Presentation on

160 MW Solar-Wind Hybrid project with BESS at Ramgiri, Andhra Pradesh

by

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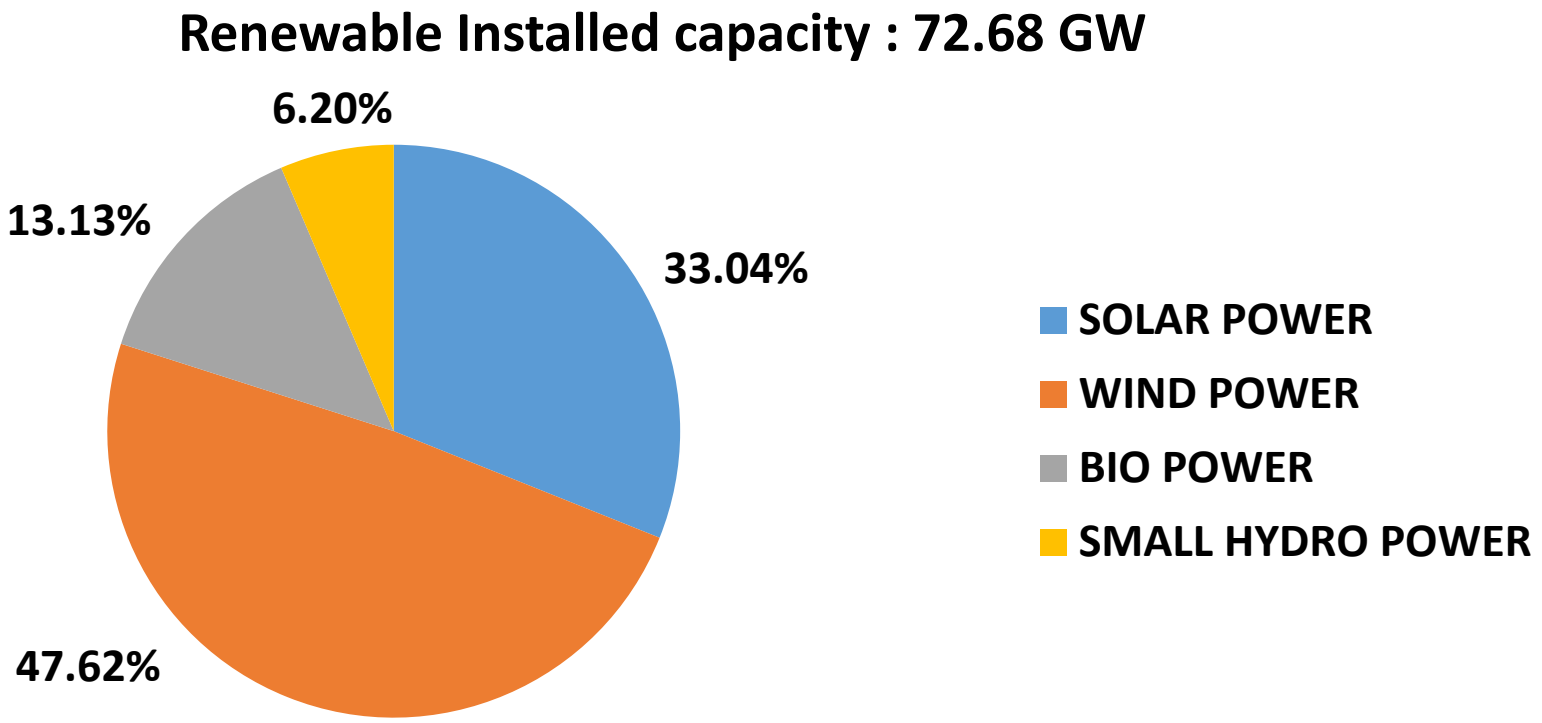
Indian Renewable Energy Scenario

Installed Capacity of RE



	SOLAR POWER	WIND POWER	BIO POWER	SMALL HYDRO POWER
INSTALLED CAPACITY (GW)	24.02	34.62	9.54	4.50
% share	33.04%	47.62%	13.13%	6.20%

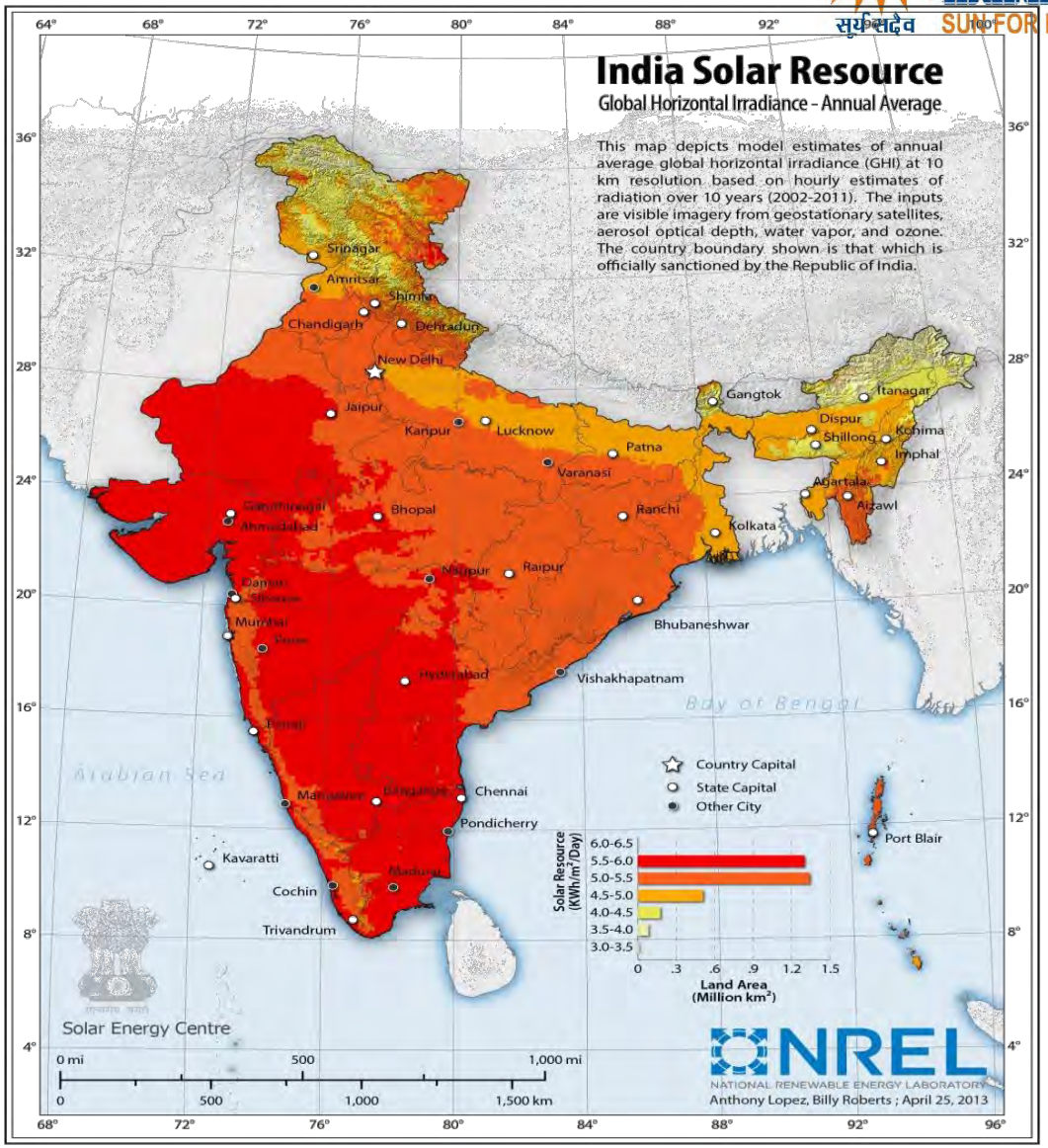
Mission 175 GW RE by 2022

- In Budget Speech in February 2015, Hon'ble Finance Minister announced an ambitious target of 175 GW by 2022:

  - ❑ Solar: 100 GW *(2014 status: 2.6 GW)*
  - ❑ Wind: 60 GW *(2014 status: 21.0 GW)*
  - ❑ Biomass: 10 GW *(2014 status: 7.5 GW)*
  - ❑ Small Hydro: 5 GW *(2014 status: 3.8 GW)*

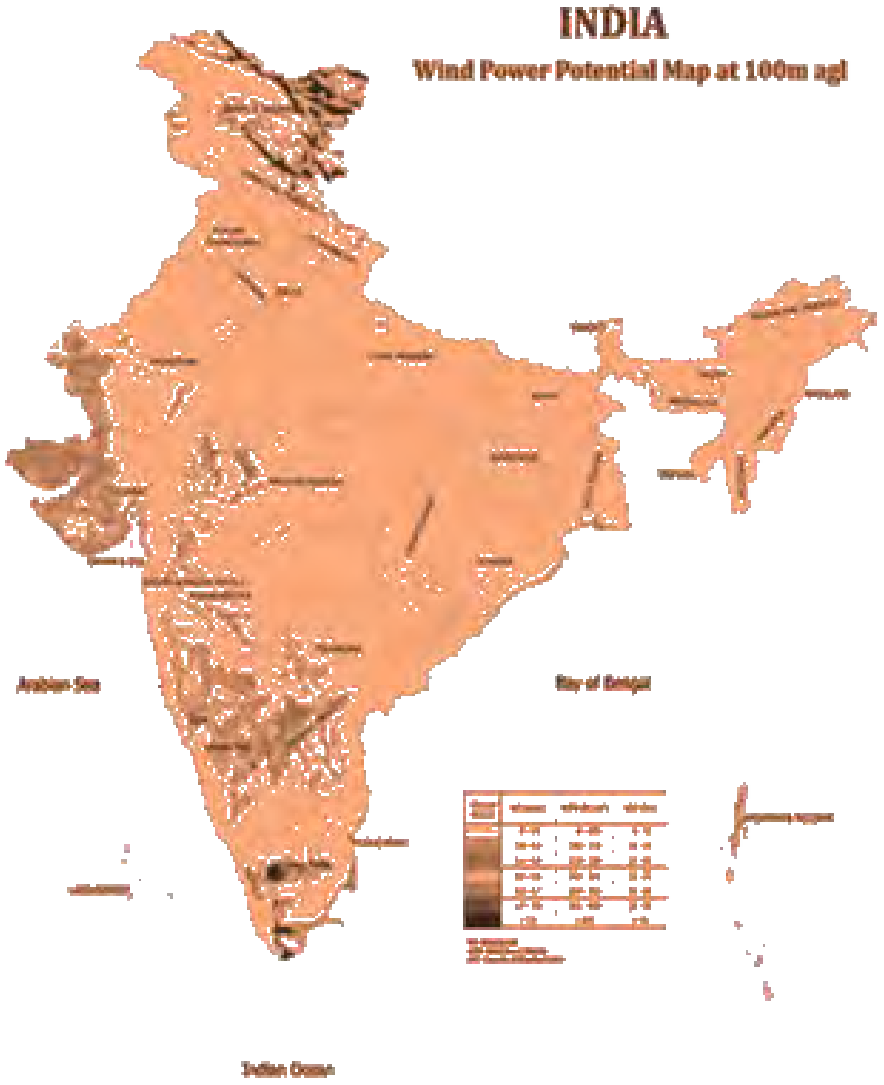
Solar Energy Potential

- Solar Power Potential in India estimated at 748 GW
- Assessment undertaken by the National Institute of Solar Energy (NISE)

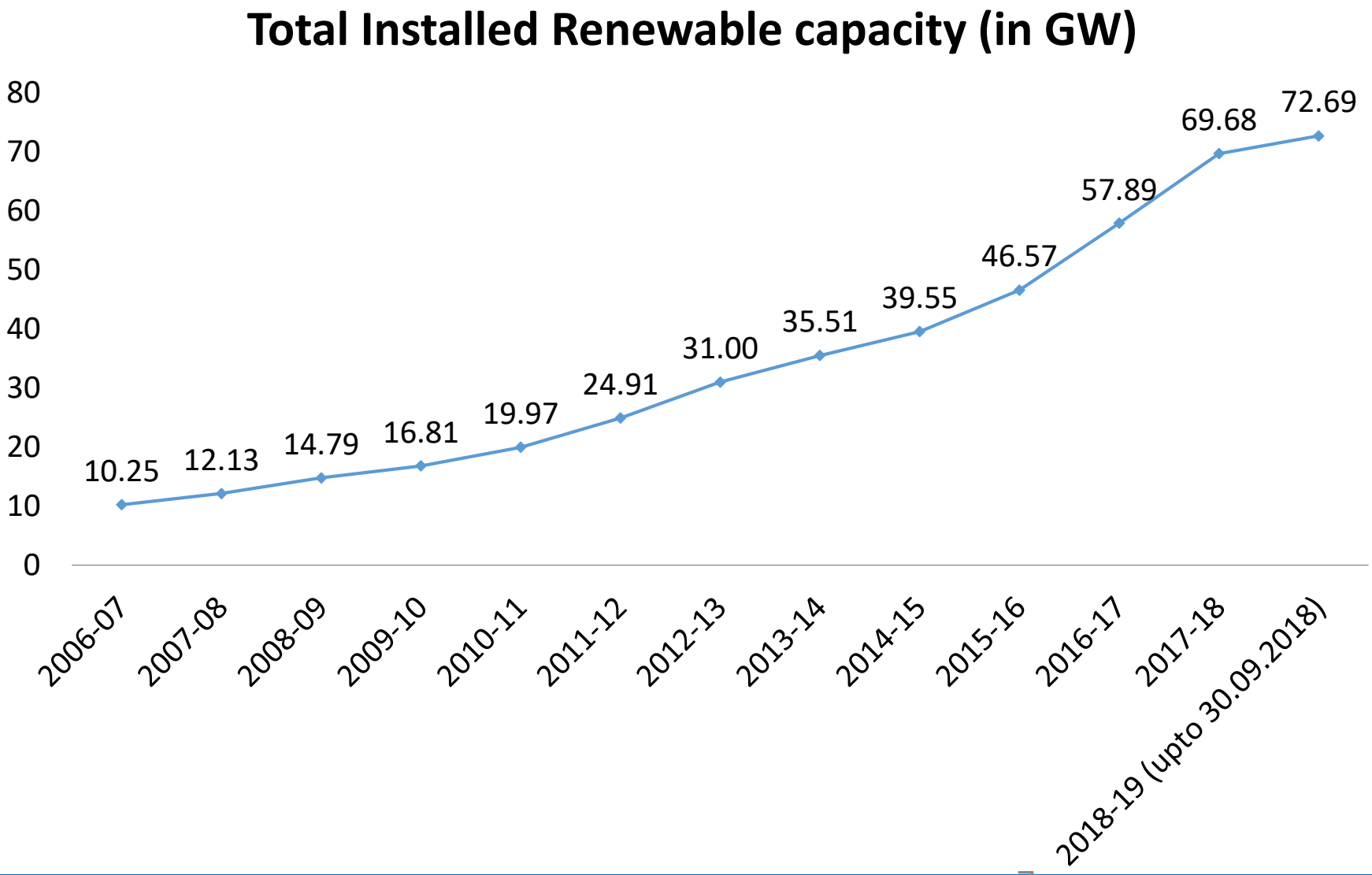


Wind Energy Potential

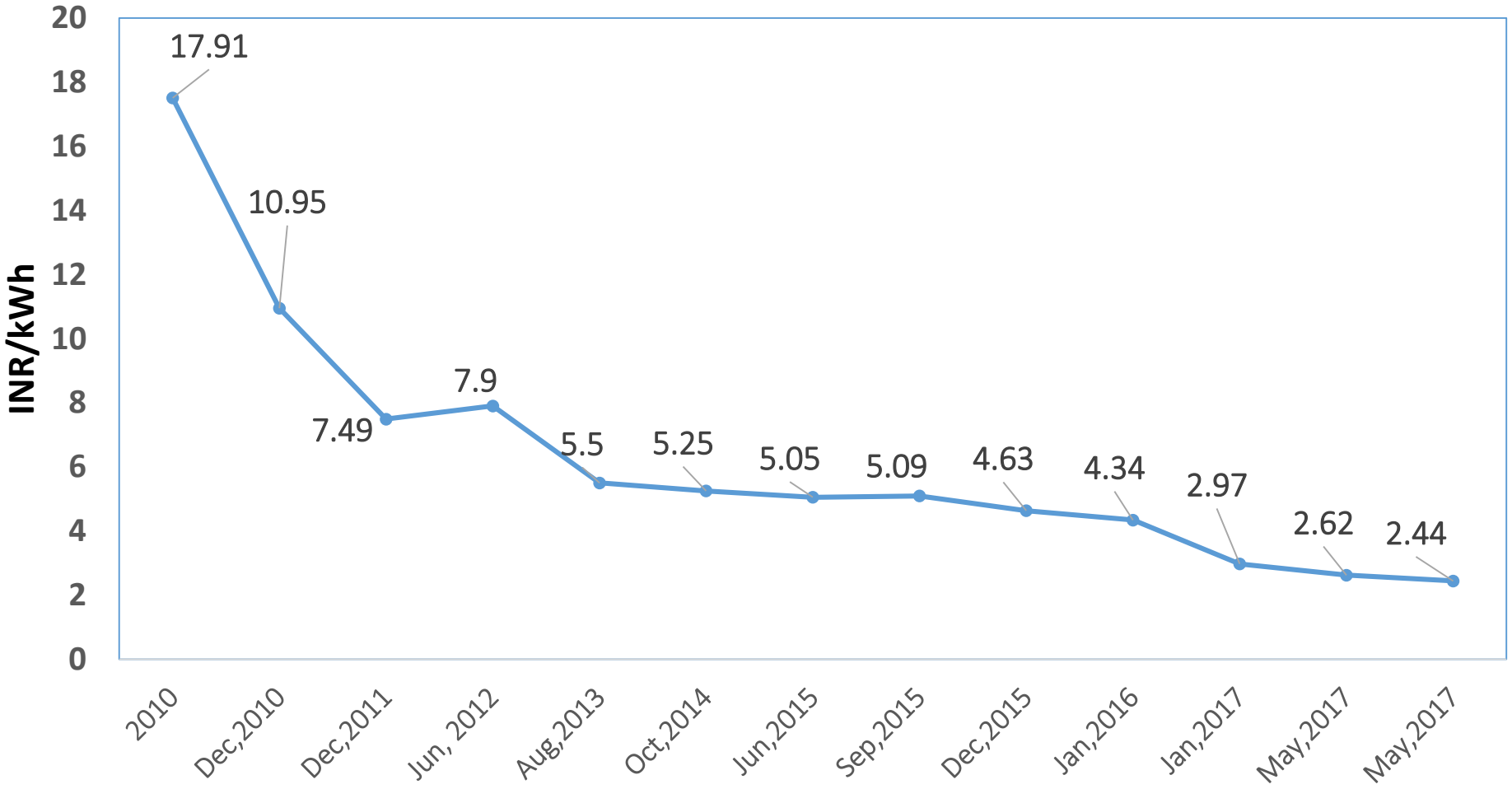
- Potential of Wind Power estimated at 302 GW at 100 m ht.
- Assessment undertaken by the National Institute of Wind Energy (NIWE)



Growth of RE in India



Tariff trend in Solar Power



Growth Drivers for Solar Energy

- **Conducive policy framework-** fiscal incentives (AD benefit, tax holiday etc.), must-run status, FIT, waiver of transmission charges etc.
- **Implementation of National Solar Mission** and upscaling of targets to 100 GW- massive tendering mechanism adopted
- Introduction of 'Solar Parks' concept
- Confidence built in investors' community due to reduced risk perception as more projects built up in different states
- Reduction in international costs of PV modules and optimisation in BOS costs have helped in tariff reduction

Solar Parks

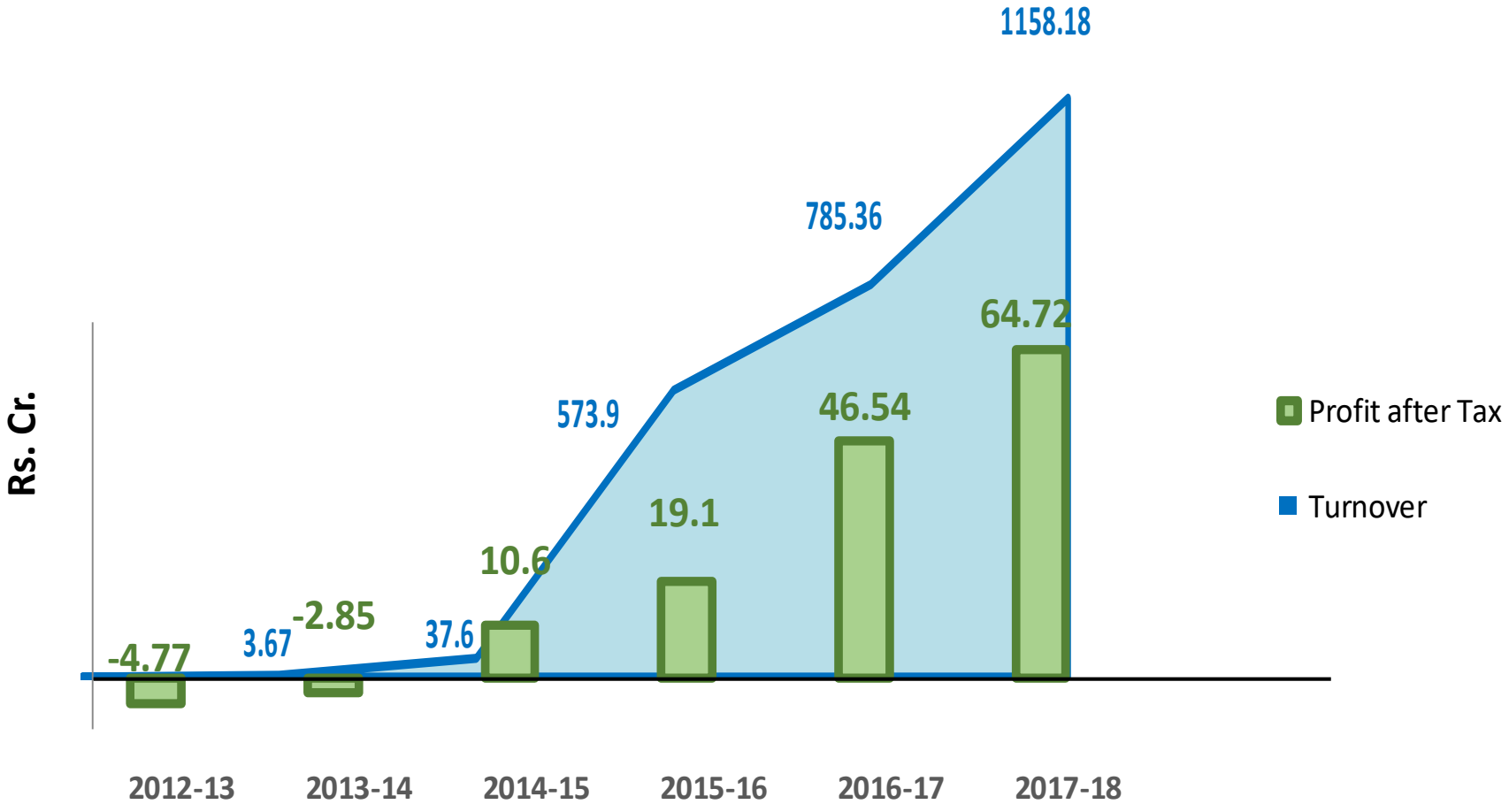
- **Concept:** Solar Park is a concentrated zone for solar project development and provides an area that is well characterized with proper infrastructure and access to amenities and where risk of projects can be minimized.
- Facilitates developers by reducing the number of approvals required to be taken by the project developer.
- Solar Park Implementation Agency (SPIA) is responsible for infrastructure development in the park
- Assured availability of land and transmission infrastructure are major benefits.
- Encourages investment by triggering economies of scale for cost reductions, optimization of power evacuation infrastructure and utilization of wastelands

About the Company

About SECI

- SECI was incorporated on 20th September 2011 for implementation of the National Solar Mission
- Under the administrative control of Ministry of New and Renewable Energy (MNRE)
- In Nov, 2015, SECI's mandate was widened to cover all RE segments
- Authorised share capital: Rs. 2000 Cr. (USD 285.7 mn)
- Paid up share capital: Rs. 354 Cr. (USD 50.6 mn)
- Rated as AA+ (Outlook positive) by ICRA
- Debt-free company
- Classified as Category I (highest category) Power Trading Licensee by CERC

Financials


Rs. Cr.
1158.18
785.36
64.72
573.9
46.54
19.1
10.6
-4.77
3.67
-2.85
37.6
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
Profit after Tax
Turnover

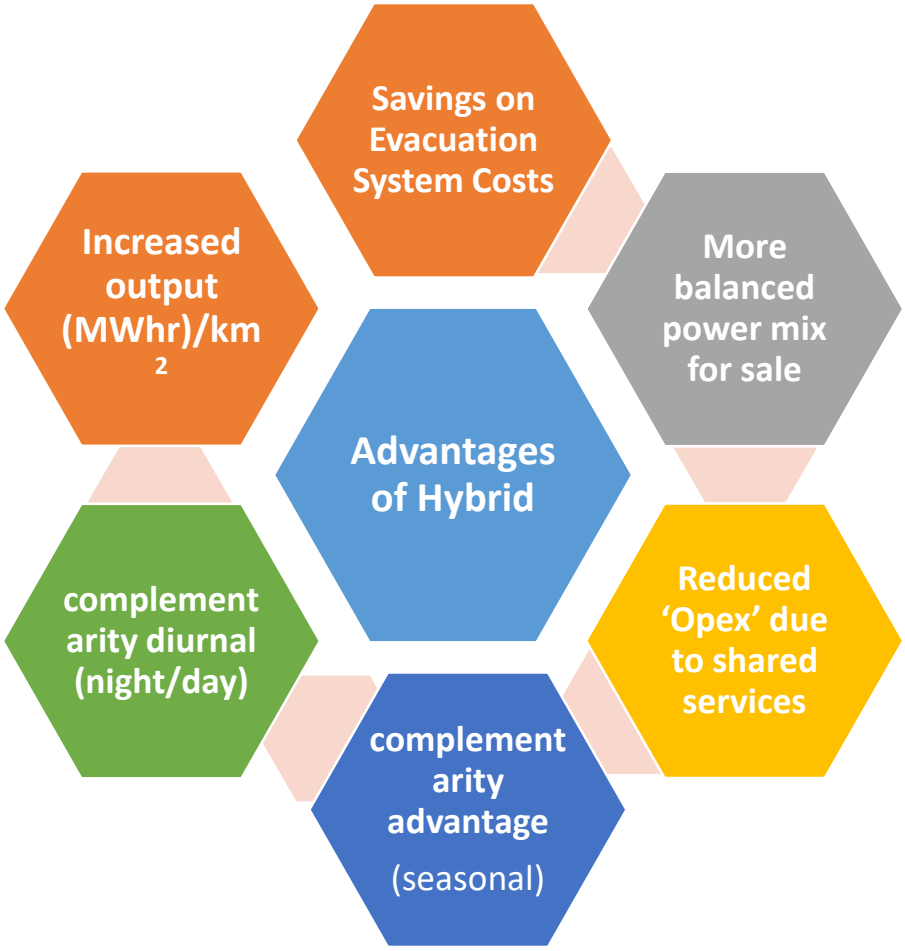
SECI's Solar-Wind Hybrid project with BESS

Project Highlights

- Title and Location: 160 MW Solar Wind Hybrid Power Plant with BESS at Ramgiri, Andhra Pradesh
- Est. Project cost: INR 870.33 Cr. (USD 124.33 mn)
- Being developed under World Bank funding proposal "**Innovation in Solar Power and Hybrid Technologies**"
- Objective: To demonstrate commercial feasibility of utility-scale solar-wind hybrid technology and demonstrate benefits of energy storage systems for RE management.
- Technologies demonstrated: (i) Solar-Wind Hybridization; and (ii) Battery Energy Storage System (BESS)

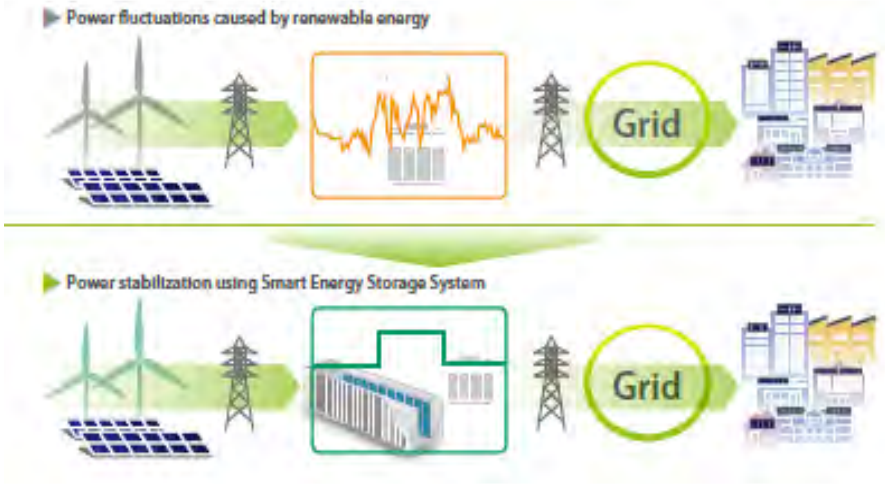
Solar-Wind Hybrid technology

- Concept of co-locating Wind and Solar capacities for land and transmission optimization
- Advantage of daily and seasonal complementarity in solar and wind resource
- Supply of more balanced power mix to the grid; minimization of transmission system costs



Battery Storage for RE management

- RE power is intermittent in nature- diurnal and seasonal variations, short-term fluctuations
- Therefore, exponential RE Growth in the country leads to challenges:
  - Generation Curtailment
  - Grid stability issues
  - Large thermal capacities in stand-by mode operating at lower efficiencies
- Energy storage systems are integral to sustain RE capacity addition



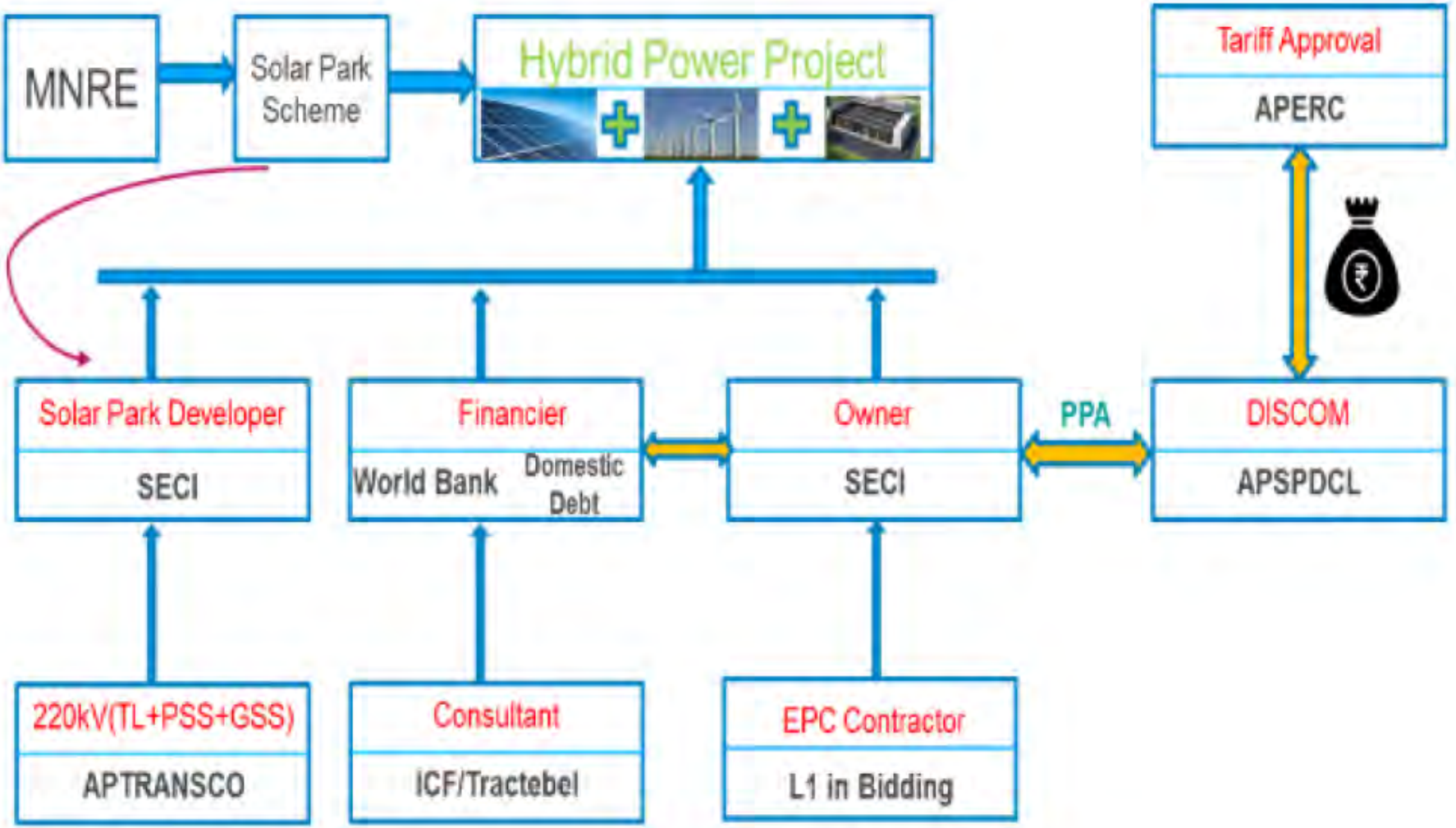
Project configuration

- **Capacity:** 160 MW (Wind: 40 MW; Solar: 120 MW; BESS size: 10 MW, 20 MWh)
- **Project life:** 25 years
- **Capacity Utilization Factor (CUF):**

	P50	P75	P90
Wind	29.44	27.00	25.00
Solar	23.95	22.96	22.06
Wtd. Avg.	25.32	23.97	22.80

- The CUF data for wind was estimated by National Institute of Wind Energy (NIWE) based on satellite and ground data, and for solar estimated by SECI with 30% overloading of DC capacity.
- **BESS round-trip efficiency**: 80%

Institutional Arrangement



Location Characteristics

- **Resource availability:** High wind and solar potential (abundance of standalone wind and solar projects in the district)
- Good site geology for providing a stable ground for positioning of cranes and erection of WTG; Flat land for blades storage (for lengths upto 60 mts)
- **Infrastructure:** Good all-weather road infrastructure for carrying heavy and ODC shipments in trailer trucks up to project site
- Grid sub-station being developed in park vicinity by APTRANSCO
- **Safeguards:** Completely barren land with no human settlement. No major social or environment issues foreseen.
- Land is under Government ownership
- **Design considerations:** Micrositing for WTG undertaken with suitable spacing for safety and vehicle movement, as per standard practices
- Placement of solar modules determined after exclusion of shadow area.

Funding pattern

- Project is part of World Bank's funding proposal of USD 200 million to SECI
  - Overall proposal comprises of other sub-projects in floating solar, energy storage technologies etc. to be developed over 3-4 years

in Mn USD

World Bank funding	IBRD + CTF loan	48.57
	CTF grant	13.6
Counterpart funding	Domestic Loan	37.3
	Equity	24.86
	Total	**124.33**

Benefits of CTF funding

- CTF grant is available for BESS
- Concessional CTF loan available for solar-wind hybrid project
- Technical Assistance for capacity building of SECI (USD 2 mn) through CTF grant
- CTF funding acts as a catalyst for promoting commercial viability of these technologies
- Due to long tenure of CTF loan, project cash flow is improved
- Demonstration of this project will stimulate further investments in these technologies
- This may lead to reduction in battery costs
- Availability of concessional Clean Technology Funds has impact of over USD 0.43 cents/kWh on cost of power generated

Project Benefits

- Increased renewable electricity supply (330,000 MWh per annum)
- Avoiding GHG emissions (429,000 tonnes of CO2 eq. per annum)
- Improved use of resources (land, RE, power transmission etc.)
- Demonstration of battery use cases and utility for the state grid
- Feedback for streamlining future policies/regulations
- Local area development

Way Ahead

Emerging Areas for RE in India

- **Solar-Wind Hybrid projects**
  - MNRE has issued policy for hybrid projects
  - Tender issued for setting up of 1200 MW of hybrid projects
- **Energy storage projects**
  - Projects being designed with generation side energy storage
  - Energy storage as a grid support service (at sub-station end)
- **Round-the-clock firm RE**
  - Solutions being explored to achieve firm RE power to replace conventional power sources
  - Being worked out through a combination of different RE sources and storage elements, to match local demand pattern
- **Floating Solar projects**

Thank You