

TOWARDS MORE SUSTAINABLE CITIES



Shakti Sustainable Energy Foundation is working to accelerate the transition to sustainable cities with a focus on energy efficiency in the built environment, sustainable transport, air quality management, utility-led efficiency measures and scaling up rooftop solar.

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Cities are increasingly becoming venues for strategic action on clean energy and climate change. The 2015 Paris Climate Agreement recognized the innovative and leading role of cities in achieving emission reductions and in the transition to low-carbon pathways. The Sustainable Development Goals include an urban goal representing cities a major sustainable development opportunity.

In India, the recent focus on urban development is particularly relevant. India's urban population reached 420 million in 2015 and is expected to almost double to 800 million by 2050.¹ By 2031, cities will account for 75% of national GDP and a majority of all net new jobs. Clearly, a major urban transformation is in the making.²

If the right policies are put in place, the current wave of rapid urbanization offers an unprecedented opportunity to create sustainable and energy efficient cities. But there are real choices to be made. The decisions that India's policy-makers take in the next 15 years will lock in its urban pathway for decades to come.

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Already the pattern of urbanization is rife with numerous stresses on cities: rapidly expanding urban sprawl, inadequate and unreliable urban infrastructure, growing congestion and travel times, hazardous air pollution and rising GHG emissions. Air pollution, in particular, has been a matter of increasing public debate in 2017, with the NCR and cities across North India grappling with hazardous levels of poor air.

Continuing this pattern of urbanization, if unchecked, will impose a cost of US \$330 billion to US\$ 1.8 trillion per year by 2050, or 1.2–6.3% of GDP.³ However, better, smarter urban growth could be an economic opportunity for India worth up to 6% of GDP by mid-century.⁴ Getting urbanization wrong—through an unplanned, sprawled urban growth model—could be very costly for India.

While much of the enabling policy framework is determined at the national level, much of the implementation work has to be done at a sub-national level, particularly in cities. Against this backdrop, Shakti Sustainable Energy Foundation (Shakti) is working to accelerate the transition to sustainable cities with a focus on energy efficiency in the built environment, sustainable transport, air quality management, utility-led efficiency measures and scaling up rooftop solar. Discussed on the next few pages are some examples of the work we have supported over the past couple of years focused on cities.

¹ India: Pathways to Sustaining Rapid Development in the New Climate Economy, The New Climate Economy (2015)

² Ibid

³ Better Cities, Better Growth: India's Urban Opportunity, The New Climate Economy (2016)

⁴ Ibid



ENERGY EFFICIENCY IN THE BUILT ENVIRONMENT



The buildings sector accounts for more than 30 percent of India's total electricity consumption. As our cities grow, building energy demand is sure to surge—nearly 70% of the building stock that will exist in 2030 is yet to be built. Designing and constructing new buildings based on energy conservation principles, and using energy efficiently in existing buildings can help reduce energy consumption.

A Thermal Adaptive Comfort Standard in the National Building Code

Efforts supported by Shakti have led to the inclusion of the thermal comfort standard in India's National Building Code (2016), the national guideline for regulating building construction activities across the country. This development comes at a critical time. The use of air conditioners is expected to rise rapidly creating pressure on the power grid. With the thermal comfort standard now a part of the National Building Code, government bodies, construction agencies, builders, developers and academic institutions can refer to an Indian specific standard for thermal comfort in naturally ventilated buildings and mixed mode buildings.

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Energy Efficiency Improvements in Commercial Buildings

The commercial buildings sector is expected to see an explosive growth in floor-space and increase in energy use. Energy efficiency measures in this sector can lead to tremendous energy savings. Recognizing this imperative, Shakti engaged with the Bureau of Energy Efficiency (BEE) to develop a comprehensive action plan for notifying commercial buildings as Designated Consumers under India's national Perform, Achieve and Trade (PAT) Scheme. These efforts resulted in the formal inclusion of hotels as Designated Consumers, the first ever inclusion of any type of buildings as Designated Consumers.

As Designated Consumers, hotels are mandated to report on energy consumption, carry out energy audits and specify consumption norms and standards. This information will help develop better data driven energy efficiency policies as well as lead to a greater understanding of the energy performance of the sector.

Energy Efficiency in High Rise Residential Buildings

The number of high-rise residential buildings in urban areas has substantially increased over the last decade. There is an urgent need to advance clean energy solutions in these buildings while simultaneously maintaining the quality of life of the residents. Given this context, Shakti commissioned the development of a [practical handbook](#) to help

existing high-rise residential buildings implement clean energy projects and smart technologies. The guidebook was adopted and co-branded by the Maharashtra Energy Development Agency (MEDA) and the Thane Municipal Corporation. Shakti is currently providing technical assistance to pilot these some of the recommendations prescribed in this guidebook.

Mainstreaming Building Efficiency in Academic Curricula

Energy use in buildings can be substantially reduced through the adoption of thermal comfort standards and energy efficient building design. So far, building code related capacity building efforts have largely been targeted at policy makers, building professionals, and industry executives. Efforts facilitated by Shakti are focusing on bringing a new stakeholder group—students of architecture and engineering—within this ambit. Shakti facilitated the development of educational curricula, Training of Trainers (ToT) programmes for faculty members, as well as certificate programmes for engineering and architecture students. So far, around 200 students and 79 faculty from 30 colleges across six cities have been trained on elements of sustainable design, space cooling technologies and building energy codes. As a result of these efforts, ten colleges will officially integrate building energy efficiency themes into their academic curriculum. This kind of knowledge will equip professionals entering the market to design energy efficient and sustainable buildings. It is also a vital asset in building efficient homes and buildings for the immediate and long-term future. Read the project report [here](#).

Sustainable Smart Space Cooling Coalition

Shakti convenes a coalition of leading civil society organizations and think tanks working in sustainable habitat and comfort conditioning. The coalition aims to drive India's transition to a sustainably cooled built environment by supporting advanced research, analysis, policy

recommendations and market transformation. Kickstarting its first year, the coalition released a report on [Thermal Comfort for All](#), a comprehensive overview of the interrelated key aspects of space cooling—Lean (building envelop), Mean (Energy efficient Appliances), and Green (Refrigerant use)—that together can meet thermal comfort needs in a holistic manner. The coalition also identified areas with high energy efficiency potential such as low-energy cooling technologies and affordable thermal comfort and is currently developing recommendations to mainstream these technologies.

District Energy Systems in Cities

Indian cities can chart out a more sustainable developmental pathway through the development of modern District Energy Systems⁵ (DES), which centralize the production of heating or cooling for a district. The DES is a more holistic approach to delivering energy and allows for more optimal energy efficiency performance as compared to other conventional delivery methods. Shakti commissioned a feasibility assessment of three Indian cities, Pune, Coimbatore and Bhubaneshwar, to understand their potential for implementing district energy initiatives. Stakeholder consultations are currently underway to identify both key barriers and successful best practices to help cities move forward with district energy.



¹ The DES was launched by the United Nations Environment Programme (UNEP) at the New York Climate Summit in 2014, and is now a major accelerator for achieving the objectives of the Sustainable Energy for All (SE4All) initiative of the United Nations.

SUSTAINABLE URBAN TRANSPORT



The transport sector (covering both passenger and freight services) is a significant consumer of energy. The massive increase in the number of private vehicles has led to widespread traffic congestion and pollution in Indian cities. Conventional approaches—such as constructing flyovers and widening roads—have largely served private vehicles while non-motorised transport and public transport are yet to gain significant momentum.

Implementing Sustainable Transport Projects in six Smart Cities Programmes

Shakti is engaging with six cities identified under the Smart Cities Mission—Jaipur, Udaipur, Visakhapatnam, Kakinada, Chennai and Ludhiana—to implement sustainable transport projects under their Smart City Proposals. This engagement entails, among other aspects, tender support for parking management, infrastructure design and bus services. For example, a project supported by Shakti to improve mobility in one of the most important corridors in the city of Udaipur has yielded good results. The streets

and intersections along the corridor have been re-designed to prioritize the movement of people over movement of vehicles. The design improvement is now a permanent feature of the intersection. It was being tested at other junctions in the city—a critical step in scaling up this outcome. In 2017, the Udaipur Municipal Corporation received the the [Volvo Sustainable Mobility Award](#) for this project in recognition of its efforts to improve mobility in this corridor.

A Smart City Index for Ranking Cities

Shakti has also supported the development of a [Smart City Index](#) for Ranking Cities' Performance, which ranks cities on important criteria such as economy, governance, environment, mobility and others to provide an indicative picture of their 'smartness'. The index allows comparisons between cities and ranks them based on how they perform. It assesses improvements over time and serves as a measure of a city's liveability and smartness.



Strengthening the Fiscal Management System of Urban Local Bodies (ULBs)

An important area of focus is the fiscal management system of Urban Local Bodies (ULBs). Shakti is currently supporting a supporting a review of best practices followed by ULBs across cities to improve their municipal finances. The focus is on finding solutions to improve the audit practices of ULBs, which will help them improve their credit rating. The improved rating will help ULBs raise municipal bonds to generate resources for sustainable urban transport projects. Shakti also supported the development of the [Model Annual Report for the city of Udaipur](#) and the Balotra Nagar Parishad, which serves as a handy reference template for ULBs.

A Public-Private Partnership Framework for Priority Sustainable Urban Transport Infrastructure Projects

Another way for cities to generate additional funds is Public-Private Partnerships. The Smart Cities Mission has placed significant emphasis on this model encouraging the private sector to mobilize capital, technology and other resources. Shakti commissioned the development of a [Public-Private Partnership framework](#) for five priority

sustainable urban transport infrastructure projects: city bus operations, bus terminals, Intelligent Transport Systems, Public Bicycle Sharing (PBS) Schemes and street infrastructure. The framework report has been shared with the Ministry of Urban Development. It has also been circulated to cities via [SMARTNET](#), the web portal launched by the Ministry of Housing and Urban Affairs to support knowledge sharing and dialogue on Smart City development in India.

Towards Better Public Transport Services

The Ministry of Road Transport and Highways is formulating an incentive scheme to introduce 200,000 low-emission buses for inter-city and intra city movement. Shakti is currently working with the Ministry to accelerate the adoption of electric vehicles and the establishment of a new institutional framework for bus operators, as well as to promote the efficient development of bus terminals and depot infrastructure.

The Bus Karo Programme

To create a more strategic vision for improved bus services, Shakti is collaborating with the Bus Karo programme. Bus Karo is a peer-to-peer knowledge sharing network consisting of State Transport Undertakings (STUs) and city bus and private bus

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operators working to discussions on Intelligent Transport Systems and taxation reforms for STUs. In 2016, the network developed a forward-looking roadmap for reforms in the management of bus STUs drawing attention to the disproportionate amount of taxes levied on STUs as compared to private vehicle users. These and other efforts facilitated by Shakti have enabled the Bengaluru Metropolitan Transport Corporation (BMTc) get a waiver on its Motor Vehicle (MV) tax, which will help direct more investment towards improving bus services.

Solutions for Electric Mobility

A focus area for Shakti is electric vehicles, which offer significant benefits in terms of meeting urban mobility needs, saving fuel and improving air quality. The Government of India is providing an impetus to electric vehicles through the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme and the National Electric Mobility Mission Plan 2020. To help boost these efforts, Shakti supported the development of an implementation roadmap and a cost-benefit analysis of alternative technology pathways for the [electrification of public transport systems in two important metros: Bengaluru and Kolkata](#). Shakti also facilitated capacity building programmes for stakeholders to enhance their

understanding of electric vehicles. As a part of these efforts, a three-day training programme was organized in Pune this year bringing together around 50 delegates representing city authorities, municipal corporations, metros, bus operators (public and private), electricity distribution companies, new mobility players and industry.

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Non-Motorized Transport

Since the launch of the Smart City Mission, there has been a renewed interest in non-motorised transport with several Indian cities looking at developing large-scale public bicycle sharing systems for their resident. Bike sharing systems are particularly relevant for metros like New Delhi, which are marked by an increasing reliance on private vehicles, which adds to traffic congestion and declining air quality. Shakti provided technical and advisory support for the design of a public bicycle sharing in New Delhi for parts of [Dwarka](#) and [South Delhi](#), to be implemented by the Delhi Development Authority and the South Delhi Municipal Corporation respectively. Intended to provide first and last mile connectivity to public



transport users, the system is primarily intended to provide access to transit stations like bus stops and metro stations and also for short distance daily commute trips.

Enhancing the Sustainability of Urban Freight Transport

The demand for intra-city freight transport is constantly increasing in cities and towns, contributing further to congestion, pollution and traffic accidents. Therefore, there is a need to plan for sustainable and integrated transport policies that optimize the use of all transport modes in the urban movement of goods. This can help reduce the distance travelled by freight vehicles and thereby decrease emissions. Shakti is supporting efforts to analyze freight mobility patterns in an urban environment, taking Chennai as a case city. Data is being collected on the travel patterns of freight vehicles, real world emissions performance and the existing freight transport infrastructure in the city. This data will be analyzed to develop a freight trip generation model that can be used to estimate the emissions impact of various freight

management strategies in cities in order to identify the most sustainable approach.

Mainstreaming TOD considerations into urban planning

More and more Indian cities are encouraging Transit Oriented Development (TOD) to meet the challenges of urbanization, rapid motorization, rising inequity as well as deteriorating air quality. At the same time, it is necessary to gauge both the impact and benefits of TOD to understand whether it is bringing about the desired changes. A study supported by Shakti takes a step forward in this direction. It assesses TOD plans and proposals in two Indian metros—Ahmedabad and Bangalore—to reveal their expected benefits and impact in terms of housing affordability, access to job opportunities, NMT mode share and carbon benefits. Based on a more detailed case study of Ahmedabad, the study proposes a comprehensive planning framework to arrive at TOD strategies for other Indian cities.



COMBATING AIR POLLUTION



Hazardous levels of air pollution in Indian cities pose a severe threat to public health. A majority of cities, including both mega cities as well as smaller cities, are emerging as pollution hotspots. The global burden of disease estimates have shown that air pollution-related diseases have already emerged as fifth largest killer in India.⁶ If deaths from indoor air pollution are also added, then air pollution is the top killer.⁷ Global air quality databases continue to state that some of the worst polluted cities in the world are in India⁸. Given this context, Shakti is supporting the development of toolkits and roadmaps for that cities can use to address air pollution.

Strengthening Policy Action at the National, State and City Level

Research and stakeholder engagement supported by Shakti focused on a broad spectrum of solutions to control air pollution and protect public health in urban areas. These efforts resulted in several favorable orders from the Supreme Court and National Green Tribunal including on the adoption of a comprehensive action plan for Delhi-NCR, nation-wide registration of only Bharat IV compliant vehicles from April 1, 2017, and a ban on pet coke and furnace oil in several north Indian states. Additionally, the graded response action plan (GRAP) in Delhi-NCR was introduced and zig-zag kilns were made mandatory in the Delhi-NCR.

Filling the Knowledge Gap on Air Quality through the APnA City Programme

To address urban air pollution, cities need to draft and implement well-designed air quality

The Air Pollution Knowledge Assessment (APnA) City Programme has created a baseline of air pollution related information for 20 Indian cities—a necessary starting point for charting out strategies for better air quality.

management plans. [The Air Pollution Knowledge Assessment \(APnA\) City Program](#) facilitated by Shakti developed city-specific modelling of emissions, meteorology and source specific pollution concentrations for 20 Indian cities, which is helping to provide an important starting point for understanding air pollution in these cities. The 20 Indian cities are: Patna, Raipur, Ranchi, Bhubaneswar, Kanpur, Agra, Varanasi, Dehradun, Chandigarh, Amritsar, Ludhiana, Jaipur, Nagpur, Pune, Indore, Bhopal, Bengaluru, Kochi, Coimbatore, Chennai.

Public Survey on Awareness About Air Pollution Reveals Interesting Results

With the Delhi-NCR region's air pollution problem now a well-documented and visible fact, Shakti commissioned a national survey on air pollution to assess awareness and perceptions amongst citizens on air pollution and related issues. The survey "[A Hazy View](#)" was held across 11 Indian cities—Delhi, Mumbai, Kanpur, Patna, Ahmedabad, Bangalore, Chennai, Gwalior, Kolkata, Varanasi and Lucknow. The survey reveals that while most respondents claim to be reasonably aware about air pollution, actual understanding appears to be lower. A similar gap between awareness and understanding of the health impact associated with

⁶ A Clean Air Tool for Cities (2016). Centre for Science and Environment.

⁷ Ibid

⁸ Ibid

air pollution was also observed. Given the need for public participation for implementing air quality interventions, this survey lays some groundwork that can form the base for further studies into public attitudes and behavior. The survey received extensive media coverage across the country (including in the [Times of India](#) and [Dainik Bhaskar](#)).

Setting up Low-Cost Air Quality Monitors

Shakti also supported the installation of low-cost air quality monitors in 10 cities under "[Breathe](#)",

an independent air quality monitoring network that measures pollution levels in cities across India—Agra, Ahmedabad, Bhopal, Chandigarh, Dehradun, Jaipur, Lucknow, Raipur, Ranchi and Varanasi. The monitors measure the ambient concentrations of particulate matter and live-stream the data online for easy access. The availability of this data is critical to addressing the information gap that exists regarding air quality in our cities. It is also an important precursor for more informed policy action on controlling air pollution.



UTILITY-LED EFFICIENCY MEASURES

Utilities-led energy efficiency reforms can generate widespread energy savings as well as address the challenges of chronic peak and energy shortages in cities. Shakti engages with electric utilities in various cities to strengthen their operational and financial performance as well as to implement energy efficiency measures.

Demand Response and Demand Side Management Measures

In New Delhi, Shakti facilitated the implementation of a [low-cost Demand Response programme](#) for the BSES Yamuna Power Limited (BYPL). The programme was targeted at industrial and large commercial consumers and led to a demand reduction of 17.4 MW over eight DR events. Based on the successful outcome, the BYPL intends to roll out a large-scale DR programme covering a larger number of consumers. This can pave the way for the large-scale adoption of similar programmes by other Discoms.

In Bangalore, Shakti also facilitated technical support to the Bangalore Electricity Supply

Company towards strengthening the DSM in its area of operations. These efforts spanned all levels—identifying DSM potential, setting realizable targets, developing policy designs and monitoring and evaluating implementation frameworks, and creating replicable, scalable DSM programmes.

Strengthening the Efficiency of Distribution transformers

Shakti also targeted Distribution transformers (DT), which are an important component of the distribution network, but due to various reasons have a fairly high failure rate. Poor repair and rewinding of DTs results in lower performance, which in turn leads to a loss in their efficiency. Better management of assets like DTs can reduce efficiency losses as well as improve service delivery. Shakti commissioned the development of a performance-based DT services model that encourages private sector participation in the efficient maintenance of the distribution transformers. This model has been presented to the Kanpur Electricity Supply Company for adoption.



SCALING UP ROOFTOP SOLAR

India's rooftop solar target of 40 GW by 2022 offers tremendous potential for Indian cities to tap into cleaner and affordable electricity. At scale, rooftop solar systems can help sustainable growth as well as contribute to climate change mitigation

Enhancing the Consumer Experience

However, the pace of growth of this sector has been slow. Shakti has initiated a few efforts to address this gap. In the past Shakti, in strategic partnership with the Chandigarh Renewable Energy Science and Technology Promotion Society (CREST) and the Ministry of New and Renewable Energy (MNRE), supported the development of the first ever Web-GIS tool for estimating the rooftop solar power potential of Chandigarh. The tool can be replicated easily in other Indian cities and will help consumers estimate the potential solar PV capacity that can be installed on their rooftops.

Further, rooftop solar installations by residential consumers will be an essential part of meeting the 40 GW target. In addition, an ongoing study commissioned by Shakti is undertaking a 5-city survey to assess the key issues faced by residential consumers in the adoption of rooftop solar installations. Based on the findings, the study will recommend solutions to enhance the consumer experience in rooftop solar.

Creating Progressive Frameworks for Implementation

Shakti has provided inputs to the Ministry of New and Renewable Energy to develop guidelines for Urban Local Bodies (ULBS) to support rooftop solar programmes in their respective cities. Shakti also supported the development of a progressive policy frameworks for rooftop solar for the Bangalore Electricity Supply Company Limited, a state-distribution company in Karnataka.





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