# 8234
# SUSTAINABLE ENERGY: ELECTRICAL SYSTEMS (11A)

30S/30E/30M

A Sustainable Energy Course

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## Course Description

This course explores systems that generate electricity without using fossil fuels as their primary energy source. Students will learn how to size, install, and maintain solar photovoltaic and small wind electrical systems.

Topics include the following:

- small wind electrical system installation
- solar photovoltaic system installation
- wind farm siting considerations
- safety practices and procedures

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**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 11A.1.1.1: Demonstrate adherence to safety practices and procedures for facilities, processes, tools, and equipment used in the sustainable energy industry.

SLO 11A.1.1.2: Identify health and safety requirements.

SLO 11A.1.1.3: Identify personal protective equipment (PPE) and procedures.

SLO 11A.1.1.4: Identify electrical safety practices and procedures.

SLO 11A.1.1.5: Identify fire safety practices and procedures.

SLO 11A.1.1.6: Identify ergonomic considerations related to the sustainable energy industry.

SLO 11A.1.1.7: Identify hazard recognition and control practices.

SLO 11A.1.1.8: Describe the hazards of confined space entry.

SLO 11A.1.1.9: Identify safety requirements as they apply to the Workplace Hazardous Materials Information System (WHMIS).

SLO 11A.1.1.10: Describe the identification and control of specified hazards.

SLO 11A.1.1.11: Identify safe work practices related to the sustainable energy industry.

SLO 11A.1.1.12: Identify safety guidelines related to the sustainable energy industry.

SLO 11A.1.1.13: Identify safe material-handling procedures.

SLO 11A.1.1.14: Read, interpret, and communicate safety information (e.g., material safety data sheets [MSDS]) related to sustainable energy.

SLO 11A.1.1.15: Demonstrate safe practices for working from heights, including ladder safety.

SLO 11A.1.1.16: Demonstrate an understanding of work-site safety at wind farms.

SLO 11A.1.1.17: Demonstrate safe practices for working with electrical systems.

SLO 11A.1.1.18: Demonstrate safe practices for solar panel installation.

## 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 11A.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 11A.2.1.2: Demonstrate the safe and appropriate operation and handling of power tools (e.g., drill, skill saw, table saw).

SLO 11A.2.1.3: Demonstrate the safe and appropriate operation and handling of instruments related to electrical work.

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

SLO 11A.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 11A.2.2.2: Demonstrate the safe and appropriate cleaning, maintenance, and storage of power tools (e.g., drill, skill saw, table saw).

## 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 11A.3.1.1: Define *demand-side management* (DSM) and demonstrate an awareness of its place in energy systems, including the benefits of DSM and retrofitting existing electrical 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 11A.4.1.1: Describe the advantages and disadvantages of different types of wind turbines.

SLO 11A.4.1.2: Identify the advantages and disadvantages of wind- and solar-generated electricity.

SLO 11A.4.1.3: Differentiate between direct and indirect solar energy, thermal and photovoltaic (PV) energy, and active and passive solar energy systems.

SLO 11A.4.1.4: Demonstrate an understanding of the function of the basic components (e.g., rotor, gearbox, tower, foundation, control system) of wind turbines.

SLO 11A.4.1.5: Demonstrate an understanding of the function of the basic components (e.g., collectors, batteries, inverters, controllers, structure) of solar PV systems.

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

SLO 11A.4.2.1: Conduct an economic feasibility analysis of switching from hydroelectricity to wind- or solar-generated electricity.

SLO 11A.4.2.2: Conduct a wind resource assessment.

SLO 11A.4.2.3: Determine the most appropriate sites for solar PV systems.

SLO 11A.4.2.4: Determine the most appropriate sites for wind farms.

**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 11A.5.1.1: Demonstrate the skills needed to install a small wind turbine.

SLO 11A.5.1.2: Demonstrate the skills needed to install a solar PV system.

**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 11A.6.1.1: Demonstrate preventive maintenance of wind turbines and rotors.

SLO 11A.6.1.2: Demonstrate preventive maintenance of solar PV systems.

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

SLO 11A.6.2.1: Demonstrate tests to diagnose failures in wind turbines and rotors.

SLO 11A.6.2.2: Demonstrate tests to diagnose failures in solar PV systems.

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

SLO 11A.6.3.1: Demonstrate the knowledge and skills required to repair failures in small wind turbine systems.

SLO 11A.6.3.2: Demonstrate the knowledge and skills required to repair failures in solar PV 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 11A.7.1.1: Demonstrate the use of information and communication technology to research topics in sustainable energy.

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

SLO 11A.7.2.1: Demonstrate an understanding of provincial and federal policy related to solar- and wind-generated electricity.

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

SLO 11A.7.3.1: Solve problems involving fractions.

SLO 11A.7.3.2: Solve problems involving decimals.

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

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

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

SLO 11A.7.3.6: Discuss the importance of the Reynolds number as it relates to wind turbines.

SLO 11A.7.3.7: Discuss the importance of the angle of attack as it relates to wind turbines.

SLO 11A.7.3.8: Discuss the importance of resultant velocity as it relates to wind turbines.

SLO 11A.7.3.9: Discuss the importance of the power curve as it relates to wind turbines.

SLO 11A.7.3.10: Demonstrate an understanding of the importance of the Betz limit as it relates to wind turbines.

SLO 11A.7.3.11: Demonstrate an understanding of the importance of the tip speed ratio (TSR) as it relates to wind turbines.

SLO 11A.7.3.12: Calculate how much solar energy strikes various surfaces.

SLO 11A.7.3.13: Calculate solar collector efficiency.

SLO 11A.7.3.14: Describe solar orientation related to solar energy.

**GLO 7.4:** Demonstrate knowledge of **science** as it relates to the sustainable energy industry.

SLO 11A.7.4.1: Demonstrate knowledge of science as it relates to sustainable electrical systems.

SLO 11A.7.4.2: Demonstrate an understanding of electronic principles as they relate to generating electricity with wind and solar energy.

SLO 11A.7.4.3: Describe the electromagnetic spectrum in terms of frequency, wavelength, and energy.

**GLO 7.5:** Demonstrate knowledge of **physical education/health education** as it relates to the sustainable energy industry.

SLO 11A.7.5.1: Discuss the level of fitness needed to work on large wind turbines.

SLO 11A.7.5.2: Discuss the stress (e.g., noise pollution, aesthetic concerns) experienced by neighbours of large wind turbines.

## 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 11A.8.1.1: Demonstrate an understanding of the ethical responsibility of communicating with neighbours prior to the installation of solar or wind systems.

SLO 11A.8.1.2: Demonstrate an understanding of the criteria that trigger federal regulatory processes for solar and wind energy projects.

## Goal 9: Practise **employability skills** required in the sustainable energy industry.

**GLO 9.1:** Demonstrate **employability skills**.

SLO 11A.9.1.1: Demonstrate problem-solving skills.

SLO 11A.9.1.2: Demonstrate critical thinking skills.

SLO 11A.9.1.3: Demonstrate regular attendance and punctuality.

SLO 11A.9.1.4: Demonstrate accountability by taking responsibility for own actions.

SLO 11A.9.1.5: Demonstrate adaptability, initiative, and effort.

SLO 11A.9.1.6: Demonstrate the ability to accept feedback and to follow direction.

SLO 11A.9.1.7: Demonstrate teamwork skills.

SLO 11A.9.1.8: Demonstrate the ability to stay on task and to make effective use of time in class and shop environments.

SLO 11A.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 11A.10.1.1: Discuss the impact of sustainable electrical systems on human health and well-being.

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

SLO 11A.10.2.1: Compare and contrast the environmental impact of hydroelectric dams and sustainable electrical energy sources.

SLO 11A.10.2.2: Demonstrate an understanding of the impact of wind turbines on birds and bats.

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

SLO 11A.10.3.1: Describe Manitoba Hydro's economic strategy related to sustainable sources of electricity.

**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 11A.11.1.1: Demonstrate an understanding of the various apprenticeship programs available in the area of electrical systems, especially as they relate to sustainable energy.

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

SLO 11A.11.1.3: Demonstrate an understanding of the various entry- and advanced-level employment opportunities available in the area of electrical 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 11A.12.1.1: Discuss how the cost of sustainable energy technologies per unit decreases and performance increases over time.

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

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

SLO 11A.12.1.4: Demonstrate an understanding of the rationale for utility-scale wind farms in Manitoba.