

# OPEN BOOK

A showcase of reports and publications  
by Shakti Sustainable Energy Foundation





Shakti Sustainable Energy Foundation seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following sectors: clean power, energy efficiency, sustainable urban transport, climate policy and clean energy finance.

***Our Vision: towards a clean and secure energy future***

# FROM THE CHAIRMAN'S DESK

Dear Friends,

I am delighted to present to you OpenBook, a snapshot of key publications and research supported by Shakti Sustainable Energy Foundation.

At Shakti, we aid the design and implementation of policies that promote clean energy and climate mitigation while dramatically reducing greenhouse gas emissions. A key goal of our grant making is to support multidisciplinary policy research that is designed to respond to specific energy and climate challenges in India, engaging with and assisting policy and decision makers. We seek to inspire large scale, high-impact policy solutions that can foster India's transition to a low-carbon future while promoting the well-being of India's citizens.

The publications showcased in OpenBook feature research and publications brought out by our distinguished grantee partners, who are drawn from the civil society, academia, energy and climate institutions and industry associations. Together, we work to contribute to public policy actions and to provide context on current energy issues in India.

With over a decade of hard work and persistence, we have supported research at the intersection of technology, innovation, and policy. To cite a few examples—increasing the share of renewable energy in the power grid, growing distributed renewable energy systems, strengthening the ecosystem for electric mobility and incorporating energy efficiency into our buildings, industries and appliances. We are currently supporting research to find ways to catalyse clean energy finance in India given the massive investment required for India to meet its NDCs.

Feel free to browse through these publications at [www.shaktifoundation.in](http://www.shaktifoundation.in). We also feature them through our newsletter, social media channels and annual reports.

We thank our grantee partners who not only have a deep understanding of the issues, but also an understanding of the economic and cultural contexts that shape key decision making. Many of the outcomes of our work would not have been possible without the breadth and depth of their knowledge.

We would like to thank our donors for their generous support and our Board for their wise counsel and thoughtful advice.

**Jamshyd Godrej**

Board Chair

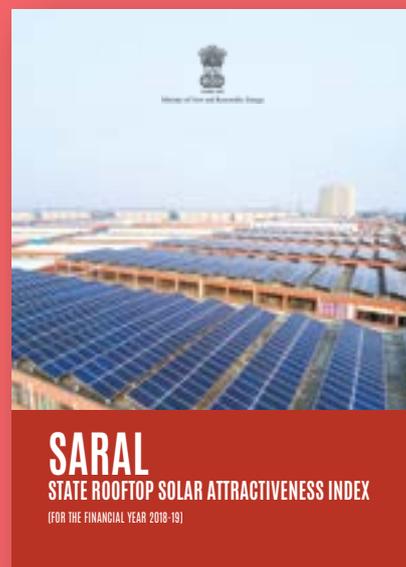
Shakti Sustainable Energy Foundation

# CLEAN POWER

## SARAL - STATE ROOFTOP ATTRACTIVENESS INDEX 2018-19

India aims to install 40 GW of rooftop solar capacity by 2022. The State Rooftop Attractiveness Index (SARAL) is designed to help states achieve this goal. SARAL is a first of its kind index that evaluates Indian states based on their attractiveness for rooftop development based on performance, growth, level of maturity, policy framework, and implementation environment. SARAL also enables states to channelize the investment required for the growth of the sector and create a more conducive ecosystem for solar rooftop installations.

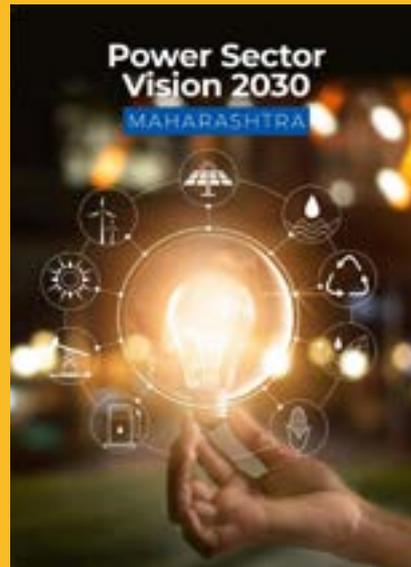
SARAL was launched by Shri R.K Singh, Minister of State (IC) for the Ministry of Power and the Ministry of New and Renewable Energy.





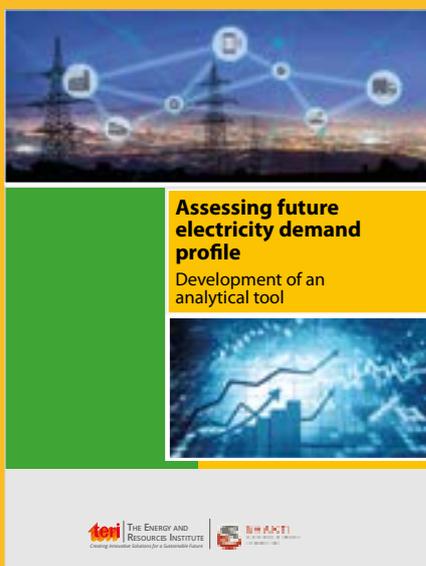
## POWER OUTLOOK SERIES

The Power Outlook series provides an overview of the current status of India's power sector with a focus on significant and emerging developments. It aims to develop a more informed understanding of the power sector and may act as a tracking tool for stakeholders. Volume 1 focuses on the entire power sector value chain and captures the key trends and transitions shaping the sector. Besides the three sub-sectors (generation, transmission, and distribution), this volume also looks at electricity demand, consumption, and development in an integrated manner.



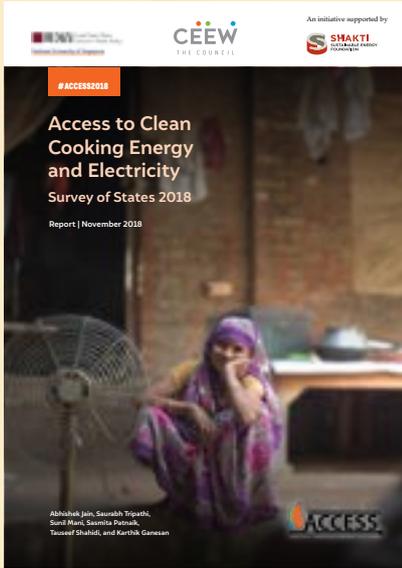
## POWER SECTOR VISION 2030 FOR MAHARASHTRA

Maharashtra's power sector has played a critical role in supporting the economic growth of the state. Reliable uninterrupted power supply is a necessary condition to achieve such a goal. The state's power sector will have to not only overcome the current challenges but also address the emerging disruptions to do so. This vision document lays out a roadmap for Maharashtra's power sector with a focus on decarbonization, decentralization and digitalization.



## ASSESSING FUTURE ELECTRICITY DEMAND PROFILE: DEVELOPMENT OF AN ANALYTICAL TOOL

Analysing the historical demand trends of a utility can help identify future trends with regards to the impact of changing consumption patterns, new policy initiatives, emerging technologies and more. This demand forecasting tool uses historical hourly utility data for the last five years to predict average monthly load curves as well as peak day load curves for next three years.

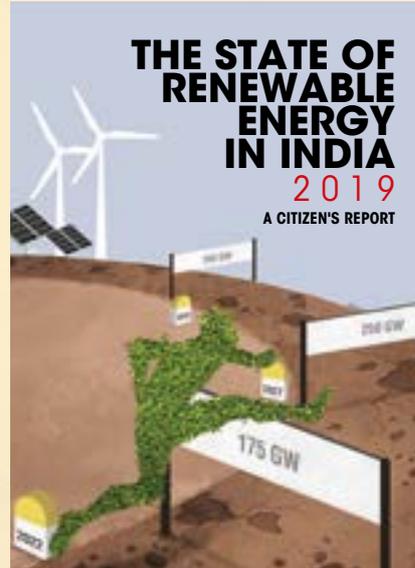


## ACCESS TO CLEAN COOKING ENERGY AND ELECTRICITY: SURVEY OF STATES 2018

This survey was conducted in order to understand energy access and consumption among rural households at a granular level and to assess the effectiveness of government interventions in improving energy access among rural households in some of the poorest states of India. It shows that while there has been significant improvement in access to electricity and clean cooking fuels in the last few years, there are many measures that can be undertaken to improve the situation on ground.

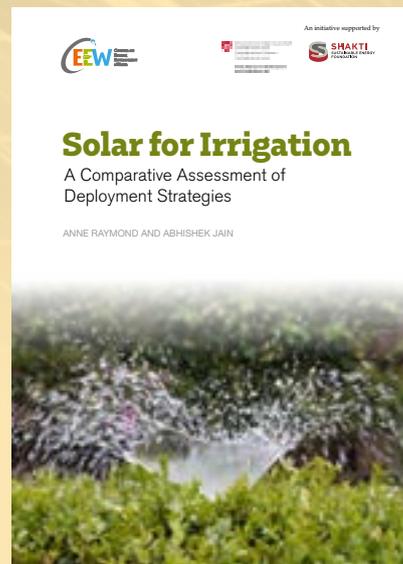
## SOLAR FOR IRRIGATION: A COMPARATIVE ASSESSMENT OF DEPLOYMENT STRATEGIES

The recent adoption rate of solar pumps in India has been slow. This report focuses on the economics of solar pump adoption for farmers and the government. It features different deployment approaches by applying a financial model to four key questions of interest to policymakers responsible for considering the costs and benefits of different irrigation pump deployment approaches.



## THE STATE OF RENEWABLE ENERGY IN INDIA 2019

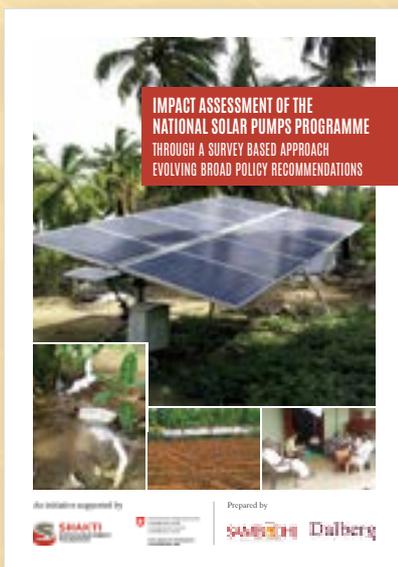
This report gives an overview of the renewable energy sector in India—the successes it has witnessed, and the challenges and opportunities that lie ahead.





## CONTINUING SUPPORT TOWARDS IMPLEMENTING UDAY (DISTRIBUTION REFORM) INITIATIVES IN KARNATAKA

The four white papers developed under this initiative analyse relevant distribution sector reform issues faced by distribution companies in Karnataka such as the need for effective energy auditing, impact of feeder segregation schemes and strategies for open access, and provide recommendations to address them.



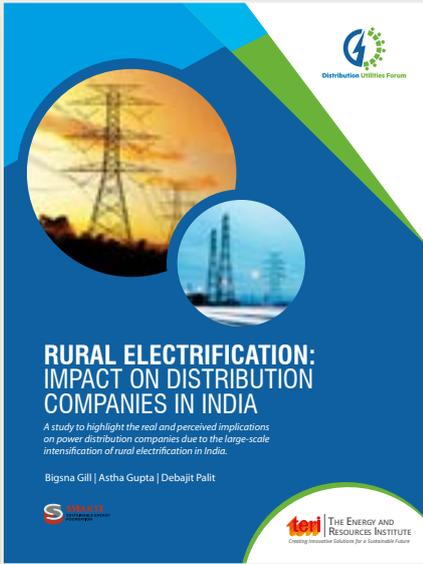
## IMPACT ASSESSMENT OF THE NATIONAL SOLAR PUMPS PROGRAMME

This study presents the results and the broader socioeconomic impact of solar water pumps installed under the Jawaharlal Nehru National Solar Mission (JNNSM) in four states—Uttar Pradesh, Bihar, Rajasthan and Tamil Nadu. The findings indicate the potential for deep and scaled impact in the future, if certain technical and policy changes are implemented.



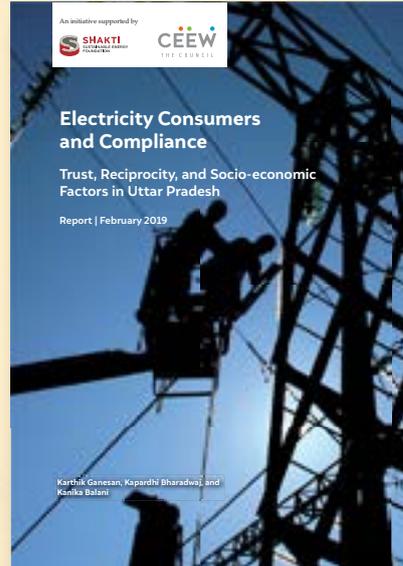
## WHAT IS THE SAFEGUARD DUTY SAFEGUARDING?

The introduction of safeguarding duty on solar cell imports in 2018 had wide-ranging effects on business prospects of manufacturers, project deployment, job creation, and investor sentiment. This study analyses the potential impact of the safeguard duty on these facets of the industry, as well as the associated effects it has on the solar sector as a whole.



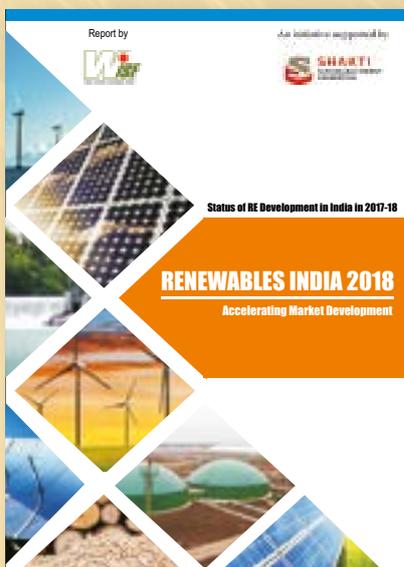
## RURAL ELECTRIFICATION: IMPACT ON DISTRIBUTION COMPANIES IN INDIA

Implementing rural electrification poses a severe challenge to distribution companies in India owing to operational and financial challenges. This study presents the perspective of the discoms on the key challenges they face in implementing the Saubhagya scheme, as well as its impending implications for their overall operational and financial performance. It was undertaken as a part of the Shakti-supported Distribution Utilities Forum.



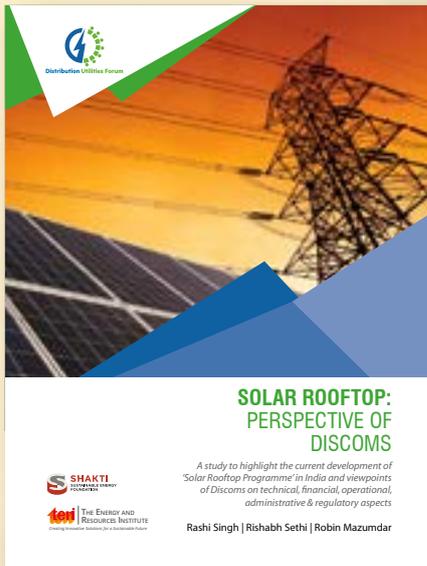
## ELECTRICITY CONSUMERS AND COMPLIANCE

Household consumption accounts for nearly 42% of the electricity supplied by all discoms in Uttar Pradesh. However, this consumer segment also accounts for hefty monetary losses for the distribution companies owing to factors like metering, billing, and collection (MBC) losses and electricity theft. This study evaluates the commercial losses attributed to domestic consumers and evaluates the perspectives of consumers on electricity provision.



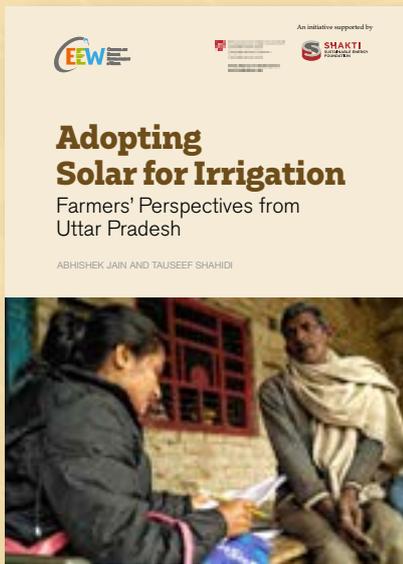
## STATUS OF RENEWABLE ENERGY DEVELOPMENT IN INDIA IN 2017-18

This report provides policy makers, government officials, renewable energy professionals, civil society and other key stakeholders with insights on developments taking place in the renewable energy sector on an annual basis, enabling them to make informed decisions, and aiding the transition to a low-carbon economy.



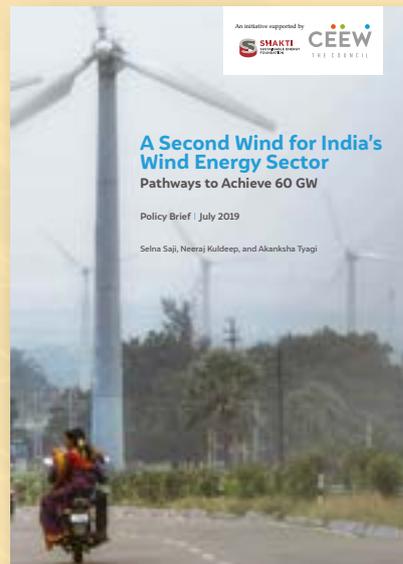
## SOLAR ROOFTOP: PERSPECTIVE OF DISCOMS

This report, prepared under the aegis of the Shakti-supported Distribution Utilities Forum, highlights the current development of the 'Solar Rooftop Programme' in India and presents the viewpoints of power distribution companies on the technical, financial, operational, administrative and regulatory aspects of solar rooftop deployment.



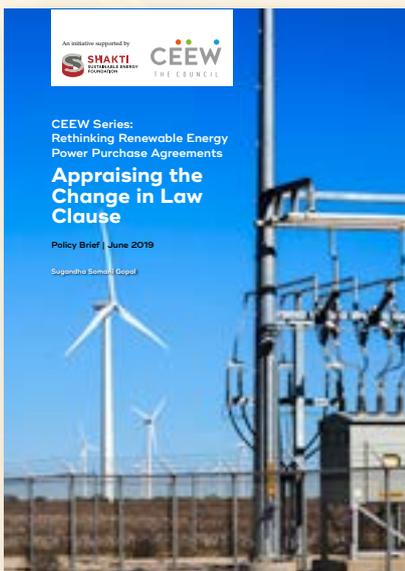
## ADOPTING SOLAR FOR IRRIGATION: FARMERS' PERSPECTIVES FROM UTTAR PRADESH

Solar pumps are viable alternatives to traditional irrigation pumps and provide cost-effective, clean irrigation to farmers. But their uptake has been limited. This study aims to understand the perspective of the farmer in order to increase uptake of solar pumps in agricultural practice.



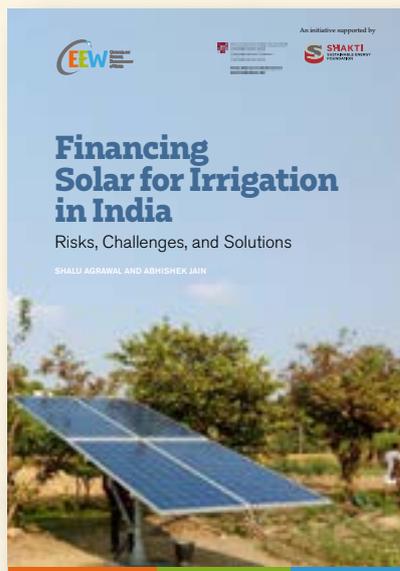
## A SECOND WIND FOR INDIA'S WIND ENERGY SECTOR PATHWAYS TO ACHIEVE 60 GW

Wind energy is intended to contribute 60 GW to India's target of achieving 175 GW of renewable energy by 2022. This study identifies the challenges faced by the sector and develops pathways towards achieving India's wind energy goal.



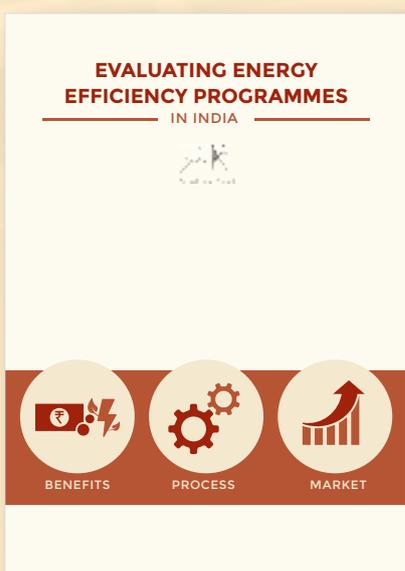
## APPRAISING THE CHANGE IN LAW CLAUSE

**U**nexpected change in the legal and regulatory framework creates uncertainty in the renewable energy sector and makes Power Purchase Agreements (PPAs) less bankable. In order to increase the bankability of PPAs, this study recommends addition of certain provisions to change in law clauses. This move will create more investor trust in the renewable PPAs.



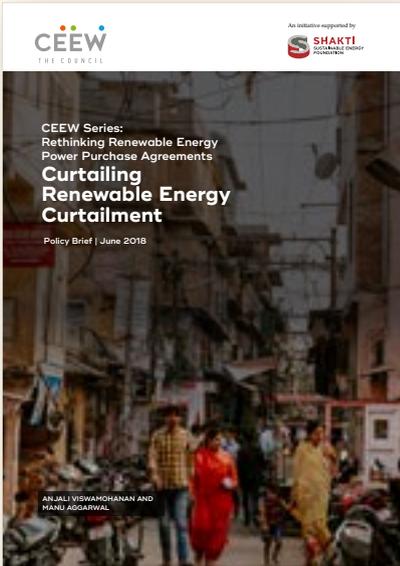
## FINANCING SOLAR FOR IRRIGATION IN INDIA

**S**olar-powered irrigation systems (SPIS) offer significant opportunities to facilitate irrigation access in an environmentally sustainable manner. But a subsidy-led approach would be fiscally unviable to achieve deployment of SPISs at scale, given their high upfront cost. This study investigates the key risks and challenges affecting financing of solar pumps in India.



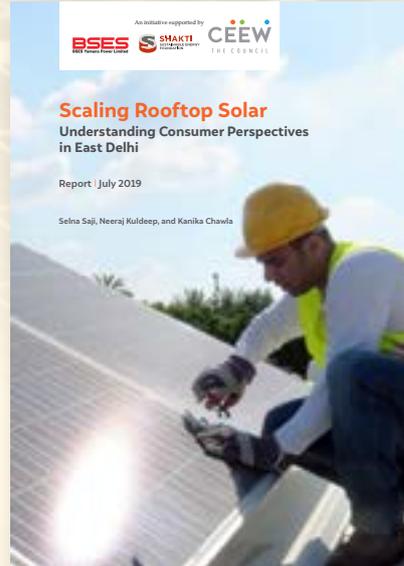
## EVALUATING ENERGY EFFICIENCY PROGRAMMES IN INDIA

**E**nergy efficiency is crucial to provide India with reliable, affordable, secure, and sustainable access to energy. There are numerous energy efficiency programmes in India and evaluating them is critical to ensure success. This report provides broad guidelines on evaluating energy efficiency programmes in India based on reviews of global best practices and backed by case studies.



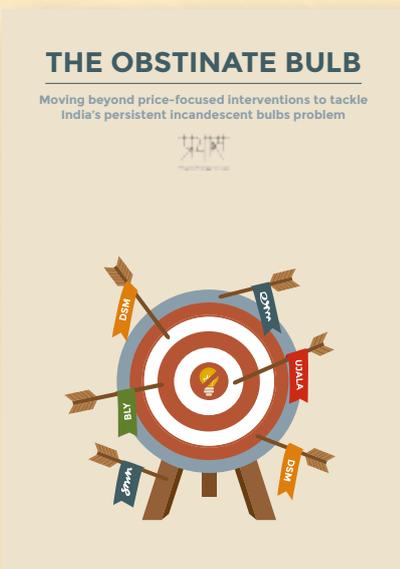
## CURTAILING RENEWABLE ENERGY CURTAILMENT

**T**his brief examines the issue of curtailment of Power Purchase Agreements for technical and commercial reasons and its impact on stakeholders, the must-run status for renewable power, and the prospective role of granting compensation for grid unavailability and instability. This is intended to help policymakers identify remedies to PPAs by re-examining the contractual structure entered into between the renewable energy generator and the offtaker.



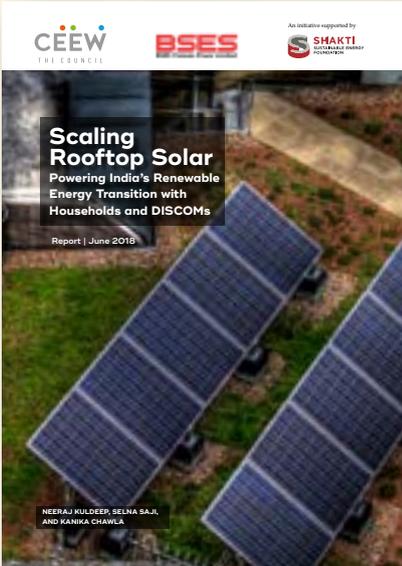
## SCALING ROOFTOP SOLAR: UNDERSTANDING CONSUMER PERSPECTIVES IN EAST DELHI

**T**his study, conducted for BSES Yamuna Private Limited (BYPL), aims to gauge how consumers perceive rooftop solar technology (RTS) and their levels of awareness and willingness to accept new RTS business models. The study presents insights from data collected from 419 households in the BYPL license area.



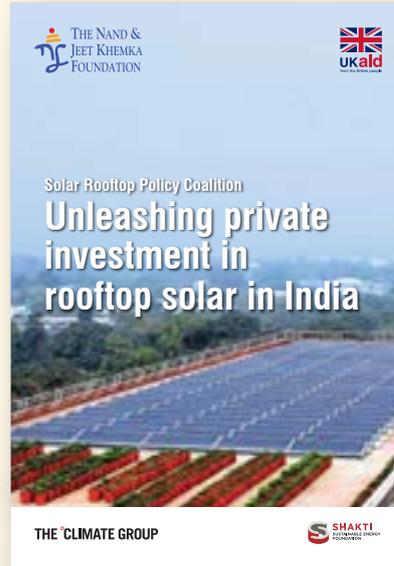
## THE OBSTINATE BULB

**D**emand for light-emitting diode (LED) lights has picked up remarkably in India since 2014, primarily driven by the UJALA programme. However, the demand for incandescent bulbs (ICB) remains high. This report examines relevant aspects of the demand and supply of various lighting options available to Indian households in order to investigate the continued usage of ICBs in India.



## SCALING ROOFTOP SOLAR: POWERING INDIA'S RENEWABLE ENERGY TRANSITION WITH HOUSEHOLDS AND DISCOMS

Bringing distribution utilities to the forefront and incentivising them to take the lead would go a long way in improving uptake of rooftop solar systems. This report presents three innovative utility-led business models that can accelerate the deployment of rooftop solar systems in the residential sector.



## UNLEASHING PRIVATE INVESTMENT IN ROOFTOP SOLAR IN INDIA

Rooftop solar systems (RTS) have significant potential to contribute to India's renewable energy targets and energy security. But currently, India has only 4 GW of installed RTS capacity owing to various awareness and policy reasons. This report shows that there is significant scope for accelerating adoption of rooftop solar and sets out measures that could double progress towards the government's target.

**Promotion of Energy Efficiency through Standard Offer Program (SOP) Approach**  
**Case Study\* of an Innovative and Replicable Project on Demand Side Management based Efficient Lighting Program (DELPP) in Puducherry**

**Need for Energy Efficiency in the Lighting Sector**

Lighting accounts for almost 28 per cent of the total electricity consumption in residential sector in India, and is a major contributor of peak load. India faces peak power shortage of more than 12 per cent as a result of the gap between demand and supply, leading to supply disruptions and power failures. The Electric Lamp and Component Manufacturers Association of India (ELCOMA) estimated that more than 75.8 crore (758 million) incandescent bulbs (ICLs) were sold in India, 92.5% of an extremely energy inefficient form of lighting with just 5% of the electricity input converted to light. The table below depicts the state-wise annual sale of ICLs in 2012. The table also indicates the energy saving potential by replacement of ICLs with a more efficient light source like Light Emitting Diodes (LEDs), which uses 80% less electricity for delivering same light output.

| States                | ICL Sale in 2012 (Cr. in crore) | Energy Savings Potential (MWh) | Cost Savings (Cr. in Rs. crore) |
|-----------------------|---------------------------------|--------------------------------|---------------------------------|
| AP                    | 6.82                            | 4238.328                       | 2262.283                        |
| Assam                 | 0.86                            | 574.298                        | 286.649                         |
| Bihar                 | 6.2                             | 4118.88                        | 2099.37                         |
| Chhattisgarh          | 1.8                             | 1155.94                        | 591.65                          |
| Delhi                 | 5.1                             | 3387.33                        | 1693.565                        |
| Gujarat               | 4.29                            | 2798.783                       | 1398.3915                       |
| Haryana               | 1.91                            | 1268.813                       | 634.4065                        |
| HP                    | 0.4                             | 265.72                         | 132.86                          |
| J & K                 | 0.62                            | 411.866                        | 205.933                         |
| Karnataka             | 7.96                            | 5098.988                       | 2549.544                        |
| Kerala                | 4.2                             | 2823.275                       | 1411.6375                       |
| Madhya Pradesh        | 2.1                             | 1388.63                        | 694.315                         |
| Maharashtra           | 9.27                            | 6158.061                       | 3079.0305                       |
| Manipur               | 0.12                            | 86.899                         | 43.4796                         |
| Mizoram               | 0.12                            | 73.716                         | 36.858                          |
| NIP                   | 3.6                             | 2391.48                        | 1195.74                         |
| Odisha                | 0.12                            | 73.716                         | 36.858                          |
| Punjab                | 1.22                            | 810.446                        | 405.223                         |
| Rajasthan             | 1.81                            | 1202.383                       | 601.1915                        |
| Tamil Nadu            | 2.6                             | 1727.18                        | 863.59                          |
| UP                    | 5.1                             | 3302.383                       | 1651.1915                       |
| West Bengal           | 0.2                             | 132.86                         | 66.43                           |
| Other states          | 0.2                             | 132.86                         | 66.43                           |
| Total                 | 67                              | 465.91                         | 232.955                         |
| ICLs                  | 0.2                             | 132.86                         | 66.43                           |
| Other states          | 0.2                             | 132.86                         | 66.43                           |
| Total savings in Cost | 75.8                            | 50365.57                       | 25182.79                        |

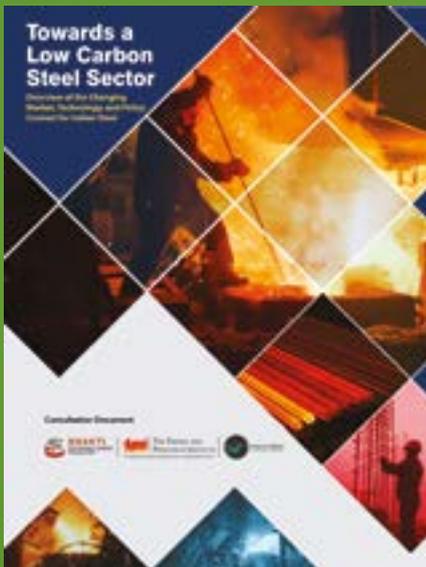
\* This Case Study has been compiled by the International Institute for Energy Conservation (IIEC) - www.iiec.org. It is based on IIEC assessment and data provided by the State Government Energy Commission www.rajeevenergy.com

## PROMOTION OF ENERGY EFFICIENCY THROUGH STANDARD OFFER PROGRAM (SOP) APPROACH CASE STUDY OF AN INNOVATIVE AND REPLICABLE PROJECT ON DEMAND SIDE MANAGEMENT BASED EFFICIENT LIGHTING PROGRAM (DELPP) IN PUDUCHERRY

This case study documents the launch of the Shakti-supported DSM-based Efficient Lighting (DELPP)-Standard Offer Programme by the Puducherry Government in partnership with Energy Efficiency Services Limited (EESL). DELPP proposes to overcome the first cost barrier to promote LEDs by using the basic architecture of Bachat Lamp Yojana. The objective of this programme is to replace incandescent bulbs by providing LEDs to households at a price similar to that of incandescent bulbs.



# ENERGY EFFICIENCY



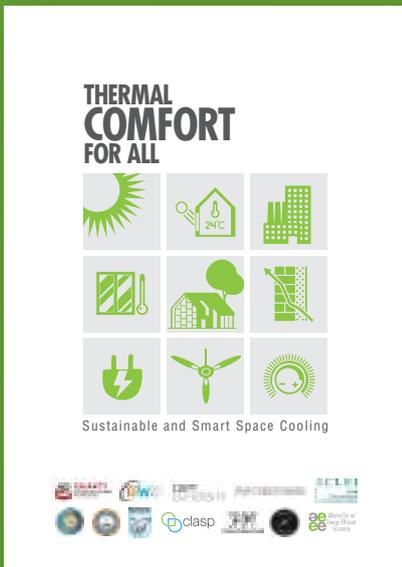
## TOWARDS A LOW-CARBON STEEL SECTOR

The Indian iron and steel sector is extremely energy and resource intensive and accounts for a large proportion of the country's emissions. Average energy efficiency levels are still low when compared with global peers. Improving the emissions intensity of the sector by making it more energy efficient can result in a sustainable growth path which can deliver not only economic but also environmental benefits for India. This report presents the current status of the steel sector and lays out recommendations to transition it towards a low-carbon pathway.



## RESOURCE EFFICIENCY IN THE STEEL AND PAPER SECTORS: EVALUATING THE POTENTIAL FOR CIRCULAR ECONOMY

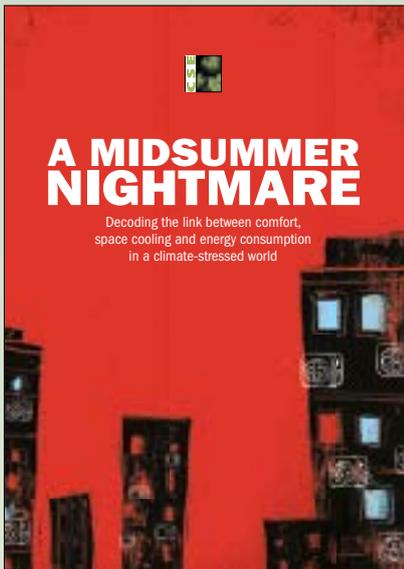
Increased population, urbanization and industrial productivity have led to an increase in material consumption which in turn exerts extreme strain on natural resources. Moving away from the linear economic model of take-make-dispose, towards a circular economy (CE), a system that is restorative by intention and design, is necessary. The study demonstrates that the application and practice of circular economy principles has significant potential to reduce virgin material requirement, improve air quality and reduce GHG emissions when applied to various industrial manufacturing sectors.



## THERMAL COMFORT FOR ALL

**R**ising temperatures will increase the adoption of air conditioning for space cooling and thereby increase peak energy demand. This report provides a holistic view of sustainable and smart space cooling strategies and recommends the adoption of the Lean (better building design), Mean (energy optimisation) and Green (clean energy use) approach for providing affordable thermal comfort to all.





### A MIDSUMMER NIGHTMARE

So far energy efficiency policies for the building sector have focused largely on making cooling and heating technologies more efficient energy-wise. But developing adaptive thermal comfort standards for buildings through passive cooling that can help reduce energy guzzling can be a game changer for the way buildings are designed. This first-of-its-kind study answers several pertinent questions on thermal adaptive cooling including the question of how we understand indoor temperature standards in relation to optimum comfort while creating an environmental balance that will work for India.



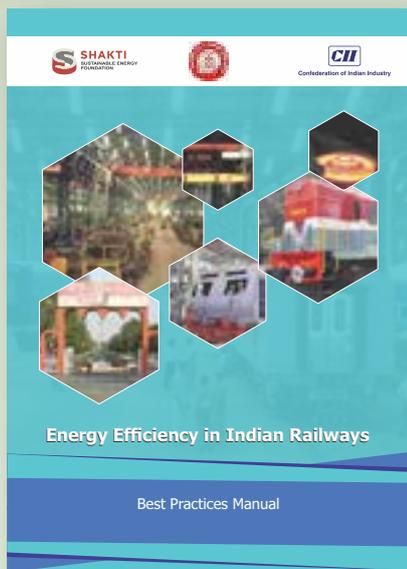
### MAINSTREAMING THERMAL COMFORT FOR ALL AND RESOURCE EFFICIENCY IN AFFORDABLE HOUSING: STATUS REVIEW OF PMAY-U MISSION TO UNDERSTAND BARRIERS AND DRIVERS

Housing that is built as part of the Pradhan Mantri Awas Yojana (PMAY) will last 40-60 years, and decisions taken today will have an impact on the level of comfort that these dwellings provide to its occupants and the energy use, costs and associated carbon emissions over the lifetime of the building. This study analyses the PMAY and discusses ways to minimise the current and future impacts of energy use from affordable housing through mainstreaming thermal comfort and resource efficiency (in building materials) within the PMAY-U Mission.



### PROMOTING CLEAN AND ENERGY EFFICIENT COLD-CHAINS IN INDIA

While cold-chains are important in order to avoid food lost in the farm-to-fork process, cold-chain systems themselves are energy-intensive applications, often relying on diesel for off-grid and on-vehicle cooling. Development of clean technologies that harness renewable energy resources, new thermally focused energy systems, and innovative thermal management to create intelligent, energy-efficient cold-chain systems are important in order to increase farmer's incomes as well as comply with the Kigali Agreement. This study assesses the present cold-chain systems and makes recommendations for the development of clean cold-chains in India.



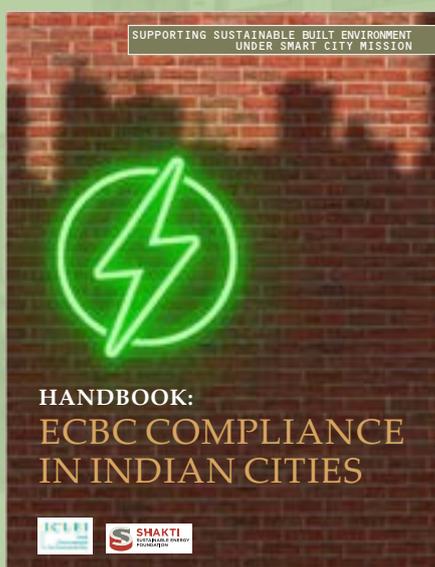
## ENERGY EFFICIENCY IN INDIAN RAILWAYS: BEST PRACTICES MANUAL

The Indian railways network is an energy intensive organization and is introducing energy and environment initiatives into its operations. This Best Practice Manual features various technologies and best practices that can assist Indian Railways production units to improve their energy efficiency levels and achieve the targets under the PAT scheme.



## FACTORS INFLUENCING THE UPTAKE OF ENERGY EFFICIENCY INITIATIVES BY INDIAN MSMEs

The Government of India plans to improve energy efficiency in MSMEs. Through a set of interviews and surveys, this study assesses the MSME sector's current state of awareness and its perceptions and responsiveness towards energy efficiency. The study also highlights the gaps in the implementation of various financial and technical support programmes for MSMEs and comes with recommendations for improvement.



## HANDBOOK: ECBC COMPLIANCE IN INDIAN CITIES

The building sector in India consumes about 33% of the total energy produced in the country. This is second highest after the industrial sector, which accounts for 45% of net production. The ECBC compliance rules were brought out in 2007 but their implementation has not been wholly satisfactory. This handbook provides a roadmap that makes ECBC compliance easier for developers.



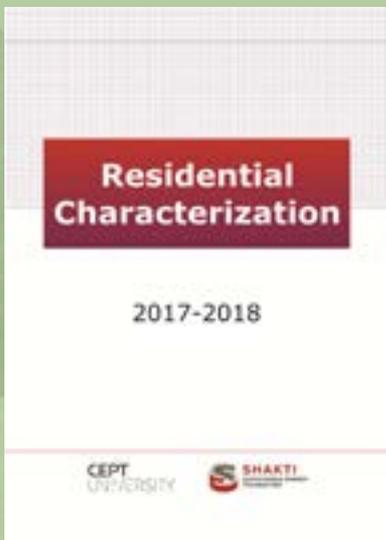
### **SMALL AND MEDIUM ENTERPRISES ENERGY EFFICIENCY AND KNOWLEDGE SHARING (SAMEEEKSHA) PLATFORM**

The Small and Medium Enterprises Energy Efficiency and Knowledge Sharing (SAMEEEKSHA) platform was set up to allow various stakeholders in the MSME ecosystem to pool and share the knowledge of institutions and key stakeholders that work towards promoting energy efficiency in India’s MSME sector. The platform can be accessed at: <http://sameeksha.org/index.php>



### **TRANSFORMING THE ENERGY SERVICES SECTOR IN INDIA: TOWARDS A BILLION DOLLAR ESCO MARKET**

The Energy Efficiency market in India has huge untapped potential. But the lack of access to financing, lack of a strong policy level push and lack of trust within the ecosystem are massive challenges to the growth of the ESCO market. These gaps, if fixed, can enable and transform the industry by facilitating interactions with policy makers, ESCOs, financial institutions and end customers. This study analyses the current market and gives recommendations that can help transform it.

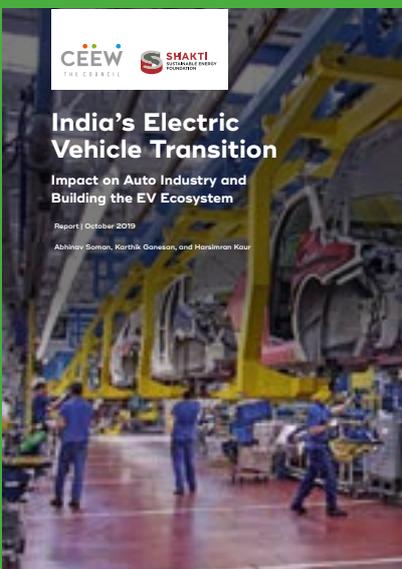


### **OVERALL THERMAL TRANSFER VALUE**

Buildings rank amongst the highest energy consumers across the globe. At present, India uses the Energy Performance Index (EPI) to measure the energy usage index of a building which in turn is used as a key parameter for evaluation of building energy efficiency. However, EPI lacks the ability to define which factors in the building are responsible for higher energy consumption. This study introduces the usage of Overall Thermal Transfer Value, which directly addresses the thermal performance of the building envelope, as a performance criterion other than the EPI.

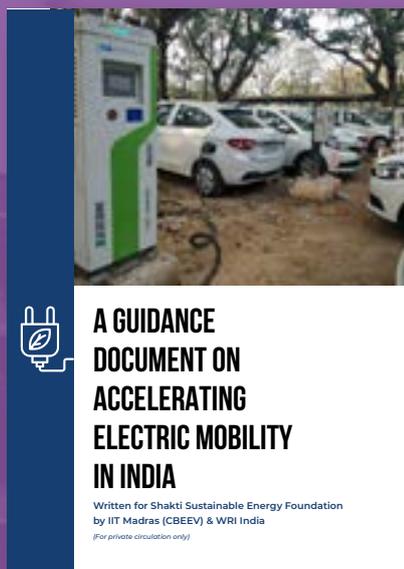


# ELECTRIC MOBILITY



## INDIA'S ELECTRIC VEHICLE TRANSITION: IMPACT ON AUTO INDUSTRY AND BUILDING THE EV ECOSYSTEM

**P**romoting the uptake of electric vehicles in India requires an in-depth understanding of the opportunities and impacts of electrification on the auto industry. This study attempts to assess this by comparing a scenario with 30 percent electric car (EV) sales in 2030 against a business-as-usual (BAU) scenario with limited EV penetration.

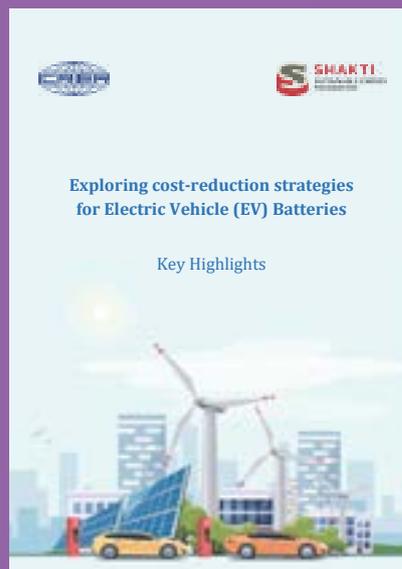


## A GUIDANCE DOCUMENT ON ACCELERATING ELECTRIC MOBILITY IN INDIA

The Indian government is keen on increasing the uptake of electric mobility. But successfully transitioning to electric mobility will require a carefully planned strategy tailored to the Indian context. This guidance document provides valuable insights into the challenges and opportunities for electric mobility acceleration in the country.

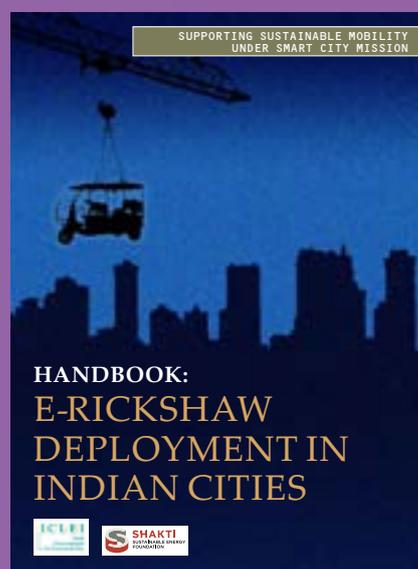
## HANDBOOK: E-RICKSHAW DEPLOYMENT IN INDIAN CITIES

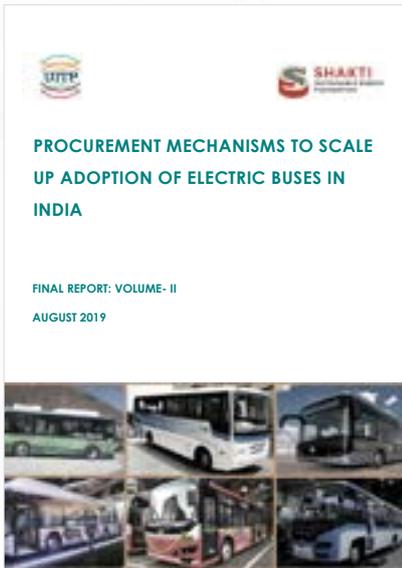
E-rickshaws can be low-hanging fruits on the road to electric vehicle adoption in India, especially as first and last mile connectivity options which have zero tailpipe emissions. The deployment of e-rickshaws requires understanding the role that cities can play and the development of detailed action plans. This report provides guidance and support to cities interested in deploying e-rickshaws.



## EXPLORING COST-REDUCTION STRATEGIES FOR ELECTRIC VEHICLE (EV) BATTERIES

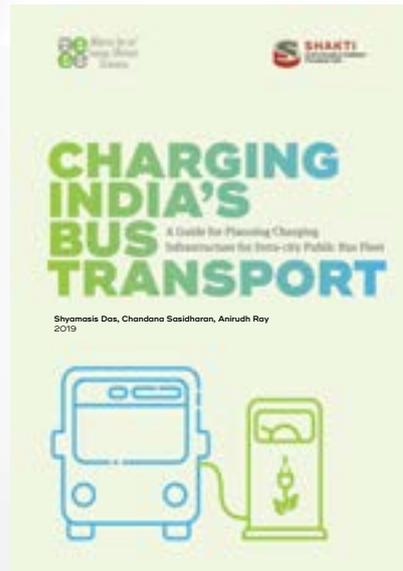
Electric vehicles have a cost disadvantage vis-à-vis traditional fuel vehicles. The battery in an EV is its most expensive component accounting for 50 percent of its total cost; thus, the affordability of EVs is directly proportional to the affordability of a battery. This study proposes a comprehensive strategy and recommends a mix of policy instruments that could reduce battery costs and make EVs affordable and improve their uptake in India.





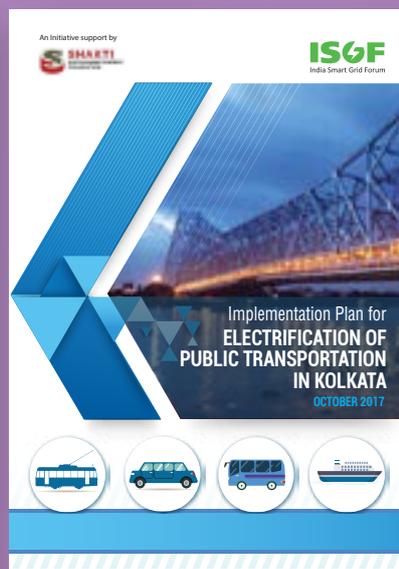
## PROCUREMENT MECHANISMS TO SCALE UP ADOPTION OF ELECTRIC BUSES IN INDIA

**A**round 35% of the total amount of FAME II has been allocated towards providing electric bus incentives. It is therefore important to strategically plan the subsidies and deployment effort to maximise results. This report discusses alternative approaches for the procurement of electric buses and provides technical inputs to agencies in their procurement processes.



## CHARGING INDIA'S BUS TRANSPORT

**S**tate Road Transport Undertakings (SRTUs) manage over 1,00,000 buses across India registering over 524 billion passenger-km annually. The electrification of these fleets could result in drastic reductions in emissions and improvement in air pollution. Charging infrastructure is a crucial component of electrification. This study sheds interesting insights into e-buses and the charging technology market and provides definitive guidance to set up a charging infrastructure for an intra-city e-bus fleet.

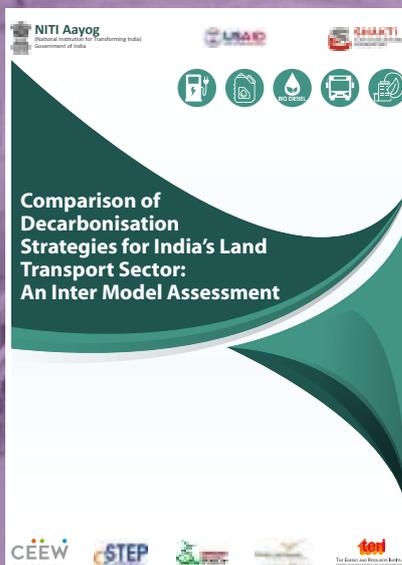


## IMPLEMENTATION PLAN FOR ELECTRIFICATION OF PUBLIC BUS TRANSPORT IN BENGALURU AND KOLKATA

**T**he electrification of public bus fleets can help India reduce emissions. These reports identify the key barriers to large-scale EV penetration and prepare a long-term implementation plan for public e-bus transportation in Bengaluru and Kolkata.



# SUSTAINABLE TRANSPORT



## COMPARISON OF DECARBONISATION STRATEGIES FOR INDIA'S LAND TRANSPORT SECTOR: AN INTER MODEL ASSESSMENT

This report provides the results of an inter-model comparison exercise undertaken by five modelling teams to analyze the future growth of India's transport sector and to evaluate the role of various transport sector policies in reducing transport related energy and emissions in India. It also addresses long-term implications of the potential realization of decarbonisation policies in the transportation sector.



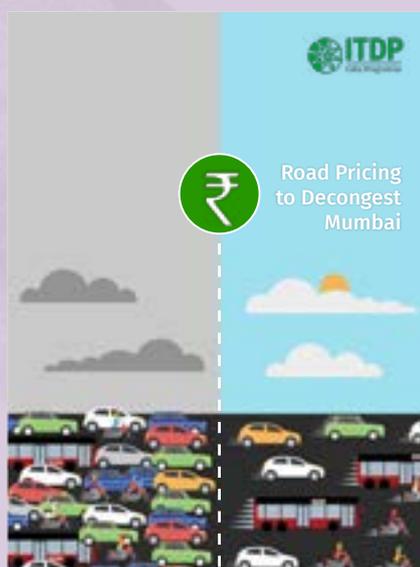
## LAP FOR TRANSIT: ILLUSTRATED HANDBOOK FOR INDIAN CITIES

**L**ocal Area Plan (LAP) is a planning instrument to integrate city-level mobility and infrastructure development envisioned in a development plan, with neighbourhood level accessibility and area-level improvement either through natural process of urban renewal or through planned redevelopment. This handbook presents and demonstrates an Indian model of LAP around transit, which will assist relevant authorities in implementing integrated land use and transport planning for Indian cities.



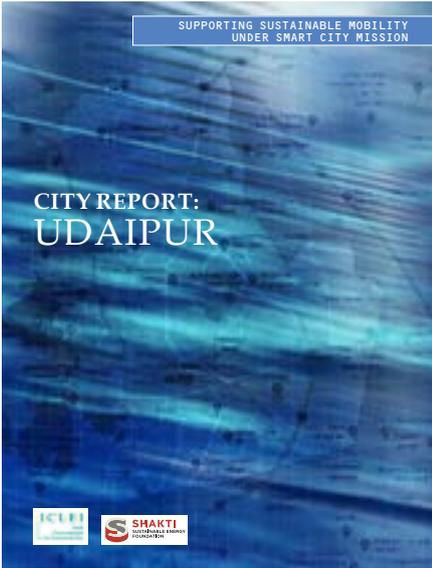
## VALUE CAPTURE FINANCE FOR SUSTAINABLE TRANSPORT INFRASTRUCTURE

**W**ith its release of the National Transit Oriented Development (TOD) policy in 2017, the Ministry of Housing and Urban Affairs (MoHUA) acknowledged the importance for cities to adopt TOD within their development plans. However, despite policy action, two critical barriers to implement TOD remained in place, namely, the lack of adequate urban planning tools for area wise implementation and the challenge of sustainably funding high-quality transit and urban infrastructure required to build TOD in our cities. These knowledge products help stakeholders understand the importance of Value Capture in various forms as a tool to implement TOD in cities.



## ROAD PRICING TO DE-CONGEST MUMBAI

**C**an congestion pricing be an effective way of managing travel demand? This report aims to assess the need and effectiveness of congestion pricing as a Travel Demand Management (TDM) measure. It notes implementation opportunities in Greater Mumbai, challenges that it might face in implementing such an initiative, and potential ways forward.



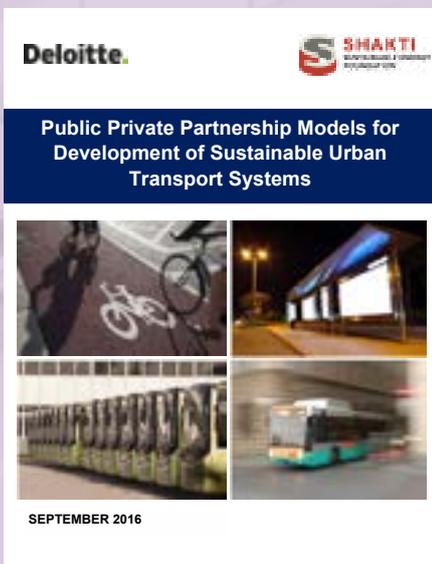
### CITY REPORT: UDAIPUR, VISAKHAPATNAM, LUDHIANA, GWALIOR

It is critical to successfully implement action plans under the Smart City Mission in order to grow cities. The City Reports showcase efforts to develop an integrated and comprehensive approach to address urban transport issues and promote sustainable built environments by implementing nationally recommended steps and strategies in the cities of Udaipur, Visakhapatnam, Ludhiana and Gwalior.



### ROADMAP FOR IMPROVING CITY BUS SYSTEMS IN INDIA

City bus systems are currently at various levels of performance in terms of their operational, planning and management practices. A wide range of interventions are required to improve their overall performance. This report proposes recommendations in the areas of: i) strategic planning ii) technology improvement iii) operational processes iv) bus transport infrastructure v) institutional and contracting frameworks and vi) funding and implementation.



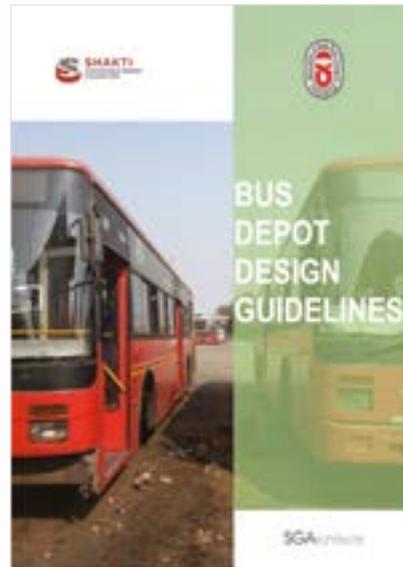
### PUBLIC PRIVATE PARTNERSHIP MODELS FOR DEVELOPMENT OF SUSTAINABLE URBAN TRANSPORT SYSTEMS

A well-developed and planned transportation system is integral to the development of urban spaces and can accelerate economic growth. But developing a strong transport infrastructure requires more resources than the public sector can provide, and public investment will therefore have to be supplemented by private sector. This report identifies key barriers to the success of PPP in urban transport infrastructure space and develops PPP models for each sector for successful PPP contracting and implementation in urban transport infrastructure projects.



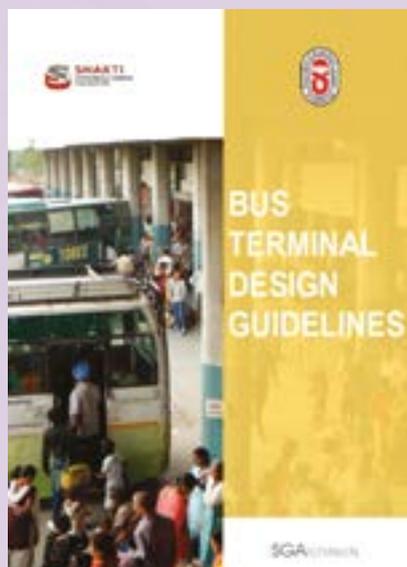
## REGULATORY FRAMEWORKS FOR INTEGRATED SHARED MOBILITY GOVERNANCE IN INDIA

The National Urban Transport Policy (2006) advocates for the provision of multimodal public transport systems in cities while discouraging private vehicle ownership. This study assesses the existing mobility regulations in place for governing shared modes of transport (such as buses, Intermediate Public Transit systems and Internet-based aggregators of transport services). Each of these modes are currently governed by separate legislations and in many cases, separate institutional mechanisms. The study identifies areas of opportunities and improvement while also acknowledging the need for providing a multimodal shared transport system in Indian cities with high quality bus-based transport systems as its core.



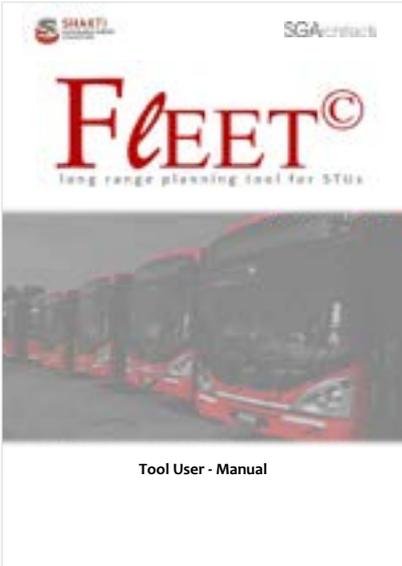
## BUS DEPOT DESIGN GUIDELINES

Buses form the core of the road-based transport in India. State Transport Undertakings will need to increase their fleet size to meet the increasing demand for road transport in the country, which will necessitate adding adequate supporting infrastructure like bus depots. This report provides detailed recommendations on planning, designing and financing bus depot infrastructure based on learning from global best practices and their demonstration for Indian requirements.



## BUS TERMINAL DESIGN GUIDELINES

Bus passenger terminals handle large volumes of passenger transfers on a daily basis. Bus terminals are essential to ensuring quality services to passengers and encouraging the use of public transport. This report provides guidelines and recommendations that can inform the process of improving the quality of public bus terminal infrastructure in Indian cities.



## FLEET TOOLKIT

The FLEET toolkit is designed to allow State Transport Undertakings (STUs) to estimate their long-range requirements as well identify interventions based on their current and projected service types as well service specific fleet and operational characteristics (fleet utilization, load factor, vehicle utilization, staff to bus ratio, etc.). Using this toolkit will allow STUs to expand to currently untapped regions (or markets) leading to overall increased patronage of bus services in general and STUs in particular.

## STANDARDS AND LABELLING PROGRAMME FOR PASSENGER CAR TYRES

Introducing fuel efficiency in vehicles can help reduce the fuel import burden. The efficiency in a motor vehicle with respect to fuel consumption is subject to several design parameters. Tyres have been identified to have a huge potential for improving fuel efficiency of vehicles. This report details the efficacy of low rolling resistance (RR) tyres in improving efficiency and reducing fuel consumption of vehicles.



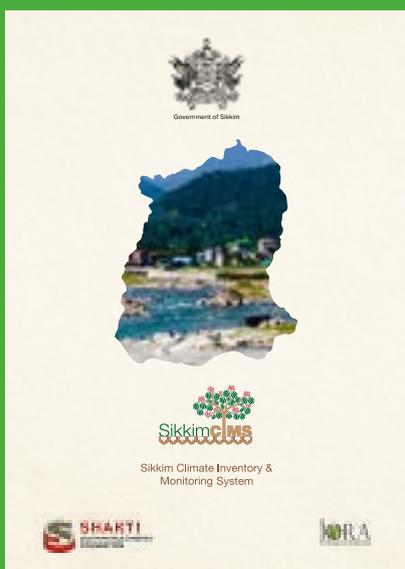
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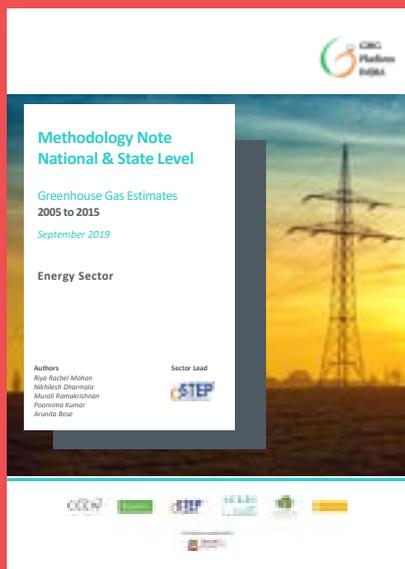
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# CLIMATE POLICY



## SIKKIM CLIMATE INVENTORY MONITORING SYSTEM (SCIMS)

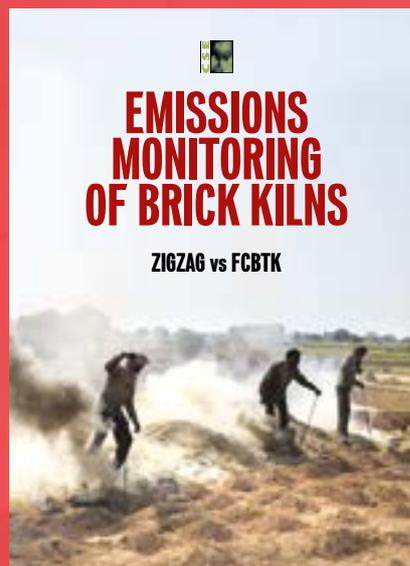
The Sikkim Climate Inventory Monitoring System (SCIMS) emerged out of Sikkim's vision to remain carbon neutral. The SCIMS annually categorises GHG emissions by sources and sinks with the additional capability of measuring, reporting and verifying (MRV) emission reduction and sequestration. This information will help the state design and implement climate relevant actions and contribute to India's NDC goals. Sikkim will be the first state in India to host such a system, thereby setting an important precedent for other states. This report presents an overview of the SCIMS as well as key findings from its GHG inventory.



## THE GHG PLATFORM INDIA

The GHG Platform is a civil-society initiative, which prepares independent estimates and analysis of India's greenhouse gas emissions across key sectors such as energy, waste, industry, agriculture, livestock, forestry, and land-use and land-use change sectors. The website displays all these analytics in the form of customisable graphs, infographics and excel sheets, which can help inform policymaking in India.

Access the website: <http://www.ghgplatform-india.org/>

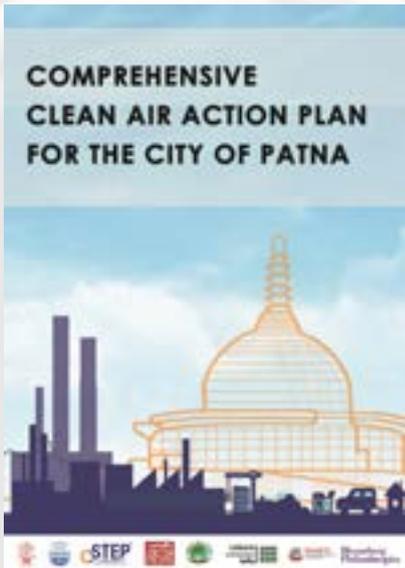


## MITIGATION INSTRUMENTS FOR ACHIEVING INDIA'S CLIMATE AND DEVELOPMENT GOALS

As a developing nation with competing priorities around limited resources, choosing the right mitigation instruments is important for India if it is to achieve both its climate and economic development goals. This report was brought out by the Working Group on Mitigation Instruments, which constitutes of experts from think-tanks, academia, and the industry. It deliberates upon the possible mitigation instruments for India and develops a framework through which the choice of instruments could be informed.

## EMISSIONS MONITORING OF BRICK KILNS ZIGZAG VS FCBTK

The clay brick manufacturing sector in India is a key contributor to air pollution. Despite several official notifications, orders and directives urging brickmakers to convert their kilns from the polluting FCBTKs type to zigzag technology, progress has been slow. This report conducts stack monitoring of brick kilns in order to assess the levels of emissions from FCBTKs and zigzag kilns.



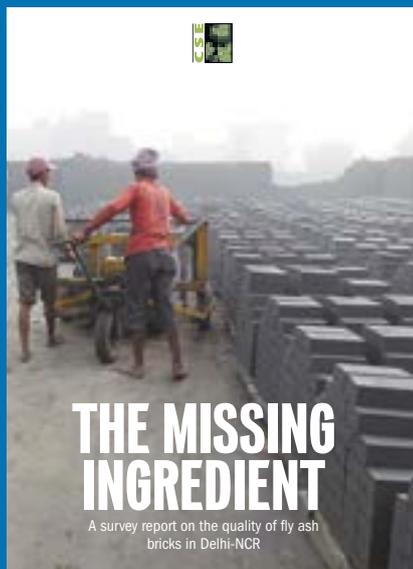
## COMPREHENSIVE CLEAN AIR ACTION PLAN FOR THE CITY OF PATNA

Patna was identified as a non-attainment city in the National Clean Air Programme. The Patna Clear Air Action Plan, which was launched by the Deputy CM of Bihar, Shri Sushil Kumar Modi, in November 2019, was developed to provide a scientifically rigorous roadmap for the city in its fight against air pollution.



## THE AIR POLLUTION KNOWLEDGE ASSESSMENTS (APNA) CITY PROGRAM

Tackling the challenge of increasing pollution levels in Indian cities requires the quantification of the impact of air pollution. While metropolitan cities have air quality monitoring infrastructure, there is little data available for Tier 1 and 2 cities. APNA highlights city-specific modelling of emissions, meteorology and source specific pollution concentrations for 50 Tier 1 and 2 Indian cities, providing an important starting point for understanding air pollution in these cities.



## THE MISSING INGREDIENT: A SURVEY REPORT ON THE QUALITY OF FLY ASH BRICKS IN DELHI-NCR

This report presents the findings of a study conducted in Delhi-NCR using brick samples from 51 fly ash making units in 11 districts to examine the issue of quality of fly ash bricks and understand the reasons for the slow uptake of fly ash in the brick sector.



## CARBON MARKETS IN INDIA: EXPLORING PROSPECTS AND DESIGN CONSIDERATIONS

Carbon pricing is an important tool to facilitate the adoption of low-carbon technologies, which can help India achieve its Nationally Determined Contributions (NDCs). As India joins the global momentum on carbon pricing, there is a need to explore avenues for implementing a domestic carbon market in the country. This report analyses some of the key considerations relating to the role carbon markets can play in India and highlights some of the lessons learnt from global examples.



## BS VI READINESS

India is set to shift to BS VI from BS IV emission standards countrywide in April 2020. More than 70% of Indian cities are classified as critically polluted and vehicles are among the highest source of emissions. Shifting to BS VI fuel standards will significantly reduce vehicular emissions and improve the air quality of our cities. But real emissions and health benefits are possible only if these advanced technologies are properly operated and maintained and requirements for real world emissions tests are made tighter with strong deterrence for tampering. This policy brief examines India's readiness for leapfrogging to BS VI standards.



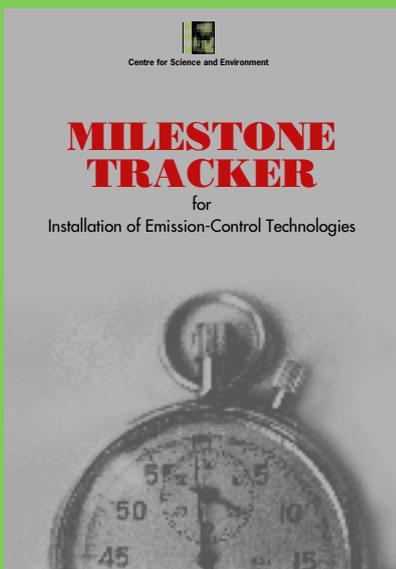
## DISCUSSION PAPER ON CARBON TAX STRUCTURE FOR INDIA

By assessing aspects like sources and levels of GHG emissions in India and the effectiveness of the measures being taken by India towards reducing carbon emissions, this paper adds to the national understanding on carbon taxation. This report was the first to assess the merits and challenges of introducing a carbon tax mechanism to help India achieve its NDC targets.



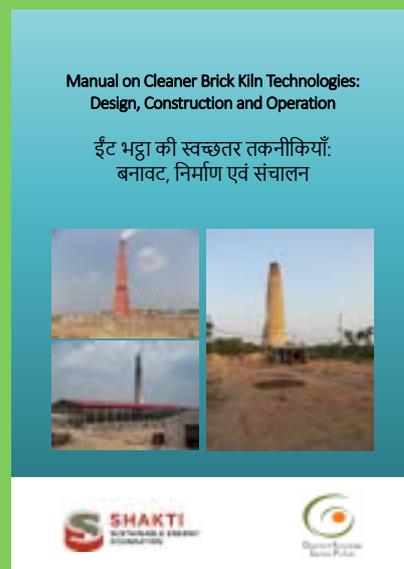
## DISCUSSION PAPER ON MARKET-BASED APPROACHES OF THE PARIS AGREEMENT: WHERE ARE WE NOW?

This paper highlights the key areas of deliberation on Article 6 of the 2015 Paris Agreement. It assesses the positions of various countries and views on the new market-based regime for trading in emissions or mitigation outcomes.



## MILESTONE TRACKER FOR INSTALLATION OF EMISSION CONTROL TECHNOLOGIES

The Ministry of Environment, Forest and Climate Change (MoEF&CC) revised the environmental standards for coal-based thermal power stations in 2015 and requested compliance from the industry, but more progress is required in that direction. One of the problems faced is the lack of a monitoring mechanism to track implementation progress. This milestone document attempts to capture the key steps which can give a picture of the progress made by the power stations towards compliance of implementation of emission control technologies.



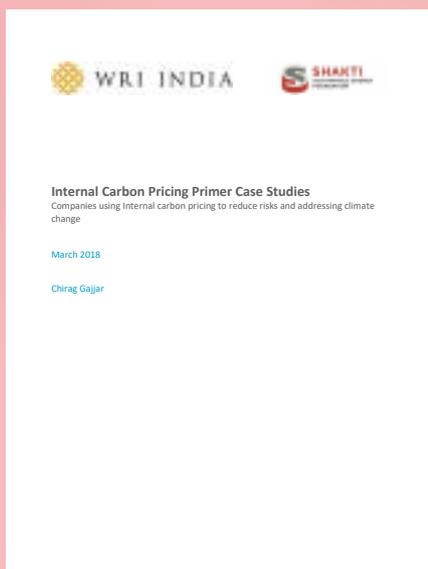
## MANUAL ON CLEANER BRICK KILN TECHNOLOGIES: DESIGN, CONSTRUCTION AND OPERATION

This report explains the design, construction and operation of cleaner brick kiln technologies like high draught zigzag kilns, natural draught zigzag kilns, vertical shaft brick kilns etc. It attempts to provide technical assistance to brick kiln entrepreneurs of the Patna district in Bihar to shift to cleaner brick manufacturing technologies.



## CAN INDIA'S AIR CONDITIONING SERVICE SECTOR TURN CLIMATE FRIENDLY?

In India, the service sector is estimated to account for as much as 40% of all refrigerant consumption in the country. Reducing demand from this sector by increasing adherence to servicing and installation practices that are vital for the safe, reliable, and climate-friendly operation of the system is key to addressing the issue of cutting HFC emissions. This report assesses the state of the AC servicing sector and the level of skill and knowledge of the technicians about good service practices to reduce refrigerant leakages and provides a foundation for future policy decisions.



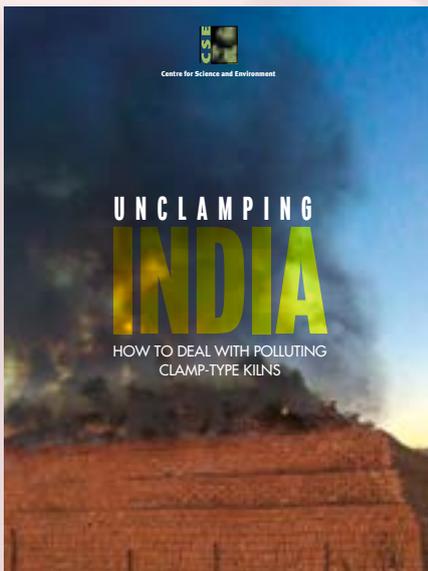
## INTERNAL CARBON PRICING PRIMER: CASE STUDIES COMPANIES USING INTERNAL CARBON PRICING TO REDUCE RISKS AND ADDRESSING CLIMATE CHANGE

Reflecting a range of organization types, sectors and geographies, this report presents case studies of companies that have used internal carbon pricing to reduce risks and address climate change. These case studies address the motivation, risks, opportunities, best practices, and business case for internal carbon pricing. They also shed light on how organizations can integrate internal carbon pricing into their business strategy.



## STANDARDIZING PRACTICES IN THE AC SERVICES SECTOR

This issue brief highlights the importance of standardising AC servicing practices as a preparatory activity to ready the AC servicing sector for the upcoming HFC phase-down and to act as a yardstick of minimum expected performance from service technicians. Adherence to good service practices can help cut HFC emissions drastically.



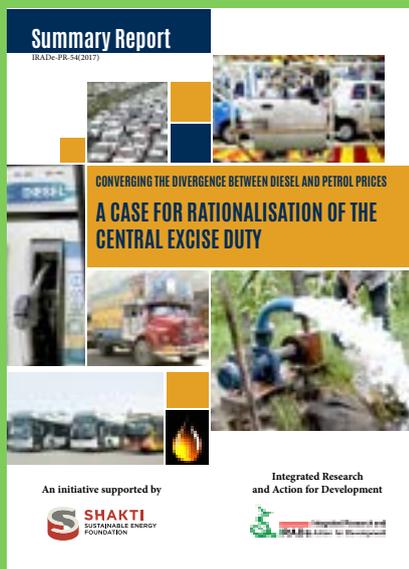
## UNCLAMPING INDIA

A clamp is the most basic type of brick kiln, and brick making in clamps is one of the oldest technologies in the world, as also in India. However, it is also one of the least efficient and most polluting. Through a sample survey of clamps in western Maharashtra where brick making takes place only through clamp-type kilns, this study attempts to deliver insights that can help in the phase out of these kilns in a smooth and time-bound manner.



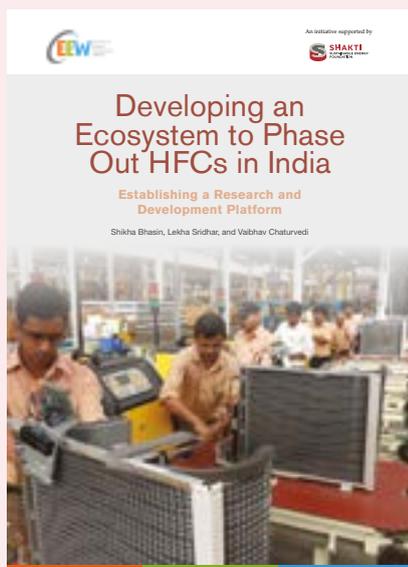
## PROMOTING LOW-GWP REFRIGERANTS THROUGH PUBLIC PROCUREMENT

Following the Kigali Amendment on Substances that Deplete the Ozone Layer in 2016, hydrofluorocarbons (HFCs), will have to be phased out from all cooling applications in India from 2028 onwards and replaced by low-Global Warming Potential (GWP) refrigerants. This report highlights the role that public procurement of low-GWP refrigerants can play in promoting climate-friendly refrigerants in the public sector in India.



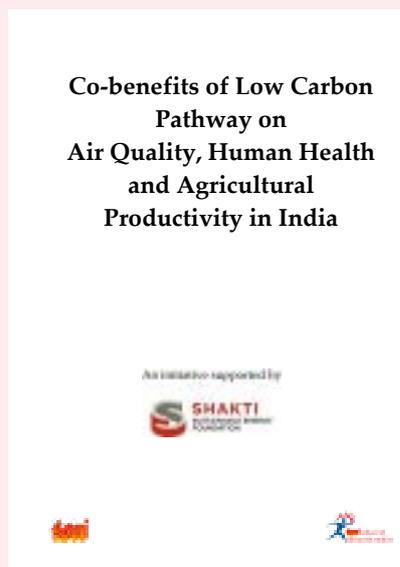
## CONVERGING THE DIVERGENCE BETWEEN DIESEL AND PETROL PRICES

There continue to be differences in petrol and diesel prices despite the government's actions to reduce the price differentials. Cutting down the pricing differences between petrol and diesel can lead to the elimination of perverse incentives that currently exist in the economy and have wide-ranging impacts on vehicular emissions and air pollution.



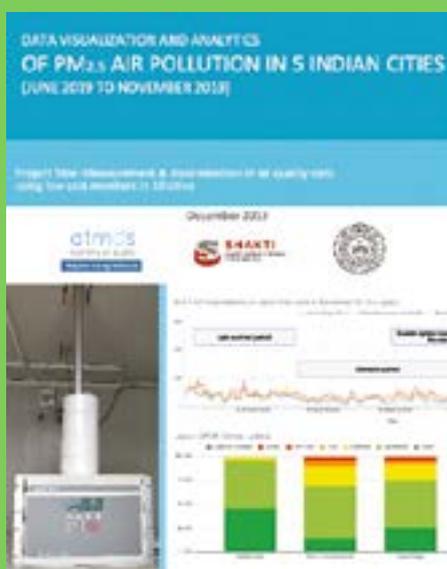
## DEVELOPING AN ECOSYSTEM TO PHASE OUT HFCs IN INDIA

**B**uilding the required ecosystem for phasing out Hydrofluorocarbon (HFC) refrigerants in India requires the addressal of various technological and systemic gaps. This report highlights the relevance of and presents an institutional design for a dedicated multi-stakeholder R&D platform to address India's domestic concerns and to meet its international commitments for the phasing out of HFCs.



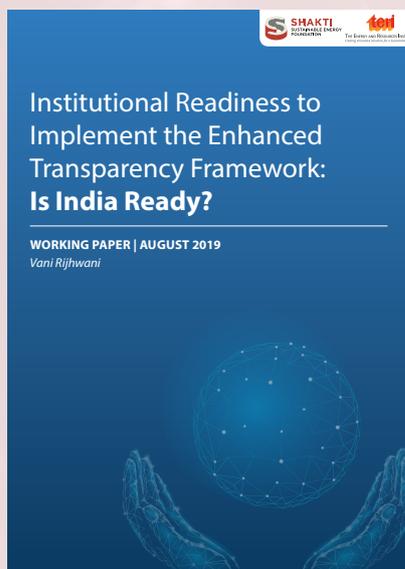
## CO-BENEFITS OF LOW CARBON PATHWAY ON AIR QUALITY, HUMAN HEALTH AND AGRICULTURAL PRODUCTIVITY IN INDIA

**A**doption of low-carbon sources of energy can have significant impacts on other areas of life like improvement of air quality, expected reductions in human health impacts, increase in agricultural yields etc. Different levels of intensity in energy policies will have different amounts of co-benefit gains. This study highlights the level of co-benefit impacts that follow four alternative energy policy scenarios.



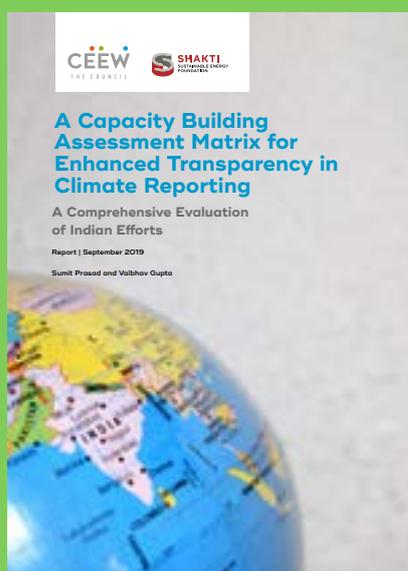
## LOW-COST AIR QUALITY MONITORS IN 50 INDIAN CITIES TO PROVIDE REAL TIME AND CREDIBLE AIR QUALITY DATA

**C**ities need good quality data on pollution levels, affected areas, sources and related information to be able to design strong air quality management plans. But a number of Indian cities are still outside the ambit of air quality monitoring. Low-cost air quality monitors are helping bridge this gap which will provide real-time measurement of PM 2.5 in 50 Indian cities, and raise public awareness and inform policies for better air quality management.



## INSTITUTIONAL READINESS TO IMPLEMENT THE ENHANCED TRANSPARENCY FRAMEWORK: IS INDIA READY?

The Enhanced Transparency Framework (ETF) entails guidelines, rules and procedures that will make it possible to track the progress made by each country on its nationally determined contribution (NDC) goals. This working paper captures the recent developments on ETF post-COP24, its implications on developing Parties and assesses India's institutional readiness to comply with emerging requirements under the ETF so as to effectively implement the Paris Agreement.

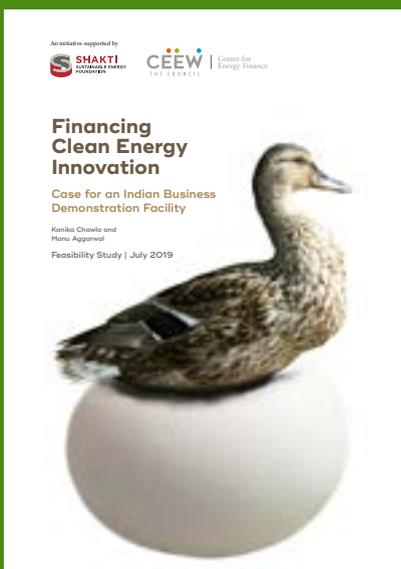


## A CAPACITY BUILDING ASSESSMENT MATRIX FOR ENHANCED TRANSPARENCY IN CLIMATE REPORTING

The Paris Agreement mandates a common reporting system while ensuring that developing countries receive adequate, timely, and transparent support (financial, technical, knowledge base) from developed countries. At present, defining capacity and ascertaining flexibility for a developing country remains a contentious process. This study aims to bridge this gap by presenting an assessment tool – Capacity Building Assessment Matrix (CBAM) – to help quantify capacity building efforts and the gaps therein, with regards to climate transparency.



# CLEAN ENERGY FINANCE



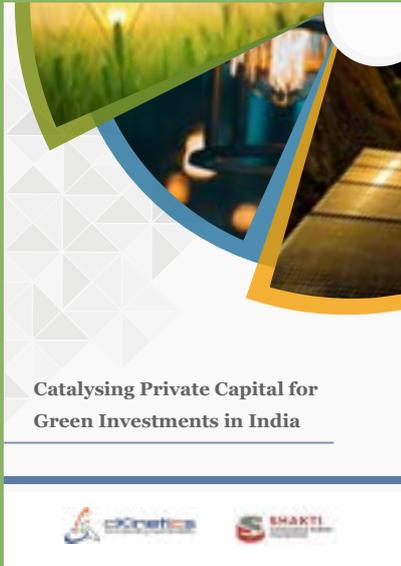
## FINANCING CLEAN ENERGY INNOVATION: CASE FOR AN INDIAN BUSINESS DEMONSTRATION FACILITY

This report highlights the need for a business development facility that can aid India's energy transition by creating market depth in its underserved and new clean energy sectors. It lays out a strategy to leverage patient, low-cost, risk-friendly capital raised predominantly from philanthropic sources and using market principles and mechanisms to scale business and technological innovations.



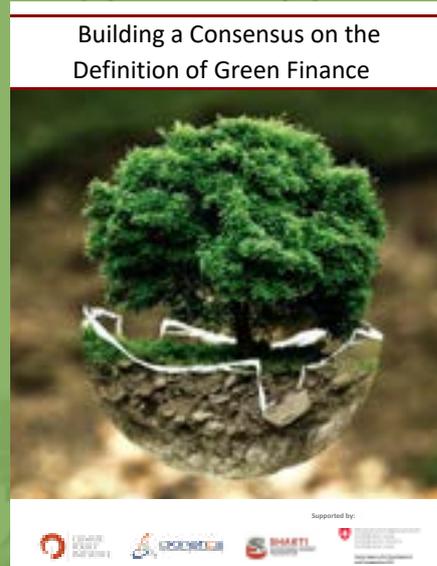
## CATALYSING GREEN OPPORTUNITIES: INTEGRATING ENVIRONMENTAL RISKS TO ADDRESS CLIMATE GOALS GUIDEBOOK FOR INVESTORS AND LENDERS

This report provides a flexible, non-prescriptive guidance for financial institutions (investors and lenders), helping them to realize the potential to climate-align activities, consider 'green' as a core dimension to business strategy and take a deeper view of environmental risks beyond compliance.



## CATALYSING PRIVATE CAPITAL FOR GREEN INVESTMENTS IN INDIA

**S**ustainable and Responsible Investing (SRI) is an investment strategy that has emerged as a key investment strategy around the globe. SRI can help channel investments into focus sectors that can have a profound impact on society. The objective of this report is to highlight the fact that climate finance and SRI have several overlapping values which can be utilised in order to mobilize finance for climate change.



## BUILDING A CONSENSUS ON THE DEFINITION OF GREEN FINANCE

**W**hile several initiatives are ongoing across countries and organizations to arrive at a definition of green finance, a universally accepted definition is not available yet. Defining green finance is an important step towards a large-scale transition to low-carbon economic development. This report has taken the first step in defining “green” in context of India’s NDC commitment and economic goals.



## CORPORATE CLIMATE ACTION IN SUPPORT OF NDCs: A CASE FOR SCIENCE BASED TARGETS IN INDIA

**C**orporates are directly or indirectly responsible for a significant amount of greenhouse gas emissions in India. Many companies are already demonstrating that they have the desire and expertise to help India meet its Nationally Determined Contributions by reducing their emissions. Science-based targets (SBTs) provide companies with a clearly defined pathway to futureproof growth by specifying how much and how quickly they need to reduce their greenhouse gas emissions.



# IN COLLABORATION WITH

## Grantees

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Citizen Consumer and Civic Action Group  
Clean Energy Access Network  
Confederation of Indian Industry  
Consumer Unity and Trust Society  
Council on Energy, Environment and Water  
Federation of Indian Chambers of Commerce and Industry  
Foundation for Innovation and Technology Transport  
Gujarat Energy Research and Management Institute  
ICLEI – Local Governments for Sustainability (South Asia)  
India Resources Trust (WRI)  
Indian Institute of Technology – Bombay  
Indian Institute of Technology – Delhi  
Indian Institute of Technology – Madras  
Indian School of Business (Hyderabad)  
Initiatives in Health, Energy, Learning and Parenthood (Prayas)  
Integrated Research and Action for Development  
iPartner India  
Janaagraha Centre for Citizenship and Democracy  
Legal Initiative for Forests and Environment  
National Institute of Urban Affairs  
Nehru Foundation-Centre for Environment Education  
Parisar Sanrakshan Sanwardhan Sanstha  
Samarthyam  
Selco Foundation  
SEWA Bharat  
Small Scale Sustainable Infrastructure Development Fund

Society for Development Alternatives  
TERI School of Advanced Studies  
The Associated Chambers of Commerce and Industry of India  
The Energy and Resources Institute  
Vasudha Foundation  
World Institute of Sustainable Energy

## Consultants

AB Lall Architects  
Adapt Technologies and Consultancy Services India Pvt. Ltd.  
cBalance Solutions Pvt. Ltd.  
CEED India Development Pvt. Ltd.  
Centre for Energy, Environment and Resources Pvt. Ltd.  
cKinetics Consulting Services Pvt. Ltd.  
Clean Air Initiative for Asian Cities Center Inc.  
Climate Policy Initiative India Pvt. Ltd  
Creative Footprints  
Dalberg Development Advisors Ltd.  
Delhi Integrated Multi-Modal Transit Systems Ltd  
Deloitte Touche Tohmatsu India LLP  
Edelman India Pvt. Ltd.  
Emergent Ventures India Pvt. Ltd.  
Ernst & Young  
Greentech Knowledge Solutions Pvt. Ltd.  
IBI Consultancy India Private Limited  
ICF Consulting India Pvt. Ltd  
Idam Infrastructure Advisory Pvt. Ltd.  
IL&FS Energy Development Company Ltd.  
Institute for Transportation and Development Policy  
Institute of Urban Transport  
Intellect Advisory Services Pvt. Ltd.  
IORA Ecological Solutions Pvt. Ltd.  
KPMG Advisory Services Pvt. Ltd.  
Leading Purpose Campaigns (India) Private Limited  
Life N Colors Pvt. Ltd.  
Meghraj Capital Advisers Pvt. Ltd.  
MP Ensystems Pvt. Ltd.  
PricewaterhouseCoopers  
Respirer Living Sciences Pvt. Ltd.  
Ricardo India Pvt. Ltd.  
S G Architects  
Skymet Weather Services Pvt. Ltd.  
Union International Des Transports Publics (UITP)  
Urban Management Consulting Pvt. Ltd.



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