



Hybrid Renewable Energy Systems: A Review

by

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Outline of Presentation

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- Introduction
- Design, Modelling and Optimisation of Hybrid Solar/PV systems
- Controls and Power Management
- Energy storage
- Environmental impacts
- Conclusions
- References

Abstract

- **Availability of renewable energies occur at different times of the day and year**
- **Hybridization of different energy systems will ensure dependability and reliability of these sources**
- **Hybrid renewable energy system (HRES) – Fast developing worldwide**
- **Review of design and optimization, control systems, energy management reliability , storage and environmental impacts of HRES**

Introduction

Why Renewable Energy in India?

- **Domestic coal supply is limited and poor quality**
- **Foreign supply of hydrocarbons have serious impact on country's energy security/finance**
- **Renewable Energy (RE) sources are not depleted**
- **RE is non- polluting**
- **Reinvestment can be used for many decades without affecting the environment**

Introduction-Contd.

Renewable Energy (RE) Development Potential for India

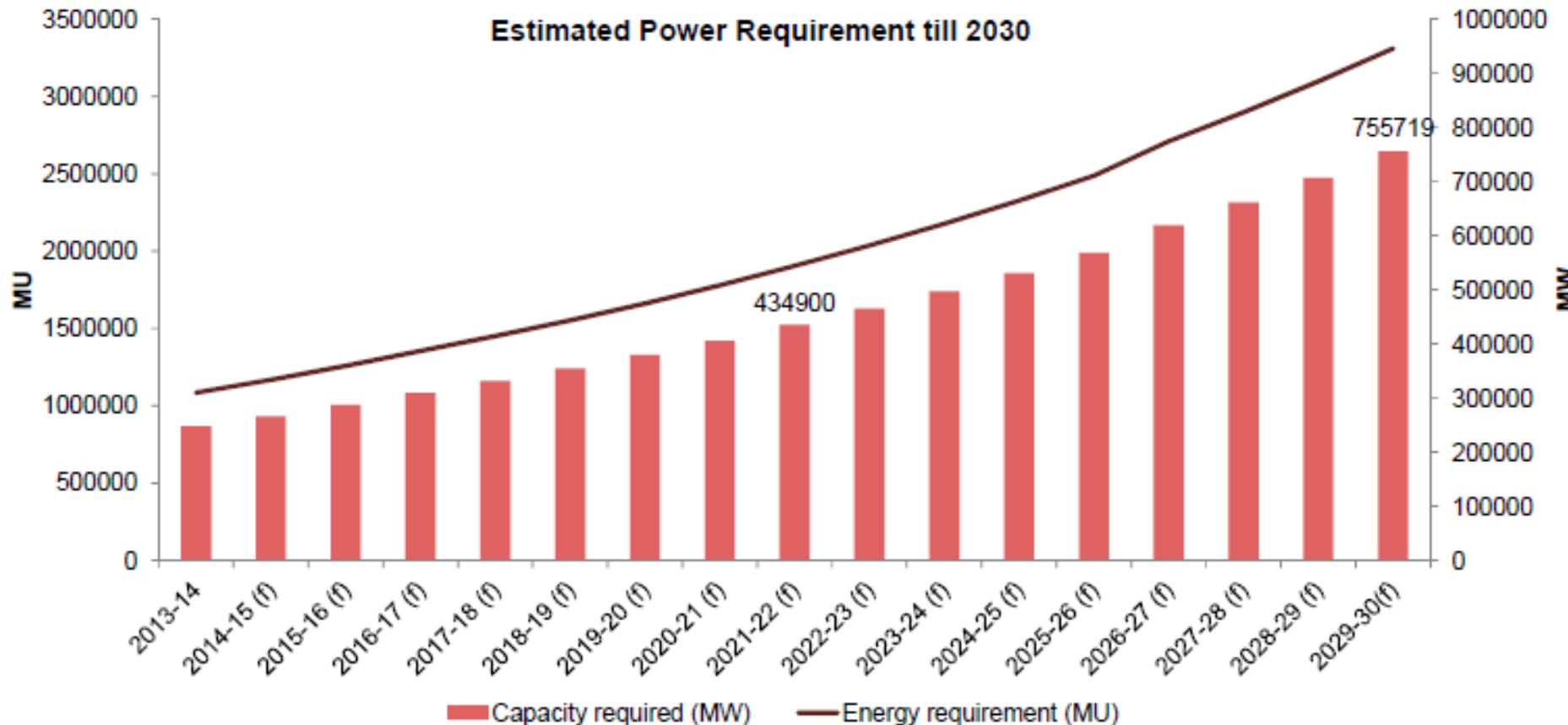
India has Abundant Solar Energy Resources:

- **> 100,000 MW by 2020 *** (5 years)
- **> 200,000 MW by 2025*** (10 years)
- **Harness Wind Energy near the sea shore and other windy sites**
- **> 50,000 MW by 2020 *** (5 years)
- **> 100,000 MW by 2025*** (10 years)
- **Additional potential for to tap Small Hydro Power plants, Biomass, Biogas, Geothermal, etc.**

***Assuming favorable Policy, Incentives, Tariffs, and Financing is provided**

Projected power requirement

Energy requirement is expected to increase by 200% from FY 15 to FY 30



GEF National Workshop in India • MNRE

13 April, 2015

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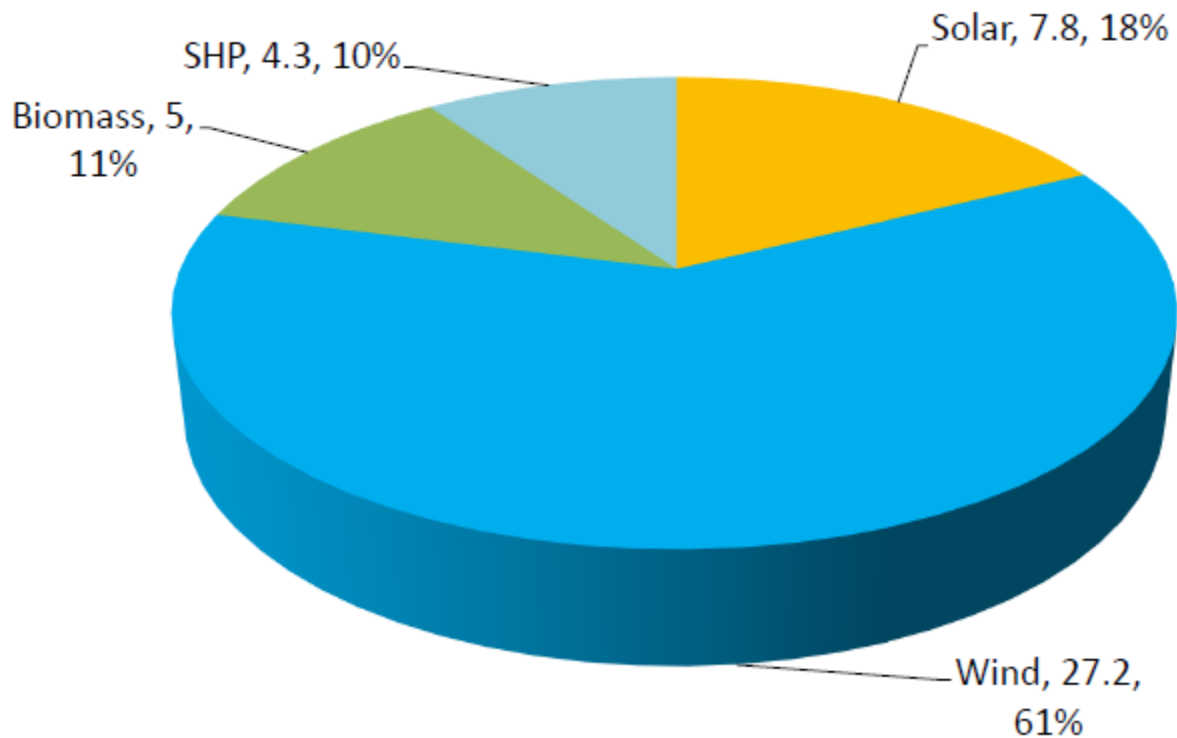
Source: 18th EPS, CEA

Assumption- Based on average PLF @ 50% prevailing at FY 11, FY 12, FY 13

Introduction –Contd.

Indian Energy Scenario

- Total Installed Capacity- 44.2 GW



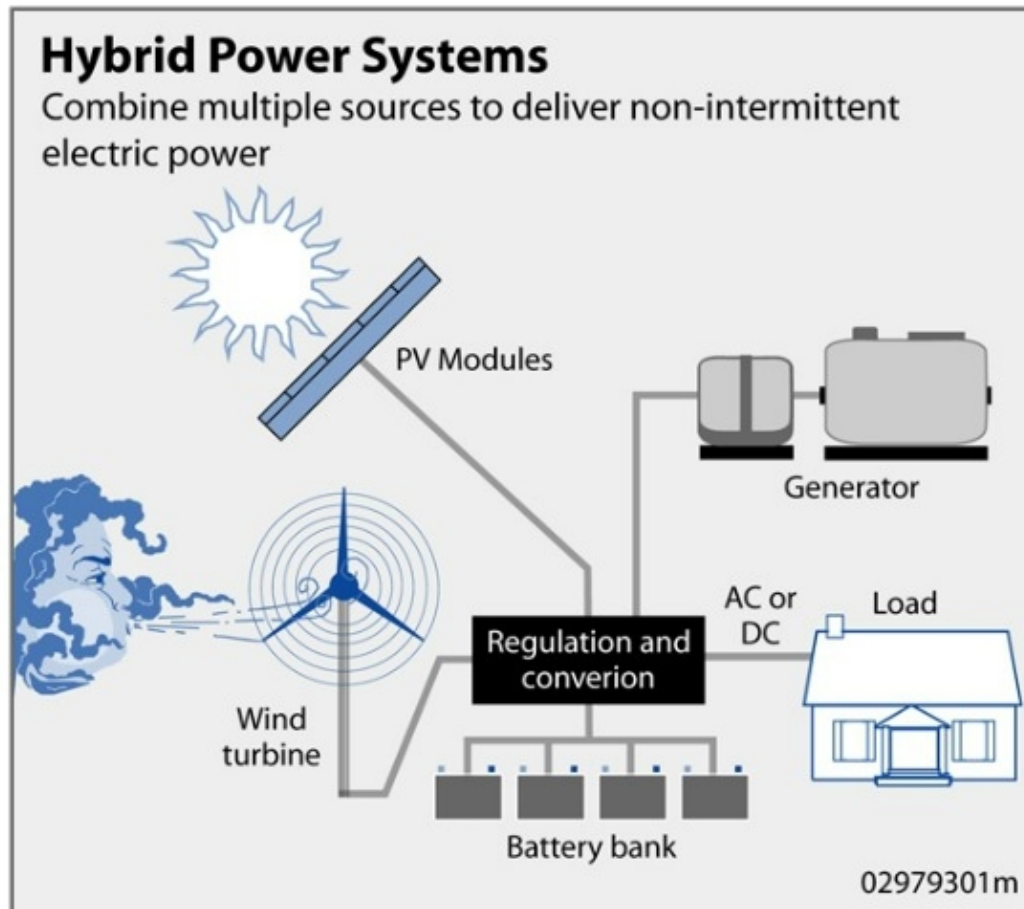
Source: MNRE 30.06.2016

Introduction-Contd.

WHY HYBRID?

- Integration of two renewable energy system that will give continuous power
- use any one source and keep another source as a stand by unit.
- affordable cost
- Clean energy sources
- Reliability improves
- Life span is more and less maintenance cost

Solar PV/wind Hybrid System



LITERATURE REVIEW

Design , Modelling and optimisation of Hybrid systems

Authors	Title	Contribution
1.Sunil Patel, Nayana Prajapati and Tapan Patel (IJIRST Issue 12 /May 2016)	Grid Connected Solar and Wind Hybrid System	This paper presented the modeling, simulation and Control of a grid connected PV and Wind Hybrid Power System, using MATLAB/SIMULINK
2. Q Hassan,M Jaszczur and J Abdulateef (Journal of Physics: Con. Series 745 (2016))	Optimization of PV/WIND/ DIESEL Hybrid Power System in HOMER for Rural Electrification	Modeling, computer simulation and optimization of hybrid power generation system in the rural area in Iraq by simulation using HOMER software was carried out and found feasible

LITERATURE REVIEW

Controls and Power Management

Authors	Title	Contribution
Himanshu Sharma, Nitai pal, Pankajkumar, Ashwini Yadav	A control strategy of hybrid solar-wind energy generation system	In this paper, the design of a DC-DC converter for a PV /wind hybrid system was covered and dynamic performance analysis of designed controller at different situations was studied including variations of ambient conditions at renewable energy sources.

Archives of Electrical Engineering Vol.. 66(2), pp. 241-251 (2017)

LITERATURE REVIEW

Energy Storage

Authors	Title	Contribution
U.Bahadır Önen and others	A Review of Energy Storage Systems for Wind Power Plants	In this paper, emerging methods of ESS, such as PHES, CAES, Batteries, HES and FES, are discussed and steps to overcome the problems that occurs due to the intermittent and variable nature of WPPs integration on the grid
International Journal of Research and Engineering, Vol. 04 No. 04 April 2017 PP. 119-124		

LITERATURE REVIEW

Energy Storage

Authors	Title	Contribution
World Energy Resources E-Storage 2016	World Energy Council report 2016	Various discussions about categorization of energy storage systems, current and emerging technologies, applications and potential, Economics and markets, socio economic impacts , and environmental impacts are highlighted by Energy storage Council in their report
<p>https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_E-storage_2016.pdf</p>		

LITERATURE REVIEW

Environmental Impacts

Authors	Title	Contribution
Alexandros Gasparatos, Christopher N. H. Colls, Miguel Esteban, Abubakari Ahmed, Tabitha A. Olang	Renewable energy and biodiversity: Implications for transitioning to a Green Economy	Discussions on the impacts of different renewable energy pathways on ecosystems and biodiversity, and found that renewable energy sector can affect ecosystems and biodiversity
Renewable and Sustainable Energy Reviews 70 (2017) 161–184		

LITERATURE REVIEW

Environmental Impacts

Authors	Title	Contribution
SchusterE, Bulling L, Köppel J.	Consolidating the state of knowledge: a synoptical review of wind energy's wildlife effects	An assessment of wind farms on bird species and environmental impacts of wind turbines on wild life effects specifically on bird and bat collision with wind turbines was studied in detail.
Environ Management 2015:300-31		

Conclusion

- A summary on the recent developments of hybrid renewable energy systems (HRES) with specific reference to solar photovoltaic and wind energy systems
- wind-hybrid energy systems are one of the best feasible options for the electrification of remotely located, electricity deprived areas since it is cheap and available in abundance

References

1. Sunil Patel Nayana Prajapati “Grid Connected Solar and Wind Hybrid System” International Journal for Innovative Research in Science & Technology| Volume 2 | Issue 12 | May 2016
2. Q Hassan, M Jaszczur and J Abdulateef “Optimization of PV/WIND/DIESEL Hybrid Power System in HOMER for Rural Electrification”, Journal of Physics: Conference Series 745 (2016)

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3. Himanshu Sharma, Nitai pal, Pankajkumar, Ashwini Yadav “A control strategy of hybrid solar-wind energy generation system” Archives of Electricaj Engineering Vol.. 66(2), pp. 241-251 (2017)
4. U.Bahadır Önen and others “A Review of Energy Storage Systems for Wind Power Plants” International Journal of Research and Engineering, Vol. 04 No. 04 | April 2017 | PP. 119-124
5. World Energy Resources E-Storage | 2016, World Energy Council, https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_E-storage_2016.pdf

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6. Alexandros Gasparatos, Christopher N.H. Dollb , Miguel Estebanc , Abubakari Ahmedc , Tabitha A. Olang “Renewable energy and biodiversity: Implications for transitioning to a Green Economy “Renewable and Sustainable Energy Reviews 70 (2017) 161–184
7. Schuster E, Bulling L, Köppel J. “Consolidating the state of knowledge: a synoptical review of wind energy's wildlife effects” Environ Manag 2015:300–31

Thank You

