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Q6

Explain briefly the ecological and economic benefits of solar energy generation in India with suitable examples.

UPSC Civil Services Mains 2025 · GS I · 10 marks · World's Physical Geography

Salient features of world's physical geography.

Core demand of the question

- **State ecological gains of solar:** less coal burn, land-water caveats
- **State economic gains:** jobs, power cost, energy import savings
- **Give Indian examples with a simple locational map:** west-dry states versus rooftop cities

Revision summary

Solar replaces some coal generation and therefore some ash, sulphur and carbon.

Large parks work best in the dry, sunny west of India; rooftops work on city buildings.

Bhadla, Pavagada and the Andhra-Karnataka parks are the locational examples.

Economics include lower auction prices, PLI manufacturing and less diesel on farms.

Grazing land, groundwater for cleaning, and night storage are the ecological and grid limits.

Introduction

India sits in the tropics with long sunshine and a coal-heavy grid. **Solar generation** is the attempt to turn that sunshine into kilowatt-hours before more coal is dug. The ecological case is cleaner air and lower carbon. The economic case is cheaper daytime power and less imported fuel. Both are true only if land, water and the grid are handled honestly.

Body**Ecological benefits - and the small print**

A megawatt of solar does not send a chimney plume of **sulphur and ash** into a downwind district. Over a plant's life it usually emits far less **carbon** than a coal unit of the same output. That helps India's Paris path and cuts the local lung cost of thermal belts in Chhattisgarh or the Singrauli region. Distributed **rooftop** solar uses already-built roofs, which is gentle on habitat.

The small print matters. Utility solar parks can **fence wasteland that was never empty** for graziers. Some plants wash panels with scarce **groundwater**. Manufacturing of cells still has a chemical footprint, often in another country. Solar does not remove the need for **storage** or for night-time power, which may still be coal or hydro. Ecology is a **net** story, not a miracle.

Economic benefits with Indian examples

Module prices fell through the 2010s, so solar is now among the **cheapest new bulk power** options in many Indian auctions. **Bhadla** in Rajasthan's Thar, **Pavagada** in Karnataka,

Kurnool and **Ananthapuramu** in Andhra Pradesh, and Gujarat's western parks sit where **insolation is high and cloud is less. That is physiography again: the arid and semi-arid west.** Kaza and other Himalayan experiments show cold desert sun, with different logistics.

Economically this means **construction jobs**, a domestic module push under **PLI**, savings on **coal freight**, and daytime support to farms through **PM-KUSUM** pumps that can replace diesel. Cities use rooftops on Delhi, Gujarat and Tamil Nadu feed-in schemes. Poor households still need **subsidy and a working DISCOM**, or the panel never arrives.

Solar is not free land. It is a better bargain than another pit-head plant for most new daytime demand.

Flow diagram

High insolation belt
Bhadla Rajasthan
Gujarat parks
Pavagada Karnataka
Kurnool-Anantapur
Rooftop
Delhi Gujarat TN cities
Tropical sun -> High insolation belt
Tropical sun -> Rooftop
High insolation belt -> Daytime cheap power
Rooftop -> Daytime cheap power

Conclusion

Solar cuts coal smoke and carbon when it actually displaces thermal power, and it cheapens daytime electricity in India's sunny west. The map is Rajasthan, Gujarat, Karnataka and Andhra parks plus city roofs. Land, water and night storage remain the conditions of the benefit.

Facts & figures

Bhadla

One of the world's largest solar parks, in the Thar of Rajasthan, sited for open land and high sunshine.

PM-KUSUM

A Union scheme for solar pumps and small solar plants so farmers depend less on diesel and erratic grid power.

PLI for modules

Production-linked incentives meant to pull solar manufacturing into India instead of only importing panels.

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