

## Institute for Oil Sands Innovation (IOSI) at the University of Alberta

# Call for Letters of Intent

**Bitumen Extraction.** *2021/22 Focus: Aqueous Extraction Optimization.*

**Smart Mining (1).** *2021/22 Focus 1: Autonomous Mining Systems.*

**Smart Mining (2).** *2021/22 Focus 2: Measurement and Instrumentation.*

**Value-added products.** *2021/22 Focus: Value-added products from TSRU tailings.*

**Deadline: ACCEPTING YEAR-ROUND**

**Challenge Statements:** Please refer to pages 2-5 for the challenge statements for each theme.

**Project Scope:** Both fundamental and applied research will be supported, including proof-of-concept. The research must demonstrate a clear line-of-sight towards technology commercialization in oil sands mining operations.

### Application Process

- The letters of intent (LOI) are maximum 2 pages long. The LOI template in Word is available at <https://iosi-alberta.ca/forms/>. The pdf is provided below (page 7). There are no restrictions on the number of LOIs per applicant.
- Please email the LOI in a pdf format to [iosi@ualberta.ca](mailto:iosi@ualberta.ca).
- The selected terms for participation in IOSI projects are attached (page 6). Other IOSI procedures are at <https://iosi-alberta.ca/investigator/>.

**Questions:** Please contact IOSI Director Natalia Semagina [semagina@ualberta.ca](mailto:semagina@ualberta.ca). Meetings with potential industrial stewards may be arranged on request.

### General Information: Oil Sands Mining 101

- A high-level view of oil sands mining, by Canadian Association of Petroleum Producers: <https://www.youtube.com/watch?v=cxiA40XHF0I>
- Virtual tour of Kearl Oil Sands (Imperial Oil): <https://www.youtube.com/watch?v=y-pLI86QSMA>
- Autonomous oil sands operation at Kearl Oil Sands (Imperial Oil): <https://www.youtube.com/watch?v=0U-OLBrH1Mk>
- Kearl Mine (Imperial Oil) by Oil Sands Magazine: <https://www.oilsandsmagazine.com/projects/imperial-oil-kearl-mine> and links therein
- Mining for bitumen by Oil Sands Magazine: <https://www.oilsandsmagazine.com/technical/mining/>
- Bitumen extraction by Oil Sands Magazine: <https://www.oilsandsmagazine.com/technical/mining/extraction> and links therein

# Institute for Oil Sands Innovation (IOSI) at the University of Alberta

## Challenge Statement

### Bitumen Extraction. 2021/22 Focus: *Aqueous Extraction Optimization*

#### Background

Mined oil sands industry uses a water-based extraction process to separate bitumen from oil sands ore. Here the mined oil sands - after being crushed - are mixed with hot process water and caustic to form a slurry. The slurry is transferred to separation vessels via hydrotransport lines where ore lumps are mechanically sheared, and bitumen gets aerated. The aerated bitumen is separated in the form of froth in the primary separation cell. The unrecovered bitumen is subjected to air flotation. Over 90% of bitumen recovery can be achieved in the water-based process depending on the ore grade and the processing conditions.

For more general information on the extraction process, including at Imperial Oil, refer to the links provided on page 1.

#### Technology and Knowledge Gaps

- Methods for decreasing extraction GHG emission.
- Reducing water usage for the extraction process.
- Methods/processes that can further enhance bitumen separation.
- Development of methods and techniques for quick slurry composition measurements – both in-situ and ex-situ.
- Fundamental understanding of bitumen aeration and de-aeration process and methods to improve both.
- Fundamental understanding of processing ore in the presence of coal.
- Using computational methods to develop predictive models (transient and steady-state) for different stages of oil sands processing.
- Alternative chemicals for bitumen processing and fundamental science.
- Fundamental science for producing cleaner froth (i.e., fewer solids) in extraction.
- Methods to reduce fines generated by extraction.
- Relationship between slurry conditioning and bitumen recovery and novel conditioning approaches.
- In-situ and continuous measurement of froth quality (e.g., imaging or other properties).

#### Preferred Processes and Methods

- New process concepts or enhancement of the current practice that could be integrated into the existing process.
- Low GHG emission, non-solvent approaches.
- Processing to minimize waste rejection.

## Institute for Oil Sands Innovation (IOSI) at the University of Alberta

# Challenge Statement

## Smart Mining (1)

### *2021/22 Focus 1: Autonomous Mining Systems*

#### **Background**

- Please refer to the 2021 video on Autonomous oil sands operation at Kearl Oil Sands (Imperial Oil): <https://www.youtube.com/watch?v=0U-OLBrH1Mk>

#### **Challenges**

##### **Instrumentation and software development for autonomy**

- Need for autonomous systems for independent projects (mine equipment inspections; facility inspections; environmental assessments; cleaning and maintenance systems in the field; aquatic systems for sample collection and bird hazing).
- Higher levels of autonomy are required (situational awareness, respond appropriately to unexpected events and obstacles).

##### **Expanded autonomy for aerial systems**

- Light-weight detect and avoid systems; meet regulatory compliance for BVLOS (Beyond Visual Line of Sight).
- Weather condition monitoring.

##### **Autonomous maintenance/reliability systems**

- Self-cleaning sensors and systems.
- Continued operation in adverse weather (rain, snow, dust, fog, cold).

## Institute for Oil Sands Innovation (IOSI) at the University of Alberta

# Challenge Statement

## Smart Mining (2)

### *2021/22 Focus 2: Measurement and Instrumentation*

#### **Background**

The oil sands mining industry uses online instrumentation to measure general trends of bitumen content and fines content through a proxy of illite. These sensors provide an indication of ore quality on a continuous point basis and, in general, provide limited time for the operation to respond to the change in feed quality.

For more general information on the mining process, including at Imperial Oil, refer to the links provided on page 1.

#### **Technology and Knowledge Gaps**

- Limited applicability for ore reconciliation due to indicative nature and point scale.
- Value in providing a true value of bitumen content, fines content, particle size distribution, and/or clay activity or clay typing.
- Missing ability to determine particle size distribution and clay activity or clay typing.
- Required earlier on in the process: mine face, on shovels, and/or conveyors, faster/more cost-effective core lab analysis, or downhole applications.

#### **Preferred Processes and Methods**

- Field applications should address the environmental suitability of the measurement system, sensitivity of the system to external factors such as ambient lighting, dust, rain, fog, frost, etc.
- Downhole applications should address operation in an aqueous environment.
- All methods should address how representative the measurement is of the bulk sample (one mm<sup>2</sup> surface measurement does not represent the mine face or a shovel bucket load. 100-1000 done quickly might.)

## Institute for Oil Sands Innovation (IOSI) at the University of Alberta

# Challenge Statement

## Value-Added Products

### *2021/22 Focus: Value-added products from TSRU tailings*

#### **Background**

Mined oil sands industry uses Paraffin Froth Treatment (PFT) process to separate bitumen from water and solids. The rejected tailing stream from the tailing solvent recovery unit (TSRU) of PFT contains about 75% water, 20% minerals, 4% asphaltenes, 1% maltenes, <0.1% paraffinic solvent. There are economic and environmental benefits to convert the TSRU stream into valuable products.

For more general information on the mining process, including at Imperial Oil, refer to the links provided on page 1.

#### **Technology and Knowledge Gaps**

- Methods/processes that can separate hydrocarbons (including asphaltenes and maltene) from the tailings, separate maltenes from asphaltenes, and convert asphaltenes to value-added products.
- Fundamental science for multiphase stream processing such as clean separation of hydrocarbons from mineral surfaces.

#### **Preferred Processes and Methods**

- New process concepts can consider dry (water removed) or wet TSRU as a feed.
- Low-GHG emission, non-solvent approaches.
- Chemical reactions to enhance phase separation and product value.
- Processing to minimize waste rejection.
- Catalytic or non-catalytic reactions.
- Co-processing with other feedstocks such as CO<sub>2</sub>, flue gas, or natural gas.

#### **Value-Added Products**

- Recovery of solvent or bitumen components (preferably boiling below 524 °C).
- Solid carbon-based products, such as graphitic carbon, and carbon black.
- Feed for chemicals synthesis, mineral products.
- Other (new) products with value.

## **Institute for Oil Sands Innovation (IOSI) at the University of Alberta (UofA)**

### **Selected Terms and Conditions for Researcher Participation in IOSI Projects** *(not applicable for the projects co-funded by COSIA and IOSI)*

The terms and conditions are provided through the Foundation Agreement between the University of Alberta (UofA) and Imperial Oil Limited, as well as through the Prime Agreement with Alberta Innovates. Agreement to these terms will be required if the proposal is accepted for funding. More details will be provided if the letter of intent (LOI) is invited for a full proposal. If you have questions before the LOI submission, please contact IOSI Director at [semagina@ualberta.ca](mailto:semagina@ualberta.ca).

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IOSI will work with researchers to establish and monitor the progress of research projects, and to ensure that procedures for publication, disclosure of intellectual property, and maintaining confidentiality are followed. Consistent with the Foundation Agreement, recipients of IOSI funding must agree to the following conditions:

- 1) **Intellectual property (IP)** – All new IP shall be disclosed to the UofA and shall be owned by the UofA (exceptions may apply). Certain rights will be granted to the Imperial Oil Limited. The Research Provider shall not own or proceed to commercialize new IP independent of the UofA (exceptions may apply). Certain rights will be granted to Alberta Innovates to use and publish the produced reports.
- 2) **Confidentiality** – All researchers shall use all reasonable efforts to prevent disclosure to third parties of any confidential information provided by the UofA and Imperial Oil Limited. Such information shall be identified in writing as confidential. This obligation does not apply if the information is already known to the researcher, or is revealed by third parties who have no duty to maintain such confidentiality, or after 10 years of receipt of the information.
- 3) **Publication rights** – IOSI must be provided with copies of all theses, abstracts, presentations, and manuscripts at least 30 days before submission for publication to permit review for possible IP protection. If IOSI determines that protection of IP is warranted, the submission may be delayed for a period up to 6 months to secure that protection. On collaborative projects, disclosure of manuscripts to collaborators at least 60 days before publication is also necessary to allow review for any confidential information. Consequent requests to remove confidential information shall be provided within 45 days of receipt of the manuscript.
- 4) **Student's thesis** – There will be no delay for the defence of a student's thesis, which is distinct from public presentation or publication. The student will own copyright in his/her thesis.
- 5) **Project reviews** – IOSI projects shall be subject to a staged review process to ensure progress and relevance.
- 6) **Salary** – IOSI emphasizes on training of highly qualified personnel. Therefore, IOSI funds are not to be used to cover the honorarium or salary/benefits of the principal investigators.
- 7) **Termination** – Either party may terminate the Project Agreement within not less than 30 or 90 days, depending on the cause.

(Maximum 2 pages)

## LETTER OF INTENT (LOI)

ENTER PROJECT TITLE

Template in Word with embedded links is available at <https://iosi-alberta.ca/forms/>

**Submission month, year:**

**Research theme:** Extraction, Smart Mining, or Value-Added Products from TSRU Tailings (*delete two irrelevant*)

**Name, affiliation and email of principal investigator:**

**Names, affiliations and emails of co-investigators:** (*if applicable, do not include trainees or technical personnel*)

**Proposed research or process concept:**

**Expected advantages relative to current commercially available technologies:**

*If applicable, we recommend including a process flow diagram, if different from existing, including regeneration/recycle and waste streams, when applicable.*

**Applicant's expertise and prior research as related to the proposed project:**

**Funding, resources, equipment required (Canadian dollars):**

*(For your convenience, you can use the [Excel IOSI budget template](#) but include here only the required information. You do not need to submit the detailed budget at this stage)*

**Project duration** (years):

**Annual and total project budget including overhead:** (note that the maximum overhead rate covered by IOSI is 25%).

**Research staff required** (students, post-doctoral fellows, etc.):

**New equipment required** (the new equipment cost may be covered up to C\$50,000. Note that IOSI houses a [laboratory](#) with free service and training for IOSI researchers):

**Comments (if any):**

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Prior to the submission, please familiarize yourself with the details of the particular call for LOI, selected terms and conditions for researcher participation in IOSI projects, and other IOSI procedures. The information is available at the IOSI website <https://iosi-alberta.ca/> under "Forms" and "Apply"

Submit the 2-page LOI pdf file by the deadline for the current call for LOI to [iosi@ualberta.ca](mailto:iosi@ualberta.ca)