Growing Green

The Manitoba Bioproducts Strategy

Manitoba

Table of Contents

Manitoba's Vision iii

Manitoba's Mission iv

Executive Summary v

1. Introduction 1
   1.1 Our Biomass Resources 1
   1.2 Our Competitive Industry 3
   1.3 Our Commitment to Green Economic Development 5

2. Priority Areas 6
   2.1 Sustainable Biomass Production and Supply 6
   2.2 Biofuels and Bioenergy 7
   2.3 Biofibres and Biomaterials 8
   2.4 Biochemicals 9

3. Implementation Framework 10
   3.1 Establish Innovation and Industry Champions 10
   3.2 Invest in Research, Innovation and Commercialization 11
   3.3 Create a Skilled Workforce 12
   3.4 Support Market Development 13
   3.5 Increase Public Awareness 14

References 15

APPENDIX 1. DIRECTORY OF MANITOBA BIOPRODUCTS FIRMS 16

APPENDIX 2. LIST OF CONTRIBUTORS 18

Manitoba's Vision

A sustainable and competitive bioproducts industry to diversify rural and northern Manitoba and strengthen the growth of Manitoba's bioeconomy. By 2020, Manitoba's bioproducts industry will generate $2 billion in revenue annually, at least 80% of which comes from rural and northern Manitoba.

Manitoba's Mission

Manitoba has advantages in biomass production and supply from agriculture and forestry. Manitoba will provide renewable feedstock to meet and sustain our needs for health and wellness, energy, and materials in an environmentally friendly manner. The bioproducts industry is of strategic importance to Manitoba's economic growth, environmental sustainability and rural and northern diversification. Manitoba will be a leader in bioenergy, natural fibres, biomaterials, and biochemicals. We will align our resources and policies and seek partnerships to foster education, research, development, commercialization and trade in these priority areas. Manitoba is positioned to power Canada's bioeconomy.

Executive Summary

Sustainable development has become an economic linchpin in the Province of Manitoba. Blessed with a clean, natural environment and vast biological resources that are the envy of the world, Manitoba is ideally positioned to capitalize on the emerging bioproducts revolution and to secure a leading position in the new bioeconomy. Manitoba produces millions of tonnes of biomass from agriculture and forestry, and enjoys a diverse and competitive bioproducts industry, manufacturing innovative bioproducts that range from biofuels to biobased composite materials for applications in the transportation, construction, and consumer products sectors.

A strong bioproducts strategy is needed to ensure that Manitoba is able to fully capture the opportunities presented by the emerging bioeconomy, while sustaining our needs for food, feed and medicines. This strategy serves as a guide for government, industry and research institutions to further develop the sustainable production of Manitoba's renewable resources. It will coordinate all our efforts to grow and sustain a vibrant bioproducts industry that creates good, green jobs and diversifies the rural economy.

Our vision is:

> ***A sustainable and competitive bioproducts industry to diversify rural and northern Manitoba and strengthen the growth of Manitoba's bioeconomy. By 2020, Manitoba's bioproducts industry will generate $2 billion in revenue, at least 80% of which comes from rural and northern Manitoba.***

Our mission is:

> ***Manitoba has advantages in biomass production and supply from agriculture and forestry. Manitoba will provide renewable feedstock to meet and sustain our needs for health and wellness, energy, and materials in an environmentally friendly manner. The bioproducts industry is of strategic importance to Manitoba's economic growth, environmental sustainability and rural and northern diversification. Manitoba will be a leader in bioenergy, natural fibres, biomaterials, and biochemicals. We will align our resources and policies and seek partnerships to foster education, research, development, commercialization and trade in these priority areas. Manitoba is positioned to power Canada's bioeconomy.***

We will focus on and excel in:

- ***Sustainable Biomass Production and Supply***
- ***Biofuels and Bioenergy***
- ***Biofibres and Biomaterials***
- ***Biochemicals***

To move this strategy forward, we will:

- ***Establish Innovation and Industry Champions***
- ***Invest in Research, Innovation and Commercialization***
- ***Create a Skilled Workforce***
- ***Support Market Development***
- ***Increase Public Awareness***

Growing a strong bioproducts sector is an integral part of Manitoba's commitments to sustainable development and green economy. Together, we are building a prosperous and sustainable future for Manitoba families.

1. Introduction

Growing concerns over climate change, and the high cost and price fluctuations of oil and natural gas are driving the energy, materials, and chemical industries to explore and capture new opportunities by developing value-added bioproducts. Manitoba's agriculture and forest industries sell bulk commodities into global markets, and must seize these bioeconomy opportunities through innovation and value-addition to remain competitive and increase demand.

Manitoba is ideally positioned to capitalize on the emerging revolution of bioproducts. We have abundant biomass resources and have the benefit of an established bioproducts industry. Further developing our bioproducts industry is an important part of Manitoba's approach to green economic development [1]. This strategy will help Manitoba reduce its greenhouse gas (GHG) emissions and prepare Manitoba for a carbon-constrained future.

Sustainable Development means meeting the needs of the present without compromising the ability of future generations to meet their own needs [7].

Climate Change refers to any identifiable change in climate over time, whether due to natural variability or as a result of human activity. Scientists generally agree that the Earth's surface has warmed by about 0.6°C in the past 140 years, due to increased concentrations of greenhouse gases [8].

Bioeconomy, also known as biobased economy, means that part of economic activities focused on managing biological resources and producing, distributing and consuming goods, materials and services based on biological resources.

Biomass refers to living and recently dead biological or renewable materials from agricultural (plant or animal), marine or forestry resources including those from industrial and/or municipal wastes. It is often used to refer to lignocellulosic biomass.

Bioproducts refer to commercial or industrial products other than food, feed, and medicines made with biomass [9].

Ecological Goods and Services (EG&S) represent the benefits that human populations derive directly or indirectly from ecosystems, including provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; culture services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling [10].

1.1 Our Biomass Resources

Manitoba is blessed with strategic advantages such as abundant quality land and fresh water [2,3], which ensure ample biomass production to fuel and grow our bioproducts industry while meeting our needs for Ecological Goods and Services (EG&S). Agriculture and forestry represent our major resources for biomass feedstock.

Agricultural Biomass

Manitoba has 36.2 million acres of land with agricultural potential [3], of which approximately 19.0 million acres are devoted to farming [4]. It is estimated that about 5.5 million acres of cultivated farmland is sown to cereal crops (wheat, oats and barley) and about 0.4 million acres to flax [4], producing about 5.5 million tonnes of cereal straw and about 0.4 million tonnes of flax straw annually based on a conservative assumption of 1 tonne/acre biomass yield. These crop residues are typically used for soil conservation, livestock bedding, and feed roughage. Excess straw and stubble, particularly in the Red River Valley, are also open-burned in the field, creating environmental nuisances and public health and safety issues. A recent study [5] has shown that Manitoba has the potential to supply surplus crop residues for the production of bioproducts.

In 2006, Manitoba reported 2.9 million pigs, 1.6 million cattle and calves, and 7.9 million hens and chickens being raised within the province [4]. These intensive livestock operations produce over 20 million tonnes of manure per year [6]. Livestock manure has the potential to be utilized for the production of biogas through anaerobic digestion, which is a naturally occurring process where bacteria break down the organic matter or solids in manure and produce biogas. Canadian research has shown that outdoor bioreactors can potentially produce 37 cubic meters of biogas per cubic meter

of hog manure. There is potential to utilize biogas to displace natural gas or propane for heating or power generation.

Forestry Biomass

Forests make up about 65.0 million acres of the province's 135.3 million acre land base [11]. Manitoba is home to vast boreal forests, and its prairie region contains unique pockets of deciduous forest, treed riparian zones, urban forests and shelterbelts that dot rural and northern areas. The northern coniferous or boreal forest is the largest forest zone and covers a broad swath across the north-central and central part of the province, dipping down to extend across our eastern border into Ontario. The principal tree species include black spruce in the lowland bogs and fens, jack pine, poplar and white spruce on the uplands. Manitoba's boreal forests support the majority of the province's forest industry, providing resources for kraft paper and lumber. The broadleaf and mixed-wood forest that dominates the south-central portion of the province is often referred to as the aspen parkland, and consists predominantly of aspen, with smaller amounts of white spruce, oak, maple and elm. This forest region contains some of the most productive forest in the province and supports many small forest operations producing a variety of wood products including oriented strand board (OSB) and lumber. Within the grasslands of southern Manitoba, there are thousands of small broadleaf forest stands that consist of deciduous trees and shrubs and provide critical habitat for wildlife and a valuable source of income to farmers and landowners through proper woodlot management. Manitoba harvests approximately 1.5 million cubic meters of softwood and 0.7 million cubic meters of hardwood annually [12], equivalent to about 1.2 million oven dry tonnes per annum of woody biomass [13]. In addition, an estimated one million oven dry tonnes of harvest residues in the form of tops and branches are left behind and currently not removed from the forest [13]. There are great opportunities for those harvest residues to be used as a feedstock for the production of bioproducts.

Biomass from Industrial and Municipal Wastes

Manitoba is home to several large food processing facilities with waste streams that can be another major source of biomass for industrial uses. In recent years, over four million hogs are slaughtered in Manitoba annually [14]. Fatty wastes from slaughter plants can be rendered to produce feedstock for biodiesel production. Four potato processing facilities, including McCain and Simplot, produce large volumes of potato waste with starch as the main component. These potato wastes can be recovered, collected, and processed into products for food and industrial applications such as feedstock for bioplastics. Two large oat processing operations, Viterra Canada Oat and Specialty Grain Milling and Emerson Milling Inc., produce significant volumes of oat hulls. Two sunflower processing operations, Keystone Grains Ltd. and Nestibo Agra, produce large volumes of sunflower hulls. These oat and sunflower hulls can be used for the production of biomass solid fuels and other bioproducts.

Manitoba has a sizeable secondary wood-using industry, including furniture manufacturers and paper processing companies. This industry generates around 100,000 tonnes of waste materials annually [13], which could be used as feedstock for bioproduct production. It is estimated that 75% of those wastes are already used (e.g., burned for energy recovery) by these companies [13].

It has been estimated that Manitoba annually produces approximately one million tonnes of municipal solid wastes (MSW), of which over 250,000 tonnes are biomass that may

be suitable for energy production [13]. More efficient use of MSW could significantly reduce GHG emissions from landfills, while offering local solutions to waste management, and contributing to our energy needs. Manitoba's landfill gas capture program will enable three of the province's largest landfills to make significant reductions to the amount of greenhouse gas emissions they release. When captured, these landfill gases can be used to generate heat and/or power.

1.2 Our Competitive Industry

Manitoba has a unique set of business advantages including:

- a productive, well-educated and multilingual labour force;
- an extremely favourable business cost environment, including competitive office and land costs, low construction costs and affordable taxes;
- one of North America's lowest electricity costs with highly reliable, renewable and environmentally responsible hydro-electricity;
- an extensive network of research and development facilities, supporting innovation and technology diffusion;
- a convenient mid-continent location in the North American central time zone; and
- cost-effective transportation links and intermodal facilities providing shipping by road, rail, air and sea.

Manitoba's bioproducts industry is represented by over 30 companies that are motivated to devise innovative and cost-effective technologies in order to create and capture more value from renewable resources. The industry manufactures a diversity of products ranging from biofuels to biomaterials for applications in the transportation, construction, and consumer products sectors. Manitoba's mid-continent location provides an opportunity for the industry to supply biomass and bioproducts to national and international markets.

Manitoba's bioproducts industry is driven by a motivation to:

- capture value for our abundant biomass,
- sustain our needs for renewable energy and materials,
- reduce GHG emissions, and
- build stronger communities in rural and northern Manitoba.

Biofuel and Bioenergy Sector

Biomass can be converted into solid, liquid and gaseous biofuels which are used to provide bioenergy in many forms including heat, electricity, and motion. Recent biofuel development has been focused on liquid biofuels such as ethanol and biodiesel for transportation.

Ethanol can be blended with gasoline to reduce greenhouse gas emissions. Husky Energy's plant in Minnedosa has been

Biofuel means any solid, liquid or gaseous material derived from biomass and used to obtain energy.

Bioenergy refers to renewable energy produced by the release of stored chemical energy contained in biofuels.

Ethanol means ethyl alcohol derived from biomass such as grain or lignocellulose.

Biodiesel means an ester-based oxygenated fuel that is derived from vegetable oils, animal fats or other biomass materials; or a prescribed renewable fuel that may be used to power a diesel engine or for heating [15].

Biogas means a mixture of gases produced by anaerobic digestion, a process in which microorganisms break down biomass such as manure and crop residues in the absence of oxygen. The composition of biogas is about 50-75% methane and about 25-45% carbon dioxide.

Bioheat means thermal energy generated by direct or indirect combustion of biofuels, particularly biomass solid fuels and biogas.

Biomaterials also know as *biobased materials*, means processed or engineered materials partly or fully made from components derived from biomass. Biobased content is the key factor to determine the percentage of the material that comes from renewable sources. Examples of biomaterials include biofibres, bioplastics, biocomposites, and fibreboard.

Biofibre means any hair-like materials directly obtained from a vegetable or animal source (e.g., flax fibre, hemp fibre and wool), or from a synthetic biomaterial (e.g., polylactic acid).

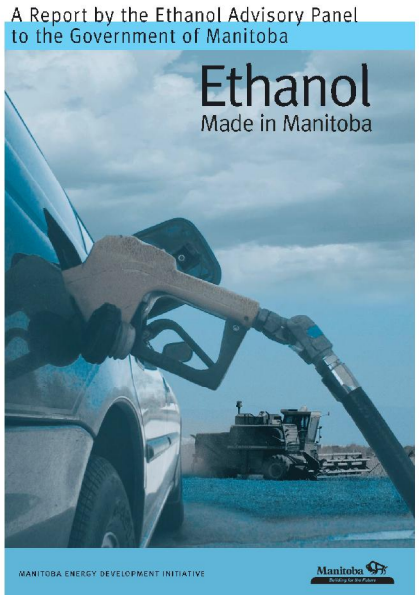
Bioplastics means plastics produced from renewable biomass such as of a plant or microbial source, in contrast to plastics based on non-renewable petroleum.

Biocomposites means a compound of biofibres and petroleum-based plastics or bioplastics for structural or non-structural applications.

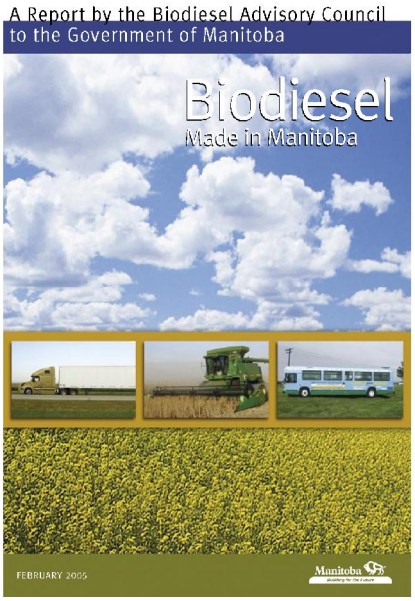
Biochemicals, also known as biobased chemicals, green chemicals, and plant-based chemicals, means chemicals produced from biomass, in contrast to petrochemicals.

producing 10 million litres of ethanol from cereal grains (wheat and corn) annually since the 1980s. Husky built and commissioned a new 130-million litre plant in December 2007. The expanded Husky plant employs 40 people and each year consumes 350,000 tonnes of grain, the majority being locally grown. As a result of the ethanol process, the plant also produces 125,000 tonnes of distillers dried grain annually, a valuable co-product that is sold for livestock feed. Although most projects consider using grains as feedstock, more than half a million tonnes of straw are estimated to be available for a cellulosic ethanol facility in southwest Manitoba [16].

Manitoba released an Ethanol Strategy in 2002 [17], and passed the Biofuels Act in 2003 to mandate the use of ethanol in the general fuel supply [15]. The ethanol mandate requires fuel suppliers in Manitoba to replace at least 8.5% of their gasoline available for sale with ethanol. The province has supported the production of ethanol with an incentive. In 2008 and 2009 ethanol producers were entitled to receive 20 cent/litre of ethanol produced and sold in Manitoba to fuel suppliers. For years 2010-2012, the incentive is reduced to 15 cent/litre. The incentive moves to 10 cent/litre for years 2013-2015. The ethanol mandate has reduced Manitoba's GHG emissions by more than 300,000 tonnes per year, the equivalent of taking more than 52,000 cars off the road.



Biodiesel blended with conventional diesel fuel improves engine wear and some of the exhaust emissions from diesel engines. Manitoba is Canada's third largest oilseeds producer (especially canola) and home to three large canola crushing operations. The province has potential sources of feedstock to support large-scale biodiesel production. There are currently three licensed commercial biodiesel producers in the province – Speedway International in Winnipeg, Bifrost Bio-blends in Arborg and Eastman Biofuels in Beausejour.



Guided by the Biodiesel Strategy released in 2005 [18], Manitoba eliminated the 11.5 cent/litre motive fuel tax on pure biodiesel (B100) and on the biodiesel portion of blends with diesel fuel [19]. On November 1, 2009 Manitoba became the first jurisdiction in Canada to have a mandate that requires, on average, 2% biodiesel in all diesel fuel sold in a year. The biodiesel mandate has reduced Manitoba's GHG emissions by 65,000 tonnes per year, the equivalent of taking more than 11,000 cars off the road. The province has also replaced the current fuel tax exemption with a 14 cent/litre, five-year production grant for both on- and off-road biodiesel produced in Manitoba.

Biogas produced from organic wastes is another green alternative to non-renewable fossil fuels. On-farm biogas production by anaerobic digestion also offers nutrient management in the wastewater stream, reducing risks of surface and groundwater contamination. Other benefits include odour control and pathogen reduction of the organic wastes. Manitoba is studying the technical and economic feasibility of anaerobic digestion and examining the potential of incorporating glycerin from the biodiesel industry into the digestion process. Cook Feeders and Riverbend Colony have been investigating the use of anaerobic digesters on their hog farms to produce biogas for generating heat and power. The University of Manitoba has constructed two pilot-scale digesters for education and research purposes.

Biomass solid fuels can be found in a loose form of chips, shives, hurds, or chopped straws, or in a dense form of pellets, cubes, pucks, or logs, and are burned in stoves or boilers for heating in greenhouses, hog barns and homes. Bioheat represents the most cost-effective use of solid lignocellulosic biomass for energy production [20]. Because carbon dioxide (CO2) is absorbed during the growth of the crop, biomass fuels are effectively carbon-neutral, reducing Manitoba's GHG emissions when they replace fossil fuels such as coal and natural gas. The cluster of biomass solid fuel suppliers and bioheat users in Manitoba is growing. Winnipeg Forest Products makes wood pellets. Central Grain Company Ltd. in Winnipeg and Viterra oat milling operation in Portage la Prairie manufacture biofuel pellets from ag-biomass. Prairie Bio-Energy Inc. in La Broquerie has developed technologies to produce 7/8 inch cubes from waste biomass. Flax Power in Carman is producing fire logs from flax shives. Other proponents including Schweitzer-Mauduit and Keystone Grain also supply loose-form biomass for heat production. Vanderveens' Greenhouses in Carman and several Hutterite Colonies are burning biomass to meet its primary energy need for heating. The success of the Annual Biomass Workshops put on by the province in 2008, 2009 and 2010 has shown that, with Manitoba's ample biomass supply, robust appliance manufacturing industry and receptive energy users, the province is well positioned to capitalize on bioheat opportunities and to realize its goal to reduce GHG emissions.

Biofibre and Biomaterials Sector

Manitoba has a diverse forest products sector. Tolko Industries Ltd.'s operations in Manitoba include solid wood and kraft paper divisions, producing lumber for the North American market and unbleached kraft paper for the North America, Europe, the Middle East and Latin America markets. Louisiana-Pacific Canada Ltd. in Swan Valley has produced oriented strand board since 1996. Spruce Products Ltd. has operated sawmills and pulpwood operations throughout Manitoba since 1942. Waugh's Woods, a sawmill in The Pas, produces specialty timbers. International Fibreboard Inc. located in Winnipeg manufactures 50-million square-feet of fibreboard annually from poplar cordwood and recycled paper products. Palliser Furniture Ltd., established in 1944, is Canada's leading home furnishings manufacturer, producing furniture in Canada, Mexico and Indonesia in their own plants and contract factories across the world.

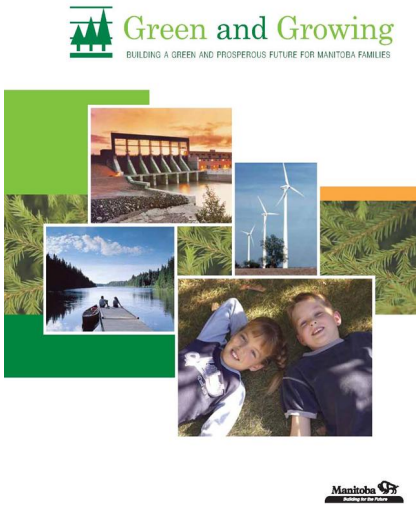
Manitoba is poised to lead Canada in biofibre processing and biomaterials manufacturing. The province has a vibrant agriculture industry supplying an abundance of biofibres including wheat, flax and hemp straw. The province has historically been a leader in processing agricultural crop residues into biomaterials. Schweitzer-Mauduit located in Carman is a major flax decortication facility in North American and processes approximately 100,000 tonnes of flax straw annually for paper production. Emerson Hemp Distribution Company located in Emerson processes hemp straw into animal bedding and small animal nesting products. Plains Industrial Hemp Processing Ltd. is building a hemp fibre processing facility in Gilbert Plains. This facility will be capable of processing up to 18,000 tonnes of industrial hemp annually and producing a series of bioproducts including non-woven matting and fuel pellets. ErosionControlBlanket.Com located in Riverton manufactures erosion control products for commercial and residential uses from wheat straw and other biofibres. Composites Innovation Centre (CIC) located in Winnipeg develops advanced composites technologies for manufacturing industries. The centre leads several initiatives focused on the development and commercialization of biocomposites using biofibres such as hemp and flax to replace the man-made glass and carbon fibres for advanced composite applications in buses, recreational vehicles, sporting goods and aircraft manufacturing. Manitoba is home to North America's two largest bus manufacturers, two major aircraft parts manufacturers, and one large agricultural machinery manufacturer. Using biocomposite parts which are generally lighter than their fiberglass counterparts will reduce vehicle weight and improve fuel efficiency, further enhancing the vehicle manufacturers' competitiveness.

1.3 Our Commitment to Green Economic Development

As outlined in *Green and Growing: Manitoba's Green Strategic Framework*, the Government of Manitoba is committed to building a green and prosperous future for our families [1]. The province has led the nation on action on climate change by passing legislation [21] that commits the province to meeting its

Kyoto target by 2012. The government has developed policies and incentives to build on our green energy strengths as one of the measures to address climate change while fostering economic growth in rural and northern Manitoba.

To promote the use of straw as a value-added resource, the province has included straw pellets in the Provincial Sales Tax exemption for firewood used for heating or cooking [22]. The province, committed to reducing our reliance on coal, announced a $10 per tonne of CO2 equivalent emissions tax on coal in Budget 2008 [23]. The province is also looking at ways to incent the use of biomass as an alternative to fossil fuels. In order to support the biofuels sector, Manitoba has led the nation with mandates and incentives for ethanol and biodiesel.



Manitoba needs a strong bioproducts strategy to fully capture the opportunities presented by the bioeconomy, and build on our green advantages. This strategy serves as a guide for government, industry and research institutions to further develop the sustainable production of Manitoba's renewable resources. It will coordinate all our efforts to grow and sustain a vibrant bioproducts industry that creates good, green jobs and diversifies the rural economy. We aim to build a world-leading bioeconomy that will be an engine of new business opportunities and sustainable economic growth for the long term.

2. Priority Areas

The era of bioeconomy has come, representing a new revolution that sees fuels, materials, and chemicals derived from crops and trees. We will capitalize on bioeconomy opportunities by creating value chains from biomass production to bioproducts. We will work together with all stakeholders in the public and private sectors and integrate our resources, industrial base, infrastructure and expertise to grow our bioproducts industry that provides renewable alternatives for energy, materials and chemicals. We will deploy biorefinery concepts to sustain our needs for food, fuel and fibre.

Building on our strengths, we will prioritize on and excel in the following areas:

- Sustainable Biomass Production and Supply
- Biofuels and Bioenergy
- Biofibres and Biomaterials
- Biochemicals

2.1 Sustainable Biomass Production and Supply

Manitoba has the potential to supply between five and seven million tonnes of agricultural and forestry lingocellulosic biomass per year, in addition to between five and seven millions tonnes of cereal grains (wheat, oats, barley) and between two and four million tonnes of oil seeds (canola, flax, hemp). Substantially more biomass feedstock could be produced through growing dedicated energy and fibre crops. Manitoba generally enjoys greater agricultural productivity per acre and greater yield stability than the other prairie provinces, and also has the potential to capture uncommitted

annual allowable cut as well as unutilized harvest residues from the forestry industry. Substantial biomass waste streams and byproducts are being generated by food processors, forestry product industries and municipal waste treatment plants. Manitoba possesses the experience and capability in procuring and supplying over 100,000 tonnes of biomass to industrial users.

Objectives:

- To diversify and enhance farm incomes in order to revitalize rural and northern communities.
- To sustain the bioproducts industry's needs for feedstock without tempering our environment and food supplies.

Actions:

- Develop and renew inventories of production, consumption and availability of biomass from conventional sources (such as crop residue, forestry waste, industrial and municipal wastes, etc.), alternative sources (dedicated biomass crops/species such as switchgrass, willow, and poplar), and incidental sources (e.g., blown-down woodlots, diseased crops, infested trees).
- Develop inventories of current practices and/or technologies used for cropping, harvesting, and post-harvest handling including transportation and storage of biomass.
- Assess the long-term impact of climate change on Manitoba's biomass production and availability and develop action plans to mitigate associated risks.
- Conduct life cycle assessment (LCA) of existing (e.g., annual crops, monoculture) and alternative (e.g., perennial crops, polyculture) biomass production systems, factoring in commodity yield and market value, fossil fuel (for energy and fertilizer) use and efficiency, greenhouse gas emissions, air quality (e.g., odors, pesticides, and particulates), water use (e.g., groundwater depletion, flooding), water quality (e.g., contamination by nutrients, sediment, pesticides), land use (e.g., deforestation for biomass production), soil conditions (e.g., organic matter), biodiversity (e.g., disruption of wildlife habitats), and rural and northern community development.
- Develop an integrated biomass production and land use strategy that identifies ecological and energy-efficient biomass production systems on a district or regional basis, and that recommends policies (e.g., guidelines, incentives, extension) to enable profitable and sustainable biomass supply.
- Support the development of high-yield and stress-resistant agricultural and silvicultural biomass species for bioenergy, biofibre and industrial oil applications.
- Support innovation and commercialization of energy-efficient and cost-effective biomass planting, harvesting (or salvaging for accidental biomass such as blown-downs), and post-harvest handling (e.g., mobile densification, chipping) technologies.
- Support extension activities (e.g., biomass workshops) that facilitate new thinking on agriculture and forestry practices and enable biomass producers and suppliers to capitalize on market opportunities by deploying the bioproducts value chain.

2.2 Biofuels and Bioenergy

Manitobans consumed about 250,000 terajoules of energy in 2006 [24]. While 26.9% of that total energy use was renewable hydro-generated power produced in Manitoba, the remaining 73.1% was from imported non-renewable fossil fuels including natural gas, gasoline, diesel, propane and coal. In 2006, approximately 1.5 billion litres of gasoline and 1.0 billion litres of diesel were burned mainly for transportation uses in Manitoba, and approximately 2.0 billion cubic meters of natural gas, about 163 million litres of liquid propane, and about 130,000 tonnes of coal [25] were consumed by stationary combustion for industrial, pipelines, commercial, institutional and residential heating [24]. Transportation

and stationary combustion were responsible for the province's GHG emissions in 2006 by 7.2 megatonnes and 4.2 megatonnes of CO2 equivalent, respectively [26]. The current mandate for 8.5% ethanol and 2% biodiesel [27] have cut the province's GHG emissions in the transportation sector by 350,000 tonnes of CO2 equivalent per year. With the potential supply of five to seven million tonnes of lignocellulosic biomass, the province could potentially get all stationary combustion users off fossil fuels while meeting the energy demand of about 81,000 terajoules for all stationary combustion [24]. Since biomass fuels are far less carbon intensive than fossil fuels such as natural gas, coal, and propane, increasing the use of biomass fuels for stationary combustion will significantly reduce the GHG emissions under this category. Replacing all known coal use in Manitoba with biomass would result in a reduction of 200,000 tonnes of GHG emissions. While continuing to implement the ethanol and biodiesel strategies, the province sees great opportunities in generating energy from lignocellulosic biomass.

Objectives:

- To facilitate the conversion of agriculture and forestry biomass into bioenergy
- To increase the availability and use of biofuels to reduce our reliance on imported fossil fuels
- To reduce GHG emissions from the use of fossil fuels in the energy sector

Actions:

- Conduct a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of the bioenergy sector, including a technological and economic scan of solid, liquid and gaseous biofuel production from a variety of biomass feedstock
- Conduct life cycle assessment of solid, liquid and gaseous biofuels in comparison to their fossil fuel counterparts.
- Develop a bioenergy strategy for Manitoba, including recommendations for legislation, policy and procedures to reflect the life-cycle value of biofuels and to enable biofuels competing with fossil fuels in the marketplace.
- Support R&D and commercialization of clean and high-efficiency biomass combustion technologies including flexible fuel technologies.
- Work with private and public stakeholders to develop and establish standards and certification programs for biomass solid fuels and combustion appliances.
- Provide incentives to biomass solid fuel manufacturers and to heat users to increase the availability and use of biomass solid fuels in order to reduce coal consumption.
- Continue to participate and support pilot biofuel production and bioenergy demonstration projects, particularly on the use of biomass solid fuels for industrial, commercial and community heating.
- Support biomass to heat and power projects for off-grid and northern communities in Manitoba.
- Conduct a financial and economic feasibility analysis of biomass for heating and power for the primary forest products industry.
- Form strategic partnerships with technology developers and investors to capitalize on opportunities with advanced biofuels including cellulosic ethanol, syngas, green gasoline and green diesel.
- Support integrated biorefinery research and development (R&D) activities and demonstrations with bioenergy as a primary co-product.

2.3 Biofibres and Biomaterials

Over the past decades, Manitoba has developed a cluster of biofibre businesses ranging from fibre production, procurement and processing to industrial application. Manitoba is one of the largest wheat, flax and industrial hemp straw producers in Canada. Manitoba has straw procurement programs that are able to handle supplying hundreds of thousands of tonnes of biofibres across western Canada. The province has also conducted a straw procurement business case study that will

provide information such as cost-effective procurement models for any biofibre based business. In addition to a large flax fibre processor, Manitoba has a cluster of small- and medium-size manufacturers which use biofibres for their industrial and commercial products such as fiberboard and erosion control devices. Composites Innovation Centre, which leads this cluster in terms of research and technology development, has established several initiatives focusing on value chain development and commercialization for industrial applications of biofibres, especially as a replacement of fiberglass in bus components.

Objectives:

- To advance the research and innovation capacities for production, processing and industrial applications of biofibres and biomaterials
- To increase the use of biofibres and biomaterials in our manufacturing sector
- To establish Manitoba's position as the capital of biofibres and biomaterials in terms of research, development and commercialization in Canada

Actions:

- Continue to support the Composites Innovation Centre, whose mandate is to stimulate economic growth through the development of advanced composite technologies for manufacturing industries, and to continue to build value chain networks through coordinating research and commercialization programs and implementing pilot scale processing capabilities.
- Continue to support new commercial start-ups and established companies to build biofibre processing capacities including decortication and further processing into value-added products such as non-woven matting, insulation mats, greenhouse potting and geotextiles.
- Continue to support the Flax Canada 2015 initiative that has a mandate to increase the flax acreage and to promote the industrial use of flax fibre and oil.
- Support implementation of Canada's National Industrial Hemp Strategy.
- Work with University of Manitoba and Natural Sciences and Engineering Council of Canada to create a research chair on biofibre and biomaterials.
- Establish networks of value chain stakeholders that can provide a reliable supply of consistent quality biofibres and biomaterials as green alternatives to non-renewable products used in Manitoba's major manufacturing industry sectors such as aerospace and transportation equipment, construction materials and other commercially viable applications such as paper, clothing, plastics, packaging and rubber.
- Work with private and public sector stakeholders to explore export markets for made-in-Manitoba biofibres and biomaterials.
- Develop policies (e.g., green procurement) and programs (e.g., green labeling) to encourage and increase the use of biofibres and biomaterials in public sector operations.

2.4 Biochemicals

Biomass can also be converted into renewable chemicals to displace petrochemicals for industrial and commercial uses. Manitoba has a fair-size chemical manufacturing sector, which produces a wide spectrum of industrial, commercial and household goods including industrial chemicals and fertilizers, primarily on a petroleum basis. Manitoba is well positioned in the life sciences industries in Canada and has expertise in white biotechnologies, which presents a great opportunity for the province to grow in the biochemical area.

White Biotechnology is an emerging field within modern biotechnology that serves industry. It uses living cells like moulds, yeasts or bacteria, as well as enzymes to produce goods and services.

Objectives:

- To develop research and innovation capacities in the area of biochemicals.
- To increase the use of biobased feedstock in the chemical manufacturing sector.

Actions:

- Continue to support R&D on advanced biomass to chemicals conversion technologies (e.g., biodegradation processes such as fermentation, aerobic digestion; thermo-degradation processes such as gasification, and pyrolysis).
- Work with stakeholders to develop industrial oil applications (e.g., biolubricants and functional oil).
- Support R&D and demonstrations of integrated biorefineries or eco-industrial clusters that co-produce biochemicals and other bioproducts such as biofuels, biofibres, and biomaterials (e.g., forestry products companies adding chemicals and energy products to their conventional wood and paper markets).
- Encourage companies in the forest sector to explore potential strategic links with the chemicals sector where fermentable sugars and other byproducts such as lignin of the pulp and paper process could potentially be utilized as feedstock for the production of chemicals and plastics.
- Encourage companies to capture additional value for biomass through the identification and extraction of high-value bioactive compounds.
- Support R&D that systematically bio-prospect for valuable fine chemicals from biomass (e.g., breeding or genetically engineering crops for the production of target chemicals).

3. Implementation Framework

3.1 Establish Innovation and Industry Champions

Manitoba has world-leading agri-food and medicine R&D facilities including the Food Development Centre (FDC), Richardson Centre for Functional Foods and Nutraceuticals (RCFFN), and Canadian Centre for Agri-Food Research in Health and Medicine (CCARM), united under the Manitoba Agri-Health Research Network. The province is also home to federal grain facilities such as Canadian Grain Commission, Canadian International Grains Institute, Canadian Wheat Board, and Cereal Research Centre, and is developing a business case for a world-leading Centre of Excellence for Cereal Grains.

The bioproducts industry, still in its infancy, is not as coordinated as the agri-food industry. The province sees the Composites Innovation Centre (CIC) leading on the priority area of biofibres and biomaterials and a number of institutions involved in biofuels and bioenergy R&D. However, we need an industry association in Manitoba as in other provinces (e.g., Ag-west Bio in Saskatchewan, BioProducts Alberta) to lead the industry development. We also need innovation champions to address our priority areas such as biomass production and bioenergy.

Bioproducts Manitoba

Objectives:

- To establish an organization responsible for implementing this strategy.

Recommended Actions:

- Learn the function and structure of similar organizations in other jurisdictions.
- Identify the best structure capable of managing the implementation of this strategy.
- Work with associations for industry sectors related to bioproducts and explore the option of creating an industry association for the bioproducts sector.
- Provide financial and/or humane resource support to the organization and the initiative.

Biomass Centre

Objectives:

- To evaluate, develop and advance biomass cropping, harvesting and post-harvest handling technologies and practices to ensure cost-effective and sustainable biomass production and supply to Manitoba's bioproducts industry.
- To bridge the gaps between applied research and commercialization through pilot-scale demonstration and industrial scaling-up.
- To collaborate with other technology centres such as Composites Innovation Centre in Manitoba in order to maximize benefits of biomass from production to conversion to energy, materials and chemicals, and to realize eco-industrial clustering of our bioproducts industry.

Recommended Actions:

- Develop a business plan that includes the identification of focus areas.
- Secure funding to establish the centre.

Bioenergy Network

Objectives:

- To align resources of bioenergy-related technology centres/labs and to create synergy for the development of bioenergy for transportation fuels, heat and electricity.
- To coordinate evaluation, development and advancement of environmentally and economically sounding technologies of converting biomass into energy.

Recommended Actions:

- Develop a business plan that includes the identification of focus areas.
- Secure funding to establish the network.

3.2 Invest in Research, Innovation and Commercialization

Manitoba's research, development and commercialization (R&D&C) activities in the area of bioproducts are primarily funded by provincial and federal grant and loan programs. Agricultural Bioproducts Innovation Program (ABIP) from Agriculture and Agri-Food Canada (AAFC) is the only available funding program dedicated to research and development on bioproducts. However, funding opportunities exist within AAFC's "Growing Forward" initiative. Bioproducts R&D&C activities can access other grant and loan programs from the federal level including Sustainable Development Technology Canada (SDTC), and AAFC's Agri-Innovation and Agri-Opportunities programs. Bioproducts-related projects are also funded at the provincial level through a suit of programs, including Agri-Food Research and Development Initiatives (ARDI), Covering New Ground (CNG), Manitoba Rural Adaptation Council (MRAC), Rural Economic Development Initiative (REDI), Sustainable Development Innovation Fund (SDIF), Business Development Fund (BDF), Community Enterprise Investment tax credits (CEI), Manitoba Industrial Opportunities Program (MIOP), Technology Commercialization Program (TCP), and Alternate Energy Loan Program. High risks associated with early development have created financing gaps within the bioproducts industry. Many bioproduct start-up companies lack the necessary capital to grow and attract investment. Manitoba's venture capital community is limited, especially for investments in the $1 million to $3 million range. This limits the capital available for small and medium sized enterprises (SMEs).

Objectives:

- To provide financial support to applied research and pre-commercialization activities in priority areas identified in this strategy.

- To address the capital market's financing, infrastructure, and educational gaps and challenges constraining the economic growth within Manitoba's bioproducts sector.

Recommended Actions:

- Develop a biomass to bioproducts program with dedicated funding to support applied research and pre-commercialization activities in converting biomass to bioproducts.
- Work with the government's business portal (BIZPAL) to create a better and more efficient delivery of services to the bioproducts industry.
- Review existing financial and tax credit programs to identify financing gaps for the growth of the bioproducts industry, and develop new programs to fill those gaps.
- Address the infrastructure and education gaps which prohibit efficient flow of capital to start up companies.
- Create grant and loan programs to provide capital to early-stage bioproducts startups and to provide matching capital investment to encourage bioproducts business in rural and northern Manitoba.
- Work with capital suppliers and facilitators to develop a capital market infrastructure, and coordinate capital investment to explore bioproducts opportunities in Manitoba.
- Educate entrepreneurs and their advisors on business opportunities and challenges in the bioproducts industry.

3.3 Create a Skilled Workforce

Manitoba's bioproducts industry, still in an early-stage of development, requires innovative and skillful workforces who have cross-training in multiple disciplines including life sciences, materials science and chemical engineering. Manitoba is home to eight universities and colleges, which offer post-secondary education and training programs to more than 50,000 students. Manitoba is committed to continuing to invest in education and training as one of the province's strategies for economic growth.

Objectives:

- To enhance the enrollment of existing bioproducts-related education and training programs offered by universities and colleges in Manitoba.
- To create and support robust and flexible research, curriculum and training programs that build on Manitoba's capacities and strengths to meet and sustain the technology and skill needs of Manitoba's bioproducts industry.

Recommended Actions:

- Assess available courses and programs, and facilitate collaboration among institutions to upgrade existing curricula to meet the needs of the emerging bioproducts industry.
- Support bioenergy and bioproducts training programs at the University of Manitoba.
- Work with the Prairie Innovation Centre at Assiniboine Community College to develop new skills and knowledge in the area of renewable energy.
- Work with Red River College's Centre for Applied Research and Sustainable Infrastructure to develop new skills and knowledge in the area of the use of biomaterials in building and construction materials and products.
- Create curriculum on bioproducts for the class room at all education levels.
- Create education and training programs that enable management and entrepreneurial skills to move bioproducts commercialization initiatives forward.
- Encourage the recruitment of skilled bioproducts workforce from immigrants.
- Foster and support local, national and international collaboration and partnerships in innovation and commercialization of bioproducts.
- Create industry advisory group(s) to support the development of bioproducts curriculum and training programs.

3.4 Support Market Development

Major challenges for new bioproducts to enter and compete in the marketplace include relatively high prices, consumers' uncertainty of performance, and lack of market intelligence in comparison to their petroleum-based counterparts. The province will use available and/or create new policy instruments to support the market development for made-in-Manitoba bioproducts, strengthening the growth of our green economy.

Green Policies

Objectives:

- To improve the market competitiveness of bioproducts against fossil fuel products through science-based policies and incentives.

Recommended Actions:

- Review and identify policies, regulations and incentives to support the development of the bioproducts sector.
- Establish tax credits for bioproducts and/or levies on fossil fuel-based products on the basis of life cycle assessment that takes into account of life-time energy consumption, greenhouse gas emissions and other sustainability criteria.
- Establish links to a carbon crediting and trading system and facilitate access to the carbon market.
- Consider policy development on mandating a proportional use of bioproducts in public sectors.

Green Procurement

Objectives:

- To demonstrate the role of government in supporting demand for bioproducts

Recommended Actions:

- Initiate pilot projects within the provincial government for use of specified bioproducts.
- Develop process for comparing bioproducts to their non-renewable counterparts.
- Increase the proportional purchase and use of bioproducts in the operation of government departments and agencies.
- Encourage green procurement guidelines for grant recipients and external agencies funded by government.

Green Marketing

Objectives:

- To realize local, national and international market opportunities for made-in-Manitoba bioproducts.

Recommended Actions:

- Identify bioproducts market opportunities and promote made-in-Manitoba bioproducts to international buyers, government and research institutions.
- Continue to provide companies exporter skills training.
- Support participation on incoming and outgoing trade missions.

3.5 Increase Public Awareness

Growing Manitoba's green economy requires the participation of all Manitobans. Creating public awareness around a bioproducts strategy is an essential component in moving the bioproducts industry forward. Increasing public awareness of commercially available bioproducts and their economic, environmental and social benefits will drive market demand and ultimately increase use of bioproducts. Better public awareness of the bioproducts sector will also help to attract research funding and commercialization investment.

Objectives:

- To improve the public's knowledge of bioproducts including their social, economical, and environmental benefits.
- To establish the public's confidence and preference of purchasing and using bioproducts.
- To ensure strong interaction with federal, provincial and municipal governments.

Recommended Actions:

- Conduct a survey on the public's knowledge, perception, experience and perspectives of bioproducts, and share the results with the industry and public.
- Organize a campaign on bioproducts to educate the public and fill identified gaps.
- Have this strategy officially announced in a major event and have the announcement published in major newsprints, radio stations, TV networks, and governmental and non-governmental websites where applicable.
- Communicate this strategy to the bioproducts industry at-large to ensure corporate policies and resources are aligned and partnerships in research, development and commercialization are maximized.
- Present this strategy to the provincial and federal governments at the ministerial level, and communicate this strategy to all three levels of government to align Manitoba's provincial and municipal policies to the federal and other provincial governments in order to remove barriers to development of the industry.
- Initiate and support public relations projects that showcase the use and benefits of bioproducts.

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APPENDIX 1. DIRECTORY OF MANITOBA BIOPRODUCTS FIRMS

(As of January 2011)

Company Name	Location	Products/Services	Website
Ag-Quest Inc.	Minto	Bio-fertilizer/pesticide, ethanol	http://www.agquest.com
Bifrost Bioblends	Arborg	Biodiesel	
Bio-Heat Resources	Winkler	Biomass stove/boiler	http://www.bioheatresources.com
Blue Flame Stoker	Headingly	Biomass furnace	http://blueflamestoker.com/home.html
Viterra Canada - Oat & Specialty Grain Milling	Portage la Prairie	Oat hull pellets	http://www.viterra.ca
Celtic Power & Machining Ltd	Rapid City	Bioenergy equipment	http://www.celticpower.ca
Central Grain Company Ltd	Winnipeg	Fuel pellets from ag-biomass	http://www.centralgrain.com
Composites Innovation Centre	Winnipeg	Biocomposites R&D	http://www.compositesinnovation.ca
Eastman Bio-Fuels	Beausejour	Biodiesel	
ELF Industries Ltd	St. François Xavier	Pellets, stoves, furnaces	
Empson Hemp Company	Emerson	Hemp fibre processing	
Erosion Control Blanket	Riverton	Straw mats	http://www.erosioncontrolblanket.com
Flax Canada 2015 Inc.	Winnipeg	Flax fibre policy development	http://www.fc2015.ca
Flax Power Ltd	Brandon	Flax straw/shive firelogs	
Husky Oil Marketing Company	Minnedosa	Bio-ethanol	http://www.huskyenergy.ca
International Fibreboard Inc.	Winnipeg	Fibreboard	
Keystone Grain Ltd	Winkler	Sunflower hulls for biomass fuel	http://www.keystonegrain.com
Louisiana-Pacific Canada Ltd.	Swan River	Wood-based oriented strand board	http://www.lpcorp.com
Manitoba Bioenergy & Bioproducts Team	Winnipeg	Bioproducts knowledge and technology transfer	http://web2.gov.mb.ca/agriculture/programs/index.php?name=aaa01s03
Manitoba Environnemental Industries Association Inc.	Winnipeg	Environmental issues and opportunities	http://www.meia.mb.ca
Manitoba Hydro	Winnipeg	Biomass electricity	http://www.hydro.mb.ca
Manitoba Sustainable Energy Association		Bioenergy technology enabler	http://www.mansea.org

(continued)

Company Name	Location	Products/Services	Website
Marathon Composites	Winnipeg	biocomposites railway tie	
Nestibo Agra	Deloraine	Sunflower hulls for bioenergy	http://www.nestiboagra.com
Palliser Furniture Ltd.	Winnipeg	furniture	
Parkland BioFibre Ltd.	Dauphin	hemp fibre processing	http://www.pihg.net
Paskwayak Business Development Ltd.	The Pas	wood pellets	
Pineland Forest Nursery	Hadashville	biomass for heating greenhouse	http://www.pinelandforestnursery.com
Plains Industrial Hemp Processing Ltd.	Gilbert Plain	hemp fibre processing	
Prairie Bio-energy Inc.	La Broquerie	biomass cubes	http://www.prairiebioenergy.com
Prairie Pellet Company	St. Claude	wood stove pellets	
Prairie Pulp and Paper Inc.	Winnipeg	straw paper	http://www.prairie-paper.com
Prairies East Sustainable Agriculture Initiative	Arborg	forage seeds residue pellets	
Pro-Fab Industries	Arborg	biomass stove/boiler	http://www.pro-fab.ca
Schweitzer-Mauduit Canada Inc.	Winkler	flax fibre/paper; shives for fuel	http://www.schweitzer-mauduit.com
Solanyl Biopolymers Inc.	Carberry	starch bioplastics	http://www.solanylbiopolymers.com
Speedway International	Winnipeg	biodiesel	
Spruce Products Ltd		sawmills and pulpwood	
Tolko Industries Ltd.	The Pas	kraft paper mill and saw mill	http://www.tolko.com
Vanderveens' Greenhouses Ltd.	Carman	flax shives heated greenhouses	
Vidir Biomass Inc.	Arborg	biomass gasifier	http://www.vidirbiomass.com
Waugh's Woods Ltd	The Pas	specialty timbers	
Winnipeg Forest Products	Winnipeg	wood pellets	

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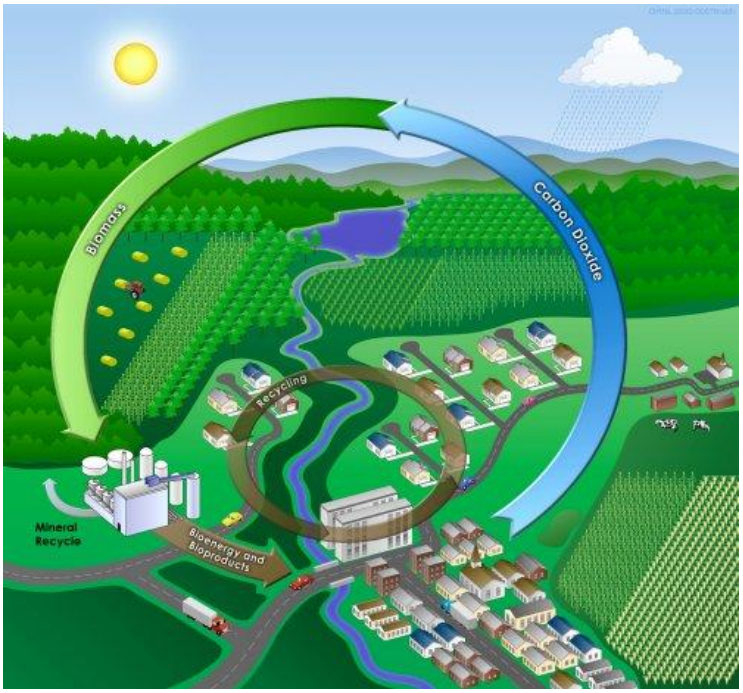

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