

## EDITORIAL



Globally, offshore wind is nearly three decades old history with total installed capacity of 23.35 GW as on December 2018 in 17 different countries of which important ones are—the UK (6,836MW), Germany (6,410 MW), China (4,558 MW), Denmark (1,358 MW), The Netherlands (1,118 MW), Belgium (1,178 MW), and Sweden (206 MW). Annual capacity additions of more than 4 GW have been observed in the last couple of years. As per the 'Wind Europe Outlook' offshore wind installation capacity may reach up to 70 GW in Europe by 2030.

The onshore wind energy potential estimated by the National Institute of Wind Energy (NIWE) stands at 691 GW at 120 m hub height. However, it has been observed in recent past that, many onshore wind energy projects are adversely affected due to land acquisition issues. Further, the tariff discovered through e-auction started moving upwards on account of exhaustion of best wind sites. In this scenario, offshore wind can be a viable option in order to protect the precious land resources. India is blessed with a coastline of nearly 7,600 km with relatively shallow waters (within 12 nautical miles of the coast) near to shore in most parts showing good prospects of harnessing offshore wind energy. With this objective, the national offshore wind energy policy has been notified in October 2015 to provide a legal framework for development of the offshore wind sector in India. Policy authorises, the Ministry of New and Renewable Energy to work in close coordination with other government entities for development of offshore wind energy within the entire exclusive economic zone (EEZ) of the country and NIWE has been designated as the nodal agency to carry out or facilitate necessary resource assessment activity for offshore wind development and demarcate blocks and facilitate developers for setting up offshore wind energy farms.

During the period, 7 nos. of dedicated wind monitoring stations of height 100 m in Gujarat were established. LiDAR based measurements for 2 year was completed at Gulf of Khambhat off Gujarat coast. Further, assessment by NIWE excluding the areas in

consultation with various line ministries/ organizations suggests around 70 GW of offshore wind energy potential exists off the coast of Gujarat and Tamil Nadu coast only. In order to exploit the potential and keeping the falling global tariff trend in view, the government has announced its intention of installing 5 GW of offshore wind installations by 2022 and 30 GW by 2030. This announcement may give confidence to the Indian and global project developers along with financing institutions in India market.

The continuous measurements for testing of three large and one small wind turbines are on-going. Site Feasibility Study was carried out for Type Testing of a 3 MW wind turbine with 145 rotor diameter at Gujarat.

Prof. Dr. Anna Modayil Mani pioneered in resource assessment and took the first visionary step of carrying out a PAN India campaign of measuring and assessing the wind and solar resource potential. To tribute and celebrate the birth anniversary of Prof. Dr. Annamani as the "Wind Resource Day" on 23 August 2019 and Prof. Dr. Annamani Centenary celebration International Conference on "Wind and Solar Resource Assessment" was conducted during 13 and 14 December 2019 at the National Institute of Ocean Technology (NIOT), Chennai

The 10 Electro Technical Division (ETD) 42 Sectional Committee meeting was organized on 24.10.2019 and the review of draft Indian standards circulated by BIS is under progress.

NIWE has completed a project on Pre evaluation of documentation in connection with the Type Certification of the wind turbine model

NIWE during this period had successfully conducted three International Training Courses (ITC). 24<sup>th</sup> ITC with 28 participants from 18 countries and 7<sup>th</sup> special ITC 29 participants from 16 countries on Wind Turbine Technology and Applications. And special International training course on Solar Resource Assessment and Development of Solar Power Plant with 34 participants from 21 different countries.

**Dr. K. Balaraman, Director General**

 [www.Facebook.com/niwechennai](http://www.Facebook.com/niwechennai)  
 [www.Twitter.com/niwe\\_chennai](http://www.Twitter.com/niwe_chennai)

## Contents

- ◆ NIWE at work - 2
- ◆ Waste Management - 13

## Editorial Board

### Chief Editor

**Dr. K. Balaraman**  
Director General, NIWE

### Associate Editor

**Dr. P. Kanagavel**  
Director & Division Head, SDT

### Members

**Dr. Rajesh Katyal**  
Deputy Director General & Division Head, WSOM

**D. Lakshmanan**  
Deputy Director General & Division Head, F&A

**S. A. Mathew**  
Director & Division Head, C&IT

**A. Senthil Kumar**  
Director & Division Head, S&R

**J.C. David Solomon**  
Director & Division Head, T&R

**K. Boopathi**  
Director & Division Head, R&D and RDAF



## Wind Solar Resource Measurements / Offshore

### ONSHORE WIND RESOURCE ASSESSMENT

#### WRA in Uncovered/New areas

During the period, 7 nos. of dedicated wind monitoring stations of height 100 m were established in Gujarat and the data measurement process is underway.

#### Wind resource assessment studies using existing Telecom Towers

26 nos. of telecom towers in Assam were mounted with sophisticated wind sensors & data loggers for collecting the wind data. The measurement campaign is underway.



Wind resource assessment sensors mounted telecom tower at Assam



100 m Wind monitoring station installed at Gujarat

### OFFSHORE

#### Geotechnical Investigation at Gulf of Khambhat off Gujarat coast

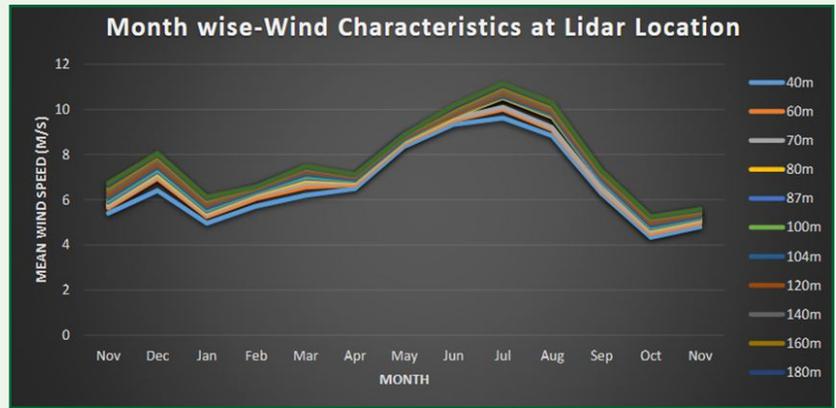
NIWE has initiated the Geotechnical work which covers Cone Penetration Test at chosen five borehole locations. The geo-technical study was conducted both at proposed 1 GW project site and at two new Lidar locations. In order to better understand the sub-surface sea profile the depth of the bore was considered upto 60 m and the soil samples were collected at regular intervals for carrying out both insitu and laboratory tests. The study will provide useful pointers for designing the offshore wind turbine foundation.



100m Wind monitoring station installed at Gujarat

## Offshore measurements off Gujarat coast

LiDAR based measurements for 2 year was completed at Gulf of Khambhat off Gujarat coast and the raw data files (time series) of LiDAR measurement was uploaded in NIWE website for the benefit of stakeholders ([https://niwe.res.in/departmentsom\\_lidar\\_raw\\_data.php](https://niwe.res.in/departmentsom_lidar_raw_data.php)). The annual average wind speed at the said offshore location measured is 7.55 m/sec and the wind power density is 360 W/m<sup>2</sup>



Monthly mean wind speed

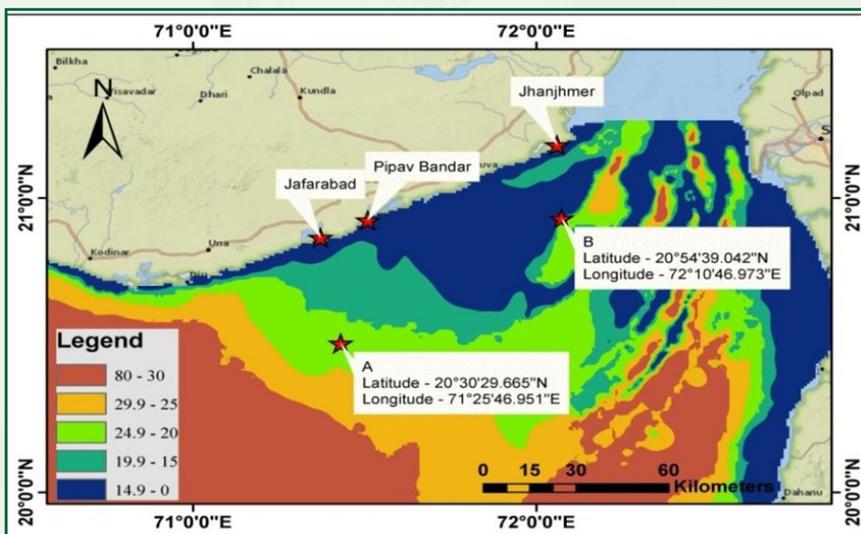
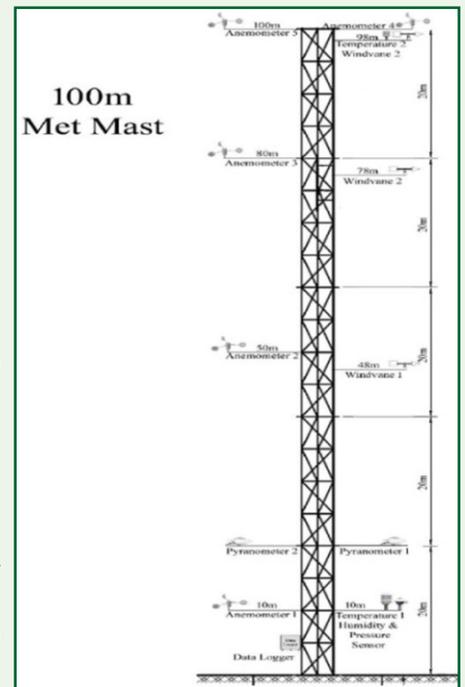
## R&D PROJECT APPRAISAL COMMITTEE (RDPAC) APPROVED PROJECTS

### Integrated wind & solar resource assessment through mapping and measurements

As part of the milestone of the project the installation and commissioning work of 25 Nos of Integrated masts for Wind Solar measurements has been initiated where in Wind measurements will be undertaken at 4 levels while the wind direction measurements will be carried out by 3 levels. The Solar radiation will be carried out by installing two Pyranometer for better redundancy at 20 m level. In addition to above the other environmental parameters like pressure, humidity, temperature, etc will also be measured.

### Met-Ocean measurements (Wind, Wave, Tide, Current, Water level, etc) at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country.

As a part of milestone activity of the project NIWE with support of NIOT has carried out the design analysis of Monopile & Platform for mounting the Lidar at Zone A1 and B2 locations at Gulf of Khambhat, off Gujarat coast. Based on the design the diameter of the monopile for zone A1 and B2 locations are 2.2 m and 1.4 m respectively. The weight/steel takeoff of the monopile & platform for A1 & B2 locations is 220T and 60T respectively.



Proposed met-ocean locations in Gulf of Khambhat, Gujarat



Design of Monopile structure with platform

## CONSULTANCY PROJECTS:

WSOM division has executed consultancy projects to the tune of about 500 MW towards supporting the stakeholders of the wind industry. The activities include;

- Verification of wind monitoring procedure
- Wind Monitoring Study
- Micrositing
- Energy Yield Estimation
- Energy Production Demonstration Test

Further, WSOM division has taken first of its kind international project for preparation of detailed project report for establishment of wind farm project from M/s Energoimport at Rio-Seco Cuba for a capacity of 50 MW of electricity power generation to be financed under the line of credit by Government of India. During the quarter, as a part of project deliverables, NIWE had carried out the data analysis for the data submitted by M/s. Energo Import towards the preparation of report.

## Testing & Research Station

### LARGE WIND TURBINE TESTING

Power Curve Measurements' of Inox 2000 kW Wind turbine of M/s. Atria Wind Power (Savarkundla) Pvt Ltd. The continuous measurements are on-going.

Power Curve Measurements of Inox 2000 kW wind turbine of M/s. Inox Wind Ltd. The continuous measurements are on-going.

Type Testing of its Model Pioneer Wincon 750/57, 750 kW, a wind turbine of M/s. Para Enterprises Pvt Ltd. The continuous measurements are on-going.

Site Feasibility Study carried out for Type Testing of Inox 3 MW wind turbine with 145 rotor diameter dated 18<sup>th</sup> December 2019 at Dayapar, Gujarat.

### SMALL WIND TURBINE TESTING

Type Testing of model Vaata Smart, Vertical Axis WT (5.5 kW) Wind Turbine of M/s. Vaata Smart Pvt Ltd. The measurements are on-going.

### VISITOR

11 delegates from the State of Massachusetts, USA visited NIWE and discussed deliberately on Test Facility Development (Blade Test Centre) at Wind Energy Test Center (WTTC) on 22<sup>nd</sup> October, 2019.

H.E. Mr. Hans Jacob Frydenlund, Ambassador – Norway accompanied by Mrs.Gina Lund – Special Advisor, Ministry of Education & Research and Dr. Maan Singh Sidhu – Counsellor, Science & Technology visited NIWE on 18<sup>th</sup> November 2019.

Mr. Murray Bainbridge, International Trade Expert for Energy, Scottish Development International visited NIWE and discussed of their product on 915 MW of operational Offshore wind including the world's first floating offshore wind farm on 05<sup>th</sup> December 2019.

Dr. Vivek DHAM, Advisor - Research & Innovation, European delegation visited NIWE and would like to learn more about NIWE initiatives in research, innovation, Tech-Transfer etc. and also made Brief presentation on EU MS/AC-India research funding programmes of respective country as well as opportunities of academic collaboration with EU member states on 06<sup>th</sup> December 2019.

## Research & Development and Resource Data Analytics & Forecasting and Solar Radiation Resource Assessment

### R&D ACTIVITIES

#### Establishment of Smart RE-Micro Grid with Integrated Resource and Building Management System (IRBM) at National Institute of Wind Energy, Chennai

- BESS design criteria and Load growth works are in progress
- The first expert committee to verify the specification of Microgrid using the various tool was held on 10.10.2019 at Bangalore.
- Simulation of Microgrid using the various tool was under progress
- Detailed Specification report for Solar Panel System, Inverter and Battery Storage System was prepared, and the same was submitted to CDAC Trivandrum for vetting.
- Draft Solar PV Tender Document has been prepared

#### Design and Development of Indigenous Grid Emulator Facility

- Draft specification preparation with the support of industries is in progress.
- Eminent persons/organizations in the field of power systems were identified & requested their nomination for the formation of R&D consortium.
- The redrafting of Technical specification and Identification of testing requirements is in progress
- Discussion with Experienced professionals for the formation of R&D consortium is in progress
- Expression of Interest for finalizing the technical specification and for the collaborative development was initiated

#### IoT Based Smart wind farm to enable real-time remote monitoring and control

- The development of a prototype for data extraction from a TMC controller is in progress.
- Interfacing of Orbital TMC controller of MICON machine with local PC for data extraction has been completed.

- A Lora module for the Data Acquisition from the wind turbine to Kayathar substation was procured.

#### Development of Long-term Wind Speed Forecasting Using Hybrid Model

- Establishment of Big data framework and Development of Visualisation Tool
- Comparative analysis of existing models (4 nos.) for WSF was in progress

### FORECASTING

- Conversion of existing day ahead forecasting model to Python program was completed. The validation & comparison report was prepared for the same.
- Documentation of the NWP and Physical Model was under progress.
- Time series analysis using the ARIMA model is under progress.
- NWP Data extraction for SRRRA stations is under progress.
- Identified the issues in the sky camera and tried to resolve it.
- An intraday simulation model for other SRLDC solar parks was under testing.
- Documentation of bias correction of ECMWF data, a combination of NWP GHI, till conversion modeling, PV module efficiently modeling, Gujarat individual power plant with single NWP is completed.
- Draft prepared for MoU and NDA of the regional level forecasting and sent it to a lawyer for a legal opinion.
- Analysis of Wind and Solar Potential states in India by RE2030, and the same report preparation has been completed.
- Analysis has been carried out for SS wise, and Capacity wise has been completed.
- The extension agreement with KPTCL regarding Forecasting has been signed on 20th December 2019.
- Extension Agreement regarding wind power forecasting has been with GETCO.



- An article on "Wind Power Forecasting Services for the whole state of Tamilnadu" has been prepared and submitted for e-governance publication.
- Storage Analysis for future server capacity for wind and solar power generation has been carried out.
- Created a script for RDAF data management System
- Invitation sent to developers for Brainstorming Solar Power Forecasting on 11-11-2019 and note for approval forwarded to the competent authority.
- WRF software was installed in the workstation.
- Regarding wind power, forecasting has been discussed with IIT Calcutta officials and DTU officials.
- Operational aggregation forecasts and single-plant level forecasts have been evaluated.
- Solar power peak generation from 121 stations in India has been analyzed, and they prepared the report.
- Fine-tuning of wind power forecasting model for individual substation wise is under progress.
- Draft of MoU and NDA for the pilot project of wind power forecasting for Madhya Pradesh is prepared, and the same has been sent.
- Model wise Error Analysis has been carried out for Tamilnadu.
- Preprocessed the static details of 2 windfarms of SRLDC and simulation model is running. 2 windfarms of SRLDC is under testing for pilot basis forecasting services. Web portal development for SRLDC for two new plants is under progress.
- Validation of the NWP model with Kayathar ground-based measurement has been carried out.
- A Template has been prepared for the bias correction of NWP models.
- Verification of Real-time generation data validation on feeder level has been carried out.
- Restoration of the operational forecasting system has been done.
- Mapping of folder location is carried out for copying the data from the old server to the new server.
- Implementation quartile based bias correction on the NWP dataset has been carried out.
- NWP data for the available WRA stations has been extracted.

- Wind and Solar Power Forecasting Services has been discussed with Ambassador Norway and delegates on 18-11-2019 at NIWE.
- Bias Correction varying window model is completed.
- Prepared First Draft of IT Policy document and submitted it.
- Error analysis report from October 2019 to December 2019 has been prepared for the state of Tamilnadu, Gujarat, Karnataka, Maharashtra, and SRLDC specific solar parks and windfarm

### Resource Data Analytics Lab

- Updated the status of the running stations, and new commissioned stations and extraction process is under progress.
- Process flow for Quality Check of Solar and Wind data has been completed.
- Carried out 100 m met mast data sale for one site (3 years data).
- The historical Data Extraction process for Ammonite, NRG, and Text data logger, as well as the column extraction, has been completed.
- Carried out the validation work for the NRG stations to sort out the issues.
- Quality check algorithm for the met mast is in progress in progress

### SRRA

#### Calibration of Solar Instruments

- Calibration of 2 pyranometers under commercial mode and calibration of 10 pyranometers & 5 pyrhemometers under the SRRA project has been carried out.

#### Inspection of SRRA stations

- Carried out inspection of SRRA station at Guntur and Medak from 21.10.2019 to 27.10.2019
- Carried out inspection of SRRA station at Bijapur, Gokak, and Karad from 16.11.2019 to 26.11.2019

### Prof. Dr. ANNAMANI CENTENARY CELEBRATION INTERNATIONAL CONFERENCE

Prof. Dr. Annamani Centenary celebration International Conference on "Wind and Solar Resource Assessment" held on 13<sup>th</sup> and 14<sup>th</sup> December 2019 at the National Institute of Ocean Technology (NIOT), Chennai. The course was

aimed at professionals engaged in wind energy planning and implementation.

## Inauguration

The day started with the welcome address by the Dr. P. Kanagavel, Director & Division Head, SDT, NIWE to welcome our Chief Guest and all the other elite dignitaries present on the Dias and the participants.

Sh. K. Boopathi, Director & Division Head, R&D, RDAF & SRRA, NIWE gave us an overview of the international conference.

Chief Guest Dr. M. A. Atmanand, Director NIOT, has given the importance of wind and solar resource assessment and collaboration with MoES for data sharing.

Dr. K. Balaraman, Director General of NIWE and Dr. G. Giridhar, Former DDG, SRRA, NIWE, gave an introduction about the purpose of the conference and the importance of wind and solar resource assessment respectively.

## Purpose of the Conference

Wind and solar energy have become an integral part of the energy mix. As of July 2019, the country has installed capacity of 66.8 GW of Grid-connected wind and solar generation along with 1 GW of off Grid-connected solar plants. The government of India has set an ambitious target to develop wind and solar power installation of 60 GW from wind and 100 GW from solar by 2022, and to have at least 40% renewable power capacity have to be installed in the country by 2030. To develop wind and solar power plants and to achieve this target, the resource assessment is a critical element.

Prof. Dr. Anna Modayil Mani pioneered in resource assessment and took the first visionary step of carrying out a PAN India campaign of measuring and assessing the wind and solar resource potential.

To tribute and celebrate the birth anniversary of Prof. Dr. Annamani as the "Wind Resource Day" on 23<sup>rd</sup> August 2019.



Glimpse of Conference

## Need for Wind and Solar Resource Assessment

National wind resource assessment program was launched in 1985 by the government of India to access the potential with actual measurements, and currently, 896 wind monitoring stations were established under this program. Further, about 1100 private wind monitoring stations are also set in the country. In total, India holds a data bank for about 2000 wind monitoring stations, which is one of the largest in the world.

To carry out the optimized measuring techniques in resource assessment, resource mapping, temporal and spatial variation of resources, to quantify the uncertainties, to address the challenges faced while implementing the wind and solar campaign as well as in the process of assessment of the resource potential, the conference will focus on the latest developments in the field of measurement and resource assessment.

The conference initiated the amalgamation of national and international countries' thoughts, leaders, engineers, and professionals working in this field. This event made an open platform for the exchange of ideas, learnings, technical advancement, sharing of experience to step forward to the next paradigm with the following sessions.

First day five sessions & second day four sessions were discussed on the following topics. The topics of first day was Session I - Wind Measurement-Best Practices and Modern Techniques, Session II - Networking and presentation by instrument manufacturers, Session III - Wind Resource Data Analytics, Data Management System for efficient automation, Session IV - Networking and presentation by Siemens Gamesa (India) and Session V - Wind Resource Assessment -Uncertainty and Challenges in modeling, Flow modeling challenges and ways to mitigate the risk.

The topics of second day was Session I - Solar Radiation Measurement-Best practices, Session II - Networking and presentation by SGS Weather, Session III - Solar Radiation Resource Data Analysis, Solar Radiation Resource Data Analytics using Space-based inputs, Session IV - Offshore Wind Resource Assessment.

Overall, more than 150 International and National participants, speakers have participated in the conference.

## OVERVIEW OF INDIGENOUS WIND POWER FORECAST MODEL PERFORMANCE

NIWE has established an operational wind forecasting system for the whole state of Tamil Nadu during September 2015 and Gujarat during April 2018. NIWE forecasting team is actively carrying out various activities, including daily event analysis, to improve the wind power forecasting model accuracy on a daily / weekly / monthly basis. The brief model analysis for the three states are explained below:

### Tamil Nadu

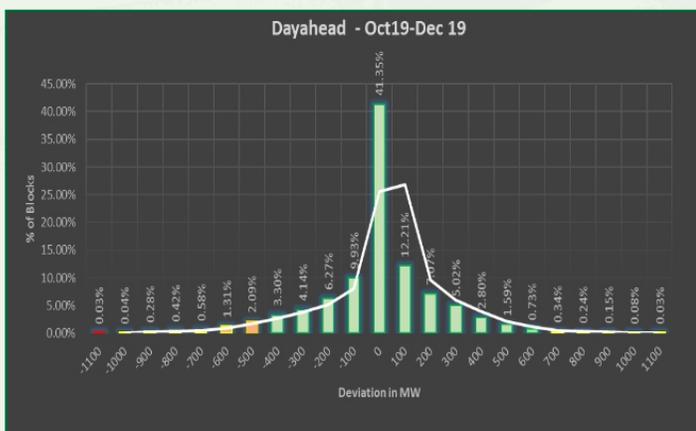


Figure : 1

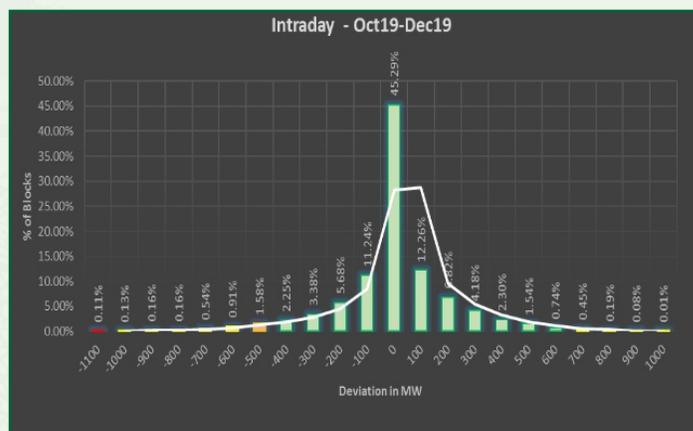


Figure : 2

Figure 1 & 2 represents the frequency error distribution for the whole state of Tamil Nadu from October December 2019 ( 3 months). From Figure 1, it may be noted that about 95% of the blocks have a day ahead deviation of 600 MW, and with intraday corrections, the 95% got improved to 96%, i.e., 1% improvement (Figure 2).

Gujarat

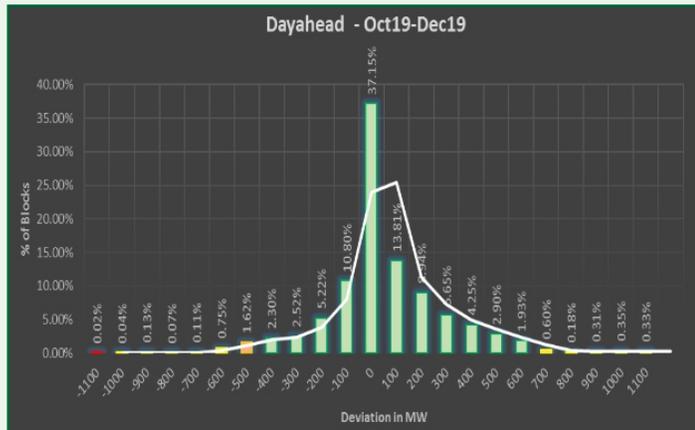


Figure : 3

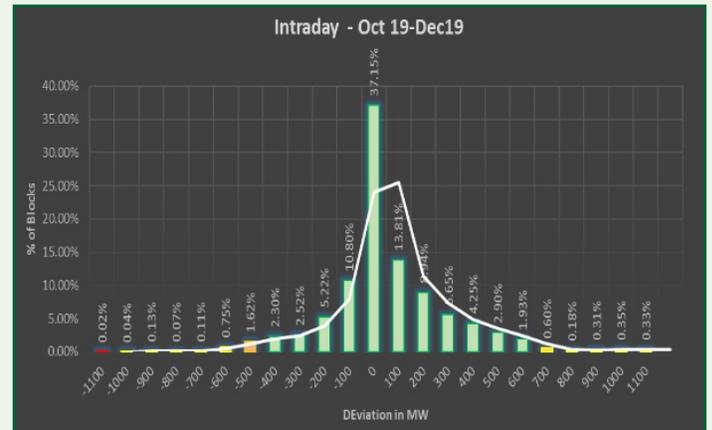


Figure : 4

Figure 3 & 4 depict the frequency error distribution for the whole state of Gujarat from October - December 2019 (3 months). From Figure 3, it may be noted that about 85%\*(Simulation model result) of the blocks are having a day ahead deviation of 600 MW, and with intraday corrections, the 85% got improved to 94%, i.e., 9% improvement (Figure 2).

Andhra Pradesh

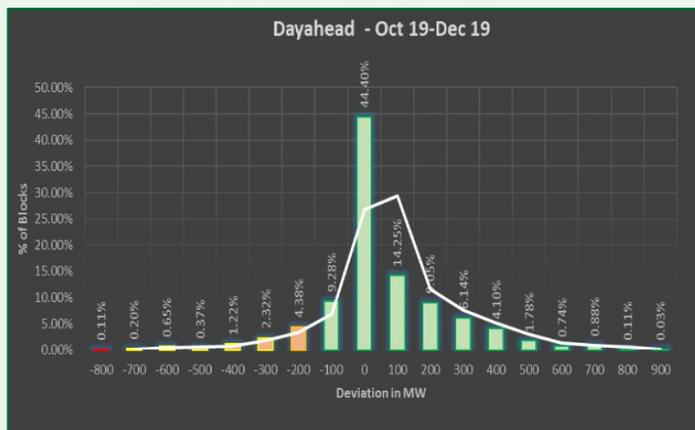


Figure : 5

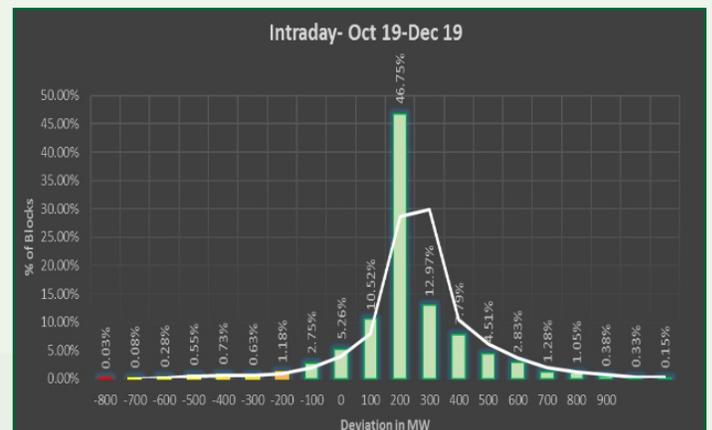


Figure : 6

Figure 5 & 6 discloses the frequency error distribution for the whole state of Andhra Pradesh from October - December 2019 (3 months). From Figure 5 it may be noted that about 95% of the blocks have a day ahead deviation of 600MW and with intraday corrections, the 95.

Further fine tuning of the wind power forecasting model for the whole state of Tamil Nadu, Gujarat and Andhra Pradesh is under progress.

WEB PORTAL

- UI improvement carried out in the Internship Portal.
- Improved the UI of Staff Monitoring Portal.
- Coordinated with admin staff regarding the staff monitoring portal and new user accounts created in the database for staff monitoring portal.
- Implemented RLMM online security audit comments, and the same was forwarded to the IT division.
- A web portal for the 2<sup>nd</sup> PAN India Research Network meeting has been designed.
- Developed a web portal for online data availability of Solar and wind measurement, and fine tuning is under progress.

## INTERNSHIP & PROJECTWORK

During the period October to December 2019, 20 UG/PG students and faculties have completed their internship & project work at NIWE in the field of Wind and Solar Energy mentored by various subject experts of NIWE Scientific staff.

## OTHER ACTIVITIES

- Preparatory work for organizing the 2<sup>nd</sup> PAN INDIA Network meet is in progress.
- Organized Prof. Dr. Annamani Centenary Celebration International Conference on "Wind and Solar Resource Assessment" on 13<sup>th</sup> & 14<sup>th</sup> December 2019 at NIOT, Chennai.

## Standards and Regulation

- Technical support has been provided to MNRE in connection with finalizing the Indian Wind Turbine Certification Scheme (IWTCS) document.
- Director & Division Head, S&R and DG, NIWE participated in the second committee meeting of IWTCS (constituted by MNRE) held on 17.10.2019 at MNRE, New Delhi. During the meeting, various works carried out by NIWE were explained in chronological order including the modifications incorporated in the draft IWTCS document. In addition, NIWE presented the modified draft IWTCS document in the meeting.
- The continuous technical support is being provided to MNRE for all the works related to Revised Lists of Models and Manufacturers of wind turbines (RLMM). Review of documentation has been carried out for 06 wind turbine models during this period.



10<sup>th</sup> ETD 42 SECTIONAL COMMITTEE MEETING

- The works for RLMM online portal development have already been completed. Further, MNRE has issued a circular dated 22.10.2019, hosted at MNRE website, for uploading the RLMM documentation in RLMM online portal. RLMM online portal has been put into operation and the online portal was used by the wind turbine manufacturers for submission of online application and documentation.
- Technical support to Bureau of Indian Standards (BIS) in connection with standards related works are ongoing.
- Review of draft Indian standards circulated by BIS is under progress.
- Organized the 10<sup>th</sup> Electro Technical Division (ETD) 42 Sectional Committee meeting on 24.10.2019 chaired by

DG, NIWE at NIWE, Chennai.

- Organized and facilitated the Power Curve Working group meetings on IEC 61400-12-1 & 2 held on 03.10.2019 & 04.10.2019 and 05.12.2019 & 06.12.2019 at NIWE, Chennai. Director & Division Head, S&R participated in the working group meetings and briefed the working group committee on objectives of working group and efforts taken by NIWE in formulation of the standards. During the meetings, participated in the detailed discussion on the review of the standards and also discussed various practical issues which are not covered adequately in the standards.
- The continual improvement and maintaining the quality management system are ongoing.

## Certification and Information Technology

- Certification Division has completed a project on Pre evaluation of documentation in connection with the Type Certification of the wind turbine model as per IS/IEC 61400-22:2010.

Manufacturer's Name	Wind Turbine Model / Capacity
M/s. Southern Wind Farms Limited	GWL 225 / 225 kW

- NIWE has been assigned to obtain accreditation for the certification services as per the ISO/IEC 17065 standard from National Accreditation Board for Certification Bodies (NABCB), Quality Council of India. The following major activity has been completed:

- a. NIWE submitted the Application along with the requisite documentation to NABCB. NABCB has completed the document review and confirmed that the documentation submitted meets the requirements of ISO/IEC 17065 standard.
- b. Subsequent to the completion of the document review, NABCB has scheduled the Office Assessment at NIWE during January'2020. The division is carrying out various preparatory works in connection with Office Assessment planned by NABCB.

IT division has established and implemented the Aadhar based biometric system for NIWE officials successfully.

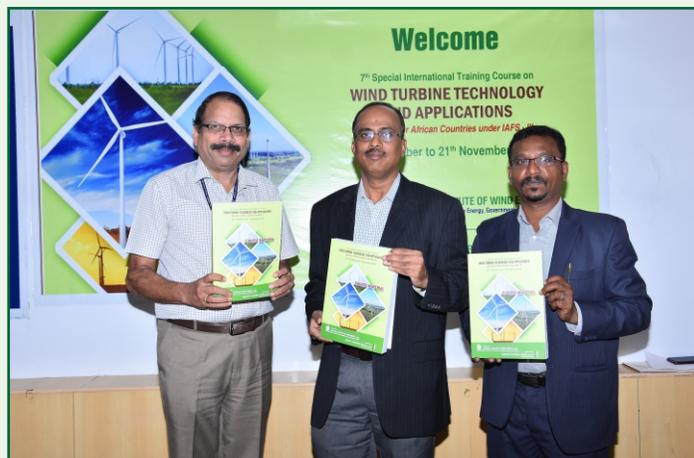
## Skill Development and Training Division

### 24<sup>th</sup> International Training Course and 7<sup>th</sup> Special Training Course

The SDT Division of NIWE has successfully conducted the 24<sup>th</sup> International Training Course on "Wind Turbine Technology and Applications" held during 23<sup>rd</sup> October to 19<sup>th</sup> November 2019, sponsored by Ministry of External Affairs (MEA), Government of India under ITEC programme. The course was attended by 28 participants from 18 ITEC countries, Afghanistan, Argentina, Bangladesh, Egypt, Ethiopia, Guinea, Iraq, Kenya, Morocco, Nigeria, Russia, Senegal, Sudan, Syria, Tanzania, Turkmenistan, Uganda and Zimbabwe.

The 7<sup>th</sup> Special International Training Course on "Wind Turbine Technology and Applications" specially for AFRICAN countries under IAFS-III was successfully conducted by the SDT Division of NIWE, held during 24<sup>th</sup> October to 21<sup>st</sup> November 2019, sponsored by Ministry of External Affairs (MEA), Government of India under India Africa Forum Summit – III (IAFS-III). The course was attended by 29 participants from 16 countries, Angola, Chad, DR Congo, Egypt, Kenya, Madagascar, Malawi, Morocco, Mozambique, Niger, Nigeria, Sao-Tome, Sudan, Tanzania, Uganda and Zambia.

Both the training courses inaugurated by Dr. K. Balaraman, Director General, NIWE in the presence of Shri. D. Lakshmanan, Deputy Director General and Head, F&A, NIWE and the Course Coordinator, Dr. P. Kanagavel, Director & Head, SDT Division, NIWE on 24<sup>th</sup> October 2019.



Release of Course Material

The course addressed all aspects of Wind Power starting from introduction to wind and its technology, wind resource assessment, installation and commissioning, operation and maintenance aspects of wind farms in a focused manner along with financial and policy aspects.

During the training, 41 classroom lectures were scheduled, which were handled by Scientists, Engineers of NIWE, wind turbine manufacturers and academic institutions, who have years of experience in the field. To provide complete knowledge transfer, arrangement were made for 7 practical training at different Laboratories at NIWE, study visit to (i) Large Wind Turbine Training Centre to M/s. Vestas, Chennai, Tamil Nadu (ii) Wind Turbine Test Station (WTTS), Kayathar, Tamil Nadu (iii) Wind Turbine Research Station (WTRS), Kayathar, Tamil Nadu (iv) Wind Farms of various models, make and capacity in and around Kayathar and Kanyakumari, Tamil Nadu (v) Centralized Monitoring Station (CMS) of M/s. Suzlon Service Centre at Thattaparai, Tamil Nadu (vi) Wind Farms of M/s. Leitwind Shriram, Tenkasi, Tamil Nadu.

Dr. K. Balaraman, Director General, NIWE had delivered the valedictory address and distributed the course certificates to all the participants during the Valedictory function for 24<sup>th</sup> International Training Course was held on 19<sup>th</sup> November 2019.

Dr. Neena Malhotra, Joint Secretary, E&SA Division, Ministry of External Affairs, Government of India was the Chief Guest for the Valedictory Function for 7<sup>th</sup> Special International Training Course held on 21<sup>st</sup> November 2019 and distributed the course certificates to all the participants after the intellectual Valedictory Address.



Dr. K Balaraman distributing the Course Certificate



Dr. Neena Malhotra distributing the Course Certificate

## Special International Training Course

The Special International Training Course on "Solar Resource Assessment and Development of Solar Power Plant" specially for ISA member countries was successfully conducted by the SDT Division of NIWE, held during 27<sup>th</sup> November to 20<sup>th</sup> December 2019. This course was sponsored by Ministry of External Affairs (MEA), Government of India under ITEC Programme. The Course addressed all aspects of Solar Power starting from introduction to solar and its technology, solar resource assessment, installation and commissioning, operation and maintenance aspects of solar power plant in a focused manner along with financial and policy aspects. The course was attended by 34 participants from 21 countries, Burundi, Cambodia, Cote D'Ivoire, Dominican Republic, Egypt, Eritrea, Ethiopia, Guyana, Kenya, Lebanon, Maldives, Mali, Nigeria, Peru, Sao Tome, Sri Lanka, Sudan, Tanzania, Uganda, Venezuela and Zambia.

The training course was inaugurated by Dr. K. Balaraman, Director General, NIWE in the presence of Dr. G. Giridhar, (Rtd. Deputy Director General and Head, SRRA, NIWE), Shri. K. Boopathi, Director and Head, R&D, RDAF & SRRA Division and the Course Coordinator, Dr. P. Kanagavel, Director & Head, SDT Division, NIWE on 27<sup>th</sup> November 2019.

The course content of the training were handled by Scientists, Engineers of NIWE and experts from solar power industries and academic institutions, who have years of experience in the field. During the 24 days course, Thirty five classroom lectures were held apart from practical training, study visits to solar power plant and solar panels manufacturing factory. The practical training with Solar Radiation Resource Assessment, instrumentation, Testing & calibration facilities was also organized.

As part of Study tour, all the participants were taken to Thiruvananthapuram to visit the Agency for Non-Conventional Energy and Rural Technology (ANERT) to know about the different kind of rural and urban solar projects and also to the



Study visit to NLC Solar power plant

southern part of Tamil Nadu to visit Solar Power Pump at Aralvoimozhi, Wind Solar Rooftop System at Rohini Engineering College, Kanyakumari, 75 kW Wind Solar Hybrid Systems and 100 MW Solar Power Plant in and around Kayathar.

The Course Certificate was distributed by Shri. D. Lakshmanan, Deputy Director General and Division Head, F&A, in the presence of Dr. G. Giridhar, (Rtd. Deputy Director General and Head, SRRA, NIWE), Dr. K. Balaraman, Director General, NIWE and the Course Coordinator, Dr. P. Kanagavel, Director & Head, SDT Division, NIWE during the Valedictory Function held on 20<sup>th</sup> December 2019.

## VISITORS

To create awareness and to motivate towards research on wind energy, achieving the indigenization and also to create awareness about the activities and services of NIWE, schools and college students are encouraged to visit the campus. During the period October to December 2019, the following visits were coordinated and facilities of NIWE showcased and explained.

- 71 students and 7 faculties from PVM School , Balaji Nagar Pallikarani on 21<sup>st</sup> October 2019
- 30 students and 2 faculties from Govt Higher Secondary School Pallikarani on 21<sup>st</sup> October 2019
- 73 students and 3 faculties from VIT Vellore on 22<sup>nd</sup> October 2019



D. Lakshmanan, DDG, NIWE distributing the Course Certificate

## Waste Management

**Dr. Poornaiya Sreenivasan**, General Manager [Human Resources & CSR]  
Indian Renewable Energy Development Agency Limited (IREDA)

Man has been living in harmony with nature from time immemorial till the advent of industrial and brown economy. In the last quarter of 20<sup>th</sup> Century and early 21<sup>st</sup> Century, the balance of environmental, economic and social equilibrium got unbalanced, which resulted in pushing this dis-balance towards the destruction of ecology and now the earth is inching towards tipping point (Md Jang, 2015). The people who think global warming is not man-made are opposing to Governments setting its targets for decarbonization. They are also ridiculing the metric on the carbon reduction. The truth is that the parsimony, opulence and flaunting of human behavior are largely aggravating this dis-balance of eco-system leading to the vagary of nature. There is no point in only some Governments taking action

At the root of civic problems, is water and its sources, its accessibility and quality. We are adhering only to minimum standard of portability. We continue to destroy river system and water bodies by not having an effluent treatment system. The effort on cleaning river cannot succeed if discharge of wastes into water bodies and river streams continue. The health of our people must be accorded to highest consideration of any sensible governance Paradigm.

Religious notions of indigenous communities in India provide an understanding of natural order & resources to resist its degradation (Novina Jafa 2019). Sadguru Jaggi Vasudev through 'Cauvery Calling' campaign set the standard for how India's rivers – the country's lifelines – can be revitalized and transform the lives of 84 million people. In India, from Paleolithic era, we worship natural power like Sun, Wind, Water, Earth, etc. (Artha Sastra). The involvement of religious groups and leaders in the politics of climate change will be a welcome sign, which can change the core value of society to consume just enough (Ghosh 2016).

India generates 55 million tonnes of wastes annually. Only 15% of the above can be classified as non-biodegradable, non-recyclable hi-calorific value wastes, which translates into above 30000 tonnes per day of wastes with the increase in population. Quantum of wastes is growing at 4% - plus annually. Though the use of plastic bags is being banned

here, thermocol (polystyrene) plates and bowls (which is more harmful) are continuing to sell like hot cakes across. Thermocol products when burnt, release poisonous gases in the environment leading to respiratory diseases and even death and also non-biodegradable.

While we are struggling to meet expectations of the community, there is a need for paradigm-shift in the context of 21<sup>st</sup> Century life style and behavior. We need an integrated, long-term social, ecological and economic sustainability. This requires architectural design of buildings, street scaping, photovoltaics and micro grid at residential and non-residential and community levels, adequate ventilation, planting of saplings. The harmful effects of waste on health of human beings are innumerable like cancer, congenital malformations, Neurological disease & chemical inhalation. Further waste can obstruct the storm water runoff resulting in flood & degrades water & soil quality. Conservation of energy should be strict norms for architectural design for buildings and streets in urban agglomeration. Safe disposal of chemical and bio-wastes, sustainable transport system with last mile connectivity should be part of holistic planning.

### Waste To Energy or Waste Management

Through a variety of process like combustion, gasification, pyrolyzation, anaerobic digestion, and landfill gas recovery waste can be converted into energy. However only non-hazardous waste to be used for energy recovery. It is a renewable energy source and can reduce carbon emissions by offsetting the need for energy from fossil sources as well as reduce methane generation from landfills. Globally, waste-to-energy accounts for 16% of waste management.

We should not look at the wastes only for generating energy as we are not segregating wastes properly. Further, we are having only 48 waste treatment plants presently, which need to augment 30000 TPD. Further, electricity produced from these wastes more expensive compare to other sources of renewable energy like solar, wind plants. We need to look at these wastes for management and treatment and not for generation of energy.

### Waste Management in Arthashastra

In the Arthashastra of Kautilya, we can find wholesome rules for hygiene, some of which we do not find even in modern society. People had to pay fines of throwing dirt on the road and for blocking it with dirty water. The fine would double if such nuisance were committed on highways. People had to pay fines for passing urine and for similar bad habits indulged in holy places, in a place for storage of water or on royal property. These rules suggest that dustbins for throwing rubbish and public lavatories on roads and public places were provided in the cities. Kautilya's town planning gives us an insight into his deep sense of beauty and cleanliness. He is also aware of the civic amenities. Special rules have been made for public convenience and breach of such laws shall be getting both criminal and civil proceedings. It is due to the hygienic concept in the formation and development of the villages. Similarly, if a person throws the filthy matter on the other and thus transgresses hygienic social norm he is liable for punishment. This rule particularly applies to those who have dirtiness of hands.

### Trends of waste disposal

The City of Gurgaon and Faridabad respectively generates 700 tonnes & 800 tonnes of wastes per day. Management of wastes produced in city has been outsourced by the Municipal Corporation of Gurgaon. Wet and dry wastes segregated by Residents in separate bags are collected from their door steps at some charges by outsourced agency. Waste to energy plant located at Bandhwari is capable of handling 600 tonnes of garbage per day.

The sanitation regulations in 10 Gram Panchayats of Ganjam of Odisha, to be enforced by 30th September 2019, while the whole district will be covered by March 31, 2020. Initially the Gram Panchayats of Chamakhandi in Chhatrapur block, Malada in Ganjam, Nadika in Hinjili, Langaleswar, Pathara, Kanheipur, Keshpur, Srikrushnasaranpur, Kairasi and Bikrampur in Khalikote block have been covered. Action plan for the management of solid waste, charges for collecting and fines for violators was prepared by each Gram Panchayat after evaluating local practices. While Rs.10 per month will be collected from each rural household for garbage disposal, hotels, lodgings, bank police stations, government and private offices, hospitals and educational institutions will be charged with Rs.500. Rs.100 to Rs.500 will be collected from business establishments. Rs 2000 per month will be charged from Residential schools and colleges, village hotels, bus stands,

railway stations and meeting venues. Entire levies and penalties for violators were decided collectively with all stakeholders such as the Panchayat Raj Institutions, the district officials and NGOs. Fine of Rs.100 to Rs.400 levied for shopkeepers dumping plastic, polythene and non-biodegradable items and fine of Rs.1000 for hotels, lodgings, food stalls, chicken and mutton shop owners. While large industries to be fined Rs. 20000, small and medium industrial units to be fined of Rs.400 – Rs.1600 and Kalyan Mandaps of Rs. 4,000.

Waste is collected by the city council, in Taipei and Malaysia only if it is put in government issued rubbish bags. In Taipei, charges depends on the volume of rubbish from households and industries. In Malaysia, an estimated 20% of waste is burned or dumped into rivers or at illegal sites, while 5% of waste is recycled and 75% of waste is disposed off in 130 landfills and dumps. Municipal solid waste exceeds 19000 tonnes daily in Malaysia. The Government of Malaysia is proposing to establish incineration plants with an emphasize on Reduce, Reuse and Recycle.

In Xicheng street of China, QR coded garbage bags help buildings management figure out of the right trashes dropped into the right bin and good waste sorting is rewarded based on accumulated points with eggs, salt, toilet rolls, detergents or eraser for kids. While systematic and precise separation of disposal of garbage and its recycling is existing in Japan. Each city of Japan has its own rule, but in general, the garbage is categorized in 4 types with collection date for each. Accordingly, 4 different trash cans will be in each apartment. If anyone missed the collection day, they have to wait next turn.

The Department of the Environment's Zero Waste Program of San Francisco has led the City to achieve 80% diversion, the highest diversion rate in North America. Zero Waste by 2020 is the goal set by San Francisco by establishing Mandatory Recycling and Composting Ordinance. This Ordinance proposes everyone in the city to keep recyclables and compostable out of the landfill. The three streams are collected with the different coloured bin – blue for recyclables, green for compostable, and black for landfill-bound materials – provided to residents and businesses and serviced by San Francisco's sole refuse hauler, Recology. The City's "Pay-As-You-Throw" system charges customers by the volume of landfill-bound materials, which provides a financial incentive to separate recyclables and compostable from other discards. The food wasted by the US & Europe is estimated, could feed the



world three times over. Excess consumption of freshwater and forest fuels along with methane and Carbon-di-Oxide emission from decomposing food are other bi-products of food wastage also influences global climate change. Every tonne of food waste prevented has the potential to save 4.2 tonnes of Carbon-di-Oxide equivalent (US Environment Protection Agency 2009).

### Methods

Incineration, a method commonly used in developed countries is most suitable for high calorific value waste with a large component of pathological waste, plastic, packaging material, etc. It can convert waste to innocuous material by reducing volume of waste by more than 90% with energy recovery. This plant can be located within city limits and relatively odorless, hygienic and noiseless. However, it requires large capital and skilled manpower.

In Bangalore method of composting, trenches of 3 ft. deep and 5-8 ft. broad, 15-30 ft. long are dug for sludge, refuse and night soil. Through fermentation process, compost is formed.

To reduce greenhouse emissions and fossil fuel combustion and also to facilitate generation of renewable energy from organic waste, anaerobic digestion can be used. Methane is up to 75% in Biogas and this can replace fossil fuel. This will help in getting sustainable energy with least impact on environment. Biogas can be cleaned & upgraded and also can be compressed. It can become cost effective with proper technology.

### Recommendations

The schemes launched by the Government such as Atal Mission for Rejuvenation and Urban Transformation (AMRIT), Heritage City Development and Augmentation Yojana (HRIDAY), National Mission for Clean Ganga (Namami Gange), Pradhan Mantri Awas Yojana (PMAY) Smart City Mission and Swatch Bharat Mission, are somehow connected to waste management and treatment. The statutory provisions & norms like Environmental Protection Act, 1986, Hazardous Waste Rule 1989, Waste Management Act 1996, Bio-Medical Waste Rule 1998,

Municipal Solid Waste Rule 2000 and Solid Waste Policy in India 2006 are there in its place to regulate waste management. However, public awareness in segregating the waste, different trash cans and door to door collection to be effectively put in place. We also can think of 'incentivizing segregation' and 'levying collection'. The interest of future generation need to be handled wisely.

### References

- 1) Agamuthu Periathamby, Fauziah Shahul Hamid & Kahil Khidzir, "Evolution of Solid Waste Management in Malaysia: Impacts & Implication of the Solid Waste Bill 2007", Waste Management 11:96-103, Springer 2000
- 2) Atelge.M.R.,Krisa D, Kumar G et al , "Biogas Production from Organic Waste:Recent Progress & Prospectives", Waste Biomass Valorization,pp1-22, Springer Netherlands, ISSN 1877-2641, 2018
- 3) Ashwani Kumar, "Despite harmful effects, thermocol widely used", Times of India 11<sup>th</sup> August, 2019
- 4) Dolly Khatter, "Waste No More", Renewable Watch Vol.9, 9<sup>th</sup> July, 2019
- 5) Energy Recovery from Waste USEPA 2014
- 6) Ghosh Amitrav, "The Great Derangement: climate change and untenable", Allen Lane India 2019
- 7) M de Jung, "Sustainable Smart Resilient Low Carbon – eco Knowledge making serve of a multiple concepts promoting sustainable urbanization", Journal of Cleaner Production, P-32, Elsevier Ltd, 2015
- 8) Mohamed Y Mustafa,Rajesh K Calayb & Romanc," Biogas from Organic Waste A case Study",Procedia Engineering, Elsevier 2016
- 9) Novina Jafa, "Ecological dharma", P-11 - Indian Express, 1<sup>st</sup> July, 2019
- 10) Raj Libeshan, "Our urban Ethos & Pathos", Millennium Post, 5<sup>th</sup> Sept., 2019
- 11) Sampad Patnaik, "Waste Management" Rs.10/- per house", Indian Express 9<sup>th</sup> Sept., 2019
- 12) Visited Wikipedia on 5<sup>th</sup> & 16<sup>th</sup> September 2019
- 13) Waste Hierarchy, New Energy Corporation 2014.

