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Course 4: Renewable Energy Integration in Agriculture

M3: Wind and Biomass Energy Applications

Co-funded by the European Union

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What will you learn?

This module aims to provide a wide understanding of wind and biomass energy applications in modern agriculture. It will explore the use of wind turbines to power large-scale farming operations, ensuring energy efficiency and sustainability.

You will gain insight into the cost-effectiveness and environmental benefits of wind and biomass energy, including reduced reliance on fossil fuels, lower energy costs, and decreased greenhouse gas emissions.

By the end of this module, you will have a clear understanding of how wind and biomass energy can be integrated into farming practices, helping to achieve energy independence while promoting environmental sustainability.

Understand…

… using wind turbines for powering large-scale operations

Identify…

… how to convert agricultural waste into bioenergy

Explain…

… cost-effectiveness and environmental benefits of wind and biomass

contents

This module is dedicated to wind energy and biomass. You will learn about the cost-effectiveness and environmental benefits of these energy sources.

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01

USING WIND TURBINES FOR POWERING LARGE-SCALE OPERATIONS

Overview

Wind turbines are becoming an increasingly popular solution for farms that want to achieve energy independence and reduce operating costs. Thanks to their ability to generate large amounts of electricity (day & night), wind turbines are perfect for powering large farms, processing plants and irrigation systems.

How do wind turbines support agriculture?

Powering outbuildings

wind energy can be used to power cold stores, warehouses and administrative buildings.

Production and storage of animal feed

modern farms use energy to operate mills, dryers and animal feed storage facilities.

Powering biogas plants and other renewable technologies

wind energy can be used to power installations that convert agricultural waste into biogas.

Energy storage

in combination with batteries or hybrid systems, wind turbines can provide power even in periods of low wind speed.

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Wind farm in Poland

One example of a European farm using wind energy is the wind farm in Potęgowo, Poland. Although the wind farm itself is a large energy investment, its location in a region with a long agricultural tradition shows how renewable energy can coexist with agriculture. The Potęgowo wind farm was commissioned in December 2020 and consists of 81 turbines with a total capacity of 219 MW, making it the largest installation of its kind in Poland. The farm is an example of how agricultural regions can become leaders in green energy production while supporting the local economy and community.

02

CONVERTING FARM WASTE INTO BIOENERGY: DIGESTERS & BIOMASS SYSTEMS

Converting agricultural waste into bioenergy

Modern agriculture generates large amounts of organic waste, such as plant residues, manure and food waste. Instead of being disposed of, they can be used to produce bioenergy, which reduces operating costs, greenhouse gas emissions and increases the sustainability of the farm.

Two key systems that enable the conversion of waste into energy are **digesters** (biogas plants) and **biomass systems**.

Digesters and biogas production

Digesters, also known as biogas plants, use the process of anaerobic fermentation, in which microorganisms break down organic waste to produce biogas. Biogas consists mainly of methane (CH_4) and carbon dioxide (CO_2) and can be used to generate electricity, heat or as a fuel for vehicles.

Biogas can be used for:

- **Production of electricity and heat –** in combined heat and power (CHP) units.
- **Fuel for heating boilers –** as an alternative to natural gas.
- **Purification and compression –** to the quality of biomethane, which can be used as a vehicle fuel.

MyGug – production of biogas from food waste

MyGug is an Irish company that has developed an innovative micro-biogas system for converting food waste into renewable energy and fertiliser.

Technology: MyGug uses an anaerobic fermentation process to convert food waste (both raw and cooked) into biogas for cooking and liquid fertiliser for crops.
Application: MyGug systems are designed for households, small catering businesses, schools and farms, enabling them to manage their waste locally and produce energy.

Efficiency: The smallest model (MyGug Mini) processes up to 5.5 kg of waste per day, providing up to 3 hours of cooking energy and 11 litres of fertiliser.
Environmental benefits: MyGug systems operate in a variety of climatic conditions (from -20°C to +40°C), reduce greenhouse gas emissions and support the circular economy.

www.mygug.eu

Biomass systems in agriculture

Biomass refers to organic materials such as wood, straw, vegetable waste or wood chips that can be burned to produce heat and electricity. Biomass boilers and biomass gasification systems are often used in agriculture.

Biomass systems can be used for:

- **Heating buildings and greenhouses –** biomass energy can be used to heat farm buildings, warehouses and greenhouses.
- **Powering grain drying systems –** biomass is used to produce heat in grain drying processes.
- **Production of fuel –** agricultural waste can be converted into briquettes or pellets used for heating or energy production.

03

COST-EFFECTIVENESS & ENVIRONMENTAL BENEFITS OF WIND AND BIOMASS

Overview

The use of renewable energy in agriculture is becoming increasingly popular due to its economic and environmental benefits. When comparing wind and biomass energy systems, it is worth noting several key technical and economic aspects. First of all, they differ in terms of initial investment costs. The installation of wind turbines involves high costs — the average cost of purchasing and installing a 1 MW turbine ranges from EUR 1 to 1.5 million. On the other hand, biomass installations, although their cost depends on the scale and technology, can be cheaper for smaller, local systems — from approximately EUR 0.5 to 2 million per 1 MW.

Another difference is the operating and maintenance costs. Once operational, wind energy generates relatively low operating costs — turbine maintenance is periodic and mainly involves monitoring.

Meanwhile, biomass-based systems are more demanding: regular fuel supplies, storage, boiler maintenance and disposal of combustion products such as ash are necessary.

The availability and reliability of raw materials is also an important issue. Wind is free and renewable, but its intensity is variable and depends on location and weather conditions. Biomass, on the other hand, requires a constant supply of organic material, such as wood, straw or agricultural waste, which makes this system vulnerable to logistical disruptions and fluctuations in raw material prices.

In terms of energy production stability, wind systems are dependent on weather conditions – lack of wind or excessive wind can temporarily shut down turbines. Meanwhile, biomass installations ensure continuity of energy production as long as regular fuel supplies are guaranteed, making them more predictable in operation.

There are also differences in the unit costs of energy produced (LCOE – Levelized Cost of Energy). In 2023, wind energy was one of the cheapest sources of electricity in the world, with an average cost of between EUR 0.04 and EUR 0.06/kWh (IRENA, 2023). Biomass, on the other hand, is characterised by greater cost variation – depending on the type of raw material and the technology used, LCOE ranges from 0.05 to 0.15 EUR/kWh (IEA Bioenergy, 2023).

Cost-effectiveness and advantages of wind turbines in agriculture

Wind turbines can significantly **reduce electricity costs** on farms that use large amounts of electricity, e.g. for irrigation, cooling or machine operation.

Initial costs – wind turbines require an investment in equipment and installation but can pay for themselves after a few years.
Low operating costs – the turbines have a long service life (20–25 years) and require minimal maintenance.
Additional income – the possibility of selling surplus energy to the power grid.
Use of wasteland – turbines can be installed on unused areas without taking up arable land.
Enviromental benefits - Wind turbines reduce greenhouse gas emissions, lower reliance on fossil fuels, and allow farms to generate clean, renewable energy with minimal land disruption.

Cost-effectiveness and advantages of biomass systems

Biomass allows farmers to use agricultural and organic waste to produce heat and electricity. This solution is particularly beneficial for farms that produce large amounts of plant or livestock waste.

Reduction of heating costs - biomass boilers can replace expensive fossil fuels, such as fuel oil or gas.
Use of own resources – agricultural waste can be incinerated or converted into biogas, which reduces energy purchase costs.
Financial support – many countries offer subsidies for biomass installations, which speeds up the return on investment.
Recycling agricultural waste – converting plant residues and manure into energy reduces waste.

How do wind turbines work?

Every 24 hours, wind generates enough kinetic energy to produce roughly 35 times more electricity than humanity uses each day. And unlike coal or oil, this resource is totally renewed each day. So how can we harness this incredible amount of energy, and is it possible to create a world powered entirely by wind?

Find information in this video

How does a biogas plant work?

Information about a professional, large-scale biogas plant – this video gives us a virtual tour through an EnviTec Biogas plant. The animation shows how energy is produced from biogas and how it can be used to produce heat, electricity or even natural gas

How does a biogas plant work?

04

LET’S PRACTICE

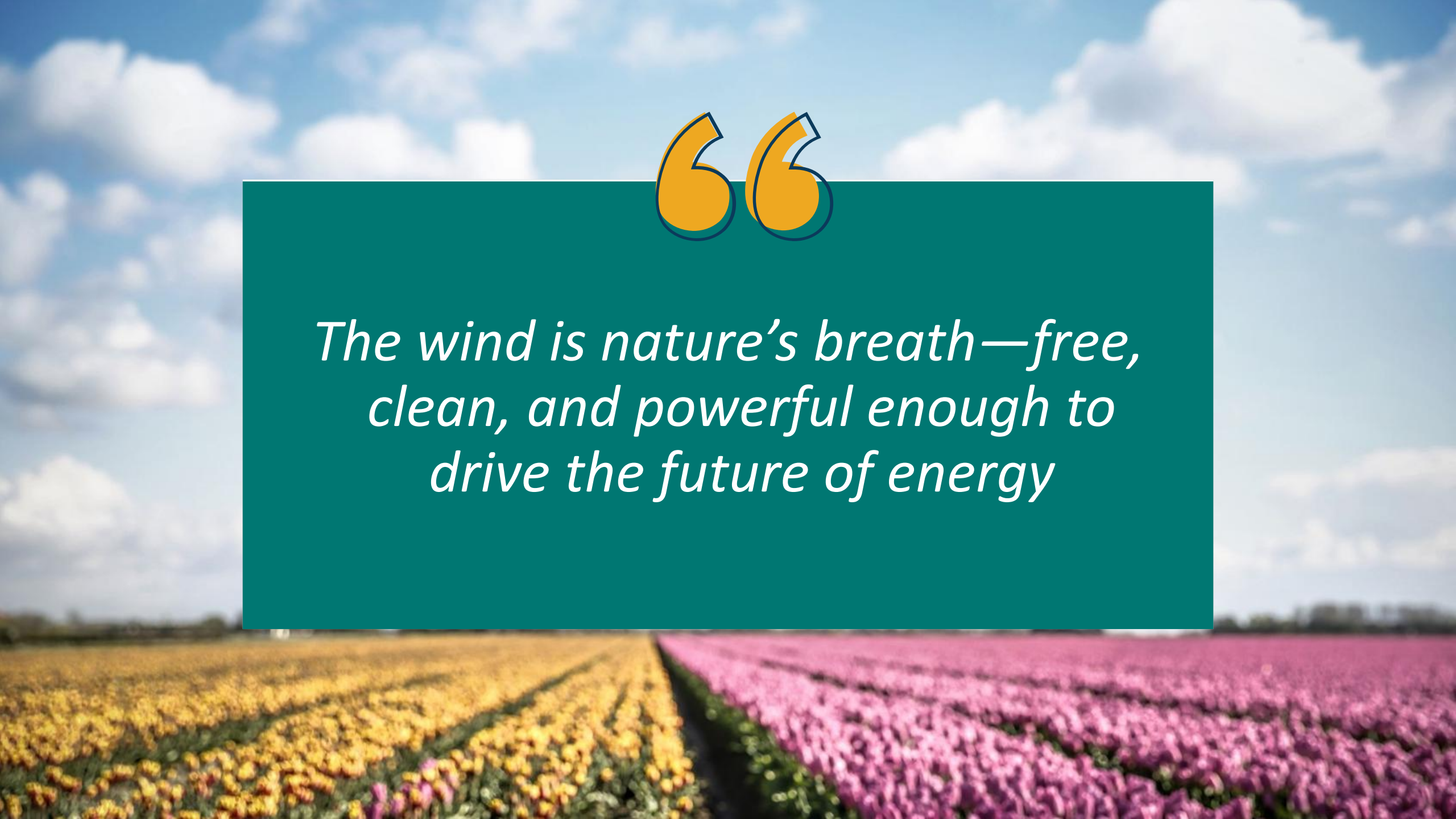
Drag the appropriate energy source to its agricultural application.

Biomass - Wind power - Biomass

_____ - Used to power large farms through turbines that generate electricity

_____ - Can power irrigation systems through the generation of mechanical or electrical energy

_____ - Processing plant residues into pellets or briquettes used to heat greenhouses



The wind is nature’s breath—free, clean, and powerful enough to drive the future of energy

Well Done!!!

You finished the third module of **Course 4**! Keep going on this learning journey.

In the **next module** you will learn about **Renewable Energy in Greenhouse and Controlled Environments.**

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