# Lesson 3: Electrical Energy and Power, SDG 7, and NASA Data

**Goal 7:**

Ensure access to affordable, reliable, sustainable and modern energy for all.

## Introduction: Electrical Energy and Power

**Electrical energy** is the ability to do work through the flow of electric charge, while **power** is the rate at which energy is used or produced. Understanding how electrical energy is measured and managed is essential for ensuring energy efficiency and sustainability, particularly in the context of **SDG 7**.

In this lesson, we'll explore how electrical energy and power are calculated and managed, and how NASA data supports energy efficiency and renewable energy integration.

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## What is Electrical Energy and Power?

- **Electrical Energy** is measured in **watt-hours (Wh)** or **kilowatt-hours (kWh)**. It represents the total amount of work that can be done by an electrical system.
- **Electrical Power** is measured in **watts (W)**, which represent the rate of energy consumption or production. The formula for calculating electrical energy is:

$$Energy\ (Wh) = Power\ (W) \times Time\ (hours)$$

For example, a 100-watt light bulb used for 5 hours consumes **500 watt-hours** of energy.

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## Energy Efficiency and SDG 7

One of the primary goals of **SDG 7** is to improve **energy efficiency**. This means using less energy to perform the same tasks, which reduces overall energy demand and leads to lower greenhouse gas emissions. Efficient use of electricity not only conserves resources but also makes energy more affordable and accessible, especially in underserved regions.

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**NASA Data and Energy Efficiency**

NASA plays a crucial role in promoting energy efficiency through its **Earth observation data**, which helps cities and industries manage their energy use more effectively:

1. **Heat Island Effect**:
   - NASA's **Landsat** satellite provides **thermal infrared data**, which helps identify areas in cities where heat is concentrated. These **urban heat islands** are often caused by inefficient energy use in buildings and transportation systems. By identifying these hotspots, city planners can implement **energy-efficient designs** such as reflective roofing and better insulation to reduce cooling costs and energy consumption.
2. **Grid Management**:
   - NASA's Earth observation data also supports the management of **smart grids**, which integrate renewable energy sources and improve the efficiency of energy distribution. These grids use real-time data to balance energy demand and supply, ensuring that power is used where it's most needed and reducing waste.
3. **Monitoring Renewable Energy**:
   - NASA's satellites also monitor the performance of **renewable energy sources** like solar and wind farms. For example, by tracking cloud cover and wind speeds, operators can predict changes in energy production and adjust grid operations accordingly. This data ensures that energy from renewables is used as efficiently as possible.
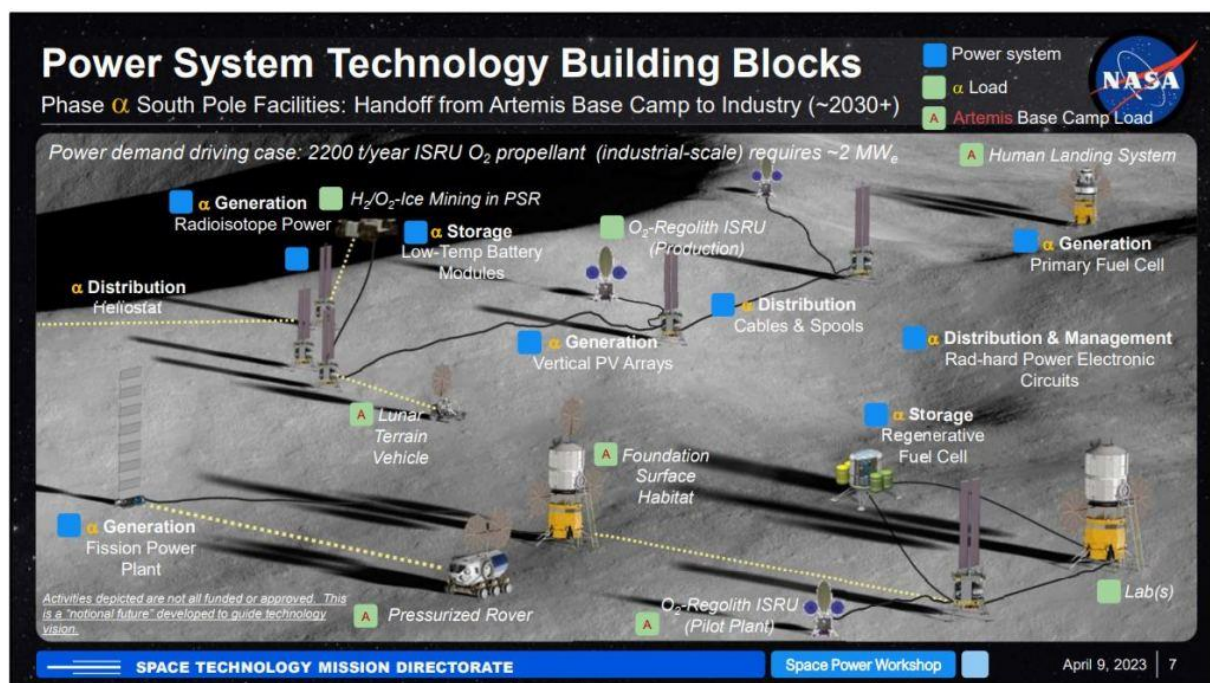
Space Based Solar Power
Functional Diagram

Innovative Heliostat Swarm Concept

Mature Planar Array Concept

Space Based Solar Power Functions

1. Collect
Solar panels receive solar energy

2. Convert
Converters turn solar energy into electricity, then into microwave

3. Transmit
Antenna array beams microwave energy to ground station rectennas

4. Receive
Rectenna receives microwave energy

5. Convert
Converters turn microwave energy into electricity

6. Deliver
Final power delivered to homes and businesses



National Aeronautics and Space Administration

NASA Energy and Water Management Program

Small Changes. Big Impact.

NASA's **vision** for energy and water management is simple: Accomplish our mission using the minimum amount of energy and water required.

Our **13 Energy and Water Managers** and their **teams** are leading the Agency in fulfilling that vision. NASA's remarkable success depends on help from **thousands of you** within our workforce—equipment operators, maintenance staff, engineers, procurement specialists, not to mention every single person who takes the time to turn off the lights when no one's home.

In FY22, our utility bill was

$132M

That's

$15K per hour

**Energy Efficiency**

From FY95 through FY22

29.5%
Total Energy Consumption Reduction

$965M
Total Energy Cost Avoidance Since FY95 (in 2022 dollars)

$52M
Average Annual Cost Avoidance Over the Past 10 Years (in 2022 dollars)

**Renewable Energy**

16,649 MWH
Renewable Electricity Generated On-Site in FY22

That's enough electricity to power more than 1,500 single-family homes for one year, or almost 37 times the annual generation of the International Space Station solar arrays

**Water Efficiency**

From FY07 through FY22

36.4%
Total Water Consumption Reduction

Over 1 billion gallons saved, enough water to fill more than 1,500 Olympic-sized swimming pools, or provide deluge water for 2,300 SLS launches from KSC Launch Pad 39B

SUSTAINABLE NASA

ENERGY WATER BUILDINGS WASTE TRANSPORTATION PROCUREMENT GHG

**Practical Example: Calculating Energy Usage**

Let's say a city uses **solar panels** to generate electricity for public lighting. The solar panels produce **DC (Direct Current)** electricity, which must be converted to **AC (Alternating Current)** for the grid. NASA's data on **solar irradiance** helps determine how much energy the panels will produce, while smart grid technology ensures that the electricity is used efficiently, reducing waste and improving reliability.

$$\frac{60\,W \times 1h}{1{,}000} = 0.06 \text{ kWh}$$

$$0.06 \text{ kWh} \times 8h \text{ per day} \times 30d \text{ per month} = 14.4 \text{ kWh per month}$$



**⚡ DOMESTIC APPLIANCES THAT CONSUME THE MOST**

| Appliance | Percentage |
|---|---|
| Fridge | 30,6% |
| Cooker | 8,3% |
| Television | 12,2% |
| Computer | 7,4% |
| Washing machine | 11,8% |
| Standby function | 6,6% |
| Domestic lighting | 11,7% |
| Dishwasher | 6,1% |

**Conclusion**

Understanding electrical energy and power is essential for managing energy resources efficiently. With the help of **NASA's Earth observation data**, we can optimize the use of renewable energy, reduce waste, and achieve the goals of **SDG 7** by ensuring that energy is clean, affordable, and accessible to all.

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**Sources:**

- **NASA Earth Energy Science**: NASA Energy Science
- **Landsat Thermal Data**: Landsat
- **SDG 7**: United Nations SDG 7