

Renewable Energy Developments in India

MINISTRY OF NEW AND RENEWABLE ENERGY

Renewable Energy Programmes / Schemes

The Programmes and Schemes of the Ministry are classified in following Five Groups:

- Grid Interactive and Distributed Renewable Power
 - Grid - Interactive
 - Off-grid power systems
- Renewable Energy for Rural applications
- Renewable Energy for Urban, Industrial & commercial applications
- Research , Design, & Development in RE
- Support Programmes

Renewable Energy Programmes / Schemes

I- GRID-INTERACTIVE AND DISTRIBUTED RENEWABLE POWER

- (A) Grid-interactive
- Wind Power
- Small Hydro Power
- Solar power*
- Biomass Power (Combustion)
- Biomass Power (Gasification)
- Bagasse Cogeneration
- Urban & Industrial Waste to Energy

Renewable Energy Programmes / Schemes

II - RENEWABLE ENERGY FOR RURAL APPLICATIONS

- Family type biogas plants
- Other Biogas applications
- Cook Stove
- Solar Cookers
- Solar Cookers for schools Large size
- RVE Programme

Renewable Energy Programmes / Schemes

III- RENEWABLE ENERGY FOR URBAN, INDUSTRIAL & COMMERCIAL APPLICATIONS

- Solar Thermal Systems
 - Flat Plate Systems*
 - CST based systems*
- Green buildings*
- Solar Cities/pilot/ related activities*
- Alternate fuel vehicles

Renewable Energy Programmes / Schemes

IV- RESEARCH, DESIGN & DEVELOPMENT IN RE

- Bio-Energy -
 - Bio-fuel
 - Biogas
 - Biomass Gasification
 - Waste-to-Energy
 - Cook stoves
- Solar Energy*
- Wind Energy
- Small Hydro Power
- New Technology:
 - Hydrogen Energy & HEFC Fuel Cells
 - Tidal Energy
 - Geo Thermal
 - Battery Operated Vehicles

Renewable Energy Programmes / Schemes

V - SUPPORT PROGRAMMES / Activities

- Information and Publicity
- International Relations
- HRD & Training
- Monitoring & Evaluation
- IREDA Equity
- e - governance
- Support to SNA
- Solar Energy Corporation*
- National Renewable Energy Corporation

Wind Power



Potential : 49,000 MW
Achievement : 17,352 MW

11th Plan Target/ Achievement: 9,000 MW/ 10,260 MW

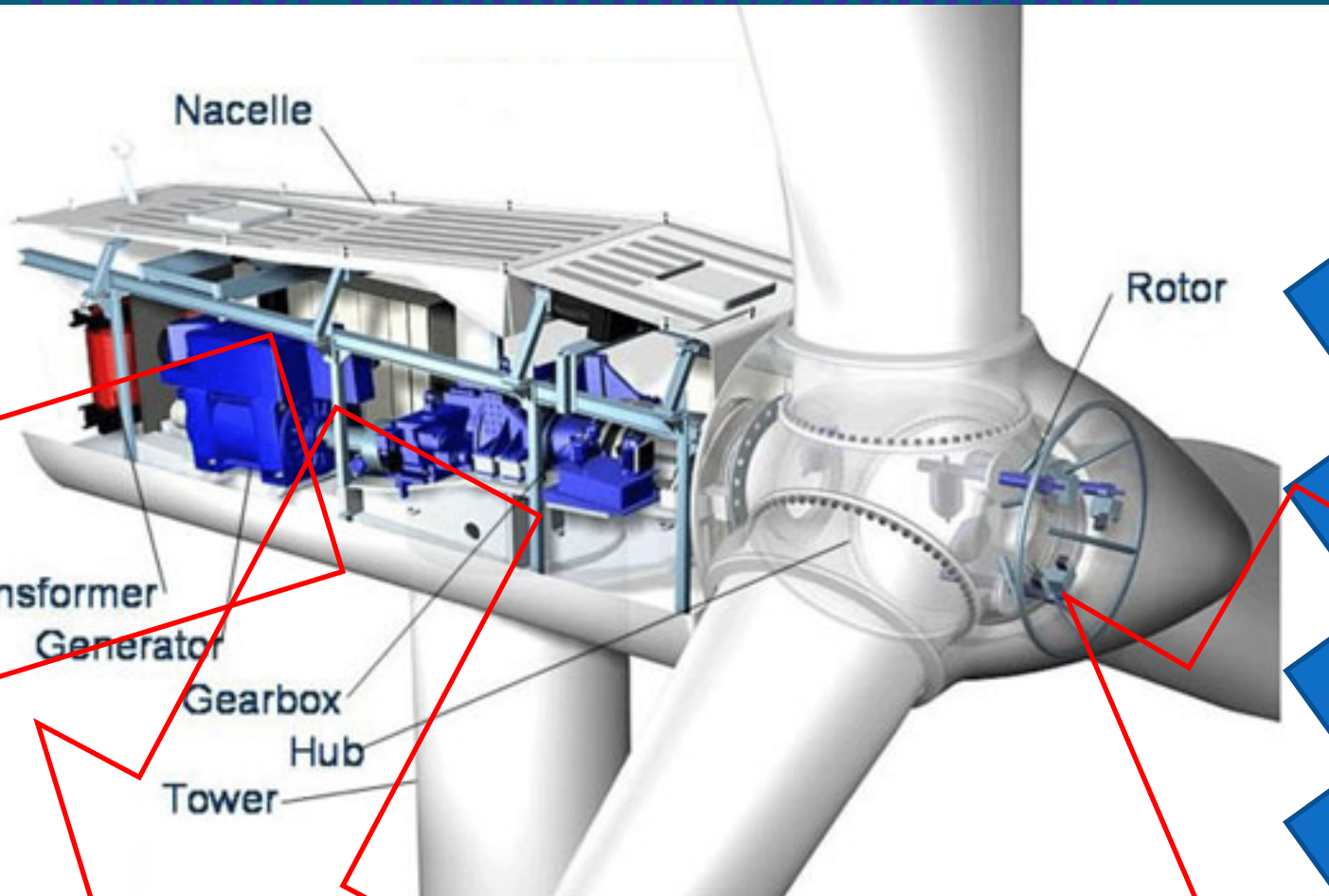
Deployment target 12th Plan : 15,000 MW.

Strategy:

- Accelerated depreciation to go away
- GBI scheme to be reviewed after 11th Plan and continued for 12th Plan for up to 4,000 MW capacity projects.
- Wind Resource activities to be substantially increased.
- Evacuation infrastructure to be developed.
- Separate RPO for wind. Enforce RPO. Make REC work.
- Work towards competitive bidding.



Wind Turbine Technology/Principle



Electrical
Energy

Mechanical Energy

Kinetic Energy gives
Power of wind

$$P_{\text{wind}} = C_p \frac{1}{2} \rho A V^3$$

Technology Status

- Technology trends towards up-scaling of wind turbine size
- Rotor diameter of 120m and capacities ranging from 5 to 7 MW
- World's largest wind turbine of unit size 7 MW developed and installed in Germany.
- Current average installation trends
 - Global : 1.5 - 2.5 MW unit size
 - India : 1.0 -2.0 MW unit size
- Global research areas
 - Off shore applications
 - large scale grid integration issues
 - wind forecasting

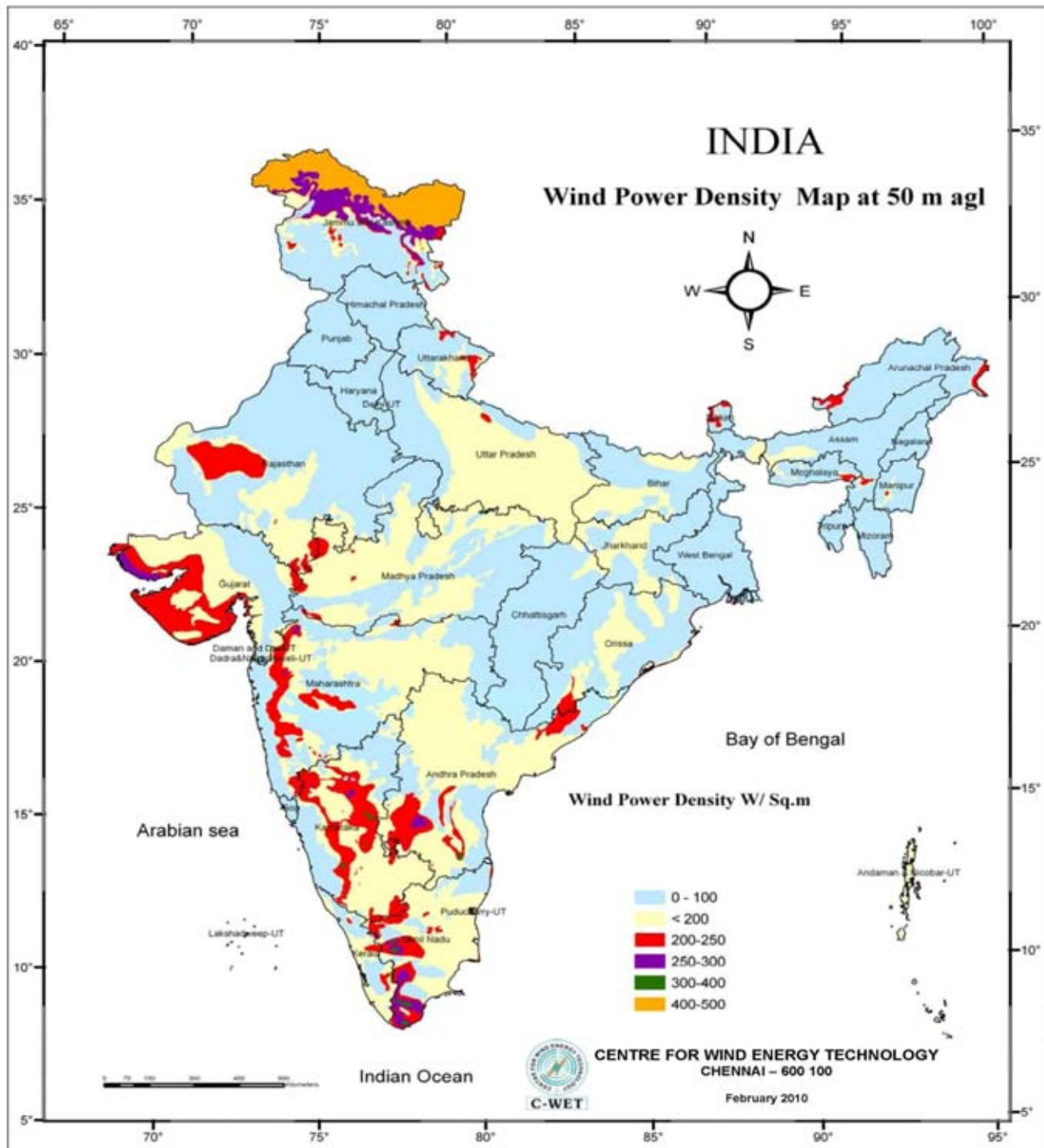
Wind Power Technology in India

- Well established technology up to 2.5 MW single turbine
- Wind turbines of late 80s : 250 kW unit size ; 30 m rotor diam.
- Current:
 - 250-2000 kW unit size being manufactured and installed in the country
 - 40 turbine models, 18 manufacturers
 - 70 % indigenization achieved upto 500 kW. Import contents high in higher capacity machines.
 - Critical components such as gear box, rotor blades, generators, controllers indigenized in last few years
 - Exports to USA, Australia, China, South Korea, Japan, Sri Lanka
 -

C-WET: Major R&D Activities

- Development and validation of design methodologies and design tools for low and moderate wind regimes
- Improve competence for design of indigenous blades.
- Wind energy forecasting
- Indian Wind Atlas development and publication
- Wind data- indicative potential anywhere in India, at different heights 50m and 80m
-





Wind Resource Assessment

- 31 States and UTs covered under Wind Resource Assessment Programme
- Wind monitoring carried out at over 600 locations
- Monitoring stations normally closed after collection of data for about 24 months
- At present 92 stations are in operation
- Wind Atlas prepared for India
-
- Recent efforts to carry out measurement at 100 m height
- Efforts also on for offshore Wind Resource Assessment

Small Hydro Power



Potential : 15000 MW

Achievement : 3395 MW

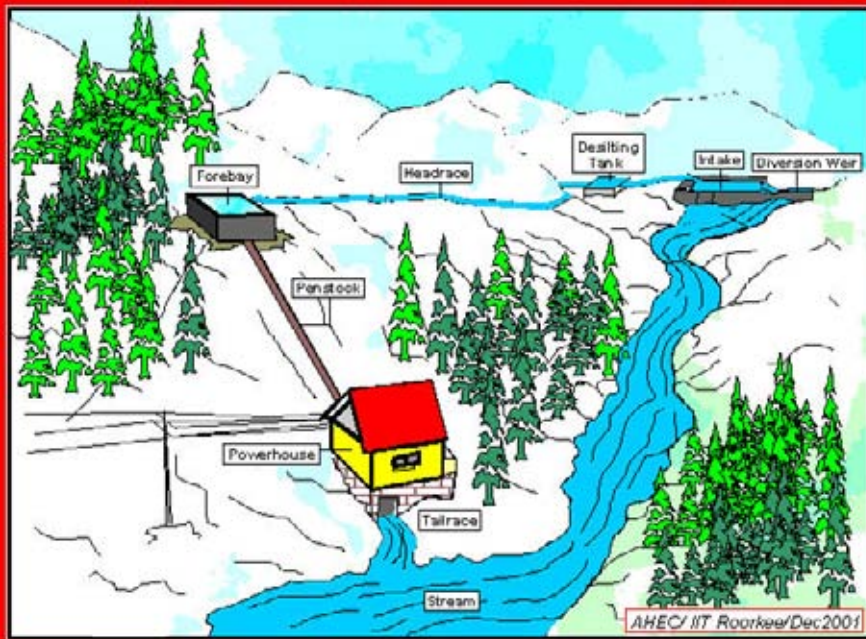
11th Plan Target/ Achievement: 1400 MW / 1419 MW

Deployment target 12th Plan : 2100 MW.

Strategy:

- **Private sector participation**
- **Performance based incentivisation for State sector / NE**
- **Small plants to get higher support.**

Rajwakti Uttarkhand



Typical Arrangement of Small Hydro Power Station





Typical Arrangement of Canal Fall Small Hydro Power Station

NARANGWAL
Punjab





SHP Technology Status

- **SHP technology fully mature in the country**
- **Equipment efficiency > 85%.**
- **Capacity Utilization Factor can be as high as 95%**
- **Over 20 equipment manufacturers**
- **Manufacturing capacity over 1000 MW**



2 x 15 Kw Nguriangbung Power House

SHP-R&D Activities

- Real time digital simulator set up at AHEC , IIT Roorkee
- Onsite project testing facility created.
- Model Turbine test and R &D bench being set up at AHEC
- Velocity Turbine developed by 2 manufacturers.
Demonstration project of 50 kW being set up in Punjab and 20 kW in Uttrakhand.

HYDRO PROJECTS



SHP Digital Simulator at AHEC



Bio-Energy Technologies

- **Biomass Combustion**

- Biomass used in boilers to generate heat/ steam to drive turbine for generating electricity.

- **Biomass Cogeneration**

- Simultaneous production of heat / steam and electricity

These technologies are fairly well established in the country.
Efficiencies of boilers / turbines comparable to best in the world.

- **Biomass Gasification**

- Conversion of woody and non-woody biomass such as Rice husk, arhar stalks, cotton stalks, wood chips etc. to producer gas

Technology successfully developed indigenously.

Biomass Power



Potential : 17000 MW

Achievement : 1150 MW

11th Plan Target/ Achievement: 500 MW/ 626 MW

Deployment target 12th Plan : 500 MW.

Strategy:

- **Promotion of small capacity biomass projects with biomass linkage and captive plantations.**

Bagasse Cogeneration



Potential : 5000 MW

Achievement : 1985 MW

11th Plan Target/ Achievement: 1200 MW/ 1369 MW

Deployment target 12th Plan :1400 MW.

Strategy:

- Promotion of BOOT/BOLT model in cooperative sector sugar mills.
- Promotion of optimum cogeneration potential in small size sugar mills (<2500 TCD).

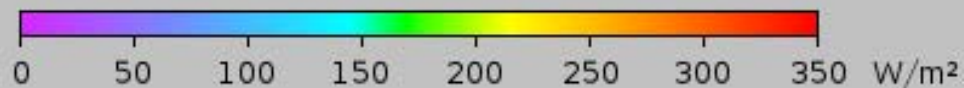
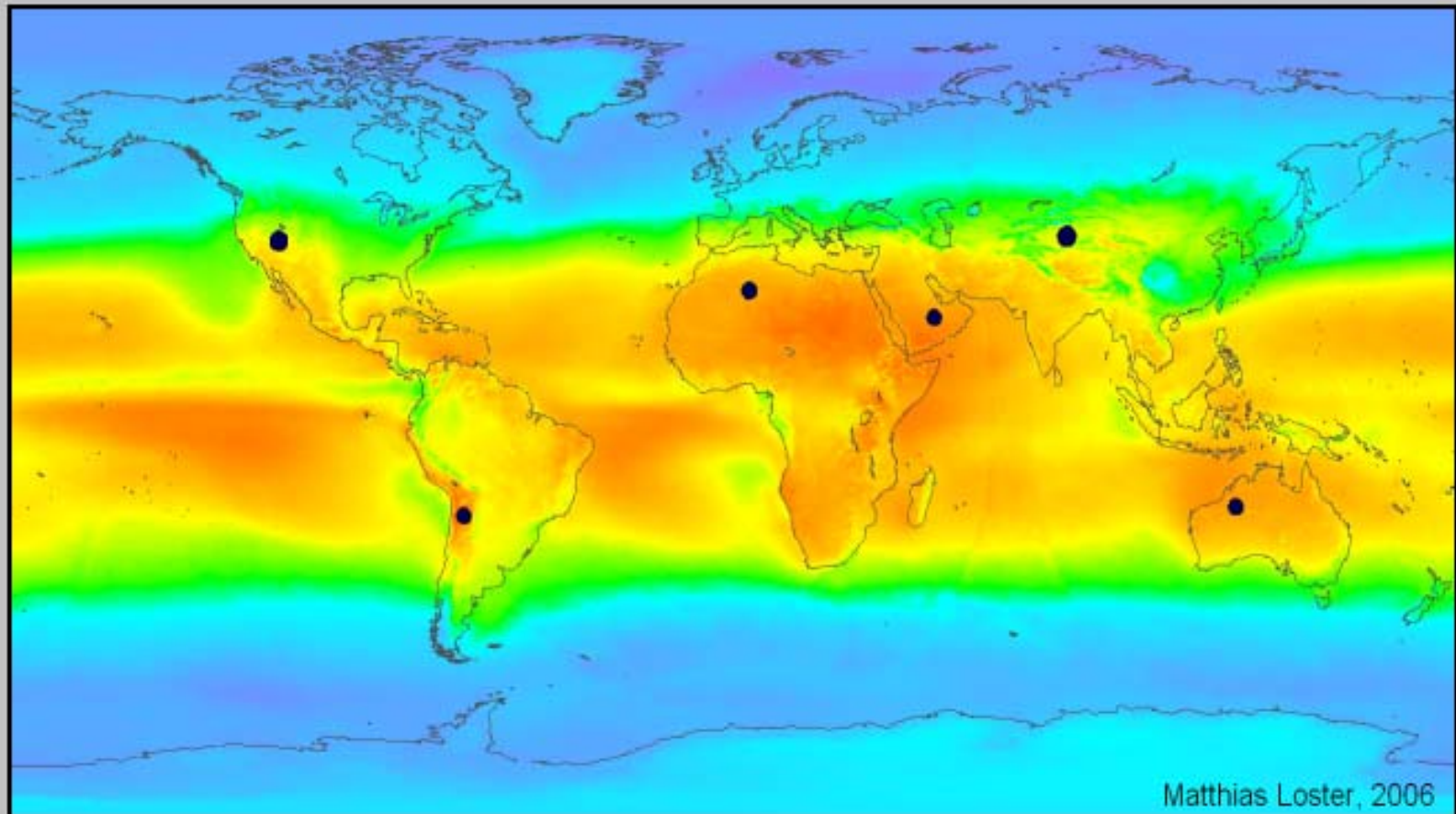
16.7 MW Bagasse Co-generation Project in A.P. using 87 ata Boiler





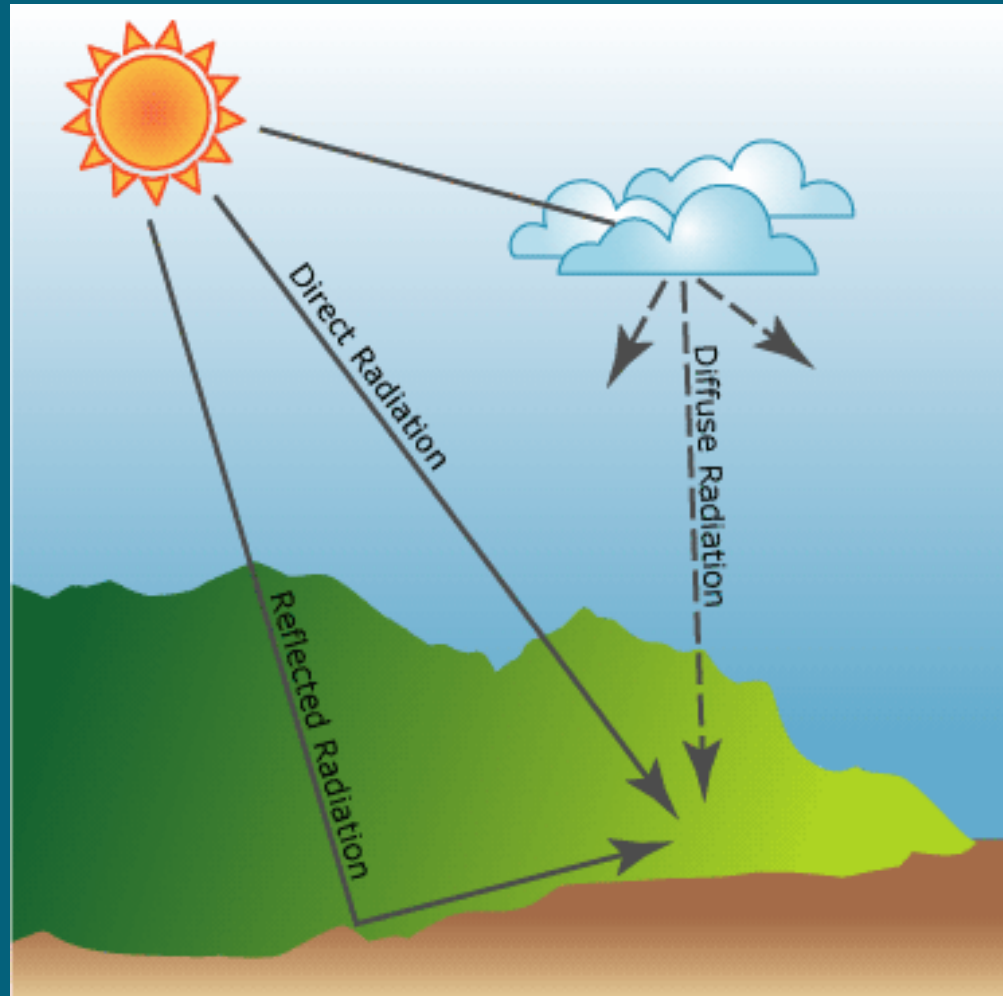
National Solar Mission

**India is in the solar belt of the world -
a potential region for utilizing solar energy**



$\Sigma \bullet = 18 \text{ TWe}$

Direct and Diffuse Solar Radiation



Global Radiation = Direct Radiation + Diffuse Solar Radiation

Solar Energy and Solar Mission



Potential : 30-50 MW/ sq. km

Achievement : 979 MW

Over 18 lakh SPV Systems installed / distributed

11th Plan Target : 1100 MW
(incl. 2013)

Target for 12th Plan : 4000 MW.
Target for 13th Plan : 15000 MW.

Solar Mission

Targets

- 20000 MW grid by 2022 (state policies extra)
- 2000 MW off-grid by 2022
- 20 million households covered by solar lighting
- 20 m sq metres of solar thermal

Objectives

- Achieve grid parity by 2022
- Increase domestic manufacturing capacity
- Develop eco system for solar industry
- Develop manpower
- Support R & D

SPV APPLICATIONS



SOLAR LANTERNS

HOME & COMMUNITY LIGHTING

VILLAGE STREET LIGHTING

WATER PUMPING SYSTEMS

VILLAGE POWER PLANTS

VACCINE REFRIGERATION

TV SETS

RADIO RECEIVERS



SPV APPLICATIONS (CONTD.)



TELECOMMUNICATION

RAILWAYS

VLPTS FOR DOORDARSHAN

**BATTERY CHARGERS FOR
DEFENCE APPLICATIONS**

**UNMANNED OFF-SHORE OIL
WELLHEAD PLATFORMS**

POWER PLANTS





PARKING/PUBLIC AREA LIGHTS



First Pump Installed at Mukerian, Distt Hoshiarpur

Solar Water Heating Systems

Types of System



Flat Plate
Collector based system



Evacuated Tube Collector
based system

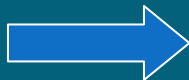


Solar Water Heaters for Cold Regions



Mahabodhi Int. Meditation
Centre, Near Leh

FPC based system with Heat
Exchanger and antifreeze fluid





MNRE

Solar Cooker

Solar dish cooker

- Cooks all kinds of food in 30 to 40 minutes
- Temperature : 300- 350 C
- Suitable for 10 to 12 people.
- Cost : About Rs. 7000
- Can save 8 to 10 LPG cylinders/ year
- Payback is about 3 years



Box Type Solar Cooker

- Suitable for 4-5 people
- Cost: Rs. 2000 – 3000
- Can save 2- 3 LPG Cylinders per year



Solar Steam Generating Systems

- Concentrating solar collectors are available to provide heat at temperatures up to 250 deg C
- Scheffler dish concentrators, 16 sq. m.
Cost: Rs. 12,000/sq.m.
- ARUN 160 solar dish concentrators, 169 sq. m.
Cost: Rs.18000/sq.m.



Solar Photovoltaics

International and National Status in Solar Cell

Japan, Germany, Australia and USA are the leading countries in research in SPV

Type of Solar cell	International Status	Indian Status Production (R&D)
Crystalline silicon solar cell (mono/multi)	Production : 15-17% R&D Lab: 24-25%	Production : 14.5 -17% R&D Lab: 19.7%
Thin-film solar cell a-Silicon Cd Te CIGS	6-9% (13%) 16.7% 19.4%	5 – 8% (9 – 12%) (12%) (13%)
Dye/ organic solar cells	10.4% / 5,15%	9.5% / 3%

Recent Initiatives in SPV R&D

- Development of poly silicon material (Maharishi Solar)
- 20 -22% efficiency single crystal silicon cells (IIT-Mumbai)
- 10 – 12% efficiency nano crystalline thin film modules (IACS-Kolkata, HHV-Bangalore, NPL-Delhi, BES University,-Howrah)
- 12- 15% efficiency CIGS cells (Moser Baer. NPL, IIT Kanpur)
- 10- 12 % efficiency Dye sensitized cells (Amrita Nano Centre, IIT-Kanpur)
- 5% efficiency organic-inorganic hetero junction cells (IIT-Delhi, Delhi University)

R&D in Solar Thermal Systems

- **Indigenous development of Solar Water Heating systems and Solar Cookers and full commercialization. Well established manufacturing base.**
- **Second generation technology developed using Selective coating absorbers**
- **Number of modes developed for Solar Box type and concentrating dish cookers.**
- **Scheffler cookers for indoor cooking for large kitchens.**
- **Concentrator technologies for steam generation and industrial process heat applications**

Setting up of 1 MW Solar Thermal Power

testing, research & simulation facility being set up at SEC through IIT Bombay & Industry consortium

- Combination of different collector technologies
- Direct and indirect steam generation to be demonstrated



Solar Dish Concentrator

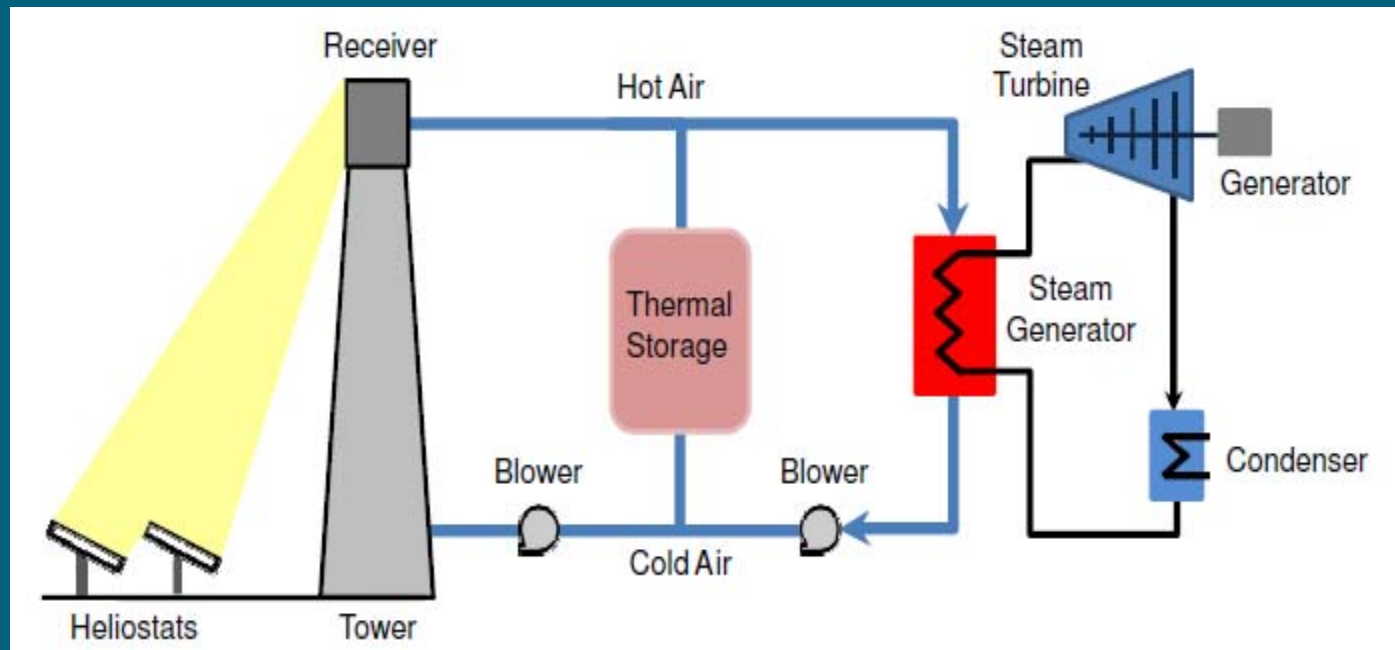
-an indigenous development project- MWS and SEC

Solar thermal Stirling engines (3 units of 3 kW each) performance evaluation at SEC jointly with ONGC Energy Research Centre)



CRISP Tower

(Collaborative Research Initiative in Solar Power Tower)
with Sun Borne Energy



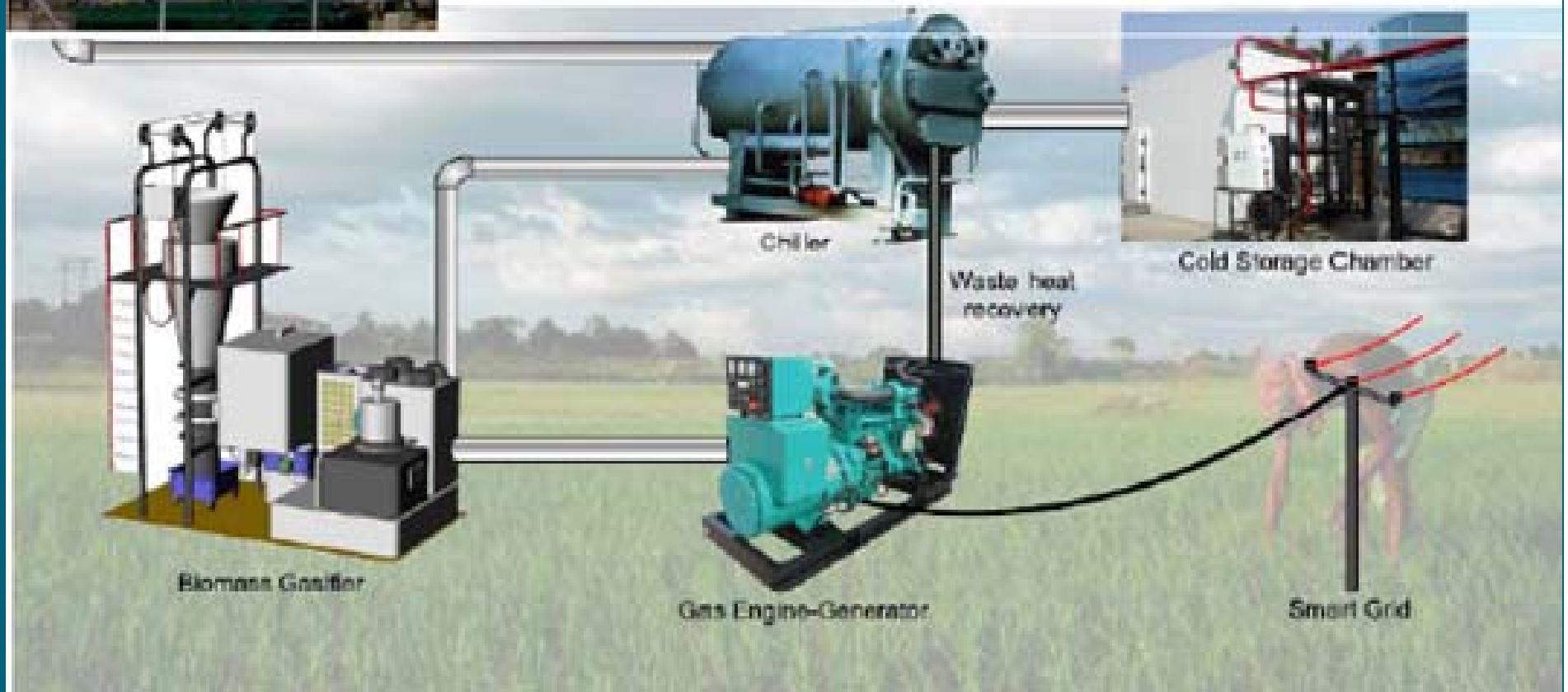
Critical components

- Receiver
- Heliostat design
- Thermal storage
- Solar power tower controls

Electricity & Cold Storage for Remote Rural Applications (SEC, Thermax, TERI)



- Electricity from biomass gasifier
- Cooling from engine exhaust
- Solar concentrators during solar hours



IMD and MNRE Network of Ground Measurements of Solar Radiation Facilities



MNRE has proposed to further expand this network in 12th Plan period

AUGMENTATION OF MONITORING NETWORK

- ❑ Aimed at to cover sites of high potential for solar power generation in Phase 1
- ❑ Installation and Commissioning of monitoring stations at 51 sites completed.

Andhra Pradesh	6	Chhattisgarh	1
Gujarat	11	Haryana	1
ladakh	1	Madhya Pradesh	3
Maharashtra	3	Karnataka	5
Pudducherry	1	Rajasthan	12
Tamil Nadu	6	C-WET	1

- ❑ C-WET, Chennai is implementing the project.
- ❑ Data from each station is received at Centralized Facility set up at C-WET for processing and analysis

Photographs of Some Sites



Vertej, Gujarat



Vellore, Tamil Nadu



Shegaon, Maharashtra

Strengths

- Dedicated Research Institutions
- Comprehensive Resource Assessment
 - Wind Atlas
 - Solar Radiation Mapping
 - Identification of Hydro Project sites
- World Class manufacturing facilities
- EPC Suppliers across the entire value chain- C2C
- Estimated employment to a million people
- Strong spirit of entrepreneurship, projects developed largely under private sector

Policy Support

- Tax & Duty concessions
- Capital & Interest Subsidy
- Pro-active regulators
- Preferential Tariffs/ Feed-in-Tariffs
- Energy buyback, wheeling & banking
- 15% RPO by 2020, RE Certificate Scheme

Technical Institutions

- Solar Energy Centre
- Centre for Wind Energy Technology
- Alternate Hydro Energy Centre
- Solar Energy Corporation of India
- State Level Nodal Agencies

Financial Infrastructure

- Dedicated RE Financial Institution – IREDA
- Dedicated Power sector financiers – PFC, PTC, REC
- Dedicated Infrastructure financiers – IDFC, IL&FS, PTC, IDBI, HUDCO
- Development Institutions – NABARD, SIDBI
- Growing interest of Banks

Wind Manufacturing

- Annual production capacity of 5000 MW, more than 60% export
- World-class manufacturing companies
- Size variants from 225 kW to 2100 kW
- 90% indigenization achieved

Solar Manufacturing

- World-class manufacturing companies
- Major global companies setting up base due to National Solar Mission
- Annual production capacity
 - 750 MW of PV Cells
 - 1250 MW of PV Modules
- Mega Capacity Solar Parks under progress

Boilers & Turbines

- About 9 manufacturers for Hydro turbines with size upto 25 MW
- About 9 leading manufacturers for boilers to support Bagasse Cogeneration and Biomass based power projects

Human Resource Capacity Building

- Specialized Courses in leading Institutes – IIT
- Business Incubation Centers – IIMA
- Adoption of Industrial Training Institutes by equipment manufacturers
- Fellowship programs
- Major Thrust to R&D

SOLAR PHOTOVOLTAIC INSTALLATIONS



SOLAR WATER HEATER INSTALLATIONS



SOLAR STEAM COOKER INSTALLATION



SOLAR WIND HYBRID INSTALLATION





SPV Water Pumping System at a agricultural farm in Punjab

SOLAR PV WATER PUMPING SYSTEM

- Models** : Several models up to 3000 Wp PV array
Most commonly used is 1800 Wp with 2 HP DC motor pump set sufficient to pump about 1,40,000 litres Water (10 metre head)
- Cost** : About Rs. 3.25 lakh of a 1800 Wp pumping system
- Central Assistance** : Rs. 110 per Wp subject to a maximum of 2.5 lakh per system. 90% financial assistance for 11 special category States
Soft loan from IREDA and Banks.
- Benefits** : Requires no fuel, easy to operate and maintain.
Suitable to irrigate about five acres land for most the crops.



THANK YOU