MM7: SDG7 SPACE4SDGS SPACE BASED RENEWABLES

SDG7: Space-Based Solar Power Solutions

- Design a space-based solar power system that can transmit clean energy to Earth or power space habitats.

Challenge

Imagine harnessing the power of the sun from space, where solar panels can capture sunlight 24/7 without interference from clouds or the atmosphere. This project challenges you to design a system that collects solar energy in space and transmits it to Earth to support clean energy needs or to provide energy for space habitats. Your design could help provide sustainable energy solutions for remote areas on Earth or power future space stations and habitats, paving the way for a greener planet and enabling longer missions in space.

Considerations

- Energy Efficiency: Space-based systems need to be highly efficient, capturing as much solar energy as possible with minimal energy loss during transmission.
- Reliability and Durability: Space environments are harsh, so your system must be durable to withstand radiation, extreme temperatures, and other space conditions.
- Transmission Methods: Consider how to transmit energy from space to Earth or within a space habitat safely. Options include microwaves, lasers, or other forms of wireless energy transfer.
- Safety and Environmental Impact: Ensure the system is safe for both space and Earth. Energy transmission methods need to avoid harming the environment, people, or wildlife.
- Adaptability for Different Environments: Think about how to adjust the design for different settings, such as energy-needy regions on Earth, space stations, or planetary habitats like the Moon or Mars.

Background

On Earth, solar power is an essential part of clean energy solutions, but it’s limited by weather conditions and the day-night cycle. A space-based solar power system offers a unique advantage: sunlight in space is continuous, providing an uninterrupted energy source that can help meet growing energy demands on Earth and support long-term missions in space. In space, solar energy can power habitats on the Moon or Mars, help run life-support systems, and enable longer and more sustainable exploration missions.

However, capturing solar energy in space and transmitting it to Earth or other space habitats presents challenges. Transmitting energy across long distances in space requires innovative technology, and the harsh conditions of space demand durable, resilient materials. With

careful design, a space-based solar power system can provide continuous, clean energy for Earth and empower human presence in space, contributing to the sustainable energy solutions necessary for our planet's future.

Your Mission

Your mission is to create a design for a space-based solar power system that can efficiently collect and transmit clean energy from space to Earth or for use in space habitats. Focus on sustainability, efficiency, and safety as you design the system, making sure that it is resilient to space conditions and suitable for various energy needs on Earth or in space. Consider how to maximize energy collection, choose the best method of transmission, and ensure that the design is scalable for different energy requirements and adaptable for future needs.

Project Objectives

- Create an Efficient Solar Collection and Transmission System:
  - Design solar collectors that maximise sunlight capture and are lightweight for launching into space.
  - Develop a reliable and safe method for transmitting energy, either down to Earth or within space habitats.
- Emphasie Sustainability:
  - Use renewable materials or methods that minimize the impact on Earth's environment and space ecosystems.
  - Consider energy storage options that allow the system to supply power consistently, regardless of transmission interruptions.
- Ensure Practicality and Scalability:
  - Make the design practical and scalable so it can provide energy to various locations, from remote Earth areas to larger space habitats.
  - Include modular elements that allow for expansion or adaptation to future needs.
- Promote Safety and Accessibility:
  - Prioritise safety by choosing transmission methods that protect people, wildlife, and the environment.
  - Ensure the design is user-friendly, reliable, and accessible for various users, from technicians on Earth to astronauts in space.

Deliverables

- User Profile: Describe a typical user, such as a technician managing the system on Earth or an astronaut in a space habitat, outlining their specific needs and challenges.
- System Overview: A one-page summary explaining how your solar power system works, including its main components, solar collection method, and energy transmission.
- Prototype or Concept Sketch: Design a basic sketch or model to show the main features of your system and how it operates in space and/or on Earth.
- Presentation: Prepare a presentation to demonstrate the impact of your solar power system, highlighting how it provides sustainable energy for Earth and space environments and the importance of safety, efficiency, and adaptability.

Questions to Consider

- Understanding the System's Users and Needs:
  - Who are the main users or beneficiaries of this system? Consider users on Earth, e.g.

    - remote communities, or astronauts in space habitats who rely on sustainable power
    - What specific energy challenges will your design address, both on Earth and in space? Think about the need for reliable power in space and the goal of providing clean energy to reduce fossil fuel use on Earth.
- Designing for Space and Earth Conditions:
    - How will you ensure that the system captures as much solar energy as possible and withstands harsh space conditions? Consider how to make it durable and effective in various environments.
    - How will you adapt your design to transmit energy safely from space to Earth or within a space habitat?
- Safety and Environmental Impact:
    - What methods of energy transmission will you use, and how can you make them safe for people, animals, and the environment? Think about options like microwaves or lasers and their potential impacts.
    - How will you minimise the environmental impact of the system during construction, launch, and operation?
- Resource Efficiency and Sustainability:
    - What materials and technology can you use to make the system efficient and sustainable? Could renewable or recycled materials be used in the design?
    - How can you ensure energy efficiency, storage, and reliability to provide consistent power in all conditions?
- User-Friendly Design and Scalability:
    - How can you make your design adaptable for different locations and future needs? Could your system be modular for easy expansion?
    - What visual guides or instructions would make it easy for people on Earth or astronauts to understand and use your system?

Design Process Overview

Step 1: Introduction: What is available and Who are your users?

- Explore examples of space technology solutions for space-based solar energy and its potential to solve Earth's energy problems - see links on the last page
- Think about how space technology supports earth-based activities also

Step 2: Empathy

- Create user profiles for the people you want to help. What are their challenges, and what would help improve their lives e.g. astronauts and communities needed clear energy

Step 3: Defining the Problem

- Define the main problem that your project will solve: the challenge capturing solar energy in space and transmitting it to where it is needed.

Step 4: Ideate

- Brainstorm different ideas for how your system could work e.g. transmission or storage of energy. How would people use it? What kind of information would it provide?

Step 5: Ideate 2 – Good Idea / Bad Idea

- Refine your ideas. Focus on the most promising ones and think about how they could be even better or more accessible.

Step 6: Prototype

- Create a model or sketch of your system or management app. This could include the type of information it provides, how people interact with it, and what it looks like.

Step 7: Test

- Share your prototype with others to get feedback. Use their suggestions to make improvements and ensure it's easy to understand for your users

Each step will take one or more lessons, your teacher will guide you with lessons and resources from 'Space Design Challenge Problem to Pitch' Module and the Future of Space

The United Nations Office for Outer Space Affairs (UNOOSA) works to promote international cooperation in the peaceful use and exploration of space, and in the utilisation of space science and technology for sustainable economic and social development.

VISIT https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg1.html

Step 1: Introduction: Explore concept of space-based solar energy and its potential to solve Earth's energy problems.

- Use the Internet to explore examples of clean energy and renewables on earth and how space technology and space missions can help with solutions producing and storing energy. Visit https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg7.html
- Explore solar projects in on earth and see who your users might be

Step 2: Empathy: Understand the needs of both astronauts needing energy in space and communities needing clean energy on Earth.

- What are their challenges, and what would help improve their lives?

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 2, Empathy - see supporting links also on the last page

These prompts and deliverables will help guide learners in designing a user-centered and adaptable space based solar power system and solutions that serve both earth and space power space habitats, promoting sustainability. Asking these questions will help you create user profiles and help you design your challenge solution.

Identifying Needs of Different Users

- Who are the primary users of this system? Consider users on Earth in remote or off-grid locations, as well as astronauts who need a reliable energy source for long missions.
- What specific energy challenges does each user group face? For example, consider limited power availability for space habitats and the need for clean energy alternatives in isolated Earth areas.

Daily Life with Limited Water Access

- Imagine a day in the life of someone relying on this system. For a technician on Earth, how would they monitor or maintain the system?
- For an astronaut, how would this system support their energy needs for daily activities?
- What role would the system play in ensuring continuous, clean power for users in space habitats or for communities in need on Earth?

Different Environments, Different Requirements

- How might a water filtration system need to be adjusted to work in space (microgravity) compared to Earth? Think about how water behaves differently in zero gravity.
- Consider the specific needs of each environment. What aspects would be important to address, like portability, ease of use, or minimal power requirements?

User-Friendliness and Reliability

- How could your system be designed to be intuitive and simple to operate for both astronauts and local users on Earth?
- What instructions, maintenance features, or visuals would help make the system clear and user-friendly for people with different levels of technical knowledge?

Community Impact on Earth

- How could a family in a remote community use this system to access clean water daily? How might it improve their health, well-being, and daily life?
- Think about the broader impact. How could this system make a positive difference for communities or schools that struggle with access to safe drinking water?

Creating User Profiles

After working through the prompts, ask learners to create a user profile for a learner or educator who might use the system. This can include:

- Name, age, and location of the user
- A description of their daily challenges and pain points
- Technology they have access to and comfort level with digital tools
- Their specific learning or teaching needs
- An example of how they would use the system to access education

Step 3: Defining the Problem: Define the main problem that your project will solve.

Define the core issue your project addresses. Is it to deliver consistent, clean energy to remote areas, or to support energy needs for long-term space habitats?

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 3, Define e.g. Create a problem tree to show the root causes, such as limited access to renewable energy and high space-energy demands. The “branches” or effects might include reliance on fossil fuels, pollution, or reduced mission duration in space due to energy limitations. This will help clarify the problem and show the importance of your solar power solution.

Step 4: Ideate: Brainstorm different ideas

Brainstorm various solutions for capturing and transmitting solar energy from space. Think about solar panel designs, energy transmission methods (like microwaves or lasers), and how energy

can be stored or distributed. Consider innovative ways to make the system adaptable, lightweight, and durable for both space and Earth applications.

Step 5: Refine your ideas. Focus on the most promising ones and think

- about how to maximise efficiency, considering challenges like long-distance transmission and energy storage.

Refine your ideas, focusing on the most promising concepts. Think about how to make the design more efficient, user-friendly, and sustainable. Could you make the system modular for easy expansion? Ensure it meets safety standards for people, animals, and the environment, whether in space or on Earth.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 4 and 5, Ideate

Step 6: Prototype: Create a sketch or model of your solar power system, showing its key components and how it will function.

- Create a basic model of a space-based solar panel array or an energy transmission system. Include solar collection panels, energy storage, and transmission features. Your prototype should highlight the system's adaptability for different environments and user needs.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 6 Prototype

Prototypes can be 3D or 2D if using wireframes for software / apps. You can read this article to help you https://www.figma.com/resource-library/what-is-wireframing/

Mock-ups can help you imagine how a user might interact with your satellite data -based app or system. The following links in Canva to create prototypes for any platform

- https://www.canva.com/prototypes/templates/
- https://www.canva.com/prototypes/

Follow the steps in Canva to create a user Interface (UI) Mock-up for a mobile interface that might control your solar system

Steps in Canva:

- Open a New Project:
  - Create a Custom Dimensions project, and set it to 1080x1920 pixels (this mimics a mobile screen format).
- Set Up a Mobile Background:
  - In Elements, search for "mobile screen" to find a blank phone outline. Place it in the centre of the canvas.
- Design the App's Home Screen:
  - Inside the mobile frame, add a rectangle for a menu bar at the bottom and a circle or square near the top for the main icon or app name.
  - Use text to title this screen as "Track" or "Generate", 'Store'

- Add Buttons or Icons for Key Functions:
  - Create buttons or icons for each function as a means to navigate the \ programme
  - Place each button within the phone / tablet screen as a tapable icon.
  - Label each icon clearly with small text beneath or beside it.
- Add a Sample Data Preview:
  - Use a rectangle as a sample “data preview” section in the middle, where satellite data like Precipitation, Temperature would appear.
  - Use smaller text for this data to simulate a realistic UI (user interface) feel.
- Enhance with Colours and Borders:
  - Add borders to each button/icon for a polished look, and apply a consistent colour theme (e.g., blue and white for a “tech” feel).
- Review, Download, and Save:
  - Make sure everything is aligned neatly and easy to read.
  - Download the mock-up once it’s polished!

You can also use cardboard - Cardboard Prototyping | Techniques, Cal Maritime Makerspace see https://www.youtube.com/watch?v=qxXj2RhKjZY

Or Paper Mobile Application Design: Paper Prototype Video, Cor-mac https://www.youtube.com/watch?v=y20E3qBmHpg

Step 7: Test: Share your prototype with others to get feedback. Use their suggestions to make improvements and ensure it’s easy to understand and helpful for your users.

- Simulate energy collection and transmission in a classroom setting or via digital modeling and gather feedback on efficiency.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 7 Test

Supporting links to help you define your users and testing

- Bord na Mona (2024) A Beginner’s Guide to Solar Energy in Ireland https://www.bordgaisenergy.ie/home/solar-energy-guide
- ISEA (2024) https://www.irishsolarenergy.org/
- Renewable Energy (2024) Renewable Ireland https://renewableenergyireland.ie/
- SEAI (2024) Electricity from Solar https://www.seai.ie/renewable-energy/solar-energy/electricity-from-solar
- United Nations (2024) SDG7 Targets and Indicator https://www.un.org/en/energy/page/sdg7-targets-indicators
- UNOOSA (2024) Affordable Clean Energy https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg7.html