



# Workshop on Smart City Mission

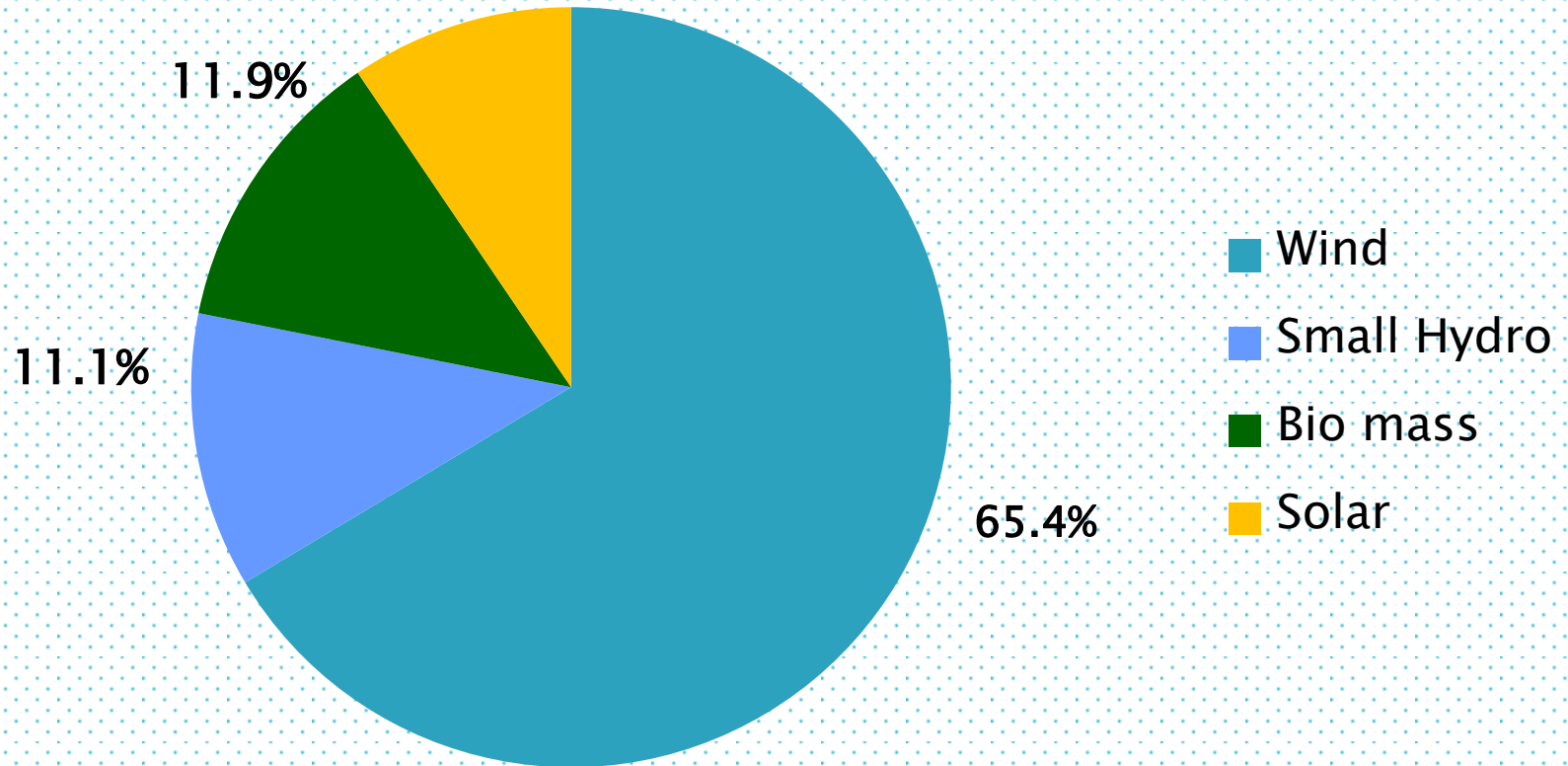
## Solar Energy Applications in Smart Cities

21<sup>st</sup> November, 2015 at

**Government of India**  
**Ministry of New and Renewable Energy**

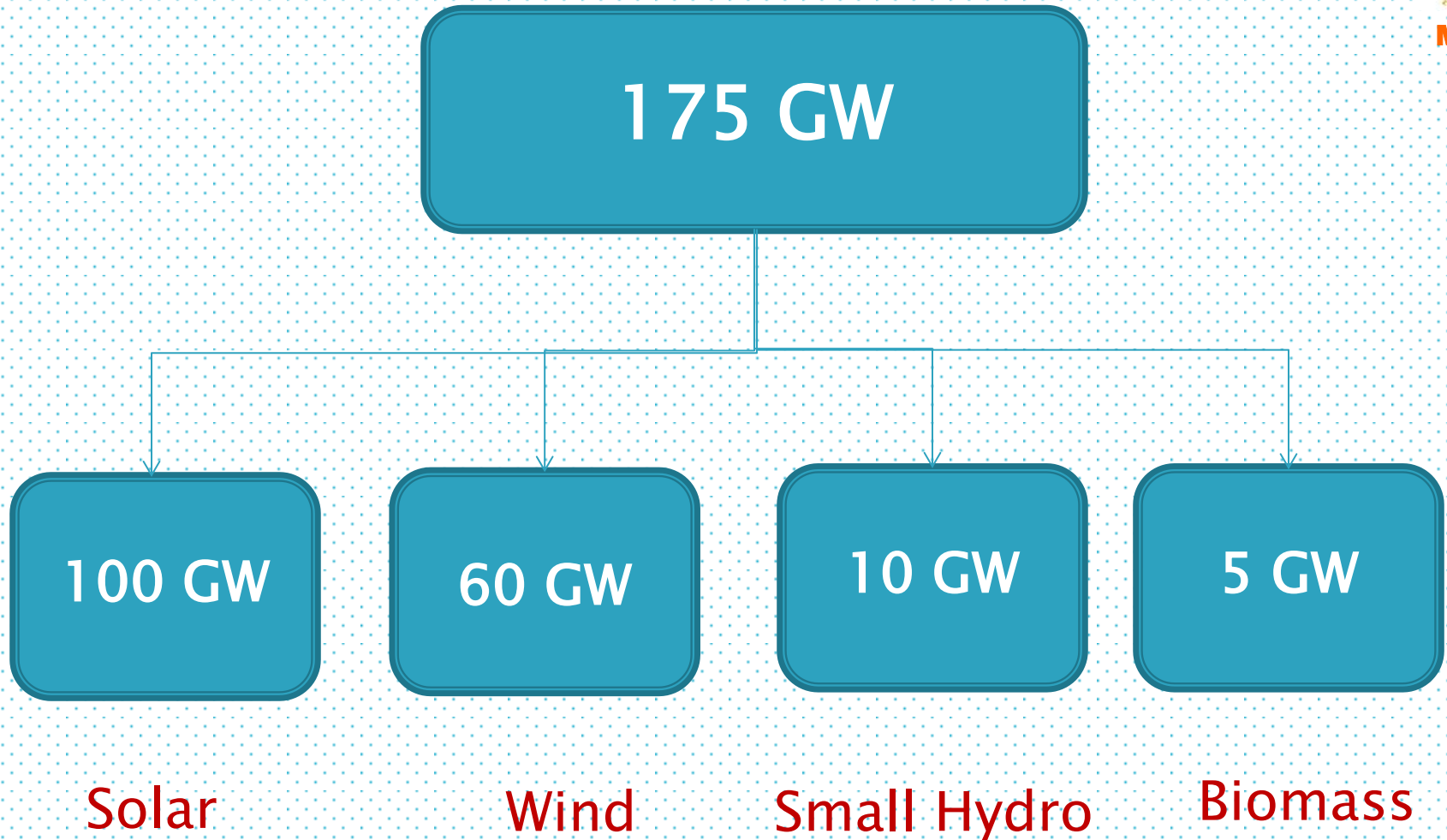
# Renewable Power Installed Capacity (As on

11.6% 30.09.2015)



<b>Wind</b> 24377 MW	<b>Small Hydro</b> 4147 MW	<b>Solar</b> 4345 MW	<b>Biomass</b> 4419 MW	<b>Total</b> 37288 MW
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# Road Map for Renewable Power by 2022



# Road Map for Solar Power by 2022



100 GW

20 GW

10 GW

30 GW

40 GW

Solar Park

Unemployed  
Youth/Farmers

Govt./States/  
Private/Others

Solar Rooftop

# Renewable Energy in Smart Cities

- ▶ Hon'ble Prime Minister's vision of making 100 Smart Cities with emphasis on–
  - **Smart Energy**
    - Co-generation & **Renewable Energy Generation**
    - Smart Meters, demand response
    - Assured electricity supply
  - **Smart Waste Management**
    - **Treatment using waste to energy technologies**
  - **Smart Building**
    - Green buildings with application of **renewables**
  - **Sustainable Environment**

# Renewable Energy for Smart Cities

- ▶ The Smart City guidelines insists **10% of the Smart City's energy requirement to come from solar**
- ▶ India imports nearly 80% of its crude oil consumption, 15% of its coal consumption and 35% of its natural gas consumption
- ▶ 75% of Greenhouse gas emissions are produced in Cities & Communities
- ▶ Potential Answer to above challenge–
  - **Dovetail Renewable Energy with Conventional Energy in a big way for all Smart Cities**

# Renewable Energy in Smart Cities

- ▶ Solar power generation in City & offsite
- ▶ Solar Water Heaters for hot water
- ▶ Solar PV Rooftop systems for electricity
- ▶ Solar street lightings
- ▶ Solar pumps for water lifting
- ▶ Solar concentrators for steam based cooking
- ▶ Solar traffic signals, solar road studs/blinkers

# Renewable Energy in Smart Cities

- ▶ Sewage treatment plants with biogas / power generation
- ▶ Waste to energy technologies for treatment of MSW
- ▶ Hybrid systems (solar–wind, solar DG set)
- ▶ Space conditioning with earth tunnel
- ▶ Green buildings with solar passive designs
- ▶ Net zero energy buildings



# Green Buildings in Smart Cities

- ▶ About 40% energy is consumed by buildings in a city
- ▶ Energy efficient green buildings on solar passive design to be promoted
- ▶ Green buildings integrated with Renewable Energy and energy conservation systems can save about 30 - 40% of conventional energy used in building
- ▶ Building bye-laws should have provisions for green buildings

# Grid-connected SPV Rooftop systems

## World-wide Experience .....



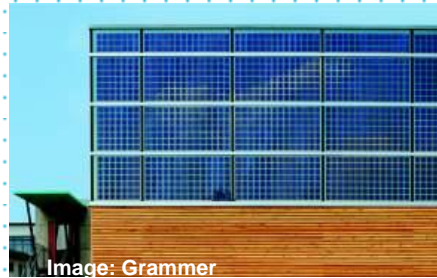
- ▶ Germany, USA and Japan are leaders in adopting grid-connected SPV Rooftop systems.
- ▶ Germany has highest PV installed capacity of over 38 GW of which 71% is in rooftop segment (as on 31.08.2015).
- ▶ Italy has 12.7 GW PV installation with over 60% rooftop systems
- ▶ In Europe of total 50.6 GW PV installation, over 50% in in rooftop segment.
- ▶ FIT is norm in Europe while net-metering is popular in USA.

# PV market segments in Germany



<1%

Building integrated



Private buildings:  
1-10 kWp

Social, commercial,  
agricultural buildings:  
10-100 kWp

Large commercial  
buildings:  
> 100 kWp

71%

Rooftop



28%

Ground-mounted



Market share in %  
of MW installed in  
2011

# Development of Solar Cities

- ▶ Solar Cities Aims to assist urban local bodies in assessing their present energy consumption & future demand and preparing Master Plans for energy savings & generation through RE installations & energy efficiency measures.
- ▶ Each city to reduce their projected energy demand by 10% over 5 years
- ▶ 60 cities are being developed as solar cities. Master plans for 50 solar cities prepared.
- ▶ In solar cities, Municipal Corporations have come forward to implement the scheme and setup RE Projects.

# Development of Solar Cities

- ▶ **34 solar cities are falling in the list of smart cities:**  
Guwahati, Raipur, Bilaspur, Panaji, Gandhinagar, Surat, Rajkot, Faridabad, Hubballi– Dhardwad, Kochi, Bhopal, Indore, Gwalior, Thane, Nagpur, Kalyan–Dombivilli, Aurangabad, Imphal, Aizwal, Kohima, Bhubaneswar, Ludhina, Amritsar, Jaipur, Ajmer, Coimbatore, Agartala, Moradabad, Allahabad, Agra, Dehradun, New Town Kolkata, Chandigarh, NDMC
- ▶ These cities may work in association with Smart Cities.
- ▶ All Smart Cities to be taken under solar cities programme
- ▶ Creation of a Renewable Energy Cell in all Smart Cities

# Development of Solar Cities

- ▶ Ministry provides upto Rs. 50 lakh per city for Preparation of a Master Plan, setting-up a solar city cell, awareness generation, capacity building and oversight of implementation.
- ▶ Most of the urban local bodies are not taking advantage of financial assistance of solar cities
- ▶ Urban Local Bodies to set up Solar City Cell

## Solar Rooftop PV Systems

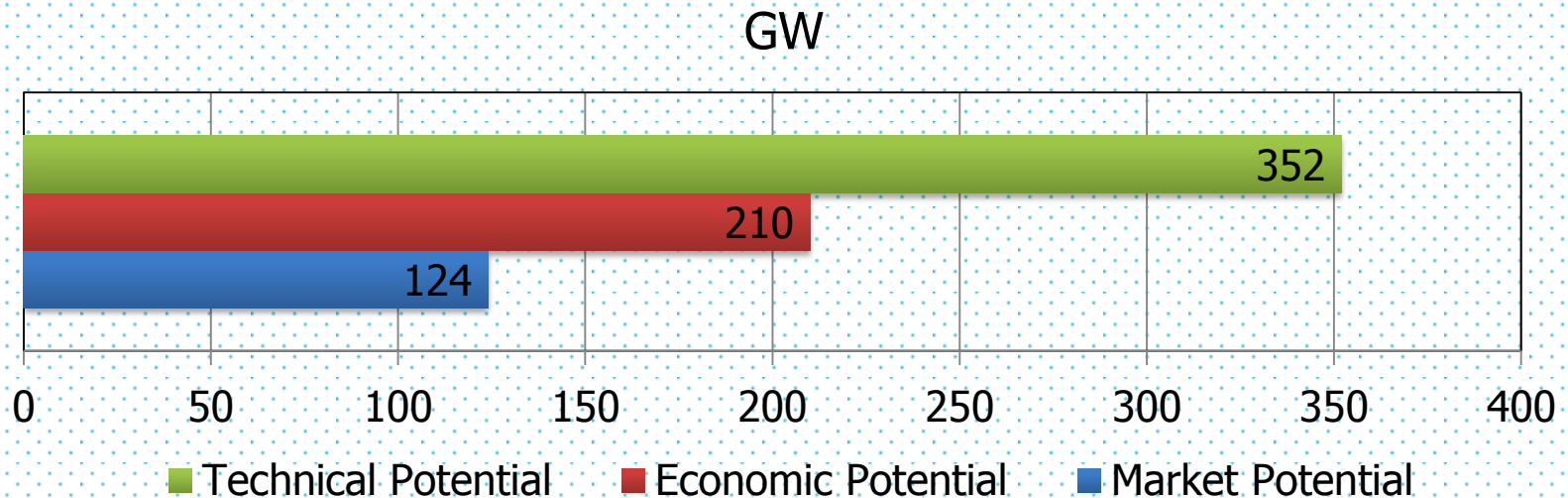
- ▶ Solar systems installed on rooftops of residential, commercial, institutional & industrial buildings :



- ▶ Electricity generated could be
  - fed into the grid at regulated feed-in tariffs or
  - used for self consumption with net-metering approach

# All-India Rooftop SPV Potential

In India market potential for rooftop SPV is 124 GW.





# Advantages of solar rooftops

- ▶ Savings in transmission and distribution losses
- ▶ Low gestation time
- ▶ No requirement of additional land
- ▶ Improvement of tail-end grid voltages and reduction in system congestion with higher self-consumption of solar electricity
- ▶ Local employment generation
- ▶ Reduction of power bill by supplying surplus electricity to local electricity supplier
- ▶ Battery elimination makes easy installation and reduced cost of system



# Requirements for solar rooftops

- ▶ About 10 sq.m area per kWp capacity
- ▶ Cost about Rs.75,000 per kWp
- ▶ The roof should be shadow free and south facing
- ▶ Can be installed in slanting, plain and curved roofs
- ▶ Regulation of SERC, State policy and DISCOMs cooperation for grid connectivity

# Economics of rooftop system

- ▶ Initial cost Rs.75,000 per kWp
- ▶ Cost of electricity generation Rs.7.00 per kWh
- ▶ Cost of generation with 30% subsidy of MNRE is about Rs.5.50 per kWh
- ▶ Most of commercial, industrial and Government establishments pay about Rs.8-10 per kWh
- ▶ Hence the solar rooftop is economically viable



मन्त्रालय जयते  
**MNRE**

# Net Metering mechanism

- ▶ The Net Metering mechanism shall allow the consumer to reduce its electricity import
- ▶ The utility benefits by avoiding purchase of electricity from short term market
- ▶ Electricity generation at load center also minimises the loss of electricity in wires
- ▶ Capacity for development under Net Metering Mechanism may be allowed in phases to take care of the following aspects.
  - Equivalent to suitable percentage the utility propose under the intra state network losses or
  - Capacity projected for purchase of Short Term market
  - Financial viability

# Present Status: Policies and Regulations



- ▶ **16 States have come out with Solar Policy supporting grid connected rooftop systems :**
- ▶ Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Manipur, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal.
- ▶ **Remaining 20 States/UTs which has not issued Solar Policy supporting grid connected rooftop systems :**
- ▶ Arunachal Pradesh, Assam, Bihar, Goa, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tripura and (7 UTs) Andaman & Nicobar and Lakshadweep Islands, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Delhi & Puducherry.

# Present Status: Policies and Regulations

- ▶ **SERCs of 25 States/UTs have notified regulations for net-metering/feed-in-tariff mechanism :-**
- ▶ Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Goa, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal and (7 UTs) Andaman & Nicobar and Lakshadweep Islands, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Delhi and Pondicherry have notified regulations for net-metering/feed-in-tariff mechanism
- ▶ 80 Smart Cities falls in these 25 States having regulations.
- ▶ **SERCs of remaining following 11 States may notify regulations for grid connected rooftop systems:-**
- ▶ Arunachal Pradesh, Jammu & Kashmir, Jharkhand, Telangana, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura should notify regulations for net-metering/feed-in-tariff.

# Urban Local Bodies help required

- ▶ **Issue Governments orders to make solar rooftop mandatory in building bye-laws.**
- ▶ **Provide rebate on property tax.**
- ▶ **Publicity and motivation**
- ▶ **Buildings owned by ULBs/Government must have solar rooftops**
- ▶ **Dis allow diesel based power generation**
- ▶ **Promote green buildings**
- ▶ **Use waste to energy for treatment of MSW and methane generation based sewage treatment**

# What MNRE can do?

- ▶ Potential assessment for rooftop installations using GIS techniques
- ▶ Preparation of Master Plans for renewable applications in cities
- ▶ Central Financial Assistance of RE projects
- ▶ Consultants/hand holding
- ▶ Publicity/awareness/workshops
- ▶ Capacity building



# Solar Water Heaters

**Park Sheraton, Chennai(40,000 liter/day)**



**Sheraton Chola, Chennai (10,000 liter/day)**



**The Taj Ambassador, Delhi (7000 LPD)**



# Solar Steam Based cooking sytem at Shridi



# Solar Steam Generation System at ITC Hotel, New Delhi





Module	India Make
Aggregate Plant Capacity	404 kWp
Rooftop Owner	Manipal University
City	Jaipur
State	Rajasthan
Project Cost	Rs. 2.86 Cr
CFA through SECI	Rs. 86 Lakh



Module	India Make
Plant Capacity	115 kWp/85 kWp
Rooftop Owner	DMRC
Project Site	Anand Vihar/Pragati Maidan
City	Delhi





Module	India Make
Plant Capacity	130 kWp
Rooftop Owner	ISBT Kashmere Gate
City	Delhi
State	Delhi
Project Cost	Rs. 114.3 Lakhs
CFA through SECI	Rs. 30.3 Lakhs





Module	India Make
Plant Capacity	360 kWp
Rooftop Owner	Super Auto Forge Pvt., Ltd.,
City	Chennai
State	Tamilnadu
Project Cost	Rs. 3.06 Cr
CFA through SECI	Rs. 92 lacs





Module	India Make
Plant Capacity	100 kWp
Rooftop Owner	Rockwell Industries
City	Hyderabad
State	Andhra Pradesh
Project Cost	Rs. 0.74 Cr
CFA through SECI	Rs. 22.2 lacs







Module	India Make
Plant Capacity	300 kWp
Rooftop Owner	IIT Madras
City	Chennai
State	Tamilnadu
Project Cost	Rs. 2.49 Cr
CFA through SECI	Rs. 75 lacs





Module	India Make
Plant Capacity	500 kWp
Rooftop Owner	Medanta Hospital
City	Gurgaon
State	Haryana
Project Cost	Rs. 4.15 Cr
CFA through SECI	Rs. 1.24 Cr





Module	India Make
Plant Capacity	100 kWp
Rooftop Owner	NIAS
City	Bengaluru
State	Karnataka
Project Cost	Rs. 83 lacs
CFA through SECI	Rs. 25 lacs



# Government House, Sector – 7, Chandigarh



# 1.0 MW Rooftop plant at Punjab Engineering College, Chandigarh



# Government Hospital, Sector – 16, Chandigarh



# 495 kW Rooftop plant at Govt. College for Girls, Sector - 11, Chandigarh



# Largest rooftop plant in the world on single roof\*



- 7.52MW plant installed by Larsen & Toubro construction in Punjab
- L&T installed more than 30,000 PV panels on the rooftop
- Power from the plant being fed to the local grid through a PPA signed with the state distribution company
- \* Claims L&T