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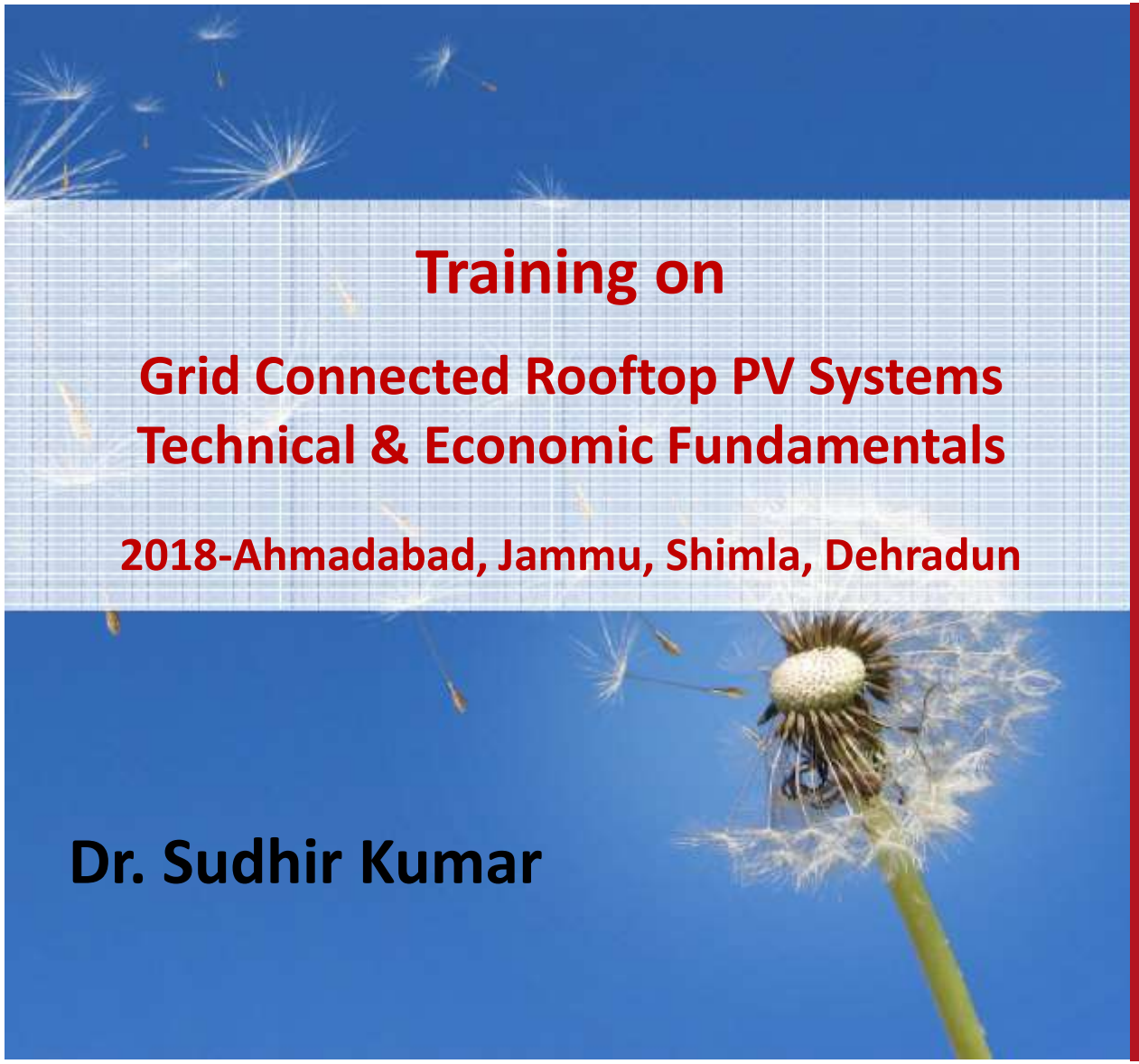

Training on

Grid Connected Rooftop PV Systems
Technical & Economic Fundamentals

2018-Ahmadabad, Jammu, Shimla, Dehradun

Dr. Sudhir Kumar

renac
renewables academy

In cooperation with:

Steinbeis Centre for Technology Transfer India

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

www.renac.de

Solar Resource Assessment

Method of Radiation Measurement

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- **Land-based measurement**
  - Radiation Measurement Stations
  - Global Horizontal Irradiance (GHI) – **Pyranometer**
  - Direct Normal Irradiance – **Pyrheliometer**

- **Satellite derived data**
  - Offer a wide geographical coverage
  - Historical periods where no ground-based measurements were taken
  - Provide long term averages
  - Data are not susceptible to maintenance and calibration discontinuities
  - Bias errors are consistent due to same sensor is used
  - Useful in comparing and ranking sites
  - Comparison of the **GHI** values obtained from satellite readings **correspond** well with ground-measured data
  - In the case of **DNI** values **No** such relation observed

Data Sources for Solar Radiation

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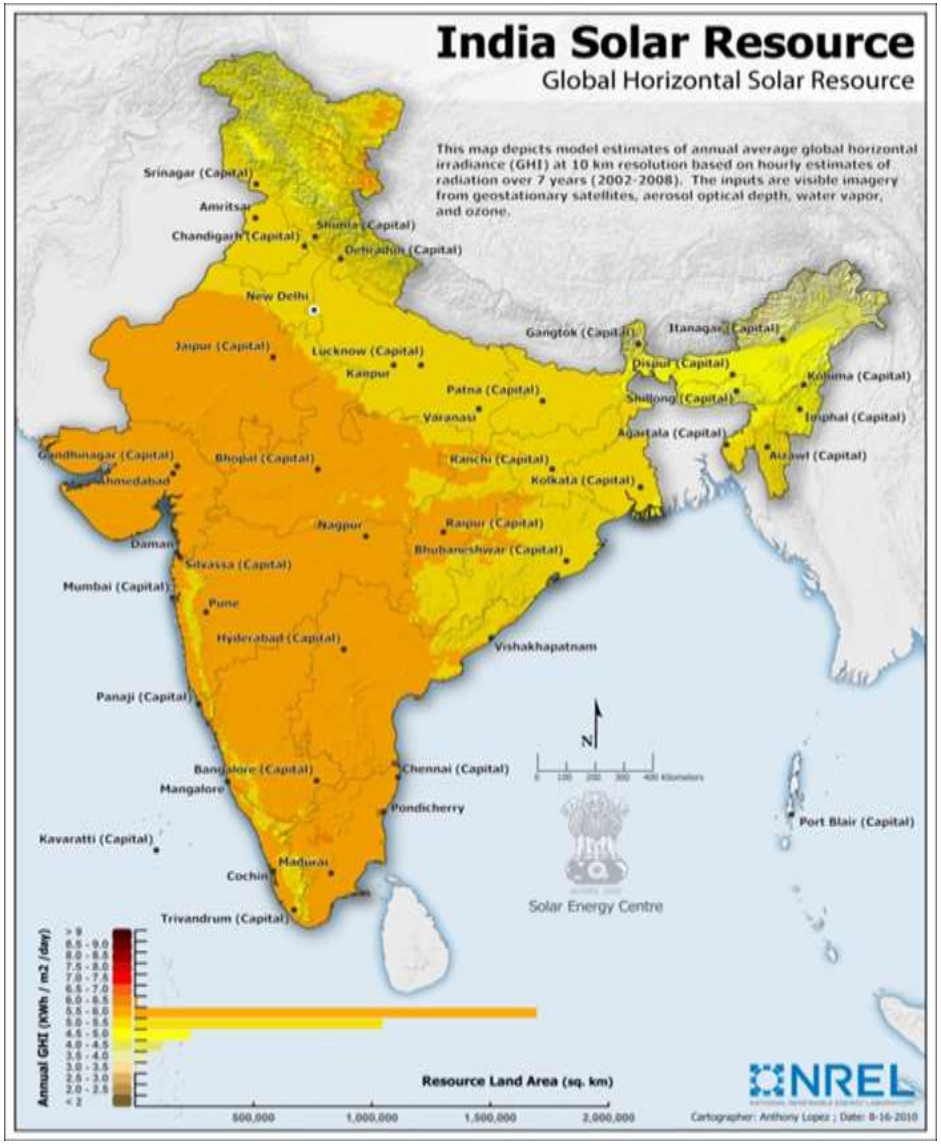
- MNRE-NREL Database
- National Institute of Wind Energy (NIWE)
- METEONORM Software

MNRE -NREL Database

- Products developed by the National Renewable Energy Laboratory (NREL) with SEC,MNRE
- Solar Resource Assessment based on satellite imagery
- 8 yrs data Jan 2002 to Dec 2008
- Spatial Resolution: 10 km x 10 km
- Better than NASA
- Free of cost Map, No site specific data http://mnre.gov.in/sec/solar-assmnt.htm



National Institute of Wind Energy (NIWE)

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- World's largest net work of solar radiation resource assessment stations
- National Institute of Wind Energy (NIWE), formerly Centre for Wind Energy Technology (C-WET), Chennai
- Total 123 Nos. Solar Radiation Resource Assessment Stations in the Country
- SRRA station consists of two towers:
  - The 1.5 m tall tower:
    - Pyranometer and Pyrheliometer to measure GHI, DNI, DHI
  - The 6 m tall tower:
    - Ambient temperature, Relative humidity, Atmospheric pressure, Wind speed and direction, Rain fall

NIWE-SRRA (Solar Radiation Resource Assessment)

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- The solar sensors are traceable to the World Radiometric Reference (WRR) and the meteorological sensors are traceable to World Meteorological Organization (WMO)
- Data is sampled every second and averaged over a minute and transmitted to the Central Receiving Station (CRS) established at NIWE through GPRS mode.
- Spatial resolution: 3 km X 3 km (Good Resolution)
- Annual average values of GHI, DNI and DHI are provided
- Just 1 to 6 years quality ground measured solar data used for geographical adjustment and validation of the long term (1999-2014) data from Meteosat-5 and Meteosat-7

http://www.niwe.res.in/indian_solar_atlas.php

NIWE-SRRA Data Available Free of Cost

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- In order to facilitate solar power developers, stake holders, policy makers, R&D institutions, NIWE has been providing various SRRA data products on a commercial mode till April 2017.

- Ministry (MNRE) vide a circular in May 2017 has indicated that, the SRRA data has to be put in public domain without charging any cost.

- As directed by MNRE, NIWE has developed a web portal to facilitate general public to download solar radiation data. The link of the web portal is as follows.

  http://niwe.res.in/index_map_1.php

NIWE – Sample Data Sheet

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NATIONAL INSTITUTE OF WIND ENERGY

(An Autonomus Research and Development Institution under the Ministry of New and Renewable Energy)

Government of India

Velachery-Tambaram Main Road, Pallikarani, Chennai -600 100

Solar Radiation Resource Assessment (SRRA)

Summary of Monthly Values of Solar Radiation and Meteorological Parameters

Month: February-2015

Station Name	Station ID	State	District	Date of Com-missioning	Latitude[°N]	Longitude[°E]	Elevation[m]
Chennai	1791	Tamil Nadu	Chennai	2011-05-28	12.96	80.22	1

2015-02	GHI*	GHI	DNI*	DNI	DHI*	DHI	AT	RH	AP	RA*	WS	WD
	[kWh/m^2/d]	[W/m^2]	[kWh/m^2/d]	[W/m^2]	[kWh/m^2/d]	[W/m^2]	[°C]	[%]	[hPa]	[mm]	[m/s]	[°]
average	5.70	238	5.39	225	2.04	85	25.8	85	1011	0.0	2.6	62
min	3.80	0	0.69	0	0.98	0	20.3	35	1006	0.0	0.1	2
max	6.76	993	8.27	1001	3.40	587	31.0	100	1017	0.5	59.6	345
sum [kW-h/m^2],[mm]	160	160	151	151	57	57	-	-	-	1.0	-	-

GHI	Global Horizontal Irradiance	AT	Air Temperature	WD	Wind direction
DNI	Direct Normal Irradiance	RH	Relative Humidity	AP	Atmospheric Pressure
DHI	Diffuse Horizontal Irradiance	RA*	Rain Accumulation	WS	Wind Speed

DNI: NIWE, INDIA-123 Stations

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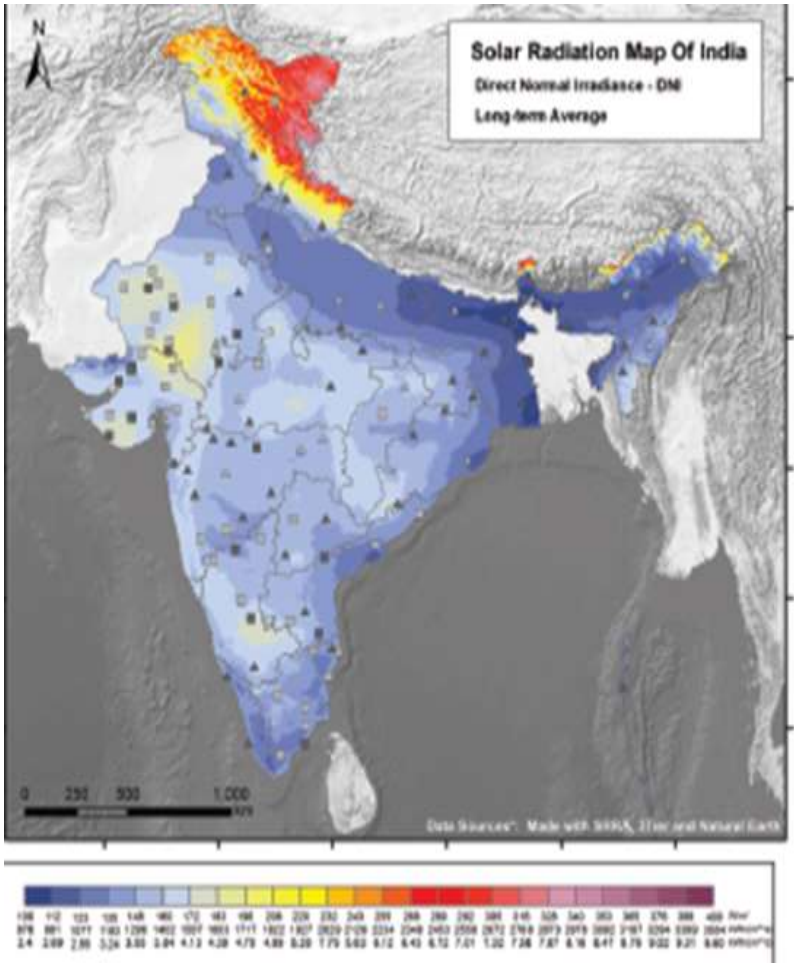
- SRRA Map prepared by NIWE/MNRE under SOLARMAP Project sponsored by The Federal Environment Ministry (BMUB) executed by GIZ, Germany with technical support of Suntrace GmbH

- Values given in three lines top to bottom are W/sqm, kWh/sqm/yr and kWh/sqm/d

- Square and triangle symbols represent phase 1 and phase 2 installations respectively of SRRA stations

- Dark and blank symbols represent validated and adjusted values respectively

- 3-Tier (1999-2014) and SRRA measurement data (2012-14) applied by Suntrace GMBH



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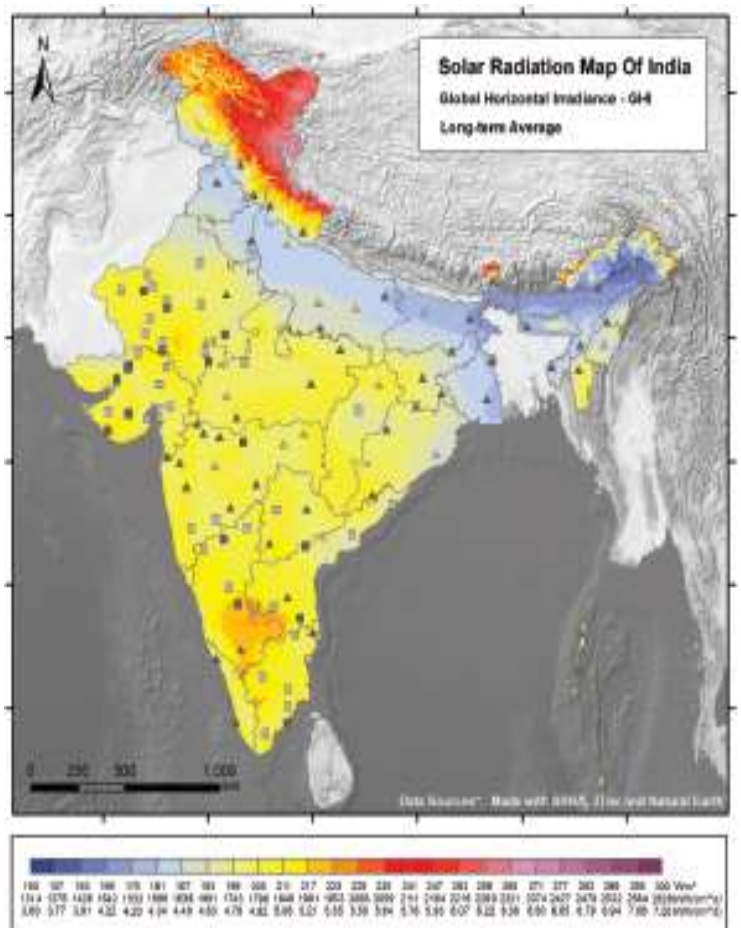

METEONORM Software

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- Data Period: 20 yrs 1981-2000
- Fixed database contains 6200 cities , 8000 weather stations and 1162 Design Reference Year (DRY) sites
- Resolution = 1.85 km x 1.85 km
- Actual site within 50 km of Reference site : Data from METEONORM Meteorological Station
- Actual site more than 50 km but near than 300 km from Reference site - A mixture of ground and satellite information
- Actual site more than 300 km from Reference site- Satellite data
- Data at every location of the globe available
- Better accuracy in simulation: Very close to ground data
- Generated data files compatible with PVsyst designing software
- Paid data source (Now comes as package with Pvsyst)

Conclusion

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S.N.	Data Source	Remarks
1	SEC-NREL	Data for exact latitude, longitude is not available
2	NIWE	Free data is good option although efficacy yet to be proven
3	METEONORM	For most of the sites data is interpolated fairly accurately

Meteonorm is preferred due to high resolution, global applications and conservative approach

Site Feasibility Analysis

Solar Resource

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- Higher the solar energy resource, the greater the energy yield per kWp installed
- Ideally more than 1500 kWh/sq m /year required for an SPV power plant
- For rooftop solar, less than 1500 kWh/sq m /year is also accepted

Project Area Required

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- Depending on the type of PV modules selected (efficiency) and the site location (latitude)
- Sufficient area to avoid significant inter-row shading
- Crystalline modules - 7 sqm/kWp
- Thin film modules - 10 sqm/kWp

Local Climate

- Temperature : Efficiency reduces with increasing temperature
  - Thin Film PV module (-0.25%/^{0}C)
  - Crystalline PV module (-0.45%/^{0}C)
- Saline or Corrosive Air: the risk of erosion of support structure and foundations
- High wind speeds: Locations with a high risk of damaging wind speeds should be avoided
- Seismic zone: Earthquake proof structure
- Snow : Snow settling on modules reduce annual energy yield

Roof Topography

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- The roof should be ideally flat
- Type of Roof: Flat concrete, Slanted tiled, Tin, Corrugated
- Condition: Load bearing capacity
- Slope Roof: Prefer south facing
- Slope tolerance< 3-5%
- Distance of array from charge controller, battery, inverter
- Shadow free area: Visit 9am, 1pm and 4pm (photographs 4 sides)
- Parapet walls and columns position
- Whether elevated structure needed

Permission and Approvals

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- If individual building: Permission from local government (Municipal and Gram Panchayat Authorities)
- If society or condominium: Whether approved by GBM
- Any other local public issues: Reflection glare to nearby building
- Electrical wiring and grid connectivity norms

Access To Project Site

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- To carry material during construction, commissioning and decommissioning
- Easy operation and maintenance
- Availability to large water source in case of fire (any quality)
- Clean, low mineral content water for cleaning modules: 15-20 liters/kW panel

Module Soiling Possibility

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- Efficiency of the solar plant could be significantly reduced: Typically 2-5 % losses
- Dust particles from traffic, building activity, agricultural activity or dust storms
- Fumes from industrial chimneys using petroleum coke: Soot with Ammonia, Sulphur dioxide
- Bird excreta: Areas close to bird breeding areas and lakes should be carefully assessed

Thank You