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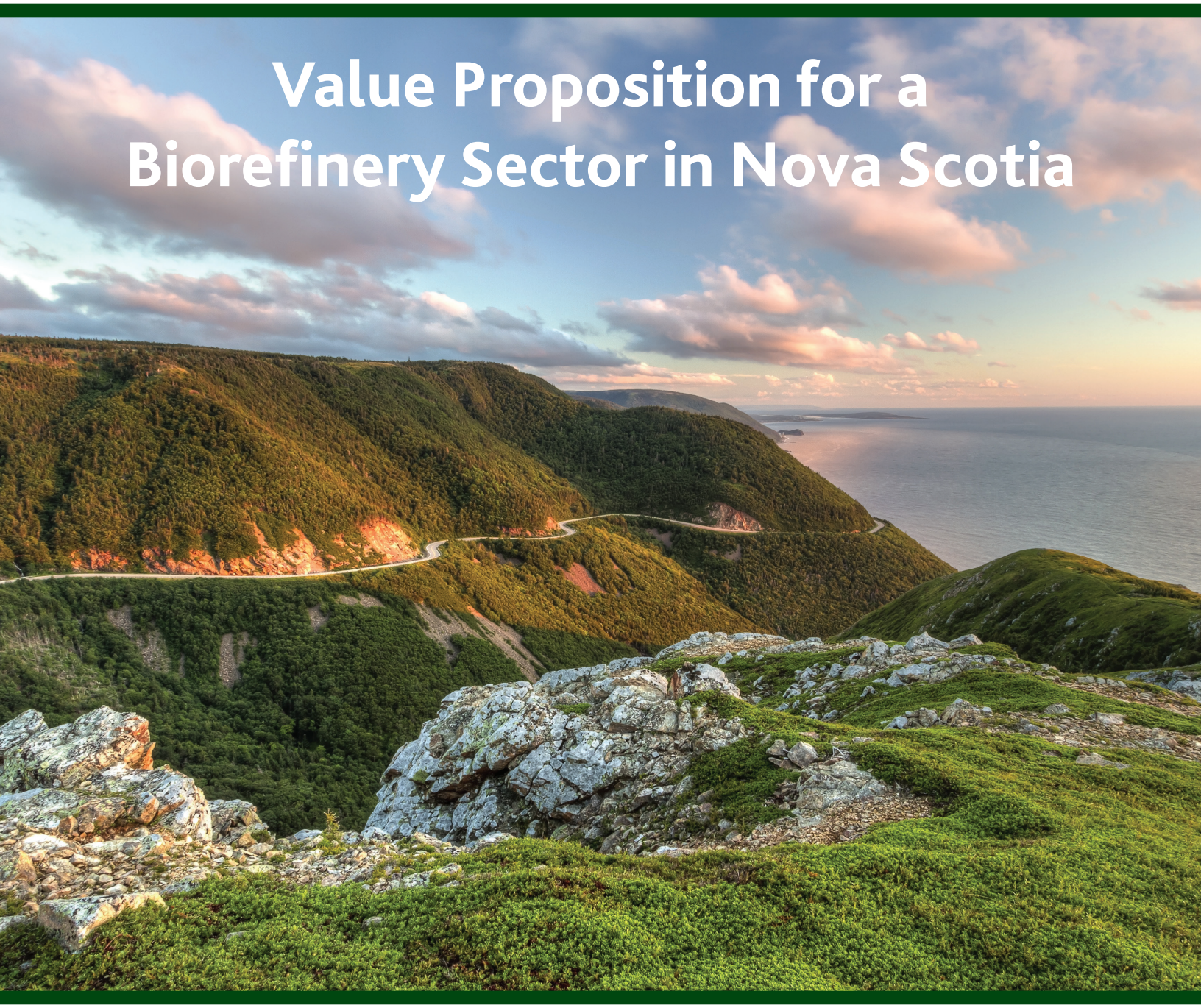
Value Proposition for a Biorefinery Sector in Nova Scotia



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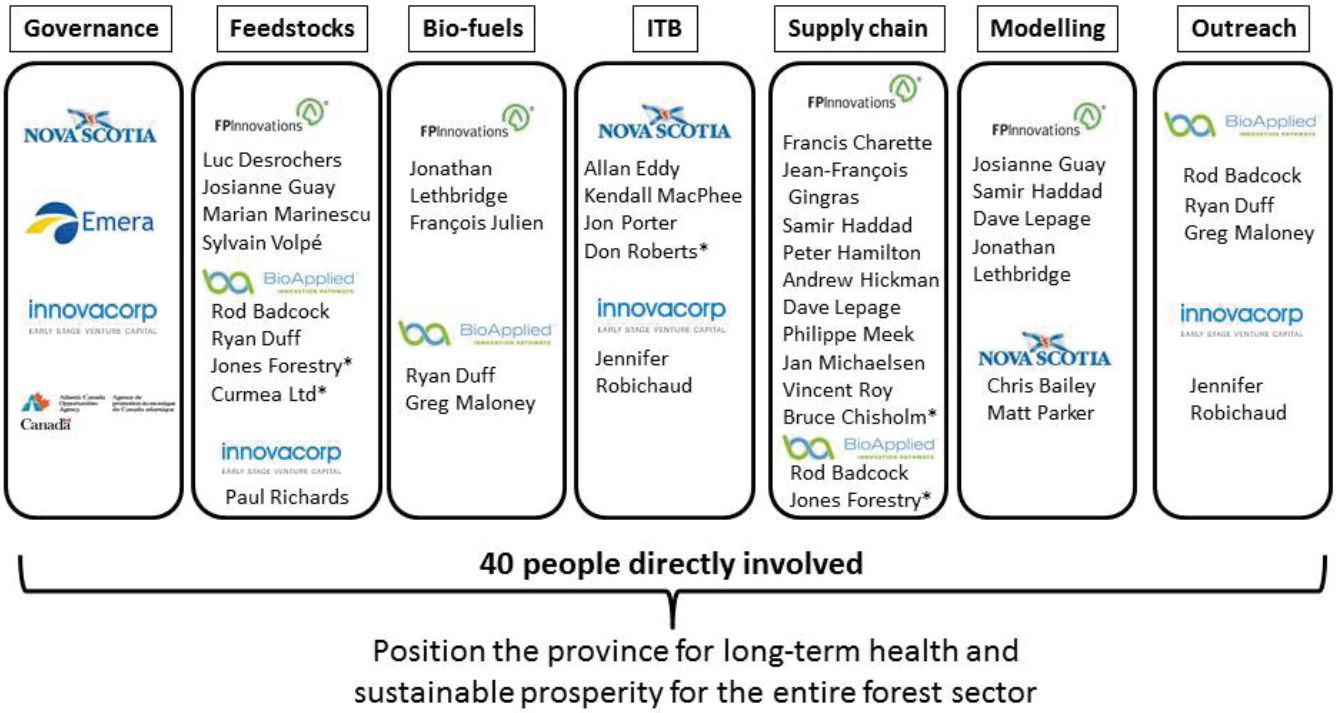
The emerging global bio-economy presents an opportunity for Nova Scotia's renewable bio-resource sector (forest, agricultural, ocean, and municipal solid waste). Nova Scotia is well positioned to lead in providing low-carbon solutions that will also enhance economic prosperity within the province. Across Canada, forest industries have entered an unprecedented period of structural change. Within Nova Scotia, the right actions must be taken to nurture and support a successful and suitable transformation. Doing so, in concert with the entire bio-resource spectrum, will assure maximum value for all sectors. The creation of an Innovation Hub (iHub) is a first and critical step towards this outcome.

The iHub will foster strong collaboration among all stakeholders. It will determine the primary actions required to establish a compelling value proposition to attract and support an industrial cluster of bio-based processing and manufacturing industries, including a liquid fuel biorefinery.

Initially, five key areas have been considered of primary importance: feedstocks, supply chains, technology, markets, and funding. An initial undertaking was implemented to fully analyze and understand these categories, built around seven projects: Feedstocks, Bio-based Fuels, Industrial and Technological Benefits, Supply Chain, Dynamic Modelling, Operations and Outreach, and Governance.

A brief description of the main findings for each of these parts follows.

7 paths leading to a single objective



*Consultants hired for the purpose of the project

FEEDSTOCKS

A primary goal of the Feedstocks project was to determine the volumes of forest, agricultural (short-rotation energy crops), and municipal solid waste feedstocks potentially available for a biorefinery in Nova Scotia. Based on existing local assets and other strategic factors, seven potential sites for establishing a biorefinery were identified across the province. It was then estimated what volumes of each feedstock would be available within 50, 100, 150, and 200 km of each site.

Based on biorefinery projects from other jurisdictions, it is believed there are sufficient feedstocks available from the forestry, agriculture, and municipal solid waste sectors to attract an investment in a biorefinery for a number of the seven sites in Nova Scotia. For example, an Ensyn plant in Quebec is expected to use 65 000 oven-dried tonnes (odt) of forest origin/sawmill by-product feedstock when construction is completed in 2017, producing 37 million litres of biocrude. Each of the seven sites analyzed across Nova Scotia would have more than sufficient volumes of feedstock available to supply this plant and similar commercial biorefineries.

Current and future prospects of supporting a biorefinery investment will be impacted by provincial policy planning and developments in the private sector. For example, there are 510 000 odt per year of harvest residues that could be sustainably recovered if forest management policy would allow for it, and if proper contractor infrastructure was in place. Volumes would also increase if sawmills produce at full capacity, full-tree harvesting is permitted, available agricultural land is put to use for short-rotation energy crops, and sorting and treating of municipal solid waste are improved.

An additional goal of the Feedstocks project was to benchmark the Nova Scotia biomass sector against other jurisdictions. This revealed that delivered roundwood costs in Nova Scotia are similar to adjacent jurisdictions, varying with supply and demand conditions, but no competitive advantage is evident. Low-grade roundwood typically sells on the pulpwood market for just over $100/odt, and can range between $97 and $125 per odt, while fuelwood used to supply biomass facilities sells for between $70 and 100 per odt. Mill by-products such as wood chips can be purchased for between $90 and $125 per odt.

SUPPLY CHAIN

In order to increase demand for bio-based fibres in Nova Scotia, improvements to the efficiency of the fibre supply chain will be required. This may be accomplished by providing a road map for contractors, industry, and government to integrate innovation, technology, efficiency, and best practices in the forest fibre supply chain. It is with this road map in mind that the Supply Chain project was undertaken, looking at trucking infrastructure, training initiatives for contractors and equipment operators, and opportunities to improve the operational planning processes for contractors.

Trucking infrastructure

One of the largest factors in determining the efficiency of the supply chain is transportation costs, and a major driver of transportation costs is provincial regulations for load weights and dimensions. Most of these fall under the responsibilities of the Nova Scotia Department of Transportation and Infrastructure Renewal, and several recommendations were drafted for that department as part of this study. For example, although Nova Scotia's Allowable Gross Vehicle Weights (AGVWs) are generally competitive with other provinces, regulations limit the use of higher AGVWs on certain road classifications. Many common transportation routes are restricted to load weights of 41 500 kg or less, when loads up to 49 500 kg could be allowed with a different classification. This leads to transportation costs that are 40% to 119% higher, depending on the configuration of the truck.

Another primary factor affecting transportation is the aging population of qualified professional logging truck drivers, as 58% are over the age of 50 and only 7% are under 30. Thus, there is a need to recruit new entrants and to promote the adoption of new trucking technology to avoid a severe labour shortage in the coming years.

Contractor road map

Nova Scotia's harvesting contractors have an excellent work ethic, good relationships with stakeholders (industry, landowners, Department of Natural Resources, etc.), and are able to leverage previously used equipment to reduce capital costs. However, they are relatively small-scale by Canadian standards and, therefore, lack the economies of scale seen in other regions. To help improve the competitiveness of Nova Scotia contractors, the Supply Chain project team compiled 12 recommendations that cover areas such as business skills and financial management, tax credits, incentives for woodlot owners, sector image, use of technology, and equipment knowledge.

Implementation of training initiatives was executed through High Performance Logging (HPL) - an initiative established as a partnership between the Canadian Woodlands Forum and BioApplied Innovation Pathways. HPL delivers programs such as the Contractor Operations Efficiency Program (COEP) and Forestry Machine Operator Training Program (MOT), which aim to improve operational performance and business viability.

COEP supports logging businesses by engaging them in the use of productivity information captured from on-board computers (such as FPDats), as well as tailoring specific action plans to their unique business needs. The pilot stage of COEP has been completed, and contractors making best use of the data have shown substantial productivity gains.

The goal of the MOT program is to attract new equipment operators to the forestry industry and provide them with advanced skills training, helping to boost overall efficiency and capacity of the fibre supply chain. The program consists of three phases: employer engagement, student recruitment, and training delivery. Potential employers were engaged prior to the start of the program, and they were asked to commit to hiring successful graduates. Nine employers agreed to participate, and each was given the opportunity to interview applicants prior to their acceptance into the program. Program applicants were also closely screened using advanced equipment simulators and personality assessments. Ultimately, ten students were admitted to the program with a commitment for employment upon graduation. At the time of writing, the third and final phase (training delivery) is expected to finish early in 2017.

Key to the success of MOT is the level of sector collaboration. Many organizations have worked together to deliver the program, including New Brunswick Community College,

the Canadian Woodlands Forum, the Nova Scotia Department of Labour and Advanced Education, and Northern Pulp. Upon completion, ten new jobs with earning potential upwards of $50,000/year will be created, and supply chain capacity will have increased by as much as 250,000 green metric tonnes of wood fibre per year (about 5% of the provincial sustainable harvest level).

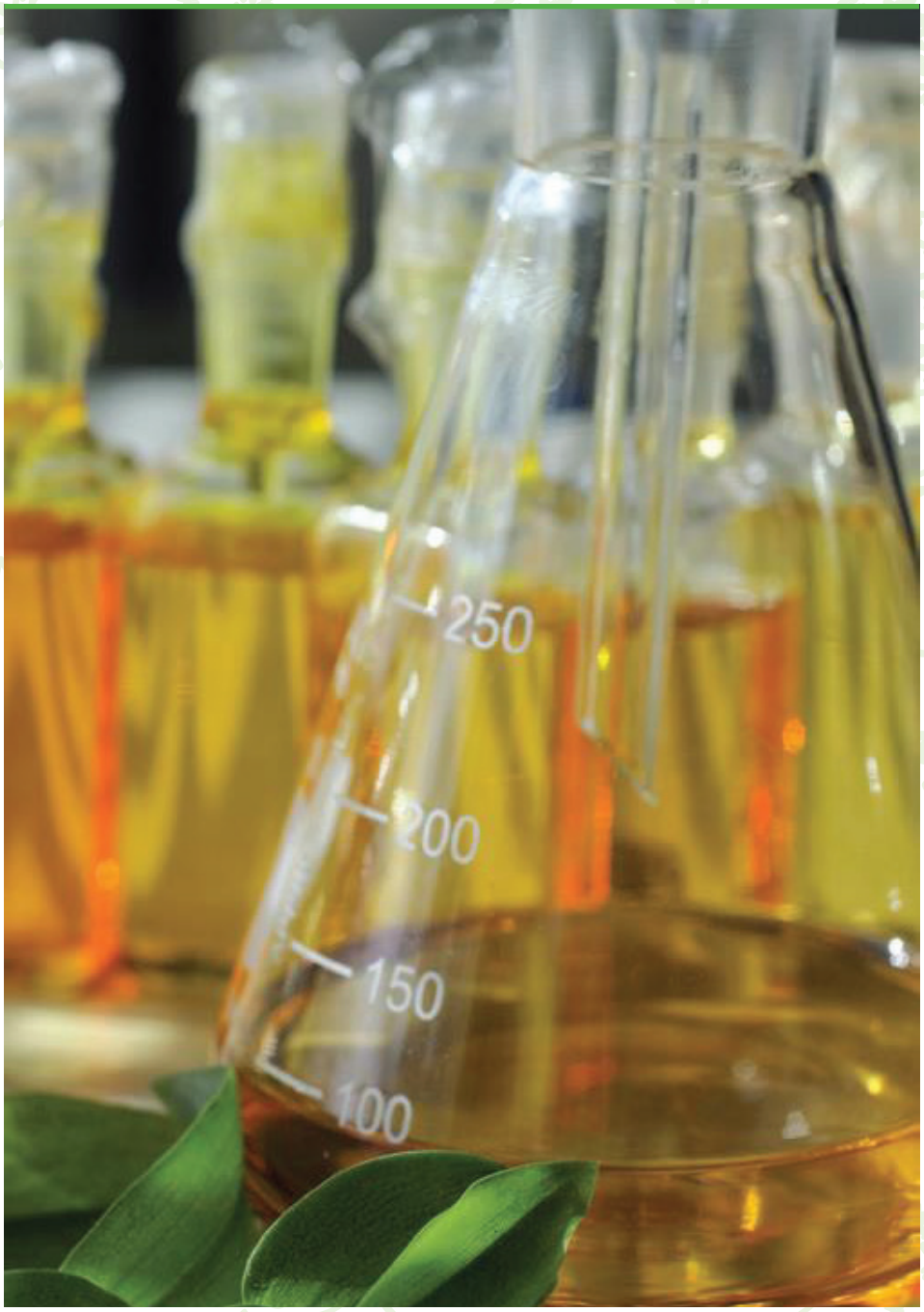
Operational planning

Operational planning processes can have a significant impact on harvest costs and operational efficiencies, especially when dealing with small and dispersed cutblocks such as those common across Nova Scotia. Nova Scotia's planning systems are well-adapted to its specific context, which includes a high proportion of private land relative to other provinces. Opportunities for improvement identified through this project include centralizing planning information, standardizing the planning process on Crown land, using operational key performance indicators (KPI) during the planning process, sharing the pre-treatment assessments, increasing lead time, having better accuracy of the forest inventory data, and reducing dispersion of cutblocks.

DYNAMIC MODELLING

The goal of the Dynamic Modelling project was to build a linear programming model capable of performing a comprehensive analysis of the forest products supply chain in Nova Scotia. The modelling team leveraged data from the Nova Scotia Department of Natural Resources, as well as other iHub projects in order to generate an accurate digital depiction of the province's forest products supply chain.

The model was designed and built to optimize (maximize) the difference between the aggregate value of all final products produced and the aggregate supply/transformation costs. The data supporting the model describe three basic aspects of the industry: the resource supply (forest), the manufacturing demand (mills), and the infrastructure linking them (harvesting and transportation).



To run the model, three scenarios were developed: the baseline scenario, representing the actual wood flow across the province; alternative scenario 1, illustrating a hypothetical situation based on the assumption that softwood sawmill capacity in the province is consolidated; and alternative scenario 2, illustrating the situation in which a large biorefinery is added to the current mill network.

Ultimately, the Dynamic Modelling project team was successful in incorporating province-wide forest product supply chain data into a single optimization model. In the baseline scenario, the model calculated that Nova Scotia generated an average value of $80.59/m^3 from the primary wood processing industry. In the first alternative scenario, the model estimated that a consolidated sawmilling industry would reduce transportation distances significantly and would help improve the industry's cost structure. The second alternative

scenario, involving the introduction of a biorefinery, generated an improvement in fibre utilization with minimal impacts on the costs of feedstock.

SUBSTITUTION OF BIO-BASED PRODUCTS IN HEATING OIL AND MARINE DIESEL APPLICATIONS

The primary goals of the Bio-based Fuels project were to determine the level of marine and heating fuel demand in Nova Scotia, and assess the existing supply chain for opportunities to introduce a new liquid biofuel (biodiesel) for those applications. The project team conducted extensive primary and secondary research, including consultations with almost 40 local players in the petroleum fuels supply chain, to provide the iHub with an overview of existing demand and potential markets in which to substitute petroleum products with bio-based fuels.

The report's quantitative analysis reveals that roughly 4 billion litres of petroleum fuel is consumed in Nova Scotia annually, 720 million litres of which is in the marine and heating fuel markets. Therefore, if Nova Scotia were to introduce a 2% mandate for biodiesel, the resulting demand would be equal to 14.1 million litres. At a 5% mandate, demand for biodiesel climbs to 34.3 million litres. Roughly 85% of this demand is attributable to the heating fuel market.

These volumes compare favourably with the output of existing and proposed biorefineries, such as CelluFuel's proposed 17 million litre commercial biodiesel plant and Ensyn's 37 million litre biocrude plant in Quebec. The result would be the de-risking of a significant portion of a commercial biorefinery's output, while allowing the proponent to explore high-value export opportunities.

An extensive qualitative analysis was also performed that led to a number of conclusions. In particular, the report emphasizes the importance of policy (biodiesel mandates, air emission regulations, and procurement), prices (the relative costs of competing fuels), technology (the potential for drop-in fuels), and local market opportunities (the potential for off-take agreements from local distributors and end-users). A summary of the main players in the marine and heating fuel supply chain in Nova Scotia is included as well, including a range of end-users, service providers, distributors, stakeholders, and various departments and agencies related to procurement and regulatory areas.

INDUSTRIAL AND TECHNOLOGICAL BENEFITS

The Industrial and Technological Benefits Program, a component of Canada's Defence Procurement Strategy, is an investment attraction tool that ensures that purchases for defence equipment and services result in economic growth for Canada. Members of the iHub project team have begun researching the program to better understand how it could be used to improve Nova Scotia's value proposition to the biorefinery sector, particularly as it relates to marine biofuels.

OPERATIONS AND OUTREACH

The Operations and Outreach project focused on a number of key activities, with the primary goal of ensuring the future success of the iHub. These activities included development of a strategic plan, stakeholder engagement, networking and education, and establishing a centre of operations.

A strategic plan was identified as a critical component in refining the overall objectives for the iHub. As such, Dr. Mark Raymond from the Sobey School of Business at Saint Mary's University was engaged to lead the development of the strategic plan. The Innovation Hub Governance Committee was heavily involved in the development process, and the completed plan was approved by the Innovation Hub Board on May 3, 2016.

With respect to stakeholder engagement, FPInnovations and BioApplied collectively made contact with over 170 stakeholders from industry, research, private landowners, and government and non-government organizations. These connections helped provide key intelligence and initiated stakeholder relationships spanning a number of the iHub's key strategic focus areas.

To provide a base of operations and a central gathering point, the iHub established an office at Innovacorp's Technology Innovation Centre (TIC) in Dartmouth, Nova Scotia in September, 2015. The TIC houses a number of early stage companies, and has excellent resources to support these resident firms that iHub operations are able to leverage.

GOVERNANCE

The Governance project built a crucial foundation that contributes to the success of every other project, as it led to a Board of Directors and assigned project managers responsible for the outcome of the iHub. The governance structure provides a mechanism for alignment among the stakeholders and other partners, as well as timely reporting for the other six projects that were developed.

CONCLUSION

Nova Scotia's iHub was created with the goal of attracting proponents interested in constructing a biorefinery in the province, jump-starting the local bio-resource sector. Seven projects were undertaken in the first year of the iHub to assess Nova Scotia's current value proposition to potential proponents, and to identify strategies to improve competitiveness. Together, the projects demonstrated that there is a foundation upon which to build and grow Nova Scotia's bio-resource sector, and there are specific actions that can be taken to execute that opportunity.

Under the Feedstocks project, it was shown that there are sufficient feedstocks available from a range of sources to supply a commercial scale biorefinery, and that much of this feedstock is available at a price comparable to neighbouring jurisdictions. While this does not currently provide Nova Scotia with a competitive advantage, actions identified in the Supply Chain and Dynamic Modelling projects would improve the efficiency of the supply chain and reduce the delivered cost of feedstocks. The Substitution of Bio-based Products in Heating Oil and Marine Diesel Applications (Bio-based Fuels) project assessed the size of the local market for petroleum fuels, and profiled the supply chain through which they are brought to market. With approximately 720 million litres of heating oil and marine fuel consumption annually in Nova Scotia, local demand for 14.1 million litres of biodiesel would be generated if a provincial 2% biodiesel mandate were introduced. This modest mandate would de-risk a significant portion of the output of existing and proposed biodiesel refineries, while allowing the proponent to explore high-value export opportunities. Through this analysis, it is clear that provincial policy plays a critical role in the success of the bio-resource sector.

Nova Scotia's forestry and other renewable resources stand at a critical point in their development. They are under-utilized, providing the opportunity to produce low-carbon solutions for fuels and other bioproducts for local and international markets, enhancing economic prosperity within the province.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