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EDITORIAL



With India reaching 30 GW of Renewable Power in 232 GW total power generation capability is no mean achievement in which wind has a share of 20 GW installed capacity as on December 2013. The policy shifts has always affected the annual capacity addition of wind power in India in the last 3 decades. However, wind Industry is resilient enough to tide over the business model from accelerated depreciation to the independent power producer's model. At this stage, with over 20 manufacturers most of them World class global operators being present in India, the wind industry needs a smart push to sustain the growth and manufacturing potential of Wind Turbine Generators (WTGs) in the Country. India being the 2nd largest in the manufacturing of WTGs if a proper directive is given it can become an export hub for the world market as well. In India a lot of emphasis on indigenous research to overcome the infirm nature of wind power with a firm will to integrate energy storage techniques and off-grid utilization of generated wind power for hydrogen generation, desalination of water and to provide lighting and electricity in local micro-grids. Because of necessity to avoid the darkness in long hours of power cut, even in a highly windy state like Tamil Nadu people are forced to use self generation of electricity either by means of wind, solar or a hybrid wind-solar system. India being tropical Country having over 300 days of sunshine partial or full in most part of India, it is appropriate to have a combination of Solar and Wind hybrids even in small scale in both forms (Grid connected and standalone off-grid house applications.) Since wind in India is mostly during south-west monsoon and is highly seasonal, efforts are being made by Wind farm developers to combine wind-solar hybrids in their new projects so that the limited available transmission and evacuation capacity could be effectively used even in the non windy seasons throughout the year to distribute green power in the grid. A focused research in this area is certainly needed for which MNRE Government of India has called for research proposals from all over the

Country which had an overwhelming response of 52 projects. MNRE is in the process of prioritizing the project proposals since finance is always limited by budget.

C-WET is all geared up to provide data at any point in India both Wind as well as Solar resource through quality measurements and quality checked data products. R&D Unit of C-WET has already received the completion report on a grid interfacing project which is under review and a consultancy has been taken up for full scale measurement of power quality in collaboration with PRDC, Bengaluru. WRA Unit has been active completing 58 stations out of the sanctioned 75 stations all over India under the 100 m anemometry projects. 55 stations are already commissioned to send data every minute to C-WET's server through GPRS network. Since October 1, 2013 the offshore wind data from 100 m mast at Dhanushkodi is being collected. The Testing Unit is instrumenting 2 MW class machine in the customers site for measurement in this wind season. At WTRS our new Chairman of Governing Council & Secretary, MNRE, Dr. Satish B. Agnihotri, IAS., dedicated the 120 m guyed met mast to the Nation. The S&C Unit has released the main list of RLMM in October, 2013 and is coordinating actively under the ET-42 for Indian Standard preparation along with BIS. ITCS Unit has completed one National Training Course and an International Training Programme during the period. SRRA Unit has completed as many as 19 automatic Solar Radiation Resource Assessment stations in the States of Maharashtra, Odisha, Bihar, Jharkhand, Madhya Pradesh & Uttar Pradesh. The Secretary, MNRE also inaugurated the Calibration Lab of SRRA on the rooftop of C-WET in presence of Shri Alok Srivastava, IAS, JS (WE) & Shri Sudeep Jain, IAS, CMD TEDA. During the period Scientists actively interacted with Prof. Dr. Partha P. Sarkar who was visiting C-WET in the eve of APCWE 8 held in Chennai.

We would like to actively collaborate in Industry sponsored research in the area of wind as well as solar for which your feedback and needs would be our focus for the future.

S. Gomathinayagam
Executive Director

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Developments in R&D UNIT

Testing of Small Wind Turbine

Small wind turbine testing at Wind Turbine Research Station (WTRS), Kayathar for the windy season 2013, were halted due to the retreat of winds at site. Presently ten models of Small Wind Turbines are under test. The models under test ranges from 650 W to 10 kW. The 10th Empanelment list has been published on the MNRE & C-WET websites for Stakeholders reference. The list has also been circulated to various State Nodal Agencies.



Small Wind Turbine Testing at WTRS

Measurement of Power Quality

The Unit in association with Power Research and Development Consultants Pvt. Ltd. has initiated a project for measurement of power quality on a 225 kW wind turbine as per the requirements of IEC 61400-21. The measurements will mainly cover voltage fluctuations, flicker, harmonic measurements and reactive power measurements. The measurements are expected to be completed during the windy season starting from April 2014.



Power Quality Measurement in progress

Move on in WRA UNIT

During the period of October to December 2013, 33 new wind monitoring stations have been established in 5 States (7 stations in Gujarat, 6 stations in Maharashtra, 7 stations in Tamil Nadu, 12 stations in Karnataka & 1 station in Madhya Pradesh). Presently, 165 wind-monitoring stations are operational in 16 States under various wind monitoring projects funded by the Ministry of New and Renewable Energy (MNRE) as well as various entrepreneurs.

The following consultancy projects have been completed and reports have been submitted during this period.

- Technical Evaluation for the proposed 217 MW wind farm projects.
- Verification of procedure of wind monitoring for 30 sites.
- Evaluation of Power Curve Energy Demonstration (PCED) test for proposed 99 MW wind farm projects
- Measure-Correlate-Predict (MCP) analysis & Verification of procedure of Wind Monitoring for one site.
- Wind Resource pre-feasibility analysis for the proposed one location.
- Identification of suitable locations for carrying out Wind Monitoring Station (WMS) studies for one location.
- Wind Power Density (WPD) Map for 1 site.

R&D Projects progress in WRA Unit

- 100 m tall wind mast for offshore wind profile measurement at Dhanushkodi, Rameshwaram has been installed and C-WET started receiving data, since October 2013.
- Non Disclosure Agreement had been signed with M/s. Vortex for R & D Project in connection with wind power forecasting.

Estimation and Validation of Wind Power Potential at 100 m Level

Under the project Estimation & Validation of Wind Power Potential at 100 m level of 7 States in India, out of 75 stations, masts have been erected approximately in





58 stations and 55 stations have been made in operation, to provide real time wind data in C-WET's server. Three teams have been deputed to expedite balance station.

Other Programmes

Scientists/Engineers of WRA, R&D, S&C Units carried out the verification of manufacturing facilities in connection with RLMM.

Steps forward in TESTING UNIT

- Instrumentation work of Xyron 1000 kW wind turbine at Richadewda Ratlam District, Madhya Pradesh is under progress.
- Continuous measurements of Inox 2000 kW wind turbine with rotor diameter 100 m at Veraval (Bhadla) village (Survey No.8), Jasdan Taluk, Rajkot District, Gujarat is under progress.
- Measurements for Power Curve Measurements for Garuda 700 kW WT at Melamaruthappapuram Village, (SF. N. 141/5) V. K. Pudur Taluk, Tirunelveli District has been completed.
- An agreement has been signed between C-WET and M/s. Garuda Vaayu Shakthi Limited for Type Testing of Garuda 1700.84 kW WT with rotor diameter 84 m on 13th December 2013 at Kampaneari Pudhukudi (Village), Tenkasi (Taluka), Tirunelveli District.

Visitors to the Unit

- Meeting held with Mr. Vasudevan, Sr. Vice President from M/s. Global Wind Power Ltd (GWPL) regarding testing of their machine GWPL 2500 kW wind turbine on 29th November 2013 at C-WET.
- Meeting held with Mr. Sridhar, M/s. Captronic Systems Private Limited regarding discussion on National Instruments (NI) Data Acquisition System held on 4th December, 2013 and 12th December 2013 at C-WET.

Windy Acts at WTRS UNIT

Operation and Maintenance activities like conditioning of 9 nos 200 kW MICON Wind Electric Generators transformers were carried out as a part of preparation of the machines uninterrupted operation during the windy season 2014.

The following visit was coordinated and showcased the Testing and R&D facilities:

- 21 International participants of Life Academy, Sweden on 4th November 2013.



- 8 students of M. Tech (Renewable Energy) along with faculties from Rajasthan Technical University Kota on 9th December 2013.
- Dr. Satish B Agnihotri I.A.S., Secretary / MNRE alongwith Shri. Dilip Nigam Director (Wind) / MNRE and ED, C-WET visited WTRS, Kayathar facilities on 24th December 2013 and dedicated the 120 m Guyed Lattice Met Mast to the Nation.



Secretary inaugurating the Met Mast

Marching ahead in S & C UNIT

- Review / verification of documentation provided by various wind turbine manufacturers for more than 50 wind turbine models have been completed in connection with "Revised List of Models and Manufactures of wind turbines (RLMM) - Main List".



- Unit Chief & Engineers of S&C carried out the verification of manufacturing facilities in connection with RLMM.
- Organized RLMM Committee meeting.
- RLMM Main List dated 29th October 2013, finalized by RLMM Committee has been issued.
- Review of requests received from two wind turbine manufacturers in connection with installation of prototype wind turbines in India, as per MNRE guidelines, has been completed. Organized Committee meeting (special) on prototype wind turbine models.
- Documentation / information provided by various wind turbine manufacturers in connection with next Revised List of Models and Manufacturers of wind turbines (Addendum-I List). Review / verification of documentation is initiated.
- The decision of Working Group on standards regarding the acceptance on the draft Indian standard "Doc. ET 42 (6421) Wind Turbines Part 13: Measurement of Mechanical Loads" has been communicated to BIS.
- Unit Chief, S&C and ED, C-WET had discussion with officials from M/s. UL India Private Limited at C-WET, Chennai.

Highlights from ITCS UNIT

15th National Training Course

The Unit had successfully organized the 15th National training course on "WIND ENERGY TECHNOLOGY" during 27th - 29th November 2013 to address all aspects of Wind Power starting from Wind Resource Assessment to project implementation and operations & maintenance in a focused manner. The course was attended by 33 participants from academic institutes, industry,



Dr. Amudeswari inaugurating the course

entrepreneurs, developers and consultants from various part of the country. The training course was inaugurated by Dr. Amudeswari, Chairperson, Project Management, Central Leather Research Institute, Chennai.

Dr. Chellapandi, Group Director (Research), Reactor Design Group, Indira Gandhi Centre for Atomic Research was the Chief Guest for valedictory function and distributed the course certificate to all the participants after his valedictory address.



Dr. Chellapandi distributing course certificates

Participation in Exhibitions

The unit had established C-WET stall and demonstrated the activities and services of C-WET and created awareness about wind energy in the following Exhibitions. Number of professionals, researchers, students and general public visited C-WET Stall.

- "Energy Expo" on "Energy as Strategy: Augmenting Non-Conventional Energy capacity" during 8th – 9th November 2013 at St. Johns' Vestry School, Trichy.
- "8th Asia – Pacific Conference and Expo on Wind Engineering" during 11th - 14th December, 2013 at Hotel Green Park, Vadapalani, Chennai.
- "28th Indian Engineering Congress" during 20th - 22nd December 2013 at Hotel Leela Palace, Chennai.



C-WET Stall in APCWE VIII

Visitors to the Campus

During the period from October – December 2013, the following visits were coordinated by ITCS Unit, with presentations and explanations on wind energy and its status along with C-WET's activities & services. The campus renewable energy facilities were also explained / showcased in detail.

- Final year Electrical and Electronic Engineering students from GKM Engineering College, Chennai on 9th October 2013.



C-WET campus visits by students

- International Participants along with the coordinators of Life Academy, Sweden on 1st November 2013.



Life Academy Participants

- First year Information Technology students along with their staff from Sathyabama University, Chennai on 25th October 2013.
- First year Information Technology students along with their staff from Sathyabama University, Chennai on 5th November 2013.
- Participants of International Training programme on "Best Practices in Power Distribution Sector" organized by Central Institute of Rural Electrification, Hyderabad on 8th November 2013.

Advances in

SRRA

- Site visit for micro siting for phase-II project were taken up in Uttarakhand, Assam, Arunachal Pradesh, West Bengal, Meghalaya, Lakshadweep, Kerala, Tripura, Gujarat, Andhra Pradesh, Maharashtra (SRRA and MEDA project) and micro siting for relocation of SRRA stations for Phase-I project in Rajasthan.

The following SRRA stations were commissioned under phase-II program:

Sl. No.	State	Stations	Date of Commissioning
1	Uttar Pradesh	Sultanpur	03/10/2013
2	Uttar Pradesh	Moradabad	05/10/2013
3	Chattisgarh	Ambikapur	07/10/2013
4	Uttar Pradesh	Banda	10/10/2013
5	Uttar Pradesh	Kanpur	13/10/2013
6	Bihar	Aurangabad	25/10/2013
7	Maharashtra	Osmanabad	01/12/2013
8	Jharkhand	Ranchi	02/12/2013
9	Madhya Pradesh	Indore	06/12/2013
10	Maharashtra	Nanded (MEDA)	08/12/2013
11	Maharashtra	Aurangabad (MEDA)	12/12/2013
12	Odisha	Bargarh	13/12/2013
13	Madhya Pradesh	Khandwa	14/12/2013
14	Maharashtra	Pune (MEDA)	18/12/2013
15	Odisha	Koraput	20/12/2013
16	Maharashtra	Wardha	23/12/2013
17	Maharashtra	Nashik	26/12/2013
18	Odisha	Bhubaneswar	29/12/2013
19	Maharashtra	Bhandara	30/12/2013

- Calibration laboratory of SRRA was set up at C-WET.
- Prepared global tender documents for procuring satellite data maps and data products.
- Dr. Satish Balram Agnihotri, Secretary, MNRE inaugurated the SRRA Calibration Laboratory and released new SRRA brochure on 23rd December 2013.



Inauguration of SRRA calibration laboratory & Release of SRRA Brochure

Launch of ESD UNIT

- Purchase of New EPABX system to replace the present system. Work order has been issued to the supplier and new EPABX system has been received, commissioning in progress.
- A committee constituted for the establishment of a surveillance system in C-WET campus, various proposals from various suppliers have been scrutinized. Finalization of the technical specification is completed and purchase process initiated.
- Purchased a new 20 kVA UPS & batteries, installed and working satisfactorily.
- Installation of sewage water treatment plant work is under process.

Invited lecture delivered / meeting attended by C-WET Scientists in external forums

Dr. S. Gomathinayagam, Executive Director

- Meeting for Procurement of 2 new Wind Turbine on 20th December 2013.
- Chaired Prototype meeting on 19th December 2013.
- Wind Resource Assessment of 500 stations meeting with NCEF on 18th December 2013.
- Guest of Honor at KCG Engineering College on 12th December 2013.
- Co-Chaired Asia Pacific Conference on Wind Engineering (APCWE-8) organized by CSIR-SERC during 11th to 13th December 2013 & delivered lecture on "Wind Power-The way Forward in India" & chaired a Session on Wind Energy Application (WEG-2).



- Offshore Wind Power Development Meeting at ONGC Mumbai on 29th November 2013.
- Standing Committee on Energy 2013-14 Examination of the subjects "Firming up of Potential capacity in NRE sector and meeting funds requirements thereof" on 27th November 2013.
- Standing Parliamentary Committee on Energy at Madurai during 9th to 12th November 2013.
- 15th National Convention-Power Tech India 2013 at Mumbai on 8th November 2013.
- "Wind Power Development in India – Way Forward" for Life Academy Members at C-WET on 1st November 2013.
- Presentation in "Offshore Wind Power Development" at MNRE Delhi on 30th October 2013.
- Small Wind Turbine Empanelment meeting on 29th October 2013.
- Steering Committee Meeting of TEDA on Renergy 2014 on 25th October 2013.
- Workshop on Under Water Technologies-2013 at NIOT on 21st October 2013.
- Discussion of Project Proposal on "Demonstration of Grid Interactive Sustainable Wind Hydrogen Power System" at Electrical Research & Development Association (ERDA), Vadodara on 9th October 2013.

Rajesh Katyal

- Discussion of project proposal on "Demonstration of Grid Interactive sustainable Wind Hydrogen Power System" at Electrical Research and Development Associations (ERDA), Vadodara on 9th October 2013.

David Solomon

- Presented the status of documentation and Manufacturing facility of Pawan Shakthi PS-1800 KW (HH 80 m / 100 m) wind turbine model to the RLMM committee.

K. Boopathi

- Wind Resource Assessment and implementation of 500 nos. of 100 m level WMS meeting at MNRE, New Delhi on 18th December 2013.
- Co-chaired one of the session of Asia-Pacific Conference on Wind Engineering (APCWE-VIII) during 11th to 13th December 2013.
- Imparted hands on training for ANERT officials at Palghat on 23rd November 2013.
- Technical Evaluation Committee Meeting at M/s. ANERT, Kerala on 22nd November 2013.
- Parliamentary Standing Committee Meeting at Madurai and visited 100 m mast at Dhanushkodi along with MNRE officials (Advisor, Wind Energy & Director Wind Energy) during 9th to 12th November 2013.
- Offshore Wind Energy Assessment Meeting at MNRE, New Delhi on 30th October 2013.
- Review Meeting of Wind Resource Assessment Programme for the North East Region including Sikkim at Guwahati during 15th to 17th October 2013.

- Prebid Meeting for proposed 25 MW Wind farm Projects at M/s.RITES, Gurgaon on 3rd October 2013.
- Visited Ennore Port Trust for site selection of R & D Project.

A.G. Rangaraj

- Asia Pacific Conference on Wind Engineering (APCWE-8) organized by CSIR-SERC from 11th to 13th December 2013 & presented a paper on "A study on influence of a ridge on mean wind speed and turbulence intensity".
- Presented the status of documentation and Manufacturing facility of Pawan Shakthi PS-1800 KW (HH 80 m / 100 m) wind turbine model to the RLMM committee.
- Visited Ennore Port Trust for site selection for R & D Project.

J. Bastin

- Visited Ennore Port Trust for site selection for R & D Project.
- Imparted hands on training for ANERT officials at Palghat on 23rd November 2013.

B. Krishnan

- Imparted hands on training for ANERT officials at Palghat on 23rd November 2013.

S.A. Mathew

- Chaired the R&D Meeting for Electrical & Electronics Engineering for innovative research proposals at VelTech Dr. RR & Dr. SR Technical University, Chennai on 6th October 2013.

A. Senthil Kumar

- "Offshore Wind Power in India" chaired by Secretary, MNRE, at Chennai on 24th December 2013.
- Asia-Pacific Conference on Wind Engineering (APCWE-VIII) at Chennai during 10th to 14th December 2013.
- Discussion with Canadian team along with Mr. Sylvian Charnonneau, Executive Vice President, Group Composites VCI at C-WET on 29th November 2013.

P. Kanagavel

- Chief Guest and delivered lecture on "Overview of Wind Energy" in the "AICTE Sponsored National Level Technical Seminar on Power Electronics Applications in Renewable Energy Sources" at Mailam Engineering College on 19th December 2013.
- "Overview of Wind Energy Technology and its Status" organized by Energy Club at Manakula Institute of Technology, Pondicherry on 15th November 2013.
- "Wind Energy: An Comprehensive overview" at Sri Venkateswara College of Engineering on 19th October 2013.
- Discussion with SNA officials for exploring the possibility of conducting training programmes in North East Region at Guwahati / Shillong and attended the WRA/NE meeting at Guwahati during 15th to 17th October 2013.



- Chief Guest for the One day National level Technical Symposium "EMERGE-2K13" organized by Valliammai Engineering College, Chennai on 12th October 2013.
- "Challenges & Research Opportunities in Renewable Energy" at Sri Sai Ram Engineering College, Chennai on 8th October 2013.

G. Giridhar

- Technical Committee Meeting of SRRA under the chairmanship of Joint Secretary, MNRE at MNRE, New Delhi on 16th December 2013.
- Indo-German Meeting on 13th November 2013 at Delhi.
- "Planning for Wind Power Training" at Chennai on 30th October 2013.
- Discussion with MNRE officials in connection with the setting up of calibration laboratory at SEC/NISE, New Delhi during 7th to 9th October 2013.

- Lecture in Sairam Engineering College on 4th October 2013.
- Lecture in SSN College of Engineering on 3rd October 2013.

Prasun Kumar Das

- Technical Committee meeting of SRRA under the Chairmanship of Joint Secretary, MNRE at MNRE, New Delhi on 16th December 2013.
- Technical Committee meeting in Agricultural Engineering Department, Chennai for technical evaluation of tender bids received for supply of Solar water pumping system on 3rd December 2013.

M. Anvar Ali

- "Renewable Energy Sources and Grid Integration Issues" at Shri Vishnu Engineering College, Bhimavaram, Andhra Pradesh on 27th December 2013.

Publications

Rajesh Katyal & Dr. S. Gomathinayagam, Offshore Wind Power Development in India - Its Future, Inwind Chronicle Magazine of Indian Wind Energy Association, New Delhi.

Visits Abroad

Dr. S. Gomathinayagam, Executive Director, visited UK in connection with the training at UK India collaboration on "Off-Shore Wind Power Development in India" during the period of 29th September to 4th October 2013

The following C-WET staffs delivered lecture(s) in the 15th National Training Course on "Wind Energy Technology" held during 27th - 29th November 2013

S.No.	Topic	Speakers
1	* Introduction and Status of Wind Energy Technology	P. Kanagavel
2	* Wind Turbine Components	J. C. David Solomon
3	* Wind Turbine Gearbox	Rajkumar
4	* Wind Electric Generators & Types	S. Arulselvan
5	* Wind Turbine Tower Concepts	Dr. S. Gomathinayagam
6	* Wind Turbine Foundation Concepts	Rajesh Katyal
7	* Type Certification of Wind Turbines	A. Senthil Kumar
8	* Wind Turbine Testing	S. A. Mathew
9	* Wind Resources Assessment & Techniques	K. Boopathi
10	* Post Installation Activities - Grid Integration	Deepa Kurup
11	* Control and Safety System of Wind Turbine System	S. Arulselvan
12	* Role of C-WET in Wind Energy Development	P. Kanagavel
13	* Small Wind Turbines And Hybrid Systems	Rajesh Katyal
14	* Indian Government Policies and Schemes	Dr. G. Giridhar

New Staff Recruitment



Mr. M. Joel Franklin Asaria

Scientist 'D' from MNRE deputed in WRA Unit with effect from 2nd December 2013.



Ms. M.C. Lavanya

has been newly appointed as Scientist 'B' in WRA unit with effect from 16th December 2013.

Visitors to C-WET

Dr. Partha P Sarkar of Iowa State University, USA visited C-WET during 3rd to 6th December 2013 and interacted with C-WET scientists on various technical and collaboration possibilities. He has also shared his knowledge and research facilities available in his research laboratory with C-WET staff and also delivered a series of lectures for the benefit of C-WET scientific community on “Overview of Research in Wind Engineering and Wind Energy” and “Experimental Techniques as applied to Aero-Elasticity”.



Dr. Partha P Sarkar discussing with C-WET staff

Dr. Sathish Balram Agnihotri, Chairman GC & Secretary, MNRE has visited C-WET on 23rd December 2013 and given inspiring addressed to all C-WET Staff members. The Executive Director explained all the activities and services of C-WET apart from showcasing the campus facilities. Shri. Alok Srivastava, Joint Secretary, MNRE, Shri. Sudeep Jain, Chairman and Managing Director, Tamil Nadu Energy Development Agency and Shri. Dilip Nigam, Director, MNRE was also accompanied with Secretary during his visit to C-WET.





WIND SOLAR PV HYBRID

J.C. DAVID SOLOMON

Scientist, Research & Development Unit, Centre for Wind Energy Technology, Chennai Email : david@cwet.res.in

India has raced past 232 GW of total installed power producing capacity and yet meeting the increasing energy demand seems to be an utopian act. Every muscle summoned, every policy possible pushed yet we find ourselves in need. Every problem has a solution, big doors are conquered by pint sized keys. A country like India sitting on the equator is blessed geographically to have the most from the sun and its different flavours of energy patterns on ground. That will be our solution. Air set in motion as winds due to the temperature gradients because of solar heat absorption and solar radiation itself directly harvested for electricity have been in use for long but in a stymied way. With the deficit nature of power management prevalent in the country, solar & wind harvest has again come into vogue with a vigour. Countries across the globe have programs to support ingress of power generated by wind and solar into their networks either as grid tied or stand alone projects. Wind & solar power plants work comfortably both in tandem or as separate entities. A hybrid system of wind solar have found many takers in off-grid application due to their capability to complement one another in battery charging and has been rolled out as the power supply unit to many isolated hamlets in remote locations to which the grid has not yet reached. In this article some facets of such a hybrid system will be ruminated.

Site Selection

Intermittent natural energy resources and the seasonal unbalance of energy resources are the most important reason to install a hybrid energy supply system. The solar PV-wind hybrid system suits to conditions where sun light and wind has seasonal shifts i.e., in summer the daytime is long and sun light is bright enough, while in winter the days are shorter and there are more clouds, but there is usually an increased wind resource that can complement the solar resource.

The solar PV-wind hybrid systems especially suit the remote location, which is inconvenient or expensive to use conventional grid supplies. The common type is connecting with battery storage. For PV array, a location without any obstacles facing the sun is needed. For the wind turbine, appropriate wind speed and wind direction are key elements to the whole system. The turbine should be mounted higher than nearby obstacles like trees and buildings and without other obstacles. Enough space is

needed to fix the PV modules, wind turbine tower with its guy wires.

According to a study released by the Reiner Lemoine Institut and Solarpraxis AG, Combining wind turbines and photovoltaic systems results in up to twice the amount of electricity being generated across the same surface area, while shading losses caused by wind turbines amount to a mere 1 to 2% – much less than previously thought. Various scenarios were simulated for the study and detailed shading analyses were carried out.

Working

The main components of the Wind-Solar PV Hybrid System are wind aero generator and tower, solar photovoltaic panels, batteries, cables, charge controller and inverter. The Wind -Solar Hybrid System generates electricity that can be used for charging batteries and with the use of inverter we can run AC appliances. Wind aero generator is installed on a tower having a minimum height of 10 m from the ground level. Wind aero generator starts generating power cut-in wind speeds as low as of 3m/s. Most of the aero generator models generate three phase AC power, which is converted into DC through the charge controller. The solar photovoltaic panels generate DC power, which is connected to the charge controller. The generated DC power is then stored in the battery bank. The batteries require minimum maintenance and their life is around 4-5 years. The stored power of the batteries is connected to utility through pure sine wave inverters, which converts D.C. power into A.C.. Various instruments are incorporated in the system for controls, safety and indication. The energy meter displays power generated and dissipated. Necessary precautions are taken to protect the aero generator from damage due to excessive wind speed. Both the aero generator and PV system are regulated through control module to control battery charging. Over charging and deep discharge of batteries are regulated in the control module and overcharge is diverted into DUMP LOAD for protection. Electricity stored in the battery is converted into AC through inverter and is utilized for local loads like light, fan etc. The hybrids come in different capacities ranging from 400 Watts to 10 kW . On clear sunny days, the system will produce about 3.0 units per kW of the installed capacity. However, it depends on the wind speed and solar radiation available at the particular site.

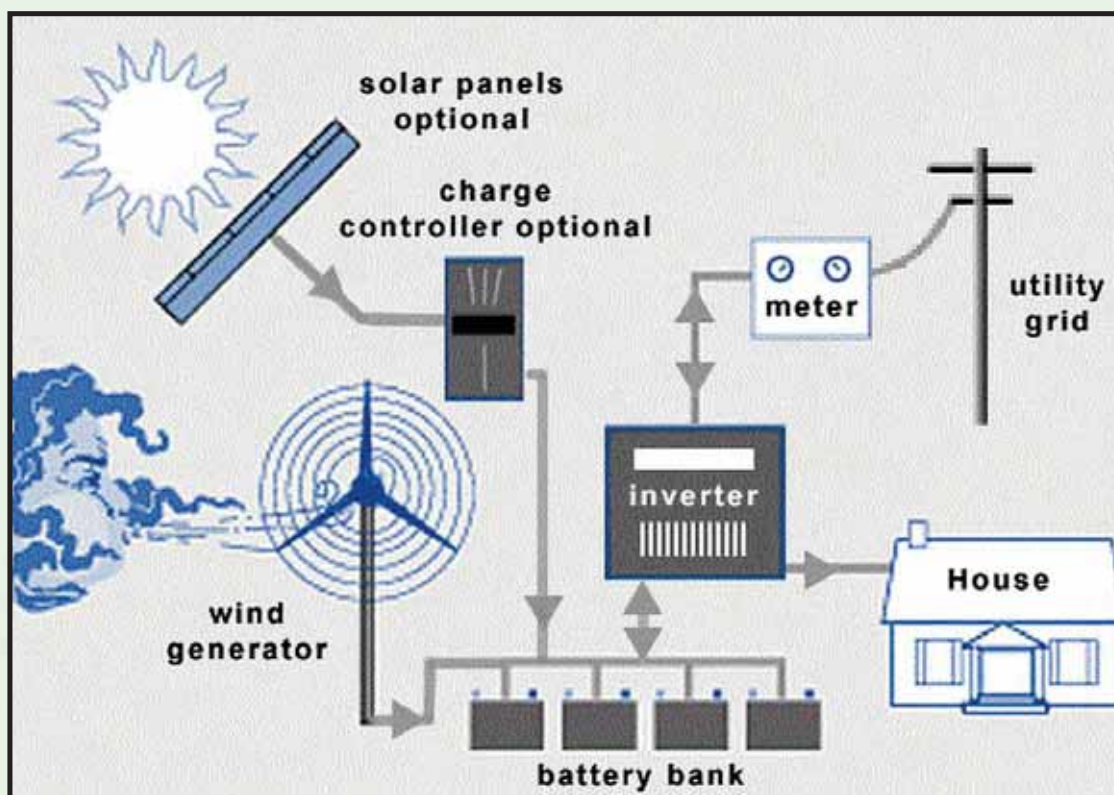


Fig: Model off-grid Wind Solar PV Hybrid system

Solar PV Array

A number of PV panels connected in series and or in parallel giving the required DC output from the available irradiance. Orientation and tilt of these panels are important design parameters, as well as avoiding as much shading as possible from surrounding obstructions. A typical PV module measures about 0.5 square meters (about 1.5 by 3.5 feet) and produces about 75 watts of DC electricity in full sun. The PV modules mounting can be a ground mount that works either on rooftops and mostly are angle-adjustable so that PV array will face the sun as near to perpendicular as possible. Many adjust their mounting racks two to four times a year to get maximum exposure as the sun changes its angle during seasons. Or if the rooftop has a good angle to the sun, the modules could be mounted solidly to the roof without an adjustable rack. Trackers are another PV mounting option, which are pole mounts that automatically adjust themselves so that the PV could face the sun throughout the day.

Aero generator

The aero-generator is mostly a two bladed or a three bladed system. the blades are made of carbon fibre to reduce weight and fixed on a hollow drum whose internal structure

houses the magnets. this forms the rotor of the turbine and is mounted around a stator winding. When the wind flows over the blades, due to aerodynamic action on the blade surface a lift is generated which turns the blades and produces the needed torque with rising wind. the magnetic field due to the magnets in the rotor tend to get cut by the stationary stator windings and the resultant emf in the winding flows out to the charge controller as AC power. At the charge controller the AC variable frequency power is converted into DC power as per the charge state of the batteries and gets the batteries charged, any excess power that cannot be accommodated in the batteries are diverted to the dump load and burnt off as heat.

Hybrid controller & Battery Bank

The system is centrally controlled by Charge control unit, (CCU) which requires no manually interaction. Charge controller regulator prevents the PV array and wind turbine from over- charging the battery. Most modern controllers maintain system voltage regulation electronically by varying the width of DC pulses they send to the batteries (this is called pulse width modulation or PWM). This means the wider the pulse; the more power goes to the batteries. A new generation of PV controllers has a feature called 'MPPT' the "Maximum Power Point Tracking." They take



advantage of the maximum power available in the module by adjusting current and voltage. Battery bank can be a single battery or multiple batteries connected together to create essentially one large battery of the required voltage and amp-hour capacity. The battery configuration and capacity are the most important electrical power decisions that have to be made, and a wise choice in this regard can help guarantee a steady supply of electrical power as well as a system that is simple to operate and maintain. Most batteries employed in RE systems use the lead-acid batteries typically encased in plastic. However, batteries do not belong inside the living space due to the dangerous chemicals in them and hydrogen and oxygen gas put out while being charged. Battery capacity is rated in amp-hours, which 1 amp-hour is the equivalent of drawing 1 amp steadily for one hour. A typical 12-volt system may have 800 amp-hours of battery capacity. This is the equivalent of 1,200 watts for eight hours if fully discharged and starting from a fully charged state. There are many brands and types of batteries available for RE systems

Converter Inverter

They change low voltage direct current (DC) power, which is produced by the PV or wind turbine charge controller or stored in the battery into standard alternating current (AC) house power that is 230 VAC, 50 hertz. The modern sine wave Inverters supply uninterruptible power. The inverters come in sizes from 250 watts to over 8,000 watts. While there are also modified sine wave inverters that are cheaper but can still handle most household tasks. The better sine wave inverters have made great strides in performance and price in recent years. Inverters can also provide a utility inter-tie between your system and the utility grid, allowing you to sell your excess energy to the utility for distribution by their grid. Many inverters also have built-in battery chargers to keep the batteries topped off from the grid or diesel generator.

Safety Philosophy & equipments

It includes over-current and lightning protection components. Over-current protection components such as fuses and fused relay switches protect the system's wiring and components in the event of short circuits. Fusing

protects from over-current situations, and disconnects allow safe shutdown of system components for maintenance and repair. Fuses and fused disconnects are rated by the amount of current they can handle. They may be as small as a few amperes for supplying metering to as large as 400 amperes for supplying the inverter. Many renewable energy systems are in areas where thunderstorms and lightning are common, especially; the wind turbine is always the highest building in the remote area. Commercial lightning arrestors are available to help protect RE system electronics against the lightning.

Meters and instrumentation

They can help owners keep track of important things like the battery voltage, the amount of power they are currently consuming, the state of charge in their batteries and also how much electricity traffics between their own supply systems to the utility grid for grid connection situations. Some meters have more than one channel to monitor two battery banks or a battery bank and a generating source for the hybrid systems.

Conclusion

Wind Solar Hybrid has a major role to make up our energy deficit. So keeping the technology simple and low cost by indigenous production would go a long way in both creating more energy for the common populace as well as create a large trickle down of money in the local economy. In our country where the shortage of power is pushing policy makers to include renewables by all means whereby we are bundling solar power with thermal power for levelising the cost, provide Venture Gap funding for making such project a reality and give generation based incentive for solar projects, more push needs to be given to off-grid Wind PV hybrid systems to keep distributed power generation strong and less burdensome on the central grid. In the breath, we also need to take useful inferences from developed countries like Germany who have now moved ahead to cap the maximum production from renewables at 45% by 2025. Lessons have to be learnt from the experiences of pioneering countries like Germany and necessary amends made in Indian to keep the renewable markets from pitfalls and going by all means.



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