

Proposal for the Green Processes Research Center (GPRC)

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Purpose

Vision of the Centre

The Green Process Research Center (GPRC) will be a hub for local and international researchers working on cutting-edge green technologies that will develop new products with the aim at transforming Canadian industries to adopt new sustainable processes with green products that will protect the environment. With its focus on sustainability, the vision of GPRC is well aligned with the Strategic Research Priorities of Lakehead University including Advanced Systems and Technologies and the Environment and Natural Resources. As a hub that brings together local, national, and international researchers, the GPRC also fits well with Lakehead University's internationalization mandate.

Background

It has long been known that oil based chemicals have adverse impacts on the environment. The federal (<http://www.nrcan.gc.ca/forests/industry/bioproducts/13323>) and provincial (<http://www.calgaryjournal.ca/index.php/news/3356-low-adoption-of-green-technologies-in-alberta-3>; <https://www.ontario.ca/page/seizing-global-opportunities-ontarios-innovation-agenda>) governments have recognized the impact and stressed the need for the use of more environmentally friendly chemicals. Universities across Canada have developed programs that focus on the creation of technologies and environmentally friendly chemicals that can be used within a variety of industries. Policies and method development for protecting the environment are also primary goals of provincial and federal governments. Lakehead University has partnered with local (e.g., OPG, Resolute FP) and regional (e.g., FPIInnovations, Domtar) companies to address these challenges.

In the past 8 years, Lakehead University established the Biorefining Research Institute (BRI) and the Centre of Excellence for Sustainable Mining and Exploration (CESME). The research objectives of BRI are focussed primarily on bioconversion, biofuel and cellulose, and the research conducted at CESME is directed towards mining exploration and the associated impact on society and the environment. The research activities of GPRC will primarily focus on research and the production of green technologies, but will also have the goal of developing guidelines that can be implemented as green policies on an industrial scale. The knowledge contributions will be published and presented through journals and conferences both nationally and internationally. Patent applications will be filed in order to protect intellectual property arising from GPRC research. There will be a strong emphasis on creating a collaborative and collegial environment that is dedicated to training of HQP, mentoring graduate students and postdoctoral fellows in the field.

With a focus on engineering aspects in the production of green chemicals which address how green processes and technologies can create new policies that can have immediate application within local and regional businesses, as well as impact global industries and the environment, the GPRC will complement both BRI and CESME. Having the three Centres/Institutes (GPRC, BRI, and CESME) at Lakehead University dedicated to finding sustainable alternatives in a wider variety of industries will enhance the research cluster that will make Lakehead University more competitive nationally and globally.

Relevance

Lakehead University

GPRC will be the first Research Centre based in the Faculty of Engineering at Lakehead University. As such, the CRGPPE will continue to include basic science as a part of its daily activities, while its main emphasis will be on applied science and technology development. As part of his Canada Research Chair mandate, Dr. Fatehi's leadership of GPRC will play a key role in building research capacity. The current platform of research does not provide his research team with sufficient capacity to further develop his program of research that includes building real-world industrial applications for this innovative technology. For example, to manage a group of 25+ graduate students, one needs access to research funds for both direct and indirect costs. Having a dedicated Research Centre will help to secure more external funding and remove a barrier to team's research operations. A Research Centre also provides the necessary structure to build on Dr. Fatehi's program of research, especially in the development of new collaborations which will further enhance Lakehead University's reputation for research excellence nationally and globally.

Regional Impact

Since 2011, research collaborations have been developed between several local companies and Dr. Fatehi that are unique in the history of Lakehead University. For example, only a few years after joining the Faculty, Dr. Fatehi was the first researcher in Canada to be able to secure funding from NSERC for a collaborative research with Resolute Forest Products. As a result of these collaborations, Dr. Fatehi has been invited to participate in meetings that are conducted elsewhere in the city of Thunder Bay for the development of local companies.

Pulp and paper, brewery, and mining companies are currently approaching Research Centres in southern Ontario or Quebec for service and consultation. GPRC could redirect the attention of these companies to Lakehead University, and as such help sustain local economic development.

National Impact

Since joining Lakehead University in 2011, Dr. Fatehi has partnered with many local and national companies bringing in more than \$5M in research grants, more than 30 graduate students, and more than 110 journal publications. His partnership with Resolute has led to training 5 graduate students and 3 patents (2 granted, 1 pending). In the last 2 years, Dr. Fatehi has created jobs for 3 Lakehead University graduates at the mill. Dr. Fatehi has successfully developed research programs on the conversion of lignin to water-soluble products to be used in the different sectors. This research programs have led to 6 patent pending processes. Based on the large demand and promising results, 1) FPIInnovations and Dr. Fatehi have secured about \$ 1M for constructing a 1000 L/batch reactor for studying the processes elopement by Dr. Fatehi at pre-commercial scale (the reactor will be located at the Resolute mill); 2) FPIInnovations, with the help of Dr. Fatehi, was able to secure about \$ 9M to study the newly developed process of TMP-Bio at a pre-commercial scale in Thunder Bay, 3) Dr. Fatehi and FPIInnovations were able to secure \$ 100k from the government of BC for Dr. Fatehi's research at Lakehead University. These facts not only show strong collaboration between Dr. Fatehi and different companies, but also show signs for capacity development at an international level. Under Dr. Fatehi's leadership, the team can have a significant impact on science and industry.

International Impact

Due to his outstanding research outcomes, Dr. Fatehi has been appointed as a distinguished professor at Qilu University of Technology, in China. One of the aims of GPRC will be to attract international research scholars to Lakehead University. Research Centres help to provide credibility and increase the reputation for research excellence outside of Canada. GPRC will highlight the research activities of Dr. Fatehi's team, and will provide sufficient credibility for attracting international collaborations.

Life Expectancy

GPRC is aimed to become an operational Research Centre while there is a demand and need for the development of green technologies, green chemicals, and green processes.

Dr. Fatehi is well positioned to serve as principal investigator and founding Director of the GPRC. However, with proper development and strategic hiring over the next few years, it is expected that the GPRC will be well positioned to grow and succeed at a scale that surpasses the accomplishments of a single researcher. With targeted investment in faculty and the establishment of productive collaborations, the GPRC will be a key pillar of Lakehead University's comprehensive strategy to nurture scholarship and make a significant impact on economic development.

Budget

Year 1: \$35,000 (\$20,000 from the Faculty of Engineering, \$15,000 from return of overhead grants)

Year 2: \$35,000 (\$20,000 from the Faculty of Engineering, \$15,000 from return of overhead grants)

Year 3: \$35,000 (\$20,000 from the Faculty of Engineering, \$15,000 from return of overhead grants)

As Director of the GPRC, Dr. Fatehi will seek external funding from the City of Thunder Bay and various local industries in order to raise the operating budget of the GPRC. Overhead from external research grants by the Director and members will also contribute to the operating budget of the GPRC.

Future plans for support of the GPRC

Academic

The GPRC will conduct a series of activities to instruct and support graduate students and local industries. These will include workshops on relevant topics from different disciplinary perspectives. Dr. Fatehi and his team have already prepared courses on lignin as well as on green chemicals and processes, which they will develop further to offer specific presentations and workshops for local industries and students. The research programs currently conducted at Lakehead are unique and industrially oriented, and the need for highly skilled workers in these areas is high in industry. The GPRC will play a key role in maintaining the highly skilled workers up to date with the current research in their areas. These extra materials will be offered in person, and online for interested individuals located elsewhere.

Research collaboration

Dr. Fatehi plans to travel to US, Europe and Asia to introduce the activities of the centre. Some research groups have already collaborated with Dr. Fatehi. For example, Dr. Fatehi was the host of an exchange PhD student from Abo Academy in Finland last year. Although the collaboration was a success, his limited capacity prevented him from inviting the researchers from Finland to continue this task. Universities in China have already shown interests in supporting their faculty members to join Dr. Fatehi's proposed centre for research and collaboration.

Establishment and growth

In the first two years of the centre, Dr. Fatehi and his team will work on developing collaboration with companies locally, regionally and nationally for research and service. Collaboration with companies is necessary for establishing the center as a hub of R & D for industry. The establishment of the center as an advanced R & D center of industry regionally is critical as it helps with revenue generation as well as technology development and transfer. It is expected that 3,4 companies will join the R & D activities of the center in the first 2 years. Dr. Fatehi has been successful in securing funds for his research in the past 6 years, it is expected that his funding level be increased to \$ 600-700k/year in the next 5 years as a result of collaboration with new companies after developing this centre.

In addition, the center will have collaborations with other universities and research institutes internationally in the first 3 years of its establishment. With these partnerships, Dr. Fatehi will launch foundation for student exchange and joint R & D for technology development internationally. The establishment of collaboration with other institutions will provide opportunities for advancing fundamental research beyond center's capacity. Dr. Fatehi will start applying for large grants, such as NSERC strategic partnership plan and NSERC CREATE programs, to secure funds for fundamental research and training graduate students. He will also seek opportunities for funding (e.g., European commission, Canada-India, Canada-Mexico, Canada-China) internationally for supporting these activities

Activity Plan

Research

It is intended that the GPRC will develop state-of-the-art programs that will be recognized internationally. 1) Fundamental and applied research on the valorization of biomass, mainly wood and agro-based, will be conducted; 2) new techniques to treat drinking water as well as municipal and industrial wastewater will be developed; and 3) pathways to facilitate the transformation of the pulping industry will be established.

Service and consultation

It is intended that the GPRC establish itself as a regional Research & Development centre. Currently, local and regional industries seek opportunity for service outside Northwestern Ontario, but this Centre will support the local industries. This will provide a substantial benefit logistically and financially to the local companies. The GPRC will act as a core for the development of engineering research at Lakehead University and in Thunder Bay.

Commitments by Lakehead University

The GPRC will be located in the CASES building, as Lakehead University has committed to providing 4500 ft² of lab and office space in CASES.

The university will allocate \$15,000/year from overhead generated by the grants of Dr. Fatehi to this centre for its operation.

The faculty of Engineering has committed to support \$20,000/year (for three years with possibilities for extension) to center to cover costs associated with the operation of the centre.

The GPRC will have start-up and operation costs. Table 1 lists the operation and start-up costs of the centre.

Table 1. Start-up and operation costs and revenues.

	Start-up revenues		Operating revenues
Item	Amount, \$	Item	Amount, \$/year
Office of Research	0	Research office	15,000
Faulty of Engineering	0	Faculty's budget	20,000
LUCAS	7000	LUCAS	0
	Start-up expense		Operating expense
	Amount, \$		Amount \$/year
Website design	1000	Admin salary and benefit, part time	20,000
Promotional materials	1000	Repair and maintenance	10000
Technology service	2000	Workshop and seminars and video	5000

		conference	
Guest speaker fee and travel	3000	Raises the profile of the centre	5000

University Facilities

The biomass Utilization Research Laboratory (BURL) of Lakehead University has already advanced instruments and research facilities worth more than \$3M. It is envisioned that the team will add instruments with a value of \$300k to the Centre in the next 5 years. The expenses for the instruments will be supported by the team's future grants, e.g., NSERC CRD, RTI... etc. These tools provide foundation for basic science and engineering research as well as for advanced state-of-the-art research in green chemicals and processes development. They can support research at laboratory and pilot scale studies. These facilities are currently located in Dr. Fatehi's labs and will be soon moved to CASES. All of these facilities will be part of GPRC. With the new research space in the Centre for Advanced Studies in Engineering and Science (CASES) building and the current research instruments, the proposed centre will have world-class facilities that makes it competitive internationally.

Membership

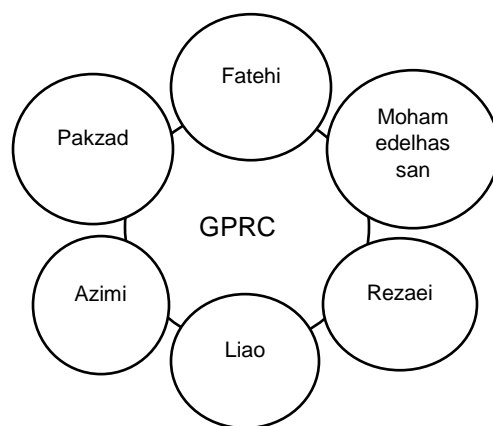
The GPRC will be a hub of research for faculty members in the chemical engineering department. The GPRC will have members from other engineering departments, e.g., civil, mechanic, and science departments, e.g., chemistry and biology, with the interest and expertise required to contribute to the GPRC's development. Members from management and forestry faculties can also join the GPRC and participate in the research activities. The GPRC will train graduate and undergraduate students in multidisciplinary fashion. Dr. Fatehi has currently more than 25 graduate students registered in different PhD and MSc programs and the new space in the CASES building will provide facilities for 30 graduate students and researchers. It is anticipated that the GPRC will have more than 6 faculty members and train more than 45 graduate students at a time, which will make it a larger than average-sized centres in Canadian universities.

Table 2 lists the name and research activities of current members of the proposed GPRC. The proposed GPRC has currently 6 proposed members from chemical and civil engineering departments. It consists of senior faculty members (e.g., Drs. Liao and Mohamedelhassan) and junior members (e.g., Dr. Rezaei). The GPRC will seek opportunities to recruit more female researchers, as it recognizes equity and diversity as part of its core values.

Table 2. Name and research activities of members

Name	Department	Research interest
Pedram Fatehi	Chemical Engineering	Biomass modification and application
Baoqiang Liao	Chemical Engineering	Membrane bioreactor for water/wastewater purification
Leila Pakzad	Chemical Engineering	Polymer rheology
Ebrahim Rezaei	Chemical Engineering	CO2 emission, air purification
Amir Azimi	Civil Engineering	Multiphase flow, hydraulic structure
Eltayeb Mohamedelhassan	Civil engineering	Solid remediation

The expertise of the members covers a wide range of engineering areas from air pollution and CO₂ capture (Rezaei) to water, wastewater (Liao) and soil (Mohammedelhassan) remediation. The GPRC will cover activities associated with the modeling and experimental behavior of open source water, e.g., lakes and rivers (Azimi) and aqueous systems in chemical processes (Pakzad and Fatehi). The proposed center will have a primary focus on biomass conversion (Fatehi) and its impact on the environment (air, water and soil). All of the members are active researchers and they have made significant scientific industrially relevant outcomes in the past. However, the creation of the GPRC will create momentum for performing research that is beyond the research capacity of each individual member as various aspects of research topics will be studied in a research team.



Governance

Dr. Fatehi will serve as Founding Director. The management committee will consist of the Director (ex officio) and five faculty members associated with the GPRC. The management committee will meet on a quarterly basis. The advisory committee will include the membership of the management committee, two community partners and will be chaired by the Vice-President (Research) or his/her designate. The advisory committee shall meet at least once a year.

Employment Opportunities & Personnel

The GPRC will involve faculty members from Engineering and other Faculties as appropriate. Students will work on GPRC projects through support of individual faculty members. In the future, with sufficient GPRC funding there may be an opportunity to hire technical staff or administrative staff to support GPRC operations.

Legal

The GPRC will work within established University guidelines relevant to grants and contracts. Any liability issues, intellectual property, or patent issues will seek the appropriate approvals and follow all University processes.