



8293

SUSTAINABLE ENERGY:
BIOMASS SYSTEMS (12C)

40S/40E/40M

A Sustainable Energy Course

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Course Description

This course focuses on the use of biomass energy for electricity, heat, and transportation (e.g., biodiesel). Manitoba is poised to be a leader in biomass energy, given its access to biomass resources (e.g., agricultural residues, forestry products) and government policies/legislation (e.g., *The Emissions Tax on Coal Act*). Students will explore significant biomass energy installation sites in Manitoba (e.g., Manitoba Hydro's Bioenergy Optimization Program sites), produce test-scale quantities of biodiesel, and plan a biomass heating or power system.

Topics include the following:

- biomass heating systems
- biomass power systems (e.g., synthesis gas, pyrolysis oil)
- combined heat and power systems
- biomass feedstock considerations (e.g., energy content, transportation, storage)
- safety practices and procedures

Goal 1: Describe and apply appropriate **health and safety practices** as they relate to the sustainable energy industry.

GLO 1.1: Demonstrate adherence to **safety practices and procedures** for **facilities, processes, tools, and equipment** used in the sustainable energy industry.

- SLO 12C.1.1.1: Demonstrate adherence to safety practices and procedures for facilities, processes, tools, and equipment used in the sustainable energy industry.
- SLO 12C.1.1.2: Describe health and safety requirements.
- SLO 12C.1.1.3: Describe personal protective equipment (PPE) and procedures.
- SLO 12C.1.1.4: Describe electrical safety practices and procedures.
- SLO 12C.1.1.5: Describe fire safety practices and procedures.
- SLO 12C.1.1.6: Describe ergonomic considerations related to the sustainable energy industry.
- SLO 12C.1.1.7: Describe hazard recognition and control practices.
- SLO 12C.1.1.8: Describe the hazards of confined space entry.

- SLO 12C.1.1.9: Describe safety requirements as they apply to the Workplace Hazardous Materials Information System (WHMIS).
- SLO 12C.1.1.10: Describe the identification and control of specified hazards.
- SLO 12C.1.1.11: Demonstrate safe work practices related to the sustainable energy industry.
- SLO 12C.1.1.12: Describe safety guidelines related to the sustainable energy industry.
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Goal 2: Demonstrate the safe and appropriate **operation, handling, cleaning, maintenance, and storage of equipment, tools, materials, products, and consumable items.**

GLO 2.1: Demonstrate the safe and appropriate **operation and handling** of equipment, tools, materials, products, and consumable items.

- SLO 12C.2.1.1: Demonstrate the safe and appropriate operation and handling of equipment, tools, materials, products, and consumable items used in biomass energy systems.
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GLO 2.2: Demonstrate the safe and appropriate **cleaning, maintenance, and storage** of equipment, tools, materials, products, and consumable items.

- SLO 12C.2.2.1: Demonstrate the safe and appropriate cleaning, maintenance, and storage of equipment, tools, materials, products, and consumable items used in biomass energy systems.
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Goal 3: Demonstrate an understanding of **demand-side management (DSM)** as it applies to sustainable energy.

GLO 3.1: Demonstrate an understanding of **DSM** as it applies to sustainable energy.

- SLO 12C.3.1.1: Demonstrate an awareness of designs and processes that maximize the efficiency of biomass energy systems.
- SLO 12C.3.1.2: Demonstrate the ability to conduct a cost-benefit analysis of biomass energy systems.
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Goal 4: Demonstrate the knowledge and skills required to **promote and plan sustainable energy systems.**

GLO 4.1: Demonstrate the knowledge and skills required to **promote sustainable energy systems.**

SLO 12C.4.1.1: Describe existing strategies, both in the private and public sectors (e.g., Manitoba Growth, Enterprise and Trade, Manitoba Hydro, Manitoba Sustainable Energy Association, EnergyManitoba), that promote biomass energy systems in Manitoba.

GLO 4.2: Demonstrate the knowledge and skills required to **plan sustainable energy systems.**

SLO 12C.4.2.1: Perform an energy audit for a building proposed as a site for the installation of a biomass energy (heating or electrical) system.

SLO 12C.4.2.2: Evaluate the energy content of feedstock options for a biomass energy system.

SLO 12C.4.2.3: Size a biomass energy system according to the energy content of feedstock options (e.g., total watt-hours/day, peak instantaneous power use, peak heat use, duty cycle, peak load versus base load).

SLO 12C.4.2.4: Determine the current local availability of biomass feedstock, and predict future feedstock availability.

SLO 12C.4.2.5: Plan appropriate biomass feedstock logistics (e.g., delivery, storage).

SLO 12C.4.2.6: Determine an appropriate battery bank set-up for a biomass electrical system.

SLO 12C.4.2.7: Plan a small-scale set-up to produce biodiesel.

SLO 12C.4.2.8: Discuss logistics (e.g., removal, storage) related to ash content in feedstock.

Goal 5: Demonstrate the knowledge and skills required to **install or convert sustainable energy systems.**

GLO 5.1: Demonstrate the knowledge and skills required to **perform the installation or conversion of sustainable energy systems.**

SLO 12C.5.1.1: Participate in the installation or conversion of a biomass energy system (for either electricity generation or heat).

SLO 12C.5.1.2: Produce a test batch of biodiesel, and run a small diesel engine with the biodiesel.

Goal 6: Demonstrate the knowledge and skills required to **maintain sustainable energy systems**.

GLO 6.1: Demonstrate the knowledge and skills required to **perform preventive maintenance** of sustainable energy systems.

SLO 12C.6.1.1: Monitor a biomass energy system to determine whether it is operating to its designed specifications.

GLO 6.2: Demonstrate the knowledge and skills required to **diagnose malfunctions** in sustainable energy systems.

SLO 12C.6.2.1: Discuss the relationship between malfunctions and energy efficiency in biomass energy systems.

SLO 12C.6.2.2: Describe the two levels (component and system levels) of troubleshooting biomass energy systems.

SLO 12C.6.2.3: Monitor and collect data on biomass energy system performance (e.g., temperature, pressure, voltage, amperage, resistance).

GLO 6.3: Demonstrate the knowledge and skills required to **repair** sustainable energy systems.

SLO 12C.6.3.1: Read and demonstrate an understanding of product warranties.

SLO 12C.6.3.2: Repair biomass energy systems.

Goal 7: Describe and apply transferable **cross-curricular knowledge and skills** as they relate to sustainable energy.

GLO 7.1: Demonstrate **information and communication technology** skills required in the sustainable energy industry.

SLO 12C.7.1.1: Demonstrate how geographic information systems (GIS) can be used to inform decisions on fuel selection for biomass energy systems.

GLO 7.2: **Read, interpret, and communicate information** related to the sustainable energy industry.

SLO 12C.7.2.1: Read, interpret, and communicate information related to biomass energy systems.

SLO 12C.7.2.2: Read, interpret, and communicate information from electrical schematics.

GLO 7.3: Demonstrate knowledge of **mathematical** concepts and skills related to the sustainable energy industry.

- SLO 12C.7.3.1: Demonstrate knowledge of mathematics skills related to biomass energy systems.
 - SLO 12C.7.3.2: Convert between imperial and metric systems of measurement.
 - SLO 12C.7.3.3: Demonstrate the use of fractions, decimals, ratios, and percentages.
 - SLO 12C.7.3.4: Apply mathematical formulas to electrical calculations.
 - SLO 12C.7.3.5: Demonstrate knowledge of load-duration and demand-duration curves.
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GLO 7.4: Demonstrate knowledge of **science** as it relates to the sustainable energy industry.

- SLO 12C.7.4.1: Demonstrate knowledge of science as it relates to sustainable biomass energy systems.
 - SLO 12C.7.4.2: Apply scientific knowledge and equations to electrical Ohm's law formulas.
 - SLO 12C.7.4.3: Define terminology associated with electrical fundamentals.
 - SLO 12C.7.4.4: Describe current and electron flow in direct current (DC) and alternating current (AC) circuits.
 - SLO 12C.7.4.5: Describe the relationships between voltage, current, resistance, and power.
 - SLO 12C.7.4.6: Calculate voltage, current, and resistance in series, parallel, and combination circuits.
 - SLO 12C.7.4.7: Identify, and describe the characteristics of, series, parallel, and series-parallel electrical circuits.
 - SLO 12C.7.4.8: Demonstrate measuring voltage, resistance, current, and power.
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Goal 8: Demonstrate an understanding of the **ethical and legal standards** that pertain to the sustainable energy industry.

GLO 8.1: Demonstrate an awareness of the **ethical and legal expectations** of the sustainable energy industry.

- SLO 12C.8.1.1: Demonstrate an understanding of the need to adhere to local authority requirements (e.g., permit, insurance, emission regulations) related to sustainable energy.
 - SLO 12C.8.1.2: Demonstrate an understanding of the importance of accurate performance reporting for biomass energy systems.
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Goal 9: Practise **employability skills** required in the sustainable energy industry.

GLO 9.1: Demonstrate **employability skills**.

- SLO 12C.9.1.1: Demonstrate problem-solving skills.
- SLO 12C.9.1.2: Demonstrate critical thinking skills.
- SLO 12C.9.1.3: Demonstrate regular attendance and punctuality.
- SLO 12C.9.1.4: Demonstrate accountability by taking responsibility for own actions.
- SLO 12C.9.1.5: Demonstrate adaptability, initiative, and effort.
- SLO 12C.9.1.6: Demonstrate the ability to accept feedback and to follow direction.
- SLO 12C.9.1.7: Demonstrate teamwork skills.
- SLO 12C.9.1.8: Demonstrate the ability to stay on task and to make effective use of time in class and shop environments.
- SLO 12C.9.1.9: Demonstrate the ability to communicate respectfully and effectively with co-workers and customers.

Goal 10: Demonstrate an awareness of **sustainability** as it pertains to the sustainable energy industry.

GLO 10.1: Describe the impact of **sustainability** on the **health and well-being** of sustainable energy industry workers, their customers, and those who are affected by their products and services.

- SLO 12C.10.1.1: Discuss the benefits of biomass energy systems to human health and well-being.
- SLO 12C.10.1.2: Discuss how biomass energy systems can negatively affect humans (e.g., emissions).

GLO 10.2: Describe the sustainable energy industry's **sustainability practices and their impact on the environment**.

- SLO 12C.10.2.1: Describe sustainability practices related to biomass energy systems and their impact on the environment.

GLO 10.3: Describe the **relationship between the economy and sustainability practices** within the sustainable energy industry.

- SLO 12C.10.3.1: Discuss the effect of biomass energy systems on the local and national economies.
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Goal 11: Demonstrate an understanding of **career options** in sustainable energy.

GLO 11.1: Describe **apprenticeship, post-secondary education, and employment opportunities** related to sustainable energy.

SLO 12C.11.1.1: Describe apprenticeship, post-secondary education, and employment opportunities related to biomass energy systems.

Goal 12: Demonstrate an understanding of the **evolution** of sustainable energy, including its **technological progression** and **emerging trends**.

GLO 12.1: Demonstrate an understanding of the **evolution** of sustainable energy, including its **technological progression** and **emerging trends**.

SLO 12C.12.1.1: Demonstrate an understanding of the evolution of biomass energy systems, including their technological progression and emerging trends.
