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Feasibility of Solar Wind Hybrid Renewable Energy in India

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Abstract-India has a population of 1.25 billion. Out of which, more than 200 million people are living in rural areas and with no grid-connected power. The Indian power grid failed spectacularly in 2012, plunging more than 600 million people into total blackout. Hybrid power systems would be a convenient & cost-effective solution which not only reduce dependency on grid supply but also improve reliability. There are some specific constraints that prevent the development of solar and wind energy system in India. However, our country has adequate sunshine and balanced wind speed. Hence there is a greater opportunity for existence of solar and wind energy system in the India. The total cost of hybrid unit can be calculated using the analysis of life cycle cost and payback period.

Keywords- Solar energy/PV system, Wind energy, Hybrid energy in India, Grid Parity, Modelling of hybrid systems.

Introduction

In the current scenario, the development of a country is based on several factors. Electricity is one of them. Looking at several developed countries like US, China, Russia; they got 100% electrified in late 90's whereas India has achieved 81%(2013) as per data bank of World Bank and is assumed to attain 100% by 2019. India has fixed a target of 175GW of power comprising only renewable energy sources by the end of 2021. Out of which 100GW comes from Solar Power and 60GW from Wind power. India has already crossed a mark 26.8 GW of wind and 7.6 GW of solar power installed capacity during May 2016.The solar-wind hybrid unit returns the least cost of unit values to keep up the same level of DPSP (Direct Profit Sharing Plan) as compared to stand-alone solar and wind power systems. The energy cost for PV-wind framework is always lower as compared to standalone solar or wind harnessing system, while this hybrid system has not gained much market maturity. In the coming future, the PV-wind hybrid option is supposed to be techno-economically viable for rural electrification. After the success of pilot project(in 2008) of setting up a solar-hybrid system in one of the villages at Morni hills of Haryana, more other panchayats have come forward to get similar hybrid system installed in their respective areas. Few panchayats have already approached the Haryana Renewable Energy Development Agency (HAREDA) and various plans are under progress to put such projects in the Aravalli belt of Haryana.

Components of Solar-Wind Hybrid System

The solar-wind hybrid system consists of the following components:-

1. Solar Photovoltaic panels which collect the incident radiation of the sun whenever it falls on them and converts it into Direct Current output.
2. Mini Wind Turbine which is installed on top of a tall tower or placed in an open field to collect kinetic energy from the wind whenever it is available.
3. Aero-Wind Generator which converts kinetic energy of the wind turbine into electricity.
4. Battery Bank includes a group of batteries which are connected together to have one large battery bank having required voltage and ampere-hour capacity. Batteries are connected in series to increase the net voltage of the bank and in parallel to increase the amperage.

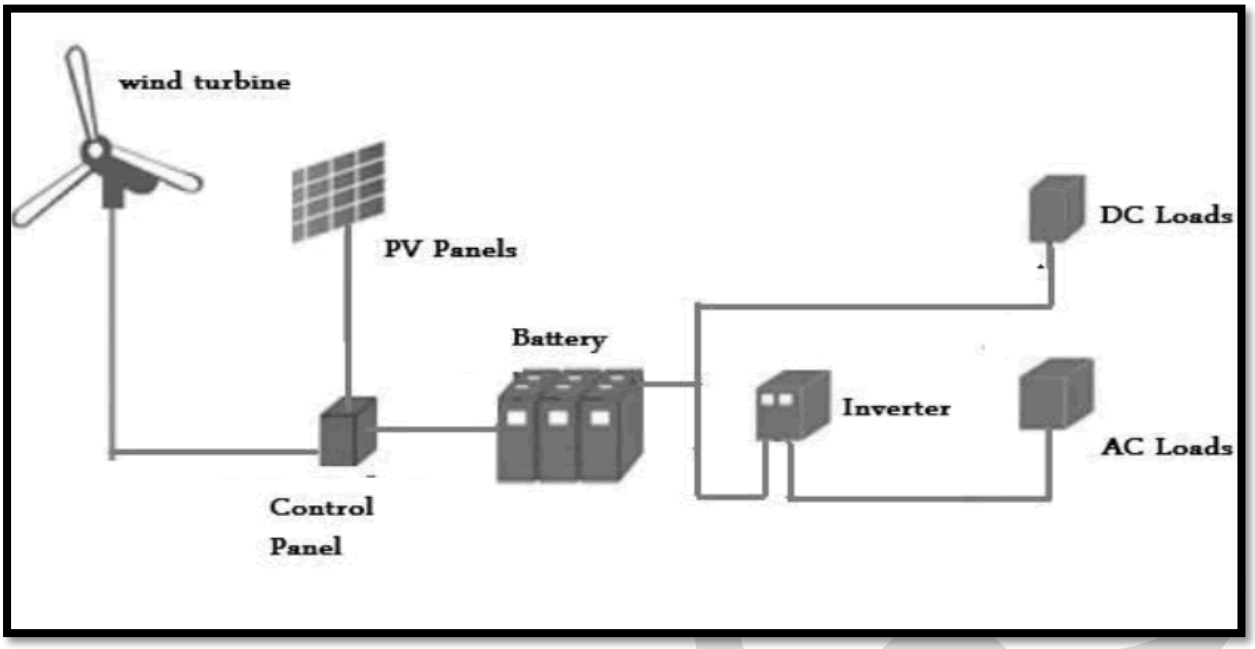

Fig (a) Components of Solar-Wind Hybrid system

5. Maximum Power Point Tracking Controller (MPPT) is an electronic power converter which does the optimization of the power coming from the solar panels and wind generators and matches it to the capacity of the battery bank. Usually DC power is generated from both the system and this is quite high for charging of batteries. So, this higher DC voltage output is brought down to the lower voltage level required to charge the batteries.
6. PV Panel Trackers track the movement of the sun for maximum sunlight. Solar panels are mounted on these trackers.
7. Inverter is connected to the battery bank. Inverter converts the DC power received from the solar panels and the wind generator into AC power which is then utilized for residential or any other commercial purpose. Inverter supplies AC loads connected to it.

Points of differentiation

The difference between solar, wind and hybrid system in various aspects is shown in tabular form as under:

	Solar	Wind	Hybrid
Operation	Produce electric current directly from sunlight	Kinetic energy of wind turbine drives the generator	Combination of both

	Solar	Wind	Hybrid
Technical Specifications	Rated Power 250W No. Of solar panel :4 Operating Voltage 24V Operating Current 5.6A Open Circuit Voltage 37V Short Circuit current 8.63A	Cut-in Speed 5.6m/s Rated Voltage 12V Wind turbine Material- Galvanized Iron No. of wings 7 Cut-out speed 50 m/s Weight :90Kgs	
Average Life	25 years	15-25years	Average of both
Initial Investment	INR49000/KW	INR89000/kW	Calculated Below

The solar-wind hybrid model utilize the combined energy from solar panel and wind energy units and generate a continuous supply of power.

Lifecycle Cost

Since the complete lifecycle cost of a solar-wind hybrid system is the aggregate cost of the capital investment, operational costs, maintenance costs and battery replacement costs.
For a residential house in India, usually, it will have 4-5 fluorescent lamp or LED bulbs,1 TV or computer, 2-3 Fans, and a 0.5HP motor as the typical connected load. The power consumption of the house in a day can be calculated to be around 1600-1800 WH or 1.8 units/day.

For an approximate power consumption of 1.8 units/day in areas without grid connected power, the cost assumed to be around INR20/unit.
Monthly cost = 1.8units x 30days x 20= INR1080.00
Annual bill = 1,242 x 12= INR12960
Since Indian villages cannot afford this high investment cost, most of it would be subsidized by the Government of India. On this basis, the cost for the solar-wind hybrid system is calculated. This tabular chart shows that solar-wind hybrid systems can be very cost effective for Indian villages as this is one-time investment for continuous supply of power:

Cost of Solar-wind hybrid system	
Capacity of solar plant –	1 unit of power
Cost of solar panel(1Kw) –	INR49000

Cost of Solar-wind hybrid system	
Wind power generation –	1.5units/day
Wind system cost(1.5KW) –	INR67,500
Inverter	INR22,000
Two lead acid batteries –	INR18,000
MPPT controller	INR2,000-6000
Installation works –	INR18,000
Total cost –	**INR1,76,000**

Payback Period calculation

The cost of the system varies from Rs 1.70lacs to Rs 5.00lacs per kW depending on the ratio of wind and solar components. The approximate installation cost, including civil works, is about Rs 13,000 per kW and maintenance cost is about Rs 3000 per kW per annum.

Total Cost of Solar and wind hybrid system=Rs. 1,76,000/-

Total Cost of utility supply= Approximately Annual bill(calculated above) + initial cost (substation, transformer and transmission line cost)

= Rs.13000 +3000+ 1,00,000

= Rs. 1,16,000/-

So , payback period for hybrid system will be,

$$\text{Payback Period} = \frac{\text{Total cost of solar and wind hybrid system}}{\text{Total cost of utility supply}}$$

Payback Period= 1,76,000/1,16,000= 1.5 years

= 2 years (approximately depending upon the climate variation)

So, Solar and Wind Hybrid System can be employed efficiently for rural area which are not yet electrified.

Application of Solar-Wind Hybrid Systems to Rural India

Solar-Wind Hybrid Systems have a long way to go since over 18,000 villages were un-electrified amid FY2016. The tremendous initial cost involved in installation and servicing of transmission lines is the prime issue for this problem. There is another problem of heavy losses in transmission and distribution along with poor power reliability. More than 200 million people living in rural areas of India are devoid of any access to grid-connected power.

Pertaining to above discussion, there is a need to set up alternative sources of energy in the remote areas which help in reducing transmission losses and providing reliable power. Solar photovoltaic and wind power generation systems may take a lead in this case. As we are aware that standalone systems are not sufficiently adequate to provide continuous electricity round the year, because of varying climate conditions. Solar energy is available only in the day-time, that too in summers, while wind energy intermittently available.

As revealed from Bridge to India's report, India has become the fourth largest solar market in 2016 globally, with an expected 8.8GW of solar power generation capacity by 2017. However, the installed capacity of wind power in India is around 28700.44MW by the month of February 2017. Both the sources of energy are cheaply available and complement each other's limitations.

Hybrid model comprising of solar and wind power will be ideal for rural implementation, since the capabilities of both the systems are utilized to provide continuous supply of power. Rural areas lack electrical equipment and they can utilize this vitality to store electricity in batteries, which serve as a backup when customary power goes down.

Grid Parity

Grid parity is said to be possible when the cost of solar and wind working as a hybrid unit equals the cost of conventional electricity. It also means that it is equal *without* subsidies like net metering, feed in tariffs, and tax credits, etc.. Grid parity depends particularly on location for a hybrid plant. Solar power plant needs insolation (Solar energy) to work and that in a nation like India; it varies with latitude and regional climate. However, the thing of great importance is that the wind and the sun extremely complement each other. Actually, there's a explanation for that. More windy months are less sunny and meanwhile, the more sunny months are less windy. A monthly distribution of solar and wind power availability is shown in the figure (b). In India, it is predicted that wind power will approach the grid parity with coal and petroleum plants without carbon sequestration by 2022 and will be cheaper than the conventional power.

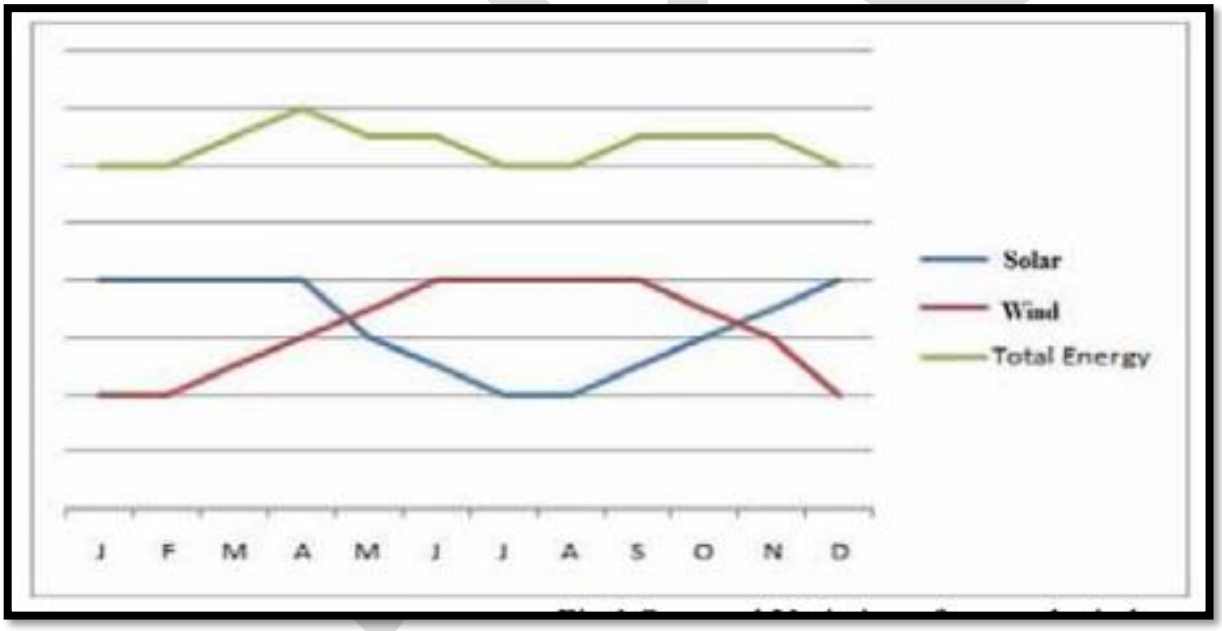

Fig (b) Monthly availability of PV and wind power

There are managers in the grid to coordinate in between the energy supply and demand in the real time. As demand of energy rises and falls all over the day, the grid operators have to employ more electricity generators depending upon the requirement of load. It is quite obvious that wind and solar photovoltaic (PV) energy production vary with climatic conditions, and so, it is the ability of an electric grid to utilize renewable energy in such a way that the scarcity of electricity can be met during peaking loads. If the electric grid has no available storage capacity and the power from wind and solar PV generation exceed the flexibility limit of the grid then excess renewable energy needed to be curtailed, for example, moving turbine blades away from the direction wind. This curtailment may reduce the income from the wind and PV hybrid plant and effectively increasing the final costs of electrical unit(1Kwh).

For a realistic case, a fixed 70% flexibility limit has been set in the hybrid energy system (meaning that 70% of capacity of the hybrid plant is ramp-able while 30% of utility is always on), and a 10% maximum limit of curtailment is set. On stand-alone basis, wind can achieve 18% of total generation while a stand- alone PV system can achieve maximum of 12% of total generation. Both wind and PV as hybrid unit can achieve a generation of almost 27% which can be approximated to 30%.

Market Availability

In a country like India, the market awareness of the hybrid systems is quite low and the capital investment for such a system is high. For roof-top solar panel mounting, the terrace space should be large enough to provide space for setting up solar panels and wind turbines. If an area doesn't receive a sufficient amount of wind or sunlight, there is no point of installing a hybrid system at that place. Due to high initial investment cost, consumers are sceptical about feasibility of the hybrid system and hence government should take major steps in setting these hybrid units for rural households in terms of subsidies or other low initial cost plans. Current Indian markets have very few businesses involved in the designing and manufacturing highly efficient solar-wind hybrid systems. The companies which are currently supplying hybrid units in India are:

1. SIKCO – Society for Innovative Knowledge & Cost Optimization: It is one of the most integrated company in renewable energy sector in India. It produces products like Solar, Wind and Biogas power plants.
2. SU Solartech Systems: One of the leading manufacturer of PV Systems, solar thermal systems, SWEG, energy saving and security devices, etc. Other companies include K-lite Industries, Akshar electronics, Powermax Energies Pvt Ltd, Soyo power, Shaktee power, Shantee Power, Prolight Systems etc.

Conclusion

In this review of future of hybrid power in India, we studied the prevailing scenarios for renewable energy in India. The above discussion shows that conditions of renewable energy sources such as solar and wind energy is satisfactory in India but requires additional attention for better development and utilization of renewable energy sources. Although, the cost reduced so much due to technological developments in the field of renewable energy systems in recent years, but still they are the expensive source of power. According to the above discussion India reaches "Grid Parity" in solar energy in 2017-2018 and in wind energy by 2022. For further development, it is necessary to focus on a specific technological system which requires better investment policy, better management and requires more attention of the government in that way.

REFERENCES:

[1] "Solar Hybrid Power Systems",Wikipedia, : The Free Encyclopedia.
[2] Ghosh S, Sengupta PP "Energy management in the perspective of global environment crisis: an evidence from India". IEEE 2011.
[3] "Grid Parity", Wikipedia: The Free Encyclopedia, March 7th ,2017
[4] Rich Press "Wind and solar energy can be a powerful combination", April 30th ,2012, environment.yale.edu
[5] Thomas Nikolakakis, Vasilis Fthenakis"The Optimum Mix of Electricity from Wind-and Solar- sources in Conventional Power System: Evaluating the Case for New York State.",Energy policy, Volume 39, Issue 11, Pages 6972–6980, November 2011
[6] Vikas Khare , Savita Nema , Prashant Baredar. "Status of solar wind renewable energy in India", Science Direct, Volume 27, Pages 1–10 , November 2013
[7] Zachary Shahan, "Solar & Wind Power Are A Match Made In Heaven", renewableenergyworld.com
[8] World Bank Global Electrification database " Access to electricity (% of population)", www.data.worldbank.org'
[9] Solar Energy Corporation of India(SECI) "Solar potential of India", http://www.mnre.gov.in
[10] Ministry Of science & Technology and Earth Sciences," Government Of India.Tifac Solar Foresight In India,pp1-276, November 2015",tifac.org.in
[11] Kamal Chaturvedi "Can Solar-Wind Hybrid Systems Bring Power to Indian Villages",May 2016, http://www.ecoideaz.com/expert-corner/solar-wind-hybrid-power-units-villages

[12] Ajay S tiwari. "Solar and Wind Hybrid System for Rural Electrification", Volume: 2, Issue: 5, ISSN: 2321-8169, pp1074–1077 https://www.scribd.com/document/283417146/Solar-and-Wind-Hybrid-System-for-Rural-Electrification

[13] Dr.S.Latha, M.Mahalakshmi, "Modelling Simulation and sizing of photovoltaic/wind/fuel cell hybrid generation system, Vol. 4, No.05, May 2012,ISSN : 0975-5462 ,pp 2356-2365

[14] Mahesh Wankede, Vadirajacharya, "Optimization Of Rural Electric Supply System Through Distributed Energy Sources", International Journal on Intelligent Electronic System, Vol. 9 No. 1, January 2015