Evaluation of the Clean Energy Innovation Research Centre

October 27, 2025

Copyright statement

The French version of this report, along with an accessible HTML version, can be found on the National Research Council of Canada's (NRC) evaluation page.

Generative artificial intelligence (AI) tools were used to support editing and formatting only. All content was reviewed and validated by NRC staff.

This report was approved by the President of the National Research Council of Canada on October 27, 2025.

Cat. No. NR16-497/2026E-PDF
ISBN 978-0-660-79592-8

Table of contents

Initialisms and abbreviations

ACE	Advanced Clean Energy program
AI	Artificial intelligence
CBMI	Critical Batteries Material Initiative
CEI	Clean Energy Innovation Research Centre
ECCC	Environment and Climate Change Canada
EME	Energy, Mining and Environment Research Centre
FWCI	Field-weighted citation index
FY	Fiscal year
GHG	Greenhouse gas
ICM	Industrial Carbon Management program
LCA	Life cycle analysis
MCF	Materials for Clean Fuels Challenge program
NRCan	Natural Resources Canada
NRC	National Research Council of Canada
NRC IRAP	National Research Council of Canada Industrial Research Assistance Program
OGD	Other government department
PRC	Peer review committee
R&D	Research and development
SDL	Self-driving laboratory
SME	Small and medium-sized enterprise
TEA	Techno-economic analysis
TRL	Technology readiness level

Introduction

The evaluation of the National Research Council of Canada's (NRC) Clean Energy Innovation Research Centre (CEI), formerly the Energy, Mining and Environment Research Centre (EME), covers the period from fiscal year (FY) 2017–18 to 2023–24. It was conducted in accordance with the NRC's Departmental Evaluation Plan and the Treasury Board's Policy on Results.

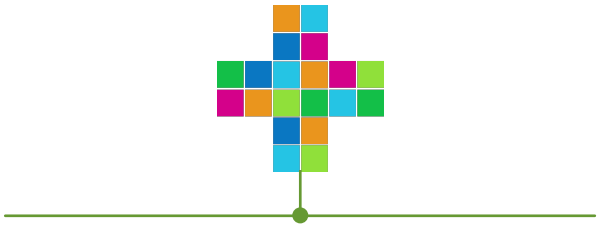
This is the second evaluation of the research centre since its inception in 2012. The previous evaluation was conducted in FY 2017–18.

The report begins with a profile of CEI, followed by evaluation findings related to outcomes, capabilities, relevance and potential areas of leadership. It concludes with recommendations for improvement.

The following icons are found throughout the report:

Information that is useful to know to help understand the findings.

This symbol indicates a quote that helps illustrate or support the main findings.



Information that supports equity, diversity, inclusion and Gender-based Analysis Plus (such as factors that illustrate how diverse groups may experience policies, programs and initiatives).

Evaluation approach

Approach

The evaluation was led by the NRC's Office of Audit and Evaluation (OAE). It assessed the research centre's progress towards outcomes and the extent to which it is positioned to achieve its FY 2024–29 strategic objectives.

A mixed -methods approach was used, incorporating both qualitative and quantitative data from multiple sources. Where appropriate, Gender-based Analysis Plus (GBA Plus) considerations were examined.

Methods


Bibliometric study


Document review


Data review


Case studies


Key informant interviews


Peer review committee

Evaluation questions

1. **Research and innovation:** To what extent is the research centre advancing research and technological innovation in Canada's clean energy sector?
2. **Outcomes:** What outcomes has the research centre achieved in support of Canada's net-zero emissions goals?
3. **Capability:** To what extent does the research centre have the capacities, facilities and resources needed to achieve its strategic objectives?
4. **Engagement:** How has the research centre engaged its staff and stakeholders to support its strategic objectives?

Appendix A details the NRC's evaluation **methodology**, while Appendix B outlines the **limitations and mitigation strategies**. Appendix C lists the members of the **peer review committee**.

Profile

The Clean Energy Innovation Research Centre (CEI), formerly the Energy, Mining and Environment Research Centre (EME), was established in 2012. Its research focuses on accelerating the development of innovations in net-zero energy, critical minerals, advanced materials and industrial decarbonization to support Canada's transition to a net-zero economy.

CEI collaborates with stakeholders across the clean energy sector to develop impactful, industry-relevant solutions.

Background

2012–2018 Inception

- EME was established in 2012 as a new NRC research centre
- Introduced 2 energy programs, Energy Storage and Bioenergy, and 2 mining programs, High Efficiency Mining and Environmental Advances in Mining

2019 Focusing and creating synergies

- Launched a 5-year strategic plan to reorient its focus in energy, mining and environment
- Established the Materials for Clean Fuels Challenge program, with significant funding to support collaborative research projects
- Began refining its project selection approach to better align with new priorities, benefits and impact

2020–2023 Sunsetting and reorganizing activities

- Refocused the 2 energy programs and launched the Advanced Clean Energy program in 2021
- Ceased operations of the 2 mining programs, the Mining Materials Wear and Corrosion Consortium, environmental remediation activities and other out-of-scope environment-related activities
- Refocused collaborations with other NRC research centres
- Launched the Industrial Carbon Management program and the Critical Battery Materials Initiative

2023–2024 Start of a new era

- Launched a 5-year strategic plan to reorient its focus toward Canada’s clean energy transition and industrial decarbonization
- Introduced a new name, vision, mission, strategic objectives and thematic areas
- Revamped its engagement and business development strategy

Overview

Vision and mission (2024–2029)

CEI's vision is to accelerate Canada's transition to a thriving net-zero economy built on clean energy and decarbonized industries.

Its mission is to catalyze Canadian innovation for a sustainable future by leveraging diverse scientific capabilities, cutting-edge technologies and strategic partnerships to pioneer solutions in net-zero energy, critical minerals, advanced materials and industrial decarbonization.

Previous vision and mission (2019–2023)

EME's vision was to be the preferred partner to Canada's clean energy and mining sectors, bridging science and application.

Its mission was to unleash scientific excellence in the clean energy and mining sectors to grow and protect Canada's future.

Key strategic priorities (2024–2029)

Climate action

Focus on areas where CEI can achieve maximum impact in supporting Canada's 2050 net-zero greenhouse gas (GHG) emission targets.

Business innovation

Strengthen collaboration with industry and academia in the clean energy sector and increase awareness of CEI's value proposition.

Research excellence

Advance the digitization of research by applying artificial intelligence (AI) and machine learning, and promote collaboration across NRC research centres.

Inclusive innovation

Increase workforce diversity, support employee participation in inclusion initiatives and expand engagement with Indigenous and remote communities.

Programs

CEI organizes and delivers its research activities through 3 programs: Advanced Clean Energy (ACE) program, Industrial Carbon Management (ICM) program and Materials for Clean Fuels (MCF) Challenge program.

As part of ACE, CEI leads the Critical Battery Materials Initiative (CBMI), launched in response to the Canadian Critical Minerals Strategy. Both CBMI and MCF include grants and contributions (G&Cs) funding components, which are administered by the National Programs Office (NPO) under the NRC's Collaborative Science, Technology and Innovation Program (CSTIP).

1. Advanced Clean Energy program (ACE)

- **Goal:** Accelerate the development of clean renewable fuels, and energy storage materials and devices in order to facilitate the transition to low- and zero-carbon fuels and the electrification of Canada's energy supply, across all sectors
- **Duration:** 7-year research program launched in FY 2021–22
- **Target technology readiness levels (TRLs):** Mid to high
- **Focus areas:** Battery energy storage, low carbon fuel switching, hydrogen production and distribution, and integration of renewables into microgrids

Critical Battery Materials Initiative (CBMI)

- **Goal:** Develop AI-enabled platforms that can discover critical battery materials and processes faster than ever before, contributing to the growth of a sustainable Canadian battery supply chain
- **Duration:** 4-year strategic initiative launched in FY 2023–24
- **Funding:**
  - $10 million in G&Cs funding for external collaborators
  - $10 million for capital investments
  - $20 million for operational support (salaries and minor capital expenditures)
- **Focus areas:** Battery energy storage

Programs (continued)

2. Industrial Carbon Management program (ICM)

- **Goal:** Develop new materials, sensors, processes and modelling tools to enable commercialization of industrial-scale carbon dioxide removal technologies
- **Duration:** 7-year research program launched in FY 2024–25
- **Target TRLs:** Mid to high
- **Focus areas:** Carbon dioxide removal, industrial decarbonization, critical minerals extraction and processing

3. Materials for Clean Fuels Challenge program (MCF)

- **Goal:** Develop innovative materials for renewable fuels and chemical feedstocks
- **Duration:** 7-year collaborative research program launched in FY 2019–20
- **Funding:** $57 million in G&Cs funding for external collaborators
- **Target TRLs:** Low (high-risk, high-reward)
- **Focus areas:** Carbon dioxide conversion, hydrogen production and accelerated materials discovery

What are technology readiness levels (TRLs)?

TRLs are a scale from 1 to 9 used to assess the maturity of a technology.

- **Low levels (1 to 3):** Early-stage development, such as identifying basic principles and demonstrating proof of concept.
- **Mid-levels (4 to 6):** Laboratory testing, validation in simulated environments and prototype testing.
- **High levels (7 to 9):** Prototype demonstration in operational environments, qualification testing and full deployment in real-life conditions.

CEI programs support projects across all levels.

Thematic areas

CEI organizes its research activities into 4 interconnected thematic areas that are supported by its programs.

Fuel switching

- Biofuels from waste
- Fuel-switching compatibility in heavy duty applications
- Mixed-fuel transportation

Electrification

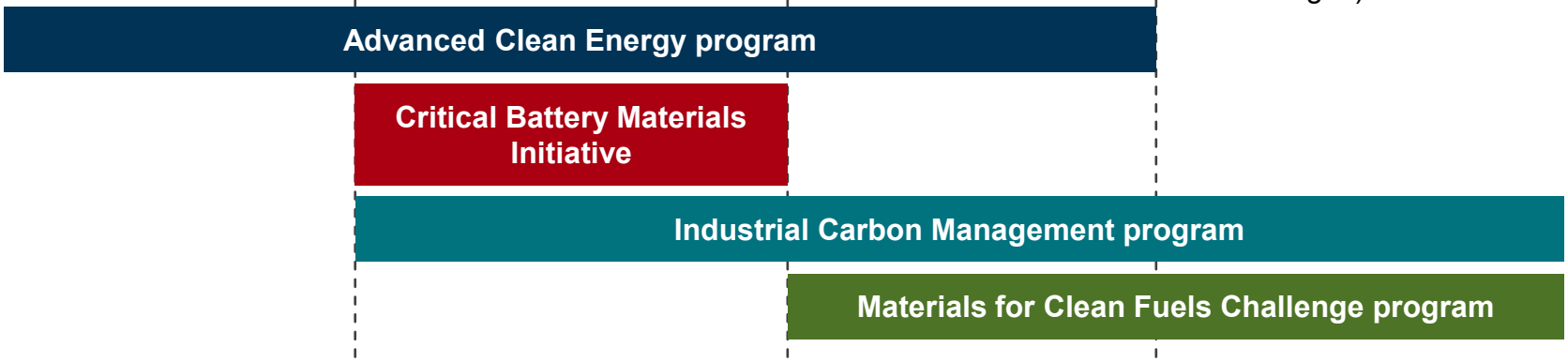
- Battery energy storage (stationary and motive applications)
- Battery supply chain (upstream and midstream)
- Microgrid component testing and integration
- Critical minerals recovery (upstream and midstream)

Hydrogen

- Clean hydrogen production from renewables
- Distribution
- Codes and standards support

Carbon management

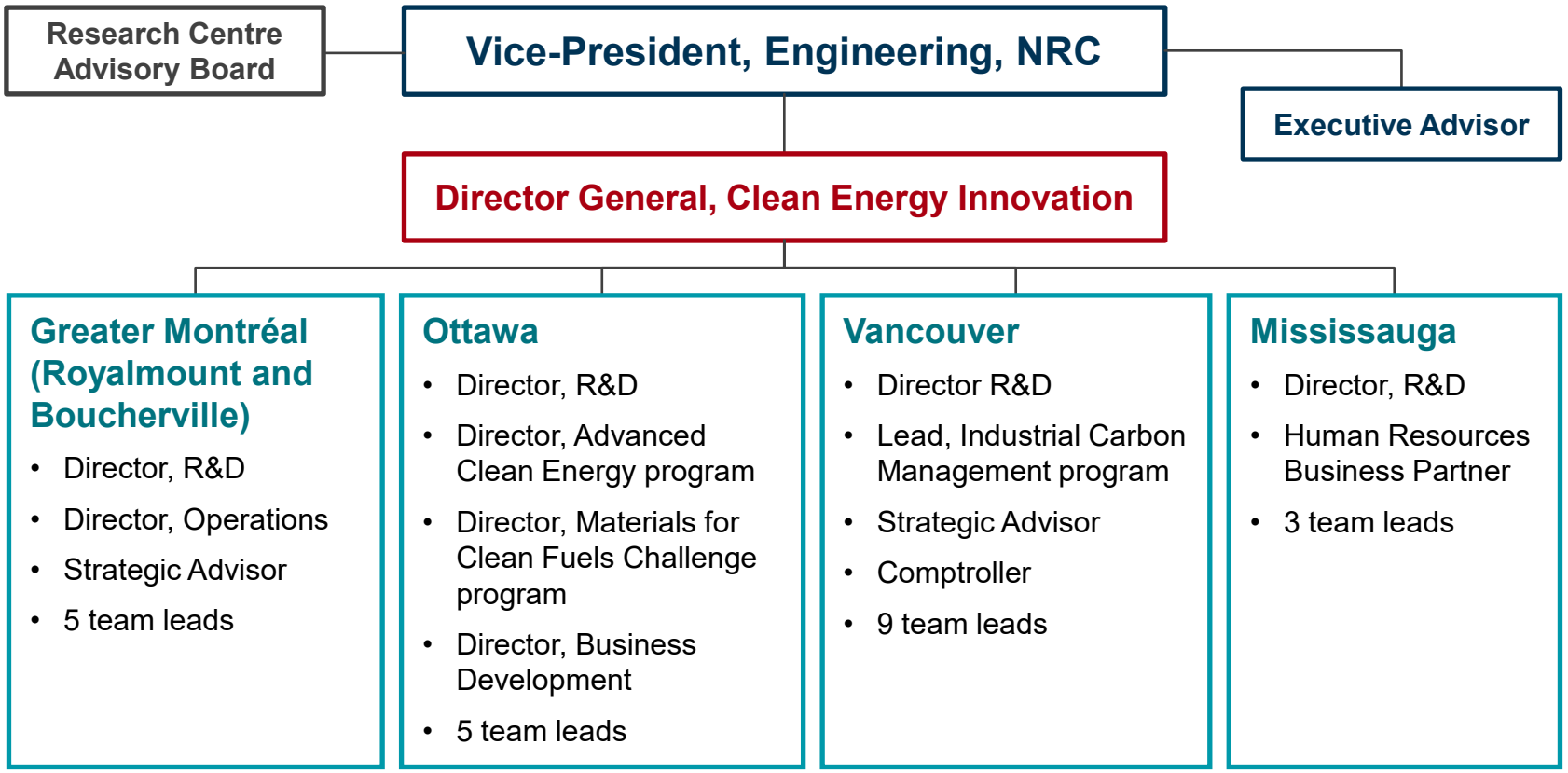
- Carbon dioxide conversion to fuels and chemicals
- Carbon dioxide mineralization, transportation and sensing
- Carbon circularity
- Efficient and low-emission processes for heavy industries (mining, steel, oil and gas)



Research activities are designed to contribute to outcomes detailed in Appendix D.

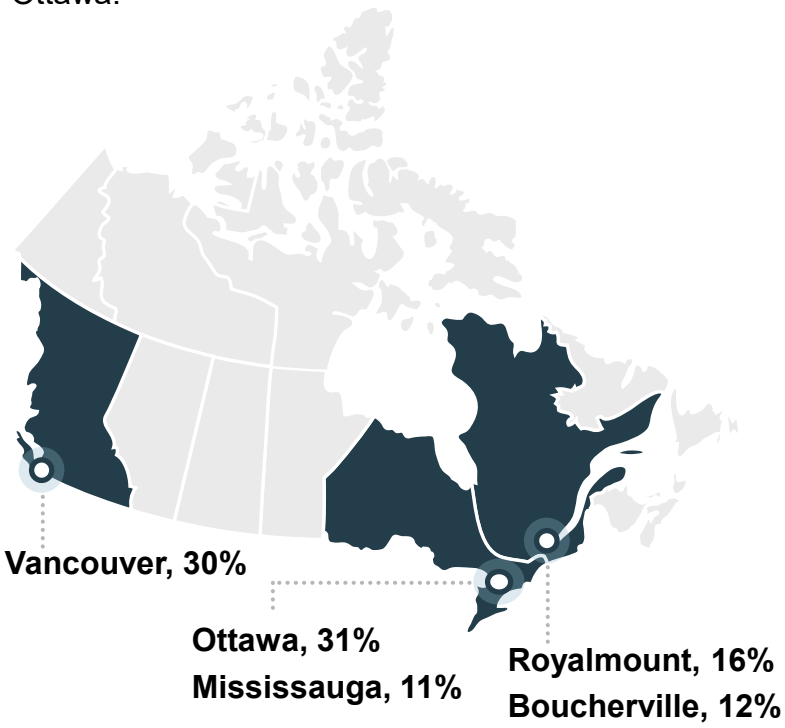
Organizational structure

Figure 1.

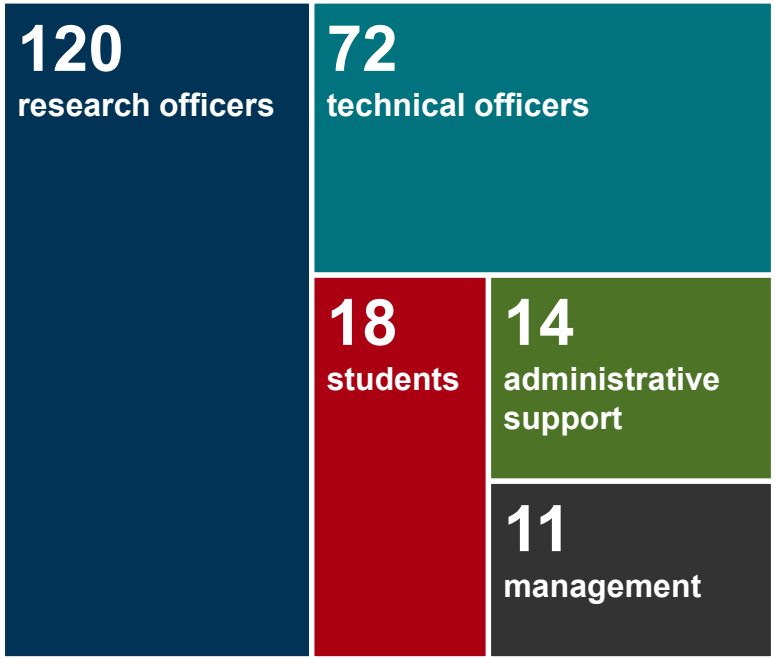


Human resources

CEI employees are distributed across 5 sites in Canada, located in Quebec, Ontario and British Columbia. Most staff are based in Vancouver and Ottawa.



In FY 2023–24, CEI had 235 personnel, including:



Facilities (1 of 3)

Mississauga

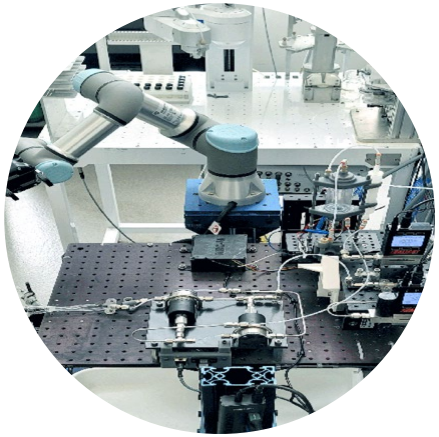
Advanced materials research facility

This facility supports a national innovation platform to accelerate the development and commercialization of advanced materials. Activities include R&D, scaling-up production, de-risking and demonstrating real-world applications.

Key capabilities include:

- **Accelerated materials discovery and process optimization:** Materials acceleration platforms (MAPs) combine automation, AI, machine learning and expert input to accelerate material discovery and process optimization across industrial sectors.
- **Advanced material scale-up and validation:** Supports the characterization, production, integration of advanced materials into devices and validates their performance for hydrogen, electrification and carbon management applications.
- **High-performance computing, AI studio and self-driving laboratories:** Offers computing capacity and AI tools to support self-driving laboratory platforms for material synthesis, characterization and testing.

Advanced materials research facility in Mississauga



Accelerated materials discovery self-driving laboratory in Mississauga

Facilities (2 of 3)

Greater Montréal

Royalmount

- **Anaerobic bioprocessing pilot plant:** Develops and validates bioprocesses that convert organic feedstocks into biofuels and bio-based products. Supports activities such as hydrolysis, fermentation, biogas production, testing and industrial scale-up.
- **Biomining and biological mineral carbonation:** Develops biotechnologies for extracting critical and strategic minerals and increasing the value of mining waste to support decarbonization.

Anaerobic Bioprocesses Pilot Plant at Royalmount

Boucherville

- **Sensors hub:** Tests and validates sensors in relevant environments to accelerate their development and commercialization. Laboratories collaborate with partners to advance various sensor technologies and their application in different industrial sectors.
- **Pilot-scale battery prototyping line:** Enables prototype battery cell fabrication using industry-standard processes, including the testing and evaluation of new battery materials and components (such as graphite and polymers). Supports the prototyping and the scale-up of large cell production for electric vehicle batteries.

Pilot scale battery prototyping line facility in Boucherville

Facilities (3 of 3)

Ottawa

- **Advanced material characterization:** Supports advanced material development, assessment and process improvement to strengthen the critical materials supply chain.
- **Bench- and pilot-scale battery recycling:** Develops small-scale, next-generation battery materials and technologies to support the clean energy transition.
- **Waste-to-fuel conversion:** Develops and advances technologies for converting waste streams (such as food waste, algae, sewage sludge and microplastics) into gaseous and liquid biofuels and high-value products.
- **Renewable fuel combustion:** Enables testing and characterization of low- and zero-carbon fuels in full-scale combustion engines. Supports emissions reduction through technology development and engine optimization.

Clean-combustion engine facilities in Ottawa

Vancouver

- **Hydrogen-safe laboratories:** Enables the development and testing of hydrogen technologies, leveraging expertise in test components, electrochemical and fuel cells and stack performance and durability, in compliance with current standards and protocols.
- **Microgrid testing and training facility:** Integrates a range of pre-commercial power generation and storage technologies for system-level microgrid testing under real-world conditions. Supports performance optimization and regulatory compliance.

Hydrogen-safe laboratories in Vancouver

Key clients

Other government departments

Includes:

- Natural Resources Canada (NRCan)
- Department of National Defence (DND)
- Transport Canada
- Fisheries and Oceans Canada (DFO)
- Environment and Climate Change Canada (ECCC)

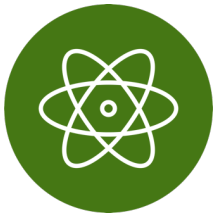
Industry

Clean energy and mining-focused small and medium-sized enterprises (SMEs) engaged in technology innovation, based in Canada and internationally.

Academia

Primarily Canadian universities, including:

- University of Toronto
- University of British Columbia
- University of Waterloo
- Simon Fraser University
- McGill University
- University of Ottawa



Other NRC research centres

Primarily:

- Automotive and Surface Transportation Research Centre
- Ocean, Coastal and River Engineering Research Centre
- Digital Technologies Research Centre
- Aerospace Research Centre

Collaboration centres

NRC collaboration centres were established to build internationally recognized expertise in CEI's research areas. These centres focus on shared research priorities. Whether located at the NRC or partner facilities, researchers collaborate on projects, share specialized equipment, and support the training of emerging scientists.

NRC–University of British Columbia Collaboration Centre for Clean Energy Transition

Launched in 2021, this collaboration centre supports a long-term partnership between the University of British Columbia and the NRC. It focuses on clean energy materials and devices, as well as future energy systems based on hydrogen and other alternative fuels. The collaboration centre aims to develop and integrate economically viable clean energy conversion processes and devices as alternatives to fossil fuels.

NRC–University of Toronto Collaboration Centre for Green Energy Materials

Launched in 2020, this collaboration centre brings together expertise from the University of Toronto and the NRC to reduce the environmental impacts of activities related to the transformation, transmission and storage of energy. Research focuses on advancing clean materials and production processes, including renewable carbon-based feedstocks and fuels, and applying AI and robotics to materials discovery.

Financial resources

Over the evaluation period (FY 2017–18 to 2023–24), CEI had, on average, the following financial resources per year:

Average budget, $23.7 million

Composed of funding from government allocations and time-limited initiatives (e.g., CBMI).

Average revenue, $9.1 million

Generated through technical services and collaborative research with industry, OGDs, academia and other clients.

The average was positively impacted by a notable increase in revenue from OGDs in 2021–22, which reached **over $9 million**.

Average expenditures, $33.2 million

Included basic operating costs such as salaries and benefits, utilities, property taxes and other operational expenses, including facility upgrades and new investments.

By the end of the evaluation period (FY 2023–24), CEI's annual budget had increased to **$26.8 million**. Actual revenues for the year totalled **$11.4 million**, and actual expenditures reached **$37.8 million**.

Refer to Appendix E for CEI's financial profile over the evaluation period.

Achievements and outcomes

The Clean Energy Innovation Research Centre (CEI) has advanced research and technology in Canada’s clean energy sector. It has contributed to global knowledge across its 4 thematic areas: fuel switching, electrification, hydrogen and carbon management.

CEI has supported clients by helping reduce risks and start -up costs associated with developing and launching technological innovations. In addition, CEI has informed the development of government policies and standards, specifically in hydrogen and energy storage.

These efforts contributed to Canada's net-zero emissions goals by advancing the development, demonstration, commercialization and adoption of low-carbon fuels and battery storage technologies.

Scientific publications

During the evaluation period, CEI exceeded its overall publication targets. Approximately half of its research output focused on clean energy. The Materials for Clean Fuels Challenge program was credited with boosting research in this area.

CEI exceeded publication targets

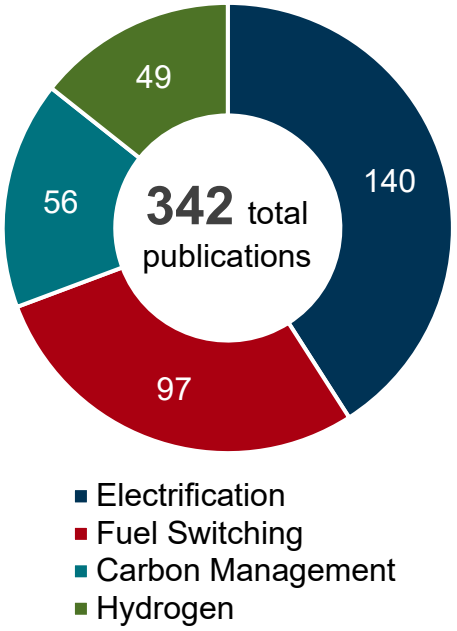
Over the 7-year evaluation period, CEI produced 706 publications, exceeding its targets for FY 2018–19 to 2023–24 by approximately 13%. This result reflects CEI's strong research productivity and its ability to advance scientific knowledge.

Nearly half of publications focused on clean energy

Of the total publications, 342 (48%) concentrated on clean energy topics. The remaining 52% covered other areas, including 19% in mining and 33% in other fields.

Within clean energy thematic areas, 41% focused on electrification, 28% on fuel switching, 16% on carbon management and 14% on hydrogen. Staff attributed these results to the Materials for Clean Fuels Challenge program, suggesting that such programs may help concentrate CEI's research efforts in strategic areas. However, a program-level analysis of publication data would be required to confirm this impact.

Figure 2. Clean-energy-focused publications (FY 2017–18 to 2023–24)



Research citations by thematic area

Publications from the Clean Energy Innovation Research Centre in its thematic areas were cited more frequently than those of peer organizations globally. However, citations related to electrification declined over the past 7 years, despite remaining above the global average.

CEI's publications in clean energy were cited more than those of peer organizations

The field-weighted citation impact (FWCI) scores indicate that CEI's publications in all 4 clean energy thematic areas exceeded global averages (i.e., FWCI of 1.00). This is a positive indication of CEI's scientific influence and impact.

Publications in carbon management and hydrogen achieved the highest FWCI scores, being cited 157% and 95% more, respectively, than publications from other organizations conducting research in the same fields. Electrification-related publications received the fewest citations, though the FWCI score remained 37% above the global average for that area.

While the FWCI for fuel switching rose from 1.85 to 2.26 across 2 measurement periods (2017–2019 and 2020–2022), the FWCI for electrification decreased from 1.72 to 1.14. This trend may reflect a reduction in scientific relevance in electrification and could warrant further analysis.

FWCI scores by thematic area

Thematic area	FWCI (2017 to 2023)
Carbon management	2.57
Hydrogen	1.95
Fuel switching	1.75
Electrification	1.37

The **field-weighted citation impact (FWCI)** is a normalized metric that compares the number of citations a publication receives to the global average for similar publications (by year, document type and subject area). A score of 1.00 represents the global average.

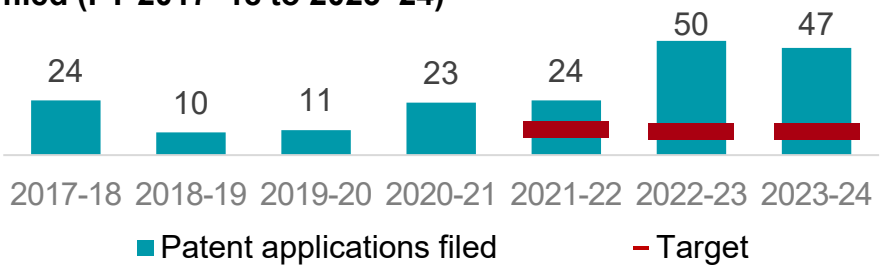
Technology patents

CEI's research has driven technological innovation, as demonstrated by numerous patent filings that significantly exceeded targets. Half of these patent applications focused on clean energy, highlighting CEI's recent shift towards this area.

CEI exceeded targets for patents

Over the last 7 years, CEI-supported research projects have driven state-of-the-art innovations, resulting in 189 patent applications, an average of 27 per year, surpassing targets. This places CEI among the NRC's most active research centres for patent filings, alongside Automotive and Surface Transportation and Medical Devices. As part of its 2024–2029 strategic objectives, CEI has set a new target of filing 50 patents annually.

Figure 3. CEI increased its number of patent applications filed (FY 2017–18 to 2023–24)



Note: No targets were set for FY 2017–18 to 2020–21.

Half of CEI's patents are clean energy-focused

During the evaluation period, CEI filed applications for 70 unique inventions. At least 49% were linked to clean energy initiatives from both ongoing and concluded programs, highlighting the research centre's recent shift toward this area.

Several patents originally developed under former mining programs, such as those involving laser-induced breakdown spectroscopy technology, also contribute to the clean energy portfolio.

The following CEI programs contributed to the clean energy patent portfolio:

- Advanced Clean Energy (18 patents)
- Materials for Clean Fuels (9 patents)
- Industrial Carbon Management (3 patents)

Accelerating research and development

CEI supported clients by helping reduce technology development risks, start-up costs and timelines. This enhanced clients' ability to advance and commercialize clean energy technologies.

CEI reduced risks and costs for clients

Clients reported that CEI's support helped lower technology development risks and start-up costs:

- Access to CEI's facilities eliminated the need to invest in costly testing equipment.
- Programs such as Materials for Clean Fuels enabled clients to access funding for financially riskier project components, supporting more ambitious research goals.
- CEI's expert guidance and strategic oversight helped clients avoid costly missteps, such as resource-intensive activities with limited return.
- Collaboration with CEI, as part of the NRC, enhanced client credibility and helped attract early-stage investments. One start-up client credited their US$6 million in private equity funding to the fact that they had the support of the NRC and its world-class researchers.

CEI accelerated client R&D timelines

CEI supported faster technology development by helping clients identify key focus areas, access facilities, analyze data and resolve technical challenges.

Clients described the research centre's advice as instrumental in maintaining momentum, keeping projects on track and accelerating time to market.

For example, CEI helped one SME accelerate market entry by several years by modelling a reactor that converts natural gas into hydrogen and solid carbon. The technology is helping reduce greenhouse gas (GHG) emissions in industrial processes. See full details on next page.

Example case: Advancing clean hydrogen technology

Overview

Hydrogen is essential for reducing fossil fuel reliance, but current production methods are costly and emit greenhouse gases (GHGs). A British Columbia clean technology company has developed a methane pyrolysis technology that addresses both issues. The technology uses heat to break down natural gas (methane) into hydrogen and solid carbon, in an innovative process that is cost-efficient and reduces GHG emissions.

Role of NRC

The NRC played a key role in advancing the SME's technology. In 2017, the NRC Industrial Research Assistance Program supported the SME's launch and helped develop a proof-of-concept reactor. CEI later assisted with reactor modelling, material selection and solid carbon characterization, enabling the SME to scale up to a larger prototype and advance from technology readiness level (TRL) 3 (proof of concept) to TRL 6 (demonstration in a simulated environment).

A technical service agreement between the NRC and the SME ensures continued support for testing and characterization, enhancing technology reliability and scalability. The goal is to reach TRL 7 (demonstration in an operational environment) next year and TRL 9 (full deployment) within 2 years.

Potential outcomes

Methane pyrolysis has the potential to make the production of clean hydrogen more affordable. According to the client, the technology's low cost supports its deployment and scaling wherever natural gas infrastructure exists in Canada.

Clean hydrogen plays a key role in reducing GHG emissions in oil refining, where it helps convert crude oil into fuels that meet environmental standards. It can also be used as an alternative to diesel and other fossil fuels in industrial processes, electricity generation and powering vehicles. The client's innovation could help reduce emissions associated with these activities by improving access to clean hydrogen.

Greenhouse gas emissions reduction

CEI has contributed to reducing net GHG emissions in industry by supporting the adoption of low-carbon fuel technologies. However, the research centre does not systematically measure its contributions to GHG emissions reductions.

CEI projects promoted low-carbon fuel adoption

- The **Advanced Microgrids towards Arctic Zero Emissions (AMAZE)** project is developing a microgrid system for deployment at Department of National Defence facilities in the Arctic. The system integrates multiple energy sources, including solar, battery, thermal and generator technologies, to optimize energy load management. It aims to reduce diesel consumption by 25% and GHG emissions by up to 50%.
- CEI supported a demonstration project at the Canadian High Arctic Research Station (CHARS) that **converted food waste into biogas** through anaerobic digestion. The project also adapted a diesel genset into a dual-fuel engine capable of using biogas. When applied at scale, the technology has the potential to reduce diesel consumption and related GHG emissions in remote communities.
- CEI supported the development of a **fuel mix that replaces up to 70% of diesel** with ammonia in heavy-duty engines. Testing suggests this blend can reduce GHG emissions by 50% to 60%.

GHG emissions are not consistently measured

CEI lacks a systematic method for measuring its contributions to Canada's GHG emissions reduction goals. Staff indicated that CEI relies on anecdotal data from laboratory tests or client estimates. They suggest that CEI's internal techno-economic assessment (TEA) and life cycle assessment (LCA) capabilities could support the development of a more consistent and reliable measurement approach.

Greenhouse gas emissions reduction (continued)

CEI has contributed to reducing GHG emissions by supporting the adoption of battery technologies. The research centre has been instrumental in developing Canada's energy storage roadmap and promoting the electrification of various sectors.

Support for battery adoption

The **Hybrid Electric Aircraft Testbed (HEAT)** project, a 4-year initiative led by the NRC's Aerospace Research Centre, achieved the NRC's first successful hybrid-electric aircraft flight. CEI led the battery system design and testing, and ensured compliance with applicable codes and standards.

The **Naval Electric Ship Technologies (NEST)** project supports the electrification of Canadian Navy vessels through collaboration between CEI and the NRC's Ocean, Coastal and River Engineering Research Centre. CEI contributes expertise in battery energy storage.

CEI also assisted the **Canadian Coast Guard** in replacing diesel-powered energy systems at remote communication sites with lithium-ion battery storage.

Contribution to the energy storage roadmap

CEI played a key role in the collaborative development of Canada's energy storage roadmap, alongside provinces and industry. The roadmap identified optimal energy storage solutions to integrate renewables, enhance grid stability and improve cost-effectiveness, while supporting GHG emissions reductions.

The roadmap has supported utility-scale adoption of cost-effective battery technologies in provinces such as Alberta and Ontario. CEI-supported innovations contributed to cost reductions in energy storage, particularly in solar and battery systems.

Business outcomes

Through its legacy High Efficiency Mining program, CEI developed a technology that improves industrial efficiency and reduces energy use. Laser-induced breakdown spectroscopy (LIBS) technology has generated outcomes for CEI clients and end-users, with broader benefits expected for Canadian industry.

Tens of millions in energy cost savings

LIBS-based devices enable real-time analysis and detection of materials in all states (solid, liquid, gas and molten), improving industrial process control.

A case study involving CEI clients and researchers reported significant cost savings for end-users. For example, in hot galvanizing steelmaking, LIBS reduces material waste by 1%, saving around 5,000 tonnes of steel per production line annually. With 60 units globally, this could yield $300 million in annual savings. The related 810,000-tonne of CO_2 reduction could save Canadian clients an estimated $64.8 million in 2024 in industrial carbon taxes.

Expansion to other sectors, such as aluminium production, could further increase impact. In this sector alone, LIBS may save 170 kWh per tonne of aluminum, with potential savings of $49.8 million annually. Global adoption among 3,000 potential end-users could amplify energy and cost savings.

Revenue generation for clients

The case study found that 3 SMEs had commercial LIBS-based devices on the market, with a fourth aiming for 2026. These devices generated over $35 million in revenue, with applications in steelmaking, agriculture and aviation. The SMEs also reported business growth, including expanded services and market access. The NRC earned over $500,000 in royalties from licensing LIBS. Future royalties are projected to exceed $3 million as clients expand into new markets.

Limited business outcome tracking

CEI does not consistently track its contributions to longer-term business outcomes. Beyond the case studies, limited data or documentation was available to demonstrate CEI's value proposition to industry.

Example case: Market-viable clean energy solution

Pilot-scale 200L BEAST technology set-up

Overview

The NRC's Bioelectrochemical Anaerobic Sewage Treatment (BEAST) technology offers a cost-effective, energy-efficient wastewater treatment option for remote communities. Using bioelectrochemical processes, BEAST purifies water with minimal electricity and air, functions in near-zero temperatures and converts organic waste into renewable energy such as biogas or electricity. Its simplified operation and maintenance requirements allow use without support from highly specialized workers.

Role of CEI

CEI supported the advancement of BEAST by collaborating with clients on pilot testing and demonstrating its capacity to reduce GHG emissions through methane capture. Its involvement was instrumental in transitioning the technology from research to field applications, particularly in Northern Canadian conditions.

Potential outcomes

- CEI's estimates indicate that BEAST can substantially reduce GHG emissions, generating approximately 75 tonnes annually per 1,000 residents, **2 to 10 times fewer emissions** than lagoon or aerobic treatment systems. The technology also offers potential for operational and energy cost savings, especially in cold regions reliant on diesel fuels. Early field tests in the Arctic, as well as installations in Nuuk, Greenland and Bezanson, Alberta, additionally demonstrated BEAST's applicability as a sustainable energy source for treatment facilities.
- A CEI-supported and licensed client intends to commercialize the technology in FY 2025–26. **Estimated revenues** for community-scale systems (serving 100 to 5,000 residents) **range from $500,000 to $4 million**. The client is also developing a residential system projected to generate $10,000 to $15,000 for a 3-bedroom home and up to $25,000 for a 6-bedroom home, with continued CEI support. Further licensing and intellectual property development are underway.

Regulations and policy

CEI supported the development of codes and standards for hydrogen and batteries, contributing to improved clean energy policy and regulations. However, more evidence is needed to assess its influence on carbon management and clean fuel regulations.

CEI enhanced battery regulations and policies

CEI worked with Natural Resources Canada (NRCan), the Canadian Standards Association and Transport Canada to develop **battery codes and standards**, including testing protocols and data analysis through joint projects.

It also partnered with the World Bank Group to create safe energy storage guidelines for developing countries. CEI engages with industry to align new technologies with updated standards and participates in energy storage policy discussions.

CEI contributed to hydrogen codes and standards

CEI played a pivotal role in NRCan's hydrogen codes and standards gap analysis and specifically helped define the hydrogen value chain in the national hydrogen strategy. The research centre provided **life cycle assessment (LCA)** and economic analysis of hydrogen technologies.

In collaboration with the Canadian Gas Association, NRCan and Environment and Climate Change Canada (ECCC), CEI helped develop hydrogen codes and standards, including a carbon intensity assessment method aligned with international standards. This work supports Canadian hydrogen exports and informs policies such as the Hydrogen Investment Tax Credit. The NRC's LCA tool also supports tax integrity and fraud prevention in related programs.

Limited evidence of broader policy influence

While CEI contributed to Canada's hydrogen and energy storage policy frameworks, there was limited evidence of continued influence in these areas of the clean energy sector. Evidence of CEI's role in carbon management or clean fuel regulations was also insufficient to assess impact.

Capabilities

The Clean Energy and Innovation Research Centre (CEI) has the expertise and organizational culture to pursue its strategic objectives. However, the evaluation identified challenges with human resource utilization, recruitment and succession planning. Workforce diversity was generally strong, with some opportunity for improvement.

CEI's facilities largely met client needs, though some issues with duplication and underutilization were noted.

The upcoming end of key funding programs, anticipated federal budget reductions, and an overreliance on revenues from other government departments (OGDs) present operational challenges and risks to achieving strategic goals.

Expertise

CEI has a highly skilled workforce, with expertise that generally aligns with its strategic objectives and is valued by clients. However, there is a need to strengthen its capacity in artificial intelligence (AI).

CEI expertise generally aligns with its strategic focus

Staff competencies align well with CEI's strategic goals and thematic areas, as confirmed by the expert peer review committee (PRC). The research centre effectively leverages its strengths to support the development of world-class innovations, advancing research and development (R&D) in the clean energy sector.

Notably, CEI researchers have also designed AI-powered self-driving laboratories to support a range of research activities across thematic areas.

What is an AI-powered self-driving lab?

A platform that uses AI, robotics and automation to digitize routine R&D activities such as accelerated material discovery, process optimization, technology demonstration and scale-up for commercialisation.

Clients value CEI's expertise

Clients consistently highlighted CEI's technical strengths in prototyping, performance testing and data analysis. Most expressed confidence in CEI's ability to meet ongoing needs. For example, BEAST and LIBS project clients noted CEI's unique capabilities, stating that, to their knowledge, no other researchers had achieved comparable results.

Need to strengthen AI expertise

Currently, AI capacity is limited to a small number of staff. Some clients reported inconsistent support for AI integration in their projects. The PRC emphasized that expanding AI expertise is essential to maintain CEI's innovative capacity and meet evolving client demands. Staff noted that the new Mississauga facility could help attract talent, though recruitment remains difficult in this competitive field.

Workplace culture

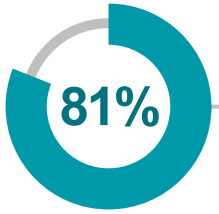
CEI fosters a positive organizational culture. Most staff feel valued and are highly committed to their work.

Organizational culture supports well-being and collaboration

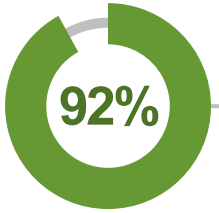
CEI's workplace culture is collaborative and supportive. In the 2022 Public Service Employee Survey, 80% of CEI respondents agreed that the research centre supported a healthy work-life balance. This rate is 7 percentage points higher than the NRC average.

Staff consultations described the workplace as collegial, respectful and focused on contributing to research excellence and impact. Survey results showed that most staff feel appreciated, find purpose in their work and take pride in their contributions. These are on par or better than results from other NRC research centres.

CEI's research and technical staff turnover averaged 4% to 5% over the last 7 years, comparable to rates across the NRC's Engineering division.



felt the workplace was respectful[1]



expressed pride in their work[1]

"CEI's workplace culture is noted for being positive and collaborative, which supports a healthy work-life balance and prioritizes innovative research."

—Peer review committee

[1]Public Service Employee Survey (2022)

Communication with staff

While communication between immediate supervisors and staff is strong, communication between senior management and staff regarding the strategic direction needs improvement.

Staff are highly satisfied with supervision

Staff generally report positive relationships with their team leads, noting that their ideas are valued and career development is supported. Most feel well-informed about work-related matters and are satisfied with the support they receive. These results are consistent with other NRC research centres.

80% were satisfied with the quality of supervision received[1]

felt supervisors kept them informed about issues affecting their work[1]

Communication from senior management needs improvement

As CEI repositions itself within the clean energy ecosystem, communicating changes to staff has been challenging. The PRC noted a disconnect between team leads and senior management on priorities.

Fewer than 50% of staff felt that essential information flowed effectively from senior management or that decisions were timely and effective (comparable to other NRC research centres)[1].

Some researchers cited unclear direction on CEI's revised focus, which created uncertainty in developing research proposals. In some cases, staff submitted multiple proposals in the hope that at least one would be approved, leading to inefficiencies.

The PRC emphasized that improved communication and clearer alignment between senior management and team leads will be essential, particularly during this transition period.

[1]Public Service Employee Survey (2022)

Human resource utilization

While CEI's new thematic areas support a range of new research activities, they also allow the continuation of projects from legacy or out-of-scope activities. Along with the time staff must spend on administrative tasks, this places considerable pressure on human resources.

Broad scope of activities strains human resources

Despite recent re-focusing efforts, concerns remain among both staff and the PRC that CEI is overstretched. The broad scope of the new thematic areas enables new activities while also sustaining projects no longer fully aligned with strategic priorities.

Evidence of this overly broad scope is seen in CEI's reliance on small teams to operate entire labs and manage complex equipment. Staff reported that losing 1 or 2 key members could halt lab operations or significantly reduce the research centre's ability to support client projects in core R&D areas.

Some processes and tasks reduce efficiency

Staff noted that some processes and tasks, such as procurement, project management, business development, site operations and proposal development, could be streamlined or delegated to non-research staff. These duties often detract from research activities and delay key deliverables such as client projects, publications and technology developments.

Cumbersome approval processes further delay routine tasks like lab restocking and project decisions. Increased administrative support and simplified procedures could enhance efficiency. CEI is currently reviewing ways to reduce this burden through task delegation and process improvement.

"The research centre struggles with a dilution of focus, where too few researchers are available to perform critical functions. This makes CEI vulnerable to staffing changes, as the departure of a few researchers could severely impact capacity in key areas."

—Peer review committee

Recruitment

CEI is experiencing challenges in recruiting staff, which poses operational challenges and risks.

CEI faces challenges sustaining expertise and staff capacity

While the Critical Battery Materials Initiative (CBMI) has provided funding to recruit experts in areas such as battery materials, critical minerals, self-driving labs, AI and machine learning, this funding ends in FY 2027–28. Other thematic areas do not have similar support and are struggling to maintain expertise and capacity.

To address gaps, CEI has increasingly relied on short-term (1- to 2-year) employment agreements. As an example, in FY 2023–24 alone, CEI had 35 term research and technical staff, accounting for 18% of staff in these categories. This figure is double the number at the start of the evaluation period. Although short-term hiring has helped CEI respond quickly to emerging needs, management recognizes it is not an effective strategy for attracting and retaining top talent or achieving long-term research goals.

Some employment conditions are less attractive compared to other sectors

Staff reported several recruitment and retention challenges:

- Salaries are viewed as not competitive with those in the clean energy sector, particularly in high-cost-of-living areas such as Vancouver and Mississauga. Even with CBMI support, recruitment at the Mississauga site was slower than expected.
- Short-term employment engagements and onsite work requirements deter highly skilled candidates, especially in AI. Some employees left due to the instability of temporary roles.
- Lengthy and complex hiring processes, relative to industry norms, hindered CEI's ability to attract top talent. Many top candidates accepted higher-paying, permanent positions with flexible remote work options before the NRC completed its recruitment.

Despite these challenges, staff highlighted CEI's strong work-life balance, collaborative research environment and lack of teaching responsibilities as advantages over industry and academia.

Succession planning

A significant portion of CEI staff will be eligible to retire within 5 years, presenting both a challenge and an opportunity for succession planning.

Retirement eligibility and hiring constraints complicate planning

About 32% of CEI staff will be eligible to retire within the next 5 years, particularly in Vancouver and in the carbon management and hydrogen thematic areas. However, not all eligible employees retire immediately. From FY 2019–20 to 2023–24, an average of only 19% of eligible staff retired each year. This was influenced by high living costs in cities such as Vancouver, and by staff who are passionate about research and choose not to retire.

With an NRC-wide hiring freeze in effect, a large proportion of staff becoming eligible for retirement could pose a challenge for succession planning. There is a risk that CEI could lose a significant portion of its experts in the two aforementioned thematic areas and would not be able to replace them.

Staff retirements created opportunities for new expertise

For CEI, retirements present a dilemma: high departure rates during a hiring freeze strain operations, while low turnover limits flexibility to bring in new talent.

CEI management viewed this dilemma as an opportunity to be agile. The research centre engaged short-term staff for R&D activities that were still being refined to fit the new strategic focus. Then, when permanent staff retired, CEI had a pool of temporary employees with relevant expertise who could be considered for longer-term roles.

CEI's key challenge currently is determining how to strategically incentivize some staff retirement to free-up resources for hiring new expertise, while still retaining experienced experts.

Workforce diversity

CEI has a culturally diverse workforce overall but continues to face gaps in representation among women, persons with disabilities and Indigenous peoples.

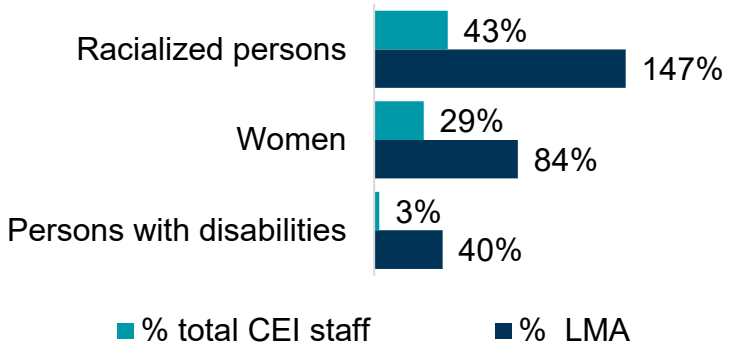
Staff diversity shows improvement

Available data indicates that CEI has recruited and retained a culturally diverse workforce. The proportion of staff identifying as a racial minority rose from 39% in FY 2021–22 to 43% in FY 2023–24, approximately 47% above labour market availability (LMA). Staff noted that CEI's global research profile attracts candidates from around the world.

The representation of women increased by 3% over the same period but remains 16% below the LMA. As in other NRC research centres, persons with disabilities are notably underrepresented.

Due to confidentiality rules related to self-identification, data on Indigenous staff cannot be disclosed when the number is 5 or fewer.

Figure 4. Women and persons with disabilities are underrepresented



What is labour market availability?

LMA compares the representation of a specific group within an organization to its availability in the Canadian workforce for similar roles.

Female representation in key roles

While female representation has improved in recent years, gaps remain, particularly in higher-paying research and technical positions. Both the NRC and CEI have introduced initiatives to promote diversity and inclusion across underrepresented groups.

Progress made, but gaps persist

CEI has made progress in gender diversity, especially at the management level. However, administrative roles remain predominantly filled by women, while higher-paid management, research and technical roles continue to be male-dominated. Female representation among students has also improved but remains relatively low.

Representation of women by role

Role	FY 2017–18	FY 2023–24
Management	0%	45%
Researchers	17%	21%
Technical officers	33%	29%
Administrative	100%	93%
Students	0%	22%

Initiatives to improve diversity are ongoing

The research centre is prioritizing the hiring of women in management and technical roles and ensuring gender representation on hiring committees. It also offers unconscious bias training and mentorship programs to support staff from underrepresented groups.

To enhance inclusivity and career development, CEI established an Early Career Advisory Committee to help new researchers integrate into the NRC and navigate challenges specific to early-career staff.

CEI also participates in NRC-wide initiatives such as the Women-STEM (W-STEM) group and the Indigenous Student Recruitment Pilot.

Facilities alignment and access

Clients generally view CEI facilities and equipment as sufficiently up-to-date to meet their needs and accessible. However, access can be limited by NRC administrative processes and a shortage of skilled equipment operators.

Facilities are generally aligned with client needs

Most interviewed clients chose to work with CEI because its facilities were up to date and met their needs. They emphasized that both the equipment and in-house expertise were vital for testing, validating and advancing their innovations.

Several clients noted they would not have had the necessary resources or capabilities to develop their technologies. Refer to Appendix F for examples of capabilities by thematic area.

Access is generally good but affected by administrative processes and staff shortages

Many clients received support without physically visiting CEI, instead sending samples or data for remote analysis. While service times were occasionally longer than expected, clients reported no notable issues when gaining virtual or distant access to services.

However, academia clients requiring on-site access faced long delays, up to a year, due to NRC safety and security clearance procedures. These delays were particularly challenging for professors and graduate students, especially for students nearing graduation who reportedly lost valuable research time.

Access to CEI facilities, whether remote or in-person, relied on a small number of highly specialized staff. Both clients and staff reported that the number of skilled staff with the necessary skills to provide support services for facilities was limited.

Facility investments

CEI's research capabilities have been affected by limited facility investments. Planned major capital funding will upgrade critical infrastructure and address key gaps.

Limited investments constrained research capabilities

Prior to the 2022 announcement of major capital funding, budget constraints limited CEI's ability to modernize its laboratories. Over the past 7 years, minor capital investments were made by CEI to maintain or upgrade equipment. The NRC made an $80 million investment in the advanced materials research facility in Mississauga.

Delays in infrastructure upgrades reduced CEI's capacity to conduct some R&D activities, particularly in hydrogen technologies, where it lags behind peers.

Major investments are underway

A 2021 NRC-wide facilities review identified the need for further investment in CEI infrastructure. CEI has since been allocated over $70 million under the first wave of major capital funding and plans to submit proposals for an additional wave of funding in 2025.

Planned facility investments (next 10 years)

- **Boucherville – Energy storage integration and battery testing facility ($30.75 million):** Purchase of new equipment and installation of specialized suites for battery fabrication and assembly.
- **Mississauga – Advanced materials research facility ($25 million):** Establishment of 2 materials acceleration platforms with advanced computing for critical minerals research.
- **Vancouver – Hydrogen-safe laboratories ($8.02 million):** Replacement of outdated systems and upgrades to safety infrastructure.
- **Ottawa – Alternative fuel and engine technology ($7.87 million):** New equipment to expand hydrogen and carbon emissions research.
- **Royalmount – Gas fermentation lab facility ($2.44 million):** Upgrade for safe, modern gas fermentation to produce renewable fuels.

Operational efficiency

Potential inefficiencies were identified related to equipment duplication and underutilization of facilities.

Duplication may be occurring

Staff noted some duplication of facilities and equipment across sites, which they attributed to geographic dispersion and saw as contributing to inefficient resource use. For example:

- Vancouver and Ottawa both have analytical chemistry expertise and facilities
- Mississauga, Ottawa and Vancouver all have X-ray diffraction equipment

Staff and the PRC also noted overlap with academic institutions. For example, although CEI invested significantly in genomic fermentation labs at Royalmount, these facilities have seen limited use at the NRC because similar capabilities exist at universities.

Some facilities are underutilized

Certain facilities and equipment remain underused due to outdated infrastructure and a lack of staff with the technical expertise to operate them. For instance, tools such as scanning and transmission electron microscopes are in high demand but underutilized because they are nearing the end of their service life and cannot be repaired or adapted to current needs.

The anaerobic bio-digestion labs at Royalmount were also underused due to a shortage of skilled personnel. Staff suggested that some underused tools and facilities could be decommissioned. In their view, doing so would result in only a minimal loss of opportunities

However, staff noted that decommissioning has been complex due to the sensitivity around potential workforce reductions. As a result, some older, less-used infrastructure is maintained alongside newer additions, which may contribute to some operational inefficiencies.

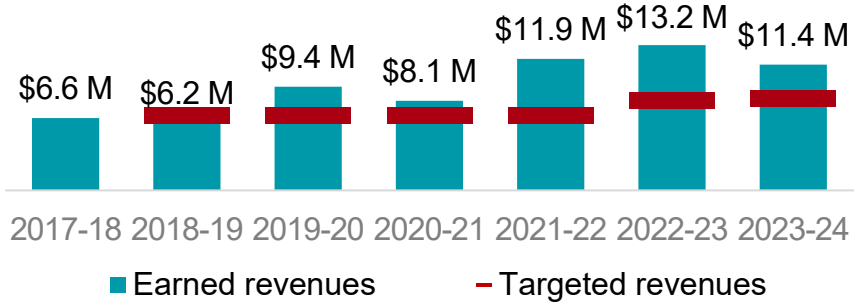
Financial management

CEI increased its budget and revenues over the evaluation period. However, sunsetting of key funding programs and broader NRC budget reductions are expected to create funding gaps. CEI plans to raise annual revenue targets to address this.

CEI increased its budget and revenues

CEI operated within its planned budgets and increased both expenditures and revenues. Expenditures rose from $26.4 million to $37.7 million, supported by a budget increase from $19.9 million to $26.8 million and revenue growth from $6.6 million to $11.0 million. Refer to Appendix E for CEI's financial profile.

Figure 5. CEI increased its revenues (FY 2017–18 to 2023–24)



Note: No target was set for FY 2017–18.

Further reductions anticipated

The upcoming end of programs is expected to create a significant financial gap. The end of the Materials for Clean Fuels Challenge program (MCF) in FY 2026–27 and CBMI in 2027–28 will reduce operational and collaborative R&D funding as well as revenue:

- **$20 million** in salaries and operational costs (CBMI)
- **$67 million** in G&Cs (CBMI and MCF)
- **Approximately $1 million** annually in revenue (MCF)

In addition, Budget 2024's "Responsible Government Spending" initiative requires federal departments to identify $4.2 billion in savings from FY 2025–26 to 2028–29, with $1.3 billion ongoing. CEI, along with other NRC programs, may be affected by these reductions.

To address the gap, CEI plans to reduce costs through natural attrition and increase revenue generated from projects with external clients. Revenue targets are being raised to offset anticipated losses.

Financial management (continued)

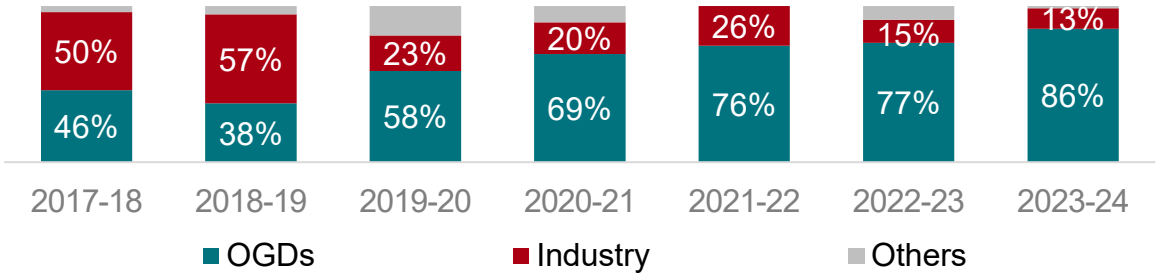
During the evaluation period, CEI became increasingly reliant on revenues from OGDs, which may pose a financial risk.

Revenue sources became imbalanced

Between FY 2017–18 and 2023–24, CEI's revenue profile shifted significantly. While OGDs made up a smaller share of the client base (10 unique clients), they contributed 86% of total revenues in FY 2023–24. In contrast, industry clients, 144 in number, accounted for just 13% of revenues.

This heavy reliance on OGDs presents a strategic risk. Potential federal budget cuts or shifting departmental priorities could significantly affect CEI's financial stability.

Figure 6. Revenue distribution by client type (FY 2018 to 2024)



Revenue diversification is underway

To mitigate financial risk, CEI is pursuing 2 revenue diversification strategies:

1. CEI aims to increase industry collaborations to generate at least $1 million in additional revenue annually. Staff expressed concern that this may not fully meet CEI's strategic objectives. Achieving this target will require strong outreach, client-centred processes and effective project management using existing resources.
2. In 2023, CEI launched a revenue-sharing model with the Automotive and Surface Transportation Research Centre. Previously, CEI contributed significant staff time to projects led by other research centres without financial return. The new model can be replicated and aims to enhance collaboration while ensuring fair compensation.

Relevance and engagement

CEI's new strategic focus has strengthened its alignment with federal and NRC climate action priorities, enhancing its overall relevance. Collaboration with key stakeholders in the clean energy ecosystem has been generally effective, though some areas for improvement remain.

The evaluation found that CEI lacks a clear identity within the broader clean energy ecosystem. While its value proposition is generally well-defined at the program level, it is less clear at the research centre level. Challenges were also identified related to client support and outreach efforts.

Alignment with federal priorities

CEI's new strategic focus has improved its alignment with Canada's national and international climate action goals.

Enhanced alignment with international climate action goals

CEI's new vision aligns more closely with international climate action efforts, including Canada's commitments under the **2015 Paris Agreement**. As a signatory, Canada has pledged to:

- reduce greenhouse gas (GHGs) emissions by 40% to 45% below 2005 levels by 2030
- achieve net-zero emissions by 2050

CEI shifted its vision from being a research partner to the mining and clean energy sectors to "accelerating Canada's transition to a thriving net-zero economy built on clean energy and decarbonized industries." According to staff, this transition better positioned CEI to support Canada in achieving and tracking progress toward its climate action objectives.

CEI improved its alignment with federal climate action policies and strategies

CEI's new thematic areas align with clean energy priorities set in the Federal Sustainable Development Strategy 2022–2026 and in key federal climate policies, including:

- **2030 Emissions Reduction Plan (ECCC):** roadmap for electrification, clean fuels and industrial decarbonization
- **Carbon Management Strategy (NRCan):** focus on carbon capture, utilization and storage
- **Critical Minerals Strategy (NRCan):** securing critical minerals supply chains and supporting clean technologies value chains, including for advanced batteries and hydrogen
- **Clean Electricity Regulations (ECCC):** targeting a net-zero emissions electricity grid
- **Hydrogen Strategy (NRCan):** scaling up clean hydrogen production and use, including codes and standards

Relevance within NRC

CEI's new focus aligns more closely with NRC's strategic priorities. CEI's new approach to prioritizing projects may boost the quality and recognition of its work. However, it also risks isolating the research centre and leading to duplication of capabilities within NRC over time.

Focus aligns with NRC's new strategy

By focusing on reducing GHG emissions, CEI supports NRC's 2024–2029 strategic plan, which prioritizes climate change and sustainability. The NRC aims to accelerate the decarbonization of high-emission industries such as transportation and construction.

CEI R&D activities help clients in these sectors adopt low-carbon solutions, aligning with NRC strategies to:

- **advance electric mobility:** develop EV batteries, powertrains, lightweight materials and low-emission technologies
- **strengthen battery supply chains:** reduce material costs and improve processing and recycling
- **promote low-carbon construction:** develop sustainable materials and systems, and provide carbon and cost analysis tools

New approach to prioritizing projects may enhance CEI recognition, but could lead to isolation and duplication

Historically, CEI contributed to projects led by other NRC research centres, often without receiving formal recognition or budgetary support. To address this, CEI began prioritizing its own research and development (R&D) projects and pursuing more limited, mutually beneficial collaborations. This shift may improve the visibility and recognition of its work within the NRC.

However, some staff expressed concerns that CEI declining R&D project requests from other research centres might discourage future collaborations, isolating CEI. There is also a risk that other research centres could independently develop similar capabilities (e.g., AI-assisted self-driving labs), leading to duplicated efforts and additional missed opportunities for collaboration.

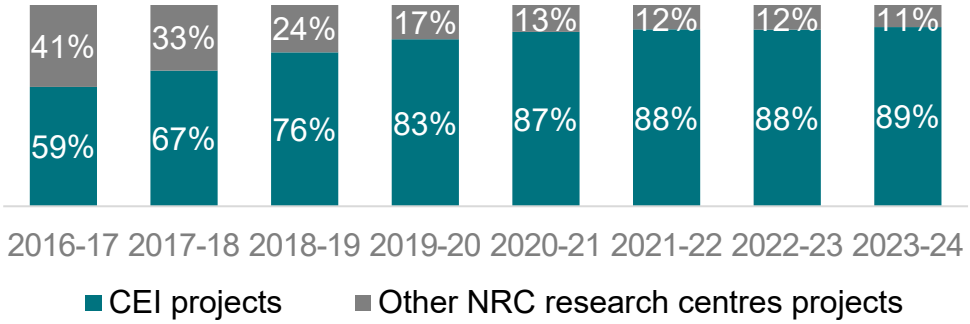
Collaborations with NRC research centres

CEI has improved the alignment of its collaborations with other NRC research centres with its new strategic direction.

CEI is prioritizing its own R&D projects

Historically, CEI's collaborations with other NRC research centres were reactive and often not aligned with its strategic goals. Over the evaluation period, CEI placed greater emphasis on its own programs and began prioritizing only collaborations that directly supported its objectives. This shift is reflected in the decrease in co-publications with other NRC research centres, from 37% in 2018 to 16% in 2023.

Figure 7. CEI researchers gradually reduced the amount of time spent supporting other research centres' projects



Collaborations with NRC research centres are more focused

CEI now only partners with other NRC research centres in specific areas, including:

- **aerospace:** batteries, hydrogen for aviation and sustainable aviation fuels
- **automotive and surface transportation:** batteries and hydrogen fuel cells for vehicles and machinery
- **construction:** carbon mineralization and low-carbon cement
- **digital technologies:** materials acceleration platforms using AI, robotics and computing
- **ocean, coastal and river engineering:** low-carbon fuels for marine applications
- **quantum and nanotechnologies:** materials for novel carbonization technologies

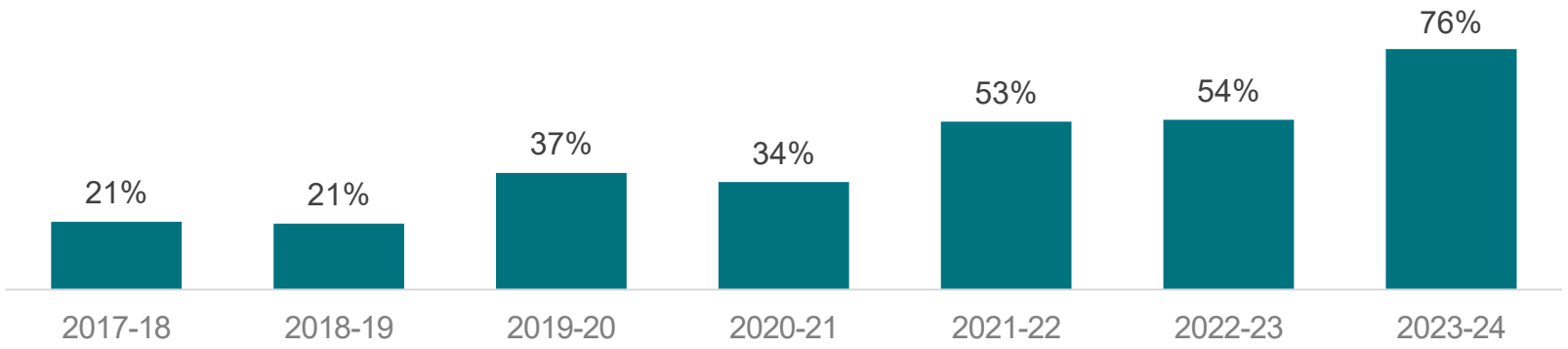
Collaborations with government departments

CEI expanded its clean energy-focused collaborations with other government departments (OGDs). While these partnerships were seen as effective, CEI's contributions were underrepresented in OGD policy documents and program outcomes.

Collaborations with OGDs increased

During the evaluation period, CEI expanded its engagement with OGDs, increasing the number of unique OGD clients from 3 in FY 2017–18 to 7 in 2023–24. Although OGDs account for only about 7% of CEI's total external clients, they represented 76% of its projects in FY 2023–24.

Figure 8. Proportion of CEI's projects with OGDs starting each year increased significantly



Collaborations with government departments
(continued)

CEI's contributions to OGD projects lacked visibility in the clean energy ecosystem

Clients and staff viewed CEI's collaborations with OGDs as effective. As a key enabler of clean energy research and technology development, CEI contributed to the implementation of the Federal Sustainable Development Strategy. While not a policy-setting body, CEI provided vital support to policy and regulatory bodies such as NRCan and ECCC.

Despite its contributions to hydrogen and energy storage policy, CEI was underrepresented in federal clean energy strategies and policies, such as Canada's Carbon Management Strategy. Document analysis revealed few references to CEI or the NRC, mostly in relation to hydrogen codes and standards and archived energy storage roadmaps. NRCan and ECCC received most of the leadership attribution in CEI's thematic areas, which inadvertently reduced recognition of CEI as a key contributor to Canada's climate action results.

The peer review committee (PRC) also noted CEI's limited visibility in the clean energy sector and encouraged the research centre to more actively assert its role and enhance the recognition of its contributions within the ecosystem.

Staff from CEI and NRCan collaborating in a meeting room at the advanced materials research facility in Mississauga, ON

Collaboration with industry

CEI has collaborated with many industry clients, primarily through technical services. However, these collaborations are not well-aligned with CEI's strategic goals or revenue targets.

CEI engaged industry across multiple sectors

CEI collaborated with industry in all its thematic areas. For example:

- In **alternative fuels**, CEI partnered with engine manufacturers to advance applications of hydrogen, ammonia and biofuels. It also worked with bioprocessing partners on biomining, wastewater treatment and off-gas methane conversion.
- In **electrification**, CEI engaged with battery experts and manufacturers and contributed to international collaborations, securing a place in global battery discussions.
- In **carbon management**, CEI leveraged its legacy mining programs to build partnerships with major Canadian firms, positioning itself as a potential global leader.

Current strategy could be strengthened

While CEI's industry collaborations have generated revenue, a refined approach is needed to meet future targets. CEI is aiming to increase industry revenue by $1 million annually.

From FY 2017–18 to 2023–24, industry accounted for 80% of CEI's external clients and 50% of its research projects, but less than 30% of total revenue. About 70% of these projects focused on technical services rather than strategic, long-term research.

These findings suggest CEI is not yet engaging the right industry partners or entering into agreements that align with its objectives. The PRC agreed, noting that the CEI's industry outreach strategy lacked focus on larger players such as utilities, oil, gas and mining companies. In their view, these key players are better suited to support high-impact research collaborations with greater revenue potential.

Collaborations with academia

The Materials for Clean Fuels Challenge program (MCF) strengthened CEI's academic collaboration. However, partnerships may decline once the Challenge program ends, as the benefits for universities to continue partnering with the NRC become less clear without dedicated funding.

High risk of losing academic collaborations when MCF ends

CEI has built strong relationships with academia, which accounted for 13% of its external partnerships. Between FY 2017–18 and 2023–24, CEI's unique academic clients grew from 0 to 23. This increase was largely driven by MCF grants and contributions (G&Cs) which funded high-risk, low-technology-readiness-level (TRL) research with academia.

- 78% of academic collaborators were MCF G&C recipients (FY 2023–24)
- 61% of CEI's collaborative projects with academia were MCF-funded (FY 2023–24)

With MCF funding ending in FY 2026–27, CEI risks losing nearly all its academic collaborators. This would significantly impact R&D capacity and scientific output unless alternative funding or partnership models are secured.

Without funding available, the benefits for academia to partner with NRC are unclear

Collaborations with academia helped CEI address knowledge and staffing gaps in low-TRL projects. With impending federal budget cuts, there is a significant opportunity to better leverage these partnerships for future client R&D support.

While CEI staff view academic collaborations as beneficial, they note that the value proposition for universities is less clear, particularly with MCF funding sunsetting.

Academics have traditionally partnered with CEI to access specialized facilities, but many now have equipment that exceeds CEI's capabilities. This was echoed by the PRC and supported by NRC facility reviews.

The PRC encouraged CEI to redefine its role as a convenor, connecting academia, industry and funding partners in the clean energy ecosystem. This shift could enhance CEI's relevance and appeal to academic collaborators.

Collaboration centres

CEI's collaboration centres have not been as effective as anticipated. The model could be re-examined alongside new strategies for academic collaboration to improve effectiveness.

Collaboration centre model did not prove to be effective

During the evaluation period, CEI established 2 collaboration centres:

- the NRC–University of Toronto Collaboration Centre for Green Energy Materials
- the NRC–University of British Columbia Collaboration Centre for Clean Energy Transition

These centres aim to co-locate researchers and equipment with partners, enabling access to specialized resources and advancing research on shared themes. However, CEI staff noted that collaboration centres have been less effective than expected, mainly due to insufficient funding for joint projects. Financial support has been provided solely by CEI and falls short of the investment levels needed to attract world-renowned scientists and additional investments from potential partners.

An internal CEI assessment confirmed that funding shortfalls significantly contributed to the collaboration centres' ineffectiveness. This was further compounded by limited industry engagement and low participation from prominent researchers at other academic institutions. Additionally, clients consulted during the evaluation were largely unaware of the collaboration centres or their value.

CEI's model could be refined

Staff noted that the existing collaboration centre model, with its complex agreement structure, imposes a significant administrative burden on academic partners, leading to lower participation in collaboration projects.

According to the internal assessment, CEI should consider exploring alternative models that address these challenges and promote broader engagement with researchers in other academic institutions and enhanced industry investments.

Collaborations in the North

CEI is supporting work in Indigenous and remote communities through some collaborative projects. With the rollout of its new engagement plan, CEI anticipates increased engagement in the coming years, further promoting inclusive innovation.

Projects support Indigenous and remote communities

Several projects demonstrate CEI's commitment to inclusive innovation, including:

- the biomass combined heat and power system in Lhoosk'uz Dene Nation (formerly Kluskus First Nation), British Columbia
- the Advanced Microgrids towards Arctic Zero Emissions (AMAZE) project in the Arctic
- Bioelectrochemical Anaerobic Sewage Treatment (BEAST) testing at the Canadian High Arctic Research Station

These initiatives align with CEI's strategic objective to expand its presence in the Canadian North by partnering with diverse stakeholders to meet community needs.

Internal communication and outreach face challenges

Despite ongoing efforts, CEI staff are unaware of current or planned projects involving Indigenous or remote communities. This highlights a need for better internal communication on how CEI is advancing inclusive innovation.

CEI's stakeholder engagement plan aims to strengthen relationships with northern and Indigenous communities. However, staff report that limited funding and high travel costs hinder effective outreach.

The research centre also struggles to recruit Indigenous or community-based staff with the necessary expertise to support these initiatives, limiting the inclusion of remote community clients in future projects.

Value proposition

While CEI's value proposition is clear at the program level, it lacks clarity and consistent communication at the research centre level. Its unique role in the broader clean energy ecosystem is not well articulated.

CEI's value proposition needs refinement

Documents highlight CEI's specialized facilities, core technology development capabilities and role as a convenor in Canada's clean energy transition. Staff and clients confirmed this description to be accurate. However, the evaluation found a lack of a well-defined value proposition beyond individual programs in CEI's documents. Descriptions were often general, lacking specifics on how programs collaboratively address gaps in the clean energy ecosystem or uniquely contribute to Canada's net-zero transition efforts.

As CEI reviews its strategic priorities, it has the opportunity to refine and better communicate its overall value proposition. This would help define its position within the ecosystems of its thematic areas and articulate its unique role and potential contributions to clients more effectively. Input from the recently renewed Research Centre Advisory Board (RCAB) could support this effort, although the evaluation noted these experts had not been fully engaged during CEI's transition.

CEI lacks a strong identity within the clean energy ecosystem

Some clients were unaware of CEI or confused it with NRCan or another federal department. Staff also viewed CEI's presence in the ecosystem as limited. The PRC report echoed these views, citing a weak brand identity.

Consultations also revealed some uncertainty about whether CEI offers unique value or duplicates efforts of others in clean energy. Some clients were unaware of CEI's full capabilities, often familiar only with the specific research team they worked with. Inconsistent communication meant clients relied on staff initiative to learn about broader services. These findings point to a need for more strategic and consistent communication of CEI's value and expertise.

Client support and outreach

Some challenges were identified in CEI's client support. Improvements are needed in its approach to new business development and relationship management.

Client support was insufficient

Both staff and clients reported high turnover in the Business Development Office (BDO), leading to frequent changes in contacts and difficulty identifying the right point of contact at CEI.

Some clients described CEI's financial processes as burdensome due to complex reporting requirements and limited support. In some cases, clients made clerical errors on financial forms due to unclear instructions, which disrupted access to project funds.

Resource-limited industry and academic clients were particularly affected. Some stated that inadequate support would deter them from working with CEI in the future.

Business development is transitioning and may not yet support strategic goals

In FY 2023–24, CEI's BDO introduced a new plan to strengthen client engagement, restructuring the team and assigning lead officers to each thematic area, with added staff for contracting and administrative support.

However, the effectiveness of these changes is yet to be determined. Ongoing hiring and turnover challenges limited implementation, and researchers continue to serve as the primary point of contact for clients and new business development.

As CEI pursues larger revenue-generating R&D collaborations with industry, the evaluation found an opportunity to improve business development and management practices. Aligning service delivery with industry standards will be essential to remaining competitive and effectively supporting strategic goals.

Areas of potential leadership

This section summarizes the key findings from the external peer review committee (PRC) on areas where CEI could take a leadership role within its 4 thematic areas.

The PRC's insights were based on a document review, site tour and discussions held during the site visit. These suggestions aim to guide CEI in refining its strategic focus and strengthening its leadership. Limitations of the PRC process are outlined in Appendix B.

According to the PRC, CEI is well-positioned to lead in Canada's clean energy sector but should narrow its focus within thematic areas to maximize impact. By concentrating on research activities where Canada can add value and building stronger relationships with key players in the innovation ecosystem, CEI can strengthen its contributions to Canadian and global innovation and support national climate action goals.

Leadership opportunities

The PRC identified opportunities for CEI to strengthen its leadership across its 4 thematic areas. These suggestions are intended to support CEI in refining its strategic focus and enhancing its leadership.

Fuel switching

CEI should integrate fuel switching with hydrogen research to develop comprehensive alternative fuel pathways. Focus areas include biogas and e-fuels production, high-value biochemicals for industry decarbonization and enhanced catalyst development using existing infrastructure such as self-driving laboratories.

Electrification

CEI can lead by enhancing battery chemistries, exploring next-generation solid-state and expanding into sodium-ion technologies, to diversify its portfolio. It could also leverage artificial intelligence (AI) to improve grid efficiency and resilience, particularly in extreme weather and remote locations.

Hydrogen

CEI should cease research on low-temperature water electrolysis, hydrogen storage and transportation infrastructure without key industrial partnerships. Instead, leadership opportunities include:

- developing high-temperature water electrolysis systems for renewable industrial energy and waste heat utilization
- producing hydrogen-based fuels for hard-to-abate sectors such as chemical, steel and cement industries
- integrating hydrogen fuel cell and battery systems with renewable energy solutions for off-grid communities, leveraging CEI's AI and machine learning

Carbon management

CEI could sharpen its focus on carbon dioxide (and broader greenhouse gas [GHG]) reduction and utilization. It could leverage self-driving laboratories for material discovery, collaborate with industry to support commercialization and adoption of existing CO_2 conversion technologies, develop carbon-negative materials and address longer-term industry needs and challenges.

Future outlook

An overly broad research focus has diluted CEI's impact and limited its leadership within Canada's clean energy ecosystem. To improve efficiency and sustain leadership amid shifting geopolitical pressures, CEI should refine its strategy to focus on core strengths and position itself as a preferred partner in clean energy research and innovation.

Current resource allocation dilutes impact

CEI is overextending its resources by pursuing numerous ambitious research areas, reducing overall impact. By critically assessing how its capabilities align with short, medium- and long-term goals, CEI can determine whether its current strategy is realistic and sustainable.

The evaluation concluded that prioritizing initiatives where CEI can lead would improve efficiency, effectiveness and relevance. In particular, scaling back selected activities, especially in hydrogen, could allow greater focus on areas where CEI is best positioned to lead and drive progress.

Stronger strategic positioning is needed

To strengthen its leadership role, CEI must improve how it positions itself in the national clean energy ecosystem. The evaluation suggested that CEI adopt a clear strategy to act as a convenor of strategic collaborations, advance technologies toward commercialization and inform policy.

Consistent focus across thematic areas is essential to establish and maintain CEI's influence. By refining its priorities and leveraging existing strengths, CEI can enhance its long-term contribution to clean energy innovation.

"CEI is currently overextending its resources by pursuing numerous ambitious research areas… [streamlining is needed]… This would involve prioritizing research initiatives where it can lead effectively, potentially scaling back efforts in some research activities."

—Peer review committee

Recommendations and management response and action plan

Recommendation 1 (1 of 3)

Streamline focus

The evaluation found that CEI's value proposition at the research centre level was not well defined. As a result, it lacked a strong presence within the clean energy research ecosystem. Although CEI closed its mining and environment programs to focus more narrowly on clean energy, the research centre remained overstretched. It introduced 4 thematic areas that were too broad, allowing the continuation of activities not aligned with its clean energy focus while also starting new, strategically aligned research and development (R&D). This broad scope resulted in staff being stretched thin, with small teams managing entire labs and complex equipment, making the research centre vulnerable to staffing changes. Equipment duplication and underutilized facilities were also noted.

Recommendation

Leveraging the expert advice from the peer review committee (PRC), this evaluation and the Research Centre Advisory Board (RCAB), CEI should streamline its thematic areas to focus on activities where it can have the greatest impact. This should include a plan to:

a. clearly define its unique value proposition within the clean energy sector by identifying specific areas where it can play a distinct role and deliver the most impact. The NRC's value chain analysis could support this.

b. re-examine the composition of research teams to ensure they have the required expertise and critical mass to support the focus areas identified in recommendation 1.a

c. review facilities and equipment to determine which are mission critical. This should consider the uniqueness of capabilities, utilization levels, upgrade and maintenance feasibility, and potential impacts of divestiture.

d. streamline activities to concentrate on fewer areas with the goal of achieving greater impact. This should include reorganizing expertise and research teams, decommissioning outdated facilities and prioritizing cost savings by divesting from equipment and facilities that are neither unique nor realistic to maintain long-term.

Recommendation 1 (2 of 3)

Management response and action plan

Management response	Measure of achievements	Proposed persons responsible	Expected dates of completion
Response: Accepted **Actions:** 1. CEI will define its unique value proposition to position the NRC as a leader in the Canadian clean energy research and innovation ecosystem while complementing the efforts of other research centres 2. CEI will cease activities unaligned with its new value proposition based on the PRC's recommendations, internal reviews and discussion with key stakeholders 3. CEI will streamline thematic areas and programs with clear scope and objectives to focus on high-impact areas, taking into account the PRC's recommendations	1. a. Discussed with NRC research centres to confirm CEI's unique value proposition; b. discussed with other government departments (OGDs) for synergies and duplication prevention; c. formulated and validated a distinct value proposition with RCAB and Vice-President 2. a. Completed mid-term reviews and cease business development of unaligned activities; and b. terminated unaligned projects 3. a. Defined new thematic areas and structure; b. developed research centre- and program-level logic models; c. secured RCAB validation and Vice-President approvals; d. completed re-scoping and updated the strategic plan	1. CEI Director General 2. CEI Director General 3. CEI Director General	1. a. October 2025 b. November 2025 c. December 2025 2. a. October 2025 b. March 2026 3. a. October 2025 b. December 2025 c. January 2026 d. March 2026

Recommendation 1 (3 of 3)

Management response	Measure of achievements	Proposed persons responsible	Expected dates of completion
4. CEI research teams will be restructured to ensure that the expertise and critical mass required to support the high-impact areas defined in action 3 are in place 5. CEI will update its facilities renewal plan in line with the new scope defined in action 3 in order to be prepared for the Office of Facilities Renewal Management wave 3	4. a. Restructured research teams with key capabilities; and b. implemented new structure 5. Updated the CEI facilities renewal plan with clear decisions for investment, co-investment, reorientation or divestment of its facilities	4. CEI Director General 5. CEI Director of Operations	4. a. February 2026 b. April 2026 5. March 2026

Recommendation 2 (1 of 2)

Enhance stability of human resources

During the evaluation period, CEI leveraged operational funding from the Critical Batteries Material Initiative (CBMI) and other sources to hire a growing number of short-term staff, doubling the proportion of such hires. This approach enabled CEI to quickly bring in experts to meet specific needs. However, the management team recognized that relying heavily on short-term staffing was not effective for attracting and retaining top talent or for achieving long-term research goals. The evaluation highlighted that short-term employment agreements discouraged highly skilled candidates from applying and led some existing staff to pursue more stable opportunities elsewhere.

In addition, approximately 32% of the CEI workforce will be eligible for retirement within the next 5 years, primarily in Vancouver and within the carbon management and hydrogen thematic areas. This presents a challenge for succession planning, particularly given the hiring freeze across the NRC. There is concern that CEI could lose a substantial portion of its experts in these areas and face difficulty replacing them. Although only about 19% of eligible staff retire each year, and some risk has been mitigated by converting short-term staff to permanent roles, the expected end of CBMI funding in FY 2026–27 may limit CEI's ability to maintain temporary staffing levels to offset retirements. This creates uncertainty for CEI’s future operations, which is not ideal for long-term planning.

Recommendation

To ensure it can achieve its strategic objectives, CEI should develop a human resources (HR) plan that assesses staffing options for recruiting new staff. This should include ensuring that key research and technical positions are adequately filled by indeterminate employees.

Recommendation 2 (2 of 2)

Management response and action plan

Management response	Measure of achievements	Proposed person responsible	Expected dates of completion
Response: Accepted **Actions:** 1. Based on mid-term reviews, CEI will update its workforce plan to ensure it has the expertise and critical mass needed to support high-impact areas and achieve long-term goals	a. Updated the list of critical positions in the CEI workforce plan b. Updated the CEI succession plan to focus on the revised list of critical positions c. Developed a retention strategy for term employees in critical positions or identified as potential successors d. Reviewed and updated the hiring plan to align with CEI priorities e. Established a development plan for employees identified as potential successors	CEI Director of Operations in collaboration with CEI directors of research and development	a. October 2025 b. November 2025 c. December 2025 d. December 2025 e. January 2026

Recommendation 3 (1 of 3)

Enhance collaborations and industry focus

The evaluation found that CEI's approach to collaborating with clients requires re-assessment. The collaboration centres with the University of Toronto and the University of British Columbia were not seen as effective. While other academic collaborations were viewed more favourably, they were primarily supported by grants and contributions (G&Cs) from the soon-to-end Materials for Clean Fuels Challenge program (MCF). Without this funding, academic institutions may see less value in partnering with CEI, especially as many have made similar investments in equipment and facilities.

CEI's industry collaborations require a strategic shift to meet the research centre's goal of increasing revenue by $1 million annually. Industry accounts for 80% of CEI collaborations but contributes less than 30% of total revenue. Moreover, 70% of industry projects focus on technical services rather than long-term strategic research. In contrast, OGDs represent only 7% of clients but account for the majority of revenue. This suggests CEI may not be engaging the right clients or structuring agreements effectively to meet its objectives.

There is an opportunity for CEI to strengthen its role as a convenor in Canada's clean energy ecosystem, leading consortia in niche areas that bring together key industry, government and academic players to address specific sector needs. This could help attract investment for large-scale collaborative R&D across technology readiness levels (TRLs). This will require a more client-focused approach aligned with the service standards and expectations common in high-value industry partnerships.

Recommendation

CEI should refine its approach to collaborations, establishing itself firmly as a convenor of key ecosystem players by:

a. identifying the optimal approach for collaborations with academia, including revisiting the collaboration centre model

b. enhancing business development, client support and relationship management to strengthen industry research partnerships, while maintaining relationships with OGDs

Recommendation 3 (2 of 3)

Management response and action plan

Management response	Measure of achievements	Proposed person responsible	Expected date of completion
Response: Accepted **Actions:** 1. CEI will develop and implement a new collaboration model with its academic partners to clearly address key issues including: a. facility access; b. HQP engagement; c. mutual benefit, especially around commercialization with industry partners 2. CEI will update its stakeholder engagement approach to: a. clearly identify key clients and industry partners; b. ensure effective engagement; and c. leverage the National Research Council of Canada Industrial Research Assistance Program (NRC IRAP)/NRC IRAP Clean Technology and other federal departments and agencies to develop stakeholder relationships, especially in high-impact areas defined as a result of recommendation 1	1. Defined academic partners engagement action plan and alternative collaboration mechanisms in place 2. Completed an update to CEI's stakeholder engagement plan to add: a. a prioritized stakeholder map that clearly identifies key clients and industry partners; b. a tailored engagement plan for key stakeholders, including strategies for communication and collaboration; and c. specific strategies for engaging with NRC IRAP and other clean technology organizations to leverage existing relationships	1. CEI Strategic Advisor 2. CEI Business Development Director	1. January 2026 2. March 2026

Recommendation 3 (3 of 3)

Management response	Measure of achievements	Proposed person responsible	Expected date of completion
3. Nurture culture of continuous improvement at the research centre through: a. training of project managers, project management office and other staff; b. streamlining project management processes (planning, execution and monitoring); and c. improving client support	3. a. Completed project management trainings by CEI's project managers and project management office b. Improved project management processes by project management office c. Improved client support by project managers	3. CEI Director of Operations	3. March 2026

Recommendation 4 (1 of 2)

Improve impact measurement of key goals

CEI aims to accelerate clean energy technology development to support Canada's transition to a net-zero economy by 2050, aligning with NRC priorities to decarbonize industry and meet national greenhouse gas (GHG) emission reduction targets. However, CEI does not currently measure its impact against these strategic goals in a systematic way.

By leveraging its techno-economic and life cycle assessment (TEA and LCA) capabilities, CEI can implement an approach and tool to measure the impact of the technologies and innovations it develops or supports. This also presents an opportunity to improve tracking and reporting at the NRC level.

Recommendation

CEI should enhance impact measurement by:

a. implementing an approach and tool to more systematically measure CEI’s impact on decarbonization and GHG emissions reduction

b. promoting the adoption of this tool by other NRC research centres to support accountability in reporting the NRC's progress toward its climate and sustainability goals, and Canada's emission reduction and net-zero objectives

Recommendation 4 (2 of 2)

Management response and action plan

Management response	Measure of achievements	Proposed person responsible	Expected dates of completion
Response: Accepted CEI will leverage internal processes and tools to improve the measurement and tracking of GHG emission reductions targeted by CEI projects. **Actions:** 1. Leverage CEI's TEA and LCA expertise to implement an approach and tools to measure decarbonization and GHG emissions reduction in targeted research areas. 2. Conduct an annual review of CEI technology progress by leveraging expertise within the research centre and NRC IRAP Clean Technology. 3. Disseminate the approach, tools and annual review results across the NRC.	1. a. Developed a GHG and decarbonization impact assessment framework. b. Implemented approach in selected key projects. 2. Completed the FY 2026–27 annual review of GHG emissions reductions and decarbonization for selected CEI projects 3. Shared outcomes and best practices with NRC corporate and other research centres to increase adoption and alignment.	CEI Director General	1. a. June 2026 b. September 2026 2. March 2027 3. May 2027

Appendices

Appendix A: Methodology

Bibliometric study

The NRC's Intelligence and Analytics team conducted a bibliometric analysis of 706 publications from the Clean Energy Innovation Research Centre (CEI) from 2017 to 2023. The publication list was compiled by searching the Scopus database for all NRC-affiliated publications, and then identifying those relevant to CEI based on metadata or authorship. CEI validated the list and categorized the publications into its clean energy thematic areas and other areas such as mining and environment.

Data review

CEI's administrative and performance data for FY 2017–18 to 2022–23 were reviewed to provide information on research and innovation, impacts, capability and engagement. Administrative data included financial, human resources, resource allocation, project, client, performance and intellectual property data.

Document review

Internal and external documents were reviewed. These included strategic, operational and engagement plans, facility and program reviews, products from the recent strategic review process, and other relevant materials.

Impact case studies

Two (2) impact case studies were conducted to examine outcomes from the Bioelectrochemical Anaerobic Sewage Treatment (BEAST) and the Laser-Induced Breakdown Spectroscopy (LIBS) technologies and related projects. These case studies assessed collaborative, technological, societal and environmental impacts, as well as market and economic benefits and unanticipated outcomes from commercialization and technology adoption across sectors. They were developed in collaboration with NRC experts and informed by interviews with industry partners, as well as document and data reviews.

Appendix A: Methodology (continued)

Key informant interviews

Individual and group interviews were conducted to gather information and perspectives related to research and innovation, impacts, capability and engagement.

A total of 66 stakeholders were interviewed, including 7 as part of the case studies.

- 43 staff from CEI and other research centres (executives, directors, team and program leaders, research and technical officers)
- 23 external clients (industry, other government departments [OGDs] and universities)

Efforts were made to include diverse perspectives across regions, sectors, research themes, positions and gender.

Peer review committee

An international peer review committee (PRC) was convened to assess CEI's capacities, facilities and resources, as well as its ability to achieve strategic objectives. Chaired by Dr. Bruno Pollet, the committee included 7 experts in hydrogen, electrification, fuel switching and carbon management (refer to Appendix C).

The PRC received preliminary evaluation findings and supporting documents in advance of a 3-day site visit in Mississauga, held February 11 to 13, 2025. The site visit included: presentations by the NRC's Vice President, Engineering Division, and CEI management; multiple question-and-answer sessions; a tour of the Mississauga advanced materials research facility; and a debrief with the research centre's leadership team.

Following the site visit, the PRC finalized an independent report, which was reviewed by CEI for factual accuracy.

Appendix B: Limitations and mitigation

The evaluation faced the following potential limitations:

Selection bias

The Office of Audit and Evaluation (OAE) carefully selected interviewees with recent and substantive interactions with CEI to ensure they could effectively address multiple lines of inquiry. This focus may have excluded clients with less extensive relationships or interactions. Nonetheless, efforts were made to include a diverse sample, ensuring comprehensive representation across thematic areas, geographic locations, organizational sectors and various project types across 5 sites.

Categorization of publications

The bibliometric analysis included all CEI publications from 2017 to 2023. CEI staff manually assigned each publication to 1 of the research centre's 4 new thematic areas established in FY 2023–2024, with mining and environment-related publications categorized separately. This manual categorization may involve human error. Assigning each publication to only 1 thematic area avoided double-counting but may have underrepresented certain areas.

In addition, as most publications were indexed prior to CEI's strategic shift, it is premature to assess trends in clean energy publications. Despite these limitations, the bibliometric analysis provides a baseline for future performance monitoring.

Appendix B: Limitations and mitigation (continued)

Peer review process

The PRC faced limitations during its assessment:

- **Time and information constraints:** The PRC had to process a large amount of information in a short period, which may have limited the depth of their assessment across various aspects of the research centre.
- **Site visit constraints:** Due to logistical and financial limitations, the site visit was limited to the Mississauga advanced materials research facility. This may have resulted in an incomplete view of CEI's full capabilities. Although some PRC members had previously visited the Vancouver site, first-hand assessments of other locations were not possible.
- **Limited staff interaction:** Engagements with CEI staff included discussions with team leaders from all sites and some early-career researchers. This limited the diversity of staff perspectives captured during the peer review.

To mitigate these limitations, the PRC was provided with the OAE evaluation team's preliminary findings report, which incorporated broader staff input as well as document and data review findings. The evaluation team considered the PRC's perspectives with these limitations in mind.

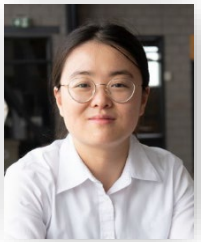
Appendix C: Peer review committee members

Dr. Bruno Pollet (Committee Chair)

Professor, Université du Québec à Trois-Rivières

Eric Hsieh

Deputy Assistant Secretary, Department of Energy's (DOE) Office of Electricity



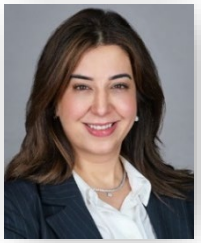
Dr. Yulin Hu

Assistant Professor, University of Prince Edward Island

Dr. Yiguang Ju

Robert Porter Patterson Professor, Princeton University

Director, DOE Energy Earthshot Research Center for Hydrogen



Mania Neisiani

Vice President, Project Engineering, Svante Technologies Inc.

Mark Rabin

Founder and Board Director, Portable Electric Ltd.

President, CarbonIP

Dr. Todd Wilke

Head of Technology, Carbon Engineering Ltd.

Appendix D: Overview of expected outcomes

Most of CEI's research activities aim to achieve the short-, medium- and long-term outcomes outlined below. These outcome categories, developed in collaboration with the research centre, align with its 2024–2029 strategic objectives.

- Accelerated development of clean, renewable fuels and battery energy storage materials and devices
- Increased client capacity to develop, demonstrate and scale up clean materials and production processes
- Reduced start-up costs and perceived risks associated with clean energy innovation

- Demonstrated research excellence
- Reduced greenhouse gas (GHG) emissions by industry and other clients
- Increased adoption of low- and zero-carbon fuels and innovative battery storage technologies
- Improved business outcomes (e.g., reduced costs and timelines, increased market opportunities and revenues)
- Improved government regulations, mandates and policies related to clean energy

- Reduced GHG emissions in Canada
- Increased sustainability of Canada’s energy supply sector
- Enhanced global recognition of Canada as a leader in clean energy research and development (R&D)

Appendix E: Financial profile

CEI financial profile[2] over the evaluation period (FY 2017–18 to 2023–24)

Financial actuals	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
Budget	**$19.9M**	**$21.9M**	**$24.5M**	**$26.6M**	**$23.9M**	**$25.0M**	**$26.8M**
Revenue[3]	**$6.6M**	**$5.5M**	**$8.7M**	**$7.7M**	**$11.4M**	**$12.8M**	**$11.0M**
OGD	$3.0M	$2.3M	$5.5M	$5.6M	$9.0M	$10.1M	$9.7M
Industry	$3.3M	$3.5M	$2.1M	$1.6M	$3.1M	$1.9M	$1.5M
Other	$0.3M	$0.3M	$1.8M	$0.9M	-$0.2M	$1.2M	$0.2M
Expenditure	**$26.4M**	**$27.4M**	**$33.2M**	**$34.3M**	**$35.3M**	**$37.9M**	**$37.7M**

[2] Figures are rounded to the nearest tenth of a million dollars, which may result in minor discrepancies between total budget, revenue and expenditure values.

[3] Net earned revenues comprise the small and medium-sized enterprise (SME) and the academia fee reduction, as well as the 2018–19 R&D certificate program.

Appendix F: Examples of capabilities

Fuel switching

CEI has state-of-the-art facilities for converting waste into fuel using both thermochemical and biological methods. The thermochemical facilities include systems for treating biomass to produce biocrude and a reactor for converting materials into gaseous fuels.

The biological facilities feature equipment for biomining, mineral carbonation, anaerobic processes and gas fermentation. These capabilities support the advancement of biotechnology readiness levels for decarbonization, enable the conversion of low-value biomass into biofuels and bioproducts, and help reduce risks associated with scaling up biofuel and biochemical production.

Ottawa’s hydrothermal conversion equipment and Royalmount’s biomining and bioprocess facilities equipment

Hydrogen

CEI's hydrogen-safe laboratories support R&D in fuel cells, electrolysis and other hydrogen technologies. Facilities include fuel cell test stations for cell and stack development, application testing and proton-exchange membrane fuel cell component screening. These code-compliant labs are equipped for testing with up to 8 flammable gases and exceed the U.S. Department of Energy’s 2026 performance target.

Recognizing the need to modernize equipment and lab space to remain competitive with global peers, CEI has planned upgrades that include additional equipment and test stations. CEI aims to play a key role in advancing hydrogen technologies from the laboratory to early pre-commercial stages.

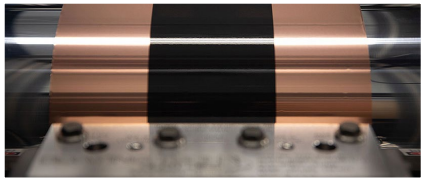
Vancouver’s hydrogen-safe laboratories equipment

Appendix F: Examples of capabilities (continued)

Electrification

CEI's battery manufacturing line is a cutting-edge facility for prototyping battery cells, producing both small cells for R&D and large cells for electric vehicle packs using industry-standard processes. It enables evaluation and qualification of battery materials and components throughout the manufacturing process, supported by in-house expertise in materials chemistry, electrochemistry, engineering and battery science.

Advanced equipment for electrode fabrication, assembly and testing allows CEI to demonstrate technologies without requiring substantial investment. CEI also leads initiatives to develop advanced testing facilities and methods for eco-friendly recovery of critical battery metals. These efforts aim to enhance Canada's recycling capacity and support a domestic circular battery economy, creating market opportunities for Canadian firms.

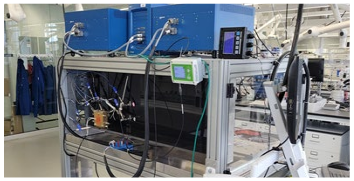


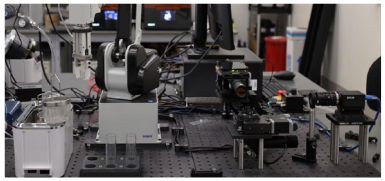
Boucherville pilot scale battery prototyping line equipment

Carbon management

CEI features cutting-edge self-driving laboratories (SDLs) that automate research processes, along with advanced materials characterization labs, positioning the research centre at the forefront of clean energy innovation. In collaboration with the University of British Columbia, CEI developed the first SDL for carbon dioxide (CO_2) utilization, transforming CO_2 into methane through bicarbonate electrolysis.

Key innovations include an automated electrolyzer, a catalyst ink dosing station and a spray coating system, all integrated into the SDL platform. This advancement supports electrochemical applications and forms the core technology of Sora Fuel, a 2024 University of British Columbia spin-out focused on zero-carbon e-fuel production.





Mississauga advanced material scale up and validation facilities equipment