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A Study on Hybrid Renewable Energy System in India

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Abstract - *The study presents HYBRID RENEWABLE ENERGY SYSTEMS (HRES), a technology which is under a heavy research phase. As world's power consumption is increasing regularly and consequently, demand for more power generation is inevitable. So this power demand can be produced by Renewable energy resources up to some significant percentage of total demand. Different Hybrid Systems can play an effective role to overcome our future energy consumptions with a cost-effective energy conversion system. Integration of these resources is highly appreciated for providing a reliable power source to the world. In this paper HRES, Different Hybrid Systems and Completely Renewable Hybrid Power Plant (solar, wind, biomass, and hydrogen) are discussed briefly and survey is done to select the regions of implementation of HRES in India and also we'll be looking into the system's scope, applications, advantages, economic benefits, sustainability, system problems and come up with ideal solutions.*

Key Words: **HYBRID RENEWABLE ENERGY SYSTEMS (HRES), cost-effective energy conversion system, Renewable energy, Completely Renewable Hybrid Power Plant, Different Hybrid Systems.**

1. INTRODUCTION

The search for "inexhaustible" energy resources to satisfy long-term needs is a high priority undertaking which has been recognized by the government and the public. Also in a recent survey conducted on consumption of the existing Oil reserves on earth revealed facts that if we keep consuming oil at the current rate, the oil wells might dry up within the next 65 years.

This situation certainly demands an alternative energy source for future generations well known as Renewable energy. But just one Renewable system (either solar or wind, etc.) of these is not sufficient [table1] and also very occupies lager area but if we combine technologies i.e., Wind-solar, Hydro-wind, Solar-biomass, all a Completely Renewable Hybrid Power Plant (solar, wind, biomass, hydrogen) which will not only save up space but also combine to produce lot of power at the same region ,allowing us to construct more such hybrid systems across the country to help meet up with the power demands of India (1408624400 MWh/yr.).

Renewable Sources	Installed Capacity	Potential
Wind	2483 MW	45000MW
Biomass	613 MW	19500 MW
Micro hydro Projects	1603 MW	15000 MW
Waste to Energy	41 MW	1700 MW
Solar Photovoltaic cell	151 MW	20 MW/sq. km

Table 1: Installed and Estimated Capacity of Renewable energy sources in India

2. SCOPE OF H.R.E.S

Presently, scientists and engineers around the globe are trying out different ways for utilization of renewable energy resources. These are abundant and don't contaminate the environment, but many complexities exist in conversion of theses energies, control, coordination etc. They are utilized as an independent system serving many applications i.e. lighting system, water pumping for irrigation, traffic control etc. But it is costly and requires individual conditioning and controlling units. In this challenging atmosphere, Hybrid Renewable Energy System (H.R.E.S) is one of the feasible solutions to harvest energy from renewable energy resources.

3. OVERVIEW OF H.R.E.S

Hybrid Renewable Energy System usually comprises of two or more renewable energy components such as (solar panels or wind mill etc.) combined to provide a stable uninterrupted power system. In other words it can be said that hybrid energy system is a combination several (two or more) energy sources with appropriate energy conversion technology connected together to feed power to local load/grid. Since, it is categorized as a distributed generation system hence there is no unified standard or structure. It is beneficial in terms of reduced line and transformer losses, reduced environmental impacts, relived transmission and distribution congestion, increased system reliability, improved power quality, and increased overall efficiency. [1]

4. TYPES OF H.R.E.S

1) *Biomass-wind-fuel cell*: considering a 100% power supply demand scenario. This system will perform at 60% power supply by biomass, 20% by wind and remaining 20% by fuel cell.

2) *Photovoltaic-wind*: Another great example of a hybrid energy system is a photovoltaic array combined with a wind turbine. This system would generate large outputs from the wind turbine during the winter, whereas during the summer, the solar panels would produce their maximum output.

3) *Hydro-wind*: A wind-hydro system generates electric energy comprising of wind turbines and pumped storage. This system was put on trial by Nova Scotia Power at its Wreck Cove hydroelectric power site in the late 1970s, but was decommissioned within ten years. Since, no other system has been implemented at a single location as of late 2010.

4) *Photovoltaic-Biomass*: this is a combination of biomass and photovoltaic cells and the system is currently under research phase.

5) *Completely Renewable Hybrid Power Plant*: this would ideally consists of solar, wind, biomass, and hydrogen. A hybrid power plant consisting of these four renewable energy sources can be made to perform remarkably by proper utilization of these resources in a completely controlled manner.

5. PROMISSING H.R.E.S APPLICATIONS

1) This technology in small scale can run an electric vehicles.
2) Applications in renewable autonomous energy supply systems mainly based on a battery/hydrogen combination.
3) Grid applications- household level, district or regional level (e.g. lithium-ion/redox-flow battery application for the island Pellworm)
4) HRES for large scale wind- and PV-park power management.

6. RENEWABLE POWER GENERATION TECHNOLOGIES WITH ITS STORAGE DEVICES

Technology;	Devices;
Biomass	Battery
Geothermal	Compressed air
Solar PV	Battery
Wind turbine	Superconducting Magnetic Energy Storage
Ocean tidal/wave	Hydrogen

7. INDIA & ITS DIFFERENT TERRAINS

India has vast varieties of different landscapes and terrains, giving us the advantage of being able to install all types of renewable energy systems in different parts of India.

1) *Wind zone map:* In general, the available wind generation capacity is determined by the average wind speed over the year for each location.

Wind speed fluctuates, which has an impact on wind electricity generation capacity and operating characteristics. In general, wind speeds are as follows:

- 2 m/s minimum is required to start rotating most small wind turbines.
- 3.5 m/s is the typical cut-in speed, when a small turbine starts generating power.
- 10–15 m/s produces maximum generation power.
- At 25 m/s maximum, the turbine is stopped or braked (cut-out speed).

And in India as shown in Fig.1:

1.1) Highest wind speed (50m/s +):

Western Ghats.

1.2) High wind speed (40 – 50m/s):

Rajasthan, Uttar Pradesh, Punjab, Haryana, Delhi, Bihar, Assam, West Bengal, Orissa.

1.3) Moderate wind speed (33 – 39m/s):

Himachal Pradesh, Uttaranchal, Arunachal Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Kerala.

1.4) Lowest wind speed (below 33m/s):

Karnataka.

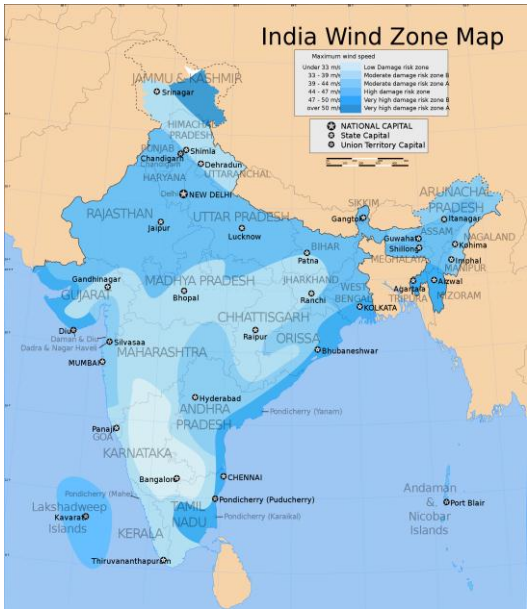


Fig.1: India wind zone map (2011)

2) Biomass map refer Fig.2:

2.1) *Highest power potential (1501+ MWe)*:

Madhya Pradesh, Maharashtra.

2.2) *High power potential (1001- 1500MWe)*:

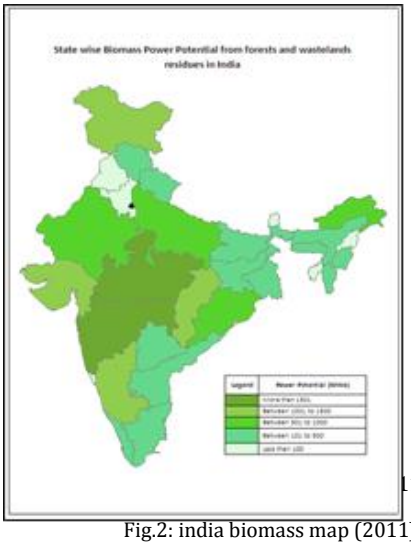
Gujarat, Karnataka, and Chhattisgarh.

2.3) *Moderate power potential (501-1000MWe)*:

Rajasthan, Arunachal Pradesh, Uttar Pradesh, Orissa.

2.4) *Fair power Potential (500 and below)*:

Kerala, Tamil Nadu, Andhra Pradesh, Himachal Pradesh, Uttaranchal, Bihar, Jharkhand, West Bengal, Eastern states.



11)

Fig.2: india biomass map (2011)

3) Solar map (refer Fig.3):

3.1) *Highest {solar radiation (2150 kWh/m² and above):*

Gujarat, Rajasthan.

3.2) *High solar radiation (2000-2150 kWh/m²)*:

Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu.

3.3) *Moderate solar radiation (1700-2000 kWh/m²)*:

Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal.

Fig.3: India's solar radiation map (2011)

8. H.R.E.S POTENTIAL REGIONS IN INDIA

1) *Biomass & wind*: this hybrid system can be implemented in states like Madhya Pradesh*, Maharashtra*, Chhattisgarh, and Karnataka*.

2) *Solar – wind*: this hybrid system can be implemented in states like Madhya Pradesh*, Maharashtra*, Andhra Pradesh, and Karnataka*.

3) *Solar – biomass*: this hybrid system can be implemented in states like Madhya Pradesh*, Maharashtra*, Gujarat, Rajasthan, U.P, Andhra Pradesh and Karnataka*.

4) *Completely Renewable Hybrid Power Plant*: only three of the states have the potential to sustain this kind of system and they are Karnataka, Madhya Pradesh, and Maharashtra.

9. ADVANTAGES OF H.R.E.S

Hybrid Energy Systems uses a wide range of primary energy sources, for frequent renewable sources generation as the stand alone system for rural electrification where grid extension is not possible or uneconomic.

- Design and development of various HES components flexibility for future extension and growth.
- Number of generation units can be increased with demand so as to assure consistent operation with existing system.
- Excess generation can be feed in to grid which leads to revenue generation.
- Its stability, reliability and efficiency will be high.

10. ECONOMIC BENIFTS

Creation of about a quarter of a million jobs that are likely to be generated in India alone at a time where unemployment is the highest for nearly a quarter of a century now.

11. LIMITATIONS OF H.R.E.S

1) *Extracting power*: Extracting maximum power is difficult for a constant load as some times the voltage outputs of different sources may vary.
2) *Stochastic Nature of sources*: These distributed sources are site-specific. So, the design of power converters and controllers has to be so designed according to the requirement.
3) *Coordination*: In order to get reliable power, these systems can be connected to a utility grid. Often frequency mismatch arises between both systems. Hence it leads instability of the overall system.
4) *Power Quality*: A wide range of power electronics converters are involved in power conditioning of hybrid energy system from source to user. These power converters generate many harmonic components in the transmission which causes large scale disturbances to the load/power distribution system.

12. SOLUTIONS FOR THE DRAWBACKS

If two or three forms of renewable energy generation systems are combined into one hybrid power generating system their drawbacks will be avoided partially/completely, reckoning on the control units. Because the one or additional drawbacks will be overcome by the opposite.

- As in northern hemisphere, it's usually seen that in windy days the solar energy is proscribed and contrariwise and in summer and rainy season the biomass plant will operate in an exceedingly full flagged therefore the power generation will be maintained within the above-stated condition.
- The price of solar array can be subsided by using glass lenses, mirrors to heat up a fluid which will rotate the common turbine utilized by wind and alternative sources.
- Now the question arises what about the winter nights or cloudy winter days with terribly low wind speeds. Here comes the activity of the hydrogen. As we all know the method of electrolysis can manufacture hydrogen by breaking water into hydrogen and oxygen, it is stored; hydrogen is additionally a good fuel and burns with oxygen to provide water. Hydrogen can be used to maintain the temperature of the biomass reservoir in winter so it can produce biogas in optimum quantity for the power generation.
- As stated above biogas could be a sensible source in summer; in this period the solar power accessible is also at its peak, thus if the demand and supply is properly checked and calculated the excess energy can be utilized in the production of hydrogen and can be stored.
- In sunny, windy & hot day, the turbine operates with full speed because the supply is surplus and this excess power can be consumed for different constructive applications. In winter, the power consumption is also low therefore the supply limit is low, and obtained with lesser consumption.

13. FUTURE TRENDS & CHALLENGES FOR RESEARCH

The renewable technologies have undergone a great amount of research and development. However there are still few minor obstacles that are to be solved that is in terms of the HRE system efficiency and optimal use. Few of the challenges faced are:

- Harnessing efficiency of photovoltaic cell is major obstruction in encouraging its use.
- The manufacturing cost needs a significant reductions as installations costs of renewable sources is expensive.
- Power loss in the power electronic devices are to be further reduced for economic power generation.
- The storage technologies need to increase their life-cycle through inventive technologies.

These stand-alone systems are less adaptable to load fluctuations which might even lead to entire system collapse.

14. CONCLUSION

HRES are an interesting and very promising flexibility technology, which can help to cover short-, mid- and long term fluctuations in a future sustainable, 100%-renewable energy system.

Though HERS could be a suitable solutions for the electricity problems in the rural region and for the future world without fuel. Yet vast research is needed to make HRES technically feasible, As the factor that's stopping HRES form implementation is not the technology but it the economic factors, but I believe that it is possible as the current technology advancements will make it very possible for real life implements.

REFERENCES

[1] *Hybrid Renewable Energy Systems & their Suitability in Rural Regions, By Shumank Deep Srivastava1 & Rajiv Banerjee.*
[2] "Solar Energy", MOOC (edx), TU Delft, Netherlands, September 2015,

https://courses.edx.org/courses/coursev1:DelftX+ET3034x+3T2015/courseware/8cbd1aac8877451f8a0011ac2095f8c6/0ce9d4a1f6ca47ddbf38e5183bbe685e/

[3] Dr. Sudhir Varma, Director, Social Policy Research Institute, "A Study on Inter Regional Economic Inequalities in Rajasthan", Jaipur, http://planningcommission.nic.in/reports/sereport/ser/stdy_rgeco.pdf

[4] N. Lakshmanan, S. Gomathinayagam*, P. Harikrishna, A. Abraham and S. Chitra Ganapathi, "Basic wind speed map of India with long-term hourly wind data", Structural Engineering Research Center, Chennai, India. indiaenvironmentportal.org.in/files/wind%20speed%20 data.pdf

[5] P. Koteswaram Fna, Director-General of Observatories Meteorological Office, "Meteorology and Climatology of the Rajasthan Desert", New Delhi.http://www.dli.gov.in/data_copy/upload/INSA/INSA_2/20005a14_401.pdf

[6] Krupali, "Solar Irradiation Data of India". http://www.eai.in/club/users/krupali/blogs/627

[7] Energy Statistics 2013, Twentieth Issue, Ministry of Statistics and Programme Implementation, New Delhi.

[8] Nidhi Verma, "Fuel Prices in India's Capital Since 1989".

[9] World Fossil Fuel Reserves and Projected Depletion, The Colorado River Commission of Nevada, March 2002. http://crc.nv.gov/docs/world%20fossil%20reserves.pdf

[10] Essam A. Al-Ammar, Nazar H.Malik, Mohammad Usman, "Application of Using Hybrid Renewable Energy in Saudi Arabia" King Saud University, ETASR vol.1, No. 4, 2011, 84-89.

[11] [11] Hybrid energy systems (HESs) using small modular reactors (SMRs) S. Bragg-Sitton, in Handbook of Small Modular Nuclear Reactors, 2015

[12] Design and performance optimisation of stand-alone and hybrid wind energy systems, E. Kondili, in Stand-Alone and Hybrid Wind Energy Systems, 2010

[13] Network Planning of Hydrogen Supply Chain

[14] Hanane Dagdougui, ... Ahmed Ouammi, in Hydrogen Infrastructure for Energy Applications, 2018

[15] Solar–wind hybrid renewable energy system: current status of research on configurations, control, and sizing methodologies Piyali Ganguly, ... Aladin Zayegh, in Hybrid-Renewable Energy Systems in Microgrids, 2018