

Study Guide: 7 Types of Renewable Energy

This study guide summarizes key information about various types of renewable energy, drawing directly from the provided sources.

I. Solar Energy

- **Description:** Solar energy is obtained by capturing **radiant energy from sunlight** and converting it into heat, electricity, or hot water. **Photovoltaic (PV) systems** specifically convert direct sunlight into electricity using solar cells.
- **Benefits:**
 - Sunlight is **functionally endless**, offering a limitless supply of energy that could potentially make fossil fuels obsolete.
 - It helps **improve public health and environmental conditions** by reducing reliance on fossil fuels.
 - Can **eliminate energy costs in the long term** and reduce energy bills in the short term.
 - Many governments (federal, local, state) offer **incentives** like rebates or tax credits for investment in solar energy.
- **Current Limitations:**
 - **Significant upfront cost**, making it an unrealistic expense for most households.
 - Homeowners need **ample sunlight and space** for solar panels, limiting individual adoption.

II. Wind Energy

- **Description:** Wind farms capture the energy of wind flow using **turbines to convert it into electricity**. Various systems are used, from commercial-grade systems powering organizations to single turbines supplementing existing energy organizations, and utility-scale wind farms. Technically, wind energy is a form of solar energy, caused by **temperature differences in the atmosphere combined with Earth's rotation and planetary geography**.
- **Benefits:**
 - A **clean energy source** that does not pollute the air.
 - Does not produce carbon dioxide, smog, acid rain, or other heat-trapping gases harmful to the environment or human health.
 - Investment in wind technology can **create new jobs and job training** for turbine maintenance.
- **Current Limitations:**
 - Wind farms are often built in **rural or remote areas**, far from cities where electricity is most needed.
 - Requires **transportation via transmission lines**, leading to higher costs.
 - Some cities oppose them due to their **dominance of skylines and noise generation**.

- Can **threaten local wildlife**, specifically birds, which may strike turbine arms.

III. Hydroelectric Power

- **Description:** Hydroelectric power is most commonly associated with **dams**, where water flows through turbines to produce electricity (known as **pumped storage hydropower**). **Run-of-river hydropower** uses a channel to funnel water through without a dam.
- **Benefits:**
 - **Very versatile**, capable of large-scale projects like the Hoover Dam and small-scale projects like underwater turbines and lower dams on small rivers and streams.
 - Does **not generate pollution**, making it an environmentally friendly option.
- **Current Limitations:**
 - Most US hydroelectric facilities **use more energy than they produce** for consumption.
 - Storage systems may require **fossil fuel to pump water**.
 - **Disrupts waterways** and negatively affects aquatic animals by changing water levels, currents, and migration paths.

IV. Geothermal Energy

- **Description:** Geothermal heat is **trapped beneath the Earth's crust** from its formation and radioactive decay. This heat can be captured using **steam from heated water pumping below the surface** to operate a turbine.
- **Benefits:**
 - Has **significant potential** for energy supply, despite not being as common.
 - Can be **built underground**, leaving a very small footprint on land.
 - **Naturally replenished**, posing no risk of depletion on a human timescale.
- **Current Limitations:**
 - **High cost** for infrastructure development.
 - Vulnerable to **earthquakes** in certain regions of the world.

V. Ocean Energy

- **Description:** The ocean can produce two types of energy: **thermal and mechanical**.
 - **Ocean thermal energy** relies on warm water surface temperatures.
 - **Ocean mechanical energy** uses the ebbs and flows of tides, created by Earth's rotation and the moon's gravity.
- **Benefits:**
 - Wave energy is **predictable**, making it easy to estimate energy output, unlike sun and wind.
 - **Abundant**, especially near populated coastal cities, making it easier to harness.
 - Has an astounding **untapped potential**, estimated to produce 2640 terawatt hours per year. Just 1 TWh per year can power around 93,850 average U.S. homes.
- **Current Limitations:**

- Primarily benefits those near oceans; **landlocked states lack access**.
- Can **disturb delicate ocean ecosystems** due to large machinery disrupting the ocean floor and sea life.
- **Rough weather** changes wave consistency, leading to lower energy output.

VI. Hydrogen Fuel

- **Description:** Hydrogen does not naturally occur as a gas on its own, so it needs to be **combined with other elements, like oxygen to make water**. When separated, it can be used for fuel and electricity.
- **Benefits:**
 - Can be used as a **clean burning fuel**, resulting in less pollution and a cleaner environment.
 - Can be used in **fuel cells**, which are similar to batteries, to power an electric motor.
- **Current Limitations:**
 - Hydrogen **needs energy to be produced**, making it inefficient in terms of preventing pollution if that energy isn't green.

VII. Biomass Energy

- **Description:** Bioenergy is a renewable energy derived from **biomass**, which is organic matter from recently living plants and organisms. Methods include **burning biomass** (like wood in a fireplace) or harnessing **methane gas** from the natural decomposition of organic materials in ponds or landfills.
- **Benefits:**
 - While burning biomass produces CO₂, the **regeneration of plants consumes the same amount**, aiming for a balanced atmosphere.
 - **Versatile** for personal and business use.
 - In 2017, biomass made up about **5% of total US energy**, coming from wood, biofuels like ethanol, and methane from landfills or municipal waste.
- **Current Limitations:**
 - Plants take **time to grow** to re-absorb emitted CO₂.
 - Lack of **widespread technology** to use biomass in lieu of fossil fuels.