publications**



**207 patents filed  
1,669 active patents**



**\$193 million total  
NRC revenues**



**983 R&D  
clients**



AS A FUNDING AGENCY FOR SME INNOVATION



**\$294 M**

in grants  
and  
contributions

**255**

Industrial  
Technology  
Advisors

**120**

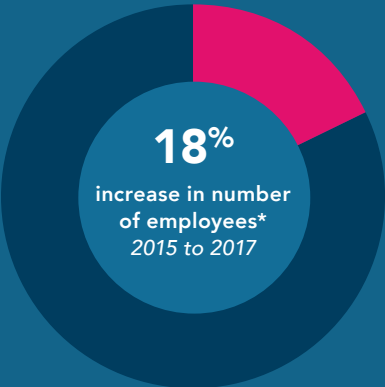
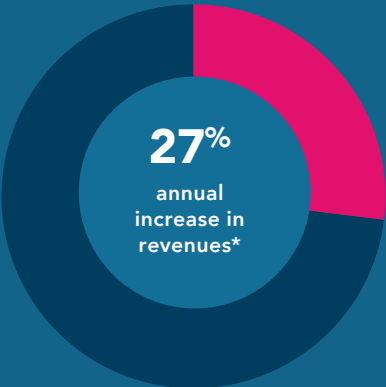
locations  
across the  
country

**3,541**

firms  
receiving  
project  
funding

**4,618**

additional  
firms  
receiving  
advice



\*Reported by IRAP-supported clients. Source: 2018-19 NRC Fact Sheet, other NRC data





Support from NRC IRAP allowed Oleet Processing to work with a graduate student from the University of Saskatchewan to study the effects of extruded flaxseed on a cow's health and on milk production. The result? Omega-3 milk with disease-fighting properties.



WHAT SETS US APART

- **Our people:** our staff include a broad range of innovative and entrepreneurial researchers and technical professionals who offer both science excellence and on-the-ground experience.
- **Geographical reach:** we are the only research institution with a physical presence in every province in Canada.
- **Partnerships:** we are the only research institution in Canada with extensive partnerships with all three pillars of Canada’s research enterprise (business sector, university sector, government sector).
- **Scale:** we are the largest federal performer of R&D, and one of the top three in Canada including universities, non-government organizations, and private sector companies.
- **Scope:** we are active in the largest scope of research fields of any federal science agency.
- **Facilities:** we have a unique national footprint to offer clients access to technology infrastructure, lab facilities, and specialized equipment.
- **Insight:** our IRAP program has a unique understanding of the research, technology and business challenges facing Canada’s innovative businesses.

HOW OUR RESEARCH CENTRES CONTRIBUTE

The NRC is made up of four R&D divisions and a horizontal digital research initiative. Under these divisions, we have 14 integrated and consolidated research centres, each guided by advisory bodies composed of academic and industry leaders. The research centres are focused on key industry sectors, or our areas of R&D, which represent areas of strategic importance and economic value for Canada.

All research centres have their own value proposition to guide how they meet business- and government-identified priorities and challenges through a unique offering of expertise, mission-oriented research, technical and advisory services, and specialized research facilities.

HOW IRAP CONTRIBUTES

For more than 70 years, IRAP has fostered technological innovation in Canadian SMEs through advisory services and funding contributions. IRAP’s support has contributed significantly to the creation of wealth in Canada with economic benefits that amount to at least \$10 billion over and above the cost of the program from 2005-2006 through 2015-2016. IRAP’s long-standing model of combining advisory services and financial assistance to Canadian firms is recognized internationally as a best practice in fostering SMEs’ innovative capabilities.

IRAP is delivered Canada-wide by a network of more than 255 Industrial Technology Advisors (ITAs), located in 120 offices across the country.

IRAPs contribution to Government of Canada programs



IRAP lends its expertise to other Government of Canada departments by providing assessment services through a “back office” function that is accessed across various government innovation funding programs. This service provides extensive technical expertise to conduct project funding assessments and provide advice in establishing and implementing new programs. The Government of Canada often calls upon IRAP to deliver targeted programs, including for example, the Canadian International Innovation Program (CIIP).

EMERGING TECHNOLOGIES

RESEARCH CENTRE	VALUE PROPOSITION
Advanced Electronics and Photonics (AEP)	AEP’s goal is to develop game-changing sensing and communications technologies that collect and move data. This work addresses economic and social challenges critical to Canada and the world, and enables Canada’s infrastructure and services to become smarter and accessible, all of which creates sustainable prosperity.
Herzberg Astronomy and Astrophysics (HAA)	HAA drives research excellence through international partnerships in world-class observatories, and collaborates across the global innovation system to provide facilities and instruments that push technological boundaries forward through cutting-edge science and creative engineering.
Metrology (METRO)	Metrology collaborates across the global innovation system to provide metrology research and services that help transform ideas into market-ready technologies that benefit Canadian society, the economy, and the environment.
Nanotechnology (NANO)	NANO cultivates nanoscience platforms that lead to revolutionary technologies and applications to enhance human health, the environment, and society’s technological future.
Security and Disruptive Technologies (SDTech)	SDTech identifies emerging technology trends and translates these into disruptive technology platforms in quantum physics, nanomaterials, and materials science to advance scientific knowledge, deliver policy solutions for government, and support business innovation in Canada.

ENGINEERING

RESEARCH CENTRE	VALUE PROPOSITION
Construction (CONST)	Construction delivers research and technology-based solutions and services to government and the construction industry. These support the development and commercialization of innovative products and systems to achieve a better built environment, advancing innovation for a safe, prosperous, and sustainable Canada.
Energy, Mining and Environment (EME)	EME develops world-leading technologies in the clean energy and mining sectors to support economic growth and to protect Canada’s future by helping Canadian industry use the latest innovations in clean energy, advanced mining technologies, and environmental sustainability.
Ocean, Coastal and River Engineering (OCRE)	OCRE works with industry, academia, and governments to expand scientific knowledge through research leading to the development of sustainable and intelligent technologies deployed in harsh marine conditions.

**LIFE SCIENCES**

RESEARCH CENTRE	VALUE PROPOSITION
Aquatic and Crop Resource Development (ACRD)	ACRD aims to make Canada a world leader in sustainable biomass transformation through scientific advancement, research services, and technology development that enable the sustainable conversion of Canadian bio-based resources into higher-value products.
Human Health Therapeutics (HHT)	HHT transforms human health outcomes by accelerating the discovery and development of innovative medicines for Canada, and advancing biologics (vaccines, antibodies, and cell and gene therapies) and biomanufacturing in collaboration with public and private sector research organizations.
Medical Devices (MD)	MD is an essential contributor to Canada’s medical devices ecosystem by developing and deploying leading-edge technology platforms; supporting industrial medical device R&D; and helping to develop the medical device technology leaders of the future.

**TRANSPORTATION AND MANUFACTURING**


RESEARCH CENTRE	VALUE PROPOSITION
Aerospace (AERO)	AERO creates, advances, and applies world-leading aerospace capabilities through research, innovation, and collaboration for a stronger Canadian and global aerospace sector.
Automotive and Surface Transportation (AST)	AST makes Canada more competitive through innovations in mobility and manufacturing excellence by identifying, developing, and applying relevant science and technology through the revolution in transportation and manufacturing industries.

**DIGITAL TECHNOLOGIES**

HORIZONTAL DIGITAL RESEARCH INITIATIVE	VALUE PROPOSITION
Digital Technologies (DT)	DT works at the forefront of digital technologies research, driving innovation with and for Canadian government, businesses, researchers, and society. The desired end-result for this work is a smarter, safer, healthier, and more prosperous society through ethical digital technologies.

**INDUSTRIAL RESEARCH ASSISTANCE PROGRAM**

PROGRAM	VALUE PROPOSITION
Industrial Research Assistance Program (IRAP)	IRAP accelerates the growth of SMEs by providing them with a comprehensive suite of innovative services, advice, and funding.



Developed in collaboration with the Text Analytics group, the Global Public Health Intelligence Network (GPHIN) was set up as a global network of connected professionals working to rapidly detect, identify, assess, prevent, and mitigate threats to human health. GPHIN has a broad public health scope. It helps tracks events such as infectious diseases and disease outbreaks, contaminated food and water, bioterrorism and exposure to chemicals, natural disasters, and issues related to the safety of products, drugs and medical devices, and radioactive agents.

## HOW OUR CORPORATE DIVISIONS CONTRIBUTE

In scientific research and business innovation, almost anything is possible with the right mix of ideas, imagination, focus, and drive. But to really push boundaries, science and innovation excellence also needs considerable support from a highly-tuned, capable organization.

The catalysts for success are the dedicated professionals in our corporate groups. Specialists in a wide range of fields, including finance, human resources, property management, information technology, communications, environment, health and safety, and business services, ensure that our researchers and ITAs have the time, resources and facilities to turn their ideas into innovations, breakthroughs, and discoveries. These groups enable the smooth functioning of the corporate machinery needed to advance the NRC's strategic direction, allowing research centre and IRAP staff to focus on driving ideas, programs and innovation forward.

The NRC is dedicated to continuous improvement in the running of its business and support for its science, technology, and innovation mandate. To that end, the NRC's corporate branches have generated their own five year plans to ensure they are aligned with the NRC's overarching research and innovation agenda, while providing sound stewardship of our resources. Much like the research centre and IRAP strategic plans, the corporate branch plans set ambitious goals and advanced action agendas to further improve the delivery of high-quality, enabling functions for the organization.

In addition to the many enabling functions played by our corporate branches, additional strategic emphasis is also being placed in the areas of human resources and overall workplace renewal.

Successful support of our ambitious agenda requires a strong emphasis on the NRC's greatest resource — our people. Development of talent has always been a top priority to nurture

creativity and a well-performing organization. This is complemented by the importance of maintaining employee well-being and job satisfaction. Increasingly, how well an organization supports its employees can also be a determining factor in competing for the best and brightest science, technology, engineering, and mathematics (STEM) talent, particularly in high-growth areas such as digital technologies.

To enable people to meet their full potential, the NRC's Strategic Human Resources Plan (see Annex 1) focuses on three priority areas over the next five years: talent development and transition; talent attraction; and talent diversity and wellness. At the same time, there are numerous functions that are essential for any high-performing science and technology organization, including effective IT, performance measurement, security, health and safety, risk and intellectual property (IP) management. Taken together, these functions comprise the necessary backbone of a dynamic and agile research and innovation agenda.

NRC Dialogue was a multi-year renewal process to reinvigorate the organization and ensure that it was properly positioned to support research excellence and business innovation. At the same time, the Government of Canada is engaged in its own effort to renew the public service across all departments and agencies. "Beyond 2020" is focused on ensuring public services rise to the needs, expectations, and demands of contemporary Canadian society. The focus of Beyond 2020 is to produce an agile, inclusive, and equipped public service.

NRC Dialogue and our contributions to Beyond 2020 together provide key underpinnings for the NRC's renewal and repositioning, and play an important role in the successful execution of this five-year strategic plan (for an overview of the Dialogue renewal initiatives and how they relate to Beyond 2020, see Annex 17).

In January 2018, NRC IRAP successfully launched the Government of Canada's first-ever live trial of public blockchain technology (on Ethereum). The program began proactively publishing information on new and amended Contribution Agreements with firms in real time. Initiatives like these will help the government to conduct business in a more transparent and accessible manner.



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## Working smarter with streamlined processes



Within every large organization there is paperwork and process to guide, track, and promote the high quality delivery of services in support of core business operations and sound stewardship of resources. Sometimes, however, these processes can become overly complicated. Streamlining processes means that both the client and the process manager will have more time to spend delivering or enabling research and innovation excellence. In pursuit of this goal, the NRC is seeking to improve its service delivery in several key areas: **security clearances; international workers and visitors; procurement; onboarding; and travel.**

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### BUSINESS AND PROFESSIONAL SERVICES

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CORPORATE DIVISION	VALUE PROPOSITION
National Programs and Business Services	To improve the delivery and impact of all NRC programs and related activities by providing responsive and valued strategic advice and services.
Communications	To support raising awareness of the NRC and its people by building the NRC brand, updating the NRC's digital presence, celebrating NRC staff, and strategically deploying communications efforts.
Design and Fabrication Services	To directly support research and innovation by enabling the NRC's programs and facilities with design, engineering and fabrication services of precise mechanical prototype equipment and apparatus aligned with the overall strategic direction of the NRC.
Health, Safety, and Environment	To proactively establish, promote, and implement best practices in health, safety, and environmental management in all NRC activities.
Knowledge, Information, and Technology	To enable NRC excellence as a trusted partner and leader in the delivery of knowledge, information, and technology solutions.

CORPORATE SERVICES

CORPORATE DIVISION	VALUE PROPOSITION
Administrative Services and Property Management	To be recognized as a partner by supplying real property expertise and services to support the NRC's mandate and business strategies.
Finance and Procurement Services	To be proactive, results-oriented leaders who work in collaboration with their clients to offer excellence in operational and strategic financial management and procurement services to support the achievement of the NRC's objectives.
Security	To provide a security posture that protects NRC people and assets, and adapts to the ever changing threat environment while supporting the NRC's mandate and business objectives.

HUMAN RESOURCES

CORPORATE DIVISION	VALUE PROPOSITION
Human Resources Branch	To work collaboratively with clients to attract, develop, and retain a talented, diverse, and engaged NRC workforce by providing expert HR advice, quality HR programs, and a comprehensive array of HR services to support employees and managers through all stages of the employment life cycle.

SECRETARY GENERAL

CORPORATE DIVISION	VALUE PROPOSITION
Policy, Strategy, and Performance	To support the NRC and its executives in setting and managing the organization's strategic direction.
International Innovation Office	To support a coordinated effort for the NRC's international activities and ensure a strategic focus on international priorities to achieve scope, reach, and impact.
Audit and Evaluation	To provide independent and objective insight, advice, and oversight designed to add value, promote sound stewardship, and strengthen the NRC.
Corporate Secretariat	To facilitate strategic, integrated, accountable decision-making and good governance, while promoting a positive work environment based on solid values and ethics.



●●● HIGHLIGHTS

# CORPORATE DIVISIONS’ STRATEGIC INITIATIVES

**Optimal information technology (IT) tools for research excellence**, including a multi-year strategy to embrace new approaches to cloud and high performance computing, specialized research environments and partnerships to co-invest in IT infrastructure.

**Leadership in scientific and technical information access and management**, including establishing quick, effective, and seamless knowledge management to help researchers, ITAs, and business groups harness their full potential, and developing a robust data management strategy.

**Updated strategy for managing intellectual property (IP)** aligned with the government-wide strategy to deal with the rising cost of protecting IP assets and increasing complexity of collaborative programs and agreements.

**New approaches to client relationship management** with specialized sales teams for high volume contracts, and strategic account management, reduced turnaround times on contracts, and more individualized service to meet clients’ specific needs.

**One voice for one NRC** by increasing digital and social media content and campaign style outreach efforts to build the NRC’s brand and name recognition as a trusted leading-edge science, technology, and business innovation partner.

**Embedded research excellence and business innovation culture in governance** including a balanced and ambitious set of key performance indicators and a “lean” approach to collecting and reporting on performance data.

**Long-range strategic planning** to ensure future impact, including looking at further removing barriers and providing more supports for researchers and ITAs to enable them to sustain research excellence and business innovation. This includes examining “hard” supports (such as funding, facilities, and equipment) as well as “soft” supports (such as clarity on research objectives, organizational modes, and design, and management culture).



# THE NRC'S STRATEGIC PLATFORMS

New Beginnings provides financial support to NRC researchers, scientists, and their external collaborators to explore transformative ideas that have the potential to become disruptive technologies.



As the NRC begins the implementation of this five-year plan, recent investments in key strategic platforms are beginning to bear fruit and propel us forward. These investments are among many actions resulting from the NRC Dialogue process and the additional NRC financing in Budget 2018, both of which reinforced our research strengths and our role as a trusted collaboration partner for government, industry, and academia. They also resulted in the creation of a range of new strategic platforms that enhance the NRC’s core roles in science and technology innovation, and position us as a partner for new forms of collaboration to help address the challenges being faced by Canada and the global community.

**INFRASTRUCTURE TO SUPPORT RESEARCH EXCELLENCE**

Research excellence is foundational to the credibility of any R&D organization. Excellence attracts the best and brightest people to the NRC. It gives confidence to our partners and customers that we are critical for their success and to government that advice on policy solutions is based on sound science.

Recent investments in strategic platforms to renew the focus on research excellence include the establishment of the **President’s Research Excellence Advisory Committee** and the appointment of the **President’s Science Advisor**. These positions empower experienced researchers to provide actionable advice on advancing the excellence agenda, including how best to mentor and develop research staff, how to frame leadership and professional development programs, and how to better facilitate self-directed research.

The appointment of a **Chief Science Officer** and **Departmental Science Advisor** is a further example of new investment in this area. This position provides a formal collaborative link with Canada’s Chief Science Advisor, advice for the NRC’s research centres, and additional capacity towards advancing research excellence across the NRC.

Finally, the **Ideation Fund** is a further initiative promoting research excellence by providing financial support to NRC researchers to pursue self-directed research and test transformative ideas that have the potential to develop into future disruptive technologies. The fund is composed of two programs: **New Beginnings** — which provides individual researchers with funding to support their

research on an annual basis; and **Small Teams** — which provides funds for up to three years for teams of NRC researchers and external collaborators. In both instances, these investments are incenting research excellence from within the NRC and are putting in place the strategic platforms that will continue to deliver results in the years to come.

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**Challenge programs**



**Current challenge programs and NRC research centre leading them**

- **Materials for Clean Fuels – EME**
- **High Throughput and Secure Networks – AEP**
- **Disruptive Technology Solutions for Cell and Gene Therapy – HHT**
- **Artificial Intelligence for Design – DT**

**Potential future challenge programs and lead research centre**

- **Internet of Things – SDTech**
- **Aging in place – MD**
- **North – OCRE**

**The funding for the 3 new challenge programs will be launched by 2022-23.**

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# SUPPORTING CANADA'S INNOVATION SUPERCLUSTERS

The Innovation Superclusters Initiative supports business-led innovation superclusters that have the greatest potential to energize the economy and become engines of growth.





## NEW COLLABORATIVE R&D PROGRAMS

Building on a wide range of ongoing research, innovation, and private-sector contributions, the NRC recently launched a range of new collaborative R&D programs to support the Government of Canada's Innovation and Skills Plan. Budget 2018 recognized the NRC's unique position at the intersection of science and business and its potential as an agent capable of "bringing together the best innovative minds from across the country to deliver solutions and breakthroughs that matter to Canadians."<sup>28</sup>

Called **NRC Challenge Programs**, these seven-year, outcome-focused initiatives focus on priority and disruptive technology areas to ensure that Canada is well positioned to contribute to the economy of tomorrow. Made up of coordinated suites of mission-oriented projects, they bring together NRC resources — including researchers, project managers and facilities — with academic and industrial participants to leverage unique strengths and strive for shared goals.

In addition, **NRC initiatives supporting the industry-led superclusters** focus on aiding the five priority economic sector programs identified by the Government of Canada: Digital Technology, Protein Industries, Advanced Manufacturing, SCALE.AI, and Ocean. The NRC assisted with the organization and launch of these superclusters by loaning staff and leveraging IRAP expertise and networks to identify SME participants. Now that the superclusters are up and running, the NRC will be making program investments that align with their priorities and goals.

## NEW COLLABORATION CENTRES

The NRC has also made important recent investments in the form of **collaboration centres**, which co-locate researchers and equipment with universities, polytechnic institutions, and colleges to create centres anchored in areas of emerging and leading-edge research. These centres are a further example of strategic platforms that will foster further collaboration and strong partnerships into the future.

The main goal of this initiative is to better connect Canada's innovation ecosystem by working with the brightest minds to advance knowledge in areas in which Canada has the opportunity to develop internationally recognized expertise. These closer collaborations will lead to discoveries and advances that will result in publications, patents, and the commercialization of technology. They will also provide support for talent through the supervision of graduate students and post-doctoral fellows, increasing the training opportunities for the next generation of researchers and innovators.

Despite only initiating this program in 2018, there are already several signed agreements in place that will see the NRC further increasing its collaboration in the areas of microfluidics, oceans technologies, cybersecurity, AI, mathematics, and advanced materials. Further collaboration centres are expected to be set up in the coming years.

## REVITALIZED FACILITIES

Investments into renewing and modernizing NRC facilities are a strategic imperative to ensure that essential infrastructure continues to enable research and innovation excellence. That's why the NRC is conducting a **Facilities Review**, examining what gets used, what does not get used, what needs to be fixed, and, in some cases, what could be divested. This review will guide facility investment decisions and even inform research directions as it provides valuable insight into capacity and capabilities.

The NRC is also participating in the **Government of Canada's Greening Government Initiative** — to transition to low-carbon and climate-resilient operations while reducing other environmental impacts beyond carbon. Targets include reducing greenhouse gas emissions from federal government facilities by 40 percent by 2030 and 80 percent by 2050. These targets will factor into the facilities review because reductions in our electricity, natural gas, oil and propane consumption are good for the environment as well as for the financial management of research facilities.

As a further part of our strategy to revitalize buildings and real estate, the NRC is working with federal partners on the \$2.8 billion **Laboratories Canada (LC) initiative**. LC enables a whole-of-government approach to science infrastructure investment and real property portfolio management. Newly-built or renovated labs will be modern and accessible, incorporating sustainability and green operations, and will bring together federal scientists from different departments to enhance collaborative science with benefits for Canadians. LC will better position federal science to overcome barriers to collaboration, be more efficient, and build synergies across programs to address current and future science, technology, and innovation challenges.

## BETTER SUPPORT FOR DIGITAL RESEARCH

The NRC recognizes the need to establish better support for research into digital technologies that will help innovative businesses grow and produce evidence-based solutions to inform decisions in government priority areas. The NRC has made recent investments into strategic platforms to innovate in the digital space, including new initiatives, leadership, and equipment.

One important investment is the appointment of a **Chief Digital Research Officer (CDRO)** to manage the NRC's **Digital Technologies Research Centre (DT)**, which explores the uses of data and information to make digital technologies smarter and more intuitive for Canadian SMEs, and supports Government of Canada initiatives, including the five superclusters and the NRC's four current challenge programs, to help solve real problems for Canadians.

The CDRO will also create a blended NRC-university digital research network through DT and the associated collaborations centres, create a digital community of practice within the NRC, and partner with the NRC's Chief Information Officer on the future of digital research tools for the NRC, including a \$20-million investment to modernize the NRC's Research IT Platform. Areas of concentration include cloud storage, specialized research environments, and a forthcoming high-performance computing facility for AI and quantum theory.

## INTERNATIONAL PARTNERSHIPS

Canada's participation in international science, technology, and innovation advances Canadian research excellence and creates access to the world's best science and technology facilities, equipment, and talent. It also opens doors for Canadian SMEs to access global value chains and new markets through co-innovation projects, partners, and intelligence, which, in turn, helps them scale-up and remain competitive.

The **NRC's International Strategy** reflects the view that our relationships with international partners are a further example of strategic platforms for future initiatives and opportunities. As part of this strategy, the NRC is building a special focus on select innovation ecosystems in target economies to create deeper and more sophisticated relationships. Part of the aim in building these strategic relationships is to increase the exposure of NRC researchers and their initiatives to global partners. Recent coordination efforts with international partners in the United Kingdom (UK), Germany and Japan are examples of the NRC's commitment to facilitate this broad, international exposure of its researchers and their initiatives.

Additionally, through delivering Canada's **associate membership in EUREKA**, the NRC is opening doors to Canadian firms and innovators to do business in Europe and beyond. This global industrial R&D network brings together governments, industry, research institutes, universities, and other innovation-focused organizations to increase competitiveness of businesses through the development and commercialization of technology.

## A SCALED-UP IRAP

Widely regarded as one of the best programs of its kind in the world, IRAP provides technical and business advice, network linkages, and funding assistance to SMEs at all stages of the innovation process to build their innovation capacity and take their ideas to market. Between 2006 and 2016, IRAP spurred \$10 billion in economic benefits for Canada above the cost of the program, which serves about 11,000 clients annually with advice, funding or both.

Following an infusion of \$150 million in new annual funding in Budget 2018, IRAP began to scale up both its relations with Canadian SMEs and its program more generally. This includes the increase in contribution funding to firms by \$133 million annually and the launch of a process for large value contributions up to \$10 million per project (previously capped at \$1 million).

To improve overall support for SMEs, IRAP will expand an internal program to support SMEs through procurement to the Government of Canada's Innovative Solutions Canada program, in which the federal government acts as a first customer for Canadian SMEs. IRAP will also support SME access to new sources of scale-up capital and continue to increase international SME engagement, as well as working with the Strategic Innovation Fund (part of Innovation, Science and Economic Development), regional development agencies, and the Trade Commissioners' Service.

In addition, IRAP has renewed a pilot launched in 2017 to engage SMEs in utilizing the services of NRC research centres through a Certificate Program that offers a 50 percent fee reduction up to a total savings of \$50,000. The objective of the program is to increase technology transfer to SMEs from NRC research centres and provide scale-up support to increase global competitiveness of Canadian SMEs. The positive synergy between IRAP and the research centres has already resulted in 101 projects with 87 SME firms in FY 2017-18.

The scaling-up of funding and services will require ongoing adjustments within IRAP, including a more streamlined service delivery system, expanded support to the IRAP Sector Teams, and more staff to meet evolving program delivery requirements. To address these demands, IRAP is establishing a robust framework for recruiting, onboarding, and training employees, as well as increasing opportunities for networking and collaboration among staff. The end-result will be an empowered, well-tooled, and world-class workforce to deliver a truly world-class SME support program.



# THE NRC'S FIVE AREAS OF STRATEGIC FOCUS



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## THE NRC'S FIVE AREAS OF STRATEGIC FOCUS

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For the NRC to perform at our fullest potential in this five-year strategic plan, we must build on our strengths, encourage our employees to participate actively, and carry out work that meets real needs. We do just that by taking cues from the ambitious goals set by our research centres, IRAP, and corporate branches in their own strategic plans; leveraging the vast potential of our new strategic platforms; and harnessing the collective knowledge, ingenuity, and enthusiasm of our employees to tackle the issues of concern facing Canada and the world.

We have identified five areas of strategic focus for the organization, and for each, we have set two high-level goals. To achieve these goals over the next five years, we have set a series of integrated, cross-NRC initiatives that leverage our strategic platforms and the work of our research centres, as well as a visionary “moonshot” that sets an ambitious but attainable goal for the future. Throughout the five-year timeframe for this plan, we will endeavour to demonstrate our science, research, and innovation excellence, support business innovation in Canada, and deliver policy solutions for Canadians, reviewing our goals and projects periodically to ensure that they remain relevant and impactful.

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## THE NRC'S FIVE AREAS OF STRATEGIC FOCUS

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# NUMBER ONE

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## ENABLING A MORE SUSTAINABLE ECONOMY

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Like the rest of the world, Canada faces the need to transition to a more sustainable economy to attempt to reverse the strains that modern life has placed on the environment. The NRC is well-positioned to support this shift to more sustainable living with research related to energy and environment, natural resources, buildings and infrastructure, food, and transportation.

Over the next five years, the NRC's work, often in collaboration with other government departments such as Natural Resources Canada, the Department of Fisheries and Oceans, and Environment and Climate Change Canada, to enable a more sustainable economy will focus on two main goals, one on reducing Canada's carbon footprint, and the other on more sustainable living.

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## ENABLING A MORE SUSTAINABLE ECONOMY

### GOAL ONE

Contribute to a cleaner future by reducing Canada's reliance on fossil fuel

### OUTCOME

Alternative low-carbon sources of energy to fuel Canada's way of life while reducing greenhouse gas emissions

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- **Launching a new NRC Advanced Clean Energy Program** to develop and deploy clean energy technologies that add value to the economy, lower costs to consumers, and reduce environmental impact in the near and long term. The program will target two key areas: first, the conversion of zero-to-negative value wastes to renewable fuels and the efficient utilization of those fuels in internal combustion engines, and second, the development of functionalized materials, components and devices for energy storage.

sample synthesis, and characterization. The partners will then "close the loop" using data analytics and AI to link measured results with expected behaviours and steer iterative refinements.
- **Collaborating with other government departments on energy research through Laboratories Canada (LC).** LC will better position federal science to overcome barriers to collaboration, be more efficient, and build synergies across programs to address current and future science, technology, and innovation challenges.
- **Working with Natural Resources Canada, the University of British Columbia and the University of Toronto as part of new collaboration centres** to reduce the cycle time for energy materials development from decades to years by developing a platform for AI-enhanced accelerated materials discovery. Collaborating across organizations, researchers will integrate computational predictions for material function, automated

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**ADDITIONAL MISSION-SPECIFIC INITIATIVES**  
**OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:**

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Aerospace	Investigating distributed electric propulsion as a practical alternative to gas turbine engines for aircraft.
Aerospace	Applying expertise on aviation engines to small-scale stationary power generation.
Automotive and Surface Transportation	Developing multi-modal mobility systems focusing on fleet optimization, vehicle electrification and simulation, active aerodynamics, and lightweighting to reduce carbon fuel consumption.
Construction	Partnering with Natural Resources Canada to expand research on hydro microgrids in the NRC’s Canadian Centre for Housing Technology.
Construction	Working toward “energy positive” buildings that generate more power than they consume.
Energy, Mining and Environment	Reducing energy consumption during mine operation toward automation.
Energy, Mining and Environment	Assembling a suite of novel processes for energy commodities of the future, such as lithium and vanadium, for implementation by the Canadian clean technology value chain.
Metrology	Supporting national and international standards for, and regulation of, black carbon emissions.
Nanotechnology, Metrology, Security and Disruptive Technologies, Advanced Electronics and Photonics	Developing new sensors and detectors for emissions sources and gas systems.
Ocean, Coastal and River Engineering	Using ocean engineering expertise to consider offshore wind technologies for energy production.

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**NRC MOONSHOT FOR A MORE SUSTAINABLE ECONOMY**  
**WE WILL WORK WITH ACADEMIC AND INDUSTRIAL PARTNERS**  
**TO PUSH THE LIMITS OF WHAT’S POSSIBLE BY:**

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**Materials for Clean Fuels Challenge Program** • Working to discover and validate the novel materials needed to enable clean and sustainable energy systems. Our endeavours in this area will support Canada’s efforts to meet future targets to reduce greenhouse gases and limit the effects of global warming. Work will focus on three areas to address Canada’s emission reduction gaps: carbon dioxide conversion or reduction, clean hydrogen production and applications, and electrochemical processes for future fuels. Working with external partners, the NRC will identify challenges to overcome, and lend its expertise and support to efforts to develop cleaner energy solutions.



## ENABLING A MORE SUSTAINABLE ECONOMY

### GOAL TWO

Support R&D that encourages sustainability and protects against threats to our environment

### OUTCOME

New technologies and approaches that lead to a more sustainable and environmentally friendly economic future for Canada

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- Establishing initiatives to support the Ocean Supercluster to drive increased sustainable economic growth from our oceans through innovation and commercialization.
- Leading the publication of a "National Infrastructure Code," focused on integrating climate resiliency into building and infrastructure design, guides, and codes, and addressing climate change and extreme weather events.
- Developing new technologies for environmental monitoring of the ocean through the Ocean Supercluster.
- Establishing a collaboration centre with Memorial University to partner on the research and technology development needed to address the challenges of a harsh marine environment.
- Contributing to Canadian climate change commitments through collaborative R&D programs such as the Advanced Clean Energy Program by working with other science-based departments and agencies to develop and deploy clean energy technologies that add value to the economy, lower costs to consumer, and reduce environmental impact.

..... <b>ADDITIONAL MISSION-SPECIFIC INITIATIVES</b> <b>OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:</b> .....	
Automotive and Surface Transportation	Developing new materials and manufacturing processes using Canadian biomasses, industrial by-products, and waste.
Construction	Considering ways to incorporate renewable energy and other green building technologies in housing.
Construction	Partnering with Treasury Board Secretariat's "Centre for Greening Government," a science hub on sustainability innovation for the federal government.
Digital Technologies	Exploring how best to harness digitalization to advance the mining industry.
Energy, Mining and Environment	Working with Environment and Climate Change Canada and federal departments with custodial responsibility (Department of National Defence, Transport Canada, DFO) to synergize Canada's efforts to solve complex contamination challenges and address the issues of emerging contaminants.
Energy, Mining and Environment	Working with Natural Resources Canada to support the objectives of their Green Mining Initiative.
Energy, Mining and Environment	Improving sustainable and clean mining technologies, including precision mining, <i>in situ</i> mining, environmentally friendly metallurgical processes, and recovery techniques for secondary resource extraction.
Ocean, Coastal and River Engineering	Developing sustainable and clean technologies for surface vessels, platforms, and structures.





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## THE NRC'S FIVE AREAS OF STRATEGIC FOCUS

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# NUMBER TWO

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## SUPPORTING A HEALTHIER FUTURE

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Canada faces the same global health-related pressures as the rest of the world, including an aging population, the re-emergence of infectious diseases, and food security, but there are other issues related to health and well-being in Canada that require attention, such as health care in rural and remote areas, and the unique needs of Indigenous communities. With a strong reputation for global scientific leadership in biologics and vaccine development, medical devices and food production, the NRC is well-equipped with a wide variety of research to address these challenges and support a healthier future for Canadians.

Over the next five years, the NRC's work to support a healthier future for Canadians — often with other federal departments such as Health Canada, the Public Health Agency, the Canadian Food Inspection Agency, and Agriculture and Agri-Food Canada — will focus on two main goals, one in the health sector, the other focused on food production.

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## SUPPORTING A HEALTHIER FUTURE

### GOAL ONE

Adopt and advance leading-edge health technologies to create a healthier future

### OUTCOME

Advances and insights that improve Canadians' health outcomes and well-being

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- **Supporting the health thrust of Canada's Digital Technology Supercluster** with expertise on healthcare practitioner training, interactive remote care, and cognitive care and remediation.
- **Creating a program to advance multi-functional, antibody-based therapeutics** to treat complex chronic disease and support business innovation.
- **Fostering an initiative in biomanufacturing, and vaccines and emerging infections readiness** to develop made-in Canada therapeutics and responsiveness to issues such as anti-microbial resistance.
- **Focusing on issues related to aging** in the next wave of NRC Challenge programs.
- **Working with the University of Toronto in our collaborative venture, the Centre for Research and Applications in Fluidic Technologies (CRAFT)**, opened in November 2018. This national innovation hub for in vitro diagnostics, regenerative medicine, and precision medicine will support the Canadian medical device and manufacturing industries by making them more competitive internationally. Projects at CRAFT will apply microfluidic technologies to tackle in vivo diagnostics, organ-on-a-chip engineering, and bioprinting to create diagnostic advances that benefit clinicians and patients, reduce costs for the Canadian medical system, and provide advanced care to those who need it.
- **Opening a collaboration centre with the Centre hospitalier universitaire Sainte-Justine (CHUSJ)** for translational research in personalized medicine for mother and child. Activities will be focused on advanced bioanalytics (for diagnosis and therapeutics) and target discovery for pediatric oncology, neonatology, mother and child health, and personalized medicine applications.
- **Collaborating with the Centre Hospitalier de l'Université de Montreal on a hospital-located lab for human tissue biomechanical research** to support simulation training, biomedical implants, and industry cooperation.
- **Leveraging the NRC's lab space in Boucherville, QC, to create capacity for industrial fabrication of microfluidic devices** using NRC know-how in nanofabrication and lab-on-chip technologies and co-managing it with industry players in fabrication and instruments integration.
- **Aligning future research directions with government partners in Laboratories Canada (LC)**, for example, by continuing our radon research collaboration with Health Canada's Radiation Protection Bureau.

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**ADDITIONAL MISSION-SPECIFIC INITIATIVES**
  
**OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:**
  
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Aerospace	Reducing health and safety risk for aging, special needs, and vulnerable air passengers using the NRC’s newly opened Centre for Air Travel Research.
Aerospace	Working with Defence Research and Development Canada to find ways to reduce air crew and pilot fatigue, and improve their performance in challenging environments.
Automotive and Surface Transportation	Developing advanced materials and additive manufacturing processes for health applications in implantable medical devices.
Construction	Finding sustainable solutions for healthy indoor environmental quality, including air quality, mould, overheating, acoustics and noise, and lighting.
Construction	Developing building codes for the specific and varying needs of Canada’s Indigenous communities.
Human Health Therapeutics	Increasing the number of “made in Canada” therapeutics available for clinical trials.
Human Health Therapeutics	Working with the Public Health Agency of Canada to develop vaccines.
Human Health Therapeutics	Enabling the development and deployment of a “made in Canada” CAR-modified T cell therapy.
Medical Devices	Designing an “apothecary in a box” that can formulate and dispense modern medications, such as biologics and cell-based therapies, in remote locations or at the patient’s bedside.
Metrology	Supporting Government of Canada collaborators in the legalization and regulation of cannabis.
Nanotechnology	Harnessing nanotechnology to reduce critical side effects of medicines in aging populations.
Nanotechnology	Integrating bio-markers into drug design for superior immunotherapy using nanotechnology.

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**NRC MOONSHOT FOR A HEALTHIER FUTURE**
  
**WE WILL WORK WITH ACADEMIC AND INDUSTRIAL PARTNERS**
  
**TO PUSH THE LIMITS OF WHAT’S POSSIBLE BY:**
  
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Disruptive Technology Solutions for Cell and Gene Therapy Challenge Program • Applying NRC expertise in antibody technologies, viral vector biomanufacturing, AI, nanomaterials, and metrology to accelerate the development and delivery of safe and affordable cell and gene therapies in Canada. Our efforts will focus on three areas: developing technologies that result in next-generation, “universal” approaches to cell and gene therapies; supporting build-up of Canada’s ability to biomanufacture and characterize cell and gene products in Canada; and leveraging disruptive technology platforms in microfluidics, AI, and gene engineering to accelerate cycles of scientific discovery in this field.



## SUPPORTING A HEALTHIER FUTURE

### GOAL TWO

Develop innovative, affordable and sustainable approaches to food production

### OUTCOME

Smart solutions to improve the efficiency and productivity of agriculture, aquaculture, and bioresource development in Canada

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- Establishing initiatives to support the Protein Industries Supercluster to position Canada as a leading source of high-quality plant protein and plant based co-products.
- Supporting the Ocean Supercluster by leading the Marine Bioresources thrust to develop approaches to utilize marine biomass.
- Developing a new program focused on agri-food to apply leading-edge technology and thinking to affordable and sustainable food production for diverse environments, high-value food products, smart solutions for food quality and safety, and value-added bioproduct innovation and development from agricultural biomass.
- Expanding critical research platforms for the food sector, including the NRC's plant tissue culture, analytical and cell technologies, plant growth facility, marine research station, and zebrafish research facility.

ADDITIONAL MISSION-SPECIFIC INITIATIVES  
OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:

Aerospace	Employing aircraft-mounted hyperspectral sensors for crop sensing and surveillance.
Aquatic and Crop Resource Development	Enabling Canadian producers, processors, and manufacturers to adapt to changing conditions and provide safer and healthier products to Canadians.
Aquatic and Crop Resource Development	Capturing more value from Canadian renewable bioresources through greater domestic production of higher-value products.
Automotive and Surface Transportation	Developing food packaging solutions derived from agricultural biomass.
Digital Technologies	Enabling Blockchain technology to assist traceability of Canadian agricultural products.
Metrology	Delivering certified reference materials and testing methods for biotoxins.





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**THE NRC'S FIVE AREAS  
OF STRATEGIC FOCUS**

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**NUMBER  
THREE**

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**INNOVATING  
THE EVERYDAY**

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In Canada, what was once dubbed “the information highway” has now given way to the new frontier in business, which includes digitalization and AI, robotics and automation, sensors and Wi-Fi. These technologies are changing the everyday lives of Canadians, unlocking economic opportunity, and bringing faster communications links and the features of networked electronic life to remote communities. The NRC is well situated and has significant expertise in digital and other technologies that touch Canadians’ everyday lives.

Over the next five years, the NRC’s work to innovate the everyday — often in collaboration with other federal departments such as Innovation Science and Economic Development and Transport Canada — will focus on two main goals, one to advance efficiency-based innovations across industry sectors, and the other to develop and deploy innovative solutions from current cutting-edge science.

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## INNOVATING THE EVERYDAY

### GOAL ONE

Achieve breakthroughs to bring greater efficiency to Canadian homes, workplaces and transportation networks

### OUTCOME

More efficient homes, workplaces, and transportation networks that improve Canadians' quality of life

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- **Pushing the boundaries with the NRC's Advanced Manufacturing Program**, which supports Canada's manufacturing sector with research to boost productivity and agility by reducing manufacturing costs in the factory, including those associated with design, supply, processing and assembly. Areas of focus will include improved analytics, better machine and plant connectivity, maximized asset utilization, increased automation, and more energy-efficient manufacturing facilities and operations. In addition, the NRC will develop novel formulations, processes, and methods for advanced manufacturing, including metallic, composite/polymer additive manufacturing, forming and assembling, as well as advancing new sustainable materials using Canadian biomasses, industrial by-products and waste.
- **Providing support to superclusters beyond advanced manufacturing**, including the protein and ocean supercluster programs.
- **Leading NRC challenge programs in areas that affect Canadians' day-to-day lives**, including those geared toward health, new energy materials, and fast, and secure high throughput networks.
- **Creating a new NRC program focused on integrated autonomous mobility** to explore the possibilities of integrating air and ground modes of transporting people and goods, and to address the limitations of current urban infrastructures, mobility congestion, and the growing demand for faster and more efficient mobility.
- **Including a focus on issues related to Canada's North** in the next wave of NRC Challenge programs.
- **Completing the NRC's Advanced Materials Research Facility in Mississauga, Ontario**, as part of Laboratories Canada (LC). Initial focus areas at this new facility will include novel feedstock materials for additive manufacturing and printed electronics, clean energy materials, smart and multifunctional structures and sensors, and wearable devices — all of which will eventually improve Canadians' everyday lives.
- **Establishing a collaboration centre with the University of Manitoba** to create a workforce attuned to the needs of advanced manufacturing.
- **Strengthening international outreach to Germany, UK, and Japan** for deeper, sustained collaboration on advanced manufacturing.
- **Collaborating with other government departments on common research areas through LC**. LC will better position federal science to overcome barriers to collaboration, be more efficient, and build synergies across programs to address current and future science, technology and innovation challenges. Likely areas for collaboration that would affect Canadians include healthy indoor environments, energy efficiency, and climate resiliency.

**ADDITIONAL MISSION-SPECIFIC INITIATIVES**  
**OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:**

Advanced Electronics and Photonics	Pushing the boundaries of printable and wearable electronics for everyday smart applications.
Aerospace	Developing niche technologies for autonomous air systems and qualifying them on static and scaled flying demonstrators.
Aerospace	Investigating new aircraft configurations that reduce weight, lifecycle costs, and use of materials of concern, and gain fuel efficiencies.
Aquatic and Crop Resource Development	Developing smart solutions for food quality and safety.
Automotive and Surface Transportation	Developing new advanced manufacturing capabilities in co-bots, metal additives, and digital threading.
Automotive and Surface Transportation	Improving safety and efficiency in rail transportation with world-leading technologies such as risk mapping and rail car and track health monitoring.
Construction	Using green building technology to increase employee well-being and improve organizational performance.
Energy, Mining and Environment	Developing technologies and analytics using digital innovation to improve productivity, sustainability, and health and safety in mining operations.
Ocean, Coastal and River Engineering	Harnessing digital technology to improve safety in the offshore and shipping industries with better understanding of the harsh environment.



## INNOVATING THE EVERYDAY

### GOAL TWO

Develop and deploy next-generation solutions to everyday challenges

### OUTCOME

Innovations that keep pace with the rapid technological change impacting our daily lives

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- Establishing initiatives to support the **SCALE.AI Supercluster** in developing leading-edge solutions for businesses and accelerating AI adoption in Canadian supply chains.
- Opening collaboration centres with the University of New Brunswick, the University of Waterloo, Université de Montréal, and the University of Toronto
- Fields Institute for Research in Mathematical Sciences to exchange ideas and further digital technology research, and to gain access to a depth of expertise in digital technology.
- Including a focus on the **Internet of Things** in the next wave of the NRC Challenge programs.

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**ADDITIONAL MISSION-SPECIFIC INITIATIVES**  
**OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:**  
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Advanced Electronics and Photonics	Leading the development of technologies required for fast, reliable Internet across Canada, including rural and remote locations through the High Throughput and Secure Networks challenge program.
Aerospace	Exploring the use of digital twins to support aircraft certification and testing.
Aerospace	Working with Transport Canada to support emerging aircraft certification requirements, particularly for autonomous aerial systems and additively-manufactured materials.
Automotive and Surface Transportation	Harnessing digital technologies to advance intelligent transportation systems targeting freight/personal mobility, multi-modal fleet optimization and cybersecurity.
Digital Technologies	Developing new sensors for vision, speech and taste.
Digital Technologies	Supporting the next generation technology for distributed ledgers (Blockchain).
Digital Technologies	Optimizing human-computer interaction and enhancing the preservation of indigenous languages through using AI.
Metrology	Supporting high-integrity precision time essential to finance, navigation, communication, security and electric power transmission.
Ocean, Coastal and River Engineering	Working with the Canadian Coast Guard, the Royal Canadian Navy and the marine industry on technologies to address next generation needs in marine transportation.

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**NRC MOONSHOT FOR EVERYDAY INNOVATION**  
**WE WILL WORK WITH ACADEMIC AND INDUSTRIAL PARTNERS**  
**TO PUSH THE LIMITS OF WHAT'S POSSIBLE BY:**  
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**Artificial Intelligence (AI) for Design Challenge Program** • Developing a foundation of AI tools, technologies, and capabilities to support the NRC’s other challenge programs in health, new energy materials, and fast, reliable networks. Our efforts will focus on three areas: deep material science to demonstrate and develop AI tools that enable material scientists to find better materials for faster deployment; AI for biological systems to create AI-enabled simulation and discovery platforms for biological system design; and description, optimization, and remediation; and AI-enabled photonic design to develop a suite of AI methods to address a variety of the design problems in the photonic space, accelerating the design of next-generation photonic components. We will also develop core competencies needed to support the other challenge programs and for the development of a suite of AI for design tools.



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## THE NRC'S FIVE AREAS OF STRATEGIC FOCUS

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# NUMBER FOUR

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## CREATING CANADIAN WEALTH THROUGH INNOVATION

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Canada's SMEs may be small, but they account for more than 98 percent of all Canadian businesses and approximately 95 percent of jobs created between 2005 and 2015.<sup>29, 30</sup> Despite this importance, Canadian SMEs face an uphill battle to grow and thrive, and in some cases, to survive. The NRC actively supports Canadian SMEs through IRAP programs, assistance from research centres, and coordinated efforts between the four "flagship platforms" of the Canadian innovation ecosystem as identified in the 2018 federal budget (IRAP, the Strategic Innovation Fund, the Trade Commissioners Service, and the regional development agencies). As such, the NRC will continue to be a driver of economic growth, jobs, and opportunities.

Over the next five years, the NRC's work to create wealth through innovation — often in collaboration with Innovation, Science and Economic Development Canada, regional development agencies, and Global Affairs Canada and other science-based departments and agencies — will focus on two main goals: one to grow SMEs to scale, the other to increase the reach of these SMEs in Canada and abroad.

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## CREATING CANADIAN WEALTH THROUGH INNOVATION

### GOAL ONE

Accelerate the start-up and commercialization of SMEs in Canada and help them to become the next generation of global multi-national enterprises (MNEs)

### OUTCOME

More SMEs and better support for scale-up, leading to improved job creation and prosperity for Canada

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- **Scaling IRAP to maximize results from the additional funding and responsibility assigned to IRAP by the federal government in 2018 to accelerate scale-up of Canadian SMEs.** Adjustments include \$133 million in increased contribution funding to firms through implementation of the program for large value contributions up to \$10 million per project (previously capped at \$1 million) to help medium-size firms reach the next level, and forging partnerships with additional funding institutions to support SME access to new sources of scale-up capital.
- **Strengthening the fabric of the Canadian workforce** by expanding the number of internships in SMEs to increase their research, development, and innovation capacity, and renewing focus on under-represented groups among IRAP clients to support their business innovation efforts.
- **Transitioning the Concierge business advisory and referral service to Innovation, Science and Economic Development Canada** to better integrate it with other federal government innovation support programs.
- **Continuing the NRC Certificate Program beyond the pilot stage to make the cost of NRC research and development services more affordable for SMEs.** This initiative pairs a SME client with a NRC researcher on a short-term basis to solve a defined innovation challenge, helping SMEs gain solutions to innovation impediments.
- **Expanding a NRC internal program to support SMEs through procurement** using the government's new Innovative Solutions Canada program. This new approach allows the federal government to act as a first customer for business innovations by Canadian SMEs.
- **Supporting Canadian SMEs participating in Canada's five new supercluster initiatives with IRAP** financial assistance, advisory services, and business connections.
- **Underpinning the NRC's many collaboration centre initiatives with IRAP** financial assistance for SMEs, advisory services, and business connections.
- **Completing the NRC's Advanced Materials Research Facility in Mississauga, Ontario,** as part of Laboratories Canada. This new facility will support SMEs by bridging the gap between laboratory- and industrial-scale production, and accelerating novel materials development, application, validation, and industrial adoption.
- **Leveraging the Canadian Photonics Fabrications Centre** to spur the growth of Canadian telecommunications SMEs.
- **Increasing support to IRAP Sector Teams** and, by extension, nine areas of strategic importance to Canada with high concentrations of SME activity. The teams were established to identify common issues affecting SMEs in different sectors, share information about these issues, and develop initiatives to address them. The sectors include:
  - Biomedical, including pharmaceuticals, medical devices, e-health, and natural health products
  - Advanced manufacturing
  - Agri-food
  - Bioproducts
  - Construction
  - Aerospace
  - Mining
  - Information and Communications Technology
  - Cleantech

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**ADDITIONAL MISSION-SPECIFIC INITIATIVES**
  
**OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:**
  
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Advanced Electronics and Photonics	Develop and animate a photonics ecosystem delivering full solutions to Canadian SMEs from novel materials development through system integration.
Astronomy and Astrophysics	Employing Canadian SMEs in supplying technology solutions for new telescopes.
Astronomy and Astrophysics	Engaging with SMEs to apply technologies developed for observatories in other potential uses.
Automotive and Surface Transportation	Creating additional industrial R&D groups for SMEs and larger companies to share knowledge and expertise to the benefit of the entire industry.
Construction	Establishing living laboratories to test technologies for green buildings and flexible living with clients and stakeholders, including many SMEs.
Digital Technologies	Using advances in AI to help IRAP identify the best SMEs to support for successful scale-up to large companies that are Canadian from the start.
Energy, Mining and Environment	Assisting Canadian SMEs in the development and commercialization of energy storage devices and new technologies for the clean energy and mining sectors.
Human Health Therapeutics	Supporting SME innovation in the biopharmaceutical sector with novel research expertise in biotherapeutics, vaccines, and product process development.
Medical Devices	Supporting innovation in the medical devices sector, including the SMEs that make up 85 percent of the companies.

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**NRC MOONSHOT FOR CANADIAN WEALTH CREATION**
  
**WE WILL WORK WITH GOVERNMENT AND INDUSTRIAL PARTNERS**
  
**TO PUSH THE LIMITS OF WHAT'S POSSIBLE BY:**
  
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**Building Canadian Innovation Ecosystems to Support Start-up and Small-scale Company Growth • Using the NRC to create high-impact consortia within Canadian innovation ecosystems in priority areas for Canada.** Our efforts will focus on working through IRAP with the three other flagship platforms of the Canadian innovation landscape (the Strategic Innovation Fund, the Trade Commissioners Service and the regional development agencies) to work together to grow innovative SMEs in Canada to scale.



## CREATING CANADIAN WEALTH THROUGH INNOVATION

### GOAL TWO

Supercharge Canadian SMEs to help them seize opportunities and expand their global reach

### OUTCOME

More SMEs tied to global value chains, leading to a strengthened, diversified, Canadian economy

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- **Delivering on the three-year international strategy for the NRC**, built on the pillars of business innovation, research excellence, and international scientific relations, taking into account governance and management of key relationships, and support for the NRC's leadership in international fora.
- **Increasing SMEs' international engagement through the NRC's connection to EUREKA**, an international network for market-driven industrial R&D that includes over 40 economies from the EU, Israel, South Korea, Chile, South Africa, and Canada. Through Canada's associate membership in EUREKA, Canadian innovators have a new advantage in accessing technology, expertise, and markets in Europe and beyond. The NRC is the national contact point for EUREKA.
- **Focusing incremental efforts on three strategic markets for deeper, sustained collaboration: Germany, the United Kingdom and Japan.** These three countries were selected because of the NRC's long-standing engagements there, as well as for deeper strategic opportunities of benefit to Canada: Germany for its leadership in advanced manufacturing ("Industrie 4.0"), the United Kingdom for its solid research base, and Japan for its deep science and advanced manufacturing capabilities.
- **Creating an on-the-ground presence by opening offices in Germany and Japan** to help identify capacity and partnership opportunities. The relationships built and maintained through these offices will be of benefit to our proactive research agendas supporting ideation, supercluster initiatives, and our challenge programs.
- **Focusing on ways to better integrate Canadian SMEs into global value chains and grow exports** from IRAP clients, including help for SMEs in creating co-innovation strategies for accessing markets and global value chains as well as supporting mechanisms that help SMEs access global value chains.
- **Simplifying the business model for accessing international programs** for IRAP ITAs, SMEs and NRC researchers.

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**ADDITIONAL MISSION-SPECIFIC INITIATIVES**  
**OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:**  
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Advanced Electronics and Photonics	Enabling Canadian SMEs in the photonics sector to succeed on the international stage by taking them from concept to new product introduction phase at the Canadian Photonics Fabrication Centre.
Aerospace	Supporting the insertion of SMEs in the aerospace global value chain, particularly in the area of autonomous mobility.
Aquatic and Crop Resource Development	Growing the Canadian bioproduct sector through innovation in SMEs and larger companies that makes bio-based technologies and products more globally competitive.
Automotive and Surface Transportation	Facilitating the adoption of emerging and innovative technologies by SMEs and other Canadian companies to better position them in the global manufacturing and surface transportation ecosystems.
Construction	Collaborating with international partners such as the UK Catapult Centres to develop satellite structural health monitoring technologies.
Medical Devices	Creating and supporting globally competitive Canadian innovation networks and clusters for medical devices.
Nanotechnology	Inserting Canadian SMEs into the value chain with Hitachi and other Japanese organizations and universities, as part of the next Canada-Japan Science and Technology Agreement.



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**THE NRC'S FIVE AREAS  
OF STRATEGIC FOCUS**

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**NUMBER  
FIVE**

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**UNDERSTANDING  
OUR WORLD**

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Home to about 2,200 scientists, engineers, and technicians contributing to science and engineering breakthroughs around the world, the NRC brings deep and diverse expertise to bear on many of the fundamental questions and enabling technologies that will spur Canadian innovation in the future.

Over the next five years, often working with federal partners such as the Canadian Space Agency, the NRC will focus on two main goals, one broad, one more targeted, but each important to Canada's long-term prosperity.

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## UNDERSTANDING OUR WORLD

### GOAL ONE

Dig deep into questions of fundamental science to spur Canadian innovation

### OUTCOME

Advanced knowledge from breakthroughs leading to a better, safer, more prosperous future for Canada

#### WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- Using global investments that provide Canadian astronomers access to world-leading observatories through national and international partnerships in astronomy and astrophysics, including the Canada-France-Hawaii Telescope (CFHT) and the Gemini Observatory. The NRC will also work with the astronomy community to develop new facilities and services following the roadmap in the community-based Long Range Plan for Canadian Astronomy, including the Thirty-Metre Telescope (TMT) and the Square Kilometre Array (SKA).
- Launching a new NRC program focused on next-generation electron microscopy technology development to support our research centres and programs with application-specific problems in multiple disciplines and industrial sectors. Electron microscopy is a fundamental technology for science and technology developments in all fields, and advances in this tool would have a cascading effect on innovation and scientific discoveries, in all disciplines and most R&D-driven economic sectors.
- Establishing or leveraging cooperative research arrangements with leading Canadian universities to address key areas of fundamental understanding, including the University of Ottawa Collaboration Centre on Extreme Photonics; the University of Alberta Nanotechnology Initiative; the Canadian Centre for Research and Applications in Fluidic Technologies (CRAFT) Collaboration Centre at the University of Toronto; the Centre hospitalier universitaire Sainte-Justine (CHUSJ); the Canadian Astronomical Data Centre with University of Victoria, and the University of Waterloo and Université de Sherbrooke on quantum devices, in addition to other opportunities.
- Strengthening international partnerships on quantum physics with the UK through Oxford University and with Germany through the Max Planck Institute, as well as with Japan for electron microscopy research and development.
- Completing the NRC's Advanced Materials Research Facility in Mississauga, Ontario, as part of Laboratories Canada. Functioning as a hub for innovation in advanced materials, this new facility will specialize in the design, prototyping, and production of new advanced materials and operate a national platform to support foundational research in new materials.



ADDITIONAL MISSION-SPECIFIC INITIATIVES  
OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:

Aerospace	Understanding the fundamental physics underlying ice formation on aircraft frames and engines in flight in varying atmospheric conditions.
Astronomy and Astrophysics	Pioneering astrophotonics for extremely large telescopes (40-metre mirrors) that require advanced optics, composed of numerous miniaturized photonic components.
Automotive and Surface Transportation	Developing novel formulations, processes, and methods for manufacturing and smart manufacturing.
Energy, Mining and Environment	Developing new approaches for AI-enabled accelerated materials discovery.
Human Health Therapeutics	Catalyzing a breakthrough in disease treatments by developing “universal cells” capable of attacking diseases or replacing function in any patient, and by creating genome editing technologies, capable of correcting genetic defects with high precision.
Medical Devices	Employing microfluidic technologies to support a health decision process in space that can also be used in remote areas.
Metrology	Leading Canada’s contribution to the redefinition of the International System of Units (SI).
Security and Disruptive Technologies	Developing adaptive and intelligent materials to go beyond current theoretical limits imposed by conventional assemblies in order to create on-demand materials and devices that will transform the way all things are manufactured, used, and commercialized, from medical devices to engineered structures.
Security and Disruptive Technologies	Working with Government of Canada partners to develop a quantum science strategy for the federal government.
Security and Disruptive Technologies	Harnessing the convergence of nanotechnology, computation, measurement science, and material engineering to develop ground-breaking intelligent materials that will sense and react to the environment in ways that surpass the capabilities of conventional materials.



UNDERSTANDING OUR WORLD

GOAL  
TWO

Fuel the next generation of fast, secure communication networks

OUTCOME

Fast, affordable, reliable internet connections throughout Canada, from coast to coast to coast

WE WILL LEVERAGE THE NRC'S STRATEGIC PLATFORMS TO ACHIEVE THIS GOAL BY:

- Establishing cooperative research arrangements with leading Canadian universities to address key network challenges.
- Developing next generation tools for quantum measurement, sensing, and communication.
- Developing new atomic-scale computing nanodevices to extend the Internet of Things to otherwise unpredictable or uncontrollable parts of our lives, such as health and environmental monitoring, as well as tackle issues associated with the need for increased bandwidth.

ADDITIONAL MISSION-SPECIFIC INITIATIVES  
OUR RESEARCH CENTRES WILL FURTHER SUPPORT THIS GOAL BY:

Advanced Electronics and Photonics	Demonstrating quantum-secured optical links in both a short- (free-space optics terrestrial) and long-range (low earth orbit satellite) span.
Digital Technologies	Taking computer and network security to the next level by finding new ways to integrate cybersecurity discoveries directly into products and services, which would improve national security, privacy, and safety.
Metrology	Developing next-generation tools for improved quantum measurement and timing, including the development of precision, ultrafast, and attosecond timing; ultrafast frequency combs; state tomography and detection; and next-generation quantum standards to facilitate adoption of quantum technologies.
Nanotechnology	Developing new atomic-scale computing nanodevices to extend the Internet of Things to otherwise unpredictable or uncontrollable parts of our lives, such as health and environmental monitoring, as well as tackle issues associated with the need for increased bandwidth.
Security and Disruptive Technologies	Building the elements of quantum computers through the development of qubit spin, photonic, and quantum systems; advanced theory and computation; and quantum AI interface development.
Security and Disruptive Technologies	Designing un-hackable communication components, systems, and networks through the development of light-matter interfaces; quantum repeaters; single-photon sources; and quantum processing.

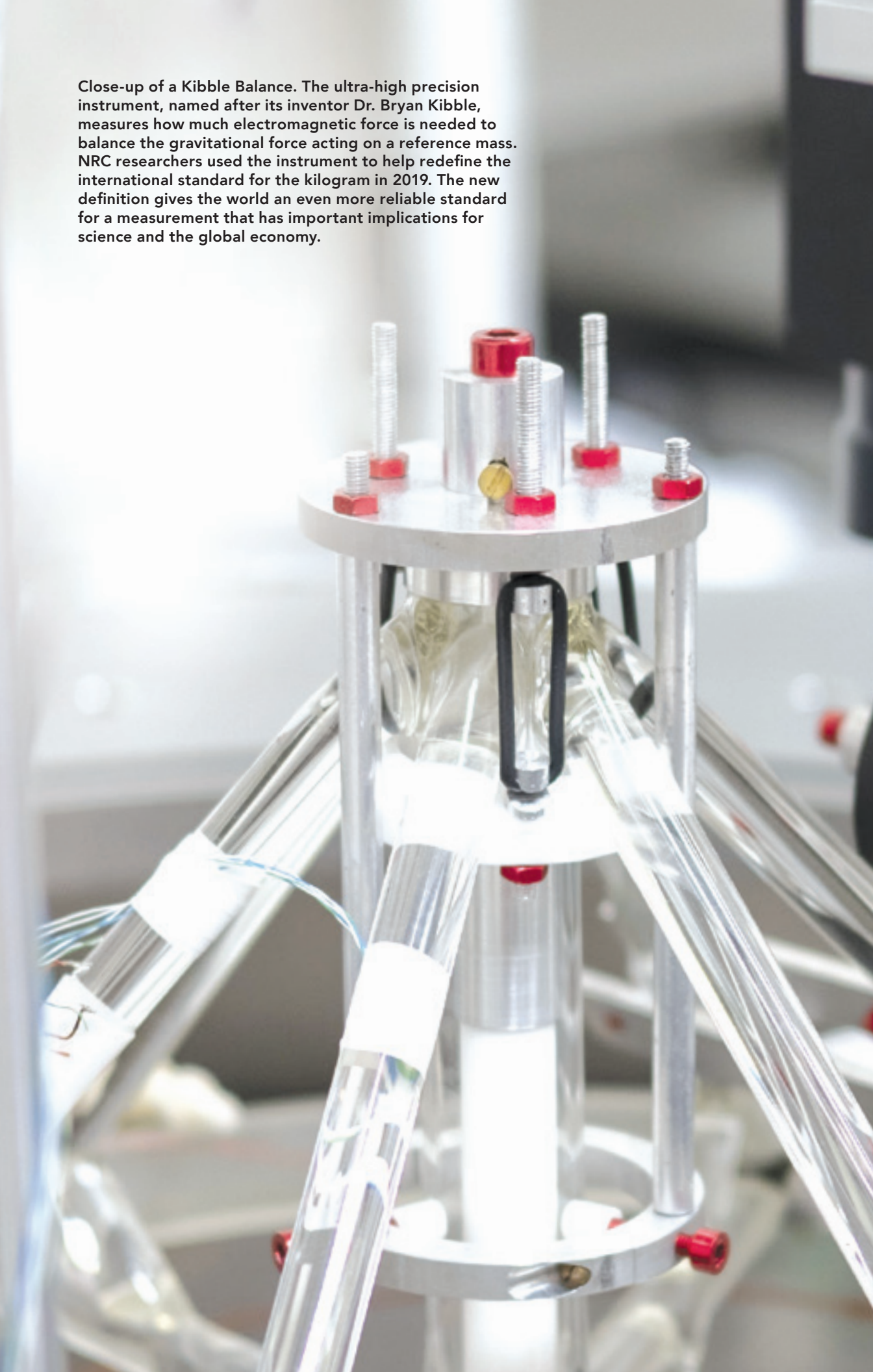
NRC MOONSHOT FOR UNDERSTANDING OUR WORLD  
WE WILL WORK WITH ACADEMIC AND INDUSTRIAL PARTNERS  
TO PUSH THE LIMITS OF WHAT'S POSSIBLE BY:

High Throughput and Secure Networks Challenge Program • Developing innovative technologies that can help deliver affordable, high-speed, and secure broadband services to rural and remote communities. Our efforts will focus on increasing the transmission capacity of optical communication in core networks, enhancing security of transmission channels, and developing a suite of last mile/first mile and space optical communication technologies.



# **TRACKING PROGRESS AND MEASURING SUCCESS**

Close-up of a Kibble Balance. The ultra-high precision instrument, named after its inventor Dr. Bryan Kibble, measures how much electromagnetic force is needed to balance the gravitational force acting on a reference mass. NRC researchers used the instrument to help redefine the international standard for the kilogram in 2019. The new definition gives the world an even more reliable standard for a measurement that has important implications for science and the global economy.



Planning and advancing a five-year strategic plan is a big undertaking, but ultimately it only precedes the heavy lifting that comes with implementation. Tracking progress towards our shared goals and measuring their impact will be important work throughout the life of the plan. Because the NRC’s five-year integrated strategic plan is an amalgam of the 28 strategic plans developed by our research centres, IRAP, and corporate branches, we will take a multifaceted approach.

**FOCUS ON RESULTS**

We will measure and report the success of our strategic plan according to the NRC’s three core roles and our Performance Measurement Framework.

Some of our top line indicators for each of our core roles will be:

**To support business innovation**

- SME client satisfaction
- Revenue growth of NRC-supported firms

**To provide science-based policy solutions to government**

- Publications in government priority areas
- Collaboration with government partners

**To advance scientific and technical knowledge**

- Patents granted
- Publications generated
- Citation score

**PROGRESS ON THE FIVE AREAS OF STRATEGIC FOCUS**

To track the impact of our progress on the 10 goals we have set for ourselves against our five areas of strategic focus, we will engage our research centres and IRAP in assessing their progress on their strategic plans and performance indicators. These results will then be rolled up to inform the NRC’s overall progress.

At the end of each fiscal year for the duration of this plan, these results will be reported to the NRC Council and the full Executive Committee. They will also be made available to all NRC employees.

**PLANNING AND PRIORITIES UPDATES**

Annually, each of the NRC’s 28 research centres, IRAP, and corporate branches will update their operational plans and priorities in line with their strategic plan commitments. This interlocking process will drive progress on the five areas of strategic focus, support our overall focus on results, and deliver on the NRC’s core roles. Mid-way through the implementation of the NRC’s five-year integrated strategic plan, we will perform a thorough review of the continued relevancy of the plan’s goals and strategies against our changing external and internal environment, making adjustments to the plan as needed. We will consult our external advisory boards, our Council and other key stakeholders as we undertake this review.



**Emerging science  
and cutting edge  
innovations are rapidly  
redefining industry  
business models,  
research, lifestyles,  
community obligations  
and societal needs,  
and the NRC must  
adapt to ensure the  
well-being of Canada  
and Canadians.**

1. World Economic Forum. *Global Risks Report 2017*. Davos, Switzerland: World Economic Forum; 2017: <http://reports.weforum.org/global-risks-2017/>.
2. U.S. Global Change Research Program. *Climate Science Special Report: Fourth National Climate Assessment, Volume I* Washington, DC: U.S. Global Change Research Program; 2017: <https://science2017.globalchange.gov/>.
3. Intergovernmental Panel on Climate Change. *Climate Change 2013: The Physical Science Basis 2013* <http://www.ipcc.ch/report/ar5/wg1/>.
4. World Economic Forum. *Global Risks Report 2019*. Davos, Switzerland: World Economic Forum; 2019: <http://reports.weforum.org/global-risks-2019/>.
5. The United States has stated its intent to withdraw from the Paris Agreement, but it can't formally do so until 2020.
6. The Conference Board of Canada. *Canada 2030: The Defining Forces Disrupting Business*. August 2018. <https://www.conferenceboard.ca/e-library/abstract.aspx?did=9813&AspxAutoDetectCookieSupport=1>
7. Government of Canada. *Pan Canadian Framework on Clean Growth and Climate Change*. 2016. <https://www.canada.ca/content/dam/themes/environment/documents/weather1/20170125-en.pdf>
8. UNDESA (UN Department of Economic and Social Affairs). *World Population Prospects: The 2017 Revision*, [https://population.un.org/wpp/Publications/Files/WPP2017\\_DataBooklet.pdf](https://population.un.org/wpp/Publications/Files/WPP2017_DataBooklet.pdf)
9. PWC. *Rapid Urbanisation 2018*: <https://www.pwc.co.uk/issues/megatrends/rapid-urbanisation.html>.
10. World Economic Forum. *Global Risks Report 2019*. Davos, Switzerland: World Economic Forum; 2019: <http://reports.weforum.org/global-risks-2019/>.
11. OECD. *OECD Science, Technology and Innovation Outlook 2016*. Paris: OECD; 2016: [https://www.oecd-ilibrary.org/fr/science-and-technology/oecd-science-technology-and-innovation-outlook-2016\\_sti\\_in\\_outlook-2016-en](https://www.oecd-ilibrary.org/fr/science-and-technology/oecd-science-technology-and-innovation-outlook-2016_sti_in_outlook-2016-en)
12. Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11-402-x/2011000/chap/seniors-aines/seniors-aines-eng.htm>
13. Frost and Sullivan. *The Future of the United States*, 2<sup>nd</sup> ed. Mountain View, CA: Frost and Sullivan; 2017.
14. World Economic Forum. *Global Risks Report 2017*. Davos, Switzerland: World Economic Forum; 2017: <http://reports.weforum.org/global-risks-2017/>.
15. World Economic Forum. *Global Risks Report 2019*. Davos, Switzerland: World Economic Forum; 2019: <http://reports.weforum.org/global-risks-2019/>.
16. OECD. *OECD Science, Technology and Innovation Outlook 2016*. Paris: OECD; 2016: [https://www.oecd-ilibrary.org/fr/science-and-technology/oecd-science-technology-and-innovation-outlook-2016\\_sti\\_in\\_outlook-2016-en](https://www.oecd-ilibrary.org/fr/science-and-technology/oecd-science-technology-and-innovation-outlook-2016_sti_in_outlook-2016-en)
17. Public Safety Canada. *National Cyber Security Strategy - Canada's Vision for Security and Prosperity in the Digital Age*. 2018: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/ntnl-cbr-scrtr-strtg/index-en.aspx>.
18. The Conference Board of Canada. *Canada 2030: The Defining Forces Disrupting Business*. August 2018. <https://www.conferenceboard.ca/e-library/abstract.aspx?did=9813&AspxAutoDetectCookieSupport=1>
19. OECD. *OECD Digital Economy Outlook 2017*. Paris: OECD; 2017: [https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017\\_9789264276284-en](https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017_9789264276284-en)
20. OECD. *OECD Digital Economy Outlook 2017*. Paris: OECD; 2017: [https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017\\_9789264276284-en](https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017_9789264276284-en)
21. Council of Canadian Academies. 2018. *Competing in a Global Innovation Economy: The Current State of R&D in Canada*. [http://new-report.scienceadvice.ca/assets/report/Competing\\_in\\_a\\_Global\\_Innovation\\_Economy\\_FullReport\\_EN.pdf](http://new-report.scienceadvice.ca/assets/report/Competing_in_a_Global_Innovation_Economy_FullReport_EN.pdf)
22. Nicolson, Peter. 2018. *Facing the Facts: Reconsidering Business Innovation Policy in Canada*. IRPP Insight 22. <https://on-irpp.org/2Z1ftt3>
23. Nicolson, Peter. 2018. *Facing the Facts: Reconsidering Business Innovation Policy in Canada*. IRPP Insight 22. <https://irpp.org/wp-content/uploads/2018/10/Facing-the-Facts-Reconsidering-Business-Innovation-Policy-in-Canada.pdf>
24. BDC. *10 Things You (Probably) Didn't Know About Canadian SMEs 2017*: <https://www.bdc.ca/en/articles-tools/business-strategy-planning/manage-business/pages/10-things-didnt-know-canadian-sme.aspx>
25. Canada's Economic Strategy Tables. *The Innovation and Competitiveness Imperative: Seizing Opportunities for Growth*. 2018. <https://www.ic.gc.ca/eic/site/098.nsf/eng/00027.html>
26. Canada's Fundamental Science Review. *Investing in Canada's Future: Strengthening the Foundations of Canadian Research*. 2107. [http://www.sciencereview.ca/eic/site/059.nsf/vwapj/ScienceReview\\_April2017.pdf/\\$file/ScienceReview\\_April2017.pdf](http://www.sciencereview.ca/eic/site/059.nsf/vwapj/ScienceReview_April2017.pdf/$file/ScienceReview_April2017.pdf)
27. Innovation, Science and Economic Development Canada. *Building a Nation of Innovators*. 2019. [http://www.ic.gc.ca/eic/site/062.nsf/eng/h\\_00105.html](http://www.ic.gc.ca/eic/site/062.nsf/eng/h_00105.html)
28. Government of Canada. *Budget 2018: Equality and Growth for a Strong Middle Class*. <https://www.budget.gc.ca/2018/docs/nrc/2018-02-27-en.html>
29. Innovation Science and Economic Development Canada. *Key Small Business Statistics*. 2016(June). [https://www.ic.gc.ca/eic/site/061.nsf/vwapj/KSBS-PSRPE\\_June-Juin\\_2016\\_eng-V2.pdf/\\$file/KSBS-PSRPE\\_June-Juin\\_2016\\_eng-V2.pdf](https://www.ic.gc.ca/eic/site/061.nsf/vwapj/KSBS-PSRPE_June-Juin_2016_eng-V2.pdf/$file/KSBS-PSRPE_June-Juin_2016_eng-V2.pdf)
30. Statistics Canada. *Survey on Financing and Growth of Small and Medium Enterprises 2014*. [https://www.ic.gc.ca/eic/site/061.nsf/vwapj/SummarySFGSMEs-ResumeEFCPME\\_2014\\_eng.pdf/\\$file/SummarySFGSMEs-ResumeEFCPME\\_2014\\_eng.pdf](https://www.ic.gc.ca/eic/site/061.nsf/vwapj/SummarySFGSMEs-ResumeEFCPME_2014_eng.pdf/$file/SummarySFGSMEs-ResumeEFCPME_2014_eng.pdf)



**ANNEXES**

**NRC's Canadian Photonics Fabrication Centre keeps Canadians and the world connected by pushing the boundaries in photonics and electronics research and the development of new communication and sensor technologies.**



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ANNEX 1

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STRATEGIC HR PLAN

SUMMARY

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## ANNEX 2

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# ADVANCED ELECTRONICS AND PHOTONICS AT A GLANCE

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### VISION

To develop game-changing sensing and communications technologies that collect and move data, enabling Canada’s infrastructure and services to become smarter and accessible; and creating sustainable prosperity.

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### MISSION

To work with academia, other research organizations, and industry to discover, de-risk, develop and commercialize technologies that address economic and social challenges critical to Canada and the world.

.....

### EMPLOYEES

158

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### MAJOR FACILITIES

The NRC’s Advanced Electronics and Photonics Research Centre (AEP) works with clients to push boundaries in photonics and electronics research, and develop new communication and sensor technologies. AEP clients benefit from world-class facilities. The following are a few examples of AEP’s major facilities:

**Epitaxy (Ottawa):** early stage semiconductor materials development using molecular beam epitaxy (MBE), chemical beam epitaxy (CBE), metal-organic chemical vapour deposition (MOCVD); and organic materials deposition.

**Printable electronics (Ottawa):** a comprehensive suite of printing and coating equipment for process and prototype development.

**Canadian Photonics Fabrication Centre (Ottawa):** world-class design, engineering and semiconductor fabrication services, commercial-grade prototyping and pilot-run production.

**Advanced Technology Fabrication Centre (Ottawa):** early stage research for High-throughput and Secure Network (HTSN) program, development of Internet of Things (IoT) and Quantum components.



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**GOALS**

Increase strategic engagement with small and medium enterprises (SMEs)

Integrate Canadian photonics ecosystem to offer full solutions to private and public partners

Develop a research platform to support the High Throughput and Secure Networks challenge program

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**STRATEGIES TO ACCOMPLISH GOALS**

- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"><li>• Partner with IRAP to identify needs of Canadian SMEs and assist eligible clients through research certificate program</li><li>• Refocus CPFC business model to maximize the creation and support of SMEs</li><li>• Ensure Canada develops competitive and disruptive products.</li><li>• Help companies scale effectively, with a clear path to volume production</li></ul> | <ul style="list-style-type: none"><li>• Strengthen the photonics supply chain in Canada so that more services are available locally to companies, greatly reducing their product development cost and speeding time to market</li><li>• Partner with universities and other research organizations in Canada and abroad to increase complementary foundry and post-processing capabilities</li><li>• Offer full-time business development to ecosystem to grow effective partnerships</li></ul> | <ul style="list-style-type: none"><li>• Develop a suite of photonic technologies to support vision of 1 Gbps everywhere; e.g. cost/performance improvements in core photonics for fiber optics and fixed wireless access</li><li>• Convene a consortium of Canada’s optical satellite industry and research stakeholders.</li><li>• Advance capabilities and knowledge in quantum communication and QKD</li></ul> |
|---|---|---|
- .....

**PROGRAMS**

- High Throughput and Secure Networks challenge program
  - Materials for Clean Fuels challenge program
  - Support for Advanced Manufacturing Supercluster
  - Quantum Photonics for Sensing and Security
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capability in:** InP and GaAs active semiconductor device fabrication; advanced technology fabrication; novel III-V semiconductor materials discovery and device development; organic materials discovery and device development; metamaterial photonics; and photonic and electronic device design and test.

**Increase current capability in:** integration and packaging of semiconductor technologies; materials growth and exploration; quantum technologies; sensors; free-space optics; and device design and testing.

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## AEP'S COMMITMENT TO RESEARCH EXCELLENCE

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### How AEP defines research excellence

Leading-edge, high-impact research with international recognition proven by:

- individual researchers/team awards and serving on international scientific bodies
- publications in high impact journals and invited conference presentations
- patents leading to technology transfer and licensing opportunities
- meaningful collaborations with leading organizations in the field
- recognition by customers as a reliable source of expertise and manufacturable solutions.

### Science goals AEP aims to achieve to advance in their field(s) of research

Creation of next-generation photonic and electronic technologies through innovations in materials, device design, and fabrication.

### Actions AEP will take to increase the level of research excellence

- continued leadership of DG's Research Excellence Advisory Committee (DREAC) – a scientific advisory committee which assists AEP management in setting strategic research directions, and attracting, recruiting, and retaining excellent researchers.
- AEP will create RC level research projects to build capabilities for future programs, to strengthen strategic research areas, and to ensure critical resources are available, particularly in leading-edge fabrication.
- encourage and support exploratory research ideas by creating a general time code for early research and encourage involvement in NRC-wide ideation activities.

### How AEP engaged researchers in developing a research agenda to support growth in excellence

AEP established a DG's Research Excellence Advisory Committee (DREAC) — a scientific advisory committee comprised of PROs/RCO5s to assist AEP management in setting strategic research directions and to assess research activities against excellence criteria. The Committee includes AEP's PREAC representative to maintain alignment with the NRC's agenda for growth in research excellence.

## FORWARD LEADING EDGE OF AEP'S RESEARCH AGENDA

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**Fabrication:** novel growth (compound semiconductors, quantum dots) methods and processing technologies for next generation optical and electronic devices.

**Photonics components:** communications (core network and satellite communication) and sensing (environmental, advanced manufacturing, transportation, astrophotonics) based on engineered materials, novel nanostructures, AI-enabled design, and optical coatings.

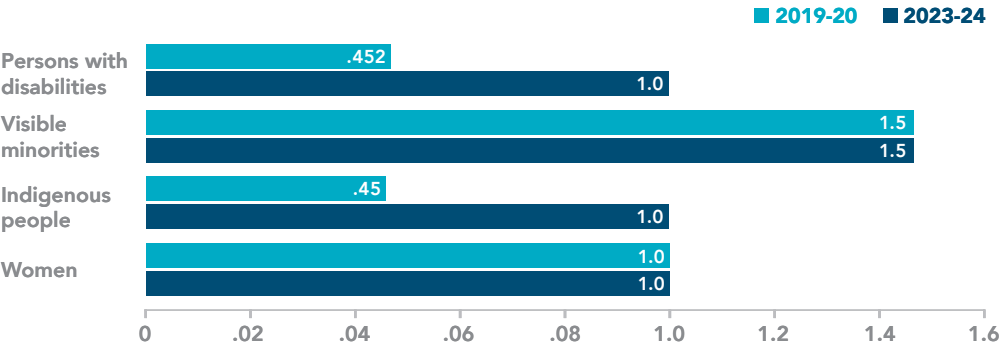
**Printable electronics for IoT:** power-autonomous sensors for IoT through development of novel materials, device physics, and fabrication processes.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	69	45	65
Citation score†	1.38	1.5	1.5
Unique patents granted	–	1	4
Students, postdoctoral fellows and research associates	18	18	23
Clients and collaborators	20	22	24
Revenue (\$M)	18.897	19.58	19
Expenditures (\$M)	29.718	28.15	28.229

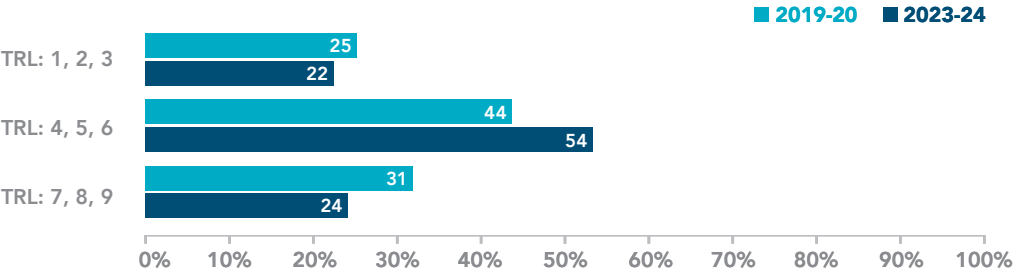
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017-2018 = 2017)  
† Field-weighted citation impact (FWCI) is the average citation rate for RC publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016 and 2017, extracted from Scopus on March 8, 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 3

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# AEROSPACE RESEARCH CENTRE AT A GLANCE

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### VISION

A stronger Canadian and global aerospace sector through research, innovation, and collaboration.

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### MISSION

Create, advance, and apply world-leading aerospace capabilities in Canada for the benefit of society.

.....

### EMPLOYEES

311

.....

### MAJOR FACILITIES

The NRC’s Aerospace Research Centre (AERO) offers industry partners access to world-class R&D facilities. The following are a few examples of AERO’s major facilities:

**Altitude Icing Wind Tunnel (Ottawa):** provides skilled and experienced professional and technical support in all aspects of icing wind tunnel testing, including test design, model design and fabrication, instrumentation, test management, and report preparation.

**Aerospace Manufacturing Technologies Centre (Montreal):** supports clients by performing research and technology development in areas such as advanced material removal technologies, aircraft assembly, fibre placement and autoclave processing, and metal forming.

**Gas turbine research facilities (Ottawa, ON and Thompson, MB):** deliver advanced technology solutions to the aerospace and energy sectors through multiple NRC aerospace and energy programs, both in civilian and military applications.

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<b>GOALS</b>			
Enhance AERO's value in the Canadian aerospace sector	Develop partnerships to enable program goals and grow AERO's capabilities	Develop the workforce to support AERO's vision and mission	Ensure AERO's facilities are managed with its "3S" vision: sustainable, stewarded, strategic

.....			
<b>STRATEGIES TO ACCOMPLISH GOALS</b>			
<ul style="list-style-type: none"> <li>• Engage clients and stakeholders throughout program development to validate proposals</li> <li>• Target new and emerging focus areas</li> <li>• Engage new and existing partners in technology consortia</li> </ul>	<ul style="list-style-type: none"> <li>• Leverage university capabilities / resources to develop sustainable areas of research</li> <li>• Formulate and execute collaborative technology roadmaps</li> <li>• Work with IRAP to advance program technology objectives</li> </ul>	<ul style="list-style-type: none"> <li>• Provide the resources for new hires</li> <li>• Continuously improve staff competencies through career development</li> <li>• Improve diversity in AERO's workforce</li> <li>• Participate in NRC ideation initiatives</li> </ul>	<ul style="list-style-type: none"> <li>• Update facility charge-out rates, where appropriate</li> <li>• Focus business development efforts on increasing utilization of strategic facilities</li> <li>• Consult stakeholders to identify and co-develop shared platforms</li> </ul>

.....			
<b>PROGRAMS</b>			
<ul style="list-style-type: none"> <li>• Aerospace Product Development and Certification</li> <li>• Advanced Manufacturing</li> <li>• Integrated Autonomous Mobility</li> </ul>			

.....			
<b>CHANGES IN CAPABILITIES</b>			
<p><b>Maintain current capabilities in:</b> aerodynamics; manufacturing; flight research; structures and materials; and gas turbines.</p> <p><b>Increase capabilities in:</b> aerodynamics analysis; process control and optimization, and new materials development for advanced manufacturing; hybrid electric system integration in airborne vehicles; application of artificial intelligence and machine learning for autonomous flight; and aerothermodynamics, hybrid-electric propulsion and systems engineering for airborne propulsion.</p>			
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## AERO'S COMMITMENT TO RESEARCH EXCELLENCE

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### How AERO defines research excellence

Exploiting our unique knowledge, abilities, and facilities to realize impactful innovation; facilitating renewal, transformation, and growth through ideation; being recognized by our peers and sought out by our clients and collaborators.

### Science goals AERO aims to achieve to advance in their field(s) of research

Development of innovative technologies for autonomous air vehicles used in urban transport, air-enabled services, and drone-related applications; creation of high-fidelity physics-based models to address the complex challenges of designing, certifying, and sustaining aeronautical products; advancement of fundamental understanding of the hazards associated with aircraft operation in icing environments, and supporting the development and certification of risk mitigation solutions; and insight into the human factors of all aspects of air travel, and development of technologies and tools to improve comfort, safety, and efficiency.

### Actions AERO will take to increase the level of research excellence

AERO will transform our capabilities to create research capacity in four emerging areas: autonomous mobility, disruptive architectures, digital twins, and additive/subtractive manufacturing; continue to pursue research excellence in areas of current strength (e.g. aircraft icing, high temperature materials, advanced manufacturing); enhance our relationship with targeted universities through more strategic engagement to accelerate the expansion of effort in the emerging areas; and increase the number of graduate students and postdoctoral fellows with a focus on developing our talent pipeline and enhancing the research profile of our staff.

### How AERO engaged researchers in developing a research agenda to support growth in excellence

Lab-level strategic planning informed by industry workshops; research centre strategic planning kickoff at all-staff town hall meeting; staff workshops at every site designed to review, validate, and fine-tune the shortlist of key focus areas in AERO's strategic plan; a facilitated session to review and update the AERO vision statement; and town hall meetings at every site to present and discuss the AERO strategy when it was in draft form.

## FORWARD LEADING EDGE OF AERO'S RESEARCH AGENDA

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**Collision avoidance sensors** for remotely-piloted aerial systems.

**Advanced microstructural fatigue models** for metallic materials in high-temperature environments (as found in high-performance gas turbine engines).

**Collaboration with international partners in large-scale experiments** to better understand icing hazards that may impact aviation safety.

**Passenger comfort index** to quantify the seamless travel experience and to aid cabin designers in predicting passenger satisfaction based on cabin design parameters.

OVERVIEW OF EXPECTED RESULTS

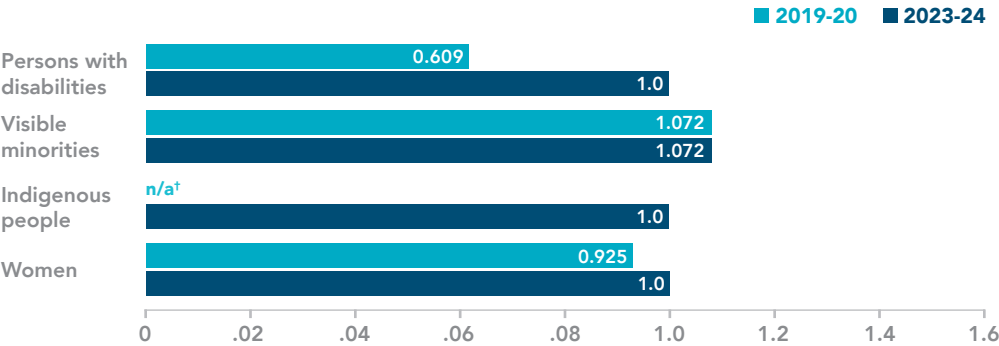
INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	96	109	132
Citation score†	1.21	–	–
Unique patents granted	–	3	3
Students, postdoctoral fellows and research associates††	37	35	35
Clients and collaborators	76	85	90
Revenue (\$M)	37.84	33	31.5
Expenditures (\$M)	59.37	57.824	53.596

\* Counted by calendar year, tracked as fiscal year start (i.e., FY2018 – 2018 = 2017)

† Field-weighted citation impact (FWCI) is the average citation rate for RC publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on March 8, 2019.

†† While the average number of students in AERO’s work force will stay relatively constant, over 5 years, AERO plans to increase the percentage of graduate students within its total student population from approximately 20% to over 30% (as high as 50% in some labs).

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*

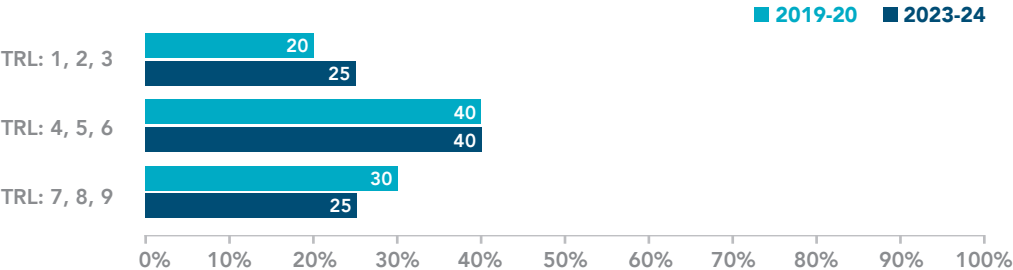


\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

†To adhere to confidentiality rules related to self-identification data, any representation number of 5 or less is listed as “N/A”.

Data on women does not come from the self-identification process and is therefore not subject to the same restrictions.

TECHNOLOGY READINESS LEVELS (TRLs)



ANNEX 4

AQUATIC AND CROP  
RESOURCE DEVELOPMENT  
AT A GLANCE



VISION

To make Canada a world leader in sustainable biomass transformation.

MISSION

To provide excellence in scientific advancement, research services, and technology development that enables the sustainable transformation of Canadian bio-based resources into higher-value products.

EMPLOYEES

213

MAJOR FACILITIES

The NRC’s Aquatic and Crop Resource Development Research Centre (ACRD) is home to a number of globally competitive research facilities across Canada. Select ACRD facilities include:

**Algal Research Facility (Ketch Harbour, NS):** designed for the cultivation and characterization of microalgae, seaweed, and other marine organisms, including maintenance of Canadian microalgae reference libraries. Supercritical CO<sub>2</sub> extraction capabilities are in place for downstream processing, and an analytical laboratory is onsite for conducting biomass and extract analyses.

**Zebrafish Facility (Halifax, NS):** designed for the innovative development and application of zebrafish animal models for bioproduct development and safety testing, including support for other government department mandates. It is gaining recognition internationally.

**Plant Growth Facility (Saskatoon, SK):** designed for small- and large-scale pilot plant studies in support of crop improvements and agricultural input development. It is one of the largest plant growth facilities (Phytotron) in North America.



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**GOALS**

Facilitate advances in sustainable agriculture and food production practices through fundamental R&D and industry support

Capture more value from renewable Canadian bioresources by supporting innovative technology development

Enhance ACRD Research Centre platforms and expertise

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**STRATEGIES TO ACCOMPLISH GOALS**

- |  |  |  |
|--|--|--|
| <ul style="list-style-type: none"><li>• Strengthen NRC’s position as an innovator in the Canadian agri-food sector</li><li>• Lead NRC’s contribution to the Protein Industries Canada (PIC) Supercluster</li><li>• Enhance ACRD’s reputation and impact in the Canadian agri-food sector</li></ul> | <ul style="list-style-type: none"><li>• Strengthen ACRD’s leadership role in bioresource (esp. marine) development and valorization</li><li>• Support NRC’s contribution to the Ocean Supercluster</li><li>• Enhance ACRD’s reputation and impact in the Canadian bio-based sector</li></ul> | <ul style="list-style-type: none"><li>• Expand capabilities at core NRC facilities hosted by ACRD:<ul style="list-style-type: none"><li>– Algal Research facility</li><li>– Plant Growth facility</li></ul></li><li>• Expand capabilities aligned with emerging priorities at other government departments and within the Government of Canada</li></ul> |
|--|--|--|
- .....

**PROGRAMS**

- Support for Ocean Supercluster
  - ACRD Marine Bioresource Valorization initiative
  - Support for PIC Supercluster
  - Bio-based Specialty Chemicals
  - Advanced Manufacturing
  - ACRD Agri-Food Initiative
- .....

**CHANGES IN CAPABILITIES**

**Maintain current core capabilities in:** agricultural biotechnologies, marine biotechnologies, natural products and ingredients development, bioprocessing and bioproduction, genomics and microbial profiling.

**Align:** core capabilities to better support marine and agricultural biomass valorization emphasis, including support for the PIC Supercluster, the broader NRC Agri-food program, the Marine Bioresource thrust of the Ocean Supercluster, and the broader NRC initiative in marine bioresources.

**Refocus:** agricultural biotechnologies on a broader range of crops and applications than current wheat focus; marine biotechnologies from cultivation to applications such as marine biosensors and microalgae engineering.

**Enhance:** microbial production capabilities through strategic partnerships; microbiome profiling capabilities with a greater emphasize on soil and probiotic communities.

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## ACRD'S COMMITMENT TO RESEARCH EXCELLENCE

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### How ACRD defines research excellence

Strengthening the NRC's position as an innovator in Canada's transition to a bioeconomy by enabling the sustainable transformation of Canadian bio-based resources into higher-value products.

### Science goals ACRD aims to achieve to advance in their field(s) of research

Enhance ACRD's reputation and impact in sustainable agriculture and food production through fundamental R&D and industry support; and in the bio-based sector through technology innovations that capture more value from Canadian bioresources.

### Actions ACRD will take to increase the level of research excellence

ACRD will lead the NRC's contribution to the Protein Industries Canada (PIC) Supercluster, the Marine Bioresource thrust of the Ocean Supercluster and the NRC's broader initiatives in these sectors; undertake targeted expansion of ACRD facilities and strategic hiring in key areas (microalgae, aquaculture feed and nutrition, plant cell technologies, microbial production); and leverage external partners and collaborators to enhance available resources.

### How ACRD engaged researchers in developing a research agenda to support growth in excellence

ACRD staff established the research centre's mission and vision following extensive cross-centre planning sessions. ACRD staff were also recruited to develop one of ACRD's three strategic R&D priority pillars and are extensively engaged in developing ACRD's new programming initiatives.

## FORWARD LEADING EDGE OF ACRD'S RESEARCH AGENDA

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**Better food through AI:** broad spectrum technology development aimed at facilitating the adoption of AI approaches to address uniquely Canadian challenges in agriculture and bioresource development.

**Greening of Canada via development of the first self-sustaining city of the future:** demonstration-scale urban environment operating as a fully circular or closed economy in terms of food production, energy generation, and waste recycling.

**Next-generation bioproduction and bioprocessing:** innovations in technologies purpose-designed to address the unique challenges associated with upscaling and valorizing biomass (esp. agricultural and biomarine) and renewable resources.

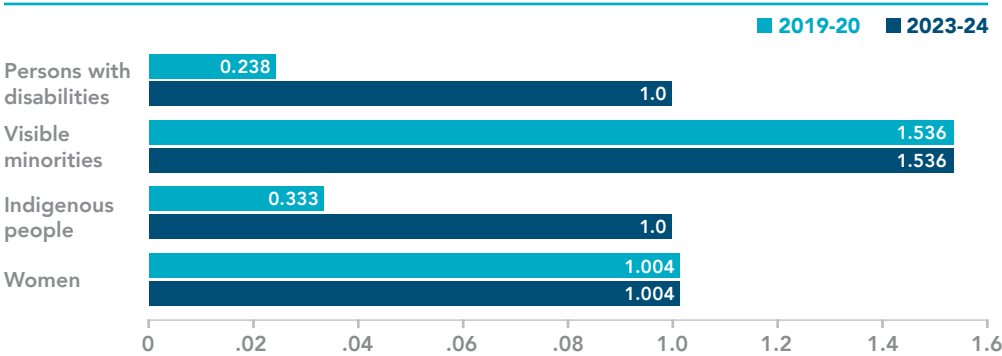
OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	52	50	65
Citation score†	1.26	1.1	1.4
Unique patents granted	–	2	4
Students, postdoctoral fellows and research associates	9	10	14
Clients and collaborators	116	147	160
Revenue (\$M)	5.551	4.9	4.9
Expenditures (\$M)	26.454	30.208	27.695

\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 – 2018 = 2017)

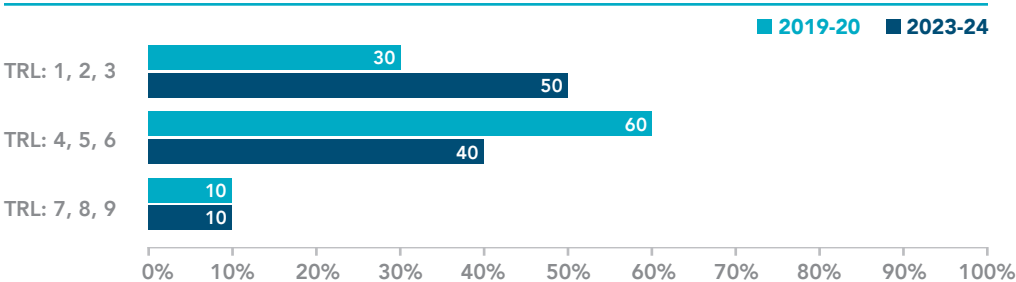
† Field-weighted citation impact (FWCI) is the average citation rate for research centre publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on March 8, 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 5

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# AUTOMOTIVE AND SURFACE TRANSPORTATION AT A GLANCE

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### VISION

Making Canada more competitive through innovations in mobility and manufacturing excellence.

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### MISSION

To identify, develop, and apply relevant science and technology that will ensure Canada’s continued prosperity through the revolution in the transportation and manufacturing industries.

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### EMPLOYEES

270

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### MAJOR FACILITIES

The NRC’s Automotive and Surface Transportation Research Centre (AST) offers clients access to its world-class facilities to help take ideas from concept to commercialization. The following are a few examples of AST’s major facilities:

**Materials and processes (Boucherville):** composite stamping press; state-of-the-art pilot-scale research platform for demonstrating the potential of a variety of powder metallurgy and polymer manufacturing processes; cold-spray additive manufacturing with industry 4.0 embedded technologies.

**Aluminum Technology Centre (Saguenay):** advanced welding, hot forming and casting laboratories to conduct prototyping, tools development, industrial production, control development and deployment on industry 4.0 concepts.

**Transportation Engineering Centre (TEC) (Ottawa):** safety, durability and reliability testing facilities provides a single location to test road vehicle, rail car and component performance under an exceptionally wide range of climatic and dynamic loading conditions.

**Advanced manufacturing facilities (London):** research, develop, demonstrate and implement advanced manufacturing technologies in the areas of additive manufacturing, microfabrication, digital manufacturing, and automation. Automotive laboratories conduct research and validation of components for connected/autonomous vehicles, and new technology integration and testing on vehicles.

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**GOALS**

Provide Canadians access to research, scientific knowledge, and technologies for innovation in transportation and advanced manufacturing

Increase AST impact across the value chain

Build and sustain a highly skilled workforce and unique facilities

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**STRATEGIES TO ACCOMPLISH GOALS**

- |  |   |   |
|--|---|---|
| <ul style="list-style-type: none"><li>• Follow Advanced Manufacturing Program Roadmap</li><li>• Build a strong and relevant Advanced Transportation Systems Program</li><li>• Evolve AST engagement in the field of Defence and Security</li></ul> | <ul style="list-style-type: none"><li>• Develop collaborations with industries, governments, and academia</li><li>• Promote AST expertise and impact through regional presence</li><li>• Establish Winnipeg advanced manufacturing site</li></ul> | <ul style="list-style-type: none"><li>• Create and sustain a safe and working environment</li><li>• Support AST current and future operations</li><li>• Ensure AST personnel is qualified and engaged</li></ul> |
|--|---|---|
- .....

**PROGRAMS**

- Advanced Manufacturing
  - Advanced Transportation Systems
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capabilities in advanced manufacturing:** metallic component manufacturing; composite and polymer component manufacturing; surface engineering and coating; energy materials and battery manufacturing, among others.

**Maintain current capabilities in transportation:** vehicle design and engineering; intelligent transportation systems; vehicular testing and evaluation; fuel and energy consumption, among others.

**Increase capabilities in:** digital and smart manufacturing such as additive; Intelligent Transport Systems (ITS); connected and autonomous vehicles (CAV); advanced vehicle integration and electrification; and zero emission vehicles, among others.

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## AST'S COMMITMENT TO RESEARCH EXCELLENCE

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### How AST defines research excellence

Bring innovation in the marketplace from ideation, early TRL partnerships, high TRL validation to value chain development, driven by our R&D industrial group members and supercluster partners.

### Science goals AST aims to achieve to advance in their field(s) of research

Increase transportation equipment manufacturers' speed, agility, and adaptability; increase environmental sustainability in manufactured products; develop technologies to deploy more sustainable, efficient, safe, and resilient mobility systems.

### Actions AST will take to increase the level of research excellence

AST will promote existing industrial R&D groups and develop new ones in key sectors especially in transportation; engage and convene key stakeholders to increase number of multi-client collaborations; develop capabilities in targeted areas; and develop projects aligned with relevant superclusters.

### How AST engaged researchers in developing a research agenda to support growth in excellence

Include researchers in the definition of program research roadmaps; provide researchers program investment to conduct internal projects; include more researchers in industrial R&D groups.

## FORWARD LEADING EDGE OF AST'S RESEARCH AGENDA

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**Polymer, composites and metal products manufacturing and systems** in new areas such as additive manufacturing.

**Increased digital maturity in manufacturing** by embedding more data engineering and AI.

**Development of intelligent, connected and autonomous transportation system technology** for more safe, secure and reliable rail and road transport.

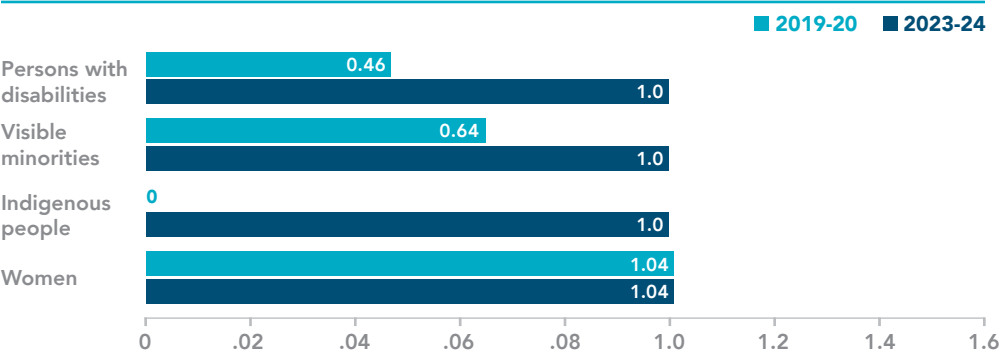
**Zero emission transportation** with safe and efficient electrification of mobility systems from road, speciality vehicles to rail.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	46	51	101
Citation score†	1.04	1.5	1.5
Unique patents granted	–	2	2
Students, postdoctoral fellows and research associates	42	40	50
Clients and collaborators	191	174	183
Revenue (\$M)	25.727	25.5	25.5
Expenditures (\$M)	41.999	43.278	41.67

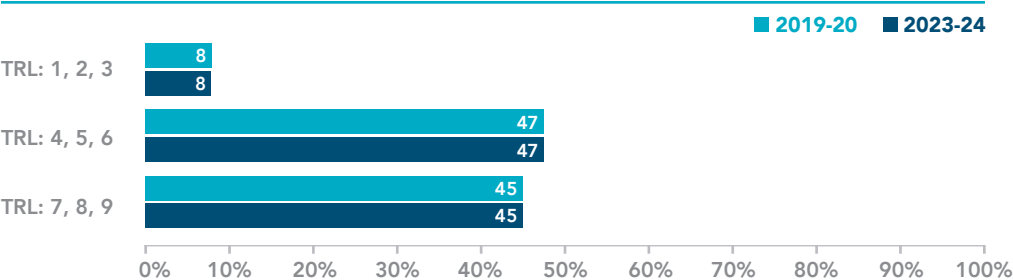
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 - 2018 = 2017)  
† Field-weighted citation impact (WFO) is the average citation rate for research centre publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016, and 2017 extracted from Scopus on March 8, 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 6

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# CONSTRUCTION AT A GLANCE

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### VISION

To become the partner of choice, for government and the construction industry, in advancing innovation for a safe, prosperous, and sustainable Canada.

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### MISSION

To deliver research and technology-based solutions and services, to government and the construction industry, that support the development and commercialization of innovative products and systems to achieve a better built environment.

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### EMPLOYEES

243

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### MAJOR FACILITIES

The NRC's Construction Research Centre (CONST) provides clients and collaborators with access to world-class facilities. The following are a few examples of CONST's major facilities:

**Infrastructure testing facilities (Ottawa):** offer technology developers and infrastructure owners unique laboratories to perform structural tests on materials and components under a range of climatic exposures and loading conditions to improve the cost-effectiveness and performance of infrastructure assets.

**Indoor environment and human impact testing facilities (Ottawa):** offer technology developers and regulators state-of-the-art laboratories with a wide variety of acoustical, lighting, ventilation, and air quality testing capabilities to improve building energy efficiency and building occupant health.

**Fire safety testing facility (Ottawa):** works with industry partners to advance technologies for improving the fire safety of buildings and transportation systems, enhance fire detection and suppression systems, and reduce the risks and costs of fire.

**Canadian Centre for Housing Technology (Ottawa):** offers manufacturers, public utilities and housing technology companies unique, real-life, whole-house performance evaluations with fully-monitored testing environments to develop and validate innovative residential products, including net-zero energy technologies.



GOALS

Improve resilience of infrastructure and buildings to climate change and natural disasters

Achieve carbon-neutral construction and reduce waste during the course of construction

Create buildings and infrastructure that improve the wellbeing of end-users

STRATEGIES TO ACCOMPLISH GOALS

- Partner with other government departments (OGDs) and research organizations to develop a construction resiliency roadmap
- Collaborate with OGDs and research organizations to develop innovative structural monitoring technologies
- Explore the development of national infrastructure codes and standards
- Establish and lead a consortium on built environment issues in Indigenous communities
- Include sustainability in capital planning to demonstrate technologies through 'living labs'
- Lead a consortium to develop technologies and building codes
- Participate in a science hub on sustainability innovation for the federal government
- Partner with leading organizations to position CONST as a leader in construction sustainability
- Collaborate to facilitate faster inclusion of evidence-based practices in building codes
- Develop a national strategy and establish living laboratories, in partnership with clients and stakeholders
- Increase strategic research on building occupant wellbeing
- Develop benchmarking methodologies for organizational productivity

PROGRAMS

- Building Regulations for Market Access
- High-Performance Buildings

CHANGES IN CAPABILITIES

**Maintain current capability in:** building energy-use modelling and monitoring; climate adaptation and resilience; acoustics and noise control; indoor air quality and contaminant management; productivity and wellbeing measurement; codes, specifications, and technical standards; infrastructure evaluation and rehabilitation; among others.

**Increase current capability in:** construction waste/water usage reduction; low-carbon asset management knowledge/processes; digital and virtual workplace; mobility in built environment.

## CONST'S COMMITMENT TO RESEARCH EXCELLENCE

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### How CONST defines research excellence

How CONST defines research excellence: Peer recognition for contributions to construction science, including highly-cited publications and inclusion of research outputs in codes and standards.

### Science goals CONST aims to achieve to advance in their field(s) of research

Reduced risk and impact prior to events and improved post-event response; validated renewable energy technologies for buildings and infrastructure; improved carbon emissions, energy use and durability of buildings and infrastructure.

### Actions CONST will take to increase the level of research excellence

CONST will invest in strategic research; strengthen relationships with academic collaborators; support researchers seeking national and international leadership roles; and develop early career researchers.

### How CONST engaged researchers in developing a research agenda to support growth in excellence

Research teams were consulted to identify research priorities for CONST's strategic and operational plans, and researchers are being engaged to develop CONST's research agenda.

## FORWARD LEADING EDGE OF CONST'S RESEARCH AGENDA

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**Development of new building insulation materials** that combine biodegradable materials for improved sustainability with nanoparticles for improved performance.

**Evaluation of structural monitoring tools for infrastructure** using satellite-based radar to measure millimeter-scale deflections.

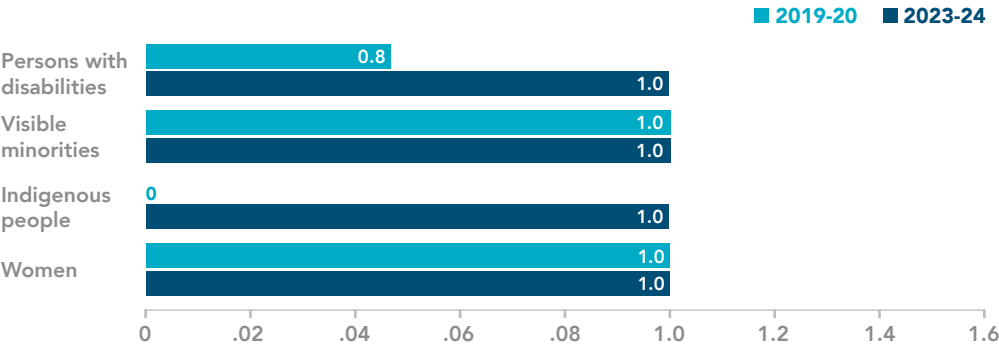
**Measuring water ingress in construction materials** using nuclear magnetic resonance.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	59	48	60
Citation score†	1.05	1.73	1.73
Unique patents granted	–	0	2
Students, postdoctoral fellows and research associates	55	40	40
Clients and collaborators	171	138	138
Revenue (\$M)	30.5	21	21
Expenditures (\$M)	38.907	47.246	46.191

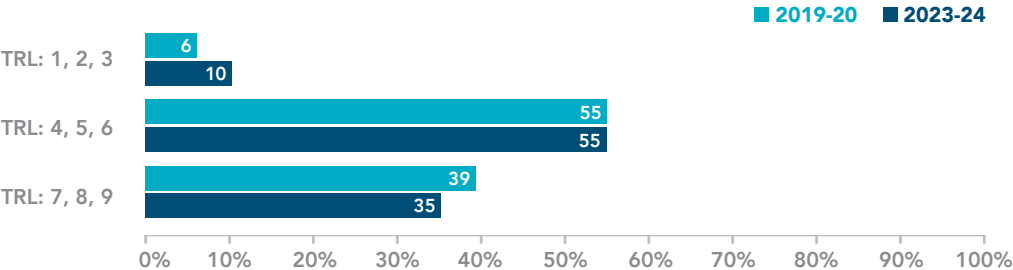
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 – 2018 = 2017)  
† Field-weighted citation impact (FWCI) is the average citation rate for research centre publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on March 8, 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



ANNEX 7

DIGITAL TECHNOLOGIES  
AT A GLANCE



VISION

A smarter, safer, healthier, and more prosperous society through ethical digital technologies.

MISSION

At the forefront of digital technologies research, driving innovation with and for Canadian government, businesses, researchers, and society.

EMPLOYEES

145

MAJOR FACILITIES

The NRC’s Digital Technologies Research Centre (DT) offers clients access to world-class facilities that focus on advanced analytics, computer vision, natural language processing, and artificial intelligence (AI) technologies. The following are a few examples of DT’s major facilities:

**Data Analytics Centre (Ottawa):** brings together machine learning experts and state-of-the-art algorithms to address data analytics needs arising from industrial and scientific sources. DT’s data scientists work with clients to organize and analyze large data sets to discover patterns and trends, provide explanations, and make predictions in order to create actionable knowledge.

**AI for Design Cluster (New, Ottawa):** A dedicated HPC GPU focused cluster for the AI for Design Challenge Program, providing the NRC with a compute environment similar in caliber and support to those provided by Compute Canada to other academic facilities. The facility will be hosted in Ottawa but accessible across the NRC’s locations.

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**GOALS**

Continue research excellence in AI	Build strong collaborations	Support government priority areas
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**STRATEGIES TO ACCOMPLISH GOALS**

- |  |   |  |
|--|---|--|
| <ul style="list-style-type: none"><li>• Leverage current capabilities and develop new capabilities in cybersecurity, Internet of Things, and robotics</li><li>• Develop AI Design Cluster facility</li><li>• Support computer vision in advanced manufacturing</li></ul> | <ul style="list-style-type: none"><li>• Build collaboration centres in Montreal, Fredericton, Waterloo, and Toronto</li><li>• Leverage collaboration centres for DT programs and research goals</li><li>• Continue to build and maintain collaborations with other research centres and programs across the NRC</li></ul> | <ul style="list-style-type: none"><li>• Build and maintain excellence in digital technologies research through the AI for Design program, and research in multimedia analytic technologies and Canadian languages technologies</li><li>• Support government supercluster programs in digital technologies and AI</li></ul> |
|--|---|--|
- .....

**PROGRAMS**

- Support for Digital Technology Supercluster
  - Multimedia Analytic Tools
  - Support for Scale.AI Supercluster
  - Canadian Indigenous Languages Technology
  - Artificial Intelligence in Support of Design Challenge
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capabilities in:** human computer interaction; bioinformatics; vision and modelling; translation and natural language processing; AI and machine learning; data and text analytics; e-learning and MOOC.

**Increase capabilities in:** cybersecurity; and Internet of Things (e.g. sensors, robotics).

**Build new capabilities** through DT's own high-performance computing (HPC) facility.

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## DT'S COMMITMENT TO RESEARCH EXCELLENCE

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### How DT defines research excellence

Research excellence leads to influential results, driving innovation with and for Canadian society, businesses, researchers, and government. It leads to new knowledge and intellectual property that directly produces new products and services. Research excellence requires talented, skilled people and a supportive ecosystem.

### Science goals DT aims to achieve to advance in their field(s) of research

Develop novel methods for AI, data mining and data analysis in sciences; advance collaborative bioinformatics and computational biology for scientific discovery; advance neural machine translation and polylingual processing; contribute to shaping the new reality of ethics for digital technologies research; complete deep-learning transition for computer vision and robotics; develop novel UI technologies and methods for visualization in virtual reality environments; and develop workforce, talent, and learning technologies.

### Actions DT will take to increase the level of research excellence

DT is taking several mutually reinforcing steps in parallel to increase research excellence:

- **Increase collaboration with external researches known for their excellence in targeted technologies.** We are achieving this by establishing operations at four new collaboration centres — cybersecurity in UNB; AI and natural language processing in Montreal; Internet of Things and robotics in University of Waterloo; and applied mathematics through the Fields Institute in Toronto. We are also achieving this indirectly through our use of grants and contributions allocated to critical programs that we are responsible for delivering — namely AI for Design Challenge Program, and the programs in support of two superclusters — Scale.AI in Montreal and Canada's Digital Technology Supercluster in Vancouver. Finally, DT is also continuing collaborative research with other government research facilities, particularly in the areas of security and defense, which are also significant contributors to the national research ecosystem. Combined, these access strategies position DT researchers to be working with the best of Canada's research talent, coast-to-coast.
- **Continue to shift our model from the traditional compartmentalized research model to one that is more collaborative across the NRC.** This shift will be guided by the Chief Digital Research Officer whose mandate spans the organization and includes a pathfinder mission to shape and inform the requirements of the NRC's new digital research infrastructure. We will convene the digital research communities in all of the NRC's research centres.
- **Equip the researchers with the tools and infrastructure they need to conduct leading-edge digital research.** The NRC is making significant capital and operating investments to provide high-performance computing infrastructure that can be optimized towards a variety of different end-use conditions. We are also focusing on removing process and procurement bottlenecks. These investments will significantly reduce friction and improve researcher effectiveness.

### How DT engaged researchers in developing a research agenda to support growth in excellence

Extensive consultations throughout the strategic planning process, including two workshops with DT team leads; an all-staff survey to refine DT's vision and mission; consultations with research teams on motivators, research goals, and priorities for the research component of the strategic plan; and extensive consultation to determine DT's component of the NRC's key performance indicators. Regular bimonthly meetings with component leads, team leads, and project leads have also been established to ensure that the strategic plan remains current, is embedded in the rhythm of the business, and is resilient.

## FORWARD LEADING EDGE OF DT'S RESEARCH AGENDA

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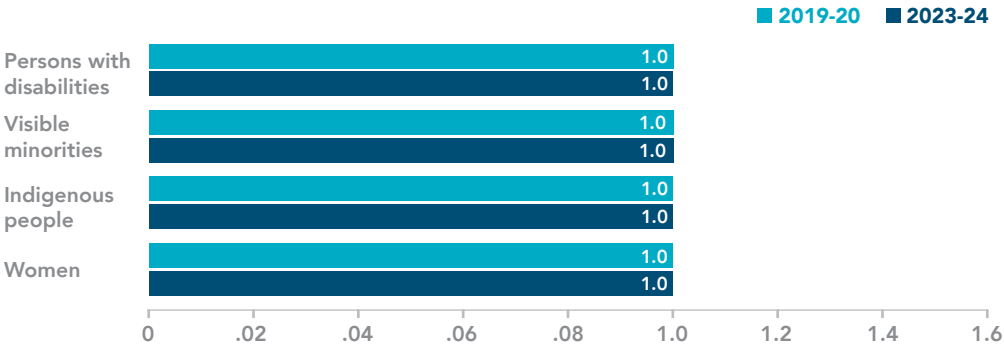
**AI to accelerate research and discovery** agnostically and across specific verticals such as health; energy materials and high-throughput and secure networks; natural language processing and computer vision.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	25	76	142
Citation score†	2.2	1.5	1.5
Unique patents granted	–	7	20
Students, postdoctoral fellows and research associates	29	12	18
Clients and collaborators	18	20	42
Revenue (\$M)	4.188	3.5	5.5
Expenditures (\$M)	16.464	21.284	16.028

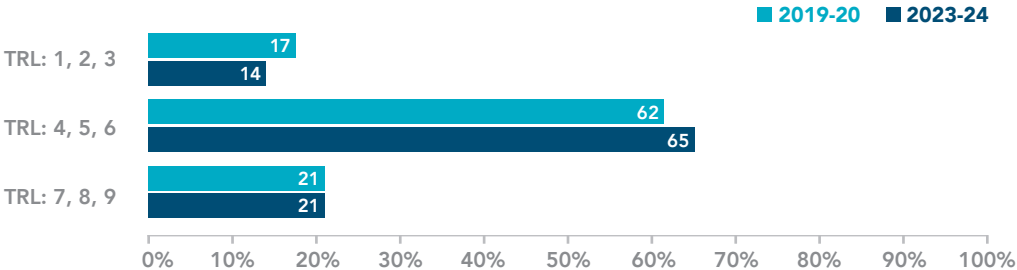
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017-2018 = 2017)  
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EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 8

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# ENERGY, MINING AND ENVIRONMENT AT A GLANCE

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### VISION

To be the preferred research partner to the Canadian clean energy and mining sectors, bridging science and application.

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### MISSION

Unleashing scientific excellence in the clean energy and mining sectors to grow and protect Canada’s future.

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### EMPLOYEES

180

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### MAJOR FACILITIES

The NRC’s Energy, Mining and Environment Research Centre (EME) delivers advanced technology to Canada’s mining and energy industries through its world-class research facilities. The following are a few examples of EME’s major facilities:

**Optical and Ultrasonic Sensor Development Facility (Boucherville):** an internationally recognized laboratory, developing and designing real-time sensors for applications in the mining and other industries.

**Biorefinery Pilot Plant (Montreal):** a customizable platform for testing and validating the scale-up of bioprocesses, accommodating process requirements for high temperatures and pressures.

**Battery Performance and Abuse Facility (Ottawa):** a safe environment for controlled and repeatable testing of battery energy storage systems at multiple scales.

**Hydrogen-safe labs (Vancouver):** unique, certified gas handling safety infrastructure for experimental development of hydrogen production and energy conversion systems.



GOALS

Develop and deploy clean energy technologies to position Canada as a world-leader in clean energy materials and clean fuels	Solve mining sector challenges through breakthrough processes and digital innovation	Reduce the environmental footprint of the energy and mining sectors using innovative technologies
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STRATEGIES TO ACCOMPLISH GOALS

- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"><li>• Develop next-generation materials for low carbon fuel production and advanced electrochemical devices</li><li>• Develop process technologies to support Canadian supply of clean energy materials</li><li>• Develop and deploy new processes for producing and utilizing future fuels with reduced- and zero-emission lifecycles</li><li>• Support Canadian industry in the development and commercialization of energy storage devices</li></ul> | <ul style="list-style-type: none"><li>• Develop technologies and analytics enabling step-change digital innovation</li><li>• Provide solutions to wear in the mining sector using advanced materials and additives.</li><li>• Reduce mining operations liabilities by bio-hydrometallurgical and bioremediation processes</li></ul> | <ul style="list-style-type: none"><li>• Develop advanced water characterization and treatment technologies for emerging contaminants</li><li>• Use LCA and TEA capabilities to apply full cost accounting to energy and mining process across all of EME activities in the sector</li></ul> |
|---|---|---|

PROGRAMS

- Materials for Clean Fuels Challenge
- Consolidated Mining
- Advanced Clean Energy

CHANGES IN CAPABILITIES

**Maintain current capabilities in:** material characterization, optimization, and evaluation; clean energy conversion technology; and water characterization and wastewater remediation.

**Shift capability profile towards:** material discovery, design, characterization, and optimization for deployment in clean energy conversion technologies and applications.

**Expand and develop:** energy device and system modelling and testing to include integration of clean energy materials.

**Enhance capabilities in:** sensors and sensing technology in mining system integration and digitalization.

## EME'S COMMITMENT TO RESEARCH EXCELLENCE

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### How EME defines research excellence

Delivering world-leading innovations to the most challenging problems in the energy and mining sectors through collaboration with government, industry, and university partners.

### Science goals EME aims to achieve to advance in their field(s) of research

Advance the fundamental understanding of materials, processes, and systems to enable the development and deployment of clean energy devices and fuels, reduce the impact of natural resources extraction, and address remediation challenges while enabling those sectors to fully participate in the digital age.

### Actions EME will take to increase the level of research excellence

EME will continue to coordinate and sponsor researcher participation in corporate initiatives such as New Beginnings and Ideation Fund. EME will also increase investment in capabilities outside of programs, and revamp its suite of programs to ensure that research excellence is inherent within design and operation regardless of the TRL level of the program.

### How EME engaged researchers in developing a research agenda to support growth in excellence

EME has actively engaged researchers over the past two years, at a group level, and one-on-one to collect input and ideas on: refining and focusing current program operations into areas with strong EME research capability, focused capability development, and internal investment in new areas outside of programs; developing new programs in areas where EME can be a world player; implementing new committees, workshops, and presentations to provide additional opportunities for dialogue and engagement.

## FORWARD LEADING EDGE OF EME'S RESEARCH AGENDA

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Advancing characterization and sensor technologies for mining and mineral processing, from laboratory through to *in situ*, real-time sensor systems.

Developing methods for accelerated materials discovery and characterization for functional materials for electrochemical and biological clean energy production.

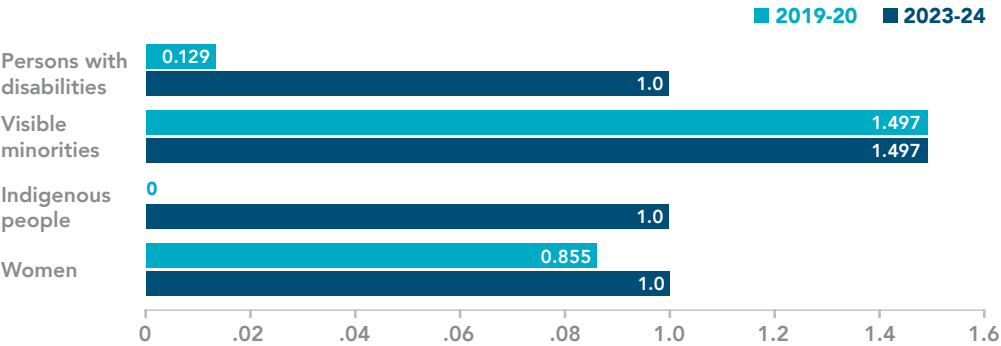
Improve scientific rigour in testing and failure mode analysis under realistic in-service conditions for electrochemical clean energy storage and conversion devices.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	84	93	115
Citation score†	1.48	1.5	1.5
Unique patents granted	–	2	2
Students, postdoctoral fellows and research associates	30	39	56
Clients and collaborators	86	82	90
Revenue (\$M)	5.808	6.81	6.81
Expenditures (\$M)	25.846	29.779	26.803

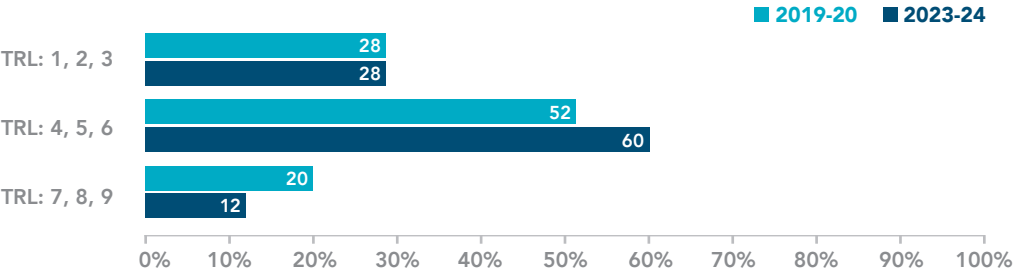
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 – 2018 = 2017)  
† Field-weighted citation impact (FWCI) is the average citation rate for research centre publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on March 8, 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 9

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# HERZBERG ASTRONOMY AND ASTROPHYSICS AT A GLANCE

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### VISION

To be a leader among the world’s national astronomy programs by enabling Canadians to perform research at the highest level of international science.

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### MISSION

We drive research excellence through international partnerships in world-class observatories and collaborate across the global innovation system to provide facilities and instruments that push technological boundaries forward through cutting-edge science and creative engineering.

.....

### EMPLOYEES

144

.....

### MAJOR FACILITIES

The NRC’s Herzberg Astronomy and Astrophysics Research Centre (HAA) manages Canada’s participation in international observatories, some of which are the world’s most important optical and radio astronomy observatories, and facilitates access to these observatories for the Canadian astronomy community. At the two national observatories in Victoria and Penticton, HAA works with industry and other research partners to design and develop innovative technologies to advance our understanding of the universe. The facilities managed or supported by HAA include:

**The Canada-France-Hawaii Telescope (CFHT), the Gemini Observatory and the Atacama Large Millimetre Array (ALMA)**, which represent global investments in excess of \$2 billion and provide Canadian astronomers with access to world-class observing capabilities.

**The Dominion Astrophysical Observatory and Dominion Radio Astrophysical Observatory (British Columbia)**: operate seven telescopes (two optical, three radio and one solar), support deployment of university-led experiments (e.g. CHIME telescope), and conduct R&D into advanced instrumentation for telescopes.

**The Canadian Astronomy Data Centre (British Columbia)**: offers an interdisciplinary team of astronomers and software developers that specialize in data mining, processing, distribution and transferring of very large astronomical datasets. These experts develop sophisticated tools to support and enhance the research efforts of Canadian and international astronomers.

GOALS

Manage suite of national and international facilities	Provide research support services	Enhance facilities capabilities and competitiveness	Work with community to develop new facilities and services	Engage with industry to leverage technologies
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STRATEGIES TO ACCOMPLISH GOALS

- |   |  |  |   |  |
|---|--|--|---|--|
| <ul style="list-style-type: none"><li>• Telescope time allocation management</li><li>• Participation in governance boards and committees</li><li>• Leadership in designing next-generation international telescopes</li></ul> | <ul style="list-style-type: none"><li>• Enhance CADC data-intensive astronomy support, including SKA regional data centres</li><li>• Design scientific surveys that open up new discovery space in time and wavelength</li></ul> | <ul style="list-style-type: none"><li>• Participate in next-generation instruments at CFHT, Gemini, and ALMA</li><li>• Design and test new observing and data analysis methods for Canadian facilities</li></ul> | <ul style="list-style-type: none"><li>• Continue support to SKA, TMT</li><li>• Support science cases for CASTOR and MSE</li><li>• Support plans for next-generation telescopes in Canada, including CHIME+ and CGEM</li></ul> | <ul style="list-style-type: none"><li>• Engage industry in supporting instrumentation development projects</li><li>• Provide unique big data training sets for applied AI/ML solutions developed by industry</li></ul> |
|---|--|--|---|--|

PROGRAMS

Mandated activities distributed across three directorates:  
Optical astronomy  
Radio astronomy  
Astronomy technology

CHANGES IN CAPABILITIES

**Maintain current capabilities in:** observatory facilities management, research support, and technology development.

**Increase capabilities in:** collaborations with academia and other NRC research centres; synergistic exploitation with industry of advances in areas such as microwave components, wavefront control, adaptive optics, (astro-) photonics, and machine learning.

## HAA'S COMMITMENT TO RESEARCH EXCELLENCE

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### How HAA defines research excellence

Providing leadership and support to the strongest field of physical science in Canada.

### Science goals HAA aims to achieve to advance in their field(s) of research

Understand dark matter and dark energy; enable time-domain and multi-messenger (e.g., EM and gravitational waves, neutrinos) astronomy; and search for habitable planets and evidence of life beyond our solar system.

### Actions HAA will take to increase the level of research excellence

HAA will deepen collaborations with academia, extend collaborations with NRC research centres, and exploit convergences with industry (e.g., microwave components).

### How HAA engaged researchers in developing a research agenda to support growth in excellence

Internally: monthly "Science Council" and R&D team leads meetings, weekly instrumentation meetings, daily conversations on science, technology, and data. Externally: through an International Astronomy Observatories Contributions Program, long-range (decadal) plans and strong linkage with Canadian universities.

## FORWARD LEADING EDGE OF HAA'S RESEARCH AGENDA

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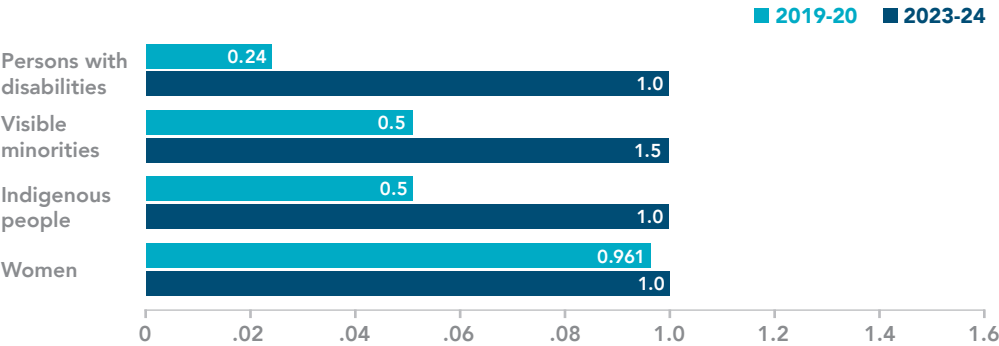
SKA, TMT, CASTOR, CHIME+, MSE — These are all the next-generation telescopes that HAA will be supporting to provide incredible advances in astronomical instrumentation and fundamental science.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	210	160	160
Citation score†	1.77	1.5	1.5
Unique patents granted	–	–	–
Students, postdoctoral fellows and research associates	34	35	30
Clients and collaborators	7	9	9
Revenue (\$M)	1.801	2.28	2.28
Expenditures (\$M)	22.204	23.244	19.871

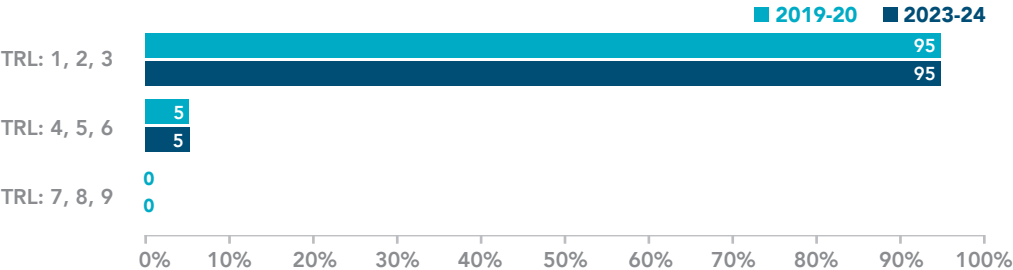
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 – 2018 = 2017)  
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EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



ANNEX 10

HUMAN HEALTH  
THERAPEUTICS  
AT A GLANCE



VISION

To transform human health outcomes for the benefit of society.

MISSION

To accelerate the discovery and development of innovative medicines for Canada, advance biologics (vaccines, antibodies, cell and gene therapy) and biomanufacturing in collaboration with public and private sector research organizations.

EMPLOYEES

340

MAJOR FACILITIES

The NRC’s Human Health Therapeutics Research Centre (HHT) offers industry partners access to world-class R&D facilities and laboratories. The following are a few examples of HHT’s major facilities:

**Microbial Fermentation Pilot Plant (Ottawa, Montreal):** offers versatility and a broad range of equipment for microbial expression from laboratory to industrial-scale, up to 1,500 L.

**Cell Culture Pilot Plant (Montreal):** offers process development and scale-up for the production of biologics and vaccines using proprietary animal cell line expression systems (e.g., CHO, VERO).

**Preclinical *in vitro* and *in vivo* Facility (Ottawa):** leverages HHT’s expertise in immunobiology, molecular biology, chemistry, pharmacology and microscopy, and imaging science to evaluate biologics and vaccines in variety of *in vitro* and *in vivo* disease and challenge models.



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**GOALS**

Support business innovation

Apply disruptive technology solutions to advance cell and gene therapies

Deliver policy solutions for government

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**STRATEGIES TO ACCOMPLISH GOALS**

Enable Canadian SMEs to de-risk the development, testing, and production of multifunctional antibody-based therapeutics by:

- launching a program to expand Canadian biopharma pipeline to address unmet needs in cancer and neurological diseases
- launching an initiative to foster biomanufacturing

Advance scientific knowledge to develop innovative medicines for transforming health outcomes by:

- launching the Engineered Cell and Gene Therapies Challenge Program to develop safe, affordable and accessible cell and gene therapies to treat cancer and rare genetic disorders of importance to Canada
- launching a collaborative unit for translational research

Catalyze public health solutions for unmet medical needs (e.g. emerging infections) by:

- launching an initiative to develop vaccines and solutions for emerging infections and anti-microbial resistance
  - expanding OGD partnership for vaccine research innovation development
- .....

**PROGRAMS**

- Advanced Biologics and Biomanufacturing
  - Engineered Cell and Gene Therapies Challenge
- .....

**INITIATIVES**

- Biomanufacturing; platforms and automation
  - Vaccines and emerging infections readiness innovation
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capabilities in:** immunobiology, translational bioscience, bioprocess engineering and down-stream processing, and analytics to enable the progress through value chain (discovery to IND) of biologics.

**Increase current capability in:** design and development of engineered cell-based immunotherapeutics; viral vector manufacturing platforms and disruptive technologies (e.g., Omics, molecular modeling, AI).

**Expand collaboration** with academia and hospitals to enable clinical translational of HHT discoveries.

**Recruit strategically** to increase capability in gap areas and enhance scientific excellence

**Foster high quality personnel (HQP) development** in key gap areas such as bioprocess engineering.

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## HHT'S COMMITMENT TO RESEARCH EXCELLENCE

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### How HHT defines research excellence

Valued by stakeholders (academia, industry, and other government departments) as a national leader that drives solutions for unmet medical needs of importance to Canada through discovery and pre-clinical development of vaccines and biologics medicines.

### Science goals HHT aims to achieve to advance in their field(s) of research

HHT aims to advance a pipeline of multi-functional biotherapeutics products against cancer and neurological disease; develop and deploy disruptive technology platforms for step-change advancement of cell and gene therapies against immunological and rare diseases; support efficient biomanufacturing through development of high-yield production cell lines and automation of scale-up processes; develop vaccines against emerging infections and alternatives to antibiotics to combat anti-microbial resistance.

### Actions HHT will take to increase the level of research excellence

HHT will expand collaboration with academia and increase adjunct professorships to foster graduate student and PDF training; promote self-initiated innovation through ideation projects; and create the HHT brand through targeted outreach and dissemination activities.

### How HHT engaged researchers in developing a research agenda to support growth in excellence

Programs and initiatives are driven through >50 percent internal self-directed research projects steered through a Research Management Committee comprised of senior HHT researchers that advises the DG and management on the quality of science.

## FORWARD LEADING EDGE OF HHT'S RESEARCH AGENDA

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HHT is at the forefront of **multi-functional biologics medicines development for unmet medical needs** in cancer, emerging infections, and neurological disease.

HHT is poised to catalyze a **national effort to advance safe, efficacious and affordable made-in-Canada cell and gene therapies** that can revolutionize the treatment of immune and rare genetic disorders.

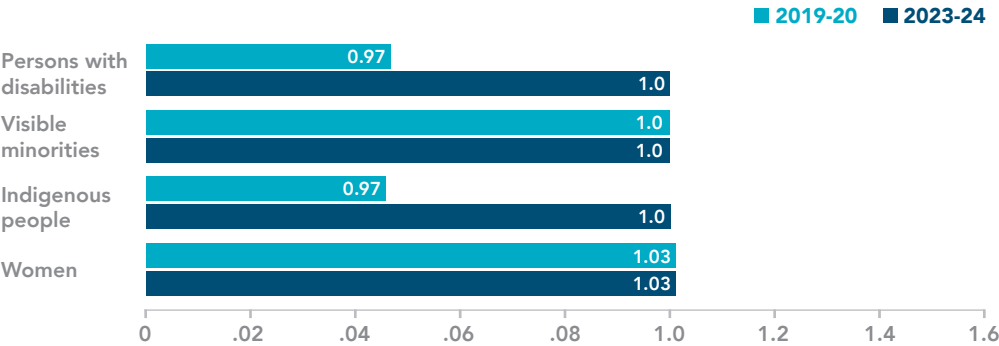
HHT will foster **growth of the Canadian biotech industry** and deliver improved health outcomes for all Canadians.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	79	90	106
Citation score†	1.08	1.2	1.5
Unique patents granted	–	5	6
Students, postdoctoral fellows and research associates	18	26	45
Clients and collaborators	103	0	0
Revenue (\$M)	12.176	13	13
Expenditures (\$M)	47.271	48.888	44.301

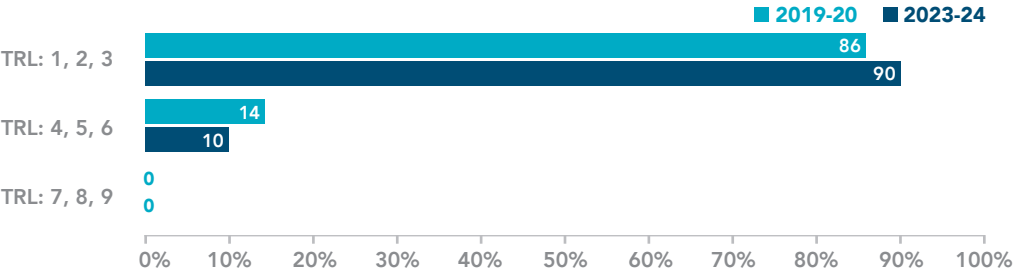
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 – 2018 = 2017)  
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EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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# ANNEX 11

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# MEDICAL DEVICES AT A GLANCE

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## VISION

Essential contributor to a vibrant Canadian medical devices eco-system, with a strong culture of ideation to market to clinical use of innovations for prevention, diagnosis, monitoring, and treatment, making Canada’s industry top five in the world.

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## MISSION

To be the go-to translational engine for medical device innovation by developing and deploying leading-edge technology platforms; supporting industrial medical device R&D; and helping to develop the medical device technology leaders of the future.

.....

## EMPLOYEES

72

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## MAJOR FACILITIES

The NRC’s Medical Devices Research Centre (MD) offers world-class services and supports to clients through access to three major facilities:

**Boucherville Facility:** BioAnalytical Micro-Devices (BioAMND) Clean room; Polymer-based micro and nanofabrication facility; Polymer lab-on-a-chip and microanalytics laboratory; Microfluidic prototyping facility; Molecular diagnostics (clinical, food, veterinary, environmental) laboratory; Object-oriented software platform for interactive simulation; Simulation and interactive haptics laboratory; Soft tissue biomechanics laboratory; Tissue-mimicking phantoms facility; Connected health and Cognitive health; Implantable biomaterials and manufacturing processes laboratory; Development and characterization facilities for metals, polymers, ceramics and their composites

**Winnipeg Facility:** Computer-aided engineering, design and simulation software; Spectroscopic technologies (Visible, IR, Raman, CARS, OCT); Molecular diagnostics (clinical, food, veterinary, environmental) laboratory

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**GOALS**

<b>Leadership:</b> Ensure research excellence of MD's platforms	<b>Support:</b> Contribute to policy initiatives by supporting supercluster programs and other government departments	<b>Convene:</b> Pan-Canadian academic/clinical networks and collaboration centres
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**STRATEGIES TO ACCOMPLISH GOALS**

<ul style="list-style-type: none"><li>• Provide science and technological leadership via two large-scale, cutting-edge internal R&amp;D platforms</li><li>• Collaborate with thought-leading clinicians, scientists, and industry clients</li><li>• Refine HR strategies to support research goals</li></ul>	<ul style="list-style-type: none"><li>• Deliver developments through internal research within the research centre, leadership of pillars in supercluster support programs</li><li>• Support Canadian Space Agency renewed mandate in health with microfluidics</li><li>• Chair panels and collaborate with Health Canada, Communications Security Establishment on policy for adoption of digital health technologies</li></ul>	<ul style="list-style-type: none"><li>• Facilitate increased clinical adoption and to-market efficiency through greater connectivity with industry</li><li>• Active management and leadership of two collaboration centres (CRAFT; CUTR)</li><li>• Establish clinical network for xR cognitive care</li></ul>
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**PROGRAMS**

- Engineered Cell and Gene Therapies
  - Pillar/Thrust in support for Digital Technologies Supercluster
  - AI in Support of Design Challenge
  - Support for Advanced Manufacturing Supercluster
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capabilities in bioanalytical micro and nano devices:** imaging and diagnostic systems; microfluidic systems; micro nano fabrication; nanomaterials / bio-interfaces.

**Maintain current capabilities in simulation and digital health:** biomechatronics; biomedical data intelligence; connected health; cognitive health.

**Maintain current capabilities in advanced prototyping and manufacturing processes:** advanced bio-devices manufacturing; and implantable materials fabrication.

**Increase capabilities in:** regenerative medicine, oncological, and immunological sciences and treatments; clinical expertise in infectious disease management; and neuropsychology, biomedical data science, and cognitive neuroscience.

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## MD'S COMMITMENT TO RESEARCH EXCELLENCE

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### How MD defines research excellence

Can be defined by traditional means such as recognition of novelty and thought leadership (publications, awards, patents), but also by broad adoption, co-development and deployment of our platforms (licensing, clinical trials, strategic R&D contracts with industry).

### Science goals MD aims to achieve to advance in their field(s) of research

MD will de-risk realistic and ecologically valid digital health solutions for clinical training, connected health and cognitive care by implementing science-founded competencies based on visual computing, physics, neuropsychology and data science. MD will continue to innovate in advanced microfluidic technologies for life sciences research, diagnostic and clinical applications with a parallel stream of advanced manufacturing innovation to support the development of low cost platforms and plastic-based disposables to deliver these applications.

### Actions MD will take to increase the level of research excellence

MD will take advantage of novel collaborative models such as participation in two collaborative research centres, living labs, and the establishment of research networks of clinicians and early adopters.

### How MD engaged researchers in developing a research agenda to support growth in excellence:

MD section heads have engaged research teams in the elaboration and synthesis of their science-focused strategic vision.

## FORWARD LEADING EDGE OF MD'S RESEARCH AGENDA

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### Leading edge in simulation and digital health

- Omnipresence: synchronized, suspension-of-disbelief reality in remote, virtual interactions
- Affective computing: human-like, natural interactions with secure, intelligent systems
- Kinesiology devices: personalized mechatronics for assisting mobility and psycho-motor skills, and stimulating brain plasticity

### Leading edge in bioanalytical microdevices

- Apothecary in a Box: microfluidic powered device that can formulate and dispense modern medications at the patient's bedside. Decreases reliance on mass production/delivery of complex therapies. Key enabler of individualized therapy.
- Biodevices for space research and operational medicine: develop unprecedented capacity for remote bio-analytics supporting biomedical and health sciences research and technology aimed to sustain human long term space flights

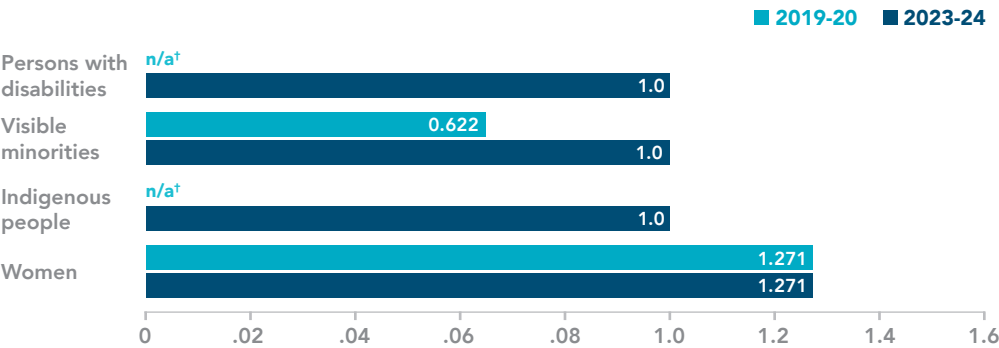
### Novel, smart implantable devices

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	5	15	30
Citation score†	1.01	–	–
Unique patents granted	–	6	8
Students, postdoctoral fellows and research associates	7	31	31
Clients and collaborators	27	29	25
Revenue (\$M)	3.344	4.9	3.2
Expenditures (\$M)	10.161	11.311	10.674

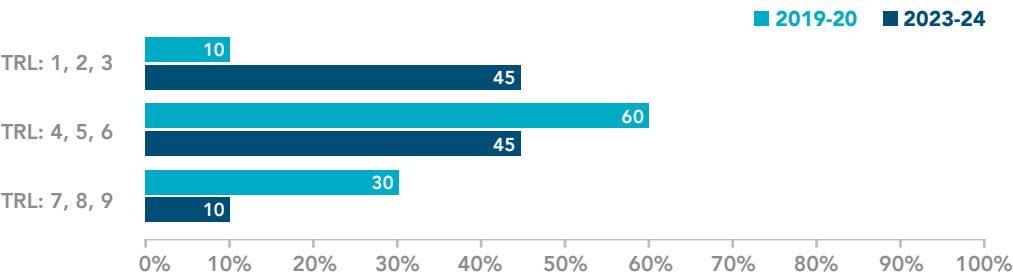
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2017 – 2018 = 2017)  
† Field-weighted Citation impact (FWCI) is the average citation rate for research centre publications generated in a specific period. Results can vary greatly for publications published within the past two years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on March 8, 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.  
† To adhere to confidentiality rules related to self-identification data, any representation number of 5 or less is listed as “N/A”. Data on women does not come from the self-identification process and is therefore not subject to the same restrictions.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 12

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# METROLOGY AT A GLANCE

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### VISION

To create a better Canada and world by fostering innovation through high-precision measurement science and advancements in metrology.

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### MISSION

To collaborate across the global innovation system to provide metrology research and services that help transform ideas into market-ready technologies that benefit Canadian society, the economy, and the environment.

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### EMPLOYEES

178

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### MAJOR FACILITIES

The NRC's Metrology Research Centre meets the demand for accurate measurement that underpins industrial success across all sectors of the economy through world-class facilities, technologies, and staff. Following are a few examples of Metrology's major facilities:

**Precision instrumentation for mass measurement (Ottawa):** Kibble and vacuum balances are used to realize the kg from the defined value of the Planck constant, to establish and disseminate the NRC mass scale, and to support mass calibration services for Canadian industry.

**World-leading single-ion optical frequency determination (Ottawa):** Single trapped Strontium ion optical frequency standard provides the most accurate frequency realization in Canada and one of the best in the world. It provides Canada with the foundational capabilities needed for the upcoming redefinition of the second that will be based on optical frequency standards.

**A comprehensive suite of mass spectrometers for speciation and quantification (Ottawa and Halifax):** From our certified reference materials, Glow Discharge Mass Spectrometry (GDMS), specialized testing services for cannabis, mass spectrometers are at the core of all of organic, inorganic, and biological metrological measurements.



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**GOALS**

Contribute to a strong Canadian measurement system	Support the integration of metrology into next-generation technology	Adapt and respond to organizational priorities and opportunities
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**STRATEGIES TO ACCOMPLISH GOALS**

- |   |   |  |
|---|---|--|
| <ul style="list-style-type: none"><li>• Managed succession and development of research expertise to increase leadership and influence within international metrology community</li><li>• Develop and implement new models for disseminating metrological traceability</li><li>• Strengthen network of other government departments that support the Canadian measurement system</li><li>• Increase influence in public and private metrology networks</li></ul> | <ul style="list-style-type: none"><li>• Validate metrological and measurement tools and systems built into advanced manufacturing processes</li><li>• Exploit research and innovations in quantum, photonics, and nano to develop novel measurement solutions and advance metrology</li><li>• Advance metrology in specific innovation areas (e.g. quantum, nano)</li></ul> | <ul style="list-style-type: none"><li>• Embed Metrology research projects in challenge programs, supercluster support, and collaboration centres</li><li>• Increase metrology expertise and support to projects and initiatives across NRC</li></ul> |
|---|---|--|
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capabilities in high-precision metrology infrastructure:** precision instrumentation for mass measurement; world-leading single-ion optical frequency determination; a comprehensive suite of mass spectrometers for speciation and quantification; and advanced microscopes for nanoscales. Succession planning and allowing the required time to develop excellent scientists into world-class metrologists.

**Increase capabilities in:** Cannabis in collaboration with other government departments and industry; quantum, frequency and time within the Joint Centre for Extreme Photonics (JCEP) with the University of Ottawa.

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METROLOGY’S COMMITMENT TO RESEARCH EXCELLENCE

How Metrology defines research excellence

Top-5 national metrology institute.

Science goals Metrology aims to achieve to advance in their field(s) of research

Next generation SI realization; new measurement solutions for needs of the industry and regulators.

Actions Metrology will take to increase the level of research excellence

Metrology will build on our leadership/ participation/ relationships internationally to give us access to expertise and facilities through collaboration; leverage international collaboration to strengthen the NRC’s capabilities and support our Canadian partners (other government departments and industry); leverage scientific excellence and core competencies for the agility required to capitalize on the capabilities embodied in NRC Metrology resources.

How Metrology engaged researchers in developing a research agenda to support growth in excellence

Established a task force consisting of three PROs from various disciplines who conducted meetings with researchers, technicians etc. Report submitted to the Chief Metrologist.

FORWARD LEADING EDGE OF METROLOGY’S RESEARCH AGENDA

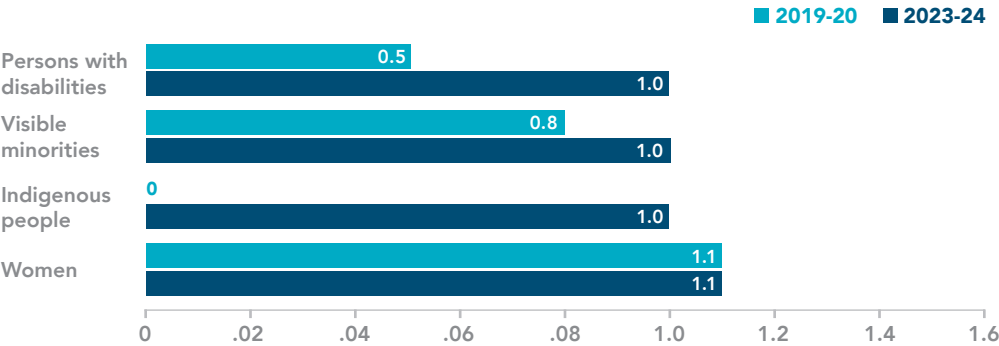
- Redefining and implementing the revised SI
- Supporting high-integrity precision time via NRC TimeLink™
- Supporting government activities for legalisation and regulation of Cannabis

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	151	114	121
Citation score†	1.2	–	–
Unique patents granted	–	0	0
Students, postdoctoral fellows and research associates	16	19	19
Clients and collaborators	197	200	205
Revenue (\$M)	8.185	8	8
Expenditures (\$M)	25.357	26.236	24.192

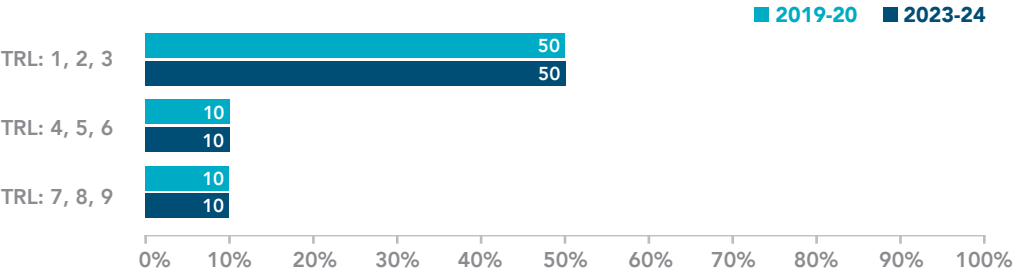
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EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 13

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# NANOTECHNOLOGY AT A GLANCE

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### VISION

Canada leads in innovations enabled and improved by ground-breaking nanoscience.

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### MISSION

To cultivate nanoscience platforms that lead to revolutionary technologies and applications to enhance: human health; the environment; and society’s technological future.

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### EMPLOYEES

60

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### MAJOR FACILITIES

The NRC’s Nanotechnology Research Centre (NANO) enables the translation of nanoscience into applications in various industry sectors through its first-rate facilities, equipment, and staff. The following are a few examples of NANO’s major facilities:

**Electron Microscopy Lab (Edmonton):** home to three transmission electron microscopes (TEMs), three scanning electron microscopes (SEMs), and two focused ion beam (FIB) microscopes. All microscopes are situated in specially-designed characterization suites that minimize environmental disturbances and ensure optimal performance for clients.

**Innovation Centre (Edmonton):** experienced team of technology advisors assists start-ups and establishes companies with their nanotechnology ventures, and provides a supportive teaching environment by providing the latest instrumentation and technical expertise to clients

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<b>GOALS</b>				
Build an internationally recognized, diverse, inclusive, and enthusiastic workforce	Achieve long-term sustainability of NANO's leadership and capabilities	Foster thriving, collaborative relationship with UofA in NRC programs	Secure national leadership in developmental and analytical microscopy R&D	Achieve high-quality intellectual assets in a few, focused nanoscience platforms

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<b>STRATEGIES TO ACCOMPLISH GOALS</b>				
<ul style="list-style-type: none"> <li>• Grow high-potential staff and develop pathways for career development</li> <li>• Increase diversity in STEM through national workshops and contests with academia</li> </ul>	<ul style="list-style-type: none"> <li>• Invest capital on key equipment and divest in uncompetitive facilities</li> <li>• Establish an evergreen strategic workforce plan and succession/retention strategy for key positions</li> </ul>	<ul style="list-style-type: none"> <li>• Align Nanotech Initiative and UofA activity with NRC programs</li> <li>• Open new NRC “hosting centre” in Edmonton to enable cross-NRC engagement with Alberta stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• Launch the Advancing Developmental and Analytical Microscopy program</li> <li>• Build strategic relationships with top microscopy institutions nationally and in Japan</li> </ul>	<ul style="list-style-type: none"> <li>• Pursue discoveries and IP disclosures through Nanotech Initiative, capability platforms and new R&amp;D collaborations across the NRC</li> <li>• Focus investments on technologies with cross-cutting applications</li> </ul>

.....				
<b>PROGRAMS</b>				
<ul style="list-style-type: none"> <li>• Engineered Cell and Gene Therapies Challenge</li> <li>• Artificial Intelligence in Support of Design Challenge</li> <li>• Materials for Clean Fuels Challenge</li> </ul>				

.....				
<b>CHANGES IN CAPABILITIES</b>				
<p><b>Maintain current capabilities in:</b> nanomaterials, sensors, nanobiology, and microscopy.</p> <p><b>Build capabilities in:</b> biomedical nanotechnologies, detection platforms, microscopy engineering.</p>				
.....				

## NANO'S COMMITMENT TO RESEARCH EXCELLENCE

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### How NANO defines research excellence

R&D excellence means nurturing and enabling capability teams that make major S&T contributions in biomedical nanotechnologies, detection systems, and microscopy.

### Science goals NANO aims to achieve to advance in their field(s) of research

We will empower staff by forming vision-driven capability teams, to increase scientific depth and critical mass in strategic R&D areas. Specific goals include developing creep-free motion control integrated into nano-scale systems, enhancing nanoparticle based bio-delivery systems, and advancing detection platforms for environmental applications.

### Actions NANO will take to increase the level of research excellence

- Restructuring into capability teams for more impactful use of resources;
- Building and sustaining active relationships with a few top national and international partners;
- Hiring up-and-coming research associate talent to revitalize our workforce.

### How NANO engaged researchers in developing a research agenda to support growth in excellence

- Held townhalls in order to socialize our collective mission, vision and goals;
- Invited senior RC staff to provide scientific input into our strategy;
- RC experts worked with KITS in extensive bibliometric analyses on exploring R&D directions for NANO;
- Capability team leads held discussions with team members to develop their team-specific R&D excellence and vision for long-term success, aligned with NANO's strategy.

## FORWARD LEADING EDGE OF NANO'S RESEARCH AGENDA

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- Begin planning for the ADAM Program — Advancing Developmental and Analytical Microscopy — and promoting it nationally. Explore incorporation of machine intelligence into microscopy technology.
- Promote cross-team interactions between biomedical nanotechnologies and microscopy to leverage our unique expertise and infrastructure in these areas.
- Set agreements with Japanese partners in microscopy, aligned with NRC's International Strategy.
- Strengthen capabilities in biomedical nanotechnologies, detection systems, and microscopy engineering.
- Supply unique capabilities to the NRC's Challenge Programs: Health and Clean Energy Materials.

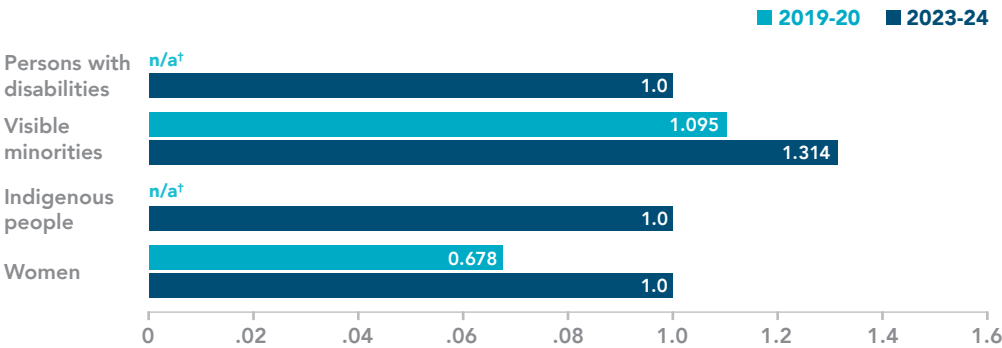
OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	88	40	55
Citation score†	2	1.3	1.5
Unique patents granted	–	2	4
Students, postdoctoral fellows and research associates	21	15	25
Clients and collaborators	25	22	25
Revenue (\$M)	0.869	1	1.1
Expenditures (\$M)	10.011	10.794	9.881

\* Counted by calendar year, tracked as fiscal year start (i.e., FY2018 – 2018 = 2017)

† Field-weighted Citation Impact (FWCI) is the average citation rate for RC publications generated in a specific period. Results can vary greatly for publications published within the past 2 years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on 8 Mar. 2019.

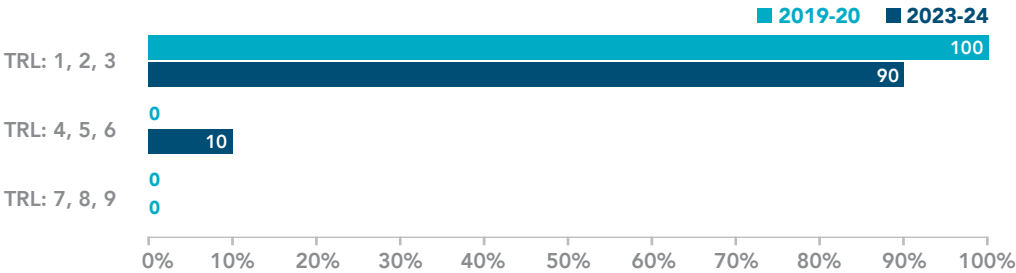
EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

† To adhere to confidentiality rules related to self-identification data, any representation number of 5 or less is listed as “N/A”. Data on women does not come from the self-identification process and is therefore not subject to the same restrictions.

TECHNOLOGY READINESS LEVELS (TRLs)



ANNEX 14

OCEAN, COASTAL AND RIVER ENGINEERING AT A GLANCE



VISION

By 2024, to be recognized as a global research leader for novel engineering solutions in harsh marine environments characterized by ice, waves, cold and wind.

MISSION

Working with industry, academia, and governments to expand scientific knowledge through research leading to the development of sustainable and intelligent technologies deployed in harsh marine conditions for the benefit of Canada’s economy and environment.

EMPLOYEES

90

MAJOR FACILITIES

The NRC’s Ocean, Coastal and River Engineering Research Centre (OCRE) provides industry with a competitive advantage of world-class, customizable physical testing facilities, combined with the broad knowledge and experience of its research staff. Following are a few examples of OCRE’s major facilities:

**Ice Tank (St. John’s):** one of the world’s largest facilities of its kind that simulates realistic Arctic and northern marine conditions.

**Towing Tank (St. John’s):** deep enough to test underwater vehicles, suited for high-speed vessels such as warships, and used to evaluate performance of submarines, bulk carriers, and patrol vessels.

**Offshore Engineering Basin (St. John’s):** one of the most advanced indoor model ocean facilities in the world that produces multi-directional waves representing extreme sea-state conditions. It has been used to test all platforms operating offshore Canada.

**Large Area Basin (Ottawa):** used for conducting large physical model studies of hydrodynamics in marinas, ports, and harbours.

**Coastal Wave Basin (Ottawa):** ideal for conducting physical model studies of wave and current interactions with structures and shorelines at medium to large scales.



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**GOALS**

Lead the development of next generation marine transportation in Canada	Develop advanced digital models representing harsh marine environments	Improve the resilience of Canadian coastal infrastructure and waterways from the impacts of climate change
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**STRATEGIES TO ACCOMPLISH GOALS**

<ul style="list-style-type: none"><li>• Develop technologies to facilitate autonomous shipping in Canada’s harsh environment and ice-covered waters</li><li>• Participate in and drive future regulatory frameworks</li><li>• Reduce ship emissions and improve efficiencies by applying AI to the interpretation of vessel operational data</li><li>• Mitigate effects of ship underwater radiated noise using numerical prediction models</li></ul>	<ul style="list-style-type: none"><li>• Develop extensive expertise in AI for modelling and predicting ice and harsh environments</li><li>• Build comprehensive databases of environmental parameters (tank, field, numerical)</li><li>• Develop required hardware infrastructure and partnerships to enable large-scale numerical and AI projects and programs</li></ul>	<ul style="list-style-type: none"><li>• Characterize and develop a better understanding of harsh environments</li><li>• Develop resilient, intelligent, and connected, coastal infrastructure</li><li>• Physically (tanks) and digitally represent coastal processes and infrastructure to adapt and optimize design for climate change resilience</li></ul>
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**PROGRAMS**

- Digital Seaway (St. Lawrence/Great Lakes/Gulf)
  - Support for Ocean Supercluster
  - Arctic Challenge
- .....

**CHANGES IN CAPABILITIES**

**Build on current capabilities in the following areas:** naval architecture; ocean engineering; coastal engineering; water resources engineering; cold regions engineering; human performance and safety in harsh environments.

**Develop new capability** in data science and artificial intelligence.

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## OCRE’S COMMITMENT TO RESEARCH EXCELLENCE

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### How OCRE defines research excellence

**Quality research** published in peer-reviewed journals, cited in the best journals, attracting international attention, and increasing national and international collaborations.  
**Impactful research** generating positive economic impacts to Canada, societal impacts by enabling paradigm shifts in the area of marine transportation, new knowledge, and technologies that improve lives and the environment, and that is used in policy-making and drive future regulatory frameworks

### Science goals OCRE aims to achieve to advance in their field(s) of research

Lead the development of next-generation marine transportation in Canada; develop advanced digital models representing harsh marine environments; and improve the resilience of Canadian coastal infrastructure and waterways from the impacts of climate change.

### Actions OCRE will take to increase the level of research excellence

Ensure research effort is highly focused; provide a significant and maximized amount of internal R&D time to researchers; improve and streamline operational support to reduce overhead; increase involvement of students; increase collaborations; increase critical mass and further develop competencies in strategic areas (i.e., AI, digital); conduct strategically-positioned lower TRL research (5- to 10-year time horizon in mind); encourage risk-taking and value failure; and increase equity, diversity and inclusion.

### How OCRE engaged researchers in developing a research agenda to support growth in excellence

Strategic consultations, focus defined by research teams, empowerment at the team level for internal R&D (bottom-up approach to feed the strategic direction).

## FORWARD LEADING EDGE OF OCRE’S RESEARCH AGENDA

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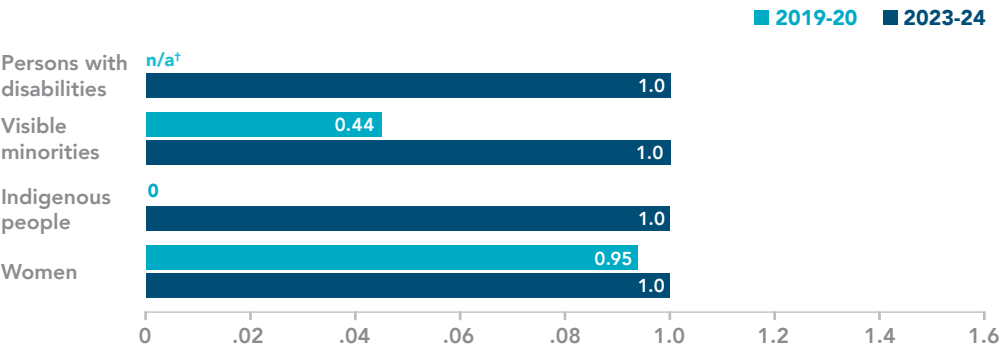
Enable Canada to be the first country in the world to have a major seaway (the Great Lakes - St. Lawrence Seaway and Gulf of St. Lawrence) fully digital, instrumented, and intelligent, tracing the path towards autonomous ships, ports, and resilient coastal infrastructure.

OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	19	28	48
Citation score†	0.99	1.5	1.5
Unique patents granted	–	0	2
Students, postdoctoral fellows and research associates	9	4	10
Clients and collaborators	45	47	52
Revenue (\$M)	9.215	9.5	9.5
Expenditures (\$M)	14.333	14.985	14.44

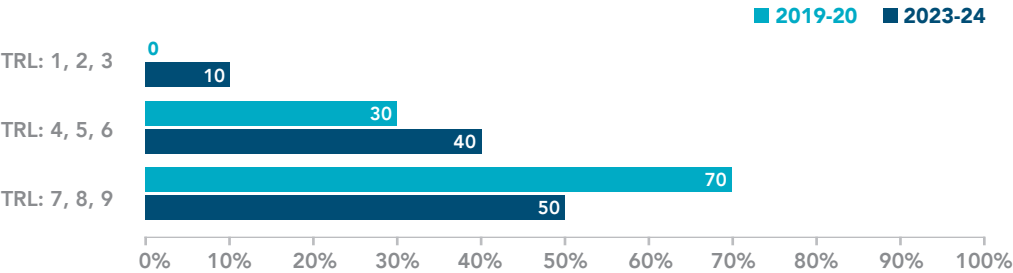
\* Counted by calendar year, tracked as fiscal year start (i.e., FY2018 – 2018 = 2017)  
† Field-weighted Citation Impact (FWCI) is the average citation rate for RC publications generated in a specific period. Results can vary greatly for publications published within the past 2 years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on 8 Mar. 2019.

EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.  
† To adhere to confidentiality rules related to self-identification data, any representation number of 5 or less is listed as “N/A”.  
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TECHNOLOGY READINESS LEVELS (TRLs)



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## ANNEX 15

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# SECURITY AND DISRUPTIVE TECHNOLOGY AT A GLANCE

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### VISION

To be a world leader in foundational quantum science and materials science.  
To identify emerging technology trends and translate these into disruptive technology platforms of strategic importance to build a better Canada and world.

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### MISSION

To **advance scientific knowledge** through world-leading foundational research in quantum physics and materials science. To **deliver policy solutions for government** related to disruptive innovations in quantum technologies and nanomaterials to strategic government partners including higher-TRL NRC programs. To mobilize the scientific, government and industry research community to **support business innovation** through research collaboration, workshops, roadmaps, technology projects, and symposia, in order to provide social, economic, and environmental solutions for Canada.

.....

### EMPLOYEES

83

.....

### MAJOR FACILITIES

The NRC’s Security and Disruptive Technologies Research Centre (SDTech) provides key players across Canada’s innovation system with access to its world-class facilities to build the emerging technology platforms that will sustain Canada’s industrial competitiveness. Following are a few examples of SDTech’s facilities, all located in Ottawa:

**NRC-UOttawa Joint Centre for Extreme Photonics:** Combining world class expertise from NRC and University of Ottawa to push the frontiers of extreme photonics.

**NRC-UOttawa Joint Attosecond Science Laboratory** specializes in femtosecond laser sources, attosecond xuv sources, molecular dynamics, and theory of atoms and molecules in intense fields.

**Advanced, Ultrafast Quantum Photonics Laboratories:** Allows researchers and clients to study light matter interactions at both intense and quantum limits. Applications include secure communications, quantum sensing, and computation.

**Quantum Electronics Facilities:** design, development, and testing of quantum electronics devices.

**Fibre Photonics Facilities:** Development of advanced optical fibre systems.

**Nanotube Production Laboratories:** offers fabrication, characterization and prototyping of carbon and boron nitride nanotubes for real-world applications of these advanced materials.

**Printed Electronics:** 2-D and in-mold 3-D printing prototypes using internally developed conductive inks and specialized composites with nanotubes.

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**GOALS**

Continue to be a world leader in quantum science and technology	Become a world leader in advanced materials for additive manufacturing and adaptive intelligent objects	Advance scientific knowledge
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**STRATEGIES TO ACCOMPLISH GOALS**

<ul style="list-style-type: none"><li>• Hire and retain outstanding talent</li><li>• Maintain and grow leading laboratory infrastructure</li><li>• Grow collaborations with global world-class partners</li><li>• Increase collaboration with OGDs and agencies</li></ul>	<ul style="list-style-type: none"><li>• Grow competence and infrastructure to support materials design and development for additive manufacturing</li><li>• Build strategically aligned industry, OGD, and academic collaborations</li><li>• Produce IP that delivers on partner goals</li></ul>	<ul style="list-style-type: none"><li>• Increase number of unique NRC intellectual assets (patents and publications)</li><li>• Launch the uOttawa Extreme Photonics Collaboration Centre</li></ul>
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**PROGRAMS**

- Quantum Photonic Sensing and Security
  - Security Materials Technologies
  - High-Throughput and Secure Networks Challenge
  - Materials for Clean Fuels Challenge
  - AI in Support of Design
- .....

**CHANGES IN CAPABILITIES**

**Maintain current capabilities in:** atomic and molecular optics, fibre photonics, quantum information and quantum electronics, nanomaterials synthesis, printable electronic materials, nanocomposite formulation and testing.

**Increase capabilities in:** ultrafast quantum photonics, 3D printed electronics and smart objects, and AI design of new functional nanomaterials.

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## SDTECH'S COMMITMENT TO RESEARCH EXCELLENCE

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### Sustain globally leading research and technology development excellence

SDTech researchers partner with leading scientists throughout the world and collaborate on research and publications. SDTech scientists invite and welcome 40+ visiting scientists and students into our labs annually. SDTech supports staff exchanges with leading scientific establishments and universities.

### Science goals SDTech aims to achieve to advance in their field(s) of research

Scientific world leadership in ultrafast quantum photonics and electronics, and functional nanomaterials for 3D additive manufacturing.

### Actions SDTech will take to increase the level of research excellence

Hire and retain outstanding and diversified talent; grow collaborations with global world-class partners.

### How SDTech engaged researchers in developing a research agenda to support growth in excellence

The overall strategic research agenda was developed through individual consultations with every research team in the centre. Researchers continuously propose new bottom-up science and technology projects for SDTech's research program through both regular annual cycles and ad-hoc opportunities. Collaboration with leading external researchers is strongly supported.

## FORWARD LEADING EDGE OF SDTECH'S RESEARCH AGENDA

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**Quantum Sensing and Imaging:** next-generation sensing for environment, health, and security.

**Quantum Communications and Computing:** un-hackable communication components and computing systems.

**Materials Science:** new functional nanomaterials for print-on-demand manufacturing techniques.

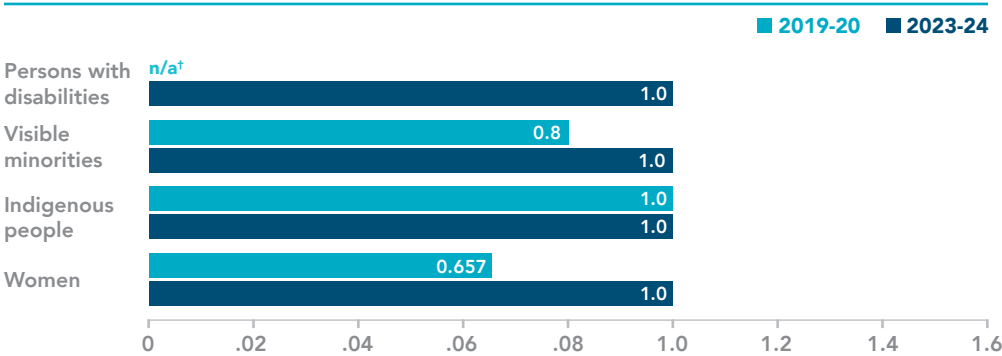
OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Peer-reviewed publications*	109	106	120
Citation score†	1.25	1.5	1.5
Unique patents granted	–	10	14
Students, postdoctoral fellows and research associates	27	65	79
Clients and collaborators	20	19	19
Revenue (\$M)	3.721	2.78	2.58
Expenditures (\$M)	15.525	15.136	13.231

\* Counted by calendar year, tracked as fiscal year start (i.e., FY2018 – 2018 = 2017)

† Field-weighted Citation Impact (FWCI) is the average citation rate for RC publications generated in a specific period. Results can vary greatly for publications published within the past 2 years. The 2018-19 data is based on publications published in 2015, 2016, and 2017, extracted from Scopus on 8 Mar. 2019.

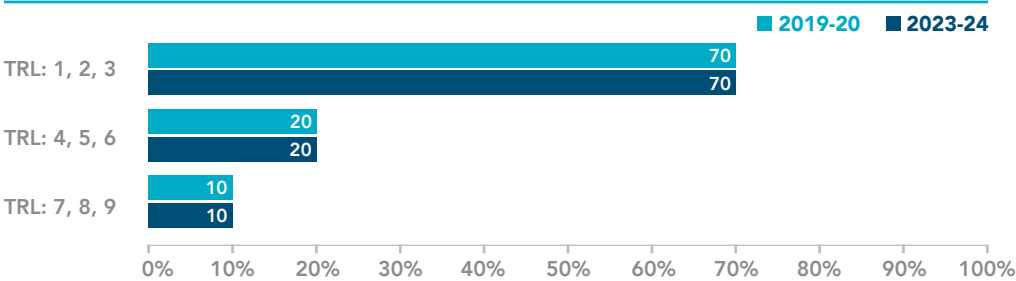
EMPLOYMENT EQUITY · UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

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TECHNOLOGY READINESS LEVELS (TRLs)



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# ANNEX 16

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# INDUSTRIAL RESEARCH ASSISTANCE PROGRAM AT A GLANCE

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## VISION

To be the most impactful program of its kind in the world, where Canadian firms go first to transform their ideas into commercial success.

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## MISSION

To accelerate the growth of small and medium-sized enterprises (SMEs) by providing them with a comprehensive suite of innovative services and funding.

.....

## EMPLOYEES

406

.....

## OVERVIEW OF CURRENT CAPABILITIES

IRAP is a key component of the NRC and one of the Government of Canada’s primary mechanisms for providing innovation support to Canadian small and medium-sized enterprises (SMEs). The program provides customized support through expert advice, network linkages, financial assistance, and access to national and international networks in all industry sectors, such as deep ocean exploration, autonomous vehicles, agri-food technology, and more. In 2018-19, more than 8,159 Canadian businesses benefited from NRC IRAP support, and more than 15,662 jobs were supported across the country.



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**GOALS**

Enhance SME  
outcomes

Empower world  
class workforce

Streamline  
program delivery

.....

**STRATEGIES TO ACCOMPLISH GOALS**

- |   |   |  |
|---|---|--|
| <ul style="list-style-type: none"><li>• Enhance IRAP client experience</li><li>• Improve supports to IRAP clients to increase exports</li><li>• Facilitate increased integration of Canadian SMEs into global value chains</li><li>• Streamline transition and leveraging of financial partners</li><li>• Support increased entrepreneurial engagement for underrepresented groups</li><li>• Support increased internship opportunities</li></ul> | <ul style="list-style-type: none"><li>• Establish framework for recruiting, onboarding, and ongoing PD for all roles within the organization</li><li>• Increase opportunities for collaboration and networking</li><li>• Evolve organizational design to meet program delivery requirements</li><li>• Implement programs and practices to support GBA+ priorities</li></ul> | <ul style="list-style-type: none"><li>• Maintain classic IRAP</li><li>• Continue to evolve program infrastructure in support of program delivery and retool staff and systems</li><li>• Provide larger funding for scale up and transformative projects through LVCs (\$3M to \$10M)</li></ul> |
|---|---|--|
- .....

**PROGRAMS**

- Industrial Research Assistance Program (IRAP)
- .....

**CHANGES IN CAPABILITIES**

**Providing IRAP programming to over 8,000 firms annually through advisory services and funding:** Enhance programming for clients by helping more businesses across the country to innovate. This will be achieved in part by funding larger projects and increasing the contribution threshold of \$1 million to \$10 million.

Hire an additional 100 staff members to expand IRAP's capacity to support the delivery of an expanded program and larger project funding to SMEs.

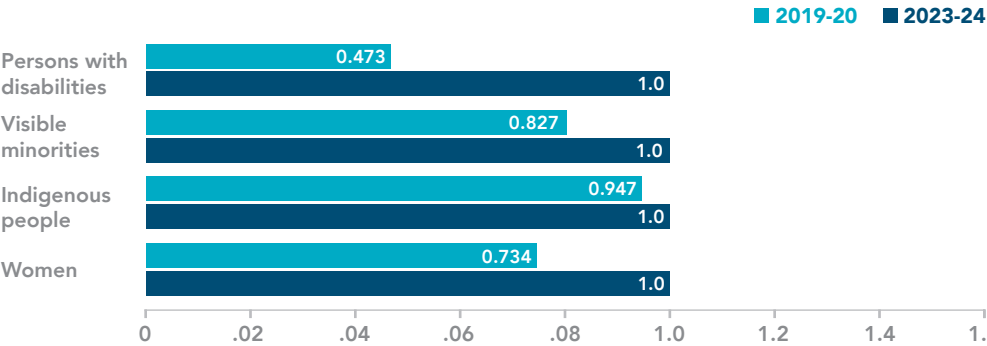
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OVERVIEW OF EXPECTED RESULTS

INDICATOR	2018-19 RESULT (PRELIM)	TARGET FOR 2019-20	TARGET FOR 2023-24
Revenue growth of IRAP supported firms (annual %)	27%	20%	20%
Growth in S&T jobs of IRAP supported firms (annual %)	18%	10%	10%
SMEs served (unique firms with CTF funding starting in 2019)	3,541	1,500	1,500
Revenue (annual total) <sup>1</sup>	\$2.512M	\$1M	\$1M
Students and post-docs (annual total)	19	30	30

<sup>1</sup> Budget 2018 recognized IRAP as one of the 4 key pillars in the innovation ecosystem with a specific focus on raising funding for larger projects from \$1 million to \$10 million. In 2018-19, IRAP approved 29 projects with a contribution greater than \$1M and it is expected to support more than 30 projects with funding greater than \$1M to \$10M in 2019-20.

EMPLOYMENT EQUITY • UNDER-REPRESENTED GROUPS  
(ANNUAL % RELATIVE TO CANADIAN AVERAGE LABOUR MARKET AVAILABILITY)\*



\* Labour market availability will be achieved by 2022-23 for persons with disabilities, visible minorities, and women.

**This strategic plan seeks to advance an action agenda that will leverage the NRC's excellence in research and innovation to deliver targeted impact for Canadians.**

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# ANNEX 17

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# DIALOGUE AND BEYOND 2020

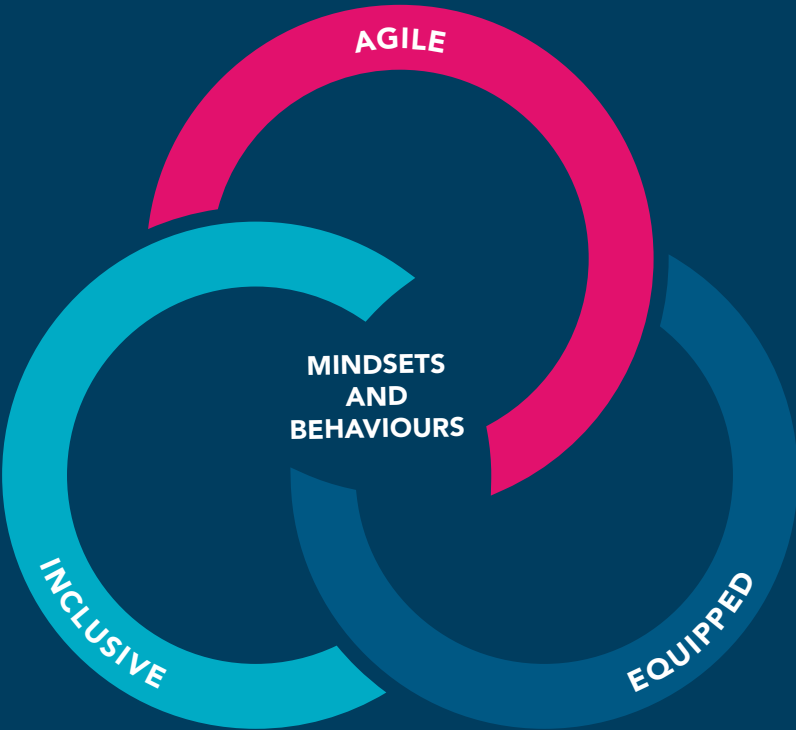
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## SUPPORTING INNOVATION: NRC DIALOGUE AND BEYOND 2020

NRC Dialogue is a multi-year effort to renew the NRC and better-position it to support research and innovation excellence. Beyond 2020 is a cross-government initiative to develop a more agile, inclusive and equipped public service. Together, the two initiatives provide a key underpinning to the NRC’s five year strategic plan.

The Dialogue consultation and engagement process produced more than 60 organizational renewal projects. This page gives you an overview of those projects and how they contribute to the Beyond 2020 effort.

.....



## **MOBILIZING RESOURCES AND PEOPLE**

- Five new supercluster support programs
- Four new challenge programs in conjunction with academic and private-sector researchers
- More than 50 self-directed research projects via the New Beginnings initiative
- Allocating \$100M in additional, ongoing funding to IRAP to ramp up work with SMEs on high value/high impact R&D projects

## **EMPOWERING OUR WORKFORCE**

- Strategic HR plan to support our 5-year strategic direction
- Guidelines for self-directed research
- Staffing lead positions for new and revised programs at the management level
- Developing and implementing an engagement strategy for regional employees, fostering a “one NRC perspective”

## **EMBRACING UNCERTAINTY AND LEARNING THROUGH EXPERIMENTATION**

- Establishing new leading-edge, funded ideation programs
- As part of our revamped stakeholder engagement strategy, undertaking a “strategic account management” pilot project involving 5 to 6 corporate strategic accounts and account managers

## **CREATING AN ENVIRONMENT WHERE INDIVIDUALS FEEL SAFE TO EXPRESS THEMSELVES**

- Organizational wellness strategy
- Clear and accessible appeals process for IRAP clients
- Researcher-based President’s Research Excellence Advisory Committee to provide frank advice on research issues
- Outreach in collaboration with other partners, with a particular focus on underrepresented groups and women
- Updating the harassment policy, establishing an ombuds position and creating an NRC Equity, Diversity and Inclusion strategy

## **EXPANDING PARTNERSHIPS AND REMOVING BARRIERS TO COLLABORATION**

- Provide IRAP clients with reduced-cost access to NRC technical and research support
- Collaboration Centres that amplify the impact of NRC researchers’ work, and leverage the efforts and facilities of leading researchers in universities and research hospitals
- Encouraging the inclusion of IRAP Industrial Technology Advisors on Research Centre Advisory Boards
- An international engagement strategy to ensure alignment of activities and increased impact in priority countries

## **CO-CREATION BY BRINGING DIFFERENT PERSPECTIVES TO THE TABLE**

- Expanded Post-Doctoral Fellowship and Student Co-op programs
- External Advisory Boards for Research Centres to ensure engagement with and input from leading experts
- Additional to Dialogue, emphasizing the importance of gender-based analysis

## **DESIGNING WORK ENVIRONMENTS TO OPTIMIZE PERFORMANCE**

- Integrated and responsive Health, Safety and Environment branch
- New, client-centered, “lean” approach to common and shared services
- Three-year peer review of research facilities and a plan for renewal
- Simultaneously, assessing and planning for renewal of NRC buildings and real estate in order to improve the workspace and to achieve reductions in waste, energy consumption and green-house gas emissions

## **MAKING LEARNING FUNDAMENTAL TO OUR WORK**

- Career paths for program leaders, team leaders and technical officers
- Re-establishing the Leadership Development Program
- More opportunities for professional development via out-placements and external assignments
- Access to internal assignments, project work and committee participation, notably at the regional sites
- An improved training approach for IRAP employees to enhance onboarding and support performance
- Professional development guidelines to support researchers, advance their work and enhance their capabilities

## **EXPLORATION OF TECHNOLOGY AND TOOLS**

- \$20M for new IT investments
- New Information Management Platform (DocZone), extending it to enable external collaboration
- Modernizing Research IT Platform (cloud storage, Specialized Research Environments (SREs) and high-performance computing (HPC)).
- Email in the more secure “green” network and IRAP Industrial Technology Advisors moved to mobile platforms



**Research excellence  
gives confidence  
to our partners  
and customers that  
we are critical for  
their success and  
to government that  
advice on policy  
solutions is based  
on sound science.**

