

SECTION

5

SOLAR PANELS



VIGOUR BEHIND LIFE

Powering the future with energy

INTRODUCTION

In this section, you will dive into the exciting world of solar energy and discover how sunlight can be transformed into electricity by the use of panels. But we won't stop at just learning the theory; you will get hands-on experience in designing and building your solar panel using materials you can find around you.

At the end of this section, you will be able to:

- Describe the generation of electricity from solar cells/panels.
- Design and build solar panels.
- Design and build solar panels using locally available materials.

KEY IDEAS

- **Solar panels** are devices that are made up of multiple solar cells (photovoltaic cells) that capture sunlight and convert it into electricity.
- **Photovoltaic technology** is the method used to convert sunlight directly into electricity using materials that exhibit the photovoltaic effect, typically semiconductors like silicon.
- **Sustainable methods** are approaches that do not deplete resources or harm the environment.

HOW SOLAR PANELS REDUCE THE RELIANCE ON FOSSIL FUELS IN GHANA

Hello learner! Have you ever thought about the power of the Sun, which lights up our world, and how it is useful in our homes, schools, and communities?

Activity 5.1

Quickly discuss with your neighbour some of the benefits that we, as humans, get from the Sun. Produce a concept map to summarise your ideas, including anything that you recall about solar energy from your studies in Junior High School.

Ultimately, everything on Earth depends upon the Sun and the energy it transfers to us. The energy we derive directly from the Sun is known as solar energy.

Overview of Fossil Fuels

To better appreciate the usefulness of solar energy, let us discuss some facts about fossil fuels.

Activity 5.2

Observe the items in **Figure 5.1**. Which of them are you familiar with? How often would you say that you use them? And for how long? What would be the most difficult aspect of your life without them?



Fig 5.1: Examples of fossil fuels

Fossil fuels are natural energy sources formed from the remains of ancient plants and animals that lived millions of years ago. These organisms were buried under layers of sediment and rock, where heat and pressure over time transformed them

into coal, oil, and natural gas. They are a primary source of energy for modern civilisations, powering everything from transportation to electricity generation. However, they are non-renewable.

In addition to being non-renewable, they let out some gases into the air when they are combusted. Some of these gases are carbon dioxide (CO₂), methane (CH₄), and sulphur dioxide (SO₂). They are not good for our planet! These gases pollute our air, making the Earth warmer, and leading to climate change. Obtaining fossil fuels can be pretty messy, too! It can destroy habitats, errors in transportation can cause oil spills and does lots of damage to nature. Therefore, it is super important for us to think about how we can phase out the use of these fuels and find cleaner options!

Do this activity to enhance your knowledge of fossil fuels.

Activity 5.3

Objective: To visually represent the environmental consequences of fossil fuels and learn the importance of sustainable energy sources.

You can work alone as well as in a group.

What you need

- magazines, newspapers, brochures and online images related to fossil fuels (e.g., images of oil spills, coal mines, smog-filled cities, pollution, etc. You can sketch their own images too!)
- scrap paper, cardboard, or old boxes.
- glue, paste, or homemade paste.
- Scissors.
- markers, crayons, or coloured pencils.
- leaves, twigs, or small stones from the environment to incorporate into the collage to represent nature and the impact of fossil fuels on it.

What to do

1. Plan the design of your collage. Think about the topic you want to highlight (e.g., air pollution, oil spills, deforestation) and how you will visually represent them.

2. Cut out relevant images, headlines, and text from the collected materials. Think creatively about how to arrange your images on the base to tell a compelling story about the impact of fossil fuels.
3. Glue or paste your images onto the cardboard or scrap paper. Arrange the images in a way that draws attention to the negative impacts of fossil fuels.
4. Use markers or crayons to add titles, labels, and any additional drawings that will enhance the message of the collage. Highlight the key concepts like “pollution”, “global warming”, “acid rain” and “habitat destruction”.
5. Add natural materials like leaves or twigs to represent the environment. For example, leaves could symbolise the natural world that is affected by fossil fuel pollution.
6. Present your work to the class. Explain the choices you made in your design and the message you want to convey about the environmental impact of fossil fuels.

Conclusion

Sustainable energy sources like solar and wind can help reduce the environmental damage caused by fossil fuels. Through local initiatives, education, and policy support, communities can contribute to a more sustainable and lively energy future, improving both the environment and the quality of life for current and future generations.

Solar Panels

As earlier mentioned, solar panels are devices also known as **photovoltaic (PV) panels**. They capture sunlight and convert it into electricity using semiconductor materials. This process is a clean and renewable way to generate power, meaning it doesn't produce harmful emissions like greenhouse gases or air pollutants. In Ghana, the use of solar panels can significantly reduce the reliance on fossil fuels such as coal, oil, and gas, which are the main sources of pollution and environmental damage.

Activity 5.4

You can do this activity alone and share your findings with the class.

What you need: Manilla card/cardboard, pencils, markers, internet.

What to do

1. Draw a map of Ghana, clearly showing the 16 regions and their capitals. You may use the Internet to help you with your work.
2. Using your own key, show the distribution of sunlight in each of the regions.
3. Identify regions that receive the most as well as least amounts of sunshine.
4. Using a separate key, indicate the areas of Ghana which have the most solar panels installed, currently.
5. Post your map on the wall of your classroom.

From **Activity 5.4**, you will agree that Ghana is blessed with abundant sunlight. This makes solar energy a perfect solution for our energy needs. Unlike fossil fuels, which are limited and can run out, sunlight is a renewable resource. It is always available, during the daytime, although can be affected by cloud cover. By harnessing this natural resource, Ghana can modify its energy sources and reduce its dependence on fossil fuels. This is crucial for three key reasons:

1. **Better Air Quality:** Fossil fuels release pollutants into the air when combusted, leading to health problems and environmental damage. Solar panels generate electricity without combusting anything, which means no air pollution.
2. **Lower Carbon Emissions:** Carbon emissions from fossil fuels contribute to climate change, a global problem that affects everyone. By switching to solar power, Ghana can reduce its carbon footprint, helping to slow down climate change.
3. **Energy Security:** Relying on fossil fuels, especially imported oil, makes Ghana open to unstable prices and supply disruptions. Solar energy, on the other hand, is a stable and sure source of power that can be generated locally.

It is worth noting that the generation of solar energy using PV technology does not contribute to carbon emissions or air quality. The manufacture of PV cells is very energy-intensive and will require the use of fossil fuels (at least initially).

Activity 5.5

Make a list of the benefits and challenges associated with the introduction of solar panels in Ghana. Find some suggested answers in **Annex 5.1 – Solutions to Some Activities**.

The Future of Solar Energy in Ghana

Solar energy offers Ghana a transformative opportunity to build a more sustainable and resilient energy system. By investing in solar power, we can reduce our dependency on fossil fuels, combat climate change, and improve the quality of life for all Ghanaians. Understanding how solar panels work and their environmental benefits is key to making informed decisions about our energy future and contributing to a global effort to transition to a low-carbon economy.

You will now carry out activities to demonstrate an understanding of how solar panels reduce reliance on fossil fuels. You may work alone or with a friend. You may discuss your observations and findings.

Activity 5.6

Scenario: Your community is debating whether to invest in solar panels or continue using generators powered by diesel/petrol. They need clear information on how solar energy differs from fossil fuels.

Task: Compare and contrast solar energy and fossil fuels, focusing on their sources, environmental impact, and long-term sustainability. Highlight the ways in which using solar energy can reduce our reliance on fossil fuels. Publish your findings in the form of a poster or an article for a school magazine.

How Solar Panels Are Installed In Ghana

Let us dive further with the following activities.

Activity 5.7

Scenario: You are a solar energy engineer in Ghana, and your job is to bring clean, renewable energy to a community. But before you can install solar panels, you need to go through a series of important steps to make sure everything works perfectly. Let us explore this process together!

Step 1: Site Assessment – Where is the Best Spot?

Task: Draw a simple map of your home or school and mark the spots where you think solar panels would get the most sunlight. Picture yourself standing on the roof of the building. What do you see? Look around to see if there are any tall trees or buildings that might block the sunlight. Is the roof facing the sun most of the day?

Share your map with a classmate and compare your choices!

Step 2: Designing the Solar System – How Many Panels Do We Need?

Task: Work in small groups to design a solar panel system for a small house. You will need to decide how many panels to install.

What to do

1. Start by discussing the typical energy needs of a small house in the community. Consider the number of rooms, electrical appliances used, and daily energy consumption. You may want to make a list of all the devices and appliances that would be used in the house, such as lights, a refrigerator, a television, and a fan. Estimate how many hours each device will be used per day.
2. Research the common output for a typical solar panel and outline how many you think the house will need to install.
3. Use cardboard, aluminium foil, pane glass/plain polythene, old CDs, charcoal, copper wires, markers and any available local material to create a model of your solar panel set-up. Think about where each component will be positioned and how they will be connected (in series or in parallel with one another).

Step 3: Getting Permits and Approvals – What Do We Need to Do?

Role-Play: You are a solar energy engineer who needs to get permission to install solar panels. You will need to visit different “offices” (your classmates acting as local authorities) to ask for permits and approvals.

Simulation: Create a checklist of all the approvals you may need (research these using the internet). Visit each of the relevant authorities (classmates in your group) and explain why your project should meet their standards. Can you get them all in time to start your installation?

Discussion Questions

- a. Why is it important to follow local laws and guidelines when installing solar panels?
- b. What could happen if the installation doesn’t meet safety standards?

Final Challenge: Installation Day – Putting It All Together!

Installation Simulation: Now that you have everything ready, it is time to “install” your solar panels. Using your model, explain to the class how

you decided on the number of solar panels needed, how you would place the panels and how you would ensure that everything works properly.

Reflection Questions

1. How does installing solar panels help communities in Ghana?
2. What skills do you think are most important for someone working in solar energy?
3. What do you think the purpose of the inverter is in the diagram below? Why is it important?

Conclusion: By going through these steps, you have learned how solar panels are installed in Ghana, from choosing the perfect spot to getting all the necessary approvals. How might you use this knowledge to help your community?

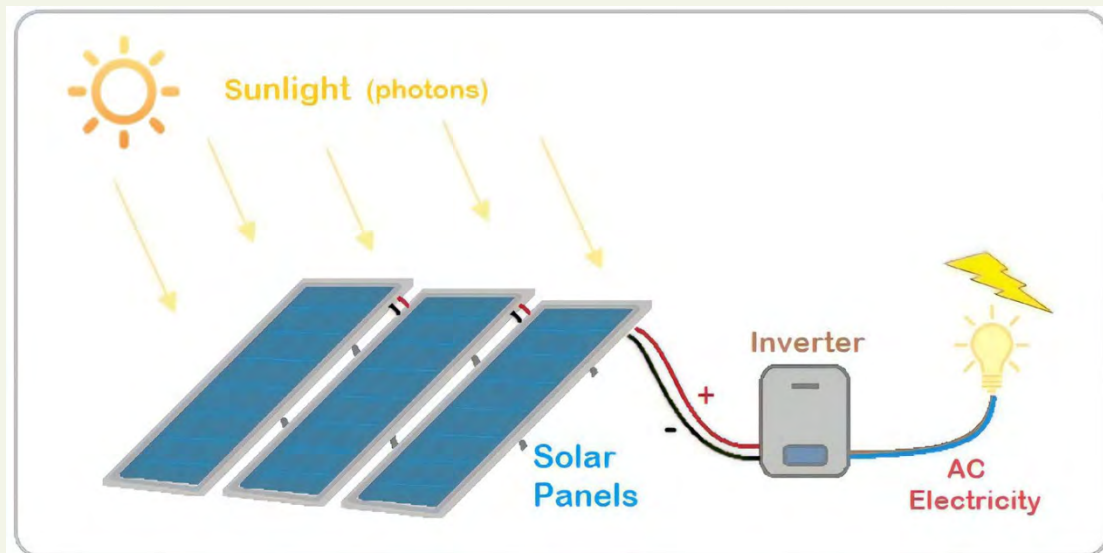


Fig. 5.2: A labelled diagram of the inverter installation

Let us do the next activity to consolidate the installation and testing process.

Activity 5.8

Aim: To install a solar panel kit, understand its components, and measure the output voltage and current under different lighting conditions.

What we need: Solar panel kit (designed for educational purposes), multimeter (to measure voltage and current), connecting wires, load (e.g., small motor or light bulb), mounting stand (optional), sunlight or artificial light source, notebook and pen for recording data.

What to do

1. Carefully unpack the solar panel kit and identify all components. Common components include the solar panel, connecting wires, a load (such as a small motor or light bulb), and a stand.
2. If your kit includes a stand or frame, assemble it according to the instructions provided.
3. Mount the solar panel onto the stand, ensuring it is secure.
4. The connecting wires attach the load (motor or light bulb) to the solar panel terminals. Ensure correct polarity (positive to positive and negative to negative).
5. Set the multimeter to measure voltage (V) and connect the probes to the output terminals of the solar panel.
6. To measure current (I), you must set the multimeter to the current setting and connect it in series with the load.
7. Vary the brightness of the light incident on the solar panel and record the new voltage and current (see suggestions for how to achieve this below).
 - a. **Outdoor in sunlight:** Place the solar panel in direct sunlight, with the plane of the panel's surface pointing directly at the sun. Record the voltage and current readings from the multimeter. Vary the light intensity by changing the angle of the panel to the Sun slowly until it is facing downwards, away from the Sun.
 - b. **Artificial light:** Bring the panel indoors and use a strong artificial light source (e.g., a desk lamp). Start with the lamp very close to the panel and record the readings. Slowly move the lamp to greater and greater distances from the panel, recording the readings at each interval.

Record Observations: For each lighting condition, note the following:

1. Voltage (V)
2. Current (A)
3. Power ($P = V \times I$)

You can put your data in a table, which might look something like this:

Table 5.1

Lighting condition	Voltage (V)	Current (I)	Power (W) = V x I
Direct sunlight			
Partial shade			
Artificial light			

Analyse data: Compare the voltage and current outputs under different lighting conditions.

Discuss how the intensity and type of light affect the solar panel's performance.

Extension activity:

Drawing a graph with enable further and more specific analysis of how the power output of the solar panel varies with light intensity.

Exploring the Impact of Environmental Factors on Solar Panel Installation

The following activities are to deepen your understanding and application of the impact of the environment on solar panel installation.

Work in groups for all of the following activities.

Activity 5.9

See conclusions to this activity in Annex 5.1

Task 1: Temperature Impact Experiment

What you need

- Two identical small solar panels or solar-powered fans/lights.
- Two clear plastic containers.
- Ice packs and hot water bottles.
- Thermometer.

What to do

1. Place one solar-powered fan or light inside a plastic container with an ice pack (to simulate a cooler environment) and the other in a container with a hot water bottle (to simulate a warmer environment).
2. Place both containers under a bright light source or outside in direct sunlight. Observe how the fans or lights operate in different temperature conditions.
3. Use the thermometer to record the temperature inside each container.
4. Compare the performance of the solar devices in cooler versus warmer environments. Discuss how temperature affects the efficiency of solar panels and what can be done to reduce overheating.

Reflection Questions

1. How did temperature affect the performance of the solar-powered devices?
2. What strategies can be used to keep solar panels cool and efficient?
3. Do you think this change in performance would continue to occur infinitely if the temperature was continually decreased?

Task 2: Roof Orientation and Tilt Angle Experiment**What you need**

- A protractor or angle finder.
- Small solar panel or light-sensitive material.
- Adjustable mount or cardboard to change the angle.
- Light source (flashlight or sunlight).

What to do

1. Place the small solar panel or light-sensitive material on the adjustable mount. Use the protractor to set the tilt angle to different degrees (e.g., 0° , 15° , 30° , 45°).
2. Shine the light source directly on the panel at each tilt angle. Measure or observe the output (e.g., how brightly a connected LED lights up, the reading on a multimeter or how much the material darkens).
3. Record the results and compare how different angles affect the amount of light absorbed.

4. Discuss why it's important to install solar panels at the correct tilt angle based on the location's latitude and how roof orientation impacts the overall energy production.

Reflection Questions

1. What tilt angle provided the best sunlight exposure for the solar panel?
2. How does the roof's orientation (facing north, south, east, or west) affect solar energy generation?
3. Why is it important to avoid shaded areas when installing solar panels?

Task 3: Wind and Weather Simulation

What you need

- A small solar panel (or a paper model representing a solar panel).
- Fan (to simulate wind).
- Spray bottle with water (to simulate rain).
- Sand or dust (to simulate dirt or debris).
- Small weights (to represent secure mounting).

What to do

1. Place the small solar panel or model in front of a fan. Gradually increase the wind speed and observe how it affects the stability of the panel. Add small weights to see how securing the panel can prevent movement.
2. Spray water on the panel to simulate rain and sprinkle sand or dust to simulate debris. Observe how these factors affect the panel's surface and ability to generate power.
3. Try cleaning the panel with a cloth or brush and see how much its efficiency improves after removing dirt and debris.
4. Discuss the importance of proper mounting and regular maintenance to ensure that solar panels function efficiently despite environmental challenges.

Reflection Questions

1. How can strong winds impact the installation and stability of solar panels?
2. What effects do rain and dust have on the performance of solar panels, and how can these issues be addressed?

Maintenance of Solar Panels: Why is regular cleaning of solar panels important?

Regular cleaning of solar panels is crucial because it ensures they operate at maximum efficiency. Over time, dust, dirt, bird droppings, and other debris can accumulate on the surface of the panels, blocking sunlight and reducing the amount of energy they can generate. Even a small amount of shading can significantly decrease the panels' efficiency, leading to lower energy output and reduced cost savings.

Cleaning the panels regularly helps maintain optimal performance, ensuring that you get the most out of your solar investment. It also prolongs the lifespan of the panels by preventing potential damage from corrosive substances that might accumulate on their surfaces.

Advantages and Disadvantages of Solar Energy to the Economy of Ghana

Advantages of Solar Energy to Life in Ghana

Activity 5.10

Initial Set-up: The Pokuase community, located in the Greater Accra Region, was part of a government initiative to provide solar power to under-served areas. The project involved installing solar panels on rooftops of households and public facilities, such as schools and clinics. The initiative was funded by a combination of government grants and international aid.

Task

1. In your group, research and analyse the case study to identify the advantages (e.g., on energy access, education and healthcare) and disadvantages (e.g. initial costs, maintenance requirements).
2. Discuss how these factors influence the overall effectiveness of solar panels in the case study.

Case Study 2: The Bui Solar Energy Project in Ghana

The Bui Solar Energy Project is a significant renewable energy initiative in Ghana, designed to complement the existing Bui Hydroelectric Dam. Located in the Bono Region, this project was developed by the Bui Power Authority (BPA) as part of Ghana's broader strategy to diversify its energy mix and

increase the share of renewable energy in the national grid. The solar farm is one of the largest in West Africa, with an installed capacity of 250 Megawatts (MW).

Initial Set-up: The Bui Solar Project was planned as a three-phase development. The first phase, completed in 2020, involved the installation of 50 MW of solar power capacity. Subsequent phases aim to expand this capacity to 250 MW. The project was financed through a combination of government funding, loans from international development banks, and partnerships with private sector entities. The solar farm utilizes photovoltaic (PV) panels spread over a vast area of land. The integration with the Bui Hydroelectric Dam allows for hybrid energy generation, balancing solar energy during the day with hydropower when solar output decreases.

Task

1. In your group, research and analyse the case study to identify the advantages (e.g., on energy access and carbon emissions) and disadvantages (e.g. initial costs, land use, maintenance requirements).
2. Discuss how these factors influence the overall effectiveness of solar panels in the case study.

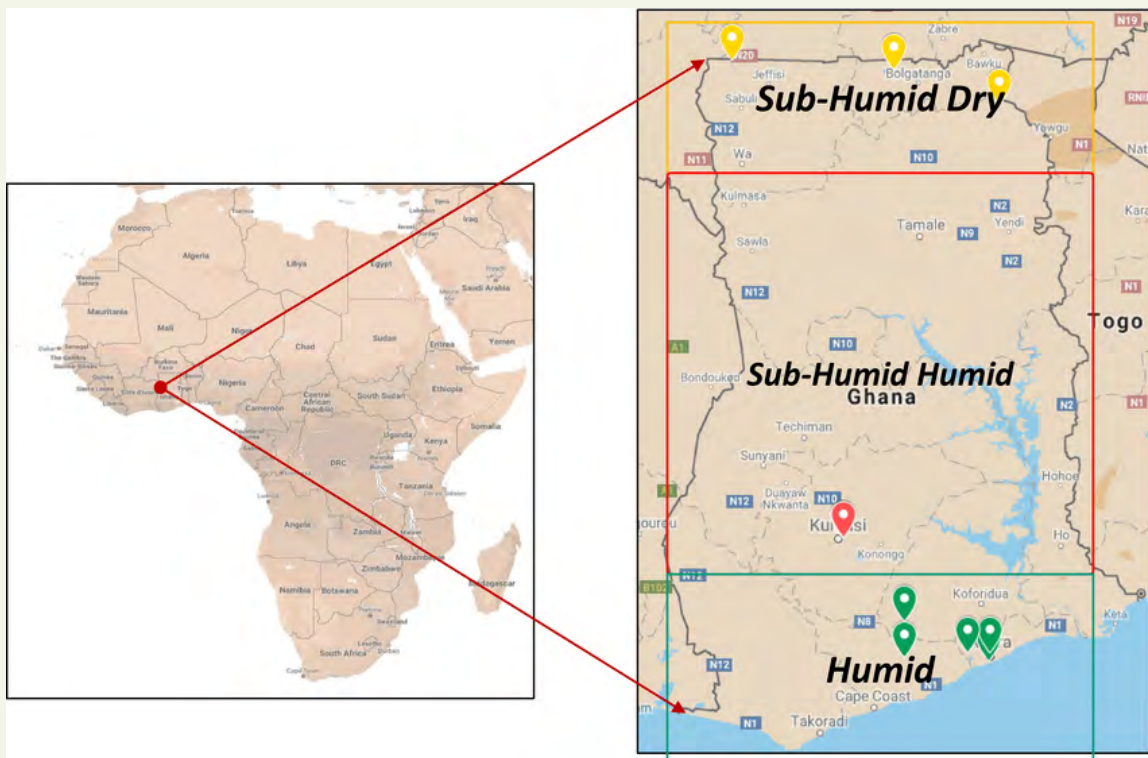
Conclusion and Class Discussion

After each group has examined the case studies, you will present your findings to the class for a class-wide discussion on the impacts of the two projects. The discussion will encourage critical thinking about the challenges and opportunities of large-scale renewable energy projects in Ghana and their implications for the country's future development.

ANNEXES

Annex 5.1 – Solutions To Some Activities

Activity 5.4



Map of Ghana showing location of solar panel installations studied (shown in green, yellow, and red highlights) source (https://www.researchgate.net/figure/Map-of-Ghana-showing-location-of-installations-studied-shown-in-green-yellow-and-red_fig2_339220812)

Activity 5.5

Benefits of Solar Energy for Ghana

1. **Economic Growth:** The solar industry can create jobs in manufacturing, installation, maintenance, and research, driving economic development.

2. **Technological Innovation:** Investing in solar energy encourages the development of new technologies and solutions, positioning Ghana as a leader in renewable energy.
3. **Environmental Sustainability:** By reducing the need for fossil fuels, solar energy helps protect Ghana's natural environment and promotes a healthier planet for future generations.

Challenges Associated with Solar Energy

1. Low generation potential on cloudy days or at nighttime. How will the demand for nocturnal energy be met?
2. Difficulty in storing excess electricity/energy during times of plentiful generation, for use during times of low generation.
3. High initial cost of manufacturing, installing, maintaining and disposing of solar technology which does not have the required large-scale infrastructure to do so.
4. Lack of flexibility in terms of energy/electricity output. In a time of spiking demand, you cannot just turn up the Sun!

Activity 5.9

- **Task 1 Conclusion:** Solar panels are designed to operate efficiently within a specific temperature range. While solar panels can still function in high temperatures, extremely hot conditions can reduce their efficiency. Panels produce less electricity as the temperature increases, so proper ventilation and cooling measures may be needed.
- **Task 2 Conclusion:** The angle and direction of the roof or mounting structure affect how much sunlight the panels receive throughout the day. In Ghana, the optimal orientation for solar panels is typically facing south, where they can capture maximum sunlight. The tilt angle should be adjusted to match the latitude of the location to maximise energy absorption.
- **Task 3 Conclusion:** The local climate, including wind, rain, and dust, affects the durability and performance of solar panels. Heavy rainfall can lead to water pooling and potential leakage issues if the panels are not installed correctly. High winds may require more robust mounting systems to prevent damage, while dust and dirt accumulation on panels

can reduce their efficiency by blocking sunlight. High humidity levels can lead to corrosion of metal components in the solar panel system. In coastal areas of Ghana, where humidity and salt levels are higher, corrosion-resistant materials should be used to ensure the longevity of the installation. For ground-mounted solar panels, the type of soil and ground stability are important considerations. In areas with frequent flooding or erosion, the installation site must be carefully selected and prepared to avoid damage.

Activity 5.10

Case study 1:

Benefits:

- **Energy Access:** The solar panels provided reliable electricity to a community that had previously faced frequent power outages.
- **Educational Impact:** Schools in the area were able to extend learning hours with the availability of electricity, improving student outcomes.
- **Healthcare Improvements:** The local clinic could operate medical equipment and refrigeration for vaccines without relying on an unstable grid.

Challenges Encountered:

- **Initial Costs:** Although the project was subsidized, some households struggled with the upfront costs required for installation and maintenance.
- **Maintenance Issues:** A lack of local expertise meant that any technical issues with the solar panels had to be addressed by technicians from outside the community, leading to delays in repairs.
- **Sustainability Concerns:** Over time, concerns arose about the sustainability of the project due to the costs of maintaining and replacing parts of the solar systems.

Case study 2:

Benefits:

- **Increased Energy Supply:** The Bui Solar Project contributes significantly to Ghana's energy supply, providing clean, renewable

energy to the national grid and helping to reduce the country's reliance on thermal power plants.

- **Reduction in Carbon Emissions:** By displacing fossil fuel-based power generation, the project is expected to reduce Ghana's carbon emissions by several thousand tons annually, contributing to global climate change reduction efforts.
- **Hybrid System Efficiency:** The integration with the hydroelectric dam allows for more efficient energy use, as water can be stored for power generation when solar energy is insufficient.

Challenges Encountered:

- **High Initial Investment:** The project required substantial upfront capital, which posed challenges in securing adequate financing.
- **Land Use Concerns:** The large area required for the solar farm raised concerns about land use and the potential impact on local agriculture and communities.
- **Technical and Maintenance Issues:** As with any large-scale infrastructure, maintaining the solar panels and ensuring optimal performance involves ongoing technical challenges.

Annex 5.2 – Further Information

How Can Solar Panels Be Used in Ghana?

Solar panels can be installed in various settings to meet different energy needs:

1. **Rooftop Installations:** Homes and businesses can have solar panels installed on their roofs to generate electricity for their own use, reducing their reliance on the national grid and cutting down on electricity bills.
2. **Solar Farms:** Large-scale solar farms can generate electricity for entire communities or regions, providing clean energy to many people at once.
3. **Decentralised Systems:** In rural areas where connecting to the national grid is challenging, decentralised solar systems can provide electricity for lighting, water pumping, and other essential services.

How the Implementation of Solar Energy/Panel Initiatives Impacts the Country's Economic Growth and Sustainability

Renewable energy, particularly solar energy, plays a significant role in fostering economic growth and sustainability. Here's a brief overview focusing on key areas:

Impact of Solar Energy:

- **Energy Independence - Reducing Reliance on Imported Fuels:** Energy independence refers to a country's ability to meet its energy needs without relying heavily on imported fuels, such as coal, oil or natural gas.
- **Reduction in Imports:** By investing in solar energy, Ghana can reduce its dependence on imported fossil fuels, which are often subject to unstable global prices.
- **Energy Security:** Solar energy enhances energy security by providing a reliable and locally sourced power supply. This reduces the vulnerability to geopolitical tensions and supply disruptions that can affect imported energy resources.
- **Economic Diversification:** As Ghana moves towards energy independence, it diversifies its economy by reducing its reliance on sectors dominated by fossil fuels, making it more resilient to global market shifts.
- **Direct Employment:** The solar industry creates jobs in manufacturing, installation, maintenance, and sales of solar panels and related technologies. This includes both skilled and unskilled labour, contributing to employment across various levels of the workforce.
- **Supporting Industries:** The growth of the solar sector stimulates job creation in related industries, such as supply chain management, transportation, finance, and engineering services. These supporting industries benefit from the demand generated by the solar energy sector.
- **Entrepreneurship and Innovation:** Solar energy fosters entrepreneurship by encouraging the development of new businesses and innovations in renewable technologies. This can lead to the creation of start-ups focused on solar solutions, driving economic growth and technological advancement.
- **Reduced Utility Bills:** Once the initial investment in solar panels is made, the ongoing costs of generating solar power are significantly lower compared to conventional energy sources. This translates into reduced electricity bills for both businesses and households.

- **Increased Disposable Income:** Lower energy costs mean more disposable income that can be spent on other needs, stimulating economic activity.
- **Enhanced Competitiveness:** Businesses that adopt solar energy can lower their operating costs, allowing them to offer more competitive pricing or increase their profit margins. This can make Ghanaian businesses more competitive both domestically and internationally.
- **Cost Stability:** Solar energy provides more predictable and stable energy costs, as it is less affected by market fluctuations compared to fossil fuels.

REVIEW QUESTION

Review Questions 5.1

1. State 3 examples of fossil fuels.
2. Describe how a fossil fuel is made and explain why they are non-renewable.
3. Explain why it would be beneficial for Ghana to transition away from fossil fuels, specifically towards solar power.
4. Outline the impacts of solar power (both positive and negative) on the Ghanaian economy.

ANSWERS TO REVIEW QUESTION

Review Questions 5.1

1. Coal, natural gas, oil, propane, kerosene.
2. Fossil fuels—such as coal, oil, and natural gas—are formed from the remains of ancient plants and animals that lived millions of years ago. Fossil fuels are considered non-renewable because the processes that form them take millions of years—far longer than the human timescale. We are consuming fossil fuels at a rate much faster than they are being naturally replenished. Once we extract and use fossil fuels, they cannot be quickly replaced. Therefore, their supply is finite, and they will eventually run out, making them unsustainable as a long-term energy source.
3. Transitioning away from fossil fuels towards solar power would offer several significant benefits for Ghana, both environmentally and economically. Here are some of the reasons why this shift would be advantageous:

<p>Abundant Solar Resources</p>	<p>High Solar Potential: Ghana is located near the equator, giving it abundant sunlight throughout the year. The country receives an average of 5-6 hours of sunshine per day, making solar energy a highly viable and reliable source of power. Leveraging this natural resource could provide a consistent and sustainable energy supply.</p>
<p>Environmental Benefits</p>	<p>Reducing Carbon Emissions: Fossil fuels are a major source of greenhouse gases, which contribute to global warming and climate change. By transitioning to solar power, Ghana could significantly reduce its carbon footprint, helping to combat climate change and protect the environment.</p>

	<p>Improving Air Quality: Burning fossil fuels, especially coal and oil, releases pollutants that can degrade air quality, leading to health issues such as respiratory problems. Solar power generation, on the other hand, produces no harmful emissions, leading to cleaner air and better public health outcomes.</p>
Economic Advantages	<p>Reducing Energy Costs: Once installed, solar power systems have low operational costs, as sunlight is free. Over time, this could reduce energy costs for consumers and businesses in Ghana, making energy more affordable and helping to stimulate economic growth.</p> <p>Energy Independence: Ghana currently imports a significant portion of its fossil fuels. Transitioning to solar power could reduce dependence on imported fuels, enhancing energy security and reducing vulnerability to global fuel price fluctuations.</p> <p>Job Creation: The solar energy sector has the potential to create jobs in manufacturing, installation, maintenance, and research and development. This could help to reduce unemployment and boost local economies.</p>
Long-term Sustainability	<p>Renewable and Inexhaustible: Unlike fossil fuels, which are finite, solar energy is renewable and will not run out. By investing in solar power, Ghana can ensure a long-term, sustainable energy supply that can meet the needs of future generations.</p> <p>Resilience to Climate Change: As climate change impacts become more pronounced, energy systems that rely on fossil fuels could become less reliable. Solar power, being decentralized and less vulnerable to climate-related disruptions, could offer greater resilience to extreme weather events.</p>
Supporting Rural Electrification	<p>Decentralised Energy: Solar power systems, particularly off-grid solutions, can be deployed in remote and rural areas where extending the national grid is challenging or costly. Bringing electricity to underserved regions, enhancing the quality of life.</p>

Positive impacts	Negative impacts
<ol style="list-style-type: none"> 1. Energy Cost Reduction: <ul style="list-style-type: none"> - Lower operational costs than fossil fuel power stations. - Reduced fuel import costs. 2. Job Creation: <ul style="list-style-type: none"> - Employment opportunities. - Skill development. 3. Economic Diversification: <ul style="list-style-type: none"> - Reduced economic vulnerability: Ghana's economy can become less vulnerable to global oil price fluctuations and supply disruptions. - New market opportunities (e.g. battery storage and electric vehicles). 4. Improved Energy Access: <ul style="list-style-type: none"> - Rural electrification. 5. Attracting Investment: <ul style="list-style-type: none"> - Green investments and international aid: A strong focus on renewable energy can attract foreign investment. 6. Environmental and Health Cost Savings: <ul style="list-style-type: none"> - Reduced healthcare costs due to the reduced levels of air pollution. 	<ol style="list-style-type: none"> 1. High Initial Capital Costs: <ul style="list-style-type: none"> - Upfront investment is high and could be a strain for the government, increasing national debt. - Affordability issues: low-income households and small businesses may struggle to afford to install solar panels. 2. Intermittency and Reliability Concerns: <ul style="list-style-type: none"> - Energy supply variability. 3. Land Use Conflicts: <ul style="list-style-type: none"> - Large-scale solar farms require significant land, which might compete with agricultural land or other uses. 4. Impact on Fossil Fuel-Dependent Jobs: <ul style="list-style-type: none"> - Job displacement. - Transition costs. 5. Dependence on Foreign Technology and Expertise: <ul style="list-style-type: none"> - Limited local manufacturing. - Skill gaps.

EXTENDED READING

- Solar energy basics: <https://www.coursera.org/learn/solar-energy-basics>
- Understanding Solar - a beginner's guide: <https://youtu.be/YtoU7167t5I>
- “Solar Power Demystified: The Beginners Guide to Solar Power, Energy Independence and Lower Bills” by Lacho Pop, Dimi Avram

REFERENCES

1. General Science Curriculum for Senior High Schools
2. “Solar Power Demystified: The Beginners Guide to Solar Power, Energy Independence and Lower Bills” by Lacho Pop, Dimi Avram
3. Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy – Designing and Installing Solar Photovoltaic Systems” by Michael Boxwell
4. <https://buipower.com/250mwp-solar-project>, BUI SOLAR PROJECT
5. <https://citinewsroom.com/2023/06/bui-power-authority-completes-first-floating-solar-project-in-sub-region/>
6. <https://www.architecturaldigest.com/reviews/solar/how-to-install-solar-panels>
7. <https://www.forbes.com/home-improvement/solar/how-to-install-solar-panels/>
8. <https://www.skillstg.co.uk/blog/how-to-install-a-solar-panel/>
9. <https://www.solarreviews.com/blog/solar-panel-maintenance-everything-you-need-to-know#:~:text=clean%20them%20manually.,It%20is%20generally%20recommended%20that%20you%20perform%20solar%20panel%20cleaning,clean%20and%20in%20top%20condition.>
10. <https://www.solar.vic.gov.au/maintenance-guide>

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