



8245

SUSTAINABLE ENERGY:
HEATING/COOLING SYSTEMS
(11B)

30S/30E/30M

A Sustainable Energy Course

8245: SUSTAINABLE ENERGY: HEATING/COOLING SYSTEMS (11B)

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Course Description

This course focuses on how to heat and cool residential and commercial buildings with ground-source heat pumps and with biomass and solar thermal systems.

Topics include the following:

- thermodynamics
- fundamentals of heat transfer as related to sustainable heating/cooling systems
- design and sizing of sustainable heating/cooling systems
- 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 11B.1.1.1: Demonstrate adherence to safety practices and procedures for facilities, processes, tools, and equipment used in the sustainable energy industry.
- SLO 11B.1.1.2: Identify health and safety requirements.
- SLO 11B.1.1.3: Identify personal protective equipment (PPE) and procedures.
- SLO 11B.1.1.4: Identify electrical safety practices and procedures.
- SLO 11B.1.1.5: Identify fire safety practices and procedures.
- SLO 11B.1.1.6: Identify ergonomic considerations related to the sustainable energy industry.
- SLO 11B.1.1.7: Identify hazard recognition and control practices.
- SLO 11B.1.1.8: Describe the hazards of confined space entry.
- SLO 11B.1.1.9: Identify safety requirements as they apply to the Workplace Hazardous Materials Information System (WHMIS).
- SLO 11B.1.1.10: Describe the identification and control of specified hazards.

- SLO 11B.1.1.11: Identify safe work practices related to the sustainable energy industry.
- SLO 11B.1.1.12: Identify safety guidelines related to the sustainable energy industry.
- SLO 11B.1.1.13: Identify safe material-handling procedures.
- SLO 11B.1.1.14: Read, interpret, and communicate safety information (e.g., material safety data sheets [MSDS]) related to sustainable energy.
- SLO 11B.1.1.15: Demonstrate safe practices for working from heights, including ladder safety.
- SLO 11B.1.1.16: Demonstrate safe practices for working with fire, including air quality considerations.
- SLO 11B.1.1.17: Demonstrate safe practices for working in confined spaces.

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 11B.2.1.1: Demonstrate the safe and appropriate operation and handling of hand tools (e.g., hammer, saw, screwdriver, wrench, pliers, metal cutters, utility knife).
- SLO 11B.2.1.2: Demonstrate the safe and appropriate operation and handling of power tools (e.g., drill, skill saw, table saw).
- SLO 11B.2.1.3: Demonstrate the safe and appropriate operation and handling of instruments (e.g., for monitoring temperature, air quality) related to heating/cooling with sustainable energy.

GLO 2.2: Demonstrate the safe and appropriate **cleaning, maintenance, and storage** of equipment, tools, materials, products, and consumable items.

- SLO 11B.2.2.1: Demonstrate the safe and appropriate cleaning, maintenance, and storage of hand tools (e.g., hammer, saw, screwdriver, wrench, pliers, metal cutters, utility knife).
- SLO 11B.2.2.2: Demonstrate the safe and appropriate cleaning, maintenance, and storage of power tools (e.g., drill, skill saw, table saw).
- SLO 11B.2.2.3: Demonstrate the safe and appropriate storage of feedstock for use as biomass heating fuel.

SLO 11B.2.2.4: Demonstrate the safe and appropriate storage of solar thermal equipment and materials.

SLO 11B.2.2.5: Demonstrate the safe and appropriate storage of geothermal equipment and materials.

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 11B.3.1.1: Demonstrate an awareness of energy-efficient heating and cooling systems.

SLO 11B.3.1.2: Demonstrate an awareness of the retrofitting of existing heating and cooling systems.

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 11B.4.1.1: Demonstrate an understanding of the different heating/cooling system options (e.g., ground-source heat pump [GSHP], solar air, solar water, biomass energy systems).

SLO 11B.4.1.2: Demonstrate an understanding of the energy savings of sustainable energy systems compared to those of conventional systems.

SLO 11B.4.1.3: Demonstrate an understanding of the function of the basic GSHP components (e.g., heat pump, earth connection, heating/cooling-distribution system).

SLO 11B.4.1.4: Demonstrate an understanding of the function of the basic components (e.g., heating plant, heat-distribution system, biomass fuel-supply operation) of biomass heating systems.

SLO 11B.4.1.5: Demonstrate an understanding of the function of the basic components (e.g., optimal window surface area, orientation, thermal properties) of passive solar heat systems.

SLO 11B.4.1.6: Demonstrate an understanding of the function of the basic components (e.g., collection, transfer, storage) of solar hot water systems.

SLO 11B.4.1.7: Demonstrate an understanding of the function of the basic components (e.g., solar collector, air-distribution system) of solar air systems.

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

- SLO 11B.4.2.1: Demonstrate an understanding of the site considerations (e.g., permits, soil characterization, sun exposure) involved in planning sustainable heating/cooling systems.
- SLO 11B.4.2.2: Demonstrate an understanding of how to size sustainable energy heating/cooling systems.
- SLO 11B.4.2.3: Demonstrate an understanding of proper product selection (e.g., tubing, collector, storage) related to heating/cooling systems.

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 11B.5.1.1: Demonstrate an understanding of GSHP installation basics (e.g., excavation, loop options, orientations).
- SLO 11B.5.1.2: Demonstrate an understanding of solar air system installation basics.
- SLO 11B.5.1.3: Demonstrate an understanding of solar water system installation basics.
- SLO 11B.5.1.4: Demonstrate an understanding of passive solar system installation basics.
- SLO 11B.5.1.5: Demonstrate an understanding of biomass system installation basics.

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 11B.6.1.1: Demonstrate adherence to manufacturers' warranty conditions for installing sustainable heating/cooling systems (GSHP, solar air, solar water, passive solar, and biomass).
 - SLO 11B.6.1.2: Perform preventive maintenance of sustainable heating/cooling systems.
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GLO 6.2: Demonstrate the knowledge and skills required to **diagnose malfunctions** in sustainable energy systems.

SLO 11B.6.2.1: Read site and system schematics for installing GSHP, solar air, solar water, passive solar, and biomass systems.

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

SLO 11B.6.3.1: Demonstrate an understanding of how to select an appropriate maintenance contractor for installing GSHP, solar air, solar water, passive solar, and biomass 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 11B.7.1.1: Demonstrate the use of information and communication technology to research topics in sustainable energy.

SLO 11B.7.1.2: Demonstrate an understanding of how to communicate with a variety of trade sectors (e.g., drillers, electricians, biomass feedstock providers).

SLO 11B.7.1.3: Demonstrate the use of spreadsheet-based software in modelling, and in calibrating models of, heating systems.

SLO 11B.7.1.4: Demonstrate project-management skills, such as procurement, tracking, and billing.

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

SLO 11B.7.2.1: Demonstrate the ability to read and interpret system schematics.

SLO 11B.7.2.2: Demonstrate the ability to read and interpret a manufacturer's warrantee.

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

SLO 11B.7.3.1: Solve problems involving fractions.

SLO 11B.7.3.2: Solve problems involving decimals.

SLO 11B.7.3.3: Solve problems involving percentages and ratios.

SLO 11B.7.3.4: Solve problems involving metric and imperial measurements.

SLO 11B.7.3.5: Solve problems involving geometric formulas.

- SLO 11B.7.3.6: Calculate quality parameters (e.g., moisture content, volatile matter content) of biomass feedstock.
 - SLO 11B.7.3.7: Demonstrate an understanding of the usable incident solar energy calculation.
 - SLO 11B.7.3.8: Demonstrate an understanding of the Fourier law of heat conduction.
 - SLO 11B.7.3.9: Demonstrate an understanding of Newton's law of cooling (R-value).
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GLO 7.4: Demonstrate knowledge of **science** as it relates to the sustainable energy industry.

- SLO 11B.7.4.1: Demonstrate knowledge of science as it relates to sustainable heating/cooling systems.
 - SLO 11B.7.4.2: Describe the difference between heat and temperature.
 - SLO 11B.7.4.3: Demonstrate an understanding of the laws of thermodynamics.
 - SLO 11B.7.4.4: Demonstrate an understanding of latent heat.
 - SLO 11B.7.4.5: Demonstrate an understanding of heat-transfer mechanisms (e.g., conduction, convection, radiation).
 - SLO 11B.7.4.6: Demonstrate an understanding of combustion basics.
 - SLO 11B.7.4.7: Demonstrate an understanding of the refrigeration cycle.
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GLO 7.5: Demonstrate knowledge of **physical education/health education** as it relates to the sustainable energy industry.

- SLO 11B.7.5.1: Demonstrate proper lifting techniques to avoid back injury.
 - SLO 11B.7.5.2: Ensure proper ventilation while working with biomass systems to avoid exposure to toxic exhaust.
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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 11B.8.1.1: Demonstrate an understanding of the importance of the contractor-consumer relationship, which should involve full disclosure.
 - SLO 11B.8.1.2: Demonstrate an understanding of the need to adhere to local authority requirements (e.g., permit regulations) related to heating/cooling systems.
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Goal 9: Practise **employability skills** required in the sustainable energy industry.

GLO 9.1: Demonstrate **employability skills**.

- SLO 11B.9.1.1: Demonstrate problem-solving skills.
- SLO 11B.9.1.2: Demonstrate critical thinking skills.
- SLO 11B.9.1.3: Demonstrate regular attendance and punctuality.
- SLO 11B.9.1.4: Demonstrate accountability by taking responsibility for own actions.
- SLO 11B.9.1.5: Demonstrate adaptability, initiative, and effort.
- SLO 11B.9.1.6: Demonstrate the ability to accept feedback and to follow direction.
- SLO 11B.9.1.7: Demonstrate teamwork skills.
- SLO 11B.9.1.8: Demonstrate the ability to stay on task and to make effective use of time in class and shop environments.
- SLO 11B.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 11B.10.1.1: Discuss the impact of sustainable heating/cooling systems on human health and well-being.
- SLO 11B.10.1.2: Describe the relationship between the proper design and installation and the long-term sustainability of sustainable energy technologies.
- SLO 11B.10.1.3: Describe how sustainable energy technologies address the issue of energy security.

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

- SLO 11B.10.2.1: Demonstrate the understanding that switching from conventional to sustainable heating/cooling systems will reduce greenhouse gas emissions.
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GLO 10.3: Describe the **relationship between the economy and sustainability practices** within the sustainable energy industry.

SLO 11B.10.3.1: Describe Manitoba's provincial strategy for using energy as a source of economic development and wealth retention.

SLO 11B.10.3.2: Describe how biomass heating systems can add value to agricultural crops.

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 11B.11.1.1: Demonstrate an understanding of the various apprenticeship programs available in the area of heating/cooling systems, especially as they relate to sustainable energy.

SLO 11B.11.1.2: Demonstrate an understanding of the various post-secondary degree and diploma programs available in the area of heating/cooling systems, especially as they relate to sustainable energy.

SLO 11B.11.1.3: Demonstrate an understanding of the various entry- and advanced-level employment opportunities available in the area of heating/cooling systems, especially as they relate to sustainable energy.

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 11B.12.1.1: Discuss how the cost of sustainable energy technologies per unit decreases and performance increases over time.

SLO 11B.12.1.2: Discuss how sustainable energy systems will become economically more attractive as fossil fuels become scarcer.

SLO 11B.12.1.3: Demonstrate an understanding of the latest industry trends.
