Prospects and challenges of Solar Power in India

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It is true
The Earth’s climate is warming up
Observed change in average surface temperature 1901–2012

Trend (°C over period)
Each of the last three decades has been successively warmer at the Earth’s surface than any preceding decade since 1850.

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010.

CO₂ concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions.

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historically</td>
<td>280 ppm</td>
</tr>
<tr>
<td>1950</td>
<td>310 ppm</td>
</tr>
<tr>
<td>2000</td>
<td>365 ppm</td>
</tr>
<tr>
<td>2025</td>
<td>about 425 ppm</td>
</tr>
<tr>
<td>2050</td>
<td>450-550 ppm</td>
</tr>
</tbody>
</table>
The burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions.
• Fossil fuels still dominate the global economy’s energy balance.
• Presently, fossil fuels – oil, coal and gas provide more than 80% of the world’s primary energy supply.
Today, a man consumes 100 times the energy his primitive ancestor used to consume.
Life cycle carbon intensity of electricity source

<table>
<thead>
<tr>
<th>Source</th>
<th>Carbon intensity (g/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>920</td>
</tr>
<tr>
<td>Oil</td>
<td>730</td>
</tr>
<tr>
<td>Natural gas</td>
<td>470</td>
</tr>
<tr>
<td>Solar PV</td>
<td>46</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>22</td>
</tr>
<tr>
<td>Biomass</td>
<td>18</td>
</tr>
<tr>
<td>Nuclear</td>
<td>16</td>
</tr>
<tr>
<td>Wind</td>
<td>12</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>4</td>
</tr>
<tr>
<td>Hydrogen from renewables</td>
<td>4</td>
</tr>
</tbody>
</table>

**IEA vision on Solar Energy**

- Least cost energy mix by 2050
- Reducing energy related carbon dioxide emission levels by half from 2005 levels
- High renewable scenario:
  - PV and CSP can provide 25% of global electricity by 2050
  - Levelised cost $0.1 per unit by 2030

![Energy Consumption Diagram](chart.png)
Decarbonisation of Fuels

Decarbonization is the progressive lightening of the amount of carbon used to produce a given amount of energy, as the energy system favors molecules that favor hydrogen over carbon.

Hydrogen completes decarbonisation trend that has accompanied evolution of energy sources for mankind over the centuries.
India’s per capita CO₂ emissions are 1.39 tonne as against world average of 4.44 tonne.
Plan-wise Renewable Capacity Addition

- XII Plan Targets (30 GW)
- XI Plan Achievements (14.7 GW)
- X Plan Achievements (6.7 GW)
- Achievements Up to IX Plan (3.5 GW)
India’s National Action Plan on Climate Change (NAPCC)

• National Action Plan on Climate Change was released on 30\textsuperscript{th} June, 2008.

• Eight Missions were envisaged on
  – Solar Energy,
  – Enhanced Energy Efficiency,
  – Sustainable Habitat,
  – Water,
  – Sustaining the Himalayan Eco-system,
  – Green India,
  – Sustainable Agriculture and
  – Strategic knowledge for Climate Change

• Conceptualizes living in harmony with Nature
• Emphasizes on ecologically sustainable development
• Aims at significantly increasing the share of solar energy in the total energy mix
<table>
<thead>
<tr>
<th>Per capita electricity Consumption</th>
<th>Per capita energy consumption:</th>
<th>Renewable electricity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>India: 730 Units</td>
<td>India: 0.59 tOE</td>
<td>India: 30 %</td>
</tr>
<tr>
<td>World: 2890 Units</td>
<td>World: 0.186 tOE</td>
<td>World: 16 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Indian Power Sector</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>12.55%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>7.48%</td>
</tr>
<tr>
<td>Hydro</td>
<td>2.10%</td>
</tr>
<tr>
<td>Renewable</td>
<td>67.86%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>Installed Power Capacity</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>1,53,847 MW</td>
</tr>
<tr>
<td>Hydro</td>
<td>39,623 MW</td>
</tr>
<tr>
<td>Nuclear</td>
<td>4,780 MW</td>
</tr>
<tr>
<td>Renewable</td>
<td>28,454 MW</td>
</tr>
<tr>
<td>Total</td>
<td>226,704 MW</td>
</tr>
</tbody>
</table>

Installed Power Capacity: India:226.704 GW, World: 995 GW
Renewable Power Capacity

- Wind: 19,051 MW
- Small Hydro: 3,632 MW
- Solar: 2,073 MW
- Biomass: 3,698 MW
- Total: 28,454 MW
Policy and Regulatory Support

- Regulatory measures- RPO/REC
- Supporting grid connected projects to bring volumes and reduce prices
- Financial support for off-grid
- Support R&D
- Encourage manufacturing
- Human resource development
Mission Road Map

In addition, 100 MW capacity distributed small grid connected power plants during Phase -1
SOLAR CONCENTRATING TECHNOLOGY LANDSCAPE

Parabolic Trough

Dish/Engine

Linear Fresnel

Central Receiver
JNNSM (Phase 1) - Key Deliverables

- 1,100 MW Grid Solar Power Projects
- 200 MW Off-grid Solar Applications
- 7 million Sq. m solar thermal collector area
- R&D and HRD; Centers of Excellence
- Domestic Manufacturing
- Institutional arrangements for implementation of activities under the Mission
## Targets & Achievements of Phase-I

<table>
<thead>
<tr>
<th>Application Segment</th>
<th>Target for Phase I (2010-13)</th>
<th>Achievement for Phase-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid solar power (large plants, roof top &amp; distribution grid plants)</td>
<td>1,100 MW</td>
<td>1,684 MW (including those under state initiative)</td>
</tr>
<tr>
<td>Off-grid solar applications allotment</td>
<td>200 MW</td>
<td>252.5 MW</td>
</tr>
<tr>
<td>Solar Thermal Collectors (SWHs, solar cooking, solar cooling, Industrial process heat applications, etc.)</td>
<td>7 million sq. meters</td>
<td>7.001 million sq. meters</td>
</tr>
</tbody>
</table>
## Solar Plants in India (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity (MW)</th>
</tr>
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<tbody>
<tr>
<td>2010</td>
<td>35</td>
</tr>
<tr>
<td>2011</td>
<td>190</td>
</tr>
<tr>
<td>2012</td>
<td>980</td>
</tr>
<tr>
<td>2013</td>
<td>1000 (Expected)</td>
</tr>
</tbody>
</table>

1 MW SPV (Crystalline Silicon) Power Plant at New Delhi (Solar RPO arrangement)

1 MW SPV Plant at Hisar in Haryana
## Solar Projects in India (August 2013)

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commissioned</strong></td>
<td></td>
</tr>
<tr>
<td>Solar PV</td>
<td>1801</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>56</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1857</td>
</tr>
<tr>
<td><strong>Under development</strong></td>
<td></td>
</tr>
<tr>
<td>Solar PV</td>
<td>2339</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>445</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2784</td>
</tr>
</tbody>
</table>
Cumulative Solar power plants: 2079 MW (September, 2013)

<table>
<thead>
<tr>
<th></th>
<th>Crystalline</th>
<th>Thin film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I Batch I</td>
<td>54%</td>
<td>46%</td>
</tr>
<tr>
<td>Phase I Batch II</td>
<td>29.63%</td>
<td>66.67%</td>
</tr>
</tbody>
</table>

5MWp Plant at Khimsar – Energy
### State-wise Solar Installations

<table>
<thead>
<tr>
<th>State</th>
<th>Installations</th>
<th>State</th>
<th>Installations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujarat</td>
<td>857</td>
<td>Orissa</td>
<td>13</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>568</td>
<td>Punjab</td>
<td>9</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>185</td>
<td>Haryana</td>
<td>8</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>37</td>
<td>Goa</td>
<td>7</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>28</td>
<td>Uttarakhand</td>
<td>5</td>
</tr>
<tr>
<td>Karnataka</td>
<td>24</td>
<td>Chhatisgarh</td>
<td>4</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>19</td>
<td>New Delhi</td>
<td>2.5</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>17</td>
<td>West Bengal</td>
<td>2</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>16</td>
<td>Total</td>
<td>~1800 MW</td>
</tr>
</tbody>
</table>
Global cumulative solar PV Power capacity

2012 : 102 GW

• Eight nations added at least a gigawatt of grid-connected capacity in 2012: Germany, China, Italy, the U.S., Japan, France, the U.K., and India.
• Thirteen nations (up from 8 in 2011) are in the gigawatt club of cumulative solar installations: Germany, Italy, the U.S., China, Japan, Spain, France, Belgium, Australia, the Czech Republic, the U.K., Greece, and India.

2013 (July): 116.5 GW

• Germany, Italy, China, US and Japan crossed more than 10 GW solar PV installations (September 2013).

The installations are concentrated only in a few countries. The vast sunshine zones are still not active.
## 10 GW Solar PV Club

<table>
<thead>
<tr>
<th>Country</th>
<th>Status/Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>FITs in Germany sink further. €0.1006 per kWh for PV systems with more than 1 MW. For small rooftop systems: €0.1230 to €0.1454 per kWh. Set a goal of subsidizing its solar program up to 52 GW.</td>
</tr>
<tr>
<td>Italy</td>
<td>Conto Energia V, has come to an in July 2013. Most parts of Italy have reached grid parity.</td>
</tr>
<tr>
<td>China</td>
<td>Target: 35 GW by 2015 (one year ago the target was raised from 15 GW to 21 GW). New tariffs for distributed solar projects at a rate of 0.42 Yuan ($0.07)/kWh. New manufacturing policy.</td>
</tr>
<tr>
<td>United States</td>
<td>U.S. residential solar demand continues to surge, and third-party-owned solar residential in particular. 50 state-based markets with a layer of federal policy. Market to hit 17 GW by the end of 2014.</td>
</tr>
<tr>
<td>Japan</td>
<td>Target: 28 GW by 2020. 89% rooftop. FIT Program for accelerated deployment of large scale projects (July ‘13): ~0.38 $/kWh</td>
</tr>
</tbody>
</table>
## Solar Thermal Power Plants

<table>
<thead>
<tr>
<th></th>
<th>Operational (MW)</th>
<th>Under Construction (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>1485</td>
<td>Spain</td>
</tr>
<tr>
<td>USA</td>
<td>785</td>
<td>USA</td>
</tr>
<tr>
<td>Iran</td>
<td>17.25</td>
<td>India</td>
</tr>
<tr>
<td>Italy</td>
<td>5.0</td>
<td>China</td>
</tr>
<tr>
<td>India</td>
<td>52.5</td>
<td>Australia</td>
</tr>
<tr>
<td>Australia</td>
<td>2.0</td>
<td>Israel</td>
</tr>
<tr>
<td>Germany</td>
<td>1.5</td>
<td>France</td>
</tr>
<tr>
<td>France</td>
<td>0.25</td>
<td>South Africa</td>
</tr>
<tr>
<td>Algeria</td>
<td>25</td>
<td>Morocco</td>
</tr>
<tr>
<td>Thailand</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>UAE</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>~ 2800</td>
<td>Total</td>
</tr>
</tbody>
</table>
# Solar Thermal Power Plants

<table>
<thead>
<tr>
<th>Country</th>
<th>Capacity under Announcement (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>3949</td>
</tr>
<tr>
<td>Spain</td>
<td>930</td>
</tr>
<tr>
<td>China</td>
<td>2000</td>
</tr>
<tr>
<td>Morocco</td>
<td>1840</td>
</tr>
<tr>
<td>Israel</td>
<td>180</td>
</tr>
<tr>
<td>Kuwait</td>
<td>280</td>
</tr>
<tr>
<td>Chile</td>
<td>100</td>
</tr>
<tr>
<td>Iran</td>
<td>72</td>
</tr>
<tr>
<td>Italy</td>
<td>30</td>
</tr>
<tr>
<td>Mexico</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>~ 9000</strong></td>
</tr>
</tbody>
</table>
Opportunities

Share of people without electricity access for developing countries, 2008 (UNDP)

- Energy availability and energy security of the country to be improved
- Technologies for conversion of solar radiation to electricity and heat have come to a stage of exploitation
  - further improvements are in the horizon
- Solar radiation availability is good
- Solar technologies can provide access to electricity on immediate basis to our un-electrified areas
Challenges

- Solar resource
- Land and water
- Technology
- Quality infrastructure
- Transmission
- Policy
- Financing
- Large scale renewable integration to grid
- Local manufacturing
- Storage
Solar radiation is the primary input for solar energy systems. It is necessary to know as precisely as possible the quantity and quality of solar radiation at the site of utilization.

**Solar Resource Maps for India**
Solar Radiation Resource Assessment

Phase I: 51 Stations
Phase II: 60 Stations
Advance stations: 4
MEDA stations: 4
Land & Water

- Solar power plants normally require 5 acres of land per MW.
- Solar thermal power plants also require substantial water for its operation.
- Both SPV and CSP plants require water for washing modules/collectors.

- Availability of solar radiation is more where water is a scarce commodity.
- CSP plants require high direct solar insolation for its operation.
  - Normally water availability is a problem in these sites.

- For PV power generation, roof tops provide very appropriate space and sites.
- Roof-top PV, therefore, is an appropriate proposition.

- Engineering research on CSP plants that require lesser water is a priority.
- Development of appropriate coatings that repel dust and moisture is also a priority.
Ultra Mega Green Solar Power Project
Kharaghoda, Gujarat Unit of Hindustan Salts Limited (HSL) in Little Runn of Kutch

Project and Site Details:
- Land availability: Approximately 18,000 acres
- Feasible capacity: 4,000 MW
- Project Duration: 7 years
- Selection of developers:
  - Through a competitive bidding process,
  - Some allocations to joint venture partners
- Phase I
  - Earmarked land: ~4,000 Acres
  - Capacity: ~1,000 MW
The aerial view of Sambar Lake
Salt Production Process at Kharaghoda
**Solar Power Project 1000 MWp in Kargil to includ 180 Kms transmission line from Kargil to Alusten (Srinagar) - Proposal**

**Brief Project Details..**

<table>
<thead>
<tr>
<th><strong>Expected Project Cost</strong></th>
<th>9000 to 12000 Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area Requirement</strong></td>
<td>4000 to 5000 hectares</td>
</tr>
<tr>
<td><strong>Expected Energy Yield(Approx)</strong></td>
<td>83 Mn Units/MWp/Yr</td>
</tr>
<tr>
<td><strong>Construction Time</strong></td>
<td>36 to 48 Months</td>
</tr>
<tr>
<td><strong>Including 180 Kms transmission line From Kargil to Alusten (Srinagar)</strong></td>
<td>36 to 48 Months</td>
</tr>
</tbody>
</table>
Tentative Proposed sites for generation of Solar power up to 1000Mw in Kargil District

<table>
<thead>
<tr>
<th>Name of Site</th>
<th>Availability of Land</th>
<th>Proposed Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodh Area (Kulubur to Hambutingla)</td>
<td>2000 hectare</td>
<td>500 Mw</td>
</tr>
<tr>
<td>Lahlung plateau</td>
<td>700 hectare</td>
<td>175 Mw</td>
</tr>
<tr>
<td>Akchamal via tharumsa upto Pushkum</td>
<td>500 hectare</td>
<td>125 Mw</td>
</tr>
<tr>
<td>Brakarthang Mulbekh</td>
<td>300 hectare</td>
<td>125 Mw</td>
</tr>
<tr>
<td>Wado to Namkila Belt</td>
<td>2000 hectare</td>
<td>500 Mw</td>
</tr>
<tr>
<td>Mangbore to Haniskote</td>
<td>3000 hectare</td>
<td>750 Mw</td>
</tr>
<tr>
<td>Minji to Saliskote</td>
<td>1000 hectare</td>
<td>250 Mw</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>9700 Hectare</strong></td>
<td><strong>2425 Mw</strong></td>
</tr>
</tbody>
</table>

**Status of Grid as on date:**
- Kargil to Drass (proposed Grid receiving station connectivity through 66kVA for Chutuk hydel project in the 2nd phase i,e 2014.
- Local grid of 11KVA is presently available from Kargil to Drass.
- Present load on sub-station Drass is 0.5 Mw of Morpochu Hydel Project within Drass block.
- National Grid is only upto Alusting Srinagar.
- Kangan to Sonamarg local grid of 11 KVA.
A tale of two solar collectors

Solar Green Collector
Natural evolution

Solar Photovoltaic Collector
Engineered product
Dye sensitised Photoelectrochemical Solar cells
Concentrator Solar Cells
Multi Junction High Efficiency Cells
Factors influencing Solar Concentrated Technology

- Direct normal Irradiance (DNI)
- Ambient Temperature
- Latitude Effect
- Wind Velocity
- Required Temperature
Solar thermal collectors
Applications

- Heating
- Drying
- Cooling
- Power generation
Solar Field
Triple Effect Vapour Absorption Machine
• Cost effective
• Reliable
• Lower carbon footprint

A considered decision is must for system efficacy, reliability and cost effective performance.
Stirling Engine

- External combustion engine
  - can work with any fuel
- High power conversion efficiency
- Can be used for distributive power generation
Solar Hydrogen System

Proposed at SEC

5 Nm³/h capacity electrolyser

Simple water electrolysis

100 kW

Hydrogen Dispenser

Applications of Hydrogen

Hydrogen storage

Vehicles

Fuel Cells
Quality infrastructure

• Maintaining credibility as energy source
• Quality, durability must be the top priority

‘...the $77 billion solar industry is facing a quality crisis just as solar panels are on the verge of widespread adoption’

• Significant number of PV installations do not deliver the projected output
• Module degradation affects power generation
• Solar reflectors get degraded
• Dust- a critical problem for India
• Quality resource data
• Improving quality lowers financial cost

2.5 MW Unit of a 10 MW capacity project at Bikaner by ACME
DEFECTS GENERATED IN CRYSTALLINE SILICON MODULES

- EVA Browning Effect
- Corrosion of Solar Cell Grid
- Delaminating of Solar Cell Module
- Corrosion of Metal Contacts
GENERATION & GROWTH OF DELAMINATION DEFECTS IN PV MODULES

GENERATION

GROWTH STAGE-1

GROWTH STAGE-2

FINAL STAGE

GROWTH STAGE-4

GROWTH STAGE-3
BROWNING IN CRYSTALLINE SILICON PV MODULES

INITIATION OF BROWNING → DARKNING STAGE-1 → ADVANCED BROWNING-2
Defects Growth in Thin film Modules (WITH and WITHOUT FRAME)
## Transmission network

### Issues in large scale renewable integration:
- Intermittency
- Variability/Uncertainty
- Plants connected at remote locations with weak transmission network
- Grid failure

### Measures:
- Strong grid interconnections
- Flexible generation, reserves for supply-balancing
- Forecasting of renewable generation and forecasting of power demand
- Establishment of renewable energy management Centres equipped with advanced forecasting tools and reliable communication infrastructure
- Grid code, Connectivity standards, real time monitoring
- Institutional arrangements with defined roles and responsibilities
RE Policy Framework

Electricity Act (EA), 2003
1. Section 86 - promotes RE by ensuring grid connectivity & sale of RE.
2. Section 3 - Central Government to develop a national policy for optimal utilization of resources including RE.
3. SERC's to:
   • Section 86 - fix a minimum percentage energy purchase from RE sources (RPO).
   • Section 61 – determine tariffs for the promotion of RE

National Electricity Policy (NEP), 2005
1. Section 5.2.20 of NEP promotes private participation in RE.
2. Section 5.12.1 of NEP targets capital cost reduction in RE through competition.
3. Section 5.12.2 of NEP states that SERCs should specify appropriate tariffs to promote RE and specify targets for RE.

National Tariff Policy (NTP), 2006
1. A minimum percentage procurement should be made latest by April 1, 2006
2. A preferential tariff to be determined by SERC to enable RET’s to compete
3. Procurement of RE by distribution licensee through competitive bidding
**Integrated Energy Policy (IEP), 2008**

1. Design of incentive structures that are linked to energy generated
2. Regulators to mandate feed-in laws for RE, where appropriate.
3. Environmental subsidy for RE through cess on conventional energy generation
4. FI’s should be encouraged to set-up Capital Funds for RE entrepreneurs.
5. Need to auction sites on public property for wind energy development
6. To encourage solar thermal a higher premium of feed-in tariff needs to be provided

**National Action Plan on Climate Change**

Paragraph 4.2.2 : Starting 2009-10, Renewable Purchase Obligations be set at 5% of total grids purchase, to increase by 1% each year for 10 years.

2011 Amendment in Tariff Policy :- 0.25% Solar RPO by 2013 and 3% by 2022
Regulatory Measures

- Renewable Purchase Obligation (RPO)
- Feed in Tariffs (FiTs)
- Renewable energy certificate (REC) mechanism
- Transmission Infrastructure
Policy intervention

- Incentives- financial and fiscal
- Removing non-economic barriers
- Public-private partnership
- Innovative business and financial models

Mandatory Solar RPO Mechanism
- State Electricity Regulators to fix a percentage of energy purchased from Solar Power under RPO.
- The Solar RPO has to begin with 0.25% of the energy procured reaching 3% by 2022.
- This requirement likely to go up to 30,000 MW by 2022.

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</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>1465</td>
<td>3018</td>
<td>4659</td>
<td>6387</td>
<td>8204</td>
<td>10109</td>
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Innovative financial mechanisms

- Attracting new investors that have not been able to invest so far
- Making tax benefits accessible to all investors
- Reduce investment risks through insurance covers

- Extending Infrastructure debt fund for renewable energy
- Extending REC benefits for off-grid projects
- Tradable accelerated depreciation credits
  - The benefit of AD are not available to most IPPs
  - Tradable AD tax credits will be certificates available to generators for trading
  - This will ensure parity to all classes of generators
Solar radiation availability is stochastic in nature

- back up power capacity
- balancing plants
- expanded electricity grid network
- smart grid concept
- precise prediction of energy production
- energy storage systems with a portfolio of a variety of technologies

Storage both for off-grid and for grid applications
JNNSM Phase II

Grid-connected
Cumulative target:
- 10,000 MW *(by March 2017)*
  - 4,000 MW under Central schemes
  - 6,000 MW under States initiatives

Thrust areas:
- Development of T&D network
- Developing cluster of Solar Parks to reduce costs
- Grid-connected Roof-top
- Achieving grid parity at the earliest

Off-grid
Target: 800 MW
Thrust areas:
ENERGY ACCESS
DIESEL REPLACEMENT
TELECOM TOWERS
COLD STORAGE
WATER PURIFICATION
WATER PUMPING
NEW INNOVATIVE PRODUCTS
Total capacity considered under Batch-I:
750 MW in 2 categories:
- With Domestic Content Requirement
- Open; no restriction.

Implementing Agency:
Solar Energy Corporation of India (SECI)
VGF Mechanism

- **Tariff** to be paid to the developer:
  - Rs.5.45/kWh, fixed for 25 years
  - 10% less viz., Rs. 4.95/kWh for projects availing benefit of Accelerated Depreciation

- **VGF** to be paid: up to 30% of project cost limited to Rs. 2.5 cr./MW, based on bid

- **Developer’s equity:** minimum Rs.1.5 cr./MW

- Balance can be raised as Loan.

- Min. Capacity of each project: 10 MW

- Max. capacity: 50 MW

- Max. 3 projects at different locations by one developer, subject to a max. of 100 MW.
India

Renewable Energy Projections for 2027
Cumulative Installed Capacities in GW
Thank you for your attention