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ENERGY

Climate Focused Agricultural Vocational Education
(CLIAVE)

2021-1-TR01-KA220-VET-000032974



ENERGY

- ❑ The energy demand is increasing rapidly due to factors such as the growing global population, urbanization, industrialization, and technological developments.
- ❑ The percentage of people who have access to electricity worldwide increased from 83% in 2010 to 91% in 2020. The number of individuals without access to electricity decreased throughout this time, from 1.2 billion to 733 million.
- ❑ Energy service delivery must be safe, affordable and have minimal negative environmental effects for development to be sustainable.

ENERGY SOURCES

- ❑ Energy is defined as the ability to perform tasks.
- ❑ Two different kinds of primary energy sources:
 - non-renewable (fossil)
 - renewable.
- ❑ Renewable energy is produced from resources that can be replenished naturally over time and are thus suitable for use,
- ❑ Non-renewable energy sources have a finite supply because they typically take a long time to replenish

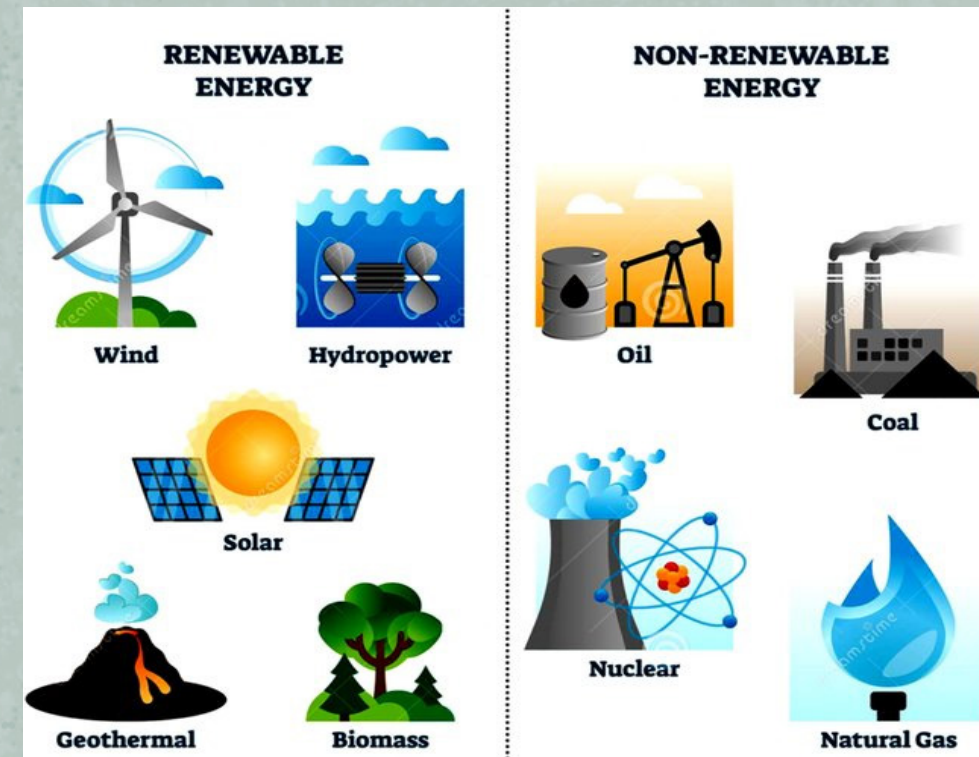


Figure 1: Energy sources



Energy Source	Advantages	Disadvantages
Nuclear	• Zero greenhouse gases. • Capable of converting energy effectively. • Resources of uranium are plentiful. • Annual refueling, as opposed to coal plants, which require trainloads of coal every day.	• Higher capital costs resulting from storage, radioactive waste management, containment, and safety concerns. • Issue with storing radioactive waste for an extended period of time. • The issue of possible nuclear proliferation.
Coal	• A plentiful supply. • Extraction is currently inexpensive. • Dependable and capable of producing large amounts of power	• Produces significant amounts of greenhouse gases and acid rain. • Mining and burning have a high environmental impact, though cleaner coal-burning technology is being developed. • Mining can be hazardous to miners' health.
Oil	• The basis for many products, from prescription drugs to plastic. • Produced at a low cost. • Effective and simple to transport.	• Significant greenhouse gas emissions. • Only found in a few places. • Natural gas/coal resources may be depleted before supply. • The potential environmental impact of drilling and transportation.
Natural gas	• It is widely available. • The cleanest-burning fossil fuel; frequently used in conjunction with other fuels. • The output can be adjusted to meet demand.	• Transportation costs are prohibitively expensive. • Gas resources are unavailable in some areas due to a lack of infrastructure. • Burns cleanly but produces emissions. Pipelines have an impact on ecosystems.





Energy Source	Advantages	Disadvantages
Solar	• <i>It is non-polluting.</i> • <i>The most plentiful energy.</i> • <i>Systems have a lifespan of 15-30 years.</i>	• <i>Expensive initial investment.</i> • <i>In areas with little sunlight, extra energy is required.</i> • <i>Photovoltaic panels necessitate a lot of physical space.</i> • <i>Limited accessibility</i>
Wind	• There are no emissions. • Reasonably priced. • Minimal disruption to ecosystems.	• Extremely high output. • The output is proportional to the wind speed. • It is not possible in all geographic areas. • Expensive initial investment and upkeep. • Extensive land use.
Hydropower	• There are no emissions. • Reliable and capable of producing large amounts of power	• Environmental effects from changing the environment around the dam. • Hydroelectric dams are costly to construct. • Drought may have an impact on dams.
Biofuels	• Plenty of supply. • Lower emissions than fossil fuels. • It is suitable for use in diesel engines. • Automobile engines can easily be converted to run on biomass fuel.	• To reduce transportation costs, the source must be close to the usage. • Produces some pollution in the form of waste. • Increased nitrogen oxide emissions. • Some fossil fuels are used in the conversion process.
Geothermal	• Low environmental impact. • Effective. • Power plants emit little pollution. • Lower costs after initial investment.	• Only a small number of locations on earth have geothermal fields. • Significant start-up expenses. • Wells could eventually dry up.



GLOBAL ENERGY SECTOR

- ❑ Total world primary energy supply grew more than 2.6 times between 1971 and 2019 and reached 606 EJ.
- ❑ China dominated the global markets for concentrating solar thermal power, hydropower, solar PV, and wind power, accounting for nearly half of all installations in 2020.

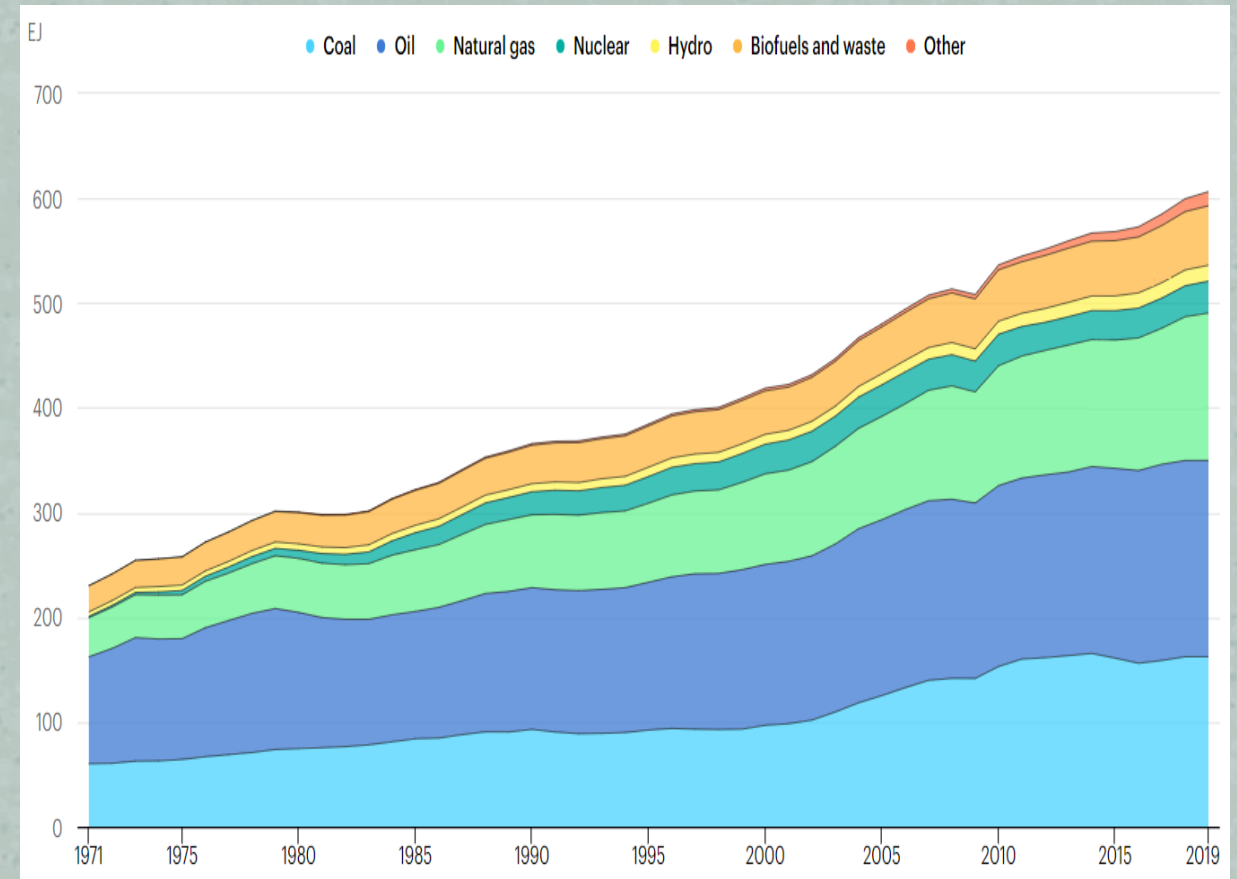


Figure 2: World total energy supply, 1971-2019 [11]



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SUSTAINABLE ENERGY

- ❑ Energy is a critical sector for any country's long-term development; however, its production and consumption have environmental, economic, and social consequences, such as climate change, pollution, and energy poverty.
- ❑ Sustainable energy is defined as energy that can be used repeatedly and meets our current energy needs without endangering its life or becoming depleted.





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SUSTAINABLE ENERGY

- ❑ Combustion of fossil fuels emits large amounts of greenhouse gases and other harmful gases and solids into the atmosphere, causing climate change, acid rain, and soil and water contamination.
- ❑ Global CO₂ emissions related to energy levels stagnated in 2019 at about 33 gigatonnes (Gt). Carbon emissions from energy use increased by 0.5% between 2018 and 2019, less than half the 10-year average annual growth rate of 1.1%.
- ❑ Advantages of renewable energy for the environment, such as lower carbon emissions and less air pollution. Using renewable energy resources to generate electricity instead of fossil fuels reduces emissions from the power sector.



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SUSTAINABLE AGRICULTURE

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SUSTAINABLE DEVELOPMENT

- ❑ Sustainability is based on the principle that “meet the needs of the present without compromising future generations' ability to meet their own needs”.
- ❑ A major objective of sustainability is for people to live peacefully and long-term on Earth.
- ❑ Decisions at the international, national, and individual levels can be guided by the idea of sustainability.





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SUSTAINABLE DEVELOPMENT

- Environmental, economic, and social pillars of sustainability. The aim of environmental sustainability is to reduce the environmental impact of human activities while also encouraging the preservation of our natural habitat. Economic sustainability refers to an economy's ability to sustain a specific level of economic production indefinitely. Social pillar of sustainability refers to values that promote equality and individual rights.

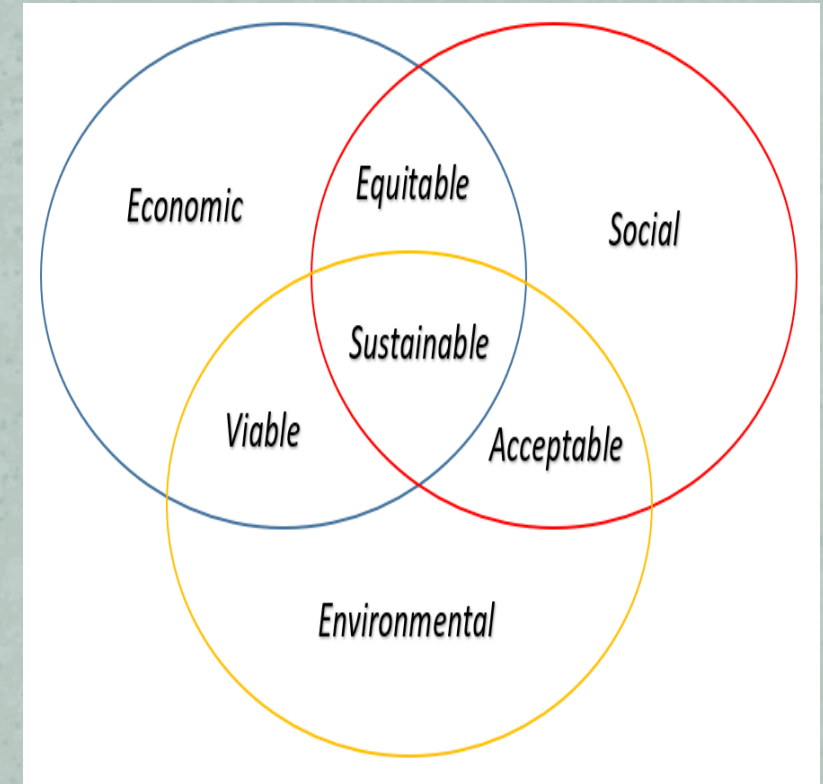


Figure 1: Three pillars of sustainability



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SUSTAINABLE DEVELOPMENT GOALS

- ❑ The Global Goals, also referred to as the Sustainable Development Goals (SDGs), were established by the United Nations (UN) in 2015 as a component of the 2030 Agenda for Sustainable Development. SDGs are a "blueprint to achieve a better and more sustainable future for all" and include 169 targets in addition to 17 goals to address these problems.



Figure 2: Sustainable Development Goals (SDGs)



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SUSTAINABLE AGRICULTURE

□ "Sustainable agriculture" refers to a long-term integrated system of crop and animal production practices with a site-specific application that includes the following goals:

- Meet people's food and fiber needs.
- Improve environmental quality and the natural resource base that supports the agricultural economy.
- Make the best use of nonrenewable and on-farm resources while incorporating natural biological cycles and controls where possible.
- Keep farm activities economically viable.
- Improve farmers' and society's overall quality of life.



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AGRICULTURE AND SUSTAINABILITY ISSUES

- ❑ The main sustainability concerns that the food and agriculture industry must address are hunger and obesity in developed countries, rising food prices, persistent climate change, rising fuel and cost of transportation, flaws in the global market, global pesticide pollution, pest adaptation and resistance, loss of soil fertility and organic carbon, soil erosion, declining biodiversity, and desertification.





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AGRICULTURE AND CLIMATE CHANGE

- ❑ Agriculture is both a significant contributor to and one of the most vulnerable economic sectors to climate change. Agriculture employees, rural communities, land and water resources, crops, and livestock can all be impacted by climate change. However, the agricultural industry also releases greenhouse gases into the atmosphere that have an impact on global warming.
- ❑ Greenhouse gas emissions from agriculture occur both within the farm gate and at the land use change boundary between natural ecosystems and agricultural land. They account for roughly 20% of all human-caused emissions.



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AGRICULTURE AND CLIMATE CHANGE

- Worldwide agricultural emissions (including those from farm gate and land use change processes) were close to 11 billion tonnes of CO₂ equivalent (CO₂ eq.) in 2019. Only crop and livestock-related GHG emissions contribute roughly 5 billion metric tonnes of CO₂ eq. to the atmosphere each year.

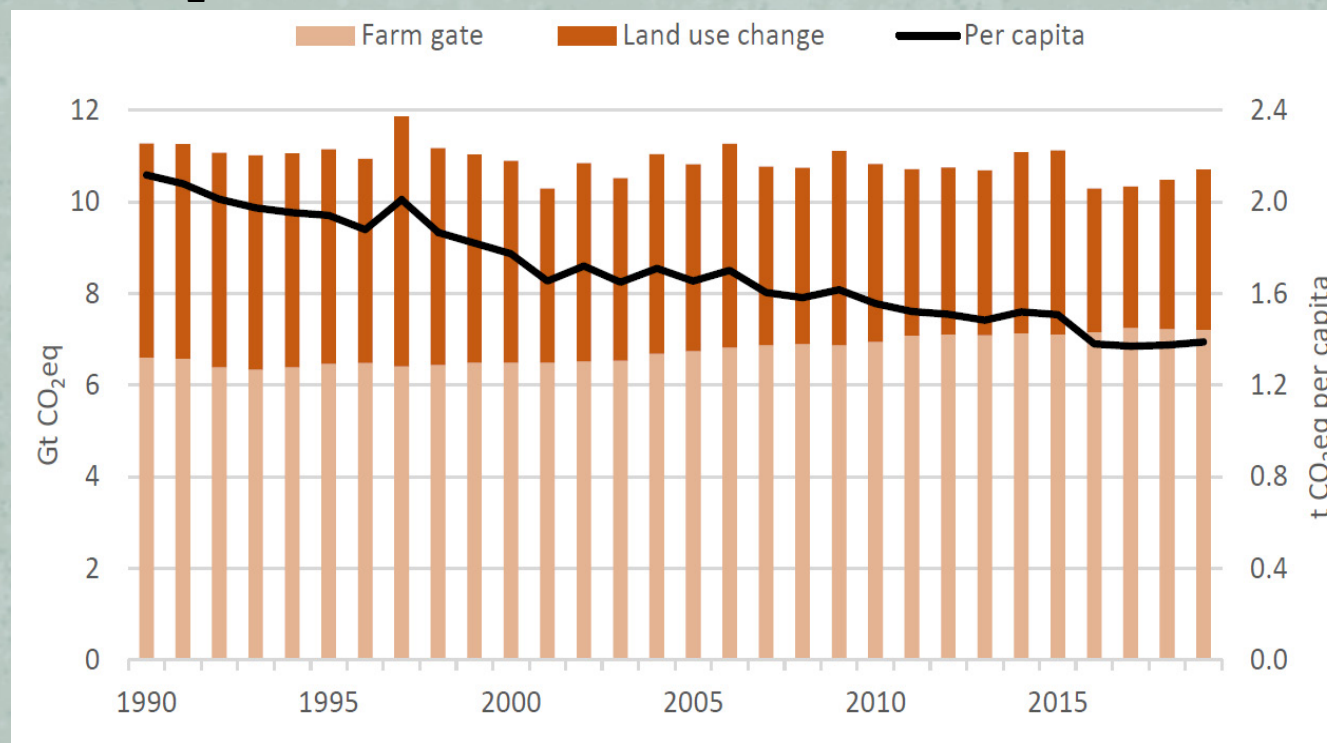


Figure 3: Agriculture's emissions from 1990 to 2019, with farm-gate and land use change



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SUSTAINABLE AGRICULTURE AND ENERGY

- ❑ The food system's current energy use is unsustainable. Due to the lack of affordable, dependable, and sustainable energy for millions of people and small and medium-sized agri-food businesses, there are significant food losses in the post-harvest stages. Before it even reaches the market, about 14% of the food produced worldwide is lost.
- ❑ Food losses are addressed throughout the supply chain, as reducing waste leads to lower demand for land, water, and energy, as well as lower emissions. In 2019, more than 2.6 billion people paid a disproportionate amount of money to live without access to clean cooking fuels and technologies.



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SUSTAINABLE AGRICULTURE AND ENERGY

- ❑ A third of the world's total final energy demand is accounted for by the agriculture and food systems, the majority of it in post-harvest processes and as fossil fuels. At some point along the value chain, food losses result in the loss of about 30% of that energy.
- ❑ All phases of food production, processing, and distribution up until final consumption are included in agri-food supply chains. In the global agri-food system, agriculture is the primary source of greenhouse gas emissions. 10% to 15% of the world's greenhouse gas emissions are directly attributable to agriculture. Up to 30% more emissions result from adding land use changes and deforestation to the production of animal feed. Methane and nitrous oxide, which together account for about 22% of global emissions, is also primarily produced by agriculture.



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ENERGY USAGE IN THE AGRICULTURAL SECTOR

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AGRICULTURAL ENERGY USE

- ❑ Agriculture converts solar energy into food energy for humans and animal feed through the process of photosynthesis. Primitive agriculture consists of simple agricultural practices such as scattering seeds on the ground and accepting the resulting low yields.
- ❑ Today, modern (intensive) agricultural practices have largely replaced primitive agriculture, in which various methods are used to obtain high yields from the soil. As a result of the adoption of modern agricultural production processes, there has been a shift away from human or animal power, which is commonly used in agricultural production processes, and toward mechanical energy fueled by fuels.

AGRICULTURAL ENERGY USE

- ❑ Agriculture and rural development have always relied heavily on energy. Agriculture consumes a lot of energy, from small organic farms to large industrial farms. Energy consumption in crop and animal production processes in the agricultural sector is now divided into two categories: direct and indirect.

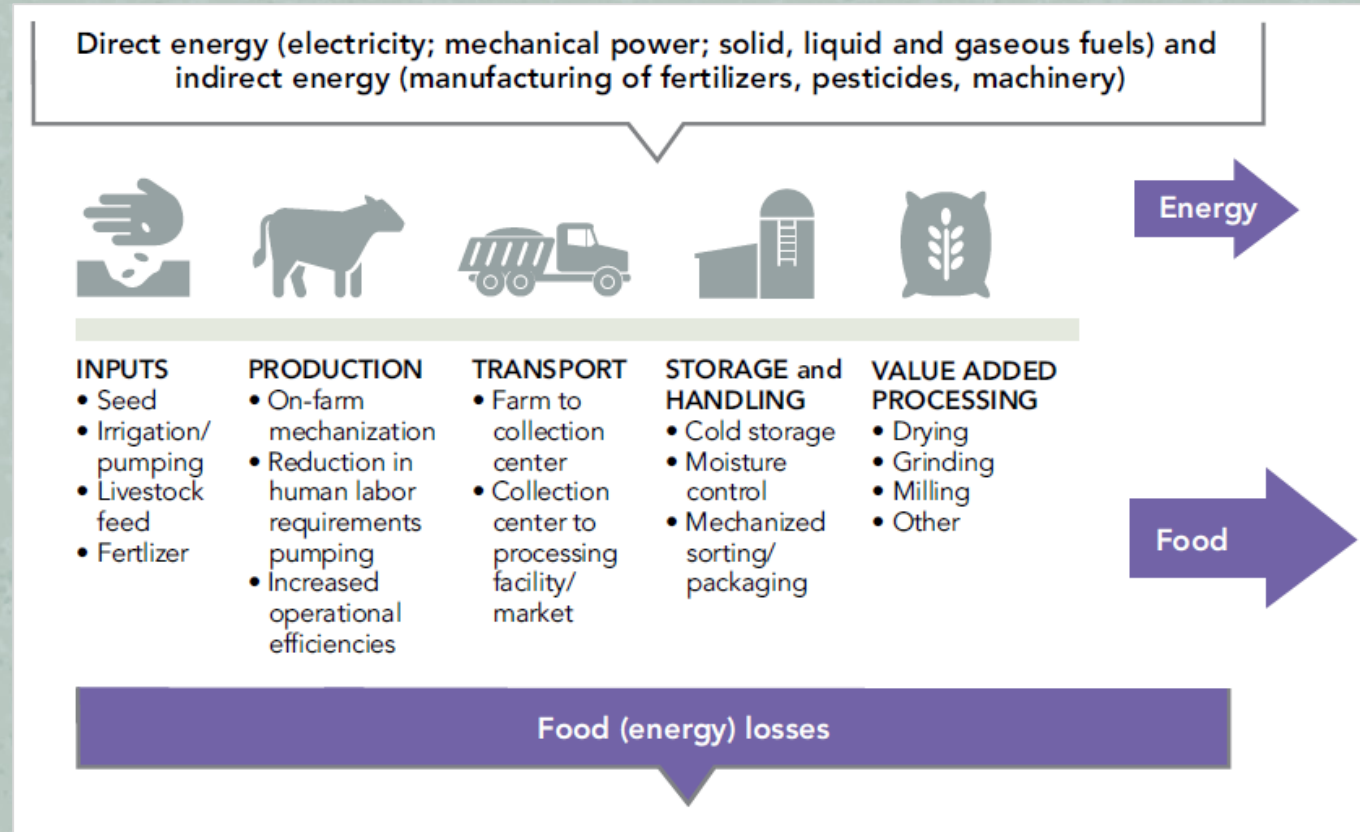


Figure 1: Energy and agriculture



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AGRICULTURAL ENERGY USE

- ❑ **Direct Energy Usage in Agriculture:** The phrase "direct energy used in agriculture" refers to energy used directly in agricultural operations like harvesting, irrigation, drying, storing, heating greenhouses, and marketing, as well as in infrastructure, farm machinery, tractors, and lorries. In animal production, electricity, biomass, coal, and natural gas are used for activities such as feed preparation-distribution, manure cleaning, milking, lighting, heating, ventilation, and cooling in agricultural buildings such as animal shelters.
- ❑ **Indirect Energy Usage in Agriculture:** The phrase "indirect energy used in agriculture" refers to the energy used in the production of mineral fertilizers and chemical pesticides, insecticides, herbicides, and other agricultural chemicals, as well as the chemical substances used in their processing. Indirect energy, as the name implies, is not used directly on the farm. These energy inputs are usually found in the industrial sector.



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AGRICULTURAL ENERGY USE

- ❑ Agriculture, which includes crop cultivation and animal husbandry, is one of the most energy-intensive stages of the food chain, accounting for roughly one-third of total energy consumed in the food production chain.
- ❑ Tillage operations, the first stage of crop production, are typically carried out using the most energy-intensive operations.
- ❑ Crop drying and storage is also a major step in fuel utilization.
- ❑ The consumption of irrigation system energy is viewed as a technical challenge, primarily for the purpose of improving performance.



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AGRICULTURAL ENERGY USE

- ❑ Energy is consumed directly by livestock farms for ventilation systems, cooling, lighting, heating, irrigation, motors, and waste treatment, whereas crop farms use energy for sowing, harvesting, irrigation, and drying.
- ❑ Fertilisers and pesticides, which are classified as indirect energy consumption, are also significant energy consumers. Fertilizer production is extremely energy intensive and requires large quantities of natural gas, so it constitutes a significant portion of operating expenses for most crops, especially when indirect energy expenditure on fertilizer is considered.

EUROPEAN UNION AGRICULTURAL ENERGY USE



- ❑ The European Union's (EU) direct energy consumption in 2020 was 886 million tonnes of oil equivalent (toe) from the direct use of oil and petroleum, electricity, natural gas, renewable energy, and solid fossil fuels. In 2020, agriculture and forestry consumed 3.2% of total direct energy consumption in the EU.
- ❑ The agricultural and forestry sectors in the Netherlands consume the greatest proportion of total direct energy consumption. Latvia (5.4%) and Poland (5.5%) are also significant contributors.



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EUROPEAN UNION AGRICULTURAL ENERGY USE

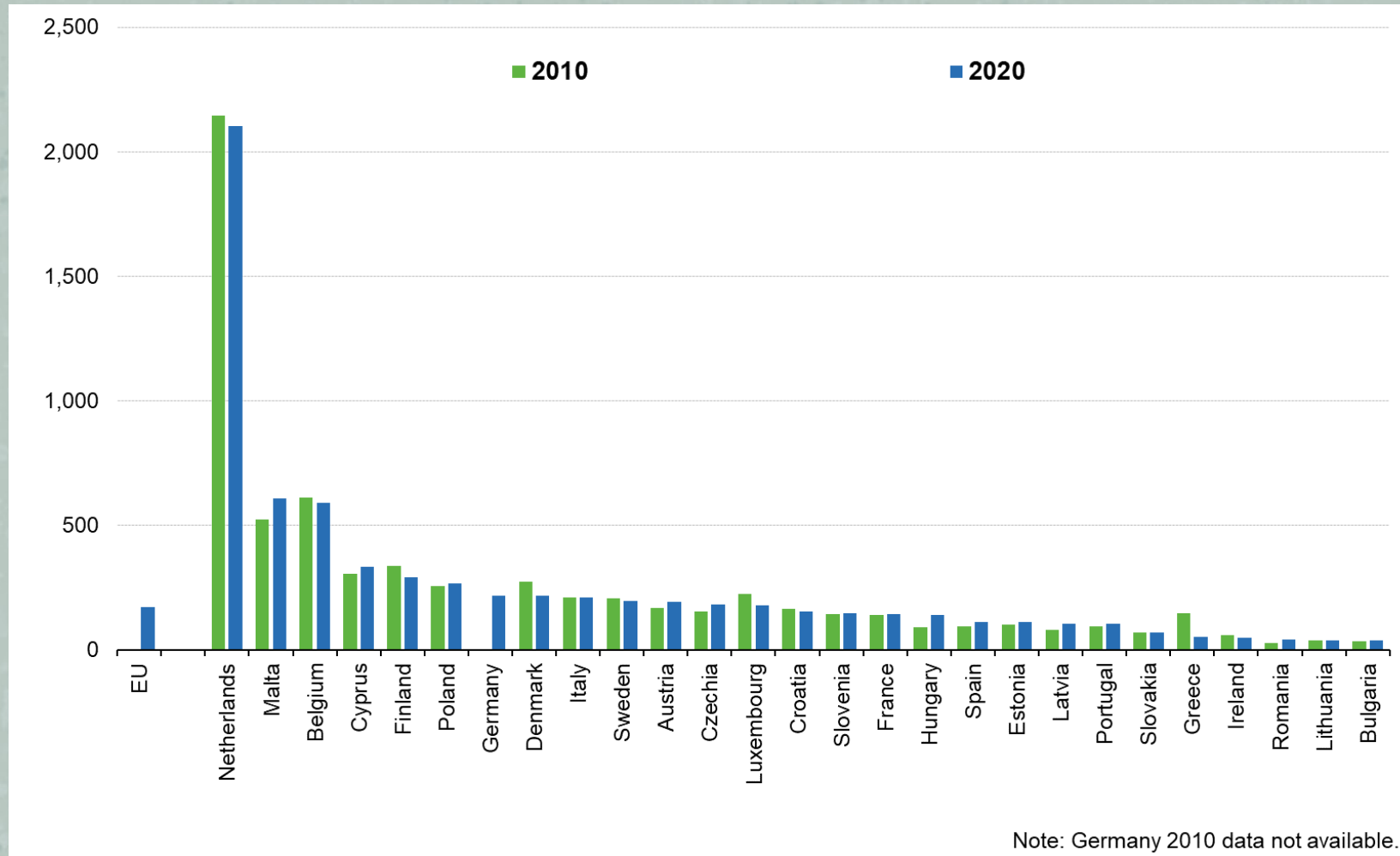


Figure 2: Energy consumption by agriculture, 2010 and 2020 (kilograms of oil equivalent per hectare of UAA)



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ENERGY PRODUCTION IN THE AGRICULTURAL SECTOR: BIOENERGY

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BIOMASS

- ❑ Biomass is defined as "the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste".
- ❑ Biomass is defined as living or recently deceased organisms, as well as their plant or animal byproducts.





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Bioenergy Resources

□ Biomass energy sources include:

- Wood and waste products from wood processing, such as firewood, wood pellets, wood chips, sawdust, and waste products from furniture and lumber mills, as well as alcohol from pulp and paper mills.
- Waste products and crops, including corn, soybeans, sugar cane, switchgrass, woody plants, and algae, as well as crop and food processing leftovers, principally for the creation of biofuel.
- The presence of biological materials in municipal solid waste, such as waste food, yard trimmings, and wool, cotton, and paper goods.
- Production of biogas and renewable natural gas from animal manure and human sewage

Bioenergy Resources

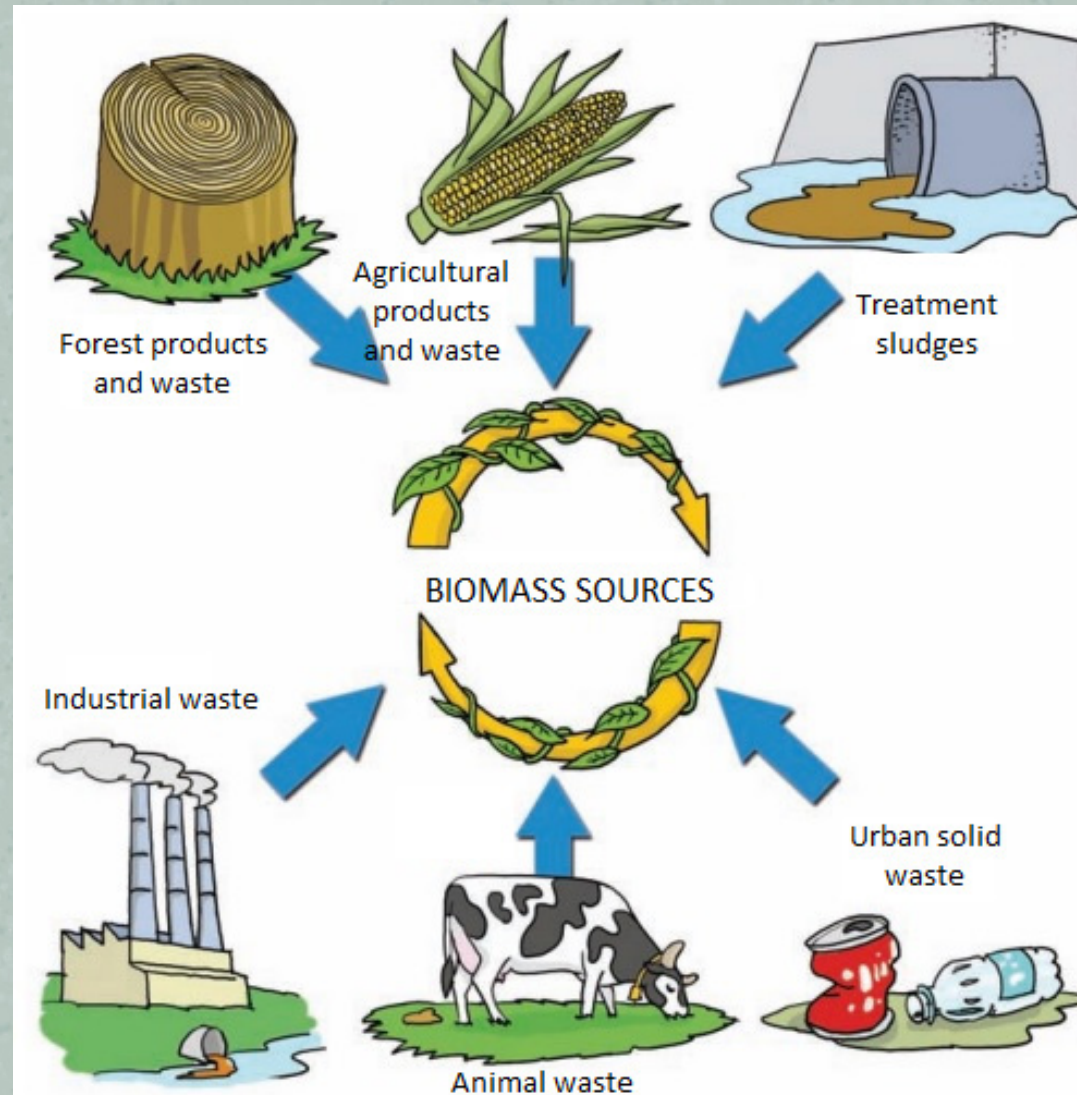


Figure 1: Types of biomass energy sources



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Biomass Utilization

- ❑ The two types of biomass utilization are categorized as traditional (classical) and modern.
- ❑ The traditional method's output, which is typically less efficient, is primarily used for cooking and heating. Given the rising population trends in many countries, reducing the use of traditional biomass continues to be a difficult task.
- ❑ In modern biomass use, conversion methods from biomass materials such as animal and agricultural wastes, domestic, urban, and industrial wastes/wastewater with organic content, energy crops, energy forestry products, forest wastes, algae and moss growing in aquatic ecosystems can be used to generate process heat, electricity, and liquid or gaseous fuel.



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CONVERTING BIOMASS TO ENERGY

- ❑ Organic materials such as forest, agricultural, domestic, and animal wastes are examples of biomass, which is defined as biological material produced directly or indirectly through photosynthesis.
- ❑ Various conversion methods are used to convert biomass into bioenergy.
- ❑ Several process steps are required to convert biomass into useful energy. The applied technologies are tailored to the physical structure, chemical composition, and energy services required by the feedstocks. Outputs such as biogas, biodiesel, bioethanol, and synthetic gas are produced using various conversion methods applied to biomass raw materials. These outputs are used in areas such as heating, electricity, and transportation.

CONVERTING BIOMASS TO ENERGY

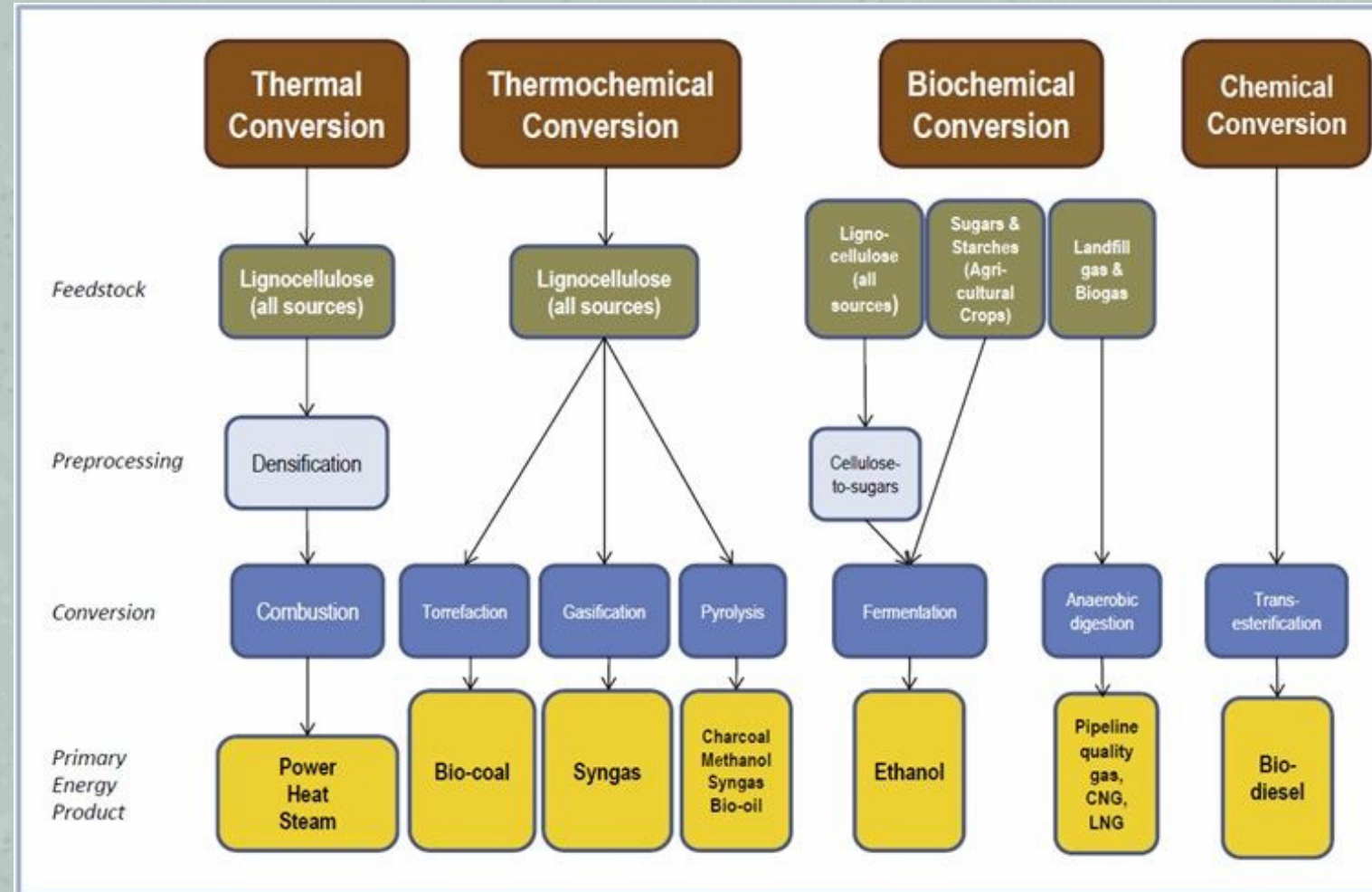


Figure 2: Biomass Conversion Technologies



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CONVERTING BIOMASS TO ENERGY

Thermal conversion - direct combustion

Direct combustion is the most common and mature method of converting biomass into useful energy. Combustion is the rapid chemical reaction of combustible components in biomass with oxygen. As a byproduct of this chemical reaction, heat, carbon dioxide, water vapour, and some metal oxides are produced.

Chemical conversion

Chemical conversion involves the use of chemical agents to convert biomass into liquid fuels. Chemical conversion of biomass is the process of converting biomass into other forms of usable energy through chemical interactions.



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CONVERTING BIOMASS TO ENERGY

Thermochemical conversion

The process of using heat to create various types of solid, liquid, or gaseous fuels is known as thermochemical conversion. This conversion produces combustible gas as a result of the high-temperature decomposition of carbon-containing biomass. Pyrolysis, torrefaction, gasification, and liquefaction are all examples of thermochemical conversion processes. Using a variety of process conditions and reactor configurations, the energy stored in the structure of biomass can be converted into solid fuels by carbonisation (charcoal), liquid fuels by pyrolysis or liquefaction (bio-oils), or gaseous fuels by gasification (syngas).



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CONVERTING BIOMASS TO ENERGY

Biochemical conversion

Biochemical conversion describes the process of utilizing bacteria or other microorganisms' enzymes to break down biomass. The term "biochemical conversion methods" describes the biological processes used to transform biomass. These procedures seek to separate various microorganisms or enzymes from biomass to produce products and intermediate products. Biogas, hydrogen, ethanol, butanol, acetone, various organic acids, and chemicals are produced as a result of the process.

Key biochemical conversion processes include anaerobic digestion and fermentation.



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ADVANTAGES OF BIOMASS ENERGY

- As a natural component of the cycle, the use of biomass lowers the amount of carbon released into the atmosphere when compared to other fossil fuels.
- Biomass can transform waste into a renewable energy source because society produces waste continuously.
- Numerous energy outputs from biomass can be produced for a variety of uses.
- Nearly everywhere has a plentiful supply of biomass resources.
- Biomass power plants have high availability and can run continuously because they can run at baseload.
- When sustainable methods are employed, biomass improves the quality of the soil, the air, and the water.



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DISADVANTAGES OF BIOMASS ENERGY

- Some biofuels need to be boosted with fossil fuels to increase efficiency even though bioenergy is not sufficiently efficient.
- Although biomass is carbon-neutral, methane gas is produced when some of its wastes are used, which is bad for the environment.
- Deforestation for energy production destroys forest areas and threatens biodiversity.
- Production losses could result from management and staff who operate bioenergy plants not having the necessary industry expertise.
- Not every type of waste can be used directly as biomass. In order to utilize waste more effectively, waste segregation should be encouraged.



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ENERGY MANAGEMENT IN AGRICULTURAL PRODUCTION

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AGRICULTURAL ENERGY USE PROBLEMS

- ❑ Energy is a vital element in production in agriculture. In addition to human and animal power, the agricultural sector uses energy in buildings (lighting, cooling/heating), agricultural operations (tools and machinery for land preparation, irrigation, sowing, fertilisation, harvesting, and transport), and commercial activities (transport, construction, and facility operation).
- ❑ The amount of energy used in agricultural production varies significantly depending on the level of development, type of activity, production practices used, location of the production area, and environmental factors like soil and climate.



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AGRICULTURAL ENERGY USE PROBLEMS

- ❑ Considering the agriculture sector's reliance on the energy sector, as well as the rising costs and negative consequences of using fossil fuels, energy management in this sector is critical.
- ❑ All agricultural production must be economically sustainable in order to ensure long-term food security. As one of the most important agricultural inputs, energy is critical to ensuring food security.
- ❑ Due to the fact that agriculture also has a negative impact on climate change, concerns about it have increased interest in energy efficiency and usage in agriculture. The majority of the energy used in agricultural activities comes from fossil fuels, which are used in almost all of them. This is a result of various types of farm equipment used, livestock-related methane emissions, farm-related greenhouse gas emissions, and more



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ENERGY MANAGEMENT

- ☐ The term "energy management" refers to the measurement, monitoring, planning, and implementation processes used to ensure the best possible use of both the energy resources used and the energy produced.
- ☐ The systematic process of energy management maximizes energy savings while also continuously improving energy performance.
- ☐ Energy management include reducing energy consumption by implementing energy-efficient techniques, as well as determining the proper type of energy and energy tariff for the relevant unit, such as a power plant, a manufacturing plant, a building, or agricultural practices



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ENERGY MANAGEMENT IN AGRICULTURAL PRODUCTION



- ❑ Agriculture needs energy to carry out its activities, but it may also be utilized to produce energy, making energy management a crucial issue given the strategic importance of the agricultural sector. As a result, optimizing consumption, production, and efficiency are all part of energy management in the agriculture industry [23].
- ❑ The following are the primary goals of energy management in agricultural production [11]:
 - Ensuring and maintaining optimal energy supply and use throughout the product's life cycle,
 - Reducing energy costs/waste while maintaining production and quality,
 - Minimizing environmental impact.



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ENERGY MANAGEMENT IN AGRICULTURAL PRODUCTION



- Energy pyramid for agricultural applications is a decision-making tool that can be used in a variety of energy-related settings, including agriculture. As one progresses from energy assessment activities to alternative or renewable energy projects, the cost and complexity of this tool rise

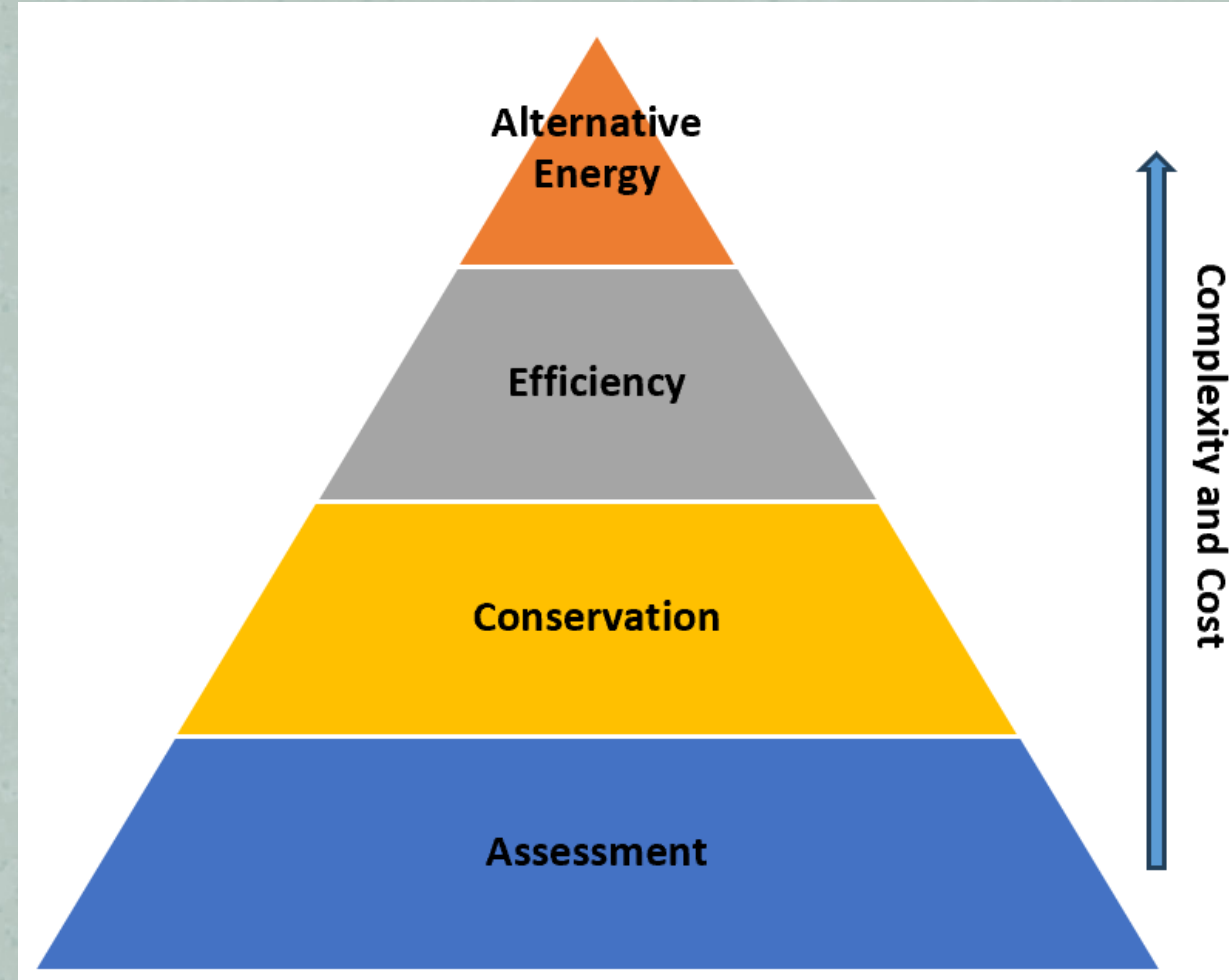


Figure 1: Energy Management Pyramid for the Agricultural Activities



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ENERGY MANAGEMENT IN AGRICULTURAL PRODUCTION



- ❑ The energy pyramid begins with an energy assessment on the farm. Before implementing any concrete measures, the energy assessment allows you to assess your energy use and needs. Energy consumption on the farm can be controlled using energy monitoring, target setting, and energy audit systems.
- ❑ After monitoring, the data must be analyzed and an energy audit performed. The energy audit includes activities to determine the measures that can be taken to achieve higher efficiency with less energy in the energy-using system.



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ENERGY MANAGEMENT IN AGRICULTURAL PRODUCTION



- ❑ Following that, simple conservation practices must be implemented, followed by energy efficiency practices.
- ❑ Energy efficiency is frequently confused with energy conservation. Energy conservation is the practice of using less energy by altering one's behavior or habits. On a farm, for example, energy is saved by turning off unnecessary lights. Energy efficiency means using less energy to accomplish the same task. Energy efficiency is demonstrated by replacing incandescent bulbs on the farm with LED bulbs.



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ENERGY MANAGEMENT IN AGRICULTURAL PRODUCTION

- ☐ The final step is to invest in and use renewable energy. The use of renewable energy sources in agricultural activities will result in improved energy use, food security, and environmental change, all of which will benefit ecological farming goals.
- ☐ Monitoring the performance of energy used in agricultural activities through the adoption of an energy management system in the agricultural sector can promote higher efficiency and capacity utilization, reduced resource waste and pollution, and lower operation and maintenance costs. As a result, energy and product prices can be cut while value creation increases, resulting in stable economic growth.



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RENEWABLE ENERGY APPLICATIONS IN AGRICULTURE 1

Climate Focused Agricultural Vocational Education
(CLIAVE)

2021-1-TR01-KA220-VET-000032974



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RENEWABLE ENERGY FOR AGRICULTURE

- ❑ Energy provision to agricultural systems has always been a crucial aspect of agricultural development and is crucial to guaranteeing food security.
- ❑ New and modern agricultural technology applications increase energy consumption even more. Alternatives to fossil fuel energy sources are required as agricultural production modernizes to ensure that food systems are constructed on safe, environmentally sustainable, and resilient foundations. Replacing fossil fuels in agriculture with low-carbon and clean energy solutions is crucial to addressing the energy needs of food systems in both developed and developing countries



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RENEWABLE ENERGY FOR AGRICULTURE

- ❑ Energy costs are one of the most important factors influencing the prices of agricultural products. Increasing energy costs raise fuel and electricity prices directly, as well as feed, fertilizer, and transportation costs indirectly.
- ❑ Energy-saving practices and the use of renewable energy are critical for lowering agricultural production costs and ensuring local production continuity. Farmers can produce their own energy and become more self-sufficient by using renewable energy.



RENEWABLE ENERGY FOR AGRICULTURE

<i>Power supply</i>	<i>Application Type</i>	<i>Application area</i>	<i>Requirements</i>	<i>Advantages</i>
Solar energy	<i>Lighting</i>	<i>Natural lighting</i>	<i>Natural agricultural structures should be designed in accordance with lighting.</i>	<i>Lighting costs are reduced. Production increase is provided. It requires little maintenance.</i>
	Photovoltaic	Electricity generation	Solar radiation should not be obstructed.	Electricity requirement is met. It can be placed in the building design or on the roof.
	Ambient Heating	Heating	Underfloor heating is required. Walls need sun exposure.	Living conditions improve. Air quality improves.
	Water Heating	Hot water	Solar radiation should not be obstructed.	Hot water requirement is met.
Geothermal energy	Heat pump	Greenhouse heating Ambient heating Product drying	Space for horizontal or vertical wells is necessary. Chemical of geothermal fluid is important.	Heating and cooling with heat exchangers Practices improve living conditions.
Biomass Energy	Biofuel	Electricity generation Ambient heating and cooling Water heating Fuel	Organic material must be continuously supplied from agricultural and forestry waste.	Waste control is provided. Operating costs are reduced. Backup power is provided.
Wind power	Turbine	Electricity generation Mechanical strength	Wind blowing at a certain speed is required.	With the developing technology, energy unit costs are decreasing.
Hydropower	Hydroelectric	Electricity generation	Reliable water flow is required.	The investment made can be used not only for energy but also for irrigation and flood purposes.



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Use of Solar Energy in Agriculture

- ❑ Solar energy technologies generate either electrical or thermal energy. Photovoltaic panels, which are typically made up of solar cells composed of layers of silicon that produce direct current electricity, can convert solar radiation into electricity.
- ❑ Photovoltaic panels are cost-effective for supplying electricity in remote locations such as farms, orchards, and other agricultural activities. In applications such as electric fence, field or house lighting, and water pumps for animal watering or agricultural irrigation, photovoltaic systems can be significantly less expensive to install than power lines



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Use of Solar Energy in Agriculture



PV-powered pumping system



PV-powered solar dryer



PV-powered dairy system



PV-powered greenhouse



PV-powered crop protection system



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Use of Solar Energy in Agriculture

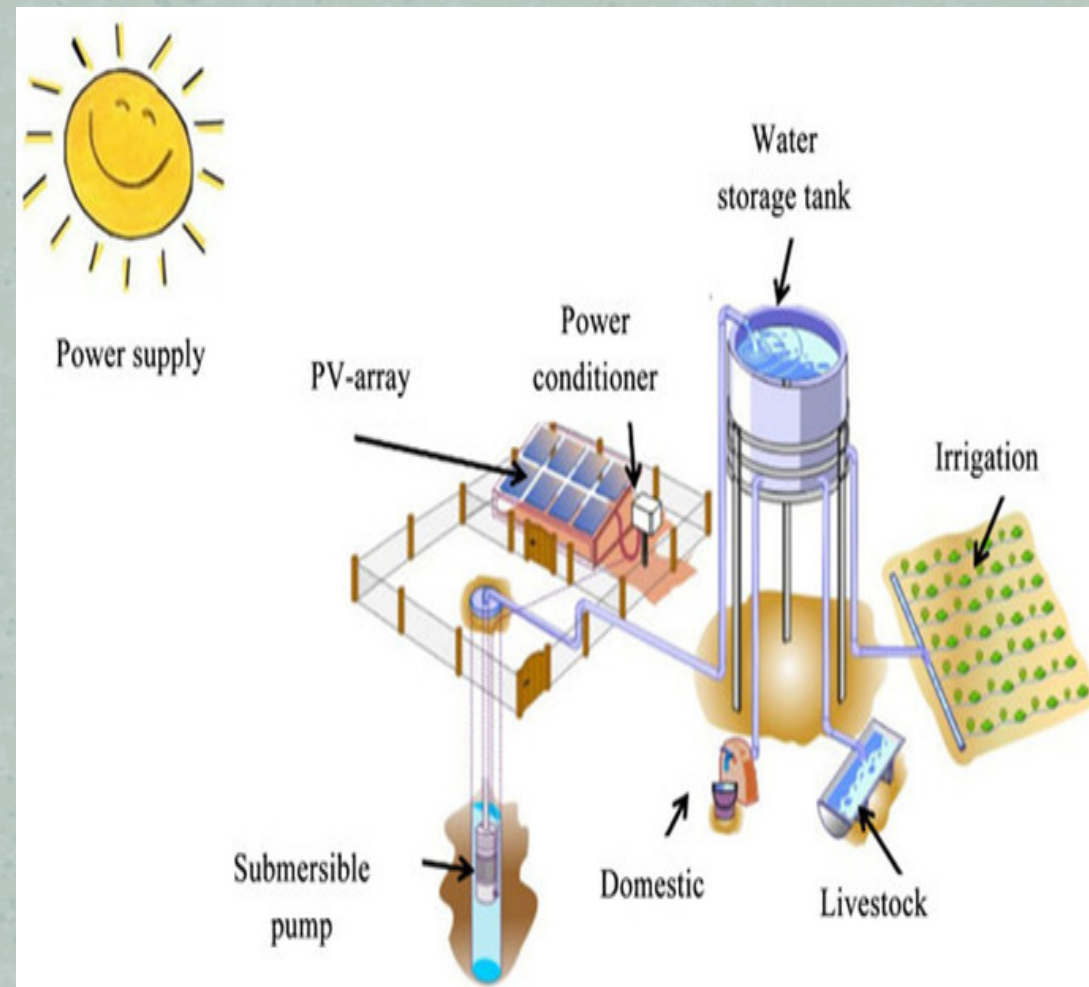
- ❑ Solar energy is one of the best solutions for running small cold stores in rural areas. Energy consumption in cold stores is high, and this energy can be provided by installing photovoltaic panels on the cold store's roof. The solar energy source can also help to reduce the operating costs of the cold storage system.
- ❑ Another use for photovoltaic panels is to power electric fans for air circulation. Modern animal farms can increase production by doubling or tripling it by housing their animals in enclosed structures. Photovoltaic systems can provide electricity for the fans used to circulate air in these systems.



Use of Solar Energy in Agriculture



- ❑ Pumping systems powered by photovoltaic panels meet a wide range of water needs, from crop irrigation to animal watering and domestic use.
- ❑ Solar panels, transmission pipes, and batteries are all that is required to use solar energy in irrigation.





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Use of Solar Energy in Agriculture

- ❑ Solar collectors are a different type of solar energy application. These systems funnel heat to a central location. In many parts of the world, cooking stoves powered by heat generated are used.
- ❑ Systems that run at a specific temperature make up greenhouse systems. Therefore, controlling temperature is the most crucial factor to take into account. It is one of the regions where solar energy systems are used.



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Use of Solar Energy in Agriculture

- ❑ Solar energy is not only used to generate electricity in the agricultural sector. The second most common use of solar energy is to generate heat for various agricultural processes. Solar heat applications include drying systems.
- ❑ Solar hot water systems have long been available. These systems feature a collector constructed of materials that absorb heat from the sun efficiently. Cold water is sent through the collector, where it is heated and returned to the tank. Cooler water is collected from the tank's bottom and returned to the solar collector as hot water climbs to the tank's top. Solar hot water can help reduce the amount of energy consumed to heat water in houses.



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Use of Geothermal Energy in Agriculture

- ❑ Geothermal energy is frequently employed in agriculture to produce electricity, but it is also a significant source for heating greenhouses, fish ponds, crops, and grains that need to be dried.
- ❑ While many of the frequent uses of geothermal energy are comparable to those of other renewable energy sources, geothermal energy is more reliable and accessible since it is constantly present. Geothermal energy offers the economic and technological potential to enable the development of numerous agricultural products with added value in the future.
- ❑ Using geothermal resources instead of conventional energy saves about 80% on fuel costs and 5-8% on total operating costs. Other benefits of geothermal heating for greenhouses include cleaner air and water, improved hygiene, a stable workforce, and the ability to take advantage of tax breaks



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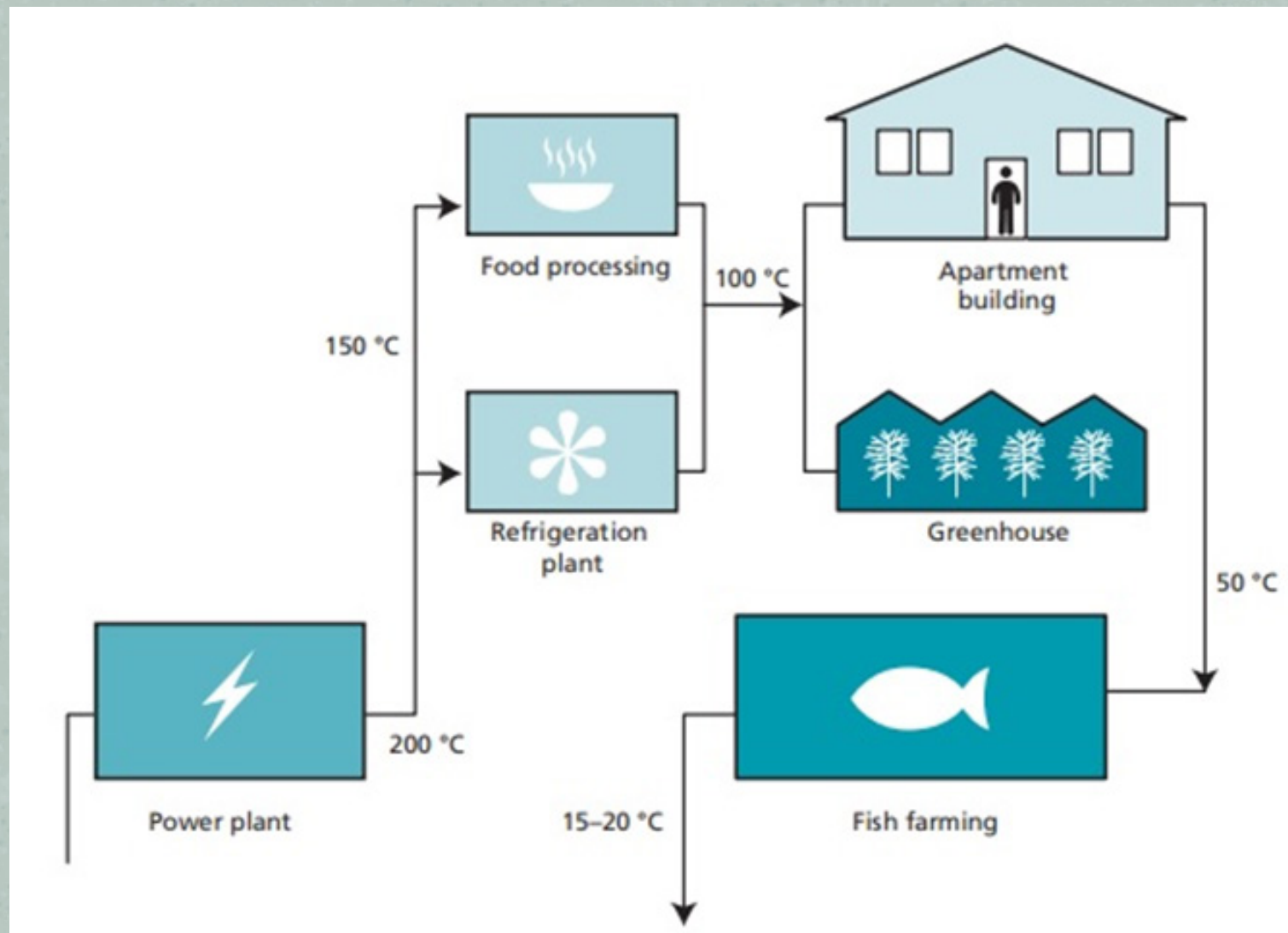
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Use of Geothermal Energy in Agriculture





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Use of Geothermal Energy in Agriculture

- ❑ Ponds and fisheries also use geothermal energy. The amount of heating needed for these facilities is substantial. In this use, geothermal energy is frequently utilized to warm water in tanks, pools, and canals.
- ❑ Around the world, geothermal heat is utilized to dry a wide variety of agricultural products. Geothermal energy is used to dry products in clean and sanitary settings. The temperature of the geothermal energy before drying and the temperature values necessary for the drying application are important criteria. Heat for drying can be obtained from geothermal wells in the form of hot water or steam, or from a geothermal plant's waste heat.



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RENEWABLE ENERGY APPLICATIONS IN AGRICULTURE 2

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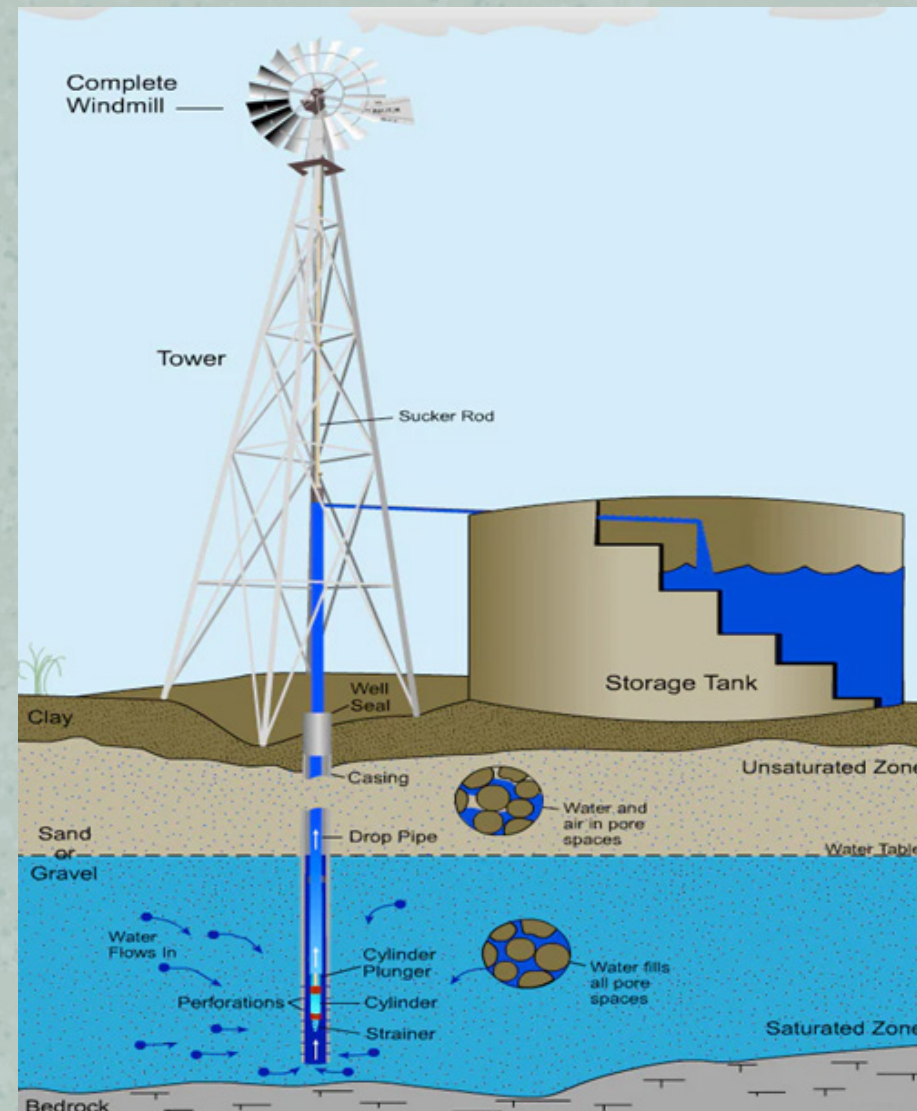
Use of Wind Energy in Agriculture

- ❑ Wind energy is environmentally friendly, can provide energy security, and is a viable alternative to traditional fossil-fuel-based energy. Wind energy applications in agriculture can be divided into two categories. These are:
 - Mechanical application areas (such as water extraction and grinding), and
 - Electrical application areas (off-grid and grid-connected applications).
- ❑ Wind energy is used to create mechanical energy from wind turbines, electricity from wind turbines, or water from wells using wind pumps. The use of wind energy in rural areas is known to have begun with windmills. Windmills have long supported agricultural activities



Use of Wind Energy in Agriculture

- ❑ Pumps are machines that convert liquid potential energy into kinetic energy. Wind-powered pumps only use wind energy to draw water. Because wind energy is an intermittent source, it is used in conjunction with storage systems to meet water demand continuously. A small amount of wind is required for the system to function. In light winds, a wind pump can draw an average of 10-15 tonnes of water.





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Use of Wind Energy in Agriculture

- ❑ Wind turbines can be used both with and without a connection to the power grid. Grid-connected wind turbines are typically used for high-power applications. Off-grid turbines are mostly used for minor requirements.
- ❑ Wind energy is a non-polluting, fuel-free energy source. Windmills installed in every farm or settlement unit in agricultural areas significantly reduce energy production costs, and such systems installed in areas far from transmission lines are economical in every way. The most significant advantage of wind turbines is that they do not take up much space due to their small projection, allowing them to be installed in agricultural areas.



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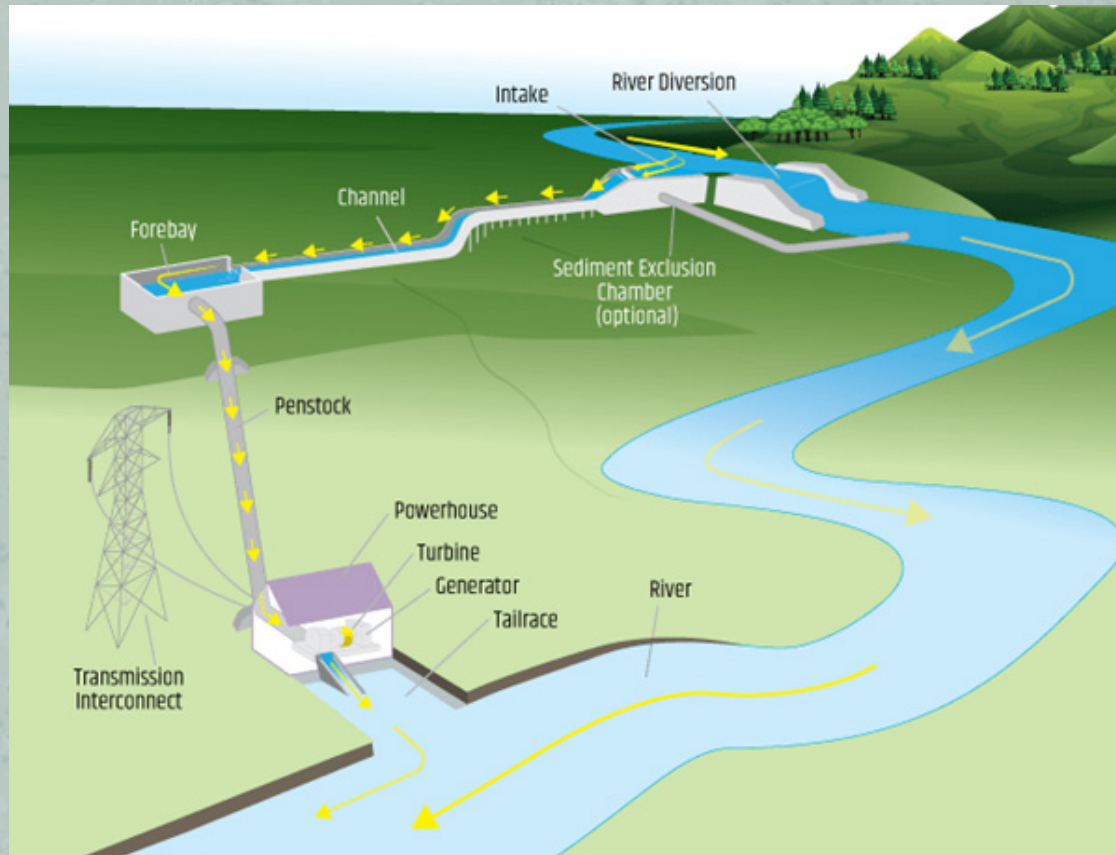
Use of Hydro Energy in Agriculture

- ❑ In agriculture, the energy of running water is used mechanically or electrically. For centuries, the power of water has been used to generate mechanical power. Mechanical power enables daily activities such as agricultural processing. The grain grinding process, which is the cornerstone of agricultural production with water mills still used today, is one of the important applications of the mechanical power of water in agriculture.
- ❑ The most widely used renewable energy source is hydropower because it has several advantages over other sources, including high energy density, low cost, and dependability.



Use of Hydro Energy in Agriculture

- Hydroelectric power plants range in size from very small to very large. River-type micro or small hydroelectric power plants, typically in the kW range, are used to generate electricity in rural areas in many countries.





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Use of Hydro Energy in Agriculture

- ❑ The use of small hydropower plants is growing because of how well they can be incorporated into the agricultural supply chain. The energy produced by the current flows in irrigation canals represents a significant untapped opportunity with the development of these systems. The irrigation canal is used in this way to operate together for effective irrigation service and energy production.
- ❑ Hydroelectric power plants generate electricity that is used for lighting, heating greenhouses, processing and storing agricultural products, and water pumping in agricultural areas. Dams are also utilized for fish farming and direct irrigation



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Use of Bioenergy Energy in Agriculture

- ❑ There are two types of biomass energy available today: traditional and contemporary. Modern biomass energy sources, also known as biofuels, include biodiesel, ethanol, and biogas produced from energy crops, energy forests, and waste materials. Traditional biomass energy is described as the simple combustion of wood and animal wastes.
- ❑ Biomass is used on farms either directly for electricity and heat or indirectly as fuels in liquid, solid, or gaseous form. More than 30% of the energy used in households worldwide for heating, cooking, and lighting is derived from biomass.



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Use of Bioenergy Energy in Agriculture

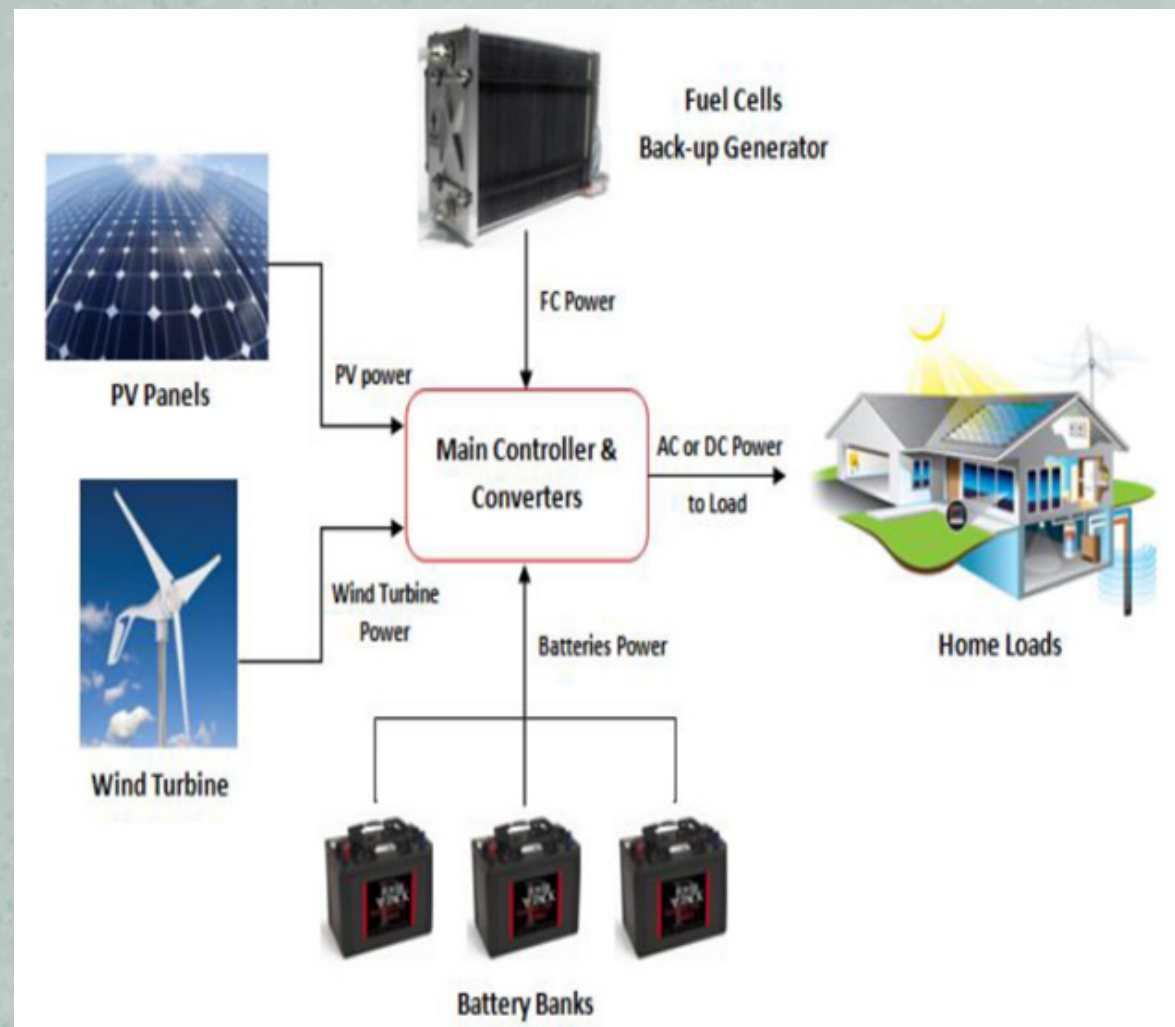
- ❑ With rapid technological innovation and growing automation, the use of petroleum-based fuels in agricultural production activities such as tillage, fertilization, spraying, harvesting, and transport to market is increasing. This raises agricultural enterprise production costs due to fuel consumption and causes environmental problems in rural areas. It is critical to use biofuels instead of petroleum fuels in agricultural activities.
- ❑ Bioenergy from agricultural and forestry activities is critical for farms to generate their own energy. It is also critical for combating climate change and ensuring energy supply security.



Use of Hybrid Energy Systems in Agriculture



- Hybrid energy systems are energy systems that use multiple energy sources. A hybrid energy system generates energy by combining renewable and fossil sources. A hybrid energy system is planned with a market focus rather than a technology focus: the priority is to select the most efficient and reliable energy systems to meet the needs of the users





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Use of Hybrid Energy Systems in Agriculture

- ❑ Hybrid energy systems provide an alternate energy source for agriculture. These systems combine one or more renewable energy sources with storage and may include a non-renewable energy source at times. Micro versions of these systems, such as a micro wind turbine with a few solar panels, can be used to power rural areas in low and middle-income countries. They can also help to overcome some of the challenges associated with traditional renewable energy systems by diversifying the energy source.



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ENERGY EFFICIENCY IN AGRICULTURE SECTOR

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ENERGY EFFICIENCY

- ❑ Energy efficiency is defined as lowering energy consumption per unit or product quantity without lowering living standards or service quality in buildings, as well as the quality and quantity of production in industrial enterprises and agriculture.
- ❑ Energy efficiency, refers to all efficiency-enhancing measures such as preventing energy losses in systems using gas, steam, heat, light, air, and electricity, recovering and utilizing various wastes, or reducing energy demand without reducing production through advanced technology, more efficient energy sources, advanced processes, and energy recoveries.
- ❑ Energy efficiency studies are conducted to improve or, if possible, completely eliminate the unnecessary use of energy by identifying the points of not needed energy use.



ENERGY EFFICIENCY IN AGRICULTURE

- ❑ Energy efficiency is a critical concern for farmers that cannot be ignored. Energy, a crucial input in production, is utilized effectively at a low level, requiring less input from farmers and increasing the profit realized in production.
- ❑ Various technologies and resources can be used in agricultural activities to improve energy efficiency, improve financial situation, reduce energy consumption, and reduce environmental impacts. Energy efficiency measures, when implemented correctly, can help agricultural producers save energy while maintaining productivity. Effective policies, such as energy efficiency training and incentives, can assist farmers in improving their operations.



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ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

- ❑ Agricultural vehicles, greenhouses, dryers, buildings, irrigation systems, and farm equipment are all part of a crop and livestock farm's daily operations and can result in high energy costs. Through efficient use of energy, it is possible to lower energy costs without losing product quality or efficiency.
- ❑ It is critical to have information about energy consumption. Energy audit refers to the entire study consisting of information collection, measurement, evaluation, and reporting stages for increasing energy efficiency. Energy auditing also includes the measurement of all energy flows and utilization within the enterprise in order to include the total energy balance, which will serve as the foundation for energy efficiency plans and applications



ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Heating

- ☐ Depending on the activity, heating can have a significant impact on an agricultural enterprise, providing a significant opportunity for energy savings.
- ☐ Temperature controls are essential for reducing the amount of energy used for this purpose.
- ☐ Thermostats should be installed in areas where they will not be affected by cold or sunlight.
- ☐ Boilers and pipework should be serviced on a regular basis.
- ☐ Heat losses in buildings, barns, and storage structures should be avoided.



ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Agricultural Vehicles

- ❑ Maintenance and use of agricultural vehicles will significantly improve energy efficiency. It is critical for energy management to reduce the amount of fuel used in tillage and other field applications. This requires optimizing the use of tractors and implements/machinery in field applications.
- ❑ Field operations such as fertilizer spreading and sowing can be combined to reduce the number of field passes.
- ❑ It is critical to change the filters, change the oil, inflate the tyres, adjust the balance, calculate the power requirement, and determine the best operating conditions for the vehicles used in the field.
- ❑ Tire pressure and fuel efficiency should be monitored. Excess weight in vehicles should be reduced to reduce fuel consumption. It is also necessary to understand the vehicle's driving characteristics in order to maximize fuel efficiency.



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ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Lighting

- ☐ Natural lighting systems use no energy to provide illumination. Transparent panels, which can take the form of light tubes, are used for natural lighting.
- ☐ In areas where natural light is insufficient, additional light sources are used. Traditional light sources are inefficient and generate a lot of radiant heat. As a result, LED bulbs for energy efficient lighting should be preferred.
- ☐ The automatic lighting control system ensures that the lights are turned on only when necessary, achieving the most efficient lighting level with the fewest lights.



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ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Ventilation

- ☐ Ventilation accounts for an estimated 14% of total energy bills in the industry. Identifying and implementing ventilation system improvements can reduce energy consumption by up to 20%.
- ☐ If possible, use windows and doors that allow for natural ventilation. As a result, the fans are turned off or run less frequently.
- ☐ Replacing inefficient ventilation fans with more efficient ventilation fans reduces energy consumption and saves money.
- ☐ Without proper maintenance, the efficiency of ventilation systems can be reduced by up to 60%, resulting in increased operating costs and the risk of failure. For this reason, it's crucial to keep the fan blades and grilles clean.
- ☐ Airflow is impeded by substances like dust, lint, and others that stick to surfaces. Inverter fan motors can also benefit from variable frequency drives to improve efficiency, reduce energy consumption, and extend motor life.



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ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Irrigation

- ❑ Systems for watering animals and irrigation can be made to use less energy.
- ❑ According to the number of animals on the farm, animal drinkers need to be properly insulated and the appropriate size.
- ❑ The choice of appropriate pumps, low-pressure irrigation, drip irrigation, and distribution system optimization are crucial for crop irrigation.
- ❑ Low-pressure sprinkler nozzles for crop irrigation lower pumping requirements without reducing water flow. These systems last longer and deliver water more cost-effectively.
- ❑ Low-height sprinkler application and low-height precision application are two of the most effective irrigation techniques.
- ❑ Electric pumps offer higher reliability, lower operating costs, and better efficiency when replacing diesel irrigation pumps.
- ❑ Irrigation systems can become more efficient with the help of smart sensors. They can measure soil moisture and determine when to water crops. They can also detect nutrient deficiencies in the soil and determine when to fertilize



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ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Drying

- ☐ In some cases, drying a crop consumes more energy than growing it. To ensure the product's dryness, a moisture meter should be used.
- ☐ Natural air or a low temperature drying system can be used if mechanical drying is required.



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ENERGY EFFICIENCY APPLICATIONS IN AGRICULTURE

Improving energy efficiency on the farm usually requires less investment than installing new energy production systems. Energy efficiency innovations in agriculture must be developed and implemented in practice. The development and implementation of integrated energy efficiency measures is also critical for the yield's sustainability. Energy efficiency on the farm and throughout the supply chain will aid in mitigating the effects of rising energy costs for heat, electricity, gas, and liquid fuels