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Mathematical Model to Implement Relevant Renewable Energy Harvesting in Rural India to Achieve Sustainability Goals (UN-SDG)

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On-Grid v/s Off-Grid

On- Grid	Off-Grid
Depends majorly on fossil fuels. (~61% in India)	Depends mainly on Renewable sources.
Can deliver heavy loads.	Cannot deliver heavy loads.
Stable load delivery during operation.	Intermittent delivery.
Electricity failure faced during load shedding.	No electricity failure as no load shedding happens.
Operation and Maintenance costs are high.	Operation and Maintenance costs are lower.
Governing body is the State or Centre Electricity Board.	No governing body.



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Mathematical Model

- Geographical factors
- Energy Demand
- Energy Prospects
- Design and Rating



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Variables and their dependency

- Energy Prospects –
 1. Daily average Solar irradiance
 2. Daily Average temperature
 3. Wind profiles
 4. Elevation
 5. Water availability and rainfall
- Energy Demand –
 1. Population Density
 2. Urbanisation
- Investment Cost –
 1. Technology
 2. Energy Demand
 3. Energy Prospects
- Return on Investment –
 1. Investment
 2. Energy Demand
 3. Savings

Case Study - 1

Thar Desert, Western Rajasthan

- High daily solar irradiance (6.1 kWh/m²/day)
- Scarce rainfall (< 500 mm)
- Scarce Water source
- Elevation (100 - 500 m)
- Moderate Winds strength (200-225 W/m²)
- Moderate population density (70-100 people/m²)
- Average annual temperature (27.5°C)

Thus, the best renewable source of energy is **Solar Thermal** and **PV**, followed by **Wind**.

Case Study - 2

Ladakh district in India

- Elevation (Above 4200 m)
- Moderate population density (10 people/m²)
- Rainfall (< 500 mm)
- Water Source available
- Daily average solar irradiance (5.7 kWh/m²)
- Average annual temperature (< 16°C)
- High Wind strength (250 – 500 W/m²)
- Geothermal Energy (~ 5 GWh)

Thus the best source of energy in this case is **Wind** followed by **Hydroelectric** and **Geothermal**. Solar does seem possible, but since Ladakh is located in the mountain terrain with many slopes, it is unadvisable to implement solar in this region. Due to the elevation and abundant water available, Hydroelectric becomes the second favourite. Ladakh district also has rich source of Geothermal but the technology is still in initial stages.



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