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Evening view of Bangalore city,

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Energy and Green Buildings

Energy and Green Buildings

India is leading the race to meet its climate change mitigation commitments¹. The energy sector is expected to contribute to 73% of India's GHG emissions². To achieve the climate goals, Indian cities, will have to focus on sustainable and resilient actions. With the urban population projected to increase from 30% to 60% by 2050³ it is likely that India's residential electricity will triple⁴. Urban India is expected to build 700 million to 900 million square meters of residential and commercial spaces, 350-400 kilometres of metros and subways, and 19,000 to 25,000 kilometres of road lanes every year⁵. This provides a unique prospect for cities to combine the climate goals and develop in a sustainable and resilient approach.

The National Action Plan on Climate Change (NAPCC) initiated by the central government in 2008 draws attention to enhancing energy efficiency, heightening the penetration of renewable energy and driving the construction of sustainable habitats. Additionally, guidance on reducing the energy intensity for municipal services as well as for the construction sector is provided by the Bureau of Energy Efficiency (BEE). The National Mission on Sustainable Habitat (NMSH) under NAPCC is steering energy efficiency in buildings that contribute to overall reduction in energy consumption by the built environment besides improving the quality of life. Further, the National

Solar Mission (NSM) under NAPCC is targeted towards increasing the renewable energy penetration in the grid infrastructure, leading to lower carbon emissions besides increasing the energy usage of urban centres. India is already working towards achieving 175 GW of renewable energy target by 2022, which includes 100 GW of solar (JNNSM) and 60 GW of wind. This will facilitate the reduction of per capita emissions as the rise in urban development will increase per capita energy consumption. The first four indicators in the thematic area of Energy and Green Buildings attempts to capture some of the key goals of the above mentioned missions. The indicator assesses the electricity consumption per capita in cities, the electricity derived from renewable energy sources, overall fossil fuel consumption and the coverage of energy efficient street lighting in the city.

Apart from the multiple missions, many standard frameworks and ratings such as Green Rating for Habitat Assessment (GRIHA), the global standard Leadership in Energy and Environmental Design or LEED (administered by GBCI India) and the Indian Green Building Council (IGBC) are available for cities to promote the construction of green buildings. The indicators on promotion of green buildings and adoption of green buildings tries to assess the cities based on the current and upcoming development.



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Director
Integrative Design
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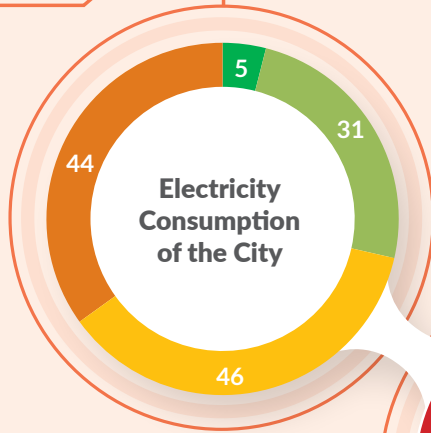
Roll-out of a comprehensive City Energy Action Plan considering energy access, energy efficiency and renewable energy integration will improve the quality of life of the citizens while reducing the climate impacts of city development and operations. The city administrators can also evaluate the implementation of innovative low carbon strategies like district energy or cooling systems, cool roofs and building energy codes.

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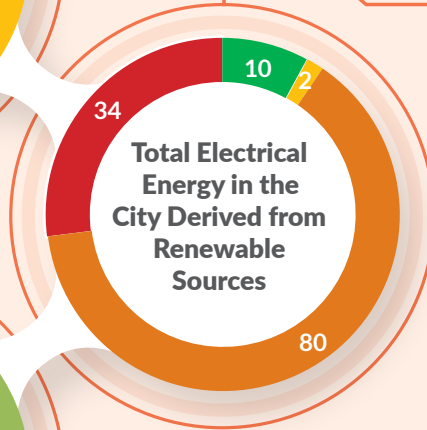
1. Mirror Now Digital, Times Now News :2020. India only country among G20 national to meet climate change mitigation Commitments. [Online] Available at: <https://www.timesnownews.com/india/article/india-only-country-among-g20-nations-to-meet-climate-change-mitigation-commitments/683884> [Accessed 20 March 2021].
2. PIB, 2018. Cabinet approves submission of India's Second Biennial Update Report (BUR) to United Nations Framework Convention on Climate Change (UNFCCC). [Online] Available at: <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1557609> [Accessed 20 March 2021]
3. PTI, 2016. 60% of India's population to live in cities by 2050: Government. [Online] Available at: <https://www.livemint.com/Politics/CyaMfUgL7r9dEAPKIRYMkl/60-of-Indias-population-to-live-in-cities-by-2050-governm.html>
4. IEA, 2021. India Energy Outlook. [Online] Available at: <https://www.iea.org/reports/india-energy-outlook-2021> [Accessed 25 February 2021]
5. McKinsey and Company, 2010. India's Urban Awakening: Building inclusive cities, sustaining economic growth. [Online] Available at: <https://www.mckinsey.com/featured-insights/urbanization/urban-awakening-in-india> [Accessed 25 February 2021]

Thematic indicators and assessment outcome

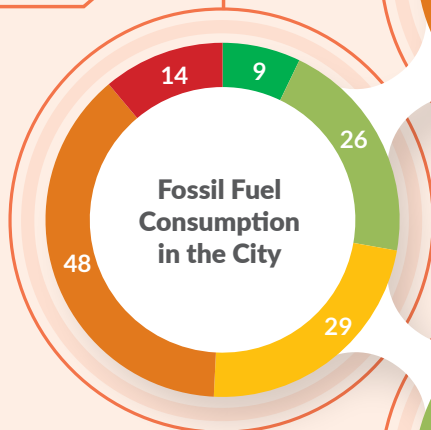
INDICATOR 1



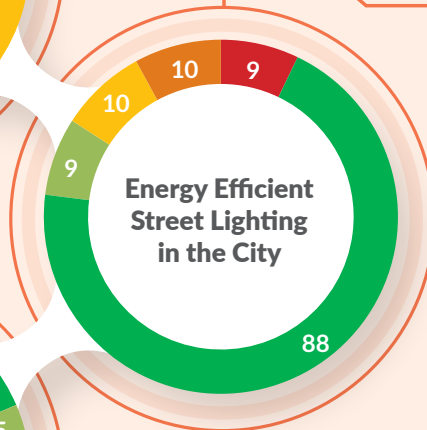
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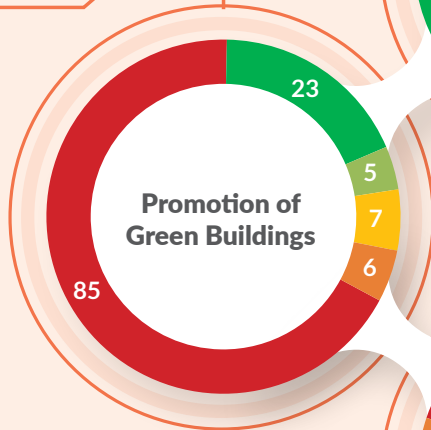
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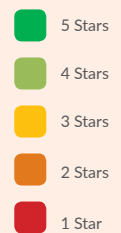
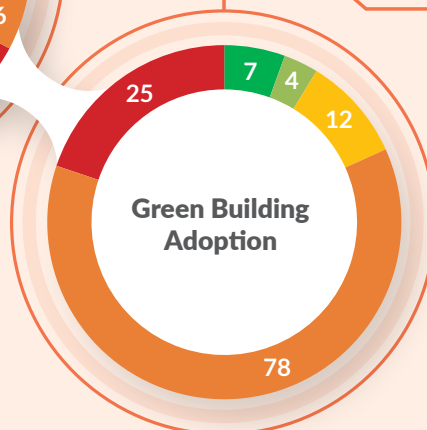
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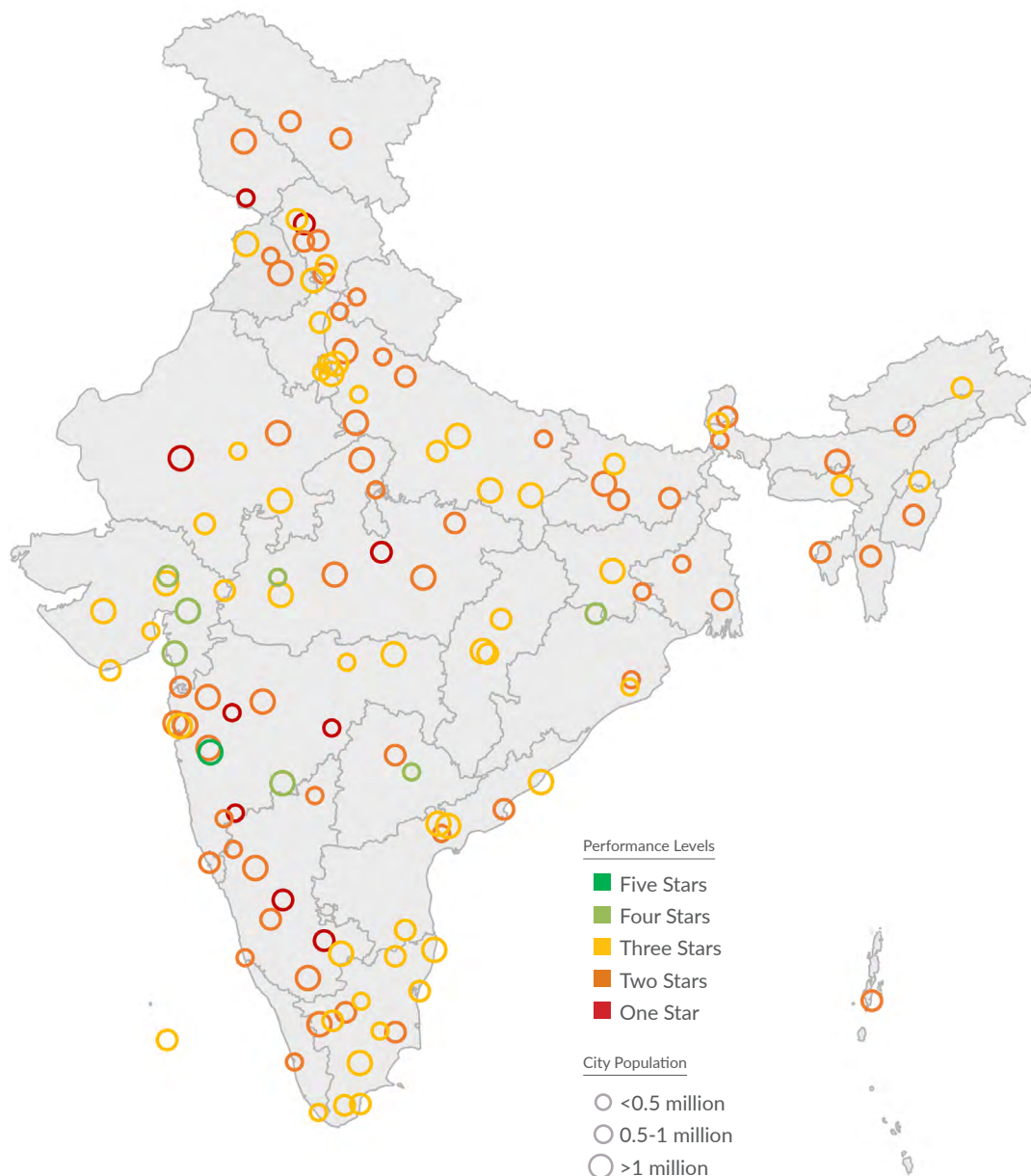


INDICATOR 5



INDICATOR 6





Performance of 126 Cities

Within this thematic area, cities have performed well with respect to green buildings and are in the process of adopting initiatives on energy efficiency and transitioning to clean energy. All states and Union Territories have established green building cells. Promotion and adoption of green buildings in cities are evident from this assessment.

Among the 8 well performing cities (*Five Stars* and *Four Stars*), 4 cities are metropolitan and 4 are large cities. Also, 4 of these 8 cities are also from the Western region showcasing their energy policy initiatives.

All the cities in Warm-Humid climatic zones are either in the *Three Stars* or *Two Stars* categories (except for Pune). These cities need to focus on energy efficiency and adoption of green buildings to address the cooling requirements of the built environment especially in light of extreme heat and GHG emissions.

Majority of the cities have adopted energy efficient street lighting solutions. Majority of cities have initiated installation of renewable energy systems in their cities.

1

5 Stars

7

4 Stars

52

3 Stars

57

2 Stars

9

1 Star



- Pune



- Gandhinagar
- Rourkela
- Solapur
- Surat
- Ujjain
- Vadodara
- Warangal



- Ahmedabad
- Ajmer
- Aligarh
- Amravathi
- ◆ Amravati
- Amritsar
- Bengaluru
- ◆ Bhavnagar
- Bhubaneswar
- Bilaspur
- Chandigarh
- Chennai
- ◆ Dahod
- Delhi
- ◆ Dharamshala
- ◆ Diu
- Faridabad
- ◆ Ghaziabad
- ◆ Gurugram
- Indore
- Kanpur
- Karnal
- Kavaratti
- Kohima
- Kota
- Lucknow
- Madurai
- Muzaffarpur
- Nagpur
- ◆ Namchi
- ◆ Naya Raipur
- ◆ Pasighat
- Prayagraj
- Puducherry
- Raipur
- Rajkot
- Ranchi
- Salem
- Shillong
- Shimla
- Thane
- Tiruchirapalli
- Tirunelveli
- Tirupati
- Tiruppur
- Tiruvananthapuram
- Toothukudi
- Udaipur
- Varanasi
- Vellore
- ◆ Vijayawada
- Visakhapatnam



- Agartala
- Agra
- Aizawl
- Aurangabad
- Barielly
- Belagavi
- Bhagalpur
- Bhopal
- Bihar Sharif
- Coimbatore
- ◆ Cuttack
- Dehradun
- ◆ Durgapur
- Erode
- Gangtok
- ◆ Gorakhpur
- ◆ Gulbarga
- ◆ Guntur
- Guwahati
- Gwalior
- Hamirpur
- Hubli Dharwad
- Imphal
- Itanagar
- Jabalpur
- Jaipur
- Jalandhar
- Jamshedpur
- Jhansi
- Kakinada
- Kalyan Dombivali
- ◆ Kargil
- Karimnagar
- Kochi
- ◆ Kolhapur
- ◆ Leh
- Ludhiana
- Mandi
- Mangalore
- ◆ Meerut
- ◆ Mira Bhayandar
- Moradabad
- ◆ Mysore
- Nashik
- New Town Kolkata
- Panaji
- Patna
- Pimpri Chinchwad
- Port Blair
- Saharanpur
- Satna
- Shivamogga
- ◆ Siliguri
- Silvassa
- Solan
- Srinagar
- Thanjavur



- Davangere
- Jammu
- ◆ Jodhpur
- ◆ Loni
- ◆ Nanded
- Palampur
- Sagar
- ◆ Sangli Miraj & Kupwad
- Tumakuru

● Smart and AMRUT cities ◆ Smart cities ◆ AMRUT cities ○ Other cities *Million + population cities

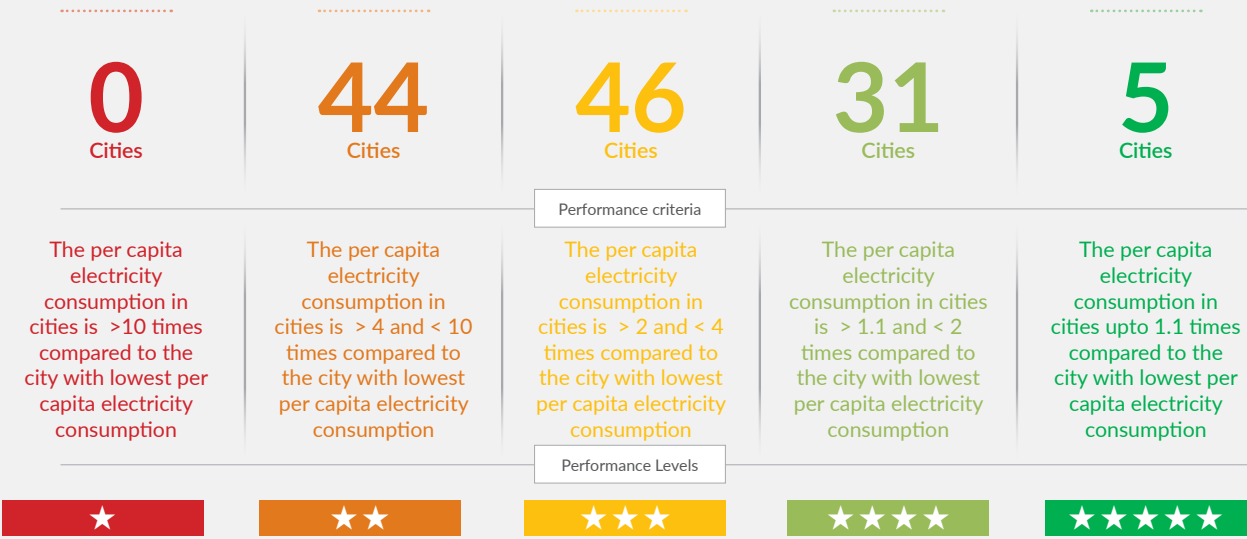
INDICATOR 1



Electricity Consumption of the City

Growing urban areas and urban population increase electricity consumption of cities around the world. Electricity generation is primarily dependent on fossil fuels, leading to higher GHG emissions. The global average for electricity consumption was 3,000kWh per capita per annum in 2017⁶. Controlling the per capita consumption of electricity will lead to lower GHG emissions.

India's average in the year 2018-20 was 1,181kWh per capita per annum⁷. The target for electricity consumption by 2040 is 3,000kWh per capita per annum where 60% demand is met from non-fossil fuel based sources⁸. While the per capita consumption in India is comparatively lower, it is important to ensure electricity access to all and improve efficiency for controlling per capita consumption. To enable



Performance of 126 cities

- ✓ The 5 *Five Stars* cities - Belagavi, Hubli Dharwad, Mysore, Bilaspur and Namchi, are growing cities. To sustain their performance, the cities will have to adopt new and energy efficient technologies as they expand. The average consumption across these cities is 394kWh per capita per annum.
- ✓ 31 *Four Stars* cities are taking advanced actions in this sector. The average consumption across these cities is 656kWh per capita per annum.
- ✓ 46 *Three Stars* cities have initiated some actions. The average consumption across these cities is 1,118kWh per capita per annum.
- ✓ 44 *Two Stars* cities have started mapping the ecosystem to enable climate actions. Average consumption across these cities is 1710kWh per capita per annum.
- ✓ None of the cities are in the *One Star* category, showcasing that all the cities have started mapping their consumption and initiated actions for the same.
- ✓ Based on the data collection, average consumption of all 126 cities is 1182kWh per capita per annum of which, more than 50% of large cities, and more than 60% of medium, small & metropolis cities are using less energy per capita than average of 126 cities.



this, cities need to understand the energy consumption pattern and adopt relevant energy efficient measures to lower per capita electricity consumption.

An early adoption of energy efficient technologies will help in reducing per capita consumption in the long run. With this intent, the indicator on electricity consumption assessed cities based on per capita consumption and were scored relative to cities with similar population. Refer Annexure 2 for population data.

Actions

SURAT

Surat Municipal Corporation has an energy efficiency cell which conducts energy audits, promotes energy conservation and renewable energy projects, and monitors usage of electricity of entire corporation. The Solar City Masterplan along with initiatives under Smart City Mission has ensured that the municipal corporation fulfils 34% of its energy needs through renewable sources (as of 2019).

Way forward to regulate electricity consumption

- Cities may consider deploying Energy Monitoring Information System (EMIS) to segregate and record major electrical loads for municipal services, commercial, industrial, and residential electricity consumption separately. This will help cities to monitor and document sector wise use of EMIS can be embedded within the existing Integrated Command and Control Centre (ICCC) platform wherever possible to help monitor and document sector wise use of electricity consumption which can support strategic planning for improving efficiency.
- Establishing a monitoring and evaluation cell that can work along the Energy Service Company (ESCO) will enable cities to develop energy efficient projects and investment grade audits as part of BEE's municipal DSM program. This cell can also facilitate energy efficiency in the existing projects. Cities can refer more about
 - Development of Municipal Energy Efficiency Projects and Energy Audits to be energy efficient.
- Cities have various opportunities to develop and implement energy efficient projects:
 - » Cities can to utilize central schemes such as BEE facilitated energy audits and situational surveys to identify suitable projects to save electrical energy under Municipal Demand Side Management (MuDSM).
 - » Cities can to explore financing support through BEE's Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE). With the use of viable technology to monitor savings, cities can achieve demonstrable energy savings and mitigation in GHG emissions. Financial support through SIDBI's Partial Risk Sharing Facility (PRSF) can also be availed.



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Associate Professor
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Historic as well as real-time data can be transformative for climate action and has become a key instrument into building resilient cities. While most data are aggregated at the national level, a lot of decision making happens at the local level. Cities need to be empowered with granular and real-time community embedded data to provide inclusive decision-making and ensure resilient communities for future crises.

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⁶ Kahan, A., 2020. Global electricity consumption continues to rise faster than population. [Online] Available at: <https://www.eia.gov/todayinenergy/detail.php?id=44095> [Accessed 25 February 2021]

⁷ Kahan, A., 2020. Global electricity consumption continues to rise faster than population. [Online] Available at: <https://www.eia.gov/todayinenergy/detail.php?id=44095> [Accessed 25 February 2021]

⁸ Niti Aayog, 2017. Draft National Energy Policy. [Online] Available at: http://niti.gov.in/writereaddata/files/new_initiatives/NEP-ID_27.06.2017.pdf [Accessed 25 February 2021]

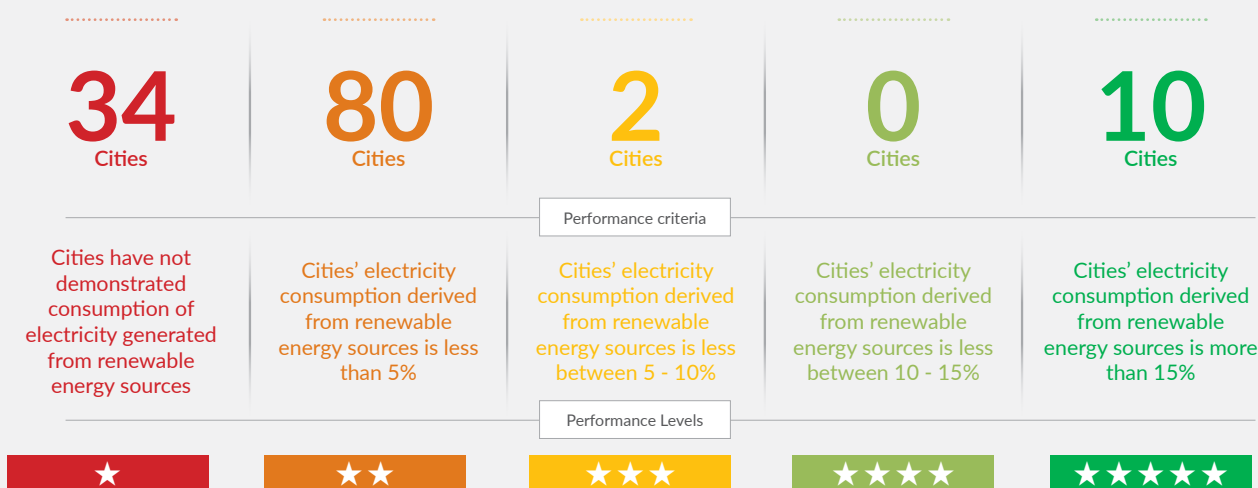
INDICATOR 2



Total Electrical Energy in the City Derived from Renewable Sources

India has witnessed the fastest rate of growth in renewable energy (RE) capacity addition among all large economies, with renewable energy capacity growing by 2.5 times and solar energy expanding by over 13 times from 2015⁹. Production of energy from cleaner renewable energy sources (solar PV, solar thermal, wind energy, hybrid-hydel power, small hydro, geo-thermal energy, tidal energy, biogas, waste to energy) will be the key for India to achieve its sustainable development goals. Renewable energy now constitutes

over 36% of the country's installed power capacity and around 26% of the electrical energy generation¹⁰. To foster this, the Ministry of New and Renewable Energy (MNRE) has launched a number of initiatives including National Solar Mission and Green Energy Corridor (Wind & Solar PV) to increase the share of clean technologies in the electricity sector in order to mitigate the negative environmental effects of coal-based electricity generation. These national level initiatives envisages to achieve 175 GW of installed



Performance of 126 cities

- ✓ 10 Cities have performed well in this indicator with more than 15% of its total energy needs generated through renewable sources. These cities have championed by increasing their renewable energy capacity by promoting and developing Solar Parks and Ultra Mega Solar and Hydro Power Projects.
 - » States like Maharashtra (2 cities) and Himachal Pradesh (2 cities) have set up the renewable energy policies in place for the cities to improve generation through renewable sources.
 - » Cities from Union Territories like Kargil, Diu, and Kavaratti have been progressive by using a higher share of solar & hydro powered energy systems.
 - » Cities like Surat, Pune, Jabalpur, Amravati and Coimbatore are the examples where the RE generation has been given priority.
 - » Hilly cities like Shimla, Shillong, Kargil and Dharamshala have the geographical advantage of using higher hydro electric energy and also with lower energy intensity per capita have championed the indicator.
- ✓ Around 80 cities in *Two Stars* category generate less than or equal to 5% of their total energy needs through renewable sources. Also, 53 of these cities which are a part of the Smart Cities Mission have less than 2% of generation through renewable energy. Although systems and processes to implement renewable energy projects are in place, cities from the states of Kerala, Odisha, Assam, Madhya Pradesh, Tamil Nadu and Maharashtra have further scope for improvement.
- ✓ 29 (out of which 21 are smart cities) of 34 cities which are in *One Star* category that participated in the assessment have not been able to provide the required information. Efforts to acquire relevant information should be a priority for these cities.



capacity of renewable energy in the power sector by 2022. In addition, the Government of India has proposed a target of 450 GW of renewable energy generation capacity by 2030⁹.

This particular indicator encourages the replacement of existing electricity generation from fossil fuels with cleaner renewable energy sources. Total renewable energy contribution in the city was calculated based on the ratio of total electrical energy consumption derived from both on-grid and off-grid renewable energy sources to total connected electrical load in the city.

Way forward for cities to increase Electrical Energy derived from Renewable Sources

- 34 *One Star* Cities can initiate a dialogue with local power distribution companies (DISCOMs) and the state energy distribution agency (SEDA), State Electricity Regulatory Commission (SERC) to improve coordination and data sharing to make informed decisions for implementing recommended actions.
- There is huge potential for 80 *Two Stars* cities to increase their share of renewable energy. These cities can leverage government schemes and initiatives like the Rooftop Solar programme, Solar Net Metering and Grid Connected Wind-Solar Hybrid Power Projects, availing existing concessions in transmission and

Actions

DIU

Diu had introduced a Renewable Energy Policy in 2017 to meet the central government's targets on solar power generation and other renewable energy technologies. Diu Smart City has been successful to meet its goals and runs on 100% renewable energy during daytime and is saving around 13,000 tonnes of carbon emissions every year. The city has adopted a two-pronged approach whereby a 9 MW solar park spread over 50 hectares rocky barren land has been developed besides installing solar panels on the roof tops on 79 government buildings thereby generating 1.3 MW annually. Diu also offers its residents a subsidy of Rs 10,000-50,000 for installing 1-5KW roof top solar panels. Due to low-cost solar energy, power tariffs have been cut in residential category by 10% last year and 15% this year.

- enhancing their distribution tariffs through wheeling / banking arrangements to implement business models such as RESCO, EPC etc.
- The 10 *Five Stars* cities are recommended to develop proposals to actively take part in various Government of India schemes such as the "Solar Cities" program of MNRE. This includes steps such as preparing an energy baseline for the city, demand-based forecasts/projections for the city's energy needs and then creating a sector-wise strategy for increasing the share of renewable energy.

⁹. PIB, 2018. Press Information Bureau. [Online] Available at: <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1685046> [Accessed 25 February 2021]

¹⁰. MNRE Report: YEAR END REVIEW-2020

INDICATOR 3

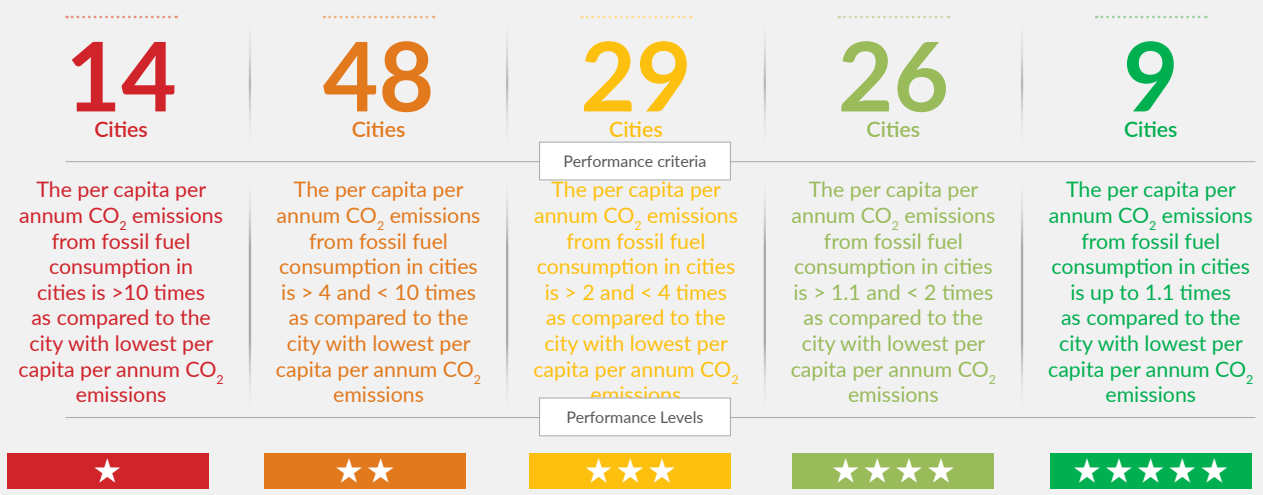


Fossil Fuel Consumption in the City

Global energy consumption in 2018 increased at nearly twice the average rate of growth since 2010, driven by a robust global economy and higher heating and cooling needs in some parts of the world. Demand for fossil fuels increased by nearly 70% of the growth, led by natural gas. As a result of higher energy consumption, CO₂ emissions rose 1.7% last year and hit a new record¹⁰. The world is moving away from overwhelming dependence on fossil fuel, and within the fossil fuels, away from coal and oil in

favour of gas. Against an 88% total share of fossil fuels globally in the primary energy mix in the year 2005, the same fell to 86% in the year 2015¹¹.

India's dependence on imported fossil fuels rose significantly, despite the country having substantial domestic fossil fuel resources. India ranked as the fourth-largest energy consumer in the world in 2011, following China, the United States, and Russia. In 2015, India



Performance of 126 cities

- ✓ The results from this assessment indicate two cities in *Five Stars* category, namely Thane and Varanasi fair relatively better in this indicator. This may be due to the availability and accessibility of public transportation and pedestrian friendly infrastructure leading to less fossil fuel consumption. Across the remaining 7 cities in the *Five Stars* category, given their relatively smaller size, it is quite likely that citizens largely prefer to use two wheelers or use non-motorised transport, leading to relatively low consumption of fossil fuels.
- ✓ All cities in *Four Stars* category have relatively small size of population except 5 cities which have a population of 1.5 lakhs or above. The per capital consumption of fossil fuels in these cities are less due to the likelihood of citizens' preference to use two wheelers and paratransit for commute. Also, given their small city size and issues related to parking within the core areas prevent people from using four wheelers.
- ✓ In Indian cities, petrol is generally used for transportation and diesel for both transportation and electricity backup (private use of generators). Average per capita petrol and diesel consumption across participating cities are as follows:
 - » *Five Stars* - In this category, cities consume on an average 23 and 22 litres per capita per annum of petrol and diesel respectively.
 - » *Four Stars* - In this category, cities consume on an average of 61 and 67 litres per capita per annum of petrol and diesel respectively.
 - » *Three Stars* - In this category, cities consume on an average of 100 and 148 litres per capita per annum of petrol and diesel respectively.
- ✓ Only 37 cities managed to submit data related to CNG and PNG consumption respectively. This indicates that the majority of the cities either do not have sufficient infrastructure or were unable to collect data from the concerned authorities during the assessment period.



Actions

PUNE

Pune has initiated adoption of Smart E-buses as a clean public transport option. This will reduce consumption of fossil fuels in long run and in turn reduce GHG emissions. The buses have also achieved 10 to 20 % rise in the revenue compared to the old buses.

consumed 121 million tonnes of petroleum products, of which high speed diesel accounted for 40.42%, petrol accounted for 11.83% and LPG accounted for 10.63%¹². Diesel, petrol, CNG, and LPG are the major sources of energy for municipal services in India, leading to increasing GHG emissions. Vehicular emissions account for a major chunk of the emissions in India owing to the fuels used to run them. The share of transport-based emissions contributes in a large measure to the release of GHGs. Fossil fuel consumption in the transport sector contributed to 17.8% or 245 million tonnes of CO₂ emissions in India in 2015¹³. Hence this sector has been identified as an area which needs immediate intervention to see desirable results. The Target 2030 envisions that natural gas will cater to 20% of the primary energy mix compared to 11% in 2010¹⁴. As the country's energy demand continues to climb due to its dynamic economic growth and modernization, therefore there is a need to switch to a safe, smart and sustainable energy consumption as key means of limiting greenhouse gas emissions in India.

This indicator aims to incentivize cities to lower their CO₂ emissions per capita per area by encouraging them to switch to alternative cleaner fuel sources and to lower the per capita emissions from the consumption of fossil fuels by shifting to lower emitting fossil fuels and non-fossil fuel based sources. Availability of data through a single point source has led to challenges in reporting. Approximately 90 cities did not submit data for PNG and CNG. Therefore, the assessment across the 126 cities were done based on data provided for petrol, diesel and LPG. Cities were scored in relative to cities with similar population. Refer Annexure 2 for population data. Additional points were given to the cities which managed to submit PNG and CNG data.

Way forward to reduce per capita fossil fuel emissions

- Cities are suggested to initiate a dialogue with petroleum products distribution companies (eg. BPCL, IOCL, HPCL, Shell etc.) to facilitate data collection which will enable them with the implementation of recommended actions.
- From our analysis it is evident that cities with improved public transportation have managed to bring down their per capita fuel consumption. Therefore, augmentation of public transport, particularly based on clean energy like CNG, electric etc, is recommended.
- Cities should promote the use of cleaner fuels for vehicular fuel consumption (Example: Biofuels, CNG, LPG, Renewable energy). An action plan can be developed with the Regional Transport Department, for the transition of vehicles (used by Municipality and Citizens) towards low carbon and renewable energy options.
- Cities can improve renewable energy generation, adopt electric/clean fuel vehicles and haul the EV charging infrastructure by participating in the FAME-II program initiated by the Ministry of Heavy Industries and Public Enterprises.

¹⁰. Global Energy & CO₂ Status Report, 2019. [Online] Available at: <https://www.iea.org/reports/global-energy-co2-status-report-2019> [Accessed 6 April 2021]

¹¹. Draft National Energy Policy NITI Aayog, Government of India, 2017. [Online] Available at: https://niti.gov.in/writereaddata/files/new_initiatives/NEP-ID_27.06.2017.pdf [Accessed 6 April 2021]

¹². Central Statistics Office, 2017. Energy Statistics 2017, New Delhi: Ministry of Statistics and Programme Implementation.

¹³. Shakti Foundation, 2017. Vehicles and Fuels. [Online] Available at: <https://shaktifoundation.in/work/transport/fuel-efficiency-norms-in-india/> [Accessed 25 February 2021]

¹⁴. PNGRB, 2013. Vision 2030 Natural Gas Infrastructure in India. [Online] Available at: <https://www.pngrb.gov.in/Hindi-Website/pdf/vision-NGPV-2030-06092013.pdf> [Accessed 25 February 2021]

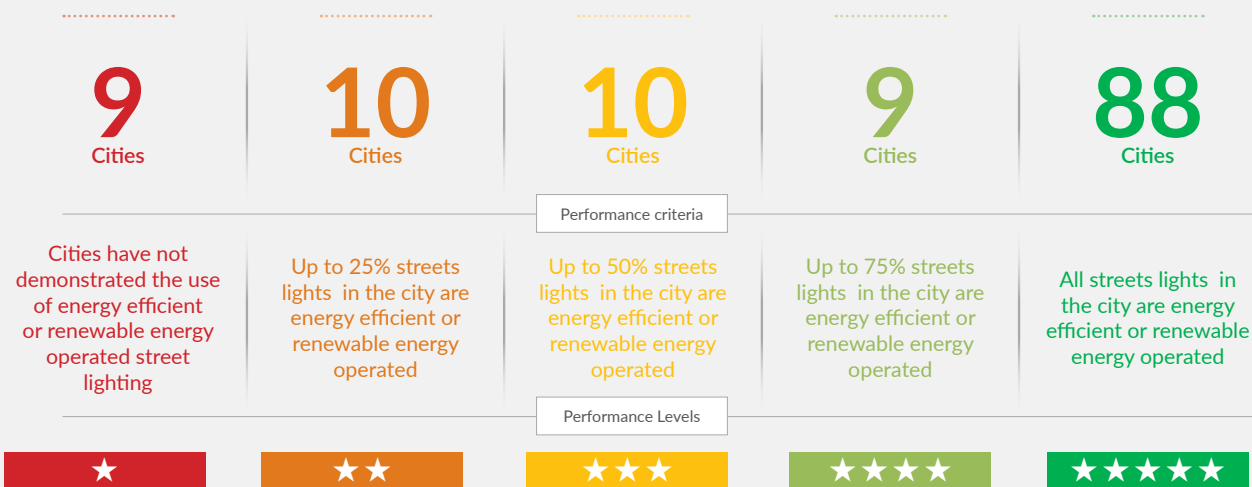
INDICATOR 4



Energy Efficient Street Lighting in the City

Street lighting is a major contributor to the city’s electricity consumption. Energy efficient and renewable energy operated street lighting systems will reduce the dependence on electricity from fossil fuels thus indirectly reduce GHG emissions in the city. As a city grows, the energy needs increases proportionately. Since street lighting is one of key mandates of ULBs and municipal corporations it is also one of the major contributors to the ULB’s total electricity consumption. Further, replacing the conventional streetlights with LEDs in countries across globe, could result in a potential annual savings of 4,300 million KWh, which is about 50% of total energy consumed¹⁵.

Energy efficient street lighting in India has seen a slew of transformations with advent of the government’s initiatives like Unnat Jyoti by Affordable LEDs for All (UJALA), the Smart Cities Mission and Street Lighting National Program (SLNP), under which the Energy Efficiency Services Limited (EESL) has set the ambitious target for replacement of traditional streetlights. Street Lighting National Program (SLNP) aims to replace 1.34 crore conventional streetlights in India with smart LEDs. This ambitious goal will make a tremendous difference, enabling peak demand reduction of about 1500 MW, annual energy savings of 9 billion kWh, and reduction in 6.2 Million tons of CO₂ per year¹⁶.



Performance of 126 cities

- ✓ The performance for cities across this indicator is very progressive with 97 cities in *Five Stars* and *Four Stars* categories moving towards 100% conversion of energy efficient street lights.
 - » Bangalore, Chennai, Jaipur, Pune and Lucknow are top 5 cities in *Five Stars* category with highest numbers of total energy efficient street lights accounting for more than 1.5 lakh installations per city.
 - » Uttar Pradesh (11), Tamil Nadu (9), Gujarat (5), Bihar (4) and Andhra Pradesh (6) are the states which have managed to achieve almost 100% conversion rate to energy efficient street lights.
- ✓ 10 cities in *Three Stars* category are from the states of Maharashtra, Madhya Pradesh, Haryana, Sikkim and Mizoram.
- ✓ 10 cities in *Two Stars* category are from Karnataka (6), Madhya Pradesh (1), Punjab (1), Kerala (1 city) and Jammu & Kashmir (1). Given their progressive reforms, these states have tremendous potential for supporting the transition of their cities from existing street light fixture to energy efficient street lights.
- ✓ 9 cities in *One Star* category currently have limited energy efficient street light installations. Except for two small towns, the rest are large and metropolitan cities which can scope existing government schemes and PPP arrangements for conversion of their existing street light fixtures.



The indicator on energy efficient street lighting, projects the extent to which cities have shifted to use of energy efficient street lights and smart street-lighting automation systems for better monitoring, operation and control of street lights. Energy efficient streetlights should have lamps with luminous efficacy of more than 85 lumens per watt. LED and renewable energy operated street lights, have been successful in improving energy efficiency of municipal services in cities across India.

Actions

RAJKOT

Rajkot has retrofitted the conventional street lights in the city with energy efficient LED in a span of three months in 2016-17. This led to energy savings of 60% and GHG reduction of around 7,000 tonnes CO₂ eq. The initiative helped the city government in saving INR 50 million, at the same time providing better illumination and enhancing public safety.

Way forward for increasing Energy Efficient Street Lighting in the City

- 10 *Two Stars* cities are recommended to improve upon the existing design and implementation of smart street lighting automation for remote operation, monitoring and control of streetlights. This involves site selection (road type/width, electrical infrastructure, location etc), an investment grade audit and baseline assessment of the proposed sites.
- 10 *Three Stars* cities are suggested to expand the number of energy efficient and renewable energy operated streetlights in the city and implement smart street-lighting automation projects. This includes expanding the stakeholders network and designing PPP models/ ESCO models for financing.
- All Municipal corporations can create a GIS based map of all streetlights in the city with attributes for type of lighting (energy efficient and renewable energy operated) which can further be monitored through the Integrated command and control centres (ICCCs) established under the smart cities mission.
- 97 *Five Stars* and *Four Stars* cities are recommended to focus on innovative solutions including but not limited to EV charging units, smart poles with wireless communication systems in tandem with renewable-energy based street lighting systems.
- The non-performing cities can also avail benefits from Street Lighting National Program (SLNP) and Atal Jyoti Yojana (AJAY) scheme for installation of solar street lights.



Mrs. Vaishali Nandan
Project Head, Climate Smart Cities
GIZ

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Rapid pace of urbanisation has made cities vulnerable to impacts of climate change. MoHUA's initiative “ClimateSmart Cities Assessment Framework” helps sensitize cities and empowers them to take informed climate-oriented actions. GIZ through the Indo German ‘Climate Smart Cities’ Project is supporting MoHUA and C-Cube to achieve the vision for sustainable urban centres. As a member of the ClimateSmart Cities Alliance, GIZ is mainstreaming local climate actions across 17 Smart Cities

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15. World Bank, 2015. India: Energy Efficient Street-Lighting--Implementation and Financing Solutions. [Online] Available at: <https://openknowledge.worldbank.org/handle/10986/22275> [Accessed 25 February 2021]

16. PIB, 2020. Press Information Bureau: Government of India's UJALA & Street Lighting National Programme Complete Five Successful years of Illuminating India. [Online] Available at: <https://pib.gov.in/newsite/PrintRelease.aspx?relid=197275> [Accessed 25 February 2021]

INDICATOR 5



Promotion of Green Buildings

Buildings and the construction industry together account for 36% of global energy use and 39% of energy-related CO₂ emissions annually¹⁷. Green buildings provide some of the most effective means of achieving a range of global goals, such as addressing climate change, economic growth and social aspects.

In India, the building stock accounts for more than 40%

of the country's total energy consumption¹⁸, energy rise from buildings is increasing at 8% annually¹⁹. According to the International Finance Corporation (IFC), 70 percent of the buildings required by 2030 are yet to be constructed in India. In a business as usual scenario, buildings would account for over 70% of the emissions by 2050²⁰, thus posing a major threat to India's green ambitions. With this in consideration, Government of India (GoI) notified the



Performance of 126 cities

- ✓ 23 cities in *Five Stars* category have implemented all four key measures both at city and state level with majority of the cities to be metropolitan cities.
- ✓ 18 cities in *Four, Three and Two Stars* categories belong to large and metropolitan city with majority of them to be smart and AMRUT cities.
- ✓ 85 cities in *One Star* category majorly belong to large towns (26), medium (24) and metropolitan cities (26) with northern region, southern region and western region.
- ✓ 41 cities have implemented all the measures at the state level. These cities have integrated the green buildings norms and guidelines in their bye laws and Development Control Regulations (DCRs). Within these, 32 cities have also implemented the promotional and penalty schemes.
- ✓ While all the participating cities have a Green Building cell at the state level, 28 out of 126 cities have dedicated cells within their ULBs to strengthen the implementation of green building measures. Nevertheless, 40 medium cities belonging to Madhya Pradesh, Tamil Nadu, Bihar, Chhattisgarh, North-Eastern states and Union Territories are yet to establish a city level unit for implementation and monitoring of green building measures.



Actions

WARANGAL

Warangal has included Energy Conservation Building Codes (ECBC) in its building bye laws and also established green building cells/committees at local level. The Telangana Energy Conservation Building Code Guidelines (TSECBC) has prescribed compliance guidelines for adoption of ECBC in building codes and building permission systems at ULB level.

National Building Code (NBC), 2016, Energy Conservation of Building Codes (ECBC), 2007 and Eco-Niwas Samhita (ENS) 2018 in order to encourage the construction and use of green and energy efficient buildings. Besides, various green building rating systems monitoring and measuring the adoption and promotion include Bureau of Energy Efficiency (BEE), Leadership in Energy & Environmental Design (LEED), Excellence in Design for Greater Efficiencies (EDGE), Green Rating for Integrated Habitat Assessment (GRIHA), Indian Green Building Council (IGBC), Green and Eco-friendly Movement (GEM).

The indicator on promotion of green buildings addresses four key measures on green buildings that indicates the readiness of the city regarding its compliance procedures, penalty/ reward schemes, stakeholder co-operation for promotion of new and existing green and construction of energy efficient buildings. The other measures include institutionalizing a green building cell at the ULB level for knowledge dissemination, and a functioning high-level

green building committee acting as strategic advisory and promotional/ penalty schemes available for code compliance, pre- certification, certification of green buildings. Since cities were facing trouble in collating the NBC, ECBC and ENS approval information, all data for this indicator was secured directly from green building approval agencies within the country. This also ensured the validity of the information analysed and reduced the additional burden on the cities for reporting on this indicator.

Way forward for the Promotion of Green Buildings

- 40 Cities are recommended to adopt Part 11 (approach to sustainability) in NBC 2016 or ECBC 2017 or Eco-Niwas Samhita 2018 in their building rules/bye-laws/development control regulations.
- 45 cities that have not started the practice of promotional/ penalty schemes for the code compliance, pre-certification and certification of green buildings can initiate this measure.
- 49 cities that have not utilized the green building incentives available at the state level can start promotional awareness raising campaigns for community, government buildings/institutions, other public institutions (school, colleges, hospitals), and private sector.
- 100 cities that have green building cells or green building committee at the state level but not at city level can aim to establish green building committees at the city level to promote implementation of measures including strategic and technical guidance. The committee may include representatives from PWD, relevant government department representatives, city planners, building architects, construction developers, material suppliers, third party certification agencies, consultants and other relevant green building stakeholders.

17. UN Environment and International Energy Agency, 2017. Towards a zero emissions, efficient and resilient buildings and construction sector. [Online]
Available at: https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf [Accessed 25 February 2021]

18. Soi, U. & Ahuja, M., 2020. The case for green buildings in India. [Online]
Available at: <https://www.orfonline.org/expert-speak/case-green-buildings-india/> [Accessed 25 February 2021]

19. Khosla, R. & Janda, K. B., 2018. India's building stock: towards energy and climate change solutions. [Online]
Available at: <https://www.tandfonline.com/doi/full/10.1080/09613218.2019.1522482> [Accessed 25 February 2021]

20. McKinsey & Company, 2010. India's Urban Awakening: Building inclusive cities, sustaining economic growth. [Online]
Available at: <https://www.mckinsey.com/featured-insights/urbanization/urban-awakening-in-india> [Accessed 25 February 2021]

INDICATOR 6



Green Building Adoption

Buildings account for more than 40% of India's total energy consumption, 20% of the raw material use, 20% of water use, and 20% of land use in cities²¹. They are also responsible for 40% of total carbon emissions, 30% of solid waste generation, and 20% of water effluents (ibid). Studies indicate that the energy use from buildings is increasing at 8% annually and, in a business-as-usual scenario buildings would account for over 70% of emissions by 2050²². The growth of buildings sector and its contribution to climate

change plays a critical role in India's actions towards addressing climate risks and achieving sustainable development goals.

Currently, India's 'Green Buildings', constitute for only 5% of the building market²³. However, current evidence shows promising potential in reduction of energy consumption and emissions through appropriate policies and implementation procedures in place. A study indicates that the national



Performance of 126 cities

- ✓ 7 cities in *Five Stars* category are performing well with relatively high green building adoption factor. Out of these, 4 are metropolitan cities and 3 are large cities.
- ✓ 4 cities in *Four Stars* category are mostly metropolitan (1), medium sized cities (2) and small towns(1). The average green building adoption factor per 10,000 population in this category is 468.
- ✓ 12 cities in *Three Stars* category are mostly metropolitan cities (5) with majority being Smart and AMRUT cities that are likely to have initiated the adoption of green buildings under these missions. However, they will need dedicated efforts to take progress in improving their green building adoption
- ✓ With 78 cities in *Two Stars* category, it is evident that majority of the participating cities are progressing towards improved green building adoption.
 - » This includes 50% of the participating metropolitan and large cities that are mostly from the northern, western and southern regions of the country.
 - » Over 75% of the cities in this category are from the composite or warm-humid climatic zone and can greatly contribute towards GHG reduction by addressing the heating and cooling requirements of their buildings.
- ✓ 50% of the cities in *One Star* category are medium sized cities. 22 out of 25 cities in *One Star* category are from composite and warm humid climatic zone and focus on green buildings can help reduce cooling requirements in the buildings.



power demand can be reduced by as much as 25 per cent in 2030 by improving energy efficiency of buildings and operations²⁴.

This indicator focuses on the adoption of green building wherein cities are assessed based on the ratio of green buildings to the total number of buildings approved for construction and occupancy in the city for the assessment year. Data for this indicator was centrally collected from the central green building councils/rating agencies - BEE, IGBC, GRIHA and GBCI.

Actions

CHANDIGARH

Chandigarh master plan has encouraged adoption of the green building rating system and design concepts in line with the Energy Conservation Building Code (ECBC), 2007. The administration has also adopted the CPWD guidelines for placing a minimum three-star GRIHA rating in all public buildings in the future.

Way forward for Green Buildings Adoption

- Cities are recommended to create a green building cell or committee consisting of stakeholders like ULB green building cell, PWD, city planners, architects, developers, material suppliers, and other relevant stakeholders to promote green building development through knowledge dissemination and construction of demonstration projects. The tasks can include awareness programs to the stakeholders, advertisement to the public, constructing/retrofitting buildings for ECBC/ENS Compliance or Green building certification.
- Cities can start capitalizing on the technical assistance available at the state level from ECBC Cells and other government schemes like PMAY(U) and AMRUT.
- Cities are suggested to initiate the ECBC/ ENS Compliance and/or green building certification for the government buildings, institutional buildings such as schools, colleges and hospitals and residential buildings constructed or promoted by ULBs such as Low Income Group (LIG) and Medium Income Group (MIG) housings to increase the green building penetration and also to aid awareness amongst citizens to rent/purchase energy efficient or green buildings.
- Cities can consider implementing incentive programs like fast-track approval, extra FAR, property tax rebate, EIA approvals, and other benefits (Towards building developers and end users) for the development of energy efficient buildings.
- Cities may regulate the building approval process with the rules and regulations for compliance with ECBC and ENS. It is also suggested to put in place an effective enforcement system into the online building approval system.
- Cities may initiate discussions with third party building certification agencies, planners, architects, engineers, developers and vendor OEMs who support the construction of green buildings in the city.

²¹. The Economic Times, 2012. Nearly 70% of building stock that will be there in 2030 is yet to be built in India.[Online] Available at: <https://economictimes.indiatimes.com/realty-trends/nearly-70-of-building-stock-that-will-be-there-in-2030-is-yet-to-be-built-in-india/articleshow/14732400.cms> [Accessed 8 April 2021]

²². U.S. Energy Information Administration, 2010. Buildings energy consumption in India is expected to increase faster than in other regions. [Online] Available at: <https://www.eia.gov/todayinenergy/detail.php?id=33252> [Accessed 8 April 2021]

²³. (IFC) International Finance Corporation - World Bank Group, GREEN BUILDINGS MARKET INTELLIGENCE. [Online] Available at: <https://edgebuildings.com/wp-content/uploads/2018/05/India-Green-Building-Market-Intelligence.pdf> [Accessed 9 April 2021]

²⁴. 7 Down To Earth, 2012. Construction boom will make cities unliveable. [Online] Available at: <https://www.downtoearth.org.in/news/construction-boom-will-make-cities-unliveable-centre-for-science-and-environment-3854> [Accessed 9 April 2021]



पिंपरी चिंचवड नवनगर विकास प्राधिकरण

Credits:

Pimpri Chinchwad:

This is the Pimpri Chinchwad New Town Development Authority building with 5 star certification under the GRIHA green building rating system. The design concentrates on natural ventilation, bringing higher efficiency of electro mechanical system installed and utilization of renewable energy system in the building.

by TERI and GRIHA



Actions in the cities



Tirupati

Solar Energy Generation through efficient usage of land, water and rooftop surface

To contribute towards national goals of GHG reduction, Tirupati has undertaken a giant leap towards renewable source of energy through “11 MW Solar Power projects”. The projects include rooftop solar installations and land based solar park along with an innovating floating solar park at Kailashgiri Reservoir.



Pimpri Chinchwad

GRIHA rated development authority building

The Pimpri Chinchwad municipal corporation has adopted GRIHA, the national rating system for green buildings in India, with the objective of promoting sustainable development and wise use of natural resources. Incentives like discounted premium for developers and reduced property tax for home owners have been implemented to promote adoption of green buildings. The Pimpri Chinchwad Navnagar Development Authority building designed in 2008 is also a certified green building which is naturally ventilated and runs on solar energy.



Nagpur

Project green light

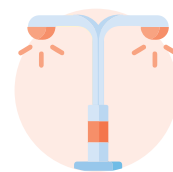
Nagpur has initiated retrofitting the existing conventional street lighting system with LED lights that has resulted in energy savings of more than 40% of electricity annually and has led to reduction in carbon footprints. It is one of the largest environmental friendly LED (Light Emitting Diode) lights project ever undertaken by a city with an aim to replace 1,36,000 streetlights.



Average electricity consumption per capita per annum
Five Stars cities –
394 kWh
Two Stars cities –
1710 kWh



All States and UTs
have established
green building cells



88 cities

have converted
all streetlights to
energy-efficient or
renewable energy
operated



Ms. Shruti Narayan
Regional Director
South and West Asia
C40 Cities

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Climate action has to become the measure of the health of an economy and its resilience. Cities need to lead the way in structuring this as an integrated effort part of their budgets ensuring inclusive stakeholder consultation and leading to job creation and quality of life.

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CSCAF being a first-of-its-kind city assessment framework on climate relevant parameters for Indian cities, has addressed unique challenges and brought out the environmental responsiveness in participating cities. Going forward it shall provide directions to enhance energy and water efficiency, waste management and improve urban mobility and air quality in Indian Cities. GBCI is very honored to have been a part of this key initiative.



Ms. Mili Majumdar
Managing Director
GBCI, India and Senior
VP,USGBC,USA

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Mr. Ernst Doering
Cluster Coordinator,
Sustainable Urban & Industrial
Development Cluster, GIZ

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GIZ is committed to support India in the areas of Climate Change and Sustainable Urban Development. In close cooperation with the Ministry, States and Cities, GIZ jointly-develops customised solutions to meet local needs and achieve sustainable, climate relevant and inclusive development.

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101 cities

have green buildings
and are actively
promoting the same



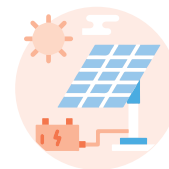
Average fuel
consumption (MS &
HSD) per capita per
annum

Five Stars cities –

22 litres

Three Stars cities –

124 litres



10 cities

have more than 15%
of their electricity
needs generated
through renewable
energy