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Pradhan Mantri Surya Sarovar Yojana: Expanding Floating Solar Energy to Strengthen India's Renewable Capacity and Energy Security

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Recent Developments:

- The **Union Cabinet** has approved the **Pradhan Mantri Surya Sarovar Yojana (PM-SSY)** as a **Central Sector Scheme** to accelerate the deployment of **Floating Solar Photovoltaic (FSPV)** projects integrated with **Energy Storage Systems (ESS)**.
- The scheme has a total financial outlay of **₹5,070 crore** for implementation from **FY 2026-27 to FY 2030-31**, with the objective of developing **5,000 MW** of floating solar capacity across reservoirs and inland water bodies.
- The initiative seeks to strengthen **India's renewable energy capacity**, improve **energy security**, reduce dependence on fossil fuels and support the country's long-term climate commitments.

Pradhan Mantri Surya Sarovar Yojana (PM-SSY):

About, Objectives:

- **PM-SSY** is a **Central Sector Scheme** designed to promote large-scale deployment of **Floating Solar Photovoltaic (FSPV)** projects integrated with **Energy Storage Systems (ESS)**.
- The scheme aims to utilise reservoirs, lakes and other inland water bodies for clean energy generation without competing for agricultural land or human settlements.
- It seeks to diversify India's renewable energy portfolio, enhance grid reliability and promote sustainable utilisation of existing water resources.
- The programme also supports **Atmanirbhar Bharat** by encouraging domestic manufacturing of critical renewable energy components.

Financial Outlay, Implementation:

- The scheme provides a financial allocation of **₹5,070 crore** to establish **5,000 MW** of floating solar capacity during **FY 2026-27 to FY 2030-31**.
- Implementation is based on the assessment of the **National Institute of Solar Energy (NISE)**, which estimates India's floating solar potential at nearly **102.18 GWp**, whereas the presently installed capacity is only around **700 MW**.
- The scheme focuses on rapid expansion of floating solar projects across suitable reservoirs and inland water bodies with high solar generation potential.

Financial Assistance:

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- Developers will receive **Central Financial Assistance (CFA)** of **₹1 crore per MW** after successful commissioning of eligible floating solar projects.
- An additional **Central Financial Assistance** of up to **₹50 lakh per project** will be provided for feasibility studies, including **bathymetric surveys, hydrographic assessments** and environmental studies.
- Financial support is intended to reduce project risks and improve private sector participation in floating solar development.

Energy Storage Requirement:

- Every project must incorporate **co-located Energy Storage Systems (ESS)** with a minimum storage duration of **2 hours** to improve grid stability.
- The scheme targets the creation of nearly **10,000 MWh** of integrated energy storage capacity across all approved projects.
- Battery storage will facilitate renewable energy integration by balancing intermittent solar generation and meeting peak electricity demand.

Floating Solar Photovoltaic (FSPV):

Meaning, Features:

- **Floating Solar Photovoltaic (FSPV)** refers to solar photovoltaic systems installed on floating platforms over reservoirs, lakes, dams, irrigation tanks and industrial water bodies instead of land.
- Solar panels are mounted on buoyant structures anchored securely to withstand water level variations and weather conditions.
- Floating solar technology enables large-scale renewable energy generation while conserving valuable agricultural and urban land resources.

Advantages:

- Floating solar minimises land acquisition challenges associated with conventional ground-mounted solar projects.
- Water beneath solar panels reduces module temperature through natural cooling, improving energy generation efficiency.
- Floating solar installations reduce water evaporation from reservoirs and may help limit excessive algal growth by partially shading the water surface.
- Existing transmission infrastructure associated with hydropower reservoirs can often be utilised, reducing evacuation costs.

Limitations:

- Floating solar projects generally involve nearly **25%** higher capital costs than conventional ground-mounted systems because of floating platforms, anchoring mechanisms and waterproof electrical infrastructure.
- Long-term maintenance requires specialised engineering solutions to address corrosion, water movement and extreme weather conditions.
- Environmental assessments are necessary to minimise potential impacts on aquatic ecosystems, fisheries and reservoir management.

Major Project:

- The **Omkareshwar Floating Solar Park** on the **Narmada River** in **Madhya Pradesh** is India's largest operational floating solar project with an installed capacity of **278 MW**, while future expansion is planned up to **600 MW**.

Significance of PM-SSY:

Renewable Energy, Energy Security:

- The scheme is expected to increase India's floating solar capacity from nearly **700 MW** to around **5,700 MW**, significantly strengthening renewable energy generation.
- Increased domestic clean energy production will reduce dependence on imported fossil fuels and enhance long-term energy security.
- Diversification of renewable energy sources will improve resilience against seasonal variations affecting conventional solar installations.

Climate Action, Environmental Benefits:

- The scheme is expected to reduce nearly **10 million tonnes** of **carbon dioxide (CO₂)** emissions annually.
- Greater reliance on renewable electricity supports India's commitments under the **Paris Agreement** and its objective of achieving **Net Zero emissions by 2070**.
- Expansion of clean energy contributes towards achieving the national target of **500 GW** non-fossil fuel electricity capacity by **2030**.

Economic, Industrial Benefits:

- The programme is expected to generate nearly **16,000–17,000** full-time equivalent employment opportunities across manufacturing, construction, engineering and operations.
- Domestic manufacturing of floating structures, photovoltaic modules, batteries and associated equipment will strengthen the renewable energy supply chain.
- Increased private investment is expected to stimulate innovation and industrial development in India's clean energy sector.

Grid Stability, Technological Advancement:

- Integration of **Battery Energy Storage Systems (BESS)** will improve grid reliability by managing fluctuations associated with renewable energy generation.
- Adoption of advanced digital monitoring, energy management systems and battery technologies will strengthen India's technological capabilities in renewable energy.

Status of Solar Energy in India:

Capacity Expansion:

- India's installed solar power capacity has increased from nearly **3 GW** in **2014** to around **129 GW** in **2025**, making it one of the world's fastest-growing solar energy markets.
- Solar energy forms a major component of India's strategy to achieve **500 GW** of non-fossil fuel electricity capacity by **2030**.

Major Initiatives:

- **PM Surya Ghar: Muft Bijli Yojana** promotes rooftop solar adoption by households and has facilitated nearly **24 lakh** rooftop installations up to **December 2025**.
- **PM-KUSUM** supports installation of solar pumps and decentralised solar power generation for the agricultural sector.
- The **Green Energy Corridor** programme strengthens transmission infrastructure for efficient evacuation of renewable energy.
- A **₹5,400 crore Viability Gap Funding (VGF)** scheme supports development of **30 GWh Battery Energy Storage Systems (BESS)** to improve renewable energy integration.

- The **Approved List of Models and Manufacturers (ALMM)** has strengthened domestic manufacturing capacity, enabling India to achieve nearly **100 GW** annual solar photovoltaic module manufacturing capability.

Global Leadership:

- India launched the **International Solar Alliance (ISA)**, headquartered in **Gurugram**, to promote solar energy deployment, technology cooperation and investment mobilisation among solar-rich countries located between the **Tropic of Cancer** and the **Tropic of Capricorn**.
- India continues to play a leading role in global renewable energy governance through initiatives such as **One Sun, One World, One Grid (OSOWOG)**.

Challenges:

Technical, Financial Challenges:

- Floating solar projects involve high initial capital investment and specialised engineering requirements.
- Long-term operational efficiency depends upon effective maintenance of floating platforms, anchoring systems and electrical infrastructure.
- Integration of large-scale renewable energy requires continued expansion of transmission networks and battery storage capacity.

Environmental, Regulatory Challenges:

- Improper project design may affect aquatic biodiversity, fisheries and reservoir ecology.
- Multiple regulatory approvals involving water resources, environment and electricity authorities may delay project implementation.
- Site selection must balance renewable energy generation with irrigation, drinking water supply and ecological conservation objectives.

Way Forward:

Strengthening Floating Solar Ecosystem:

- Expand floating solar deployment through improved policy support, faster environmental clearances and greater participation of State governments.
- Strengthen domestic manufacturing of floating platforms, photovoltaic modules, batteries and associated equipment under **Atmanirbhar Bharat**.
- Promote research and innovation in advanced battery technologies, floating structures and digital energy management systems.
- Integrate floating solar projects with hydropower reservoirs, pumped storage facilities and smart grids to maximise renewable energy efficiency and grid stability.

Value Addition for UPSC:

Important Organisations:

- **Ministry of New and Renewable Energy (MNRE).**
- **National Institute of Solar Energy (NISE).**
- **Solar Energy Corporation of India (SECI).**
- **International Solar Alliance (ISA).**

Important Schemes:

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- **Pradhan Mantri Surya Sarovar Yojana (PM-SSY).**
- **PM Surya Ghar: Muft Bijli Yojana.**
- **PM-KUSUM.**
- **Green Energy Corridor.**
- **Viability Gap Funding (VGF) Scheme for Battery Energy Storage Systems (BESS).**

Important Concepts:

- **Floating Solar Photovoltaic (FSPV).**
- **Energy Storage System (ESS).**
- **Battery Energy Storage System (BESS).**
- **Gigawatt Peak (GWp).**
- **Central Financial Assistance (CFA)**