

Annual Progress Report For 2023-2024 Fiscal Year

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Section A: Year in Review

IC-IMPACTS continued with consistent progress throughout the year, with ground-breaking scientific collaborations between Canadian and Indian stakeholders, emphasizing the development of community-based solutions in the fields of Public Health, Safe and Sustainable Infrastructure, Integrated Water Management, as well as Food Security and Agritech.

In September 2022, IC-IMPACTS submitted a comprehensive proposal to the Strategic Science Fund (SSF) program; having received strong support from key Indian stakeholders, including the High Commissioner of India, DST, DBT, and industry partners such as Tata Consultancy Services (TCS), and discussed collaborations with prominent Canadian organizations including Mitacs, Praxis Spinal Cord Institute, Genome Canada, Indigenous Works, Centre for Aging and Brain Health Innovation (CABHI) and many more non-profit, academic, and industry partners. In December 2023, we were notified that we would be eligible to apply for the SSF Transition Funds and to request support for 2 years under this program. IC-IMPACTS' application for SSF Transition Funding was submitted in January 2024 and in March 2024, it was announced that IC-IMPACTS will receive additional funding for two years, starting in 2025-26.

IC-IMPACTS consistently shows that combining Canadian and Indian scientific research effectively addresses socioeconomic challenges, resulting in high-impact, with practical outcomes. The table below summarizes the Centre's achievements:

	Past Fiscal (2023-2024)	Overall (2013-2024)
Active Projects	42	95
HQP (years)	115	1,549
Scientific Publications	83	1,644
Patents and Licenses	0	34
Partnerships	20	420
Start-ups	8	

New Projects

In July 2022, following the signing of the MoU between DST, DBT, and NSERC, a Canada-India Joint Call for Proposals on *Building Resilient and Carbon-Neutral Communities Post COVID* was announced. The purpose of the Call was to seek applications in the areas of Infrastructure, Water, Agritech and Food Security, and Health – Post COVID Health Issues and Long COVID.

In the following months, IC-IMPACTS received over 150 applications, 134 of which were considered eligible for review. Each of these applications were independently evaluated by a Joint Review Committee, comprised of representatives and independent external reviewers from India and Canada, followed by comparison of list of proposals recommended from both Canadian and Indian sides to the Selection Committee.



Figure 1: Announcing the Funding of 19 New Projects

IC-IMPACTS, DST and DBT announced the results in Spring 2023 and jointly funded 19 new projects under this Call. The following proposals have been awarded funding from both sides:

1. **Valorization of CO₂ to Fuel over MOFs derived SACs: A Machine Learning Guided Experimental Approach**
Canadian PI: Ali Seifitokaldani, McGill University
Indian PI: Sounak Roy, Birla Institute Technology and Science
2. **Multifunctional Composites and Structural Health Monitoring for Smart Concrete Structures**
Canadian PI: Martin Noel, University of Ottawa
Indian PI: Durai Prabhakaran, IIT-Jammu
3. **A Data-driven Simulation-based Machine Learning Optimisation (SML-Opt) Framework to Support Net Zero Energy Building Retrofits in Canadian and Indian Contexts**
Canadian PI: Elie Azar, Carleton University
Indian PI: Albert Thomas, IIT-Bombay
4. **Manufacturing Sustainable and Carbon Neutral Steel Structures for Construction Industry using Wire Arc Additive Manufacturing (WAAM): Static, Dynamic and Fatigue Characterization**
Canadian PI: Philippe Bocher, École de Technologie Supérieure (ÉTS)
Indian PI: Lakshmi Narayan Ramasubramanian, IIT-Delhi
5. **Sustainable Earthquake-Resistant 3D-Printed Concrete Housing: From Laboratory Testing to Industrial Application**
Canadian PI: Vahid Sadeghian, Carleton University
Indian PI: Biranchi Panda, IIT-Guwahati
6. **Remoulding Existing Buildings into Smart Carbon Neutral Buildings: A Green Cyber Physical Approach (Green-CPS)**
Canadian PI: Kuljeet Kaur, École de Technologie Supérieure (ÉTS)
Indian PI: Mukesh Singh, Thapar Institute of Engineering and Technology (TIET)
7. **Blockchain Based Multi-Layer Energy Management System for Smart Buildings**
Canadian PI: Kankar Bhattacharya, University of Waterloo
Indian PI: Rohit Bhakar, Malaviya National Institute of Technology Jaipur
8. **Next Generation Epidemiological Models for Accurate Predictions of Future Pandemic Waves: Integrating Sewer Simulations with Public Health Information using Machine-Learning Algorithms**
Canadian PI: Ajay Ray, Western University
Indian PI: Sridharakumar Narasimhan, IIT-Madras
9. **Phosphorous Recovery from Wastewater for Safeguarding Global Phosphorous Sustainability and Food Security: Denitrifying Phosphorous Accumulating Organisms (DPAOs) Have the Merits**

Canadian PI: Qiuyan Yuan, University of Manitoba
Indian PI: Prangya Ranjan Rout, Thapar Institute of Engineering & Technology

10. Reconfigurable Platform for Rapid Autonomous Quantification of Pathogens in Wastewater using PCB Electrode-Based Assays

Canadian PI: Richa Pandey, University of Calgary
Indian PI: Siddharth Tallur, IIT-Bombay

11. Climate Change Impacts on the Riverine Thermal and Flow Environments Under Diverse Climates of India and Canada

Canadian PI: Taha Ouarda, INRS
Indian PI: Shaik Rehana, International Institute of Information Technology Hyderabad

12. Machine Learning Methods for Water Quality Estimation and Control in Water Resource Recovery Facilities: Towards Circular Economy and Sustainability

Canadian PI: Peter Vanrolleghem, Université Laval
Indian PI: Seshagiri Rao Ambati, Indian Institute of Petroleum and Energy (IIPE)

13. Understanding the Impact of Climate Change and Land Use Change on the Groundwater Resources in the Future Using Deep Learning Models with Focus on Data Scarce Regions

Canadian PI: Jan Franklin Adamowski, McGill University
Indian PI: Dr. R. Maheswaran Rathinasamy, IIT-Hyderabad

14. GBM-CLIMPACT: Development of an End-to-End Modeling and Analysis Toolset to Assess Climate Impact and Readiness of Water Sector in the Ganga, Brahmaputra, and Meghna Basins

Canadian PI: Martyn Clark, University of Saskatchewan
Indian PI: Manabendra Saharia, IIT-Delhi

15. Methylotrophs Driven Bioconversion of C1 Compounds to Carotenoids for Mitigation of Greenhouse Gas, Enhancing Nutrient Uptake and Alleviation of UV Radiation Stress in Agriculture

Canadian PI: Sina Adl, University of Saskatchewan
Indian PI: Santosh Mohanty, Indian Institute of Soil Science

16. Trash is Cash – Turning Unmerchantable Crop and Forest Residues into High-Value, Carbon-Negative Fertilizers for Regenerative Farming in Rural Communities

Canadian PI: Anthony Lau, The University of British Columbia
Indian PI: Sonal Thengane, IIT-Roorkee

17. An Ultra-Sensitive Plant-Care Monitoring System with Quantitative and Real-Time Data Analysis

Canadian PI: Nazir Kherani, University of Toronto
Indian PI: Prashant Mishra, IIT-Delhi

18. Understanding and Exploiting the Role of Eukaryotic Energy Sensor TOR Kinase in Enhancing Thermotolerance and Drought Resistance in Model and Crop Plants

Canadian PI: Leon Kochian, University of Saskatchewan

Indian PI: Ashverya Laxmi, National Institute of Plant Genome Research

19. Intelligent Portable Ultrasound Imaging-Based Continuous Lung and Heart Monitoring System for Post-COVID19 Assessment

Canadian PI: Abhilash Rakkunedeth Hareendranathan, University of Alberta

Indian PI: Mahesh Raveendranatha Panicker, IIT-Palakkad

Section B: Performance Against Program Review Criteria and Objectives

B1 - Excellence of the Research Program (highlighting featured projects)

IC-IMPACTS' bilateral model is identified and driven by community need, with outcomes being deployed internationally, from Canada's Indigenous communities to urban and rural communities in India. The following theme-based examples demonstrate the success of IC-IMPACTS' model.

Agritech and Food Security Theme

❖ Variable Rate Application of Nutrients by Developing Nutrient Estimation Sensor and Precision Spraying Mechanism

Canadian Lead: Dr. Ahmad Al-Mallahi, Dalhousie University

Indian Lead: Dr. Narasimha Murty, Indian Institute of Technology – Tirupati

This project is separated into two different developments, sensing and spraying, which get combined at the time of deployment. Firstly, the sensing system of nutrients in plants was developed based on a new machine learning technique that does not only assume relationship between spectral reflectance of leaves and petioles but also finds and incorporates the effects of the nutrients on each other.



Figure 2: Site Visit and Graduate Student Training – Collecting Spectral Data

The method of correlating leaf reflectance and petiole nutrient content was published in a peer-reviewed article and was submitted to McCain Foods as an invention disclosure and is being negotiated for patenting and licencing. The part of correlating soil and plant status was delayed as the team relied on obtaining one in-bound Mitacs Global Link Award to move the work forward. Nevertheless, the award is granted and one HQP from India is scheduled to conduct internship in Canada after getting his study permit. Secondly, a new spraying mechanism which allows for accurate spraying was assembled in India using components provided to Dalhousie by one of the research partners. The new nozzles allow for spraying backwards in angle of 55 degrees which can compensate for time delays caused by the sensing or mechanical components. Several communications through presentations were done during the past fiscal year, and a full article co-authored with the colleagues at IIT Tirupati is expected to be written this year.

Licenses Under Negotiation: *Real-time field nutrient sensing solution using spectrophotometer and wireless connectivity* (IP not filed yet as the filing methodology is being negotiated between McCain and Dalhousie). In negotiation to be licenced by McCain Foods.

❖ Irrigation Management Using Deep Reinforcement Learning

Canadian Lead: Dr. Chi-Guhn Lee, University of Toronto

Indian Lead: Dr. Subimal Ghosh, Indian Institute of Technology – Bombay

Previous studies on optimal irrigation scheduling have primarily relied on static optimization with chance constraints, assuming predetermined distributions of rainfall to determine optimal irrigation plans over a short-to-medium weather forecast range of 1-7 days. However, if farmers deviate from this optimal plan due to unexpected circumstances during the planning window, the original irrigation plan becomes suboptimal, and the entire optimization process must be restarted to obtain optimal decisions for the current soil moisture level.

During the current stage of the irrigation management project, the Canadian research team collaborated with the India Team and conducted data acquisition and processing to obtain rainfall data from GEFS and irrigation data from farmers at the specific site. Additionally, researchers obtained benchmark performance from their simulation-optimization method. A training environment by studying the hydrodynamics of the farm, including soil moisture differential equations, PET process, and the farmer's irrigation process was developed. Subsequently, researchers created a Python code to simulate irrigation using any method that respects the hydrodynamics of the site.

To optimize irrigation, the team incorporated the weather model into the Deep Reinforcement Learning (DRL) algorithm by including weather model parameters as part of the state for the agent and updating them as state transitions due to new information from the environment. Then designed the action space to allow for irrigation at irregular intervals and to respect the maximum water usage per irrigation due to the specific way farmers irrigate (using ground water and irrigating in irregular daily intervals).

Researchers then evaluated the proposed DRL method by comparing it with benchmark methods (farmer's method and simulation optimization method) in terms of water usage and soil moisture level evolution. Results indicate an average of 30% reduction in total water usage compared to benchmark methods, while maintaining appropriate soil moisture levels and similar crop yield.

Public Health Theme

❖ **Smart App-Based Rapid Multiplex Screening of HIV Associated Co-Infections of at-Risk Populations at the Point-of-Care: A Demonstration Study in India**

Canadian Lead: Dr. Nitika Pant Pai, Research Institute of the McGill University Health Centre

Indian Lead: Dr. Suma Nair, DY Patil Deemed to be University

In this study, the research team is screening populations for HBV and HPV – two viral infections that are commonly ignored in screening programs. The results from this study will influence testing policy and guidelines for sexually transmitted and blood borne infections. It will allow populations who are not commonly tested for these prevalent infections to know their status, thereby managing the undiagnosed disease burden and mitigating transmission. In the past two years, the team transferred this study from Manipal Academy of Higher Education (MAHE) to DY Patil Deemed to be University (DYPU), as the Indian Principal Investigator, Dr. Suma Nair, has taken up a new position as the Founding Dean of DYPU School of Public Health.

Currently, the team is in the middle of recruitment for a study at DYPU and expanded to several community sites and clinics.

There are 464 participants enrolled, 355 of which are from the OB-GYN clinic and 109 are from the screening camps. Out of these participants, the team has detected 12 HPV positive cases (8 HPV 18/45, 3 other hrHPV and 1 HPV 16) and HPV 255 negative cases. Regarding HBV, 245 participants are negative and 41 have not been tested. Researchers aim to complete the recruitment of our study and reach the target sample size by December 2024.

Researchers have published results from this study for the AideSmart! multiplex strategy to the Lancet Microbe, which have been released in preprint. In addition, they have presented the results of that study, and preparatory work relating to both AideSmart! Canada and AideSmart! India in conferences, seminars, and workshops. The team also has a new publication on the evaluation the AideSmart! strategy in key Canadian publications in peer-review at JMIR.



Figure 3: Research Team at RI-MUHC

Integrated Water Management Theme

❖ **Development and Scale-Up of Technology for Microbial Extraction of Xylose from Agro-Waste Materials and Subsequent Conversion into Xylitol: Conversion of Hydrolysed Lignocellulosic Residues into Biopolymers for Applications in Composites.**

Canadian Lead: Dr. Tatjana Stevanovic, Université Laval

Indian Lead: Dr. Baljinder Kaur, Punjabi University

This study involves quantifying the major constituents of rice husk and wheat straw, namely hemicellulose, lignin, cellulose, and ash. In the first year, the team optimized the extraction of xylose. In the second year, hydrolyzed biomasses was converted into biopolymers lignin and cellulosic pulp using a patented organosolv process. Organosolv lignins obtained from both original and hydrolysed rice husks and wheat straw were rigorously analyzed, by spectroscopic and chromatographic methods.. Due to large amounts of residual silica in the cellulosic pulps it was difficult to study the properties of the cellulose, so the team established and optimized a mild silica extraction process using Na_2CO_3 . The absence of silica in the ash produced from the purified cellulose, confirmed through elemental analysis, was taken as a proof of a successful purification.

To facilitate spectroscopic analysis, the cellulose pulps were further bleached by successive treatments by NaClO_2 . The bleached cellulose was then analyzed rigorously. The scaling up of the hydrolysis and pulping processes was necessary to produce biomass and validate its conformity. Using the electrospray method, rice husk lignin was transformed into nanoparticles. The team optimized various parameters, including lignin concentration, flow rate, applied voltage, and tip-to-collector distance, using a response surface methodology with the Box-Behnken design to obtain small, spherical, stable, and homogeneous nanoparticles. Finally, the lignin particles were incorporated into a polylactic acid (PLA) matrix to enhance the antioxidant properties of PLA films used for food packaging.

Using high intensity ultra sonification, rice husk cellulose was transformed into fibrillated cellulose. The team is currently optimizing various sonication parameters, including lignin concentration, nominal power, time, and cellulose concentration using response a surface methodology with the Box-Behnken design to obtain small, stable and homogenous cellulose fibers.



Figure 4: Filtration of organosolv pulp and lignin Klason

Carbon Neutrality through Combined CO₂ Capture and Novel H₂ Technology with Production of Non-Conventional Fuels for Smart Cities

Canadian Lead: Dr. Ibrahim Dincer, Ontario Tech University

Indian Lead: Dr. Subrata Borgohain Gogoi, Dibrugarh University

Increasing energy demand drives the need for environmentally sustainable and economically viable renewable resources to eliminate problems related to greenhouse gas emissions. In this ground-breaking project, the research group has successfully adapted a conventional gasoline-powered generator to run on various hydrogen-blended fuel mixtures. Gasoline, methane, and propane is used as the base fuel. Each have been mixed with the ratios of 5, 10, 15, and 20%. In order to make a comparison, the cases without hydrogen have also been experimented.

Researchers have observed that significant reductions in harmful emissions across all blends with increasing hydrogen content in the fuel mixture. In the case of without hydrogen which are used gasoline, propane and methane, while the emissions tend to decrease due to lower carbon content of the propane and methane, the power output of the generator has reduced. The reductions are observed 6.1% with propane and 10.4% with methane. On the other hand, while propane has reduced the CO₂ and CO emissions 10.4% and 43%, the methane has provided 21.7% and 62.1%, respectively. There was no significant change in NO_x emissions. The best case in terms of emissions is observed with the blend of 80% methane and 10% hydrogen. In this case, while CO₂, CO, and NO_x emissions are found to be 1,440 g/kg fuel, 12 g/kg fuel and 0.8 g/kg fuel. Also, it should be noted that the hydrogen has compensate the power reduction due to the use of methane in the engine. There was almost no power reduction in the power generator.

To date, researchers working on this project have published 11 journal papers.

Safe and Sustainable Infrastructure Theme

❖ **Sustainable Earthquake-Resistant 3D-Printed Concrete Housing: From Laboratory Testing to Industrial Application**

Canadian Lead: Dr. Vahid Sadeghian, Carleton University

Indian Lead: Dr. Biranchi Panda, Indian Institute of Technology – Guwahati

3D printed concrete (3DPC) has the potential to revolutionize construction industry by using robotic technology. Similar to any other new technology, 3DPC presents new challenges that must be addressed before it can be utilized on a large scale by the industry. The main goal of this research program is to develop sustainable seismic-resistant 3DPC buildings by conducting experimental testing and computer simulations at both the material and structural levels while also considering environmental impact and architectural requirements. Over the past year, the research team has made significant progress in all three aspects of the program: material science, structural engineering, and architectural design. In material science, the Indian team has developed three new concrete mix designs using low-carbon binders and high aggregate content to enhance sustainability and workability of 3DPC. Rheological and mechanical properties of these mix designs have been evaluated through various experimental tests on printed and cast-in-place specimens.

The Canadian team has conducted similar material tests on 3DPC mix designs, exploring novel aspects such as the application of the digital image correlation measurement technique, the measurement of the shear force-slip deformation between 3DPC layers, and evaluation of the effect of steel fibers on the mix design. Parallel to the material investigations, finite element computer models of 3DPC structural elements have been developed and validated against existing experimental tests. Additionally, a comprehensive sensitivity analysis study has been conducted to gain insight into the behavior of 3DPC structures. Further, in collaboration with industry partners, specimen design and test setup preparation have been completed for quasi-static and shake table testing of large-scale 3DPC walls.

Regarding architectural aspects, various design strategies have been explored to reduce the carbon footprint and facilitate large-scale construction of affordable 3DPC housing. The proposed designs are among the first to incorporate prefabricated modular construction and topology optimization techniques with 3DPC to enhance construction efficiency and minimize material usage.

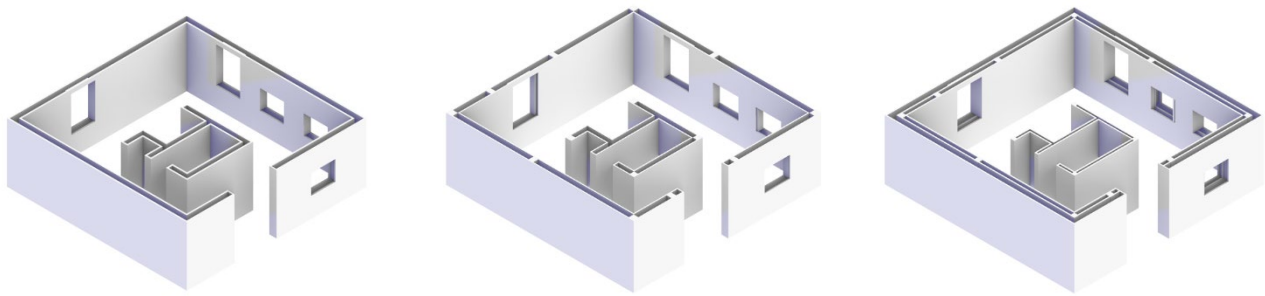


Figure 5: Proposed architectural designs and construction methods for affordable 3DPC housing

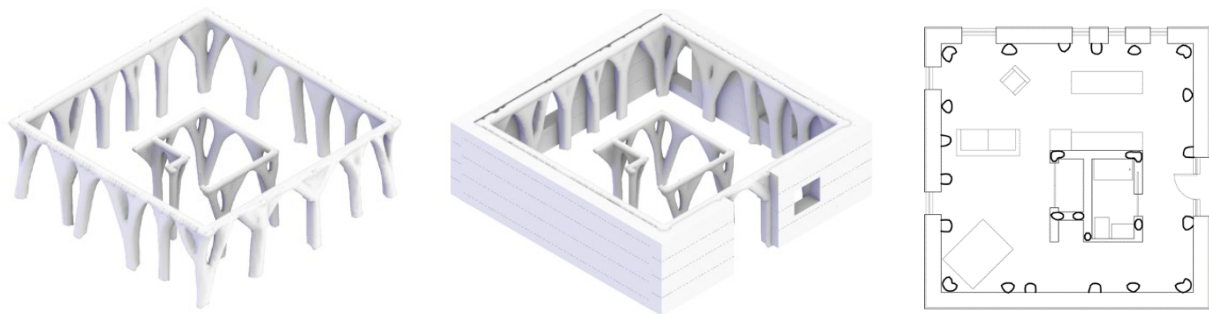


Figure 6: Proposed topology optimized designs and floor plans

New Partnerships Created: New Industry partners include Sika Canada Inc., nidus3D, Gardon Construction Ltd., and COBOD. The team also received financial support from Mitacs, for an international undergraduate student to work on this project.

New Partner Communities: Researchers are working with Ontario Aboriginal Housing Services and Habitat for Humanity to secure communities for Fall 2025.

❖ Development of Cost-Effective, Energy Efficient, and Resilient Housing Technologies for First Nations Communities

Leads: Drs. Ashutosh Bagchi and Bruno Lee, Concordia University

Wildfire activities have escalated across Canada in recent decades. Human activities and lighting are the main ignition sources of wildfires, and changing climate is responsible for increasing the frequency of compound dry and hot extreme events in the past decades. While wildfires have huge social and economic impacts nationwide, they hit First Nation Communities hard, threatening their land and culture. The goal of this research is to evaluate and improve the resilience of housing in First Nation Communities to events caused by wildfires through implementing energy-efficient technologies. More specifically, this research aims to identify the optimal sizing of building technologies that give the best performance in terms of energy and comfort for the local climatic conditions and under extreme events. In this project, several master's and Ph.D. students have collaborated and trained to develop the framework and platform for detailed analysis. The platform is developed by coupling EnergyPlus and Python, which brings strength and flexibility to the analysis of resilient housing. For this purpose, a systematic literature review has been conducted to evaluate the state-of-the-art research in the field. As part of this research, several conference and journal papers have been published or are under review.

Researchers have developed an energy model for a community center located in Val-d'Or, Quebec has been developed in EnergyPlus based on NECB. Energy and comfort analysis has been conducted for the baseline model. The ASHP and CWTES models have been developed in EnergyPlus and are sized based on the selected location climate. In addition, the resiliency indicators have been investigated. A holistic approach has been developed to automate the simulation of EnergyPlus models and conduct parametric design analysis in Python. And, parallel to this research, further analysis has been made to assess the robustness of heating and cooling systems under future climates.

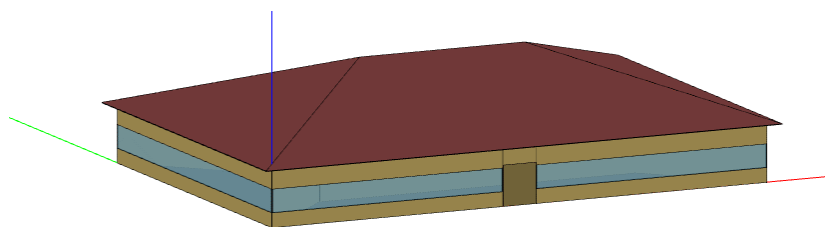


Figure 7: Schematic of the community center

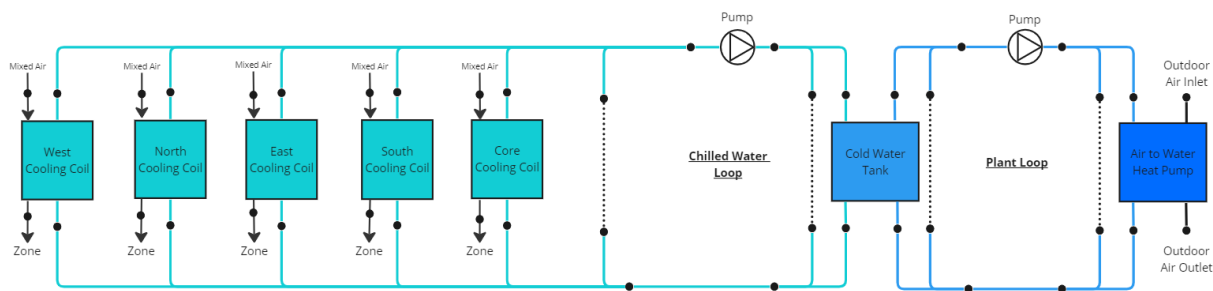


Figure 7: Schematic of the Integrated Energy System connected to the cooling coils

❖ Smart Infrastructure with High Fracture Toughness, Durable Concrete Employing Large Amounts of Industrial Wastes

Lead: Dr. Nemkumar Banthia, the University of British Columbia

Repairing aged and deteriorated sewer infrastructure is an ongoing challenge for municipalities and is often complicated by the fact that sewer pipes are located in crowded and developed areas that have changed significantly since the original design and installation. To tackle this issue, the research team at UBC is collaborating with Metro Vancouver to develop a carbon-neutral, geopolymer coating with biocides (called multi-phase composite coating, MCC) that when applied on sewer infrastructure, will resist bacterial attack, prevent further corrosion and extend the infrastructure's existing service life. Novel assessment of Microbial Induced Corrosion has been adopted by industry to assess state of Metro Vancouver infrastructure. The material will be spray-applied as repair coatings on Metro Vancouver's infrastructure assets using robots.

Researchers have partnered with Avestec Technologies Inc. which is a Vancouver-based high-tech robotic company and will internationally market the semi-autonomous vehicle which will carry the scanning and spraying gear in the sewer pipes. Collectively, the team will continue to further develop and optimize materials and robotic placement processes to strengthen Canadian sewerage and offer this expertise internationally.

The team continues to explore new applications in 3D printing of the developed material. Part of this research project primarily focuses on interface issues in 3D printing construction (3DPC) to enhance understanding of their effects. This will improve quality control and promote standardization in the field of 3DPC. Traditional construction methods can be time-consuming, leading to delays in housing projects. If done correctly, 3D concrete printing can significantly speed up the construction process, allowing for quicker completion of housing units, particularly in remote communities.

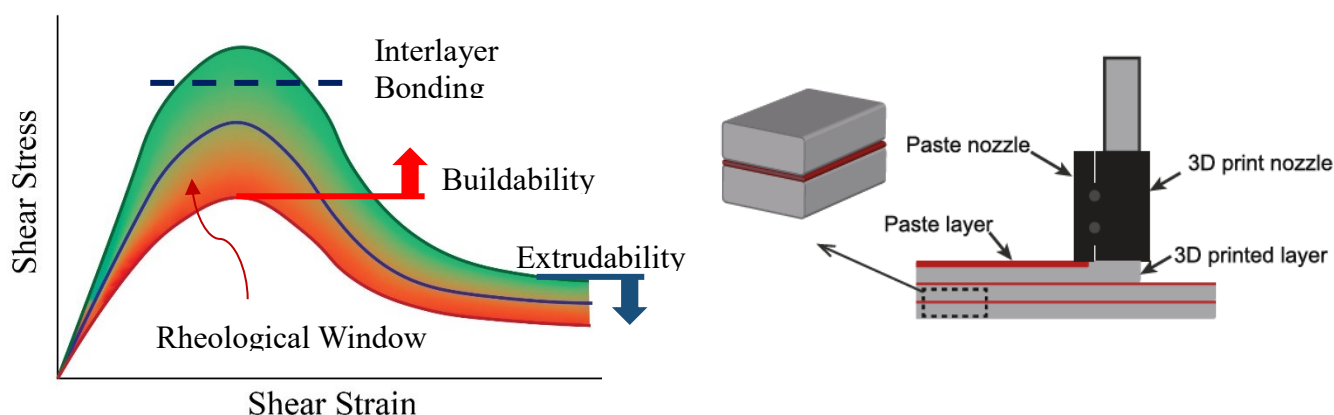


Figure 8: Testing and interstitial layer enhancement of 3DPC

Two of the HQPs working on this project have completed their PhD program and graduated; one of whom has been hired as an instructor at BCIT and the other continued their work at UBC as a Postdoctoral Fellow. One Postdoctoral Fellow working on the project has completed their term and is now employed at University of Sheffield in the UK and has started a new chapter in their academic career. One MASc student will be graduating this month.

Another graduate student is currently writing chapters of their thesis. With more than 30 research publications, the project has resulted in significant milestones over the last few years. The work includes two theses, 22 peer-reviewed articles published in high-impact factor journals, one book chapter, and one book.

Moreover, additional journal articles have been submitted for publication, and a review paper is currently in progress. The project has provided ample training opportunities for Highly Qualified Personnel (HQP). Two of the HQPs working on this project have received the HQP Leadership Award from IC-IMPACTS and successfully planned for and organized scientific programs in Vancouver, BC.

New Book Published: [Ultra-High Performance Concrete – Design, Performance, and Application](#). CRC Press. Shi, C., Wu, Z., & Banthia, N. (2024).

In the media: [Can infrastructure keep pace with immigration?](#)
Business Intelligence for BC, June 30, 2023

B2 - Development of Highly Qualified Personnel

Highly Qualified Personnel (HQP) at IC-IMPACTS play integral roles in funded projects, spanning from project inception and proposal drafting to stakeholder engagement and eventual commercialization. HQP benefit from exclusive training and learning avenues, collaborating with researchers from Canada and India to share insights, expand their expertise, and forge international ties. Their involvement in IC-IMPACTS projects exposes them to diverse experiences including technology advancement, service provision, and entrepreneurial endeavors. These are just a few highlights that HQP get to experience while working on IC-IMPACTS projects. Since 2013, IC-IMPACTS has trained a total of 1,549 HQPs (reported here as HQP-Years). These include graduate students, postdoctoral fellows, research associates and research staff, 34% of whom are female and four individuals self-declaring as non-binary. The following charts provide a breakdown of our HQP gender distribution:

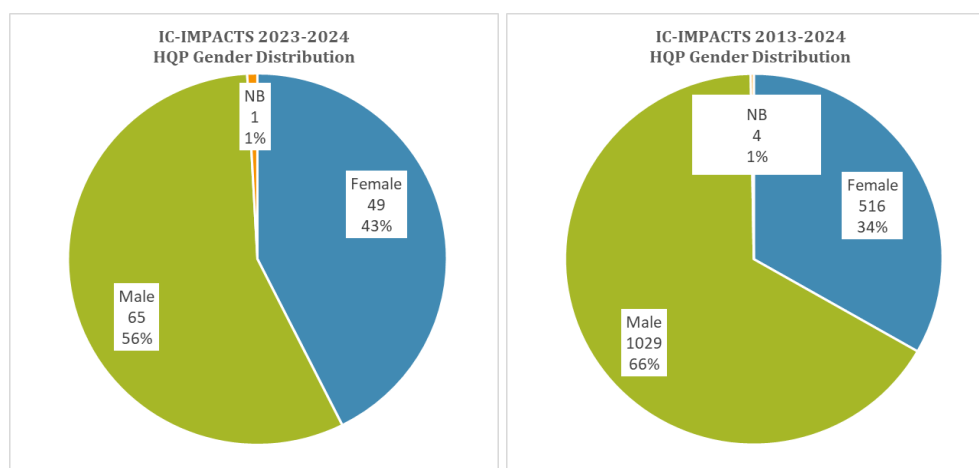


Figure 9: HQP Gender Distribution

In addition to being trained through IC-IMPACTS funded projects, HQP are trained through workshops, cohorts, and special skills sessions such as sessions on scientific communication.

IC-IMPACTS' community-based projects provide unique opportunities for HQP to directly transfer technology from labs to markets. In doing so, HQP working with community members become extremely experienced on finding the right solutions to challenges faced by those communities and, in turn, are also able to receive feedback from the end-users. IC-IMPACTS remains committed to training the next generation of leaders for a fast-changing future. In addition to what HQP gain through involvement in research projects, IC-IMPACTS' diverse programs provide further opportunities for our HQP to learn through volunteering. Skills are strengthened as HQP participate in diverse events and build connections. They also get a chance to network with industry leaders and strengthen various critical competencies. We are proud to report that 97% percent of our graduates are employed in either academic, industry, or government bodies.

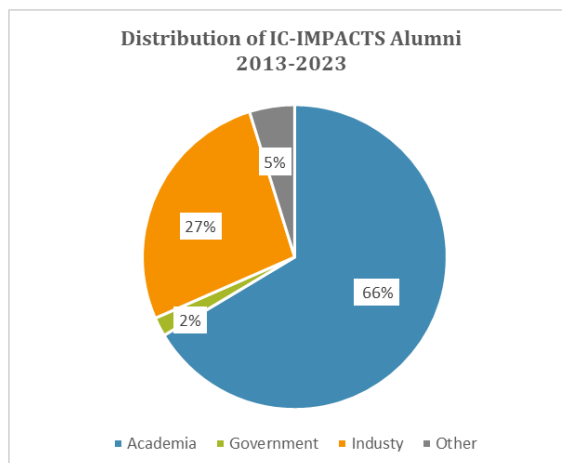


Figure 12: Alumni Employment Fields Distribution

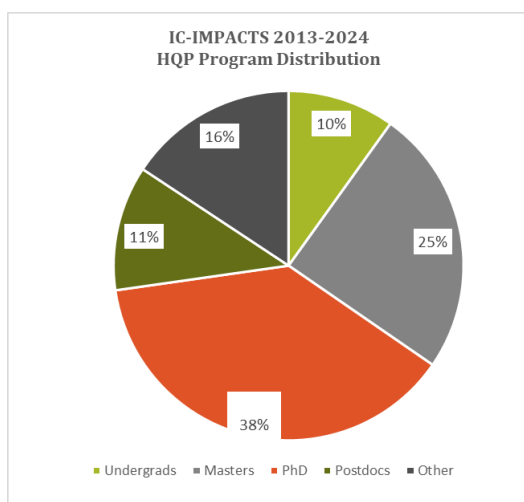


Figure 112: HQP by Program Distribution

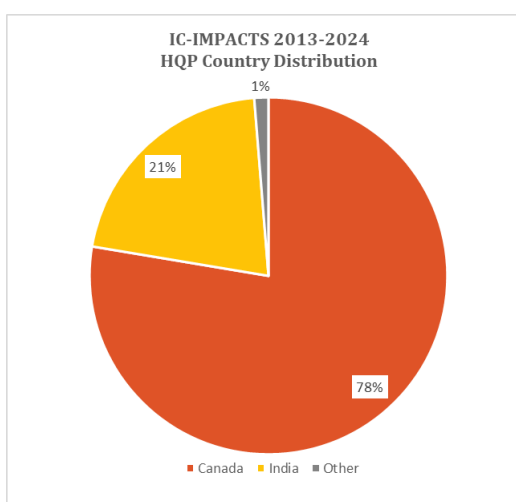


Figure 11: HQP by Country Distribution

B3 - Networking and Partnerships

With 11 Indian Institutes of Technology (IITs) collaborating with IC-IMPACTS, we are recognized as the Canadian Center for Science and Technology collaborations with India. IC-IMPACTS' collaborations with the Department of Science and Technology (DST) and the Department of Biotechnology (DBT) continue to grow with a renewed focus on demonstrating technologies in communities.

The three partners are now planning for a large conference to take place in December 2024 in New Delhi, India, to celebrate achievements and to navigate the path forward. Leadership from Canadian and India Universities, including IIT Directors, senior management from companies, government officials, members of the media and faculty and students participating in IC-IMPACTS/DST/DBT projects will be invited to attend. The conference will feature administrative sessions on student and

faculty mobility, scientific partnerships, and technology transfer between universities and companies. Parallel sessions highlighting results from current and past Canada-India projects in the areas of Infrastructure, Water, Public Health and Food Security will be held. The Conference will feature a rich cross-cultural social program and visits to important historical sites in Delhi.

B4 - Knowledge and Technology Exchange and Exploitation

IC-IMPACTS' researchers continued to be very productive in dissemination of knowledge and produced a vast amount of work, including 83 publications in the 2023-24 fiscal year, bringing the total number of scholarly publications to 1,664.

B5 - Management of the Network

IC-IMPACTS Board of Directors is responsible for the overall strategic direction of the Centre towards its objectives, milestones, and deliverables and maintains its three sub-committees which meet on regular basis; (1) Executive Committee, (2) Nominations and Governance Committee, (3) Finance Committee, and the (4) Equity, Diversity, and Inclusion Committee.



Figure 13: IC-IMPACTS Board of Directors (2023-2024)

The Executive Committee provides critical support between Board meetings and formulates agendas and key policies for Board approval. The Nominations and Governance Committee is responsible for Board nominations, governance, government relations and relations with the Host Institution. The Finance Committee oversees financial aspects and recommends audited statements to the Board members. The EDI Committee provides an overview of the role that Equity, Diversity, and Inclusion plays within the network. It also supports efforts to advance inclusion and is responsible for policy reviews and revisions. The Board of Directors meets regularly to ensure that acts, bylaws, funding and international agreements are adhered to. In addition, during the Board meetings, there were open dialogues and discussions about the benefits of having a more diverse Board as well as how to adopt policies relating to a balanced representation.

The Board continues to implement key strategies to embed diversity in the governance of the Centre. Board members were tasked to explore opportunities for expanding the Board of Directors, with regional diversity and EDI principles as priorities. IC-IMPACTS is pleased to inform the appointment of one new Board member, regionally diverse, who has varied expertise and exceptional track record and will certainly strengthen leadership and bring additional insight to our work. Moreover, IC-IMPACTS continues to participate in [Canada's 50-30 Challenge](#) as a means to ensure and improve equity and diversity. We look forward to another productive year ahead and to continue exploring and implementing innovative solutions to the challenges faced by communities in Canada and in India and to enhance community transformation and sustainability.

For more information and bios of Board Members, please visit our website: www.IC-IMPACTS.com

IC-IMPACTS Research Management Committee (RMC) is comprised of a regionally diverse, inspiring group of researchers who are top world experts in a variety of disciplines. IC-IMPACTS is fortunate to have the dedication and continued support of such highly skilled professionals who help build connections between Canada and India. In the past year, the RMC was extremely active and continued to advise the Board of the research direction of the network.

SECTION C: TRENDS AND JUSTIFICATIONS

Feedback from NCE Monitoring Committee on Previous Annual Report

The Monitoring Committee was pleased to see IC-IMPACTS continuing progress and achievements and added that the Centre is meeting the goals of the Networks of Centres of Excellence (NCE) Program by mobilizing Canadian research to help improve quality of life and create socio-economic benefits for Canada. The Monitoring Committee noted no issues with this network. The Committee further noted that IC-IMPACTS' plans for the continued involvement of Indigenous communities were appreciated, particularly the partnership with UBC on the CMHC Housing Supply Challenge to improve housing in northern and remote regions.

The Committee appreciated the clear and detailed response to last year's evaluation, especially the clarification that India has expressed support for the network beyond its end date, as well as the increase in regional diversity on the Board of Directors through the inclusion of new members. Furthermore, the Committee thanked IC-IMPACTS for its many contributions to the scientific landscape, and wishes the team ongoing success in their future endeavours.

Actual Versus Expected NCE Grant Expenditures

Over the fiscal year, without additional NCE grant, IC-IMPACTS continued to follow its prudent financial policies, from fiscal year 2013 to 2024, keeping its overall percentage of expenditures for administration operations below 15% and its active disbursement of research funding to academic institutions in Canada at 64%. IC-IMPACTS knowledge transfer (including research networking, technology transfer, and communications expenses) was at approximately 10% of the NCE funding.

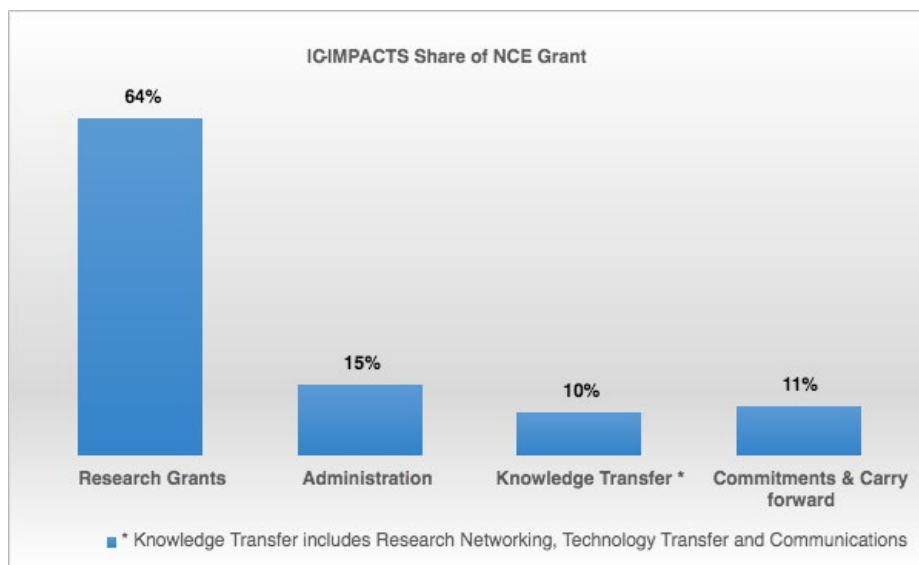


Figure 14: Distribution of NCE Funds

SECTION D: NETWORK-LEVEL PERFORMANCE

IC-IMPACTS' bilateral model has proven to be very successful since its inception in 2013, and has consistently exceeded its established targets.

Progress on Goals and Objectives Defined in Last Year's Annual Report

IC-IMPACTS made great progress on the goals and objectives identified in the 2022-2023 NCE Annual Progress Report. The following list highlights some of these achievements:

1. Continue developing a multidisciplinary and cutting-edge research program, capable of delivering solutions towards community problems in Canada and India:

IC-IMPACTS in a collaboration with DST and DBT announced the funding of 19 new bilateral projects.

2. Further strengthening engagement with Indigenous communities:

IC-IMPACTS' PIs are having follow-up meetings with site/communities and requesting their participation in collaborative workshops for their feedback (community-based solutions). A great example is Dr. Tony Yang's project at UBC (as mentioned previously in the report).

3. Supporting and training HQP in activities that are innovative and entrepreneurial:

Throughout 2023-24, IC-IMPACTS facilitated HQP-led conferences and workshops on the topics of Water Management, Agritech and Infrastructure. Three HQP received financial support for scientific workshops and seminars. These events were entirely planned and organized by graduate students from across Canada.

4. Ensuring sustainability beyond March 2025:

IC-IMPACTS is planning on creating an external advisory that can guide the renewal process. In addition, IC-IMPACTS CEO continues to meet with the Canadian Federal Government, discussing IC-IMPACTS proposal and possible path forward. In 2023-24, IC-IMPACTS hosted multiple events such as the one-day session with the Consulate General of India in Vancouver, where discussions were held with industry leaders and stakeholders on the future of the Centre.

India continues to express strong support for the IC-IMPACTS program beyond 2025. Both the Department of Biotechnology and the Department of Science and Technology continue to collaborate with IC-IMPACTS on projects on a dollar-for-dollar basis.

5. Prioritizing equity, diversity and inclusion:

Principles of EDI remain a top priority for IC-IMPACTS. Principles of EDI are built into all IC-IMPACTS activities and are carefully considered at each stage.

Commitment to the Principles of Equity, Diversity and Inclusion

IC-IMPACTS respects, honours, and celebrates the diversity in our network and as an international Research Centre, IC-IMPACTS is fully aware of the benefits brought on by having a diverse team. We remain committed to fostering and maintaining an inclusive environment that brings together diverse perspectives from our HQP, researchers, partners, and members of the community. IC-IMPACTS continues to develop and promote equity, diversity, and inclusion initiatives in our programs. Our HQP network has a 34% female ratio which we see as a notable achievement. Our Board of Directors is currently at 46% female ratio and our Administration Office is currently at 66% female ratio.