

Economic Diversification through Bio-Industrial Innovation in Alberta

***DRAFT* Strategy**



Backgrounder to

“Innovation Thought Leaders Forum”

February 7th, 8th and 9th 2012

Calgary, Alberta

Context for this Initiative

Alberta, similar to many jurisdictions, is focused on identifying and securing near and long-term economic and sustainable prosperity. Economic diversification enhances economic resilience, ensures balanced and sustained growth, maintains the well-being of communities and provides diverse employment opportunities to retain the skills and talents of all Albertans. A blue ribbon panel, the Premier's Council for Economic Strategy¹, recently noted that Alberta must broaden its economic base to effectively set itself up for long-term prosperity.

Alberta's large renewable biomass resources, supporting a resilient forestry and agricultural commodity-based sector, represent a potentially significant opportunity to further diversify its economy. Alberta Innovates, the Government of Alberta's research and innovation arm, has been working with key stakeholders and performing research and analysis to test this assertion and ultimately develop strategy for advancing Alberta's bio-economy, in particular the bio-industrial sector.²

Alberta has invested almost \$300 million since 2006 to support bio-industrial initiatives. Five years later, the time is right to engage a range of thought leaders and experts to assess where Alberta is at and gather input on how the province might best diversify its economy through bio-industrial opportunities.

This report is intended to inform development of the final strategy; stimulate discussions around the drivers, issues and opportunities; and test or validate the merits of the strategic approaches that have been developed. With your input, we can define a clear path forward resulting from the February 7/8/9th Innovation Thought Leaders Forum in Calgary, Alberta.

Current State of Alberta's Renewable Biomass Resources and Industry

Alberta is Canada's second-largest agricultural producer, leading the nation in cattle inventories and producing over a third of Canada's major field crops. With over 200 facilities in operation, Alberta's forest industry manufactures lumber, pulp, newsprint, panel board and other products. The province's renewable biomass resources include 64 million tonnes (megatonnes, MT) from agriculture sources, ~2 MT of under-utilized forest biomass and roadside residue, 4 MT from municipal waste and 78,000 MT of slowly renewable peat. The agriculture and forest industries, including food manufacturing and manufactured wood products, contribute \$7 billion to the province's economy, or just under 4% of the total GDP. This includes both primary and value-added production in both sectors.

In contrast to the established agricultural and forest industries, the current contribution of the newly-developing areas of biomaterials, biochemicals and bio-energy to the Alberta economy are

¹ Premier's Council for Economic Strategy, *Shaping Alberta's Future*, May 2011.
<http://alberta.ca/premierscouncileconomicstrategy.cfm>

² See Appendix A for an illustration the Alberta Innovates corporations relevant to the bio-economy and how it sits within Alberta's innovation model.

relatively small. There are about 50 companies working in biomaterials, 7 in biochemicals, and 14 in bio-energy. Bio-energy generates the greatest value annually at \$230 million.

Inputs to the Initiative

The original purpose of this initiative was to develop a strategy to take advantage of Alberta's bio-industrial opportunities in order to enhance the competitiveness of Alberta's resource sector (forestry, agriculture, waste, energy):

“A Ten Year Strategy (focused on a twenty year horizon) for Advancing Alberta's Bioeconomy, with a focus on the bio-industrial sector”

The strategy is intended to target and direct future investment and alignment of resources (by refocusing, redirecting, and attracting investment) to those *bio-industrial* areas with the most potential return on investment for Albertans.

The initiative was informed through a number of different mechanisms:

- I. Evidence Based Analysis: Jurisdictional Advantage Assessment
- II. Research: Current State Assessment of Alberta's Bio Industrial Sector, Activity, and the Innovation System.
- III. Consultation: Retrospective Analysis
 - a. Engagement, Dialogue and Interviews with Industry/ Academic/ Municipal
 - b. Industry Roundtable
- IV. Expert Advice: International Thought Leaders Forum – February 7th, 8th and 9th, 2012

The first three of these four mechanisms are complete, with the following summarizing the key observations and findings from these.

I. Alberta's Jurisdictional Advantage Assessment

Introducing Jurisdictional Advantage assessment

Jurisdictional Advantage assessment is a conservative approach to investment options analysis. It is an evidence-based process that identifies the unique strengths, weaknesses and opportunities that define the province's sustainable advantages.

The principle idea behind the analysis is to find core engines in the economy (those areas that drive growth and sustain the province over the long term) that can incubate diversification opportunities. Diversity within the core will spill out and create a future for Alberta beyond that core engine. By focusing on the core, resulting strategies minimize risk, stack odds of success and puts emphasis on strengths rather than fliers.

Analysis included three steps. First, one-on-one interviews with 121 companies, at the executive level, guides and focuses the economic analysis. Second, economic analysis of 25 indicators provides quantitative reference for the interview results. Finally, a global scan of similar jurisdictions and successful bio-industrial companies provides examples and case studies.

The economic analysis covered five elements of Jurisdictional Advantage assessment:

1. **Natural Environment:** the natural resources, geographical location, and environmental conditions that support strategic resource positions a set of industries leverage to sustain market entry.
2. **Capabilities:** the unique technologies, skills, and abilities that drive productivity and create a favorable jurisdiction for some set of industries.
3. **Supporting Institutions:** the governments, educational elements, economic development entities, associations and non-profit organizations that enable collective action through the facilitation of productive combinations of intellectual and human capital and organizational capabilities within a set of industries.
4. **Constructed Environment:** includes the infrastructure, regulations, political climate and historical inertia that integrate regional assets required for growing a set of industries while still enabling transitions to new areas of market growth.
5. **Industrial Ecosystems:** are the set of industries (including resource providers, competitors, complementary organizations, administrative structures, political dynamics, markets, and culture) that attracts customers, supply chain capabilities, and management quality and enable a broad innovation environment.

Overview of Alberta's Economy

The economic engine of Alberta is oil and gas. Nineteen percent of provincial GDP (including oil and gas services) was generated by the sector in 2010. Only finance, insurance and real estate (17 percent) came close to matching its strength. The next highest contributors were construction and manufacturing (each at eight percent).

While agriculture and forestry are politically and socially important sectors, they are not core engines of the economy. Combined: agriculture, forestry, food manufacturing and wood products manufacturing totaled four percent (\$7.2 billion) of GDP.

By investing in its core strength while incubating opportunities that spill out into the rest of the economy, the province can create sustainable diversity.

Bio-industrials in Alberta

Alberta's best is, without question, in its oil and gas plays. Opportunity exists in the environmental issues those industries create, in the inefficiencies within current processes, in the abandoned well sites and unproduced resources that remain in the ground, in operations of the manufacturers that feed the industry and the chemical producers that buy from and sell to the sector, and in the waste that "big energy" in Alberta produces and in the energy that the sector demands.

Three general principles define the market for bio-industrials in the province:

1. What matters most is how bio-industrials make other industrial products better.
2. Returns are inside solved problems, not on front-end premiums.
3. Price matters, but not as much as implementation.

Successful companies in Alberta within the bio-industrial sector provide reclamation services, clean up wastewater, design biopolymers to fix tailings ponds, gasify polluted wastestreams, and guide ecological services.

The interviews for this project and an additional 232 interviews for other projects reveal key insights for developing bio-industrial opportunities in Alberta:

- It is better to help change how oil and gas is produced than attempt an alternative to the product itself.
- Competing with oil and gas also ignores what productive, successful, and advisable diversification would really mean.
- Instead of diversifying outside the core of Alberta's strengths it is less risky, less costly and far more likely of success if the province would diversify within and through its core engines.

Alberta's industrial ecosystem and bio-industrial value chains"³

A sophisticated industrial ecosystem has both firm-level and system-level components. The assessment revealed that Alberta has bio-industrial firms in development, production, and (though limited) marketing. At the system level there are researchers, an insufficient and small group of input suppliers, and a thin layer of service providers. Of the bio-industrial firms in the province, few have a deep pool of end-users and most have no real network to manage supply risk or waste management, and operate in isolation and alone in the broader business environment.

The industrial ecosystem that supports the bio-economy in Alberta is patchy. The value chains are strong in a few places and weak in many others. Ultimately:

- There is nothing in bio-industrials that mirrors, even vaguely, the thriving industrial ecosystem in oil and gas.
- A bio-industrial ecosystem does not exist. What is in place is a scattered collage of technology developers, prototype and pilot-scale manufacturers, disconnected supporting institutions, and fragmented end-markets.

³ *Industrial ecosystems* are defined as a complex mix of resource providers, competitors, complementary organizations, administrative structures, political dynamics, markets and culture. These systems are important because they attract customers, supply chain capabilities, and strong management, and enable a broad environment of innovation. *Value chains* include the basic chain of development, production and marketing as well as the researchers, input supplies, support markets (that provide technical, business and financial services for the industry) and the business environment in which the industry operates.

No evidence was found of the high-volume, high-premium bio-industrial options that advocates long to discover. High returns and booming companies were identified, but not enough to save whole sectors. Specialized opportunities do exist, but these will go to a special few. Bio-industrials as they stand are deemed to continue as a mass of niches.

In the far future bio-industrials might be the cure for chronically thin margins in agriculture and forestry. But that is not what exists today. As per the Jurisdictional Advantage Assessment, it appears that Alberta's top five options to diversify bio-industrials are:

- i. *Feedstock logistics.*
- ii. *CO₂, GHG reduction, sequestration and offsets.*
- iii. *Clean coal with biomass: coal beneficiation, pyrolysis, torrefaction, co-firing.*
- iv. *Biopolymers and green fluids.*
- v. *Land remediation and abandonment services (tracking biodiversity, bioremediation and bioreplenishment, spill recovery, replanting of native species, abandonment services).*

Special themes in analysis, interviews and the synthesis include:

- Mid-size companies and EPCs (Engineering, Procurement and Construction companies) must lead new bio-industrial options. Focusing on start-ups and new technology development is not enough. Mainly mid-size companies have the credibility, mobility, and stability needed to bring bio-industrials into oil and gas, power, chemicals and other sub-sectors of manufacturing.
- Target manufacturing to produce products and services for oil and gas, power, and chemicals.
- Solving problems is all that matters; alternatives do not. Bio-industrials in Alberta should solve problems rather than producing alternatives. Drop-in substitutes sound nice but only matter if there is a problem with whatever they replace. The challenge, when substituting bio-industrials for petrochemicals, is that petrochemicals are cheap, abundant, ubiquitous and work well. Better to start with jobs that petrochemicals cannot do well than go head-to-head, especially at \$3/GJ natural gas prices.
- Market intelligence is the responsibility of the supplier, not the buyer.
- The wall around process options is very high. All companies / all sectors are open to environmental wins and waste management options.
- Standards, quality, and stability are prerequisites to engage. All of the fastest-growing small companies built their certification, health and safety, and quality assurance programs early. All of the most aggressively interested large companies complained that the best options they see are wasted because they do not meet prerequisites. Upgrading bio-industrial companies to meet prerequisites is a vital step in maturing Alberta's capacity in this space.
- Every big bio-industrial play will eventually require performance guarantees.

Conclusions of the jurisdictional advantage assessment as they relate to bio-industrial opportunities through Alberta's oil and gas sector are:

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- Oil and gas and associated manufacturing offer rich industrial ecosystems, strong market opportunities and broad global applications. Ignoring this market seems to be the consequence of a too narrowly defined notion of diversification.
 - Certainly diversification includes developing opportunities outside the core engine of the economy. But it also includes, and should place heavy emphasis on, the opportunity to diversify in and through the core engine.
 - Opportunities that exist in advanced materials, environmental services, waste management, biochemicals (some longer term than others), and benefaction and are incubated in oil and gas will spill out into other areas of the economy and global markets. This is valid diversification and mitigates risks while stacking on advantages.
 - Diversification through the core is a thoroughly viable development strategy. It benefits and builds from the established, vibrant industrial ecosystems in the province. It is an important, initial step in creating a tangible bio-economy in Alberta.

II. Current State Assessment – Research

The Alberta Government has been focused on advancing its bio-economy and bio-industrial sector for the past two decades. It has over the past five years invested \$300 million in a number of activities ranging from research to capital projects. \$166 million has been invested in Alberta research and development (R&D), and R&D infrastructure investment is about \$85 million. A “Current State Assessment” was completed by staff within the Alberta Innovates System to better understand the state of Alberta’s bio-industrial sector and achieve a sense of the results of the investments to date.

The Current State Assessment provides detail on Alberta’s innovation system, identifying the key agencies, departments, institutions, and individuals involved in supporting bio-industrial investment, research, and commercialization activities in the province. Appendix A provides an overview of the bio-industrial commercialization support providers involved.

The level and type of activity in the areas of biomaterials, biochemical, bio-energy, and biofuels are also discussed in the Current State Assessment, and summarized here.

Biomaterials

Alberta sees itself as becoming a dominant player in biomaterials development and commercialization. Areas of expertise include lignocellulosic feedstock development, pulp and paper, biocomposites, green building products, textiles (woven/nonwoven), and environmental protection products. Estimates of biomaterials currently produced from primary forest products in Alberta are valued at \$3.5 billion, secondary wood products at \$1.5 billion and non-wood products accounting for \$4 billion in total.⁴

Biochemicals

⁴ Data drawn from proposal for Alberta’s Bio Materials Development Centre.

Alberta's production of bio-based chemicals for the refining industry is small. Currently the industry is valued at approximately \$0.5 million. In comparison, Alberta's chemical and petrochemical refining industry has revenues of \$21.5 billion.⁵ While the bio-based chemical industry's size is relatively small, the presence of an already strong conventional chemical refining industry in the province actually provides an excellent opportunity for it to develop further.

Bio-energy (including heat, power, and fuel)⁶

Biofuels generation in Alberta, while more developed than biomaterial and biochemical production, is still expanding. Currently, 40 million litres of ethanol and 19 million litres of biodiesel are produced in the province annually, worth an estimated \$23 million and \$15.4 million respectively.

Combustion of forest biomass generates 300 megawatts (MW) of combined heat and power annually in the province, worth approximately \$195 million.

Alberta also has facilities that produce 17 MW from gasification and 60 MW from wood-based power boilers.

A number of facilities have been proposed that would further expand bio-energy production in the province. They are (currently):

- 76M L of ethanol production from two facilities
- 66M L/year biodiesel facility
- 75 MW from four gasification facilities
- two biogas power plants
- five pyrolysis or fast pyrolysis plants
- 17 biomass-to-liquid facilities
- 10 combined heat and power plants
- two green natural gas conversion plants

III. Retrospective Analysis – Consultation

Through the Industry Roundtable and comprehensive interviews and discussion with industry, government, community leaders, and academic stakeholders, observations and findings were related primarily to the areas of innovation, policy, and environment.

Innovation

Innovation is not the same as invention. Innovation is a process, which begins from the conception of an idea to the launching of a new product/process in the market place.

⁵ Chemicals and Petrochemicals Profile, Alberta Finance & Enterprise, 2010.

⁶ Data supplied by Alberta Innovates BioSolutions, August 2011.

Innovation is a key driver and critical feature of a bio-industrial strategy. Feedback from sector and innovation system participants was oriented around Alberta's innovation system or model: the set of institutional and built infrastructure that supports commercialization of new and commercially relevant technologies, products, and services. The overarching need identified was to enable a system to rapidly, efficiently, and effectively deploy the best bio-industrial solutions. Alberta government's research and innovation system, Alberta Innovates, is a key part of this. Alberta Innovates is made up of four board-governed provincial corporations that focus on the following strategic areas: bio-industries (i.e. agriculture, forestry, life sciences), energy and the environment, health, and bringing technology to market.

Key observations and findings from the retrospective analysis in regard to Alberta's innovation system are listed here:

- The Alberta innovation system carries certain redundancies, at times operates in a disconnected fashion, lacks clear accountability and authority, and is not organized around any particular vision.
- Alberta has research-oriented universities and technical colleges with well-established research and innovation capacity which could be developed into a centre of excellence around integrated environmental solutions.
- The existing research capacity created through bio-industrial investments in Alberta is significant. This capacity can be adapted and deployed to priorities that have been or will be identified, if integrated and aligned to achieve specific outcomes.
- Research and development efforts are not being led by industry; Alberta is in a technology “push” situation as opposed to market or commercialization “pull”. New models are required that focus on clearly understanding demand and markets, based on industry leadership, with research driven by business requirements rather than a policy or technology.
- Ability to pilot, demonstrate and commercialize is seen to be a fundamental barrier. Lots of technology and Intellectual Property exist, but the ability to move it out of the silos associated with the system and into businesses is a challenge.
- There is little recognition of the fact that “one size does not fit all” — there are different sized companies, different business models, and different target markets and products/services. Deliberate and intentional analysis is required to achieve success.
- An increased emphasis on waste streams and biological solutions is required. Despite Alberta's innovation capacity and a strong business culture in general, a strong innovative business environment relating to bio-industrial opportunities is lacking.
- Intellectual property rights can be used effectively to facilitate successful innovation. Technologies and processes stand a better chance of successfully reaching the marketplace if IP is used strategically. Gauging the importance of IP in innovation by merely focusing on patents as input and/or output of innovation, does not do justice to the significant role that can be played by the other tools of IP. A broader approach to the contribution of IP in innovation is therefore needed.
- Industry has recommended that a single innovation organization be developed, led by industry and communities across the value chain, with a core focus on the rapid commercialization of priority bio-industrial opportunities in Alberta, and on facilitating connections and relationships between industrial players.

Policy

Currently it appears that government policies are developed in isolation from each other and generally on a per sector or per issue basis. As well, coordination and communication across departments seems limited, with policies appearing at times to be either in conflict or, worse, perverse, leading to unintended consequences (e.g. fossil fuel subsidies leading to inefficient use of fuel as input). This runs counter to a desired outcome of maximizing economic and environmental outcomes across all sectors. As such, clear feedback indicated that the Government of Alberta must ensure supporting public policies are aligned, integrated and cohesive — across both sectors and issues.

The role of market and fiscal-based policy instruments in supporting the growth of Alberta’s bio-industrial opportunities were unanimously recognized in our research and analysis as a critical component to incent investment and support more rapid commercialization of products and technologies. Indeed, one Alberta-based biotechnology proponent indicated that his company is looking at other jurisdictions outside Alberta that have policies designed to support bioconversion technologies. It was pointed out that existing policy instruments and tools associated with other sectors in Alberta (e.g. oil and gas sector) could be applied to the bio-industrial sector, providing improved access to capital by putting related investments on a more “level playing field” with other investment opportunities in the province.

While many participants were quick to point out tax credits and royalty structures as key policy levers, all recognized that a suite of policy instruments must be considered and recommended. Some high-level examples of policy instruments and tools identified that might be applicable to the bio-industrial sector were:

- An expanded Scientific Research and Experimental Development (SR&ED) Tax Incentive Program that focuses commercialization on bio-industrial opportunities.
- A labour-sponsored venture capital funding mechanism whereby individual taxpayers can invest \$5000 per year into a fund, the assets of which must be invested in the province where the money is raised (Alberta is only province without this type of mechanism).
- A flow-through share tax policy where tax loss benefit from early stage projects could flow back to investors.
- Promotion of strategic purchasing policies that support innovation investments including the bio-industrial sector.

Other key observations affecting the need for new policy approaches and associated instruments were:

- Alberta lacks a shared and specific vision for diversifying the economy, much less diversifying the economy through bio-industrial and bio-economic initiatives.
- Political priorities are changing (energy, environment, and innovation) with the appointment of a new provincial premier who has a renewed focus on Alberta being a sustainability leader. An upcoming provincial election is planned for the spring of 2012.
- The Alberta government’s \$300 million investment over the last five years to support bio-industrial initiatives in bio-energy, biofuels, feedstock improvement, biomass conversion and new product development was intended to enhance competitiveness and build a strong

foundation for sustainable industries that advance economic diversification and generate environmental benefits. As such, these investments and capacities are ripe for leveraging.

- Building a thriving bio-industrial sector within Alberta would fulfill the implementation objectives of a suite of other energy and environmental-related strategies and plans that the Alberta Government has initiated to improve the quality of life and secure long-term prosperity, in particular, Alberta's:
 - Provincial Energy Strategy⁷ - Responsible Actions: A Plan for Alberta's Oil Sands⁸
 - Water For Life Strategy⁹
 - Land-use Framework¹⁰
 - Clean Air Strategy¹¹

Environment

Of significance and somewhat understated, Alberta's major trading partners are increasingly developing stretch environmental targets. Environmental responsibility and a demonstrable commitment to ecological stewardship are now requirements for a successful resource-based economy. As well, more local and regional environmental impacts must be addressed to support market access. These global and local environmental drivers are in turn generating potentially significant economic opportunities in the form of bio-based products and services, whether fuels, chemicals, materials, or energy, as well as environmental services. Importantly, such products and services must demonstrate they deliver genuine net life cycle environmental benefits, and to be branded or labeled as such will most certainly come with extensive validation and verification processes.

Other key observations around environmental drivers and opportunities were:

- Opportunity exists for this sector to connect with the values of Albertans, and assist Alberta in re-establishing its reputation for leadership in environmental policy and management.
- Opportunity exists for confirming and branding Alberta's green economy attributes (especially in lieu of recent public pressure on Alberta's energy sector).
- Creating zero-waste communities, with supporting technology and public policy to achieve them, is a clear opportunity. If backed by the appropriate policies or regulations, in time it would require municipalities to find alternative uses/outlets for materials and bioresiduals that would normally go to landfill and an incentive to do it the most economic way possible.

⁷ See <http://www.energy.gov.ab.ca/Initiatives/3082.asp>

⁸ See <http://treasuryboard.alberta.ca/ResponsibleActions.cfm>

⁹ See <http://www.waterforlife.alberta.ca/>

¹⁰ See <https://landuse.alberta.ca/Pages/default.aspx>

¹¹ See <http://www.casahome.org/>

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- Access to both private and public capital is identified as a core challenge to supporting new bio-industrial ventures, with typically low tolerance for risk. Identifying sources of new investment capital from the “social capital” sector, lesser known in Canada, that deploys higher risk and more patient capital for more environmental and social-related projects was one idea to address this.
 - While some regions and communities are clearly interested in taking a leadership role or taking advantage of new bio-based opportunities, with select communities developing regional bio-pathway strategies, community involvement has not been broad-based even though it is key to successful diversification. Public awareness and the opportunity related to a robust bio-industry is lacking.
 - An opportunity exists around new sets of services; this includes the commoditization of ecosystem services, whereby industry and government increasingly recognize the financial value of natural services that provide societal benefits, such as clean air, clean water, biodiversity, and carbon sequestration.
 - Alberta’s strong business culture provides an excellent basis for environmental entrepreneurship in the province.

Summary

In trying to better understand Alberta’s current state (as it relates to bio-industrial innovation), it became apparent that while the province has some cornerstone infrastructure and systems, it has yet to best position or leverage these to effectively enable the diversification of Alberta’s economy through value-added renewable biomass products, technologies, and services. In looking forward, the evidence points clearly towards an intentional focus on a strategy of diversifying through Alberta’s core engine: its energy sector (and in particular oil and gas). Specific opportunities to target within the energy sector include:

- advanced materials,
- environmental services,
- waste management, and
- biochemicals

Benefits incubated in oil and gas will spill out into other areas of the economy and global markets. This is valid diversification and mitigates risks while stacking on advantages.

Continuing with a focus on the competitiveness of the forestry and agricultural sector will require substantial deliberate and intentional analysis with respect to understanding the requirements to enable a health “industrial ecosystem” and the associated value chains.

Conclusions

Our consultations, combined with our research and evidence based analysis, was designed to perform a “reality check” of where Alberta is at with respect to its bio-industrial sector, and

based on the review, to develop a strategy to advance this sector. Based on the level of comprehensive engagement and research to date, it has become highly apparent that:

1. Diversifying the economy through bio-industrials should focus on diversifying within and through Alberta's core engine, the energy sector; particularly in helping to address environmental challenges associated with that sector.
2. Building a thriving bio-industrial sector within Alberta can play a key role in diversifying the provincial economy — a stated goal of the Premier's Economic Council report — and would fulfill the implementation objectives of a suite of other energy and environmental-related strategies and plans that the Alberta government has initiated.
3. Alberta's investments to date have provided solid research capacity to support the growing of Alberta's bio-industrial sector, but cannot effectively do that within a broad innovation system that currently:
 - does not have a clear bio-industrial vision, focus, or supporting goals actively supported by government and industry;
 - lacks coordination, alignment, efficiency, or clear accountability; and
 - does not have aligned and cohesive public policy approaches, nor the proper policy instruments, to effectively support the development and commercialization of bio-industrial technologies, products, and services
 - does not build from the established, vibrant industrial ecosystem associated with the core engine of Alberta's economy

DRAFT Strategy

The following approach to developing a successful strategic direction has been drafted based on the evidence-based analysis and the input received through consultations. Successful execution of these will depend on the willingness for the Government of Alberta to recognize and champion the strategies identified through evidence based analysis, and to demonstrate to industry, communities, the public, private lending agents, and institutions, that Alberta is committed to diversification of its economy over the long term, and specifically to the opportunities represented by the bio-industrial sector and future environmental technologies, products, and services.

Strategic Focus: Economic Diversification through Bio-industrial Innovation and Environmental Excellence

Associated Specific Strategic Actions (1-10 years)

Alberta's Jurisdictional Advantage

Shift focus to Alberta's core engine

- i. As part of Alberta's economic diversification strategy, government, communities, and industry should focus on bio-industrial opportunities within and through the core engine of Alberta's energy sector that builds on the robust and healthy industrial ecosystem of that sector. Based upon additional evidence based analysis, target the top 5 options identified through which to diversify.

Target mid-size companies and EPCs (Engineering, Procurement and Construction) to support this, given their credibility, mobility, and stability needed to bring bio-industrials into the energy sector.

Target the manufacturing sector to produce bio-products and services for the energy sector.

- ii. Shift focus towards solving problems rather than merely developing alternatives — particularly focus on environmental solutions and waste management options.
- iii. Support and enable market intelligence by working with the energy sector to understand where bio-solutions can play a commercial role.
- iv. Support the development, advancement, or adoption of standards for bio-products and services to establish and ensure quality and market confidence.
- v. Carry a regional delivery focus that allows communities and industry to work collaboratively on addressing problems and developing solutions that address the local needs and issues.
- vi. Target (through investment and public policy support) the specific market opportunities identified by significant market evidence gathered to date; namely, feedstock logistics; CO₂ sequestration and offsets; co-firing of biomass with coal; biopolymers and green fluids; and land remediation and abandonment services.

Include a focus on developing regional industrial clusters to increase chances of success and provide local economic opportunities.

Innovation

Develop a clear vision

- i. The Government of Alberta, working with communities and stakeholders, should set and communicate a clear vision for economic diversification with supporting goals (priorities) that includes the framed bio-industrial opportunity (i.e. focusing on energy sector/core engine and building an effective bio-industrial innovation system).
- ii. Develop and communicate a clear vision for growing Alberta's bio-industrial sector.

Enhance Alberta's innovation system; direct and target resources to opportunities within the core engine of the economy.

- i. Create a simplified, clear and streamlined innovation system with a business focus to rapidly deploy environmental technologies, products, and services that allows for investment from more than just government (e.g. public-private partnership – P3). Solicit targeted stakeholder input for recommendations.
- ii. Focus on enabling elements such collaboration, partnerships, strategic alliances and networks, with cross sector/discipline integration and effective engagement of universities and colleges, to develop a robust bio-industrial innovation model and tear down sectoral competitiveness. Learn from Oil Sands Leadership Initiative (www.osli.ca) as an example.
- iii. Focus programs to incent regional economic development and diversification focused on leadership, planning, delivery, and industrial clusters (i.e. zero waste).
- iv. Establish a shared governance model to grow the bio-industrial sector with clearly defined roles for government, business and communities, and understanding by each of their level and type of responsibility as well as accountability. Consider a single organization with representation from across the bio-industrial value chain, including communities, that plays a leadership role and enables regional and community-based planning and delivery.
- v. Have a business led opportunity-seeking concierge role with a “switchboard”/ “matchmaking” function focused on creating connections and facilitating opportunities around pre-determined innovation priorities.
- vi. More strategically integrate and align Alberta universities and colleges as part of an improved innovation model to more effectively and efficiently address environmental issues, innovations and solutions and associated economic opportunities. Solicit targeted stakeholder input (e.g. Alberta clean technology developers, mid-size enterprises, universities, and industry) for recommendations.

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- vii. Establish a virtual Centre of Excellence for (bio-industrial and) Environmental Entrepreneurship that would be a platform for shared learnings, coordinated research, formal networks, and commercialization support.
 - viii. Establish strategic processes and systems that ensure intellectual property rights can be used effectively to facilitate successful innovation.

Policy

Enhance public policy development and mechanisms

- i. Generate policy alignment, cohesion, and integration to ensure an integrated approach to public policy development and implementation that enables economic diversification innovation and competitiveness at the sector and firm level; and enables Alberta to establish leadership and credibility in environmental solutions.
- ii. Place an emphasis on enabling policy such as procurement, tax, fiscal and market-based policy instruments to incent investment in environmental and bio-industrial opportunities. Identify and evaluate successful mechanisms applied in the energy sector.
- iii. Create a strategic policy approach to ensure that intellectual property generated with public investment is used effectively to generate economic diversification.
- iv. Streamline regulatory processes to eliminate unnecessary “red tape” that create delays and inefficiencies when trying to rapidly deploy bio-industrial and environmental solutions.
- v. Work closely with suppliers, consumers, and non-governmental organizations to establish standards, protocols and processes that enable labelling and certification to demonstrate environmental integrity of products, processes and systems.
- vi. Establish policy objectives to facilitate enhancement of ecosystem services as commodities through market-based instruments, at the local, regional, or even global scale to accommodate economic growth while protecting and maintaining ecosystem health.

Environment

Focus on addressing environmental issues in Alberta's energy sector

- i. Take advantage of near-term bio-industrial opportunities for environmental entrepreneurship and new environmental technologies, services, and products by focusing on important environmental challenges in Alberta's energy sector. Identify specific areas where bio-industrial applications can offer marketable solutions.
- ii. Enable a voluntary approach for communities to set a goal of zero waste communities, with appropriate policies and programs to support this.
- iii. Focus on developing ecosystem services as commodities at the local, regional, or even global scale to accommodate economic growth while protecting and maintaining ecosystem health.

Strategic Focus: Enhanced Competitiveness in Agriculture and Forestry through Bio-Industrial Innovation

Associated Specific Strategic Actions (5 – 20 years)

This focus area is about developing opportunities outside of the core engine of the economy. Because it does not build on the rich industrial ecosystem associated with the energy sector, it involves more risk, requires specific, deliberate and intentional analysis in order to mitigate that risk, and is consequently has a longer time frame to success. The recent Premier’s Council on Economic Strategy report confirms that broadening the economic base beyond the energy sector in Alberta is a long-term proposition. The bio-industrial sector can be a primary means of achieving this.

- i. As per the Premier’s Economic Council report, we must “assess the strength of Alberta’s innovation ecosystem and fill in the gaps”. This is particularly true for the bio-industrial sector, where we must identify the various “weak or non-existent” elements of the system that focus on bio-industrial opportunities, and make direct and deliberate investments to address these.

This includes using evidence-based analysis to better understand the fundamental issues within the industrial ecosystem and value chains within various parts of the two sectors. Programs and initiatives must then be developed to address those issues.

- ii. Working with industry, ensure all policy barriers associated with the bio-industrial innovation system are identified and removed.
- iii. Jointly develop with other western provinces a “pan-western Canadian” strategy to take advantage of synergies in economic and strategic bio-industrial opportunities for British Columbia, Alberta, Saskatchewan and Manitoba — one that builds on the individual strengths of each jurisdiction and supports common goals around economic growth, diversification and innovative solutions.
- iv. Focus on building world-class globally connected expertise and research capacity. This includes focusing each university on a limited number of fields of research, with differing specialization for each university.

Appendix A: Alberta's Current Bio-industrial Innovation System

The following figures summarize the current Alberta bio-industrial innovation system including organizations and programs within an investment and commercialization continuum. These institutions and programs support the advancement of the provincial bio-economy and bio-industrial sector.

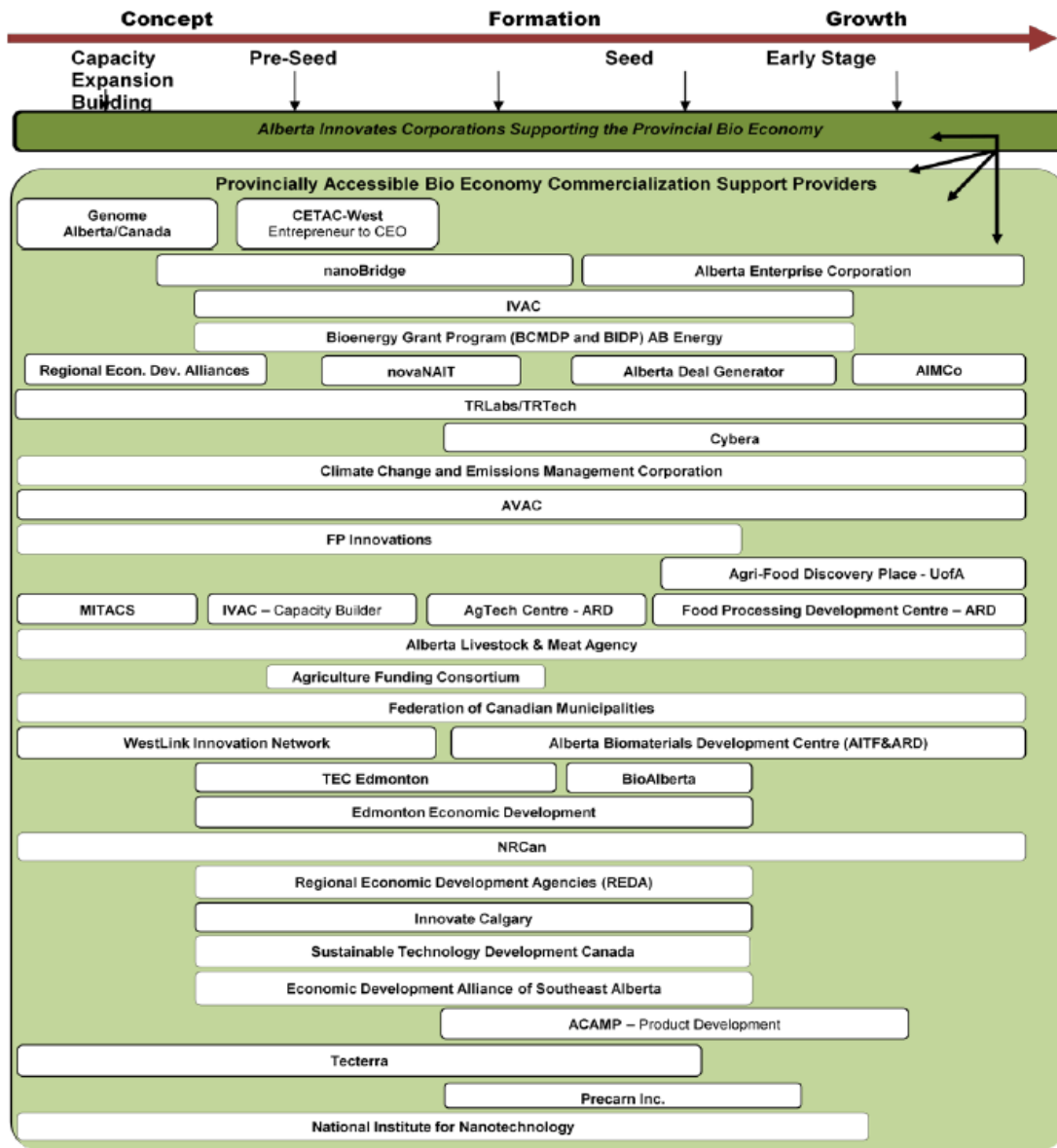


Figure 1. Provincially accessible bio-economy innovation service providers and organizations within an investment and a commercialization continuum

Appendix B: Inputs to Formulate Draft Strategic Approach

The research, analysis and strategy development process was formed with plans to connect and effectively co-create a ten-year strategy with business, academic, municipal, and public sector stakeholders in Alberta, nationally and internationally. A steering committee and related working group was established in early 2011 with much of the work in its final stages in early 2012. Outcomes (and outputs) of the following activities have acted as inputs to developing the draft strategic approaches laid out in this report, and will of course support the execution of the strategy.

Activities	Description
Current State Assessment	Baseline assessment detailing the current system and players, past commitments, industrial and research capacity, incentive structures, and a few success stories.
Retrospective Analysis: <ul style="list-style-type: none"> • Industry Roundtable • Community Dialogue 	This includes information gathered through: <ol style="list-style-type: none"> 1. A full-day meeting with leaders from the forestry, energy, agriculture, municipal waste, and chemical industries that: <ul style="list-style-type: none"> • identified and prioritized key challenges, constraints and barriers • developed and prioritized tactical strategies to address the barriers • considered the means to best advance key strategies 2. Input from discussion with community-based leaders across the province. 3. Interviews with key individuals who are working in the bio-economy space.
Jurisdictional Advantage Assessment	A quantitative and qualitative, evidence-based, comprehensive analysis to determine and highlight Alberta's competencies and the opportunities that exist to diversify through bio-industrial activities.