Theme Overview - Sustainable Energy

In this document

Challenge Prompt

Energy is the backbone of modern society, powering our cities, homes, industries, transportation and communication. However, as global energy demand continues to rise, our reliance on fossil fuels is contributing to climate change, resource depletion, and environmental degradation.

Fossil fuels such as coal, oil and natural gas are non-renewable energy sources, and are burnt for our electricity, heating and transportation which release massive amounts of greenhouse gasses (GHG), primarily carbon dioxide (CO_2) and methane (CH_4) into the atmosphere (ourworldindata.org).

These emissions trap heat and drive global warming, leading to more frequent and severe climate events with observed rising global temperatures and air pollution (science.nasa.gov), affecting our daily lives experienced by different parts of our world.

In line with United Nations Sustainable Development Goals, and in particular SDG7 (Affordable and Clean Energy), SDG13 (Climate Action), and SDG11 (Sustainable Cities and Communities), it is vital for us to transition to energy systems that are affordable, reliable, renewable, and environmentally sustainable, not forgetting equitable access for all.

Problem Details

Global energy demand is projected to rise by 23% by 2040 (iea.org), driven by population growth, urbanization, and industrialization. However, the current reliance on fossil fuels—responsible for over 75% of global greenhouse gas emissions (unfccc.int)—threatens climate stability, air quality, and long-term energy security. This tension between rising demand and environmental constraints makes the transition to sustainable energy not just a choice, but an urgent necessity.

The shift to sustainable energy is complicated by interconnected challenges, particularly in China and East Asia—a region accounting for over 40% of global energy consumption (iea.org).

- Resource variability and geographic mismatch: Renewable energy sources (solar, wind, hydropower) are unevenly distributed. For example, China's wind resources are concentrated in the north and northwest, while demand centres lie in the east; Japan and South Korea face limited land for large-scale solar or wind farms, relying heavily on imported fossil fuels (worldbank.org).
- Technical bottlenecks: Intermittency of solar and wind energy strains grid stability—China experienced over 20 TWh of curtailment (abandoned renewable energy) in 2022 due to grid inflexibility (nea.gov.cn). Energy storage technologies (e.g., batteries) remain costly, and hydrogen storage scalability is in early stages (hydrogencouncil.com).
- Institutional and policy gaps: Cross-border energy coordination is weak in East Asia, with limited shared grids or unified carbon pricing mechanisms. The lack of harmonized policies also leads to inconsistencies in energy infrastructure development, where countries/regions prioritize short-term energy security over long-term sustainability goals, impeding a cohesive regional transition to clean energy.
- Social and economic trade-offs: Transitioning away from coal threatens livelihoods in mining regions; South Korea's phase-out of nuclear power (reversed partially in 2023) sparked debates over energy security and job losses (koreaherald.com). The transition to renewable energy incurs high initial costs, creating resistance in regions reliant on traditional energy sources. Balancing economic growth with the urgent need for decarbonization remains a major hurdle.

Subthemes

The following presents a simplified framework of our energy system with examples to inspire you to explore and derive a unique energy challenge that is relevant to your own geographical context that interests you, as well as your proposed approach and solution.

Energy System	Unique Energy Challenges Examples	Solution examples to move towards sustainable energy
Energy Generation	Transition to renewable energy, carbon neutrality, resilient energy systems, role of fossil fuels in energy transition, affordability	☐ Effective application of solar/wind/biomass ☐ Policy to support pathways towards net-zero ☐ Waste to energy ☐ Carbon capture utilisation and storage

Energy Distribution	Renewable energy integration in grids, large-scale distribution of hydrogen, Affordable and scalable energy storage	☐ Smart grid: active diagnostics/maintenance ☐ AI driven nano grid in underserved community ☐ Batteries systems for integration of renewables into grid
Energy Consumption	Energy efficiency, building energy optimisation, means to mitigate carbon emissions	☐ Smart heating and cooling systems ☐ Nudges to influence behaviour change ☐ Adoption of carbon pricing mechanism
Large-scale transition	Curtailment of wind/solar, coal dependency, regional development gaps	☐ **Technical:** Ultra-high-voltage (UHV) transmission lines to connect north-western renewables to eastern demand; vanadium flow batteries for long-duration storage ☐ **Non-technical:** "Dual Carbon" policy (carbon peak by 2030, neutrality by 2060) with provincial carbon markets; subsidies for rural solar microgrids
Resource-scarce, disaster-prone	Limited land for renewables, aging nuclear infrastructure, typhoon risks to offshore wind	☐ **Technical:** Floating offshore wind farms (no seabed drilling); smart grids with AI-driven demand response ☐ **Non-technical:** Feed-in tariffs (FIT) for residential solar; public-private partnerships (PPPs) for hydrogen hubs (e.g., Yokohama Hydrogen City)
Industrial heavyweight	High energy intensity in manufacturing, public opposition to nuclear, import reliance	☐ **Technical:** Green hydrogen production from offshore wind; carbon capture in steel plants ☐ **Non-technical:** "3020 Plan" (30% renewables by 2030) with tax incentives for EVs; public engagement campaigns on renewable benefits

Well-Designed Interventions for Sustainable Energy

Effective interventions integrate technical innovation with policy, finance, and social engagement to balance affordability, reliability, and equity. Below are the key components of a well-designed intervention:

- **Technical integration:** A well-designed intervention should leverage cutting-edge technologies that can efficiently generate, store, and distribute clean energy. For example, China's Qinghai-Tibet clean energy base combines solar, wind, and hydropower with UHV transmission, reducing curtailment from 14% in 2016 to 3% in 2023 (cec.org.cn). Similarly, a study in Japan proposes to combine rooftop solar panels with electric vehicle (EV) batteries, which could supply up to 85% of Japan's electricity needs and reduce carbon dioxide emissions by 87%, highlighting the potential of integrating renewable energy with existing infrastructure (tohoku.ac.jp/en/press).
- **Policy and finance:** Sustainable energy systems require supportive policies that incentivize renewable energy adoption, alongside financial investments to make the transition affordable. South Korea's carbon tax on fossil fuels, which spurred $12 billion in renewable investments, is a great example of a policy that combines fiscal incentives with climate goals (statista.com). Similarly, China's green bonds (over $500 billion issued by 2023) which fund solar and wind projects with local governments offering land-use incentives for renewables, are another example of how finance can support sustainability.
- **Social inclusion:** A sustainable energy system should consider the needs of relevant communities, especially those in underserved or marginalized areas. Vietnam's "Solar for All" program trains rural communities to install and maintain solar home systems, increasing access from 60% to 95% in remote areas (worldbank.org). This reduces reliance on kerosene and empowers local economies.