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EDITORIAL



An eventful quarter, in terms of number of professional, official, industrial as well as academic meetings, seminars, symposia, and national and international conferences and exhibitions on renewable energy some specific to wind energy. All the deliberations

point to a single issue of power crisis, in the people packed India. What is most needed is the synergy of people, people in power, people who implement power projects. Literacy is very much up in the recent census of India, but even amidst the educated people there is a need for awareness creation. There needs a mass movement in educating people on the issues of local energy source identification, energy generation, energy conservation, excess energy storage/sharing, energy portability, energy sustainability in the long run. Such a mass attitudinal shift in peoples mind-set is possible to be highly influenced by people in power; of course they could be political, administrative, scientific, social etc., but there should be sustained focus and follow through on solving energy issues with a strong political and societal will. The last key drivers are the people who implement power projects; remember they need not be always Governments, company owners, corporate giants, independent power producers or public sectors it can be every individual who has a vision to innovate affordable systems using locally dominant energy resource and implement the same through micro generation for captive-usage and for possible sharing/distribution to the needy. Wind is everywhere and we have a long coast line and sea-breeze and land-breeze is certainly part of diurnal cycle of atmospheric convection. Even in urban environment, tall buildings are known to generate pedestrian winds around the buildings which are measured to be many times more powerful than the natural flow without the building in place, a scope for generating the campus lighting. When it comes to roof top systems the choice of right type of machine and right location in the building are key to the success of useful generation, since the flow around & above is not the normal prediction of wind speed/direction distribution, it would be highly influenced by building aerodynamics and the neighborhoods. Often in India a combination of Solar and Wind on the roof tops will be quite effective to meet low voltage applications of home needs. Every single unit generated or saved by billion individuals in whatever source they tap is certain to provide the energy security and sustainability.

C-WET with its vision and mission is moving in the right direction to sustain its research and consultancies, amidst growing competition from business starved MNCs in India using special offers to clinch some of the excellent time tested reliable technical services of C-WET, inspite of increased attrition rates. R&D unit is at the verge of coming out with useful studies on power evacuation and power quality of grid connected systems. It's experience in small wind turbine testing is certain to gear up the industry to come up with quality systems which customer acceptable performance. WRA unit records the dedicated long services of Dr. E. Sreevalsan, who made C-WET to reach the current level of excellence in the industry. Activities at WRA are however sustained in establishing 12 new wind monitoring stations, operating 89 stations in 20 states while continuing its verification and value added consultancy projects. The unit is also busy preparing for the offshore measurement of Rameswaram and the national level re-assessment at 80m level for validation. The Wind Turbine Testing (WTT) division is busy instrumenting while getting ready to use optimally its resources in multiple projects. Wind Turbine Research Station (WTRS), Kayathar has kept up O&M and farm infrastructure prepared for wind season of 2012. S&C unit coming out of the transition of draft wind power policies is on the normal course of renewal-certification, RLMM evaluation and has released the RLMM Addendum-II list as planned. The ITCS unit has successfully trained 26 African nationals under a special MEA program and coordinated several technical visits and exhibition displays. SRRA unit has commissioned its Level-2 server for data quality analysis and automated reporting. With the assistance of GIZ the algorithms have been implemented for automatic processing of all the 51-stations data.

Scientists of C-WET have been very active in their technical contributions in various forums enhancing the impetus and needed push for Wind energy/Solar energy technology research specific to Indian conditions.

As usual I request the readers to mail us your valuable, sincere and constructive feed backs to lead us to serve you better. Without the industry spearheading innovation through networking with C-WET, it cannot sail smooth long. Please come forward spell your need C-WET is there to find you a solution.

S. Gomathinayagam
Executive Director

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Developments in R&D UNIT

Power Evacuation Studies for Grid Integrated Wind Energy Conversion System

Power evacuation of grid integrated wind energy conversion system is one of the major issues faced by both the Wind turbine industry and Utility, particularly in the Tirunelveli circle in Tamilnadu which has a high concentration of wind farms. Significant progress has been made in this project which aims at identifying the weak links in the transmission lines through short circuit analysis. The weak buses in the 44 dedicated sub stations have been identified and studies will be carried out on strengthening the transmission system and enhancing the power evacuation with Thyristor Controlled Series Capacitor / VSC based HVDC link. The project is likely to be completed in August 2012.



Power Evacuation Studies

Testing of Small Wind Turbine at WTRS

C-WET is gearing up to undertake testing of Small Wind Turbines in the current windy season. Six new assignments will be taken up. Two such assignments are already underway. Turbine capacities ranging from 1.4 kW to 10 kW will be undertaken for type testing.

Model of Small Wind Turbine to be installed at WTRS, Kayathar



HRD Project: Post graduate Diploma programs at Amrita

Activities have been initiated towards Post Graduate Diploma programmes on Wind Power Development and Wind Resource Analysis at Amrita College of Engineering, Coimbatore. Lab equipment for developing a Wind Energy Centre are under procurement under this programme. The courses commenced in August 2011. The two semesters are of 9 months duration of which the first semester has been completed and the second semester is scheduled to be completed in May 2012. The intake is 15 candidates per batch. 5 candidates have been placed at the end of first semester.



HRD Programs in Amrita Engineering College, Coimbatore

Move on in WRA UNIT

Twelve new Wind Monitoring Stations have been established, 10 stations in Karnataka, 2 stations in Kerala. Presently, 89 wind-monitoring stations are operational in 20 States and one Union Territory under various wind monitoring projects funded by the Ministry of New and Renewable Energy as well as various entrepreneurs.

Projects on Verification of procedure of wind monitoring have been done for the following sites.

- Jath-2, Kottalapalle, Dorigallu, Guddepanchani-II, Ramgiri-I, Humbarane Yadiki Pholadi, Kaputrala and Katrimalafor M/s. Suzlon Energy Ltd, Pune.

- Pingarala for D.J Energy Pvt Ltd New Delhi.
- Dangri and Rajgarh for M/s. Inox Renewables Limited, Noida.
- Bhud Phase -2 and Pungamattur for M/s. ReGen Powertech Pvt Ltd, Chennai
- Akal for M/s.RRB Energy Ltd, Chennai
- Mithapur for The Tata Power Company Limited, Mumbai
- 6 sites in from Maharashtra for M/s. Maharashtra Energy Development Agency, Pune.

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

- Detailed Project Report for 8 MW wind farm in Bidda, Riase District, Jammu & Kashmir for M/s. NHPC Limited, Faridabad.
- Wind Power Density (WPD) at 50 m amsl at Yelmarwadi area in Satara District, Maharashtra.
- Wind resource assessment at Chippinikeri, Chitradurga District in Karnataka for M/s. Nuziveedu Seeds Limited, Hyderabad.
- Feasibility report on site assessment for wind monitoring studies in Uttar Pradesh for M/s. THDC India Limited, Rishikesh.
- Wind Power Density (WPD) at 50 m amsl at Revangao site in Maharashtra for M/s. Vestas Wind Technology India Private Limited, Chennai.
- Wind Resource Assessment at Purakkad, Alappuzha District, Kerala for M/s. Infopark, Kochi.

SNA Meeting

Review meeting on Wind Resource Assessment programme for the State Nodal Agencies in North East region, Jammu & Kashmir, Kargil & Ladakh were held during 9th - 10th February 2012.



Review meet in progress



SNAs officials in C-WET campus progress

Steps forward in TESTING UNIT

- An Inter Laboratory Comparison (ILC) on Power curve measurement has been completed by the unit with NREL, USA as per the requirements of IEC 61400-12-1.
- An agreement was signed between C-WET and M/s. Elecon Engineering Company Limited for Type Testing Elecon 600 kW wind turbine and measurements are expected to start during the windy season of 2012.
- An agreement was signed between C-WET and M/s. Jyoti Limited for Type testing of WIND JYOTI – SE 850 – 56 / 70 KW wind turbine and measurements are expected to start during the windy season of 2012.

Windy Acts at WTRS UNIT



- Infrastructure of test bed and C-WET's Wind farm is under constant up keep.
- O&M for 200 kW wind turbines including bearing replacement is in progress.
- Several technical visits to WTRS are coordinated and the following are the specific visits:
 - Hindi Advisory Committee's visit and discussion completed.
 - 8th International training course participants from African Countries
 - LIFE Academy / SIDA, Sweden delegation visit.

Marching ahead in S&C UNIT

- Agreement has been signed with M/s. Southern Wind Farms Limited for renewal of Certificate of GWL 225 wind turbine model under Category-III as per TAPS-2000 (amended). Carried out review / verification of documentation for renewal of Certificate of GWL 225 wind turbine model. Based on the review, renewal of Certificate has been completed and renewed Certificate has been issued to M/s. Southern Wind Farms Limited.

- Initiated activities in connection with renewal of Certificate of V 39 -500 kW with 47m rotor wind turbine model under Category – II as per TAPS – 2000 (amended).
- The process for next issue of RLMM Addendum – II to the "MAIN LIST dated 22.06.2011" has been initiated. Documentation / information have been obtained from various wind turbine manufacturers. Review / verification of documentation / information have been completed. Carried out verification of adequacy of manufacturing facilities in connection with RLMM. Organized RLMM Committee meeting. RLMM Addendum – II list to the "MAIN LIST dated 22.06.2011", finalized by RLMM Committee has been issued on 19.03.2012.
- The continual improvement and maintaining the Quality Management System are ongoing.
- Review of draft Indian Standards on Wind turbines circulated by Bureau of Indian Standards are under progress.

Highlights from ITCS UNIT

Eighth International Training Course

The ITCS unit had successfully organised the Eighth international Training course on "Wind Turbine Technology and Applications" during 1st – 24th February 2012. This is a special course for African Countries sponsored by Ministry of External Affairs (MEA), Government of India and Supported by Ministry of New and Renewable Energy, Government of India. Twenty Six participants from 11 African countries attended the course. The participants were from Burundi, Congo, Ethiopia, Mali, Mauritius, Mozambique, Niger, Nigeria, Sudan, Tanzania and Zimbabwe.



K.P.Sukumaran inaugurating the course

Dr. S. Iniyan distributing the course certificate

The training course was inaugurated by Shri K. P. Sukumaran, National Project Manager, UNDP, Former Advisor, MNRE & former Executive Director, C-WET.

The course content for the training was very comprehensive syllabus with experts in various fields giving lectures and specific case studies. Practical training with wind resource assessment, instrumentation, Testing equipment, R&D equipment was made available and factory visits to M/s Suzlon Energy Limited at Pondicherry, M/s Leitner Shriram Manufacturing limited, Chennai and Structural Engineering Research Centre, Chennai were arranged.

The course structure and organization of training was highly appreciated by the participants. The participants were very much satisfied by the quality of lectures and hospitality they found in India and the feedback from the participants reflected the need for more number of training programme like this frequently.

Dr. S. Iniyan, Professor & Director, Institute for Energy Studies, Anna University, Chennai was the Chief Guest for the Valedictory function and he had been kind enough to distribute the course certificate to the participants.

Participation in the Exhibitions

C-WET has put up a stall during the following events and disseminated information on C-WET activities & services and also created general awareness on environment friendly wind energy among the public.

- 99th INDIAN Science Congress 'Pride of India' Exhibition held during 3rd to 7th January 2012 at Bhubaneswar, Odisha.



- 3rd International Conference and Exhibition organized by Indian Wind Power Association is (3rd WE 20 by 2020) scheduled during 5th - 7th February 2012 at CODISSIA, Coimbatore.



Shri G.B. Pradhan, Secretary, Ministry of New and Renewable Energy, Government of India is addressing the gathering during International Conference & Expo on Renewable Energy (RENERGY 2012) held at Chennai Trade Centre, Chennai during 12th - 13th March 2012 organised by Tamil Nadu Energy Development Agencies (TEDA), Chennai. Dr. Gomathinayagam, Executive Director, C-WET made presentation on "WIND POWER: INFIRMITY or SUSTAINABILITY?".



Visitors to the Campus

During the period from January to March 2012, the following visits were arranged. A brief presentation about basic wind energy and C-WET activities and services were made for student visitors and the campus facilities were also showcased. The visitors were students, delegates from foreign countries and stakeholders.

- Students of Wind Power Development Department from Amrita University, Coimbatore on 11th January 2012.
- Students of EEE Department from Velammal Engineering College on 19th & 20th January 2012.
- 65 & 67 students from EEE Department of Eswari Engineering College on 14th & 12th February 2012.
- Students of EEE Department from Panimalar Institute of Technology, Chennai on 16th February 2012.
- 68 students of EEE Department from Muthammal Engineering College on 19th February 2012.
- 21 Participants of LIFE Academy, Sweden as part of the Wind Power Development and Use - Regional Phase in India along with 3 coordinators on 29th February 2012.
- Students of EEE Department from SRR Engineering College on 21st March 2012.
- 60 Students of EEE from Hindustan University on 23rd March 2012.
- 3 batches of 52 students of EIE Department from Sathyabama University, Chennai on 26th, 28th & 30th March 2012.

Shri. Tarun Kapoor, Joint Secretary (Wind Energy), MNRE visited C-WET

The Joint Secretary (Wind Energy), MNRE, Shri. Tarun Kapoor visited C-WET on 16th of February 2012. He had a meeting with the Executive Director and all Unit Chiefs. All the Unit Chiefs made presentations highlighting their respective unit's activities and progress since the beginning of C-WET and later the Joint Secretary visited various infrastructure & facilities available in the campus. He has also visited Solar Radiation Resource Assessment (SRRA), expressed his appreciation for C-WET's effort so far and offered his valuable suggestions towards the future development.



Other Activities

Upgrading the infrastructure for good research environment in C-WET by providing IT & Training facilities and also reaching

out to the public as well as industries to promote wind energy in the country, managing library, compiling information for Newsletters, updating websites and maintaining IT infrastructure, ensuring e-security in the campus by regular monitoring and taking proactive steps, are some of the other routine/special activities of ITCS unit.

Advances in SRRA

Level-2 server has been established in Central Receiving Station (CRS) for quality assessment of recorded data for all the 51 stations under Solar Radiation Resource Assessment Project. The quality assessment has been completed and reports of quality assessed data have been generated using Matlab. In this context, the constructive international collaboration of MNRE / C-WET – GIZ, Germany is worth mentioning, which ultimately aims to develop SolMap of India. Project proposal for establishment of additional 60 SRRA stations is prepared and submitted to MNRE.

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

Dr. S. Gomathinayagam
Executive Director, C-WET

- "WIND POWER: INFIRMITY or SUSTAINABILITY?" organized by RENERGY 2012 at Chennai Trade Centre on 12th March 2012.
- Invited talk in the International Conference on RE Resources for 21st century- Amrita Engineering College Coimbatore on 9th March 2012.
- Chief Guest for the Work Shop on Recent Trends in RE on 3rd March 2012 organized by Institute for Energy Studies, Anna University, Chennai.
- Chaired the Technical Committee on Offshore held at C-WET on 2nd March 2012.
- Discussion on Parliamentary Standing Committee Meeting & Detail plan for reassessment of WRA at 100 m at MNRE on 1st March 2012.
- TEDA Press Meet on RENERGY 2012 on 29th February 2012.
- "Wind power development in India - way forward" in the Regional Phase of the International training course on "Wind Power Development and Use" organized by LIFE Academy, Sweden at Hotel Raj Park, Chennai on 29th February 2012.
- "Impact of Wind Energy in today's overall Indian Energy Scenario" at National Symposium on Energy Resources, Environmental Impacts & Industrial Waste Management at Sri Venkateswara University, Tirupati on 27th February 2012.
- "Offshore Wind Energy Turbine Technology" at IIT Madras at Department of Chemical Engineering on 21st February 2012.

- Offshore Technical Committee meeting at C-WET on 21st February 2012.
- Tamilnadu Scientists Awards Committee at Directorate of Technical Education (DOTE), Chennai on 20th February 2012.
- "Environment Control-Action Plan" meet organized by Tamilnadu Pollution Control Board, Chennai on 17th February 2012.
- 60th Governing Body Meet - TEDA on 16th February 2012.
- "Recent Trends in Wind Energy Technology" at Cape Institute of Technology - Levingipuram for the One day National Seminar on Opportunities & Challenges in Renewable Power Generation" on 10th February 2012.
- Chaired the Session on "WTG Technology" in the 3rd International Wind Conference & Exhibition WE20 by 2020 during 5th – 7th February at Codissia Trade Fair Complex, Coimbatore.
- Clean Energy Ministerial Conference meet at India Habitat Centre, Delhi on 1st February 2012.
- "Wind Power Technology & Development" at the One day Seminar on "Recent Trends & Development in Wind Energy organized by Hindustan University, Chennai on 25th January 2012.
- Presentation to Parliamentary Standing Committee meeting on Energy at Cochin during 6th - 8th January 2012.

Research & Development

Rajesh Katyal, Scientist & Unit Chief

- Chief Guest & Keynote address at Kumaraguru College of Technology, Coimbatore for their Innovative in Electrical and Electronics and Control Systems – IEECONS-12" on 30th March 2012.
- "Small Wind Turbine Testing and Hybrid System" at a workshop on Renewable Energy organized by Sai Ram Engineering College on 24th February 2012.
- Parliamentary Standing Committee meet on Energy at Cochin during 6th - 8th January 2012.

Deepa Kurup, Scientist

- "Grid integration of wind turbines" at Hindustan University on 25th January 2012.

Wind Resource Assessment

Dr. E. Sreevalsan, Scientist & Unit Chief

- Meeting with Scientists of Lawrence Berkeley National Laboratory, USA regarding issues on "Wind power development in India" at MNRE, New Delhi on 06th February 2012.
- "Wind Energy" in INSPIRE Internship programme Sponsored by Department of Science and Technology at Sacred Heart College, Thevara, Ernakulam, Kerala on 12th January 2012.

- Parliamentary Standing Committee on Energy at Cochin during 6th - 8th January 2012.

Wind Turbine Testing

S. A. Mathew, Scientist & Unit Chief

- Meeting held with Mr. Subhash Babu, Garuda regarding discussion on type testing of Garuda 1700 kW wind turbine on 12th March, 2012.
- "Wind Resource Land Mapping" organised by M/s. Powerica Ltd at Mumbai on 09th March 2012.
- "Prospects of Wind Energy in India" to the visitors from Bureau of Energy Resources, Department of State Washington D.C, at Seminar Hall, C-WET on 01st March 2012.
- Meeting with Mr. M.S. Bhoi – Manager of M/s. Elecon Engineering regarding discussions on finalization of test plan of Elecon 600 kW wind turbine on 28th February, 2012.
- Parliamentary Standing Committee meet on Energy at Cochin during 6th - 8th January 2012.

Standards & Certification

A. Senthil Kumar, Scientist & Unit Chief

- Parliamentary Standing Committee meet on Energy at Cochin during 6th - 8th January 2012.

S. Arulselvan, Assistant Engineer

- "Requirement of Control & Protection System for Wind Turbines" at Hindustan University, Kelambakkam, Chennai.

Information, Training & Commercial Services

P. Kanagavel, Scientist & Unit Chief (i/c)

- "Wind Energy: at a glance" in the One day seminar on Non-Conventional Energy Sources "SUN AIRGETIC 2012" organized by Social Science department of Mohammed Sathak College of Arts & Science, Sholinganallur, Chennai on 29th February 2012.
- "Role of C-WET for Wind Power Development" in the Regional Phase of the International training course on "Wind Power Development and Use" organized by LIFE Academy, Sweden at C-WET, Chennai on 29th February 2012.
- "Wind Energy System" in the "Kurukshetra 2012", The International Techno-Management Fest of College of Engineering, Guindy, accredited by UNESCO, organized by the Institute of Energy Studies, Anna University, Chennai on 4th February 2012.

Solar Radiation Resource Assessment

Dr. G. Giridhar, Scientist & Unit Chief

- "Application of Solar Energy" for Institutions by Thermax Limited, at Hotel Benz Park, Chennai on 02nd March 2012.
- "Solar Energy: at a glance" in the One day seminar on Non-Conventional Energy Sources "SUN AIRGETIC 2012"

organized by Social Science department of Mohammed Sathak College of Arts & Science, Sholinganallur, Chennai on 29th February 2012.

- "SRRA over view" , in connection with the visit of Joint Secretary (MNRE) at C-WET, Chennai on 16th February 2012.
- "Solar Power Systems" in the "Kurukshetra 2012", The International Techno-Management Fest of College of Engineering, Guindy, accredited by UNESCO, organized by the Institute of Energy Studies, Anna University, Chennai on 4th February 2012.

R. Sasikumar, Scientist

"Solar Radiation Resource Assessment" in the 3rd CSP India Today submit at Gurgaon on 14th March 2012.

FAREWELL



Dr. E. Sreevalsan, Scientist & Unit Chief, WRA was given a warm farewell on 29th February 2012. His dedicated contribution and remarkable services towards making this organization a "Centre of Excellence" will always be remembered.

The following staffs delivered lecture(s) in the 8th International Training course on "Wind Turbine Technology & Applications", a special course for African Countries, held during 1st – 24th February 2012 at C-WET.

No	Title	Speakers
1	❖ Wind Energy Conversion Technology and Power Generation ❖ Wind Turbine Tower Concepts	Dr. S. Gomathinayagam Executive Director
2	❖ Wind Turbine Foundation Concept ❖ Small Wind Turbine and Hybrid Systems	Rajesh Katyal Scientist & Unit Chief, R&D
3	❖ Drive Train Concept	J. C. David Solomon , Scientist, R&D
4	❖ Grid Integration of Wind Turbine	Deepa Kurup , Scientist, R&D
5	❖ Wind Resources Assessment Techniques, ❖ Design and Layout of Wind Farms ❖ Offshore Wind Energy – An Overview	Dr. E. Sreevalsan Ex - Scientist & Unit Chief, WRA
6	❖ Wind Resource Assessment by Remote Sensing Instruments ❖ Wind Turbine Components ❖ Forecasting of Wind and Energy Production	K. Boopathi Scientist & Unit Chief (i/c), WRA
7	❖ Siting Guidelines for Wind Measurements ❖ Monitoring Station Instrumentation and Installation	A.Hari Bhaskaran Scientist, WRA
8	❖ Measurement Parameters and Data Analysis	G.Arivukkodi , Assistant Engineer, WRA
9	❖ Wind Turbine Testing & Measurement Techniques ❖ Power Curve Measurements	S.A.Mathew Scientist & Unit Chief, WTT
10	❖ Safety and Function Testing	M. Anvar Ali , Scientist, WTT
11	❖ Instrumentation for Wind Turbine Testing	M.Saravanan , Scientist, WTT
12	❖ Type certification of wind turbine and overview of design requirements as per IEC 61400-1	A.Senthilkumar Scientist & Unit Chief, S&C
13	❖ Design aspects of Wind Turbine Gearbox	N. Raj Kumar , Scientist, S&C
14	❖ Wind Electric Generators & Types	A.G.Rangaraj , Scientist, S&C
15	❖ Design requirements of Control and Protection System	S. Arulselvan , Assistant Engineer, S&C
16	❖ Role of C-WET in Wind Energy Development ❖ Wind Energy Development in India ❖ Environmental Aspects of wind Turbine Technology	P. Kanagavel Scientist & Unit Chief (i/c), ITCS
17	❖ Wind - Solar Hybrid Systems – Non Solar	Dr.G.Giridhar , Scientist & Unit Chief, SRRA
18	❖ Indian Government Policies, Schemes and Legal Frameworks	A. Mohammed Hussain , Scientist & Unit Chief, WTRS

SOLAR RADIATION AVAILABILITY IN INDIA: AN OVERVIEW

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In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy.

The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultra-violet radiation) streams out into space in all directions.

Solar radiation describes the visible and near-visible (ultraviolet and near-infrared) radiation emitted from the sun. The different regions are described by their wavelength range within the broadband range of 0.20 to 4.0 μm . The following is the details of solar radiation spectrum with the approximate wavelength ranges:

- Ultraviolet : 0.20 - 0.39 μm
- Visible : 0.39 - 0.78 μm
- Near-Infrared : 0.78 - 4.00 μm

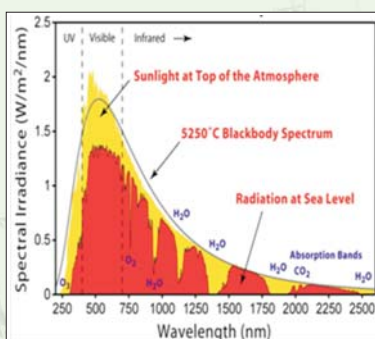


Fig 1: Solar radiation spectrum

earth-sun distance at the top of the atmosphere and is referred to as the Solar Constant. Solar radiation value on earth surface is always less than Solar Constant.

Sun's Movement:

The earth rotates around the sun. This causes the sun to "rise" and "set". The angle of the sun and its intensity on earth is affected by location (latitude and longitude) of the place on the surface of the earth. The length of the atmosphere that the solar radiation has to pass through determines the amount of radiation that reaches the earth's surface. At solar noon, the sun rays reach

the earth's surface through least amount of atmosphere. As the sun moves closer to the horizon (sunset), the path of the radiation lengthens and the intensity of the radiation decreases.

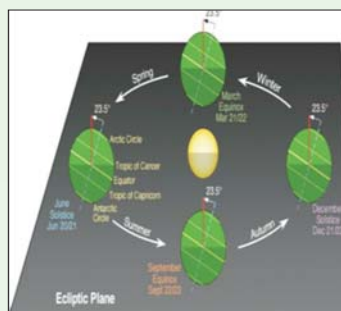


Fig.2 Earth's rotation around sun

At higher solar elevation, the amount of atmosphere that the solar rays have to travel through is lesser and therefore the energy content is somewhat higher. Because of the earth's tilt and rotation, the length of atmosphere that solar ray passes through varies with the time of day and month of the year. The path of the earth around the sun is elliptical. The earth rotates around the sun on

its axis that is tilted 23.47° from the vertical to the plane of the earth's orbit around the sun. The earth's tilt is responsible for the seasonal variations in weather. The tilt is constant as the earth revolves around the sun. When the Northern Hemisphere is tilted towards the sun, the incoming radiation is close to perpendicular to the earth's surface and the duration of sunshine is longer. When it is winter in the Northern Hemisphere, it receives fewer hours of sunshine, at a lower angle, while summer prevails in the Southern Hemisphere.

Direct Normal Solar Irradiance:

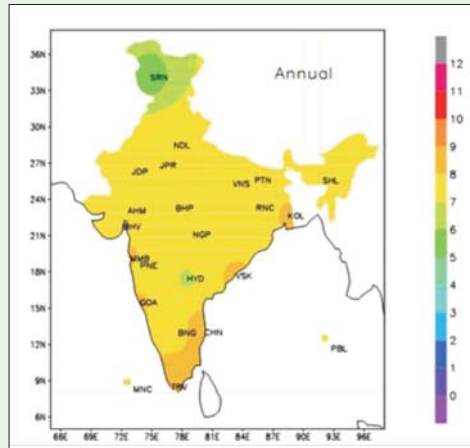
It is the irradiance of the sun emitted from the solid angle of the sun's disc, received by a unit surface held perpendicular to the solar beam. It includes a small quantity of irradiance that is scattered by the intervening medium along the axis of the cone. The attenuation is then due to the variation in the relative concentration of the individual constituents of the medium, viz. air. The term, beam solar irradiance is used to denote the direct solar beam, incident on a horizontal surface.

Diffuse Solar Irradiance:

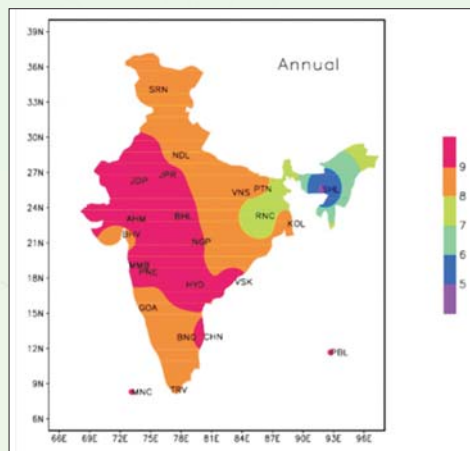
It is the downward irradiance scattered by the atmospheric constituents and reflected and transmitted by the cloud and incident on a unit horizontal surface. This irradiance comes from the whole hemisphere of solid angle of 2π with the exception of the solid angle subtended by the sun's disc.

Global Solar Irradiance:

This is the irradiance that reaches a horizontal unit surface. It is made up of the direct normal solar irradiance and the scattered diffuse solar irradiance. Since the direction of the incident solar beam changes continually from sunrise to sunset, the cosine



Source : IMD

Fig: 4 Annual Diffuse Solar radiation (MJ/m²)

Source : IMD

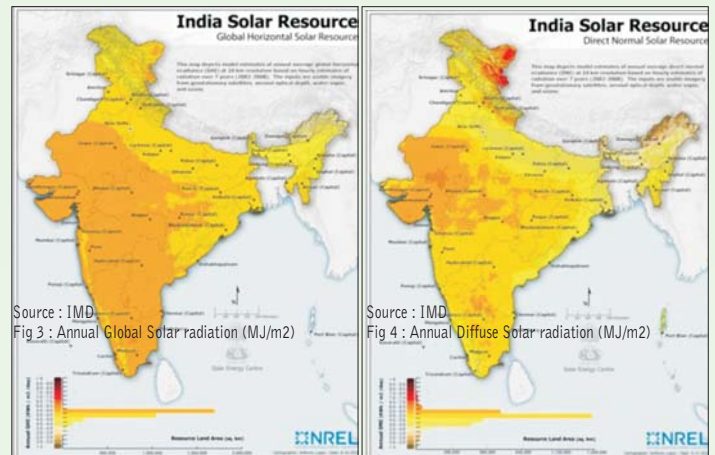
Fig: 5 Annual Daily distribution of Sunshine hours

National Renewable Energy Laboratory (NREL):

Solar Energy Centre (SEC), Ministry of New and Renewable Energy, Government of India has successfully completed a project on the preparation of high resolution solar resource maps of India in collaboration with National Renewable Energy Laboratory (NREL), USA and the Atmospheric Sciences Research Centre (ASRC) at the State University of New York (SUNY)/Albany (USA). This solar resource assessment study employed a combination of analytical, numerical, and empirical methods. The ASRC method uses a semi empirical approach to convert visible channel imagery to hourly estimates of solar resources on a 10-km grid. Solar resource estimates include both Direct Normal Irradiance (DNI) and Global Horizontal Irradiance (GHI).

In the first phase of the project solar maps (DNI & GHI) of North-Western India were prepared. The Second phase of the SEC-NREL project for constructing solar maps for the rest of the country has now been completed. The solar maps containing monthly and annual Direct Normal Irradiance (DNI) and Global

Horizontal Irradiance (GHI) data have been developed from hourly satellite data spanning from January 2002 to December 2008 generated through application of the SUNY satellite to irradiance model. SUNY adapted the model to use the European Meteosat 5 and 7 geostationary satellites, which are positioned at the longitude of Central Asia (57.50 east). These maps cover the entire country at 10 km x 10 km spatial resolution.



Source : NREL

Fig 6: GHI and DNI map for India

Solar Radiation Resource Assessment:

Ministry of New and Renewable Energy, Government of India is implementing Solar Radiation Resource Assessment (SRRA) project which also includes making of Solar Atlas through Centre for Wind Energy Technology, Chennai by establishing a specialized and exclusive cell, as C-WET has vast experience in Wind Resource Assessment and development of Wind Atlas.

The main objectives of the SRRA project are...

- Set up a network of automatic solar radiation monitoring stations at 51 high potential sites identified in collaboration with State Nodal Agencies and C-WET, Chennai
- Set up Centralized data collection and analysis facility at C-WET.
- Establish a Calibration Laboratory for Solar Radiation measuring equipments at C-WET, Chennai for Quality Assurance.

A network of 51 solar radiation measurement stations is commissioned. The stations are distributed all over India, which are measuring high resolution direct, diffuse and global irradiance. The number of SRRA stations in each state are shown below.

State	No. of stations
Andhra Pradesh	6
Chhattisgarh	1
Gujarat	11
Jammu & Kashmir	1
Madhya Pradesh	3
Maharastra	3
Karnataka	5
Puducherry	1
Rajasthan	12
Tamilnadu (including C-WET)	7
Haryana (Solar Energy Centre)	1
Total	51

A Central Receiving Station (CRS) is established at C-WET, Chennai. A level-1 server is installed at CRS which comprises of Primary, Secondary and Web server which receives data from all

SRRA stations. The sampling rate of the data logger is 1 second and the data logger transmits data averaging to 10 minutes to the Central Receiving Station (CRS) at C-WET, Chennai through GPRS mode of communication. A level-2 server has been established at C-WET for quality assessment of SRRA data. Quality assessment of the SRRA data is carried out using Matlab algorithm. The data of SRRA station at C-WET is uploaded on the C-WET website on monthly basis. (www.cwet.res.in)



Fig 7: View of SRRA station at Vellore

Monthly Average (Daily) Values of Solar Radiation at C-WET, Chennai, Tamilnadu, (Year 2011-12)

Month	Global Horizontal Solar Radiation (kWh/m ²)	Diffuse Horizontal Solar Radiation (kWh/m ²)	Direct Normal Solar Radiation (kWh/m ²)	Wind Speed (m/s)	Wind Direction (°)	Rain Accumulation (mm)	Air Temperature (°C)	Relative Humidity (%)	Atmospheric Pressure (SLP) (mb)
May	5.760	2.736	4.320	3.36	200	0	31	68	1003
June	5.472	4.032	2.160	3.50	220	57	31	63	1003
July	4.752	3.600	1.296	3.16	228	74	30	70	1003
August	4.896	3.600	1.152	2.91	218	192	29	76	1003
September	5.328	3.888	1.728	2.79	211	209	29	74	1005
October	4.464	2.448	2.592	1.93	193	168	28	85	1007
November	3.744	2.016	2.160	2.78	146	365	26	85	1009
December	3.744	2.160	2.448	3.16	152	154	26	82	1009
January	4.896	1.872	5.040	2.54	137	23.3	25	85	1010
February	5.472	2.448	4.464	3.93	138	0.1	26	84	1009

Disclaimer : The data are still under the process of quality checking and evaluation and are kept on test run basis.

SLP : Station level Pressure

CONCLUSION

In addition to satellite data providers like NASA, NREL and ground measured data of IMD, the SRRA project is very important and useful for solar plant developers/Stake holders, satellite data providers for ground truthing, researchers, policymakers and consultants. For a continuous spatial coverage of wide region, satellite based irradiation estimates are generally used which provides moderate to good accuracy. The best quality data is provided only by ground based measurements which are also used for validating and improving the satellite derived data. Thus establishment of solar resource

assessment infrastructure in India would be of great importance. In future, C-WET would be a National Data Centre for Solar Radiation data measurement and collection, thereby the SRRA project would play a key role in development of solar power plants in India.

Reference

1. http://mnre.gov.in/sec/readme_india_solar_maps.txt
2. http://www.imd.gov.in/doc/climate_profile.pdf

Visits Abroad

- Dr. E. Sreevalsan, Scientist & Unit Chief, WRA has visited Mauritius during 12th to 18th February 2012 for imparting training in Wind Energy to Mauritius professionals under the Indo-Mauritius joint working group on Renewable Energy.
- Shri A.R.Hasan Ali, participated in the 1st phase of the International training course on "Wind power development and use" organised by LIFE Academy/SIDA, Sweden held at China during 12th - 17th February 2012.
- Dr. Giridhar, Scientist & Unit Chief, SRRA, Shri. R. Sasikumar, Scientist, SRRA and Shri. D. Lakshmanan, General Manager (F&A) visited for inspection and specific SRRA - Station Equipment training at Madrid, Spain during 19-24 March 2012.

Staff transfers / Recruitment / Resignation

Transfer



Dr. P. Radhakrishna

Dr. P. Radhakrishna, Unit Chief, Hybrid Wind System has been transferred back to MNRE, New Delhi. He has been relieved of his duties at C-WET, Chennai w.e.f. 1st February 2012.

Relieved



Dr. E. Sreevalsan

Dr. E. Sreevalsan, Scientist & Unit Chief has been relieved of his duties on 29th February 2012.

Taken In-Charge



K.Boopathi

Shri. K. Boopathi, Scientist, WRA has taken as the Unit Chief (i/c) with effect from 1st March 2012