ALBERTA INNOVATES

APPENDIX: THE CLEAN TECHNOLOGY FACILITIES SUPPORT PROGRAM, FACILITY STREAMS OVERVIEW

Part of the Climate Change Innovation and Technology Framework

FACILITIES STREAMS OVERVIEW

Cleaner Oil Sands Test Facility

THE OPPORTUNITY

GHG Impact: According to Alberta's Climate Leadership Progress Report, the oil sands sector was responsible for 24% of Alberta's GHG emissions in 2015. These represent important opportunities where innovative technologies can play a role in reducing GHG emissions.

Opportunities and Barriers to be Addressed: Alberta currently produces approximately 2.4 million barrels of bitumen per day, with 46 per cent from the extraction of bitumen from mined resources and 54 per cent from the in situ production of bitumen from deeper reservoirs. Going forward, the bulk of the undeveloped resource lies within in situ opportunities. The province aims to substantially improve environmental performance by reducing the water-use intensity and greenhouse gases (GHG) emissions intensity from the industry, while enhancing the value of our resources and providing economic prosperity for Albertans. Investments in innovative solutions that can address these challenges and be deployed commercially in Alberta are critical.

The status quo in Alberta's oil and gas industry cannot continue as demands increase for Alberta to be globally competitive on both the supply cost of bitumen and the carbon-intensity of production. Out of the 71 megatons of carbon dioxide emitted from the oil sands, 34 megatons come from the in situ recovery of bitumen, and the remaining emissions come from surface mining extraction and upgrading of bitumen. There is great innovation opportunity to reduce GHG emissions and ensure that Alberta is competitive on carbon by changing the way bitumen is recovered, extracted and processed in this province.

In addition to this, Alberta is facing a $10 billion provincial royalty gap due to the sustained low price of oil over the last few years. To be cost competitive, the supply cost of bitumen must be reduced. Gains have been made in production efficiency in the low-price environment, but to shift the cost structure of

production to generate economic value for the province with less dependence on the price environment, new technologies and innovation are needed.

New technologies for the recovery of in situ bitumen resources in Alberta are needed to aid in Alberta's transition to a low-carbon economy, and aim to:

- Improve Oil Sands Efficiency: Oil sands production efficiency and economics improve by decreasing fresh water use by 50 per cent, GHG emissions by 50 per cent on a per barrel basis, and supply cost of bitumen to be globally competitive;
- Reduce GHG Emissions: Support Alberta's climate change goals by accelerating solutions to reduce methane emissions by 45 per cent by 2025 and ensure a dynamic portfolio of GHG emission reduction technologies;
- Increase Value and Market Access: Support the successful commercialization of new value-added products to increase the market value of Alberta's oil and gas exports by 25 per cent and expanding access to market; and
- Restoring Alberta's Landscapes: Reduce landscape disturbance intensity by 20 per cent and accelerate reclamation of disturbed lands to promote native habitat and species recovery.

Technology/Infrastructure Opportunities*:* A testing facility where multiple new technologies can be deployed quickly in the field without disrupting operations at individual production sites may serve to accelerate the innovation required to move the needle on environmental performance.

To be effective and efficient, this facility must ensure access and knowledge dissemination across industry. A strong industry champion can provide the operational expertise, reservoir management, and ability to process, transport, and generate revenue from the production of bitumen that is needed for success.

Example facilities that may be proposed include (but are not limited to):

- A centralized or decentralized facility, with the ability to test 4-5 different technologies and/or processes (examples could include hot or cold solvents, solvent and steam processes, radio frequency heating, etc.);
- Water treatment technology testing facilities;
- Digital solutions development and testing facilities.

Coordinated support / Leveraged investment: It will be important to consider how the proposal aligns with, is complementary with, or potentially overlaps with other provincial programs under the CCITF and programs to reduce GHGs being developed/implemented by other stakeholders.

PRIMARY OUTCOMES

Reporting and performance measurement would include both technical and strategic objectives to meet the needs of Alberta and its Climate Leadership Plan goals. Metrics of results to be captured during programs executed at the facility include:

- $ invested in research infrastructure
- $ invested in innovations infrastructure
- % usage of research infrastructure by clients
- % usage of in innovation infrastructure by clients
- # of companies using infrastructure
- $ leveraged from Federal gov't, industry and others
- # of technologies and products tested, demonstrated, certified etc.
- # of highly qualified personnel trained
- # of potential reduced GHG emissions from projected deployments
- $ invested per MT potential GHG emissions and reductions
- # actual GHG emission reductions from new clean technology deployment

Emissions Reduction Test Facility

THE OPPORTUNITY

GHG Impact: Alberta's total GHG emissions in 2014 was 274 Mt including short-lived climate pollutants, methane, volatile organic carbons, black carbon, etc. Innovative technologies can play a role in reducing GHG emissions.

Opportunities and Barriers to be Addressed: The Climate Leadership Plan has set a target for a 45 per cent reduction in methane emissions by 2025 in Alberta. While many technologies currently exist for the detection, quantification, and reduction of methane emissions, a primary barrier to widespread utilization of continuous or semi-continuous methane measurement is cost[1]. Significant improvements in efficient and effective deployment are required to ensure that Alberta's oil and gas sector can meet the target in a cost-effective manner.

Methane emissions are a global problem contributing to large amounts of GHG emissions worldwide. Alberta has an opportunity to position itself as a leading jurisdiction for the development and demonstration of methane detection, quantification, and reduction technologies and strategies, and for broader short-lived climate pollutant (SLCP) emissions over time.

A dedicated testing facility in Alberta to demonstrate technologies that can detect, quantify, and reduce methane and other SLCP emissions would attract innovators to the province to develop their technologies here and ensure that they are suitable for Alberta's unique methane and other SLCP challenges. The centre will be linked to related program supports to ensure sound integration into the provincial and federal innovation systems.

Technology/Infrastructure Opportunities*:* A testing facility that enables advancement of emissions reduction and detection technologies by requiring technology developers to meet stringent performance metrics may accelerate the innovation needed to reduce emissions arising from methane and other SLCPs. Innovators focused on methane reduction have migrated to Alberta in recent years, and an emissions reduction testing facility would further strengthen Alberta's expertise in this area.

Some of the opportunities that an emissions reduction testing facility may enable include:

- the potential to use the testing facility for verification of new technologies (i.e. proving equivalent or better performance to current optical leak detection and repair methods);

- the opportunity for companies outside Alberta to set up local facilities and operations as well as the training of highly skilled personnel at the testing centre; and

- the opportunity for technology developers to work together to create collaborative solutions that meet technical performance requirements.

A made-in-Alberta solution could include advances in performance and cost effectiveness for detection and quantification technologies, but also drive forward technology demonstrations for the reduction of

[1] MONITOR Program Overview. https://arpa-e.energy.gov/sites/default/files/documents/files/MONITOR_ProgramOverview.pdf Accessed 21 August 2017.

methane and other SLCPs. The technologies would be proven at the test facility under controlled conditions that mimic a broad range of real natural gas facilities.

Example facilities that may be proposed include (but are not limited to):

- Full field scale testing, demonstration, and verification facility able to simulate various operating conditions for different scenarios and activities;
- R&D facility for scientific and engineering related investigations into early stage emissions reduction technologies;
- Facility for validation of technologies and methodologies.

Facilities may also contribute toward the training of highly qualified personnel, knowledge exchange, and policy related to cost and competitiveness.

Coordinated support / Leveraged investment: It will be important to consider how the proposal aligns with, is complementary with, or potentially overlaps with other provincial programs under the CCITF and programs to reduce GHGs being developed/implemented by other stakeholders.

PRIMARY OUTCOMES

Reporting and performance measurement would include both technical and strategic objectives to meet the needs of Alberta and its Climate Leadership Plan goals. Metrics of results to be captured during programs executed at the facility include:

- $ invested in research infrastructure
- $ invested in innovations infrastructure
- % usage of research infrastructure by clients
- % usage of in innovation infrastructure by clients
- # of companies using infrastructure
- $ leveraged from Federal gov't, industry and others
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- # of potential reduced GHG emissions from projected deployments
- $ invested per MT potential GHG emissions and reductions
- # actual GHG emission reductions from new clean technology deployment

Electricity Technology Test Centre

THE OPPORTUNITY

GHG Impact: According to Alberta's Climate Leadership Progress Report, the electricity generation sector was responsible for 17% of Alberta's GHG emissions in 2015. These represent important opportunities where innovative technologies can play a role in reducing GHG emissions.

Opportunities and Barriers to be Addressed: Conventional power generation relies on centralized generators to produce power on a large scale. As we shift to a low-carbon economy with renewable energy making up a larger share of the power generation, the centralized power generation system will transition to include a more distributed power generation system with renewable generation distributed along the entire system and electricity flowing in multiple directions. In Alberta, this transition is already underway; the Government of Alberta is updating the micro-generation regulations for a larger size limit and investigating community generation to allow for site aggregation, and has established the Renewable Electricity Program to bring in 5000 MW of renewable energy, with some distributed systems existing as well. The Government of Alberta is also establishing various solar generation programs for agricultural, municipal, commercial and residential sectors, and also investigating community-based generation. All of which will encourage more distributed power generation within the province.

The Institute of Electrical and Electronics Engineers (IEEE) Power and Energy Society and the Canadian Electricity Association have both identified over 130 discrete research topics that will be required to enable this transition. Currently, Alberta researchers and technology developers are starting to explore these topics to ensure this transition is done safely, reliability and hopefully, cost-effectively. In addition, research institutions are investigating the opportunities to develop distributed power centers for applied research of grid modernization technologies. Finally, Alberta Innovates, Alberta Energy and Alberta's Distribution Facility Owners (DFOs – ENMAX, EPCOR, ATCO, and FortisAlberta; Cities of Lethbridge, Red Deer and Medicine Hat and the Alberta Federation of Rural Electrification Associations) have developed a consortium to advance smart grid technology development and demonstration in Alberta and collaboration activities between the consortium, researchers and technology developers are underway to develop solutions to address the industry opportunities that are arising within the electricity sector. As grid modernization technologies are developed and moved towards commercialization, the need for testing and certification facilities is going to be necessary. There currently exists some infrastructure within Alberta to meet this need but gaps exist and the intent of this program is to fill in those gaps.

Technology/Infrastructure Opportunities*:* This program is seeking to support testing facilities that enable research in the design, operation, capability and impact of distributed generation and microgrids while also providing a development and commercialization platform for researchers, technology developers and utilities working to advance technologies applicable to grid modernization.

This program will support the enhancement of an existing facility or the development of a new facility that fills a gap in the existing research, development and commercialization infrastructure for accelerating the deployment of grid modernization technologies. Some of the existing infrastructure is listed below:

- University of Alberta - Power Group Research Lab, Real Time Simulation Facility, and Energy System Design Lab

- University of Calgary - Micro Machine, Controllable Grid Sources, Battery Test & Emulator, and Power Electronic & Motor Test
- NAIT - TechGym, Alternative Energy Technology Lab, and Sensors and Systems Integration Centre
- SAIT - TransAlta epiCentre, Green Building Technologies and Demonstration Centre, Solar Labs, and Centre for Research and Innovation in Unmanned Systems

In addition, there is some infrastructure/facilities that are currently under development:

- University of Alberta - Smart Grid Technologies Lab
- University of Calgary - Containerized Microgrid
- Red Deer College - Alternative Energy Lab
- Medicine Hat College - Community Renewable Energy Microgrid
- NAIT - Distributed Energy Management Lab

Some examples of the research, development and commercialization that could occur in an enhanced or new facility are (but are not limited to):

- Optimal microgrid control in isolated and grid connected systems
- Microgrid power quality and reliability
- Optimal control and operation of wind turbines
- New energy storage technology development
- New grid interfacing techniques and technology development
- Modeling the Alberta electrical system under the proposed changes for increased renewable energy, including transient power quality effects of rapid wind power pulsations
- Developing forecast models to predict the operation of new microgrids
- Modeling energy supply options for new sustainable communities
- Optimal dispatch of microgrids into larger grid (evaluation of related software and hardware technologies)
- Testing and certification of existing storage technologies
- Appraisal of Blockchain and other innovative transaction technologies
- Performance and optimization of various technology configurations (onsite storage, microgrids) in demand curtailment events
- Testing of novel metering and billing technologies
- Impact of various technologies on power quality
- Impact of various technologies on merit order/pool price

Coordinated support / Leveraged investment: It will be important to consider how the proposal aligns with, is complementary with, or potentially overlaps with other provincial programs under the CCITF and programs to reduce GHGs being developed/implemented by other stakeholders.

PRIMARY OUTCOMES

Reporting and performance measurement would include both technical and strategic objectives to meet the needs of Alberta and its Climate Leadership Plan goals. Metrics of results to be captured during programs executed at the facility include:

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- $ invested in innovations infrastructure
- % usage of research infrastructure by clients
- % usage of in innovation infrastructure by clients
- # of companies using infrastructure
- $ leveraged from Federal gov't, industry and others
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- # of highly qualified personnel trained
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- # actual GHG emission reductions from new clean technology deployment

Centre for Biomass, Waste and Natural Gas Conversion Technologies

THE OPPORTUNITY

GHG Impact: According to the Climate Leadership Progress Report by the Government of Alberta, agriculture, forestry, waste treatment, and natural gas sectors combined was responsible for 24% of total GHG emissions of the province in 2015. These represent important opportunities where innovative technologies can play a significant role in reducing GHG emissions.

Opportunities and Barriers to be addressed:

Alberta has the highest waste generation rate in Canada, at more than 1,000 kg per capita/year in 2012. Most of this waste is disposed in 124 landfills. As the waste decomposes, it releases unpleasant odour, methane, and causes other environmental issues. These wastes along with the waste generated by agriculture and forestry sectors are characterized by high proportion of organic materials and high heat value. Converting these wastes to produce value added products such as electricity, methanol and transportation fuels, chemicals and fertilizers, represents a great opportunity for reducing overall GHG emissions, moving Alberta toward a "Landfill Free" Province, and contribute to the diversification of our economy by fostering the development of an emerging waste utilization/conversion industry in Alberta.

In addition, Alberta has a large petroleum refining and petrochemical industry, with an abundance of oil and natural gas resources, distribution networks, an large-scale processing plants, The Industrial Heartland of Alberta, a 589 km^2 region, is home to the largest cluster of refining and petrochemical manufacturing facilities in Canada. Over the past decade, technological developments and resource discoveries has lead to an unprecedented increase of oil and gas production in the US. As a result, there has been a significant drop in the demand for Alberta natural gas by the US, our primary market. The industry is under pressure to diversify the market and to pursue new technological solutions. The vast natural gas deposits, the significant energy infrastructure, as well as the market pressure, provides a perfect opportunity and the incentive for the development of new methane processing technologies.

Sustainable petrochemical and bioenergy sectors in Alberta will have the potential of attracting $10 - 15 billion of capital investments and creating more than 3,000 high paying skilled jobs. This industry will need the help of our universities and technical institutes for R&D, and more importantly for training skilled workers to fill these jobs.

New technologies for the convertion of waste, biomass and natural gas into value-added products will help Alberta in the transition to a low-carbon economy. The goals of the center are:

- Energy Diversification: Support 2030 targets of the ARIF, including enhanced value-added processing for natural gas and supporting petrochemical and chemicals manufacturing;
- Reduce landfills: Support 2030 targets of the ARIF of "50 per cent reduction in organic-wastes-to-landfill, through innovative technologies that produce value-added products;
- Renewable power: Support utilization of biomass and waste feedstock for energy production. Alberta has sufficient biomass and waste feedstock to provide up to 5,000 MW of baseload renewable electricity;
- Bio-jet fuel production. Support development of a Bio-jet fuel industry. The aviation industry is interested in a Western hub for bio-jet fuels;
- Renewable fuel production: Support development of a bio fuel industry to meet a proposed federal government mandate that requires 5-10 per cent renewable natural gas (RNG) in natural gas pipelines.

Technology/Infrastructure Opportunities*:* A testing facility where multiple new technologies can be devloped, tested and deployed quickly in the field may serve to accelerate innovations required to move the needle on environmental performance.

To be effective and efficient, this facility must ensure access and knowledge dissemination across industry. For example, facilities that may be proposed include (but are not limited to):

- A centralized or decentralized facility, with the ability to test and enhance
  - 1-3 Biological conversion technologies,
  - 1-3 thermal and/or chemical conversion technologies,
  - 1-2 renewable natural gas production technologies;
- A biocrude up-grading test facility;
- A gas to liquid development and testing facility.

Coordinated support / Leveraged investment: It will be important to consider how the proposal aligns with, is complementary with, or potentially overlaps with other provincial programs under CCITF and programs for GHG reduction being developed/implemented by other stakeholders.

PRIMARY OUTCOMES

Reporting and performance measurements would include both technical and strategic objectives to meet the needs of Alberta and its Climate Leadership Plan goals. Metrics of results to be captured during programs execution at the facility include:

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Green Building Technology Test Centre

THE OPPORTUNITY

GHG Impact: According to Alberta's Climate Leadership Progress Report, Buildings and Homes were responsible for 7% of Alberta's GHG emissions in 2015[2]. Close to half (46.5 per cent) of emissions from the cities of Calgary and Edmonton can be attributed to buildings[3]. The sector therefore represents an important opportunity where innovative technologies can play a role in reducing GHG emissions in Alberta. Furthermore, there is potential to increase the efficiency of Alberta companies and reduce the environmental impact of the buildings they produce, creating an interesting opportunity for Alberta to export innovative solutions that reduce GHGs both at home and in other jurisdictions, while creating local economic benefits in Alberta.

Opportunities and Barriers to be Addressed:

Despite a very mature and diverse construction sector in the province, the various players still struggle to maximize efficiency and incorporate green innovations into their processes and buildings. Some of the main causes of this lack of efficiency are:

1. Aversion to incorporating innovative green building products and building materials due to real and perceived risks;
2. Slow technology adoption (e.g. advanced sensors, augmented reality, automated construction and prefabrication, building information modeling, integrated project delivery (IPD), materials tracking technologies, etc.);
3. Poor coordination, information gathering, and sharing among the various stakeholders (designers, engineering, contractors, and trades); and
4. Lack of customized skills training to improve productivity (construction management, operations, safety, specification skills, adoption of new technologies, etc.).

Inefficiencies can result in costly rework, suboptimal construction, and waste of materials – all of which increase the GHG footprint of buildings during both construction and operations.

Some of the root causes of inefficiency according to the Construction Owners Association of Alberta include[4]:

- Engineering and reviews (such as late design and poor document control);
- Construction planning and scheduling (e.g. late owner input, unrealistic schedules);
- Leadership and communications (e.g. poor communication, lack of safety);
- Material and equipment supply issues (such as untimely deliveries or non-compliance with specification); and

[2] https://open.alberta.ca/dataset/854af86e-309a-4727-90f9-6bba947dc66e/resource/989797fb-b890-4f52-9e91-43938fff566f/download/clp-progress-report-2016-17.pdf p 9

[3] City of Edmonton and City of Calgary data

[4] http://www.jwnenergy.com/article/2017/6/here-what-causes-construction-project-rework-and-tool-help-you-fix-it/

- Human resource capability (e.g. insufficient skill levels, excessive overtime).

The Green Building Technology Test Centre(s) will provide tools that are required to overcome some of these challenges by, for example:

- Reducing risk associated with incorportating new green building products and materials into building designs;
- Supporting the utilization of cutting edge efficiency tools such as augmented reality, building integrated management software, automated prefabrication, etc;
- Support the growth of innovative philosophies and practices in the construction sector (Integrated project delivery, novel profit sharing contracts, etc);
- Training of existing staff as well as those looking to enter the industry on best practices for low-GHG-impact design, construction, and process integration;

***Technology/Infrastructure Opportunities**:*

Example facilities that may be proposed include (but are not limited to):

- Green building product development and certification facilities;
- Test centre for showcasing, demonstrating, and testing novel materials and products;
- Centre for construction collaboration (e.g. integrated project delivery, novel profit sharing contracts, interdisciplinary communications, etc);
- Centre for digital construction – simulation, visualization, product lifecycle management, big data processing, contract management, building information modeling, and integration of information technology systems;
- Automated facility management – predictive maintenance, use of sensors for data collection, maintenance alerts and scheduling; and
- Specialized skilled training – customized training programs in construction management, product development, skilled trades, and interdisciplinary communications.

Any centre application needs to:

- Clearly identify which specific gaps are being filled
- Explain how the centre will involve industry
- Explain how/if the centre will involve students
- Identify how the centre will be financially sustainable in the future without government funding.

Coordinated support / Leveraged investment: It will be important to consider how the proposal aligns with, is complementary to, or potentially overlaps with other provincial programs under the CCITF and programs to reduce GHGs being developed/implemented by other stakeholders.

PRIMARY OUTCOMES

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