Roundtable Discussion on "Renewable Energy onsite generation and use in Buildings"

Prayas (Energy Group) & Greentech Knowledge Solutions,

New Delhi, 20th October, 2016, 10 AM - 1:30 PM

Conference Room II, India International Centre

Agenda

- Introduction to the study
- Overview of Buildings & Energy Consumption

- Renewable energy use in buildings
  - Building Energy Codes/laws
  - Overview of RE technologies, Business Models and Policy Regulatory Framework
  - Example Case Studies

- Questions/Recommendations for discussion

Introduction to the study

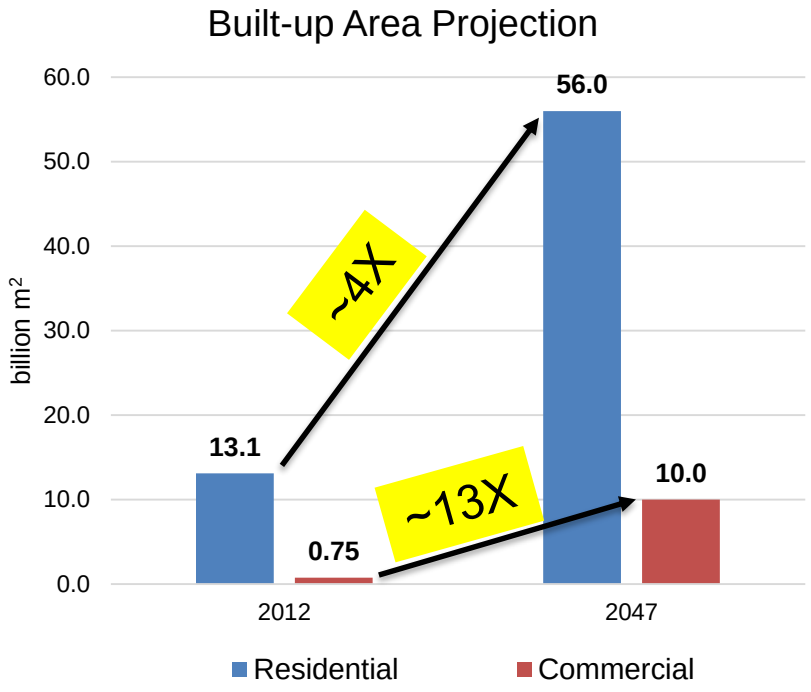
- **Background:** Large, rapidly increasing building footprint and energy consumption. Large potential for renewables

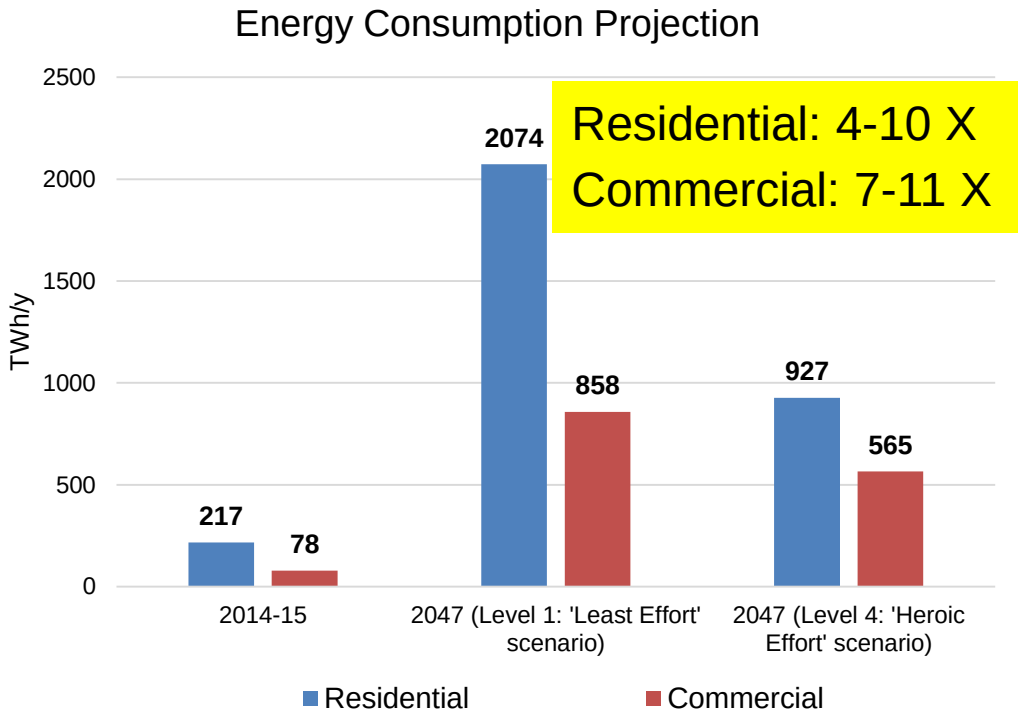
- **Objective:** Identify opportunities and challenges in realizing potential of onsite RE generation and use

- **Key components**
  - Review renewable energy technology options for use in buildings, their policy-regulatory framework
  - Case studies of various types of buildings with renewable energy use coupled with site visits
  - Interaction with key stakeholders

BUILDINGS & ENERGY PERFORMANCE

Growth in built-up area and energy demand



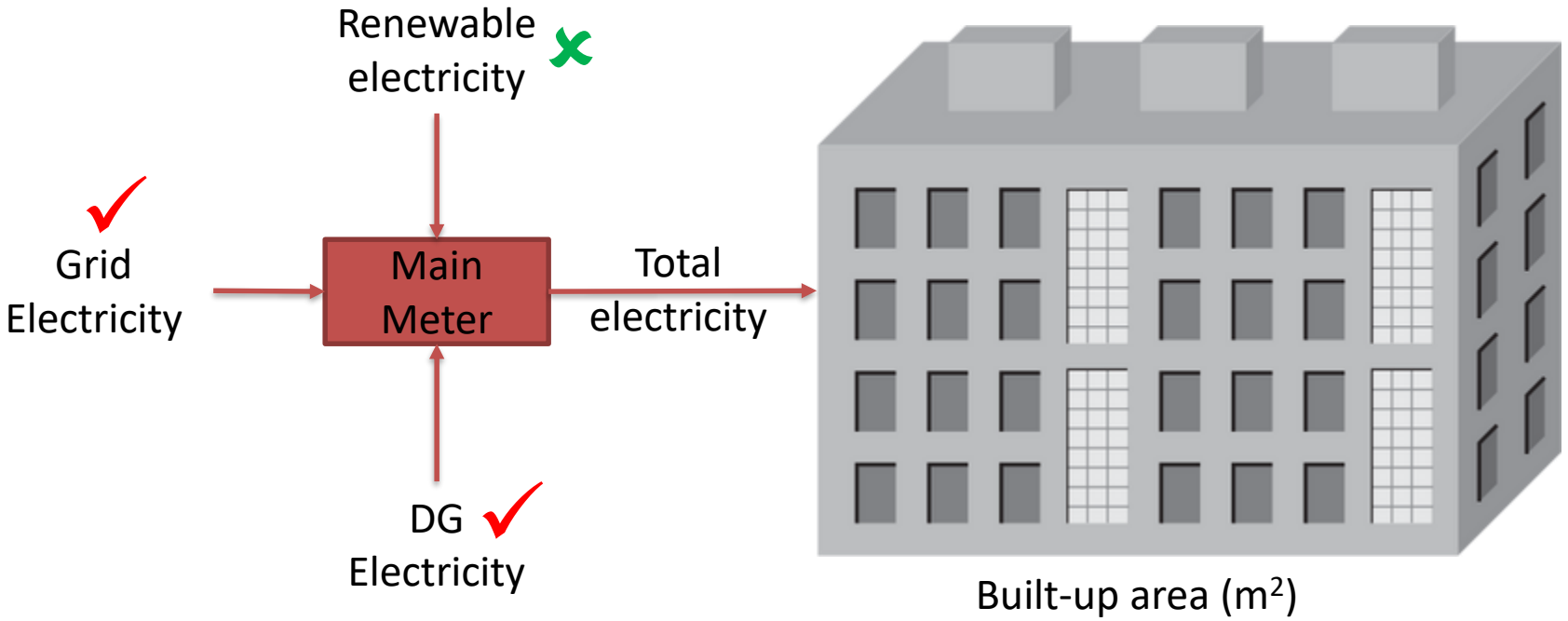


Huge potential for RE use in new buildings

Residential sector is very important; has big saving potential through EE measures

Source: India Energy Security Scenario (IESS) 2047, NITI Aayog

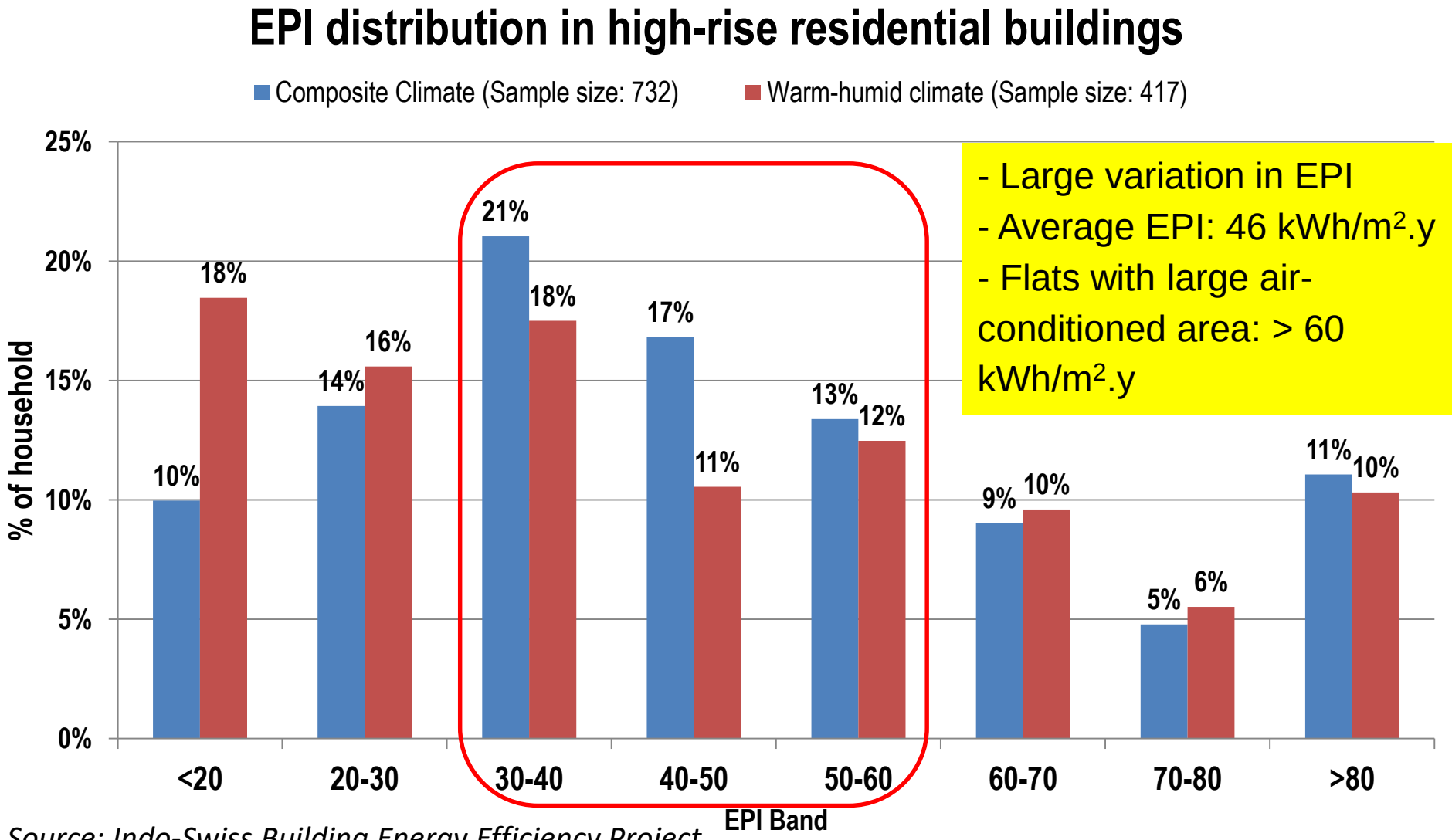
What is energy performance index (EPI)?



$$\text{Energy Performance Index (EPI) (kWh/m}^2\text{.y)} = \frac{\text{Annual Grid Electricity + Annual DG Electricity}}{\text{Built-up area}}$$

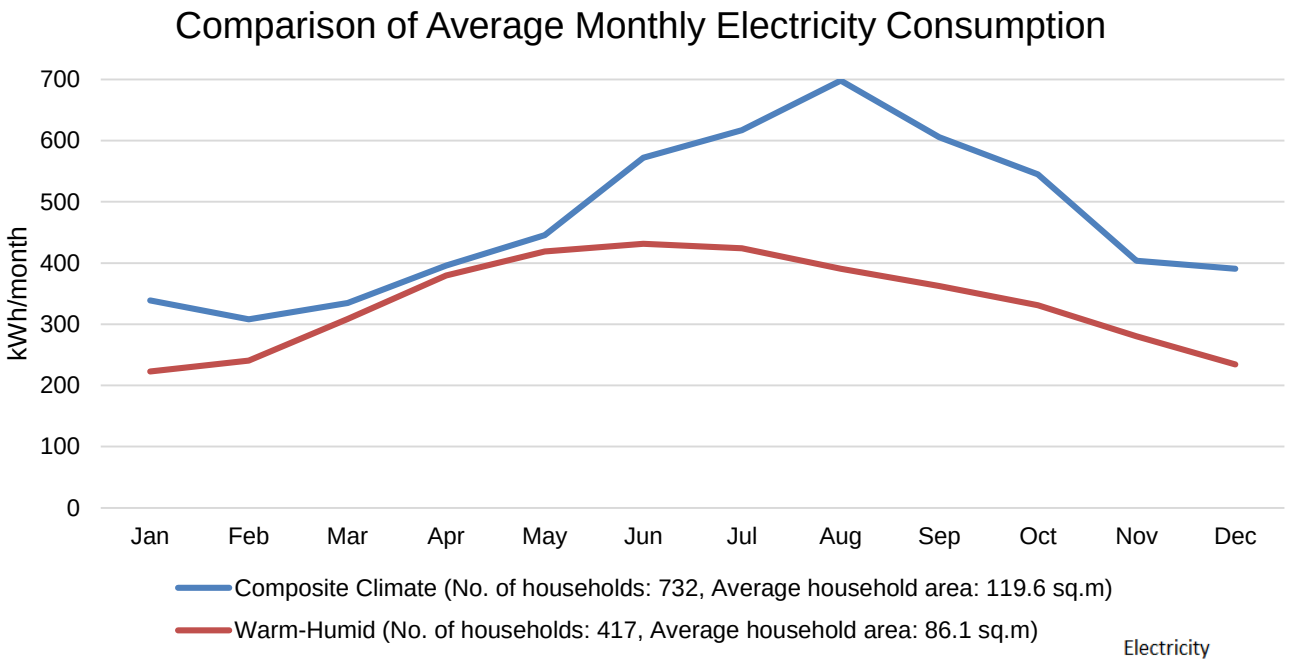
Source: BEE Star rating for Office Building & BEE Star rating for BPO

Residential Sector: EPI in High-Rise Flats



Source: Indo-Swiss Building Energy Efficiency Project

Residential Sector: EPI for Different Climates



Monthly Min: 200-300 kWh

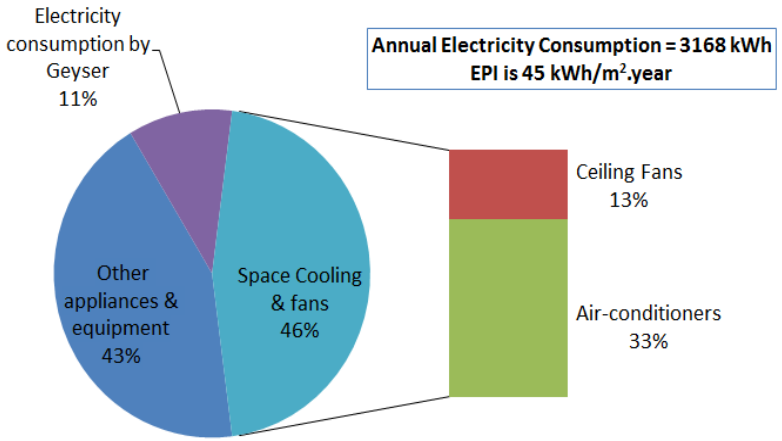
Monthly Max: 400-700 kWh

Max/Min ratio: 2-2.3

Average annual EPI:

- Composite: 48 kWh/m^2.y
- Warm-humid: 44 kWh/m^2.y

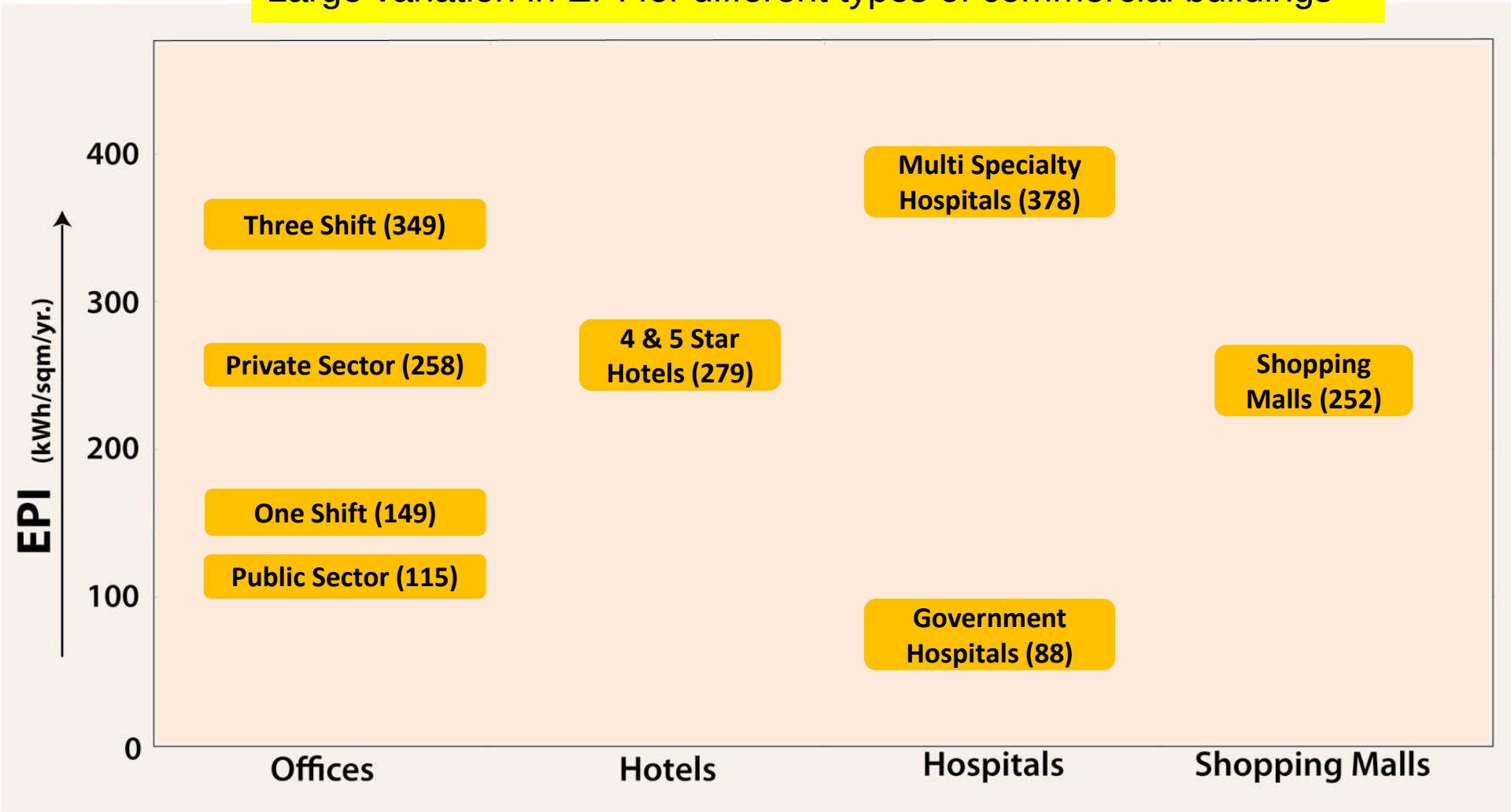
- Higher consumption in composite climate compared to warm-humid
- Maximum (30-60%) energy consumption for cooling; Significant demand for water heating



Source: Indo-Swiss Building Energy Efficiency Project

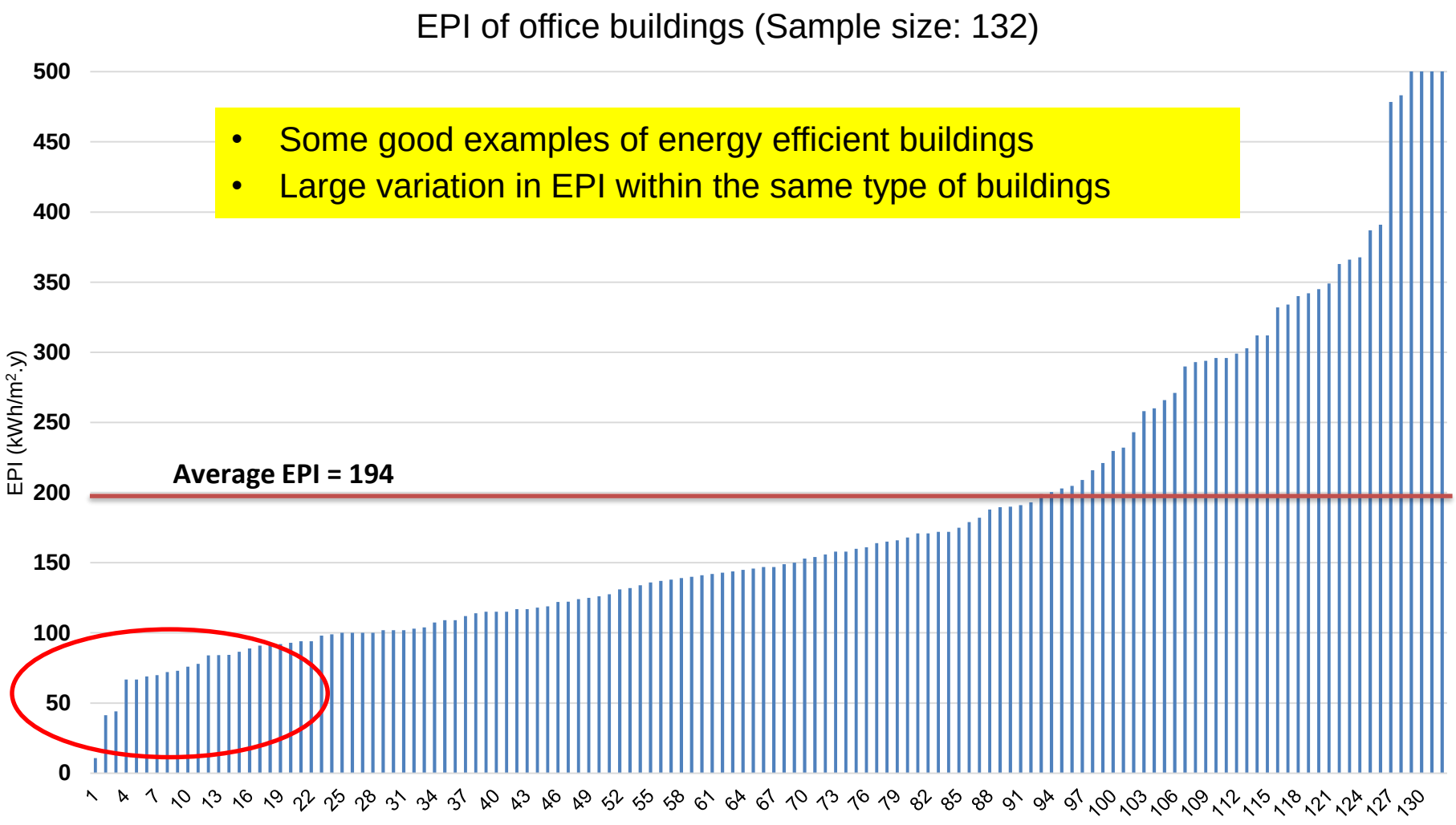
Commercial Building: EPI

Large variation in EPI for different types of commercial buildings



Source: ECO-III Study on “Energy use in commercial buildings – National benchmarking study” (2011)

Office Buildings: EPI



- Some good examples of energy efficient buildings
- Large variation in EPI within the same type of buildings

Sources: ECO-III Benchmarking study; IGBC rated buildings; BEE star rated buildings

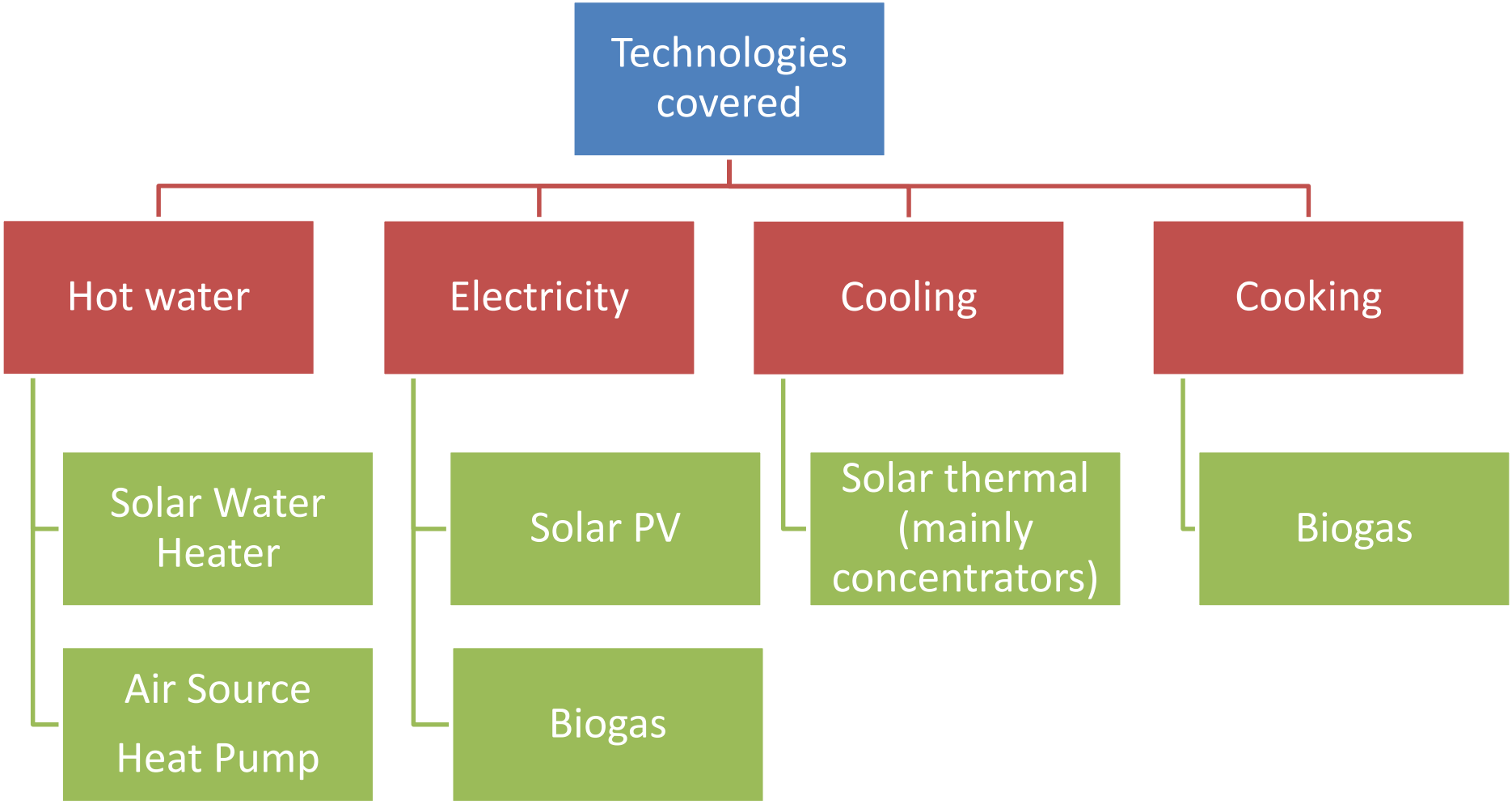
EPI of Buildings

- Large EPI variation across building types
  - Residential: **20-100** kWh/m^2/year
  - Offices (Govt.): **40-120** kWh/m^2/year
  - Offices (Pvt.): **70-200** kWh/m^2/year
  - Commercial buildings (large hotels, shopping malls, large hospitals): > **250** kWh/m^2/year

- Significant reduction (up to 50%) possible in all building types: energy-efficient design/proper operation.
- Air-conditioning (space cooling) largest contributor to electricity demand in buildings.

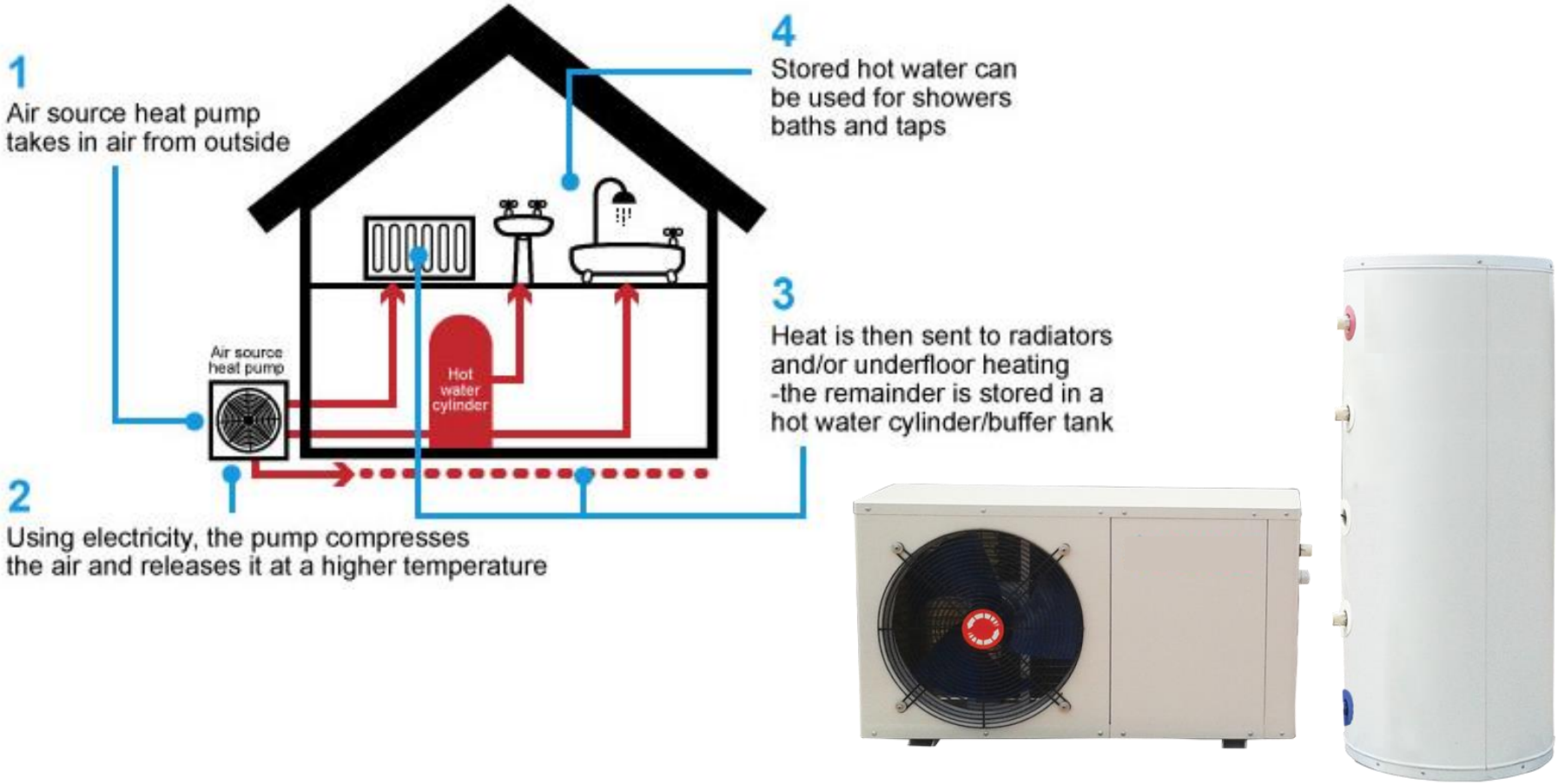
RE TECHNOLOGIES, BUILDING CODES, RATINGS & BUSINESS MODELS

Renewable Energy Technologies



Air Source Heat Pump

A device that uses a some amount of energy to move heat from low temperature to high temperature (COP: 3-4.5)



Renewable Energy: Building Bye-laws/Codes

- **National Building Code of India (2015 draft)**
  - Suggests voluntary use of renewables
- **Energy Conservation Building Code (ECBC) (Draft, 2016)**
  - Applicable to commercial building (demand > 100kW/120kVA)
  - Mandatory provisions:
    - Hotel/Hosp. should meet 20-40% of hot water through SWH
    - Earmark >10 % of roof area or meet 1% of total peak demand or connected load
    - Higher mandates for energy efficient and super energy efficient categories: 2-6% of total peak demand or connected load
- **Model building bye-laws 2016**
  - Mandatory SWH & rooftop SPV in certain types of building

Renewable Energy: Green Building Rating Systems

- **GRIHA (v2015)**
  - All buildings > 2,500 m^2, (except industrial complexes)
  - Mandatory on-site RE generation (0.5-2.5%) for Daytime Commercial/ Institutional Buildings, 24 X 7 occupied non-residential buildings
  - Points for additional on-site RE generation
- **IGBC Green Homes Rating System (v2.0)**
  - All residential, Hostels, Service apartments, Resorts, Guest houses
  - SWH and RE based electricity not mandatory
  - Credit points based on SWH system meeting part of hot water demand or RE generation capacity as percentage of total connected load
- **IGBC Green New Buildings Rating System (v3.0)**
  - All types of commercial and institutional buildings
  - Use of RE not mandatory; Credit points for RE (on-site and off-site) based on percentage of total annual energy met by RE system

RE in Buildings: Business models

CAPEX OR End-user Owned	OPEX OR Third party owned & operated	Fully integrated with Utility
• End user invests in RE system • RE is either used for internal consumption or exported • Financing for the system from banks / financial institutions • Design and deployment by system integrators	• Third Party (e.g. RESCO) makes the investments, installs & does O&M • No investment and hassle free for end-user • Agreement between third party and end-user on RE (e.g. PPA for rooftop SPV) • Allows third party to bring in lower cost financing, scale, technical expertise, efficient operation	• Emerging business model – mostly in developed countries for rooftop solar PV • Investment by utility • PV becomes an integral part of the electricity supply and distribution infrastructure

CAPEX-OPEX model

Similar to OPEX; end user invests for depreciation benefits

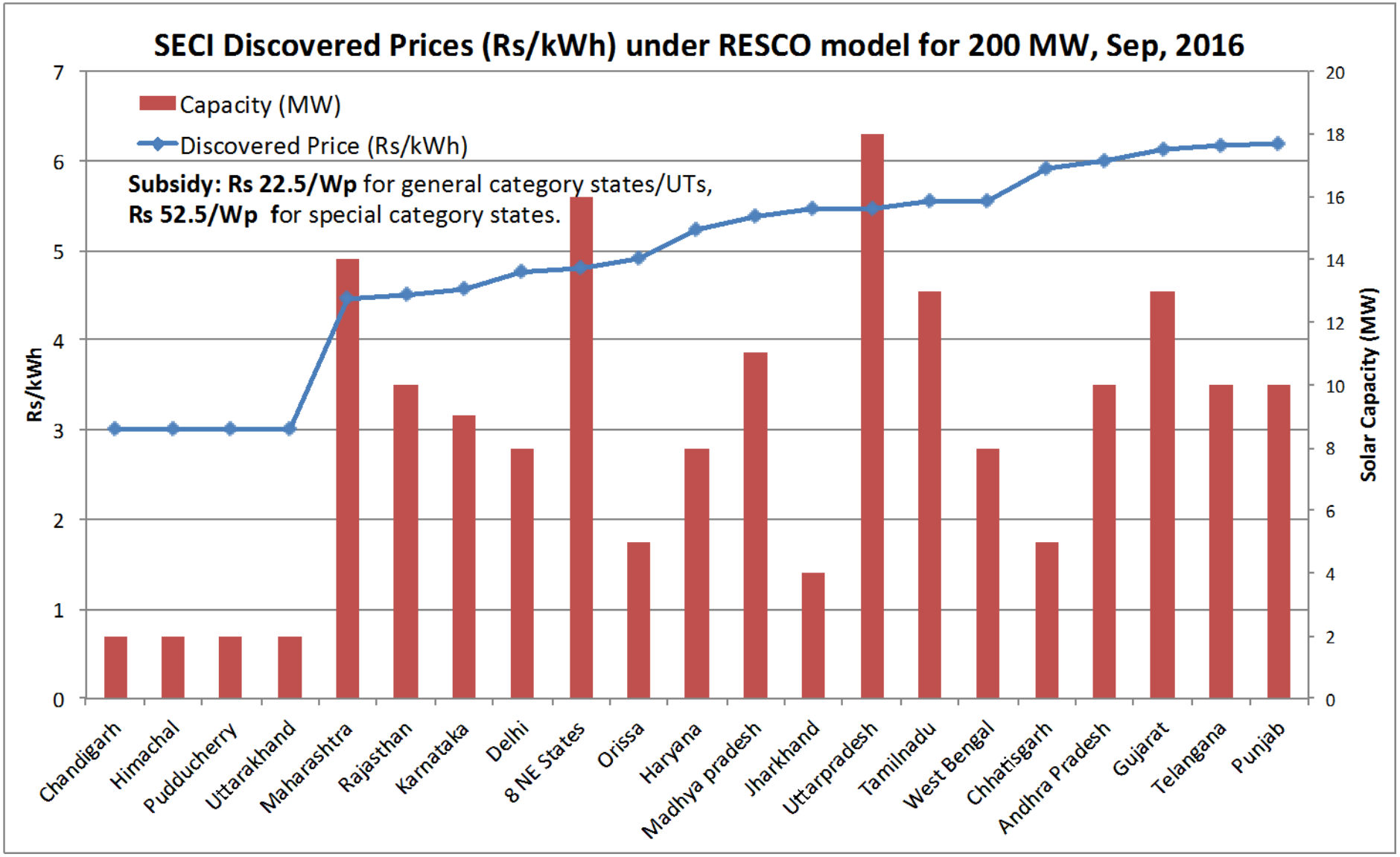
Source: MNRE/USAID/GERMI report on "Best practices manual for implementation of state level rooftop solar photovoltaic programme in India"

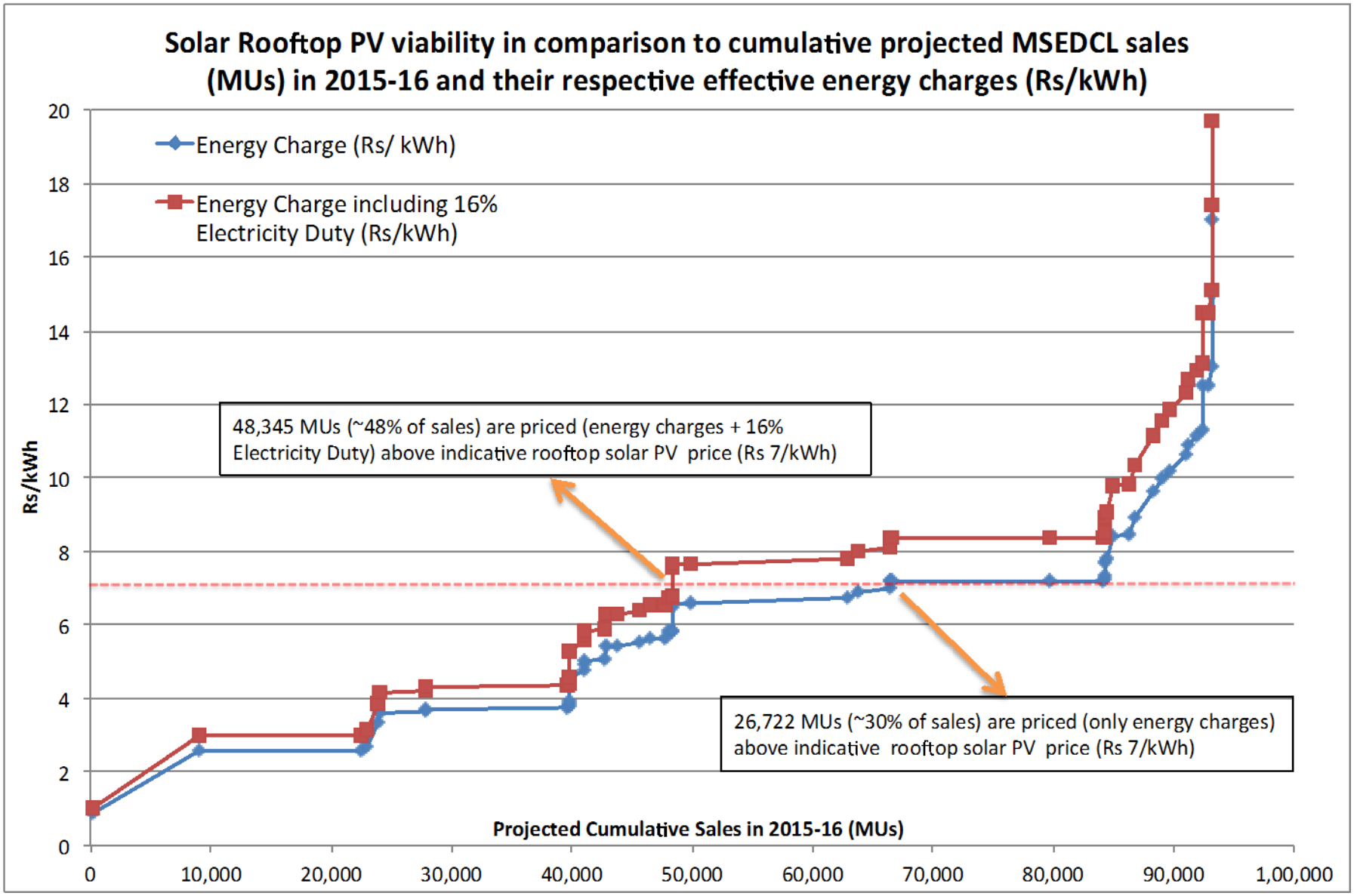
POLICY AND REGULATORY FRAMEWORK

Rooftop Solar PV

- National Target – 40,000 MW by 2022
- Net Metering
  - Net Metering: 21 States have regulations in place.
  - Systems allowed up to certain percentage of Distribution Transformer Capacity (15-40%)
  - Minimum/Maximum Project Size
  - Additional Incentives (Haryana, Delhi, TN)
  - Utility Buy Back Rates for surplus solar power
- Captive / Gross Metering
- MNRE Capital Subsidies
  - 30% / 70% of Benchmark Costs (Rs 75/kWp)

Competitively discovered Prices, Sep 16




Solar Rooftop PV viability in comparison to cumulative projected MSEDCL sales (MUs) in 2015-16 and their respective effective energy charges (Rs/kWh)
Energy Charge (Rs/ kWh)
Energy Charge including 16% Electricity Duty (Rs/kWh)
48,345 MUs (~48% of sales) are priced (energy charges + 16% Electricity Duty) above indicative rooftop solar PV price (Rs 7/kWh)
26,722 MUs (~30% of sales) are priced (only energy charges) above indicative rooftop solar PV price (Rs 7/kWh)
Rs/kWh
Projected Cumulative Sales in 2015-16 (MUs)
0
2
4
6
8
10
12
14
16
18
20
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
1,00,000

Solar Water Heating Systems

- MoUD Govt. Order and model building bye laws (1999): mandatory use of solar water heaters in certain types of buildings
  - ~ 20-25 States/UTs have issued notification
  - ~ 100 Municipal Corporations and urban local bodies have mandated use of SWHs in their building bye laws

- MoUD model building bye-law 2016 has mandatory use of SWH
- Utility driven DSM plan (e.g. Rajasthan, Uttarakhand, Bangalore, etc.) for peak load reduction, incorporating rebate in electricity bill
- MNRE capital subsidy discontinued from October, 2014

- Effective implementation only in few cities (Bangalore, Pune, Rajkot, etc.)
  - Limited technical know-how of SWHs
  - Lack of clarity on system sizing (under-sized systems)
  - Less effective where radiation is low, demand only for winter
  - Limited SWHs supply and after sales service

Heat Pumps

- Indian Geothermal Energy Development Framework, 2016 (MNRE) brings the technology into focus.
  - CFA of 30% (for projects with min 30% energy saving)
  - 40% depreciation on installation of GSHPs.
  - GSI has also published the Geo- thermal atlas for India

- Presently no policy-regulatory framework for Air Source Heat Pumps, though several products available in market.
  - Heat pumps covered under renewable energy in EU (expected to contribute 5-20% of RE target by 2020)
  - Several countries (US, Aus, Japan) have incentives for uptake

Biogas

- National Biogas & Manure Management Programme (1981-82): financial assistance for development, operation, maintenance, awareness.
- Central Scheme incentivizes **Family Type Biogas Plants** mainly for **rural and semi-urban/households**
- **Only KVIC** (Khadi Village Industries Commission) gasholder type biogas plants with a capacity of 1-6 m3 eligible for CFA up to 50 %.
- State specific policies/programs supporting biogas uptake: Haryana (40% subsidy), Gujarat (MSW provided free, ED waived), Bihar (various fiscal benefits)

- 48.6 lakh family type systems installed in India by Aug, 2016 (MNRE)
- Indicative Cost of Biogas Plant: Rs 17,000 / typical 2 m3 system
- 2014-15 as well as 2015-16 Target: 1.1 lakh family type systems, achievement of 77% and 42% respectively (MNRE)

CASE STUDIES

(10, five technologies covered across various building types)

Magarpatta City, Pune: Solar Water Heating

- SWH system for all residential units **integrated during design stage**
  - Individual SWH system for Individual housing
  - Centralized SWH systems for Multi-storey building, one system for each wing of tower
- Capacity: 10,30,000 LPD (16,480 m^2)
- **Cost included in flat price; O&M by Magarpatta City management**
- Hot water tap in each bathroom of a flat for water coming from SWH system
- No recirculation system; **flats on lower floor do not get hot water immediately**
- Some flats have now installed electric geyser; mostly having high occupancy and/or having small kid or elderly people
- Solar fraction: > 70%

India Habitat Centre: Solar PV in RESCO mode

- Multipurpose building: social and commercial

- Solar PV Capacity: 250 kWp (installed on 5 buildings) @ cost of Rs.87/Wp retrofitted on the existing building.
- Model: Renewable Energy Service Company (PPA @Rs.4.99/kWh)

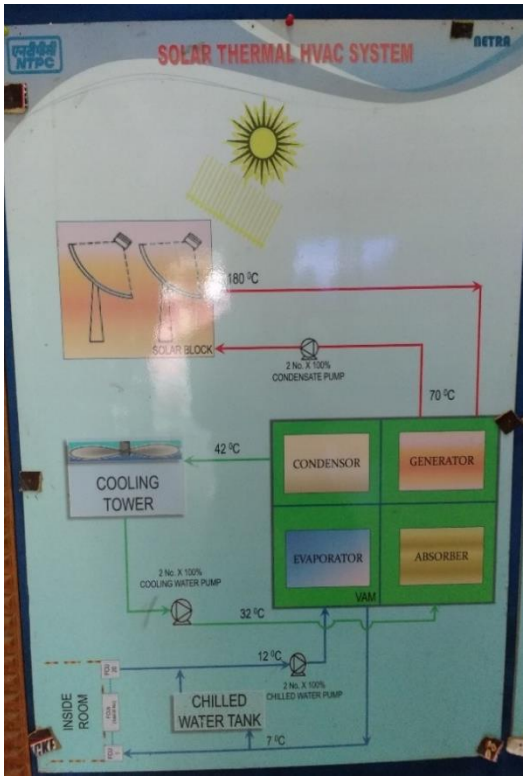
- Actual energy generation: 315 MWh/y
- Solar fraction: 2.7%

NETRA: Solar cooling system

- NTPC's research center
- Solar Cooling system:
  - Solar collector: 338 m^2 of solar concentrator
  - VAM: 50 TR (Installed cooling: 40 TR)
  - Storage: chilled water (500 m^3)
- High capital cost (~ Rs.2.5cr)

- Solar cooling is retrofitted; not integrated with Conventional HVAC system
- Chilled water storage is not utilized; energy loss during weekends/non-operational days

- Proper integration of solar cooling system with conventional HVAC is critical for its maximum utilization



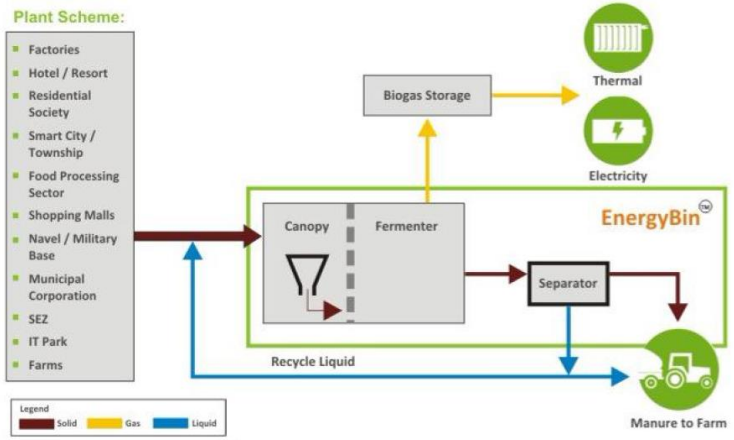
Radisson Blu, Pune: Air source heat pump - water heating

- Commercial - Hotel building
- Total hot water demand: 40,000 LPD (@55-60^{o}C) including laundry
- System details:
  - Application: Hot water for bathing, kitchen
  - Capacity: ~40 TR (138.4 kW)
  - Storage: 12,000 L
- BOOT model (15 months)
- Capital cost ~19 lacs (80% accelerated depreciation benefit)
- Payback: ~1.3 years
- **Promising for building segments with limited roof area availability**

Thyssenkrupp Industries Pune – Biogas cooking

- Industrial building – Canteen
- System details:
  - Capacity: 250 kg/day (food waste)
  - Biogas rated output: 30-32 m^3/day (Equivalent to 15 kg LPG)
  - Area required: 160 ft^2
- Self owned; Annual O&M with installer (Xeon Waste Managers LLP)
- Capital cost: ~ 9.7 lacs (80% accelerated depreciation benefit)
- Savings in LPG cost & waste disposal cost; additional revenue from organic manure
- Payback: ~1.4 years

- **Promising for cooking applications with limited roof area availability for solar concentrators**



Key learnings from case studies

- Large variation in energy demand, usage, space availability, electricity tariffs across different building typologies.
  - Composition presently 90% Residential and 10% commercial
  - Financial viability and solar fraction also show large variation.
  - Only certain types of buildings can aspire to be near/net zero energy buildings (Low-rise energy-efficient residential/ commercial buildings).
- RESCO model addresses issues of capital investment, risk of RE technology performance and seems an effective mechanism.
- Net metering results in effective utilization of installed PV capacity. The process is yet to be streamlined and is time consuming.
- Significantly advantageous to integrate RE at design stage itself.
- SWH more viable for building having longer/year long hot water demand
- Improved biogas systems operating under RESCO model may accelerate adoption while also improving waste management in urban areas.
- Incentivizing energy conservation and educating users, is key for effective utilization of Renewable Energy systems.

KEY QUESTIONS/RECOMMENDATIONS FOR DISCUSSION

Key Issues for discussion (1)

- **Rooftop Solar PV**
  - Lack of effective Net Metering implementation (delays, procedural ease, some restrictive regulations)
  - Potential options: Online applications, virtual net metering, aggregate metering, future reforms in NM (higher fixed costs in consumer tariffs, differential rate for banked energy, banking charges etc.)
- **Solar Water Heating**
  - Lack of testing centres/facilities to check standards; star rating (STFI)
  - Capital subsidy distorted mature markets (Pune, Bangalore), helped create new markets (hilly regions), was plagued with long delays and inefficiencies.
  - Since capital subsidy ended, data collection on installations challenging
- **Common Solar**
  - Is the roof better used for PV/SWH? (Depends on various factors like customer category, space, usage pattern etc.)
  - How can solar ready architecture / buildings be incentivized?

Key Issues for discussion (2)

- **Air Source Heat Pumps**
  - No policy-regulatory framework as of now; MNRE should categorize them as renewables
  - Is subsidy/incentive support needed ?
  - Need for standards / star rating ?
- **Biogas**
  - Capital subsidy presently only for family-type systems in rural/semi-urban areas. Should this be extended to urban areas?
  - What is the appropriate scale for biogas systems (individual / building / community)?
- **Solar cooling (adsorption/absorption)**
  - Technology is in demonstration stage. Will it become financially attractive and a significant alternative in near future ?

Commons issues

- In developed countries, building regulations have played a major role in energy-efficient buildings and RE integration. Indian experience? Changes needed?
  - Principal Agent problem
  - Mandatory space use for solar (roof), biogas

- Are incentives/subsidy still needed for uptake of renewables in buildings? If so, sun-set clauses important.
  - Limited number of rooftop Solar PV systems availed capital subsidy
  - Mixed experience of capital subsidy in SWH
  - Effectiveness of accelerated depreciation

- Role of renewable energy in Smart Cities – (10% solar)
- O & M of RE systems is crucial to its long term sustainability, presently weak (RESCO option)
- Need to think differently for low rise and high rise buildings

THANK YOU

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