UNLOCKING NATIONAL ENERGY EFFICIENCY POTENTIAL (UNNATEE)

Strategy Plan Towards Developing an Energy Efficient Nation (2017-2031)

February 2019

For Public Consultation

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Preface

The Bureau of Energy Efficiency (BEE) has been engaged in several initiatives to design and implement energy efficiency programs. As part of this initiative, BEE is working on coming up with a national strategic plan for energy efficiency, which would lay a roadmap for recognizing and unlocking India's energy efficiency potential in its demand sectors. Energy saving through adoption of new technologies, increasing the scope of the wide gamut of energy related policies and programs and sensitizing the consumers towards the importance of saving energy in their day-to-day lives would go a long way in making India energy secure and resource efficient.

In India, there is still an immense potential to be realized from large scale implementation of energy efficiency interventions in the various demand sectors like industry, agriculture, transport, municipal, domestic and commercial lighting and appliances and Micro, small and medium scale enterprises (MSME).

In this context, BEE, with support from PricewaterhouseCoopers Private Limited has developed the national strategic plan for energy efficiency, presented in the form of this report "**Unlocking National Energy Efficiency Potential – UNNATEE, Strategy plan towards developing an energy efficient nation (2017-2031)**".

The strategy plan sheds light on the energy efficiency potential of the above mentioned sectors today and in the long term. One of the key barriers to energy efficiency financing in India is lack of awareness amongst banks and financial institutions. The strategy plan also estimates the investment potential of the sectors and the key financing instruments that would play a bigger role in the future.

The findings of the project would benefit policy makers, planners, domain consultants and other relevant stakeholders. The report will also facilitate knowledge sharing between the stakeholders and scale up the energy efficiency activities in the country in the long term.

I am happy to share this document with all stakeholders for kind persual and seeking valuable inputs

(Abhay Bakre)
Director General
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New Delhi
Febuary 2019

Acknowledgement

The study “Unlocking National Energy Efficiency Potential – UNNATEE, Strategy plan towards developing an energy efficient nation (2017-2031)” is the outcome of the collaborative efforts of the Bureau of Energy Efficiency (BEE) and PricewaterhouseCoopers (PwC) Pvt. Ltd.

The team extends its profound thanks to **Mr. Abhay Bakre**, Director General (BEE), for his leadership and guidance during the execution of the assignment. The team recognizes and extends its sincere gratitude to **Mr. Pankaj Kumar,** Secretary (BEE), for his invaluable inputs provided during many interactions and deliberations. PwC acknowledges the co-operation and the support extended by **Mr. Arijit Sengupta**, Director (BEE) for supervising the assignment throughout the execution phase. The team appreciates Project Engineer (BEE), **Mr. Rakesh Biswas**, for his support in coordination with various ministries and government agencies.

PwC also acknowledges the support provided by the government ministries and agencies during the stakeholder consultation. The list of Ministries and agencies include Ministry of Power (MoP), Central Electricity Authority (CEA), Coal Controller’s Organization (CCO), Petroleum Planning and Analysis Cell (PPAC), Ministry of Micro, Small and Medium Enterprises (MoMSME), Ministry of Statistics and Programme Implementation (MOSPI), Ministry of Statistics and Programme Implementation (MOSPI) – Annual Survey of Industries (ASI) and Department of Heavy Industries (DHI).

Last but not the least, PwC is grateful to the in-house team of PwC for their consistent efforts in bringing this report to fruition.

Contents

Abbreviations

AAI	Airports Authority of India
ACCA	Accelerated capital cost allowance
ACEEE	American Council for an Energy Efficient Economy
ADD	Advanced Direct Drive
ADI	Accelerated Depreciation based Incentivization
AgDSM	Agriculture Demand side management
AJAY	Atal Jyoti Yojana
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
APEDA	Arunachal Pradesh Energy Development Agency
APEPDCL	Andhra Pradesh Eastern Power Distribution Company Limited
APSECM	Andhra Pradesh State Energy Conservation Mission
ARRA	American Recovery and Reinvestment Act
ATM	Air Traffic Management
BAU	Business As Usual
BEE	Bureau of energy efficiency
BEIS	Business, Energy and Industrial Strategy
BESCOM	Bangalore Electricity Supply Company Limited
BIS	Bureau of Indian Standards
CAC	Credit Aggregation Centers
CAFÉ	Corporate Average Fuel Economy
CBTT	Cross-Border Technology Transfer and Energy Efficiency Financing Facility
CCAs	Climate Change Agreements
CCL	Climate Change Levy
CCO	Coal Controller's Organization
CCSAMMN	Climate Change and Sustainable Agriculture Monitoring, Modelling and Networking
CDM	Clean development mechanism
CEA	Central Electricity Authority
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Program
CFCs	Chlorofluorocarbons
CFD	Computational fluid dynamics
CIL	Coal India Limited
CIPEC	Canadian Industry Program for Energy Conservation
CLCSS	Credit Linked Capital Subsidy for Technology Up gradation

CS	Capital Subsidy
CSP	Concentrated Solar Power
DBT	Direct benefit transfer
DC	Designated Consumers
DCC	Data Communications Company
DDUGJY	Deendayal Upadhyaya Gram Jyoti Yojana
DEA	Designated Energy Auditors
DECC	Department of Energy and Climate Change
DEDE	Department of Alternative Energy Development and Efficiency
DEEP	Distribution Energy Efficiency Project
DFC	Dedicated Freight Corridor
DGH	Directorate General of Hydrocarbons
DHI	Department of Heavy Industries
DISCOM	Distribution company
DRC	Dynamic Reactive Compensation
DSM	Demand side management
ECB	Energy Conservation Bonds
ECBC	Energy Conservation Building Codes
ECS	Eskom's Energy Conservation Scheme
EDM	Energy data management
EE	Energy Efficiency
EEDO	Energy Efficiency Deployment Office
EEDO	Energy Efficiency Directive
EEDSM	Eskom's Energy Efficiency and Demand-side Management
EEFP	Energy Efficiency Financing Platform
EEM	Energy Efficient Mortgage
EEN	Energy efficiency networks
EESL	Energy Efficiency Services Limited
EIA	Energy Information Agency
EIM	Energy Improvement Mortgage
EMC	Energy management center
EnMS	Energy Management System
EPA	Environmental Protection Agency
EPC	Energy performance contracts
EPI	Energy Performance Index
Escerts	Energy Saving Certificates
ESCO	Energy Service Company
ESI	Energy Savings Insurance

ETD	Energy Tax Directive
EXIM	Export Import
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India
FEEED	Framework for Energy Efficient Economic Development
FI	Financial Institutions
FortF	Forfaiting funds
GCF	Green Climate Fund
GEF	Global Environment facility
GHG	Green House Gases
GRF	Green Receivables Fund
SGDP	State Gross Domestic Product
GVA	Gross Value Added
GWP	Global Warming Potential
HCCI	Homogeneous charge compression ignition
HFCs	Hydro fluorocarbons
HLPF	High-Level Political Forum
HPMP	HCFC phase out management plan
HPMV	High pressure mercury vapour
HPS	High-Pressure Sodium
HPSV	High pressure sodium vapour
HRIDAY	Heritage City Development and Augmentation Yojana
HVAC	Heating, Ventilation and Air- conditioning
ICAR	Indian Council of Agricultural Research
ICES	Integrated Community Energy Solutions
INDC	Intended Nationally Determined Contributions
IPPU	Industrial Processes and Product Use
IRBD	Interest rate buys down fund
IRP	Integrated resource planning
ISO	International Organization for Standardization
ITS	Information technology systems
KREDL	Karnataka renewable energy development limited
KSEB	Kerala state electricity board
KUSUM	Kisan Urja Suraksha Evam Utthaan Mahabhiyan
LED	Light emitting diode
LPG	Liquefied Natural Gas
LSG	Local self-government
LULUCF	Land Use, Land-Use change and Forestry
MEDA	Maharahtra energy development agency

MEEP	Municipal Energy Efficiency Program
MEPS	Minimum energy performance standards
METI	Ministry of Economy, Trade and Industry
MFM	Multifunction Measurement and Control unit
MNRE	Ministry of New and Renewable Energy
MoEFCC	Ministry of Environment, Forests and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MoMSME	Ministry of Micro, Small and Medium Enterprises
MoP	Ministry of Power
MoPNG	Ministry of Petroleum and Natural Gas
MoRTH	Ministry of Road Transport and Highways
MOSPI	Ministry of Statistics and Programme Implementation
MoU	Memorandum of Understanding
MoUD	Ministry of Urban Development
MSME	Micro, Small and Medium Enterprises
MTEE	Market Transformation for Energy Efficiency
Mtoe	Million tonne of Oil Equivalent
MuDSM	Municipal demand side management
NABERS	National Australian Built Environment Rating System
NAPCC	National Action Plan on Climate Change
NBFC	Non-banking financial corporation
NDRC	National Development and Reform Commission
NEET	Non-Profit Energy Efficiency Transition
NEMMP	National Electric Mobility Mission Plan
NEPP	National Energy productivity Plan
NHAI	National Highway Authority of India
NICRA	National Innovations on Climate Resilient Agriculture
Ni-MH	Nickel Metal Hydride
NIMZs	National Investment and Manufacturing Zones
NITI Aayog	National Institution for Transforming India
NIWE	National Institute of Wind Energy
NMCP	National Manufacturing Competitiveness Program
NMEEE	National Mission on Enhanced Energy Efficiency
NMSA	National Mission on Sustainable Agriculture
NPCIL	Nuclear Power Corporation of India Limited
NSM	National Solar Mission
NZEB	Net zero energy buildings
OBF	On-bill financing

ODS	Ozone depleting substances
OFWM	On farm water management
OIL	Oil India Ltd.
ONGC	Oil and Natural Gas Corporation
PACE	Property Assessed Clean Energy
PAT	Perform, Achieve and Trade
PCCI	Premixed Charge Compression Ignition
PCP	Power Conservation Program
PFCs	Per fluorocarbons
PKVY	Paramparagat Krishi Vikas Yojana
PMC	Pune Municipal Corporation
PMFBY	Pradhan Mantri Fasal Bima Yojana
PMKSY	Pradhan Mantri Krishi Sinchai Yojana
PMUY	Pradhan Mantri Ujjwala Yojana
PNG	Piped natural gas
PPAC	Petroleum Planning and Analysis Cell
PPL	Peer to Peer Lending
PRGF	Partial Risk Guarantee fund
PRGFEE	Partial risk guarantee fund for energy efficiency
PRI	Panchayati Raj Institutions
PSU	Public Sector Undertakings
QMS	Quality Management Standards
QTT	Quality Technology Tools
RAD	Rain fed area development
REC	Rural Electrification Corporation
RES	Renewable Energy Sources
RLF	Revolving loan fund
RoI	Return on Investment
RRR	Reserve Replacement Ratio
SAATHI	Sustainable and Accelerated Adoption of efficient Textile technologies to Help small Industries
SANEDI	National Energy Development Institute
SAUBHAGYA	Pradhan Mantri Sahaj Bijli Har Ghar Yojana
SCADA	Supervisory control and data acquisition
SDA	State designated agencies
SDGs	Sustainable Development Goal
SERC	State electricity regulatory commissions
SHM	Soil Health Management
SIDBI	Small Industries development bank of India

SLEE	Securitization of Loans for Energy Efficient Appliances
SLNP	Street Lighting National Program
SOP	Standard Offer Program
SPFF	Stranded Project Financing Facility
SPV	Solar photo voltaic
STIP	Science Technology and Innovation Plan
TADP	Transformation of Aspirational Districts Program
TEDI	Thermal Energy Demand Intensity
TEQUP	Technology and Quality up gradation support to Micro, Small and Medium Enterprises
TEUI	Total Energy Use Intensity
TGS	Toronto Green Standard
UCA	Unnat Chulha Abhiyan
UJALA	Unnat Jyoti by Affordable LEDs for All
ULB	Urban Local Bodies
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UREDA	Uttarakhand Renewable Energy Development Agency
VCFEE	Venture Capital Fund for Energy Efficiency
VEC	Village Energy Committee
VMC	Vadodara Municipal corporation
VNRs	Voluntary National Reviews
xEVs	Electric and Hybrid Vehicles
ZED	Zero effect Zero Defect

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Executive summary

With the GDP expected to grow at around 8%, if energy consumption (primary energy and electricity) in India were to continue along current lines, it could lead to a growing imbalance between supply and demand. The gap between supply and demand can be fulfilled by either increasing generation or by enhancing the efficiency of energy usage. Supply options often require huge investments and have a high gestation period. Enhancing energy efficiency (primary energy and electricity) provides an attractive solution for meeting the ever rising demand without sacrificing the greater goal of high growth. This should help to avoid, or at least limit, the perpetual headlong rush towards new production capacities which, even when based on the use of alternative energy forms to fossil fuels, still require heavy investment and significant financing. Apart from the demand and supply imbalance, the emissions intensity of the country is mounting with India contributing to 6% of global emissions. With the country submitting the Intended Nationally Determined Contributions (INDC) targets to United Nations Framework Convention on Climate Change (UNFCCC), intending to reduce emission intensity of its GDP, the role of energy efficiency would be crucial in complying by those targets.

UNNATEE strategy plan lays a plain framework and implementation strategy, in the short, medium and long term, to establish a clear linkage between energy demand scenarios and energy efficiency opportunities in order to conceptualize a comprehensive roadmap to address India's environmental and climate change commitments. The national target for energy efficiency savings and implementable roadmap to be achieved in the next fourteen years is established. Such an exhaustive exercise is the first of its kind clearly delineating the energy savings targets for each state in their respective sectors. Developing India's blueprint of effective energy efficiency strategy is a leap towards stimulating energy efficiency ecosystem and enabling reduction of the pressure on demand. The report is organized in the following seven chapters:

Chapter 1 establishes India's current year (baseline) energy supply and demand, broken down into primary energy and electricity. It also covers identified data gaps in energy data reporting practice and recommendations on effective energy data management (EDM).

Chapter 2 presents a comprehensive mapping of current polices, programs and action plans in India applicable for energy and energy end-use sectors. The coverage of policies and programs include national programs, state programs (SDAs and DISCOMs), local level programs (municipalities and panchayats) and other indirect policies that affect energy efficiency (Montreal Protocol, Kigali meeting and Smart Cities).

Chapter 3 presents a mapping of key future technologies that would impact energy consumption in each of the demand sectors and provides a detailed analysis of five of the key future technologies

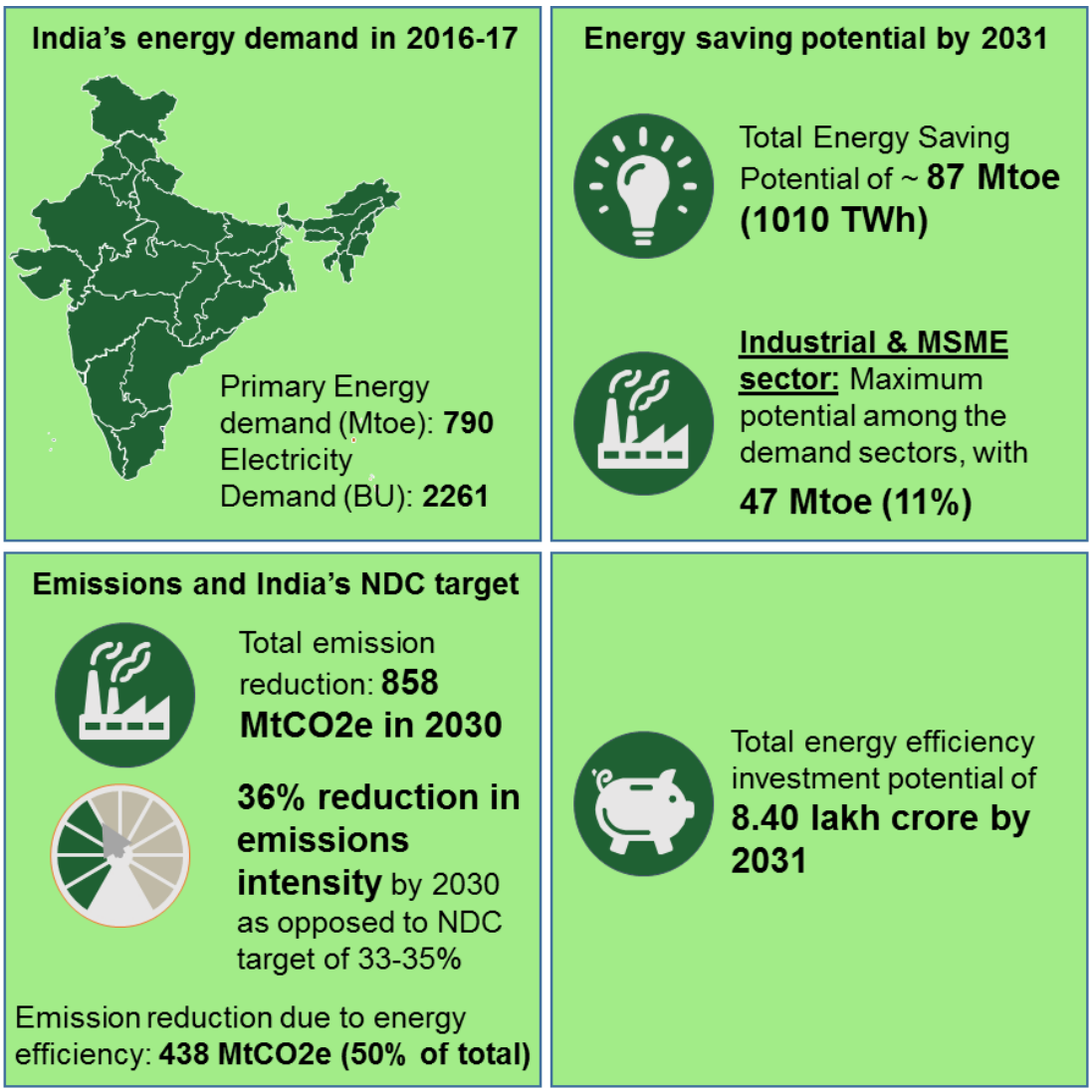
Chapter 4 establishes energy saving potential of various sectors in India by the year 2031. It also forecasts energy consumption by various sectors in India. The methodology for calculation of energy saving potential is discussed in this chapter. The allocation of energy saving targets to each state and sector is established in this chapter

Chapter 5 presents the energy saving investment potential for various demand sectors in India by the year 2031. The chapter also explores current EE financing landscape across the world and suggests best suited schemes for Indian EE market.

Chapter 6 assesses India's NDC target emissions in absolute terms, calculates the achieved emission intensity reduction targets by 2030 and estimates the potential contribution of energy efficiency in emissions intensity reduction. It also provides a commentary on global progress made in achieving emission reduction commitments.

Chapter 7 establishes a national implementation strategy for achieving energy saving target. It also provides a review of global best practices for scaling up energy efficiency. It also covers a review of international energy efficiency strategies such as that of U.K., Canada, Australia, Japan and South Africa.

National Strategy Plan for Energy Efficiency: By Numbers



Establishing India's current energy supply and demand

Effective strategy formulation in the energy sector relies on rigorous analysis of available, accurate, reliable and comprehensive data. The baseline year for this assignment is assumed to be FY 2016-17 and the energy data for this year has been streamlined. The total energy supply and demand in the country as of FY 2016-17 is estimated to be 815.0 and 540.8 Mtoe respectively.

Particulars	Supply (Mtoe)	Demand (Mtoe)
Primary energy incl. electricity	815.0	540.8
Electricity	123.2	91.7

The primary energy and electricity demand in FY 2016-17 for various sectors in the country is estimated below:

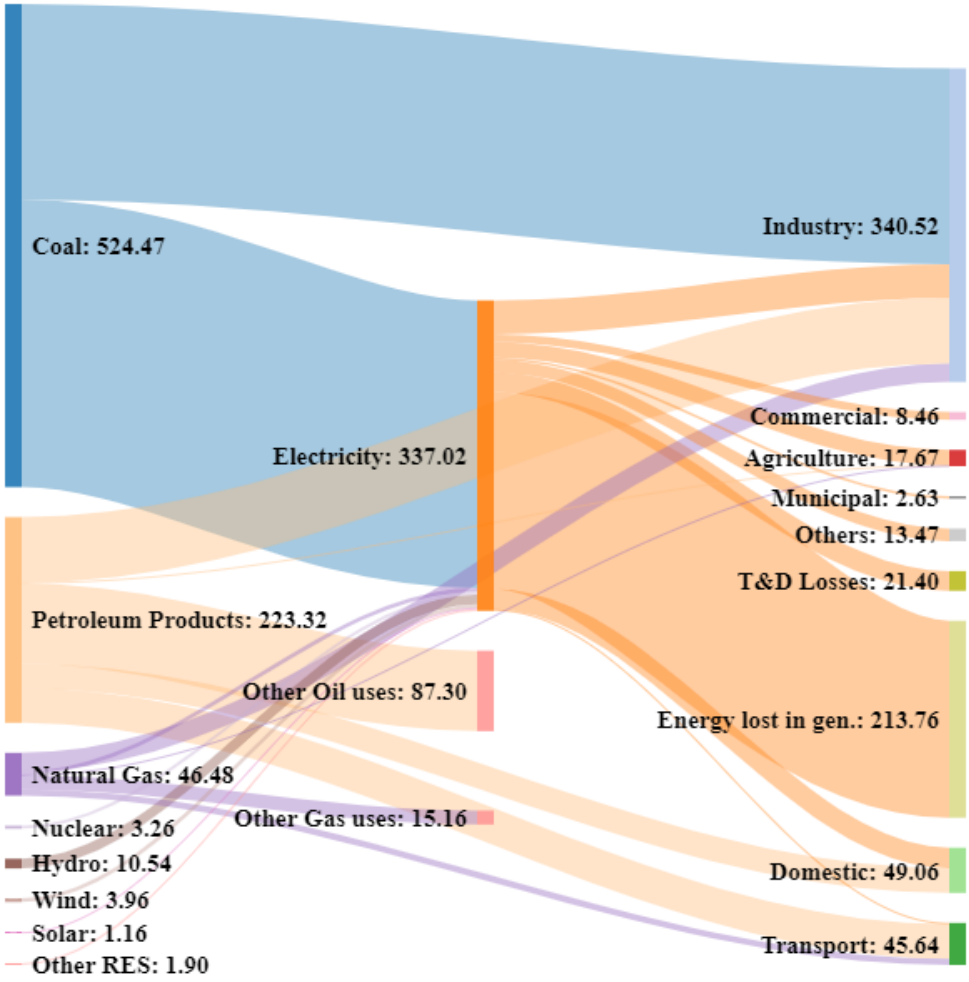
Mtoe (2016-17)	Domestic	Commercial	Industry	Municipal	Transport	Agri.	Others	Total
Primary energy excl. electricity	26.8	0.0	303.8	0.0	44.1	0.9[1]	73.6	**449.1**
Electricity	22.3	8.5	36.7	2.6	1.5	16.8	3.3	**91.7**
Total energy	49.1	8.5	340.4	2.6	45.6	17.7	76.9	**540.8**

The coverage of current energy supply and demand data across country, state and sector includes:

	National	State	Sector
Primary energy supply	✓	NA	✓
Primary energy demand	✓	✓	✓
Electricity supply	✓	✓	✓
Electricity demand	✓	✓	✓

The energy balance of India for energy supply and demand for FY 2016-17 is established (the supply and demand numbers are in Mtoe).

[1] The primary energy demand of the agricultural sector in 2017 is sourced from Energy Statistics 2018, MOSPI. However, using the bottom-up approach of analysis, the primary energy demand of the agricultural sector in 2017 is estimated to be 12.2 mtoe (primarily sue to diesel consumption in pumps).



While establishing the energy data, multiple data sources were referred which consisted of data gaps. Some of the data gaps included inconsistencies in reporting from various ministries, non-reporting of state level primary energy data, delay in data reporting and lack of standardized definitions. The unavailability of primary energy demand at the state level is a shortcoming in the energy data reporting practice. There are two proposed institutional solutions to overcome this barrier:

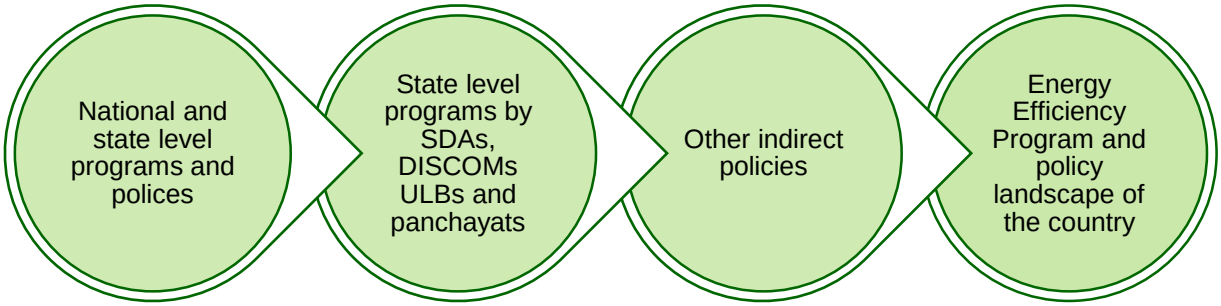
- Setting up of a nodal agency responsible for data dissemination of primary energy at the state and national level whose role would be to enhance coordination among agencies
- Strengthening of the already existing agency (MOSPI) responsible for data reporting of primary energy at the national level

Some other recommendations on effective energy data management (EDM) includes:

- Improve technology and statistical methods for data collection and management
- Systematic data quality checking to ensure data consistencies
- Maintaining commonality in standardization
- Improved data dissemination in user-friendly formats

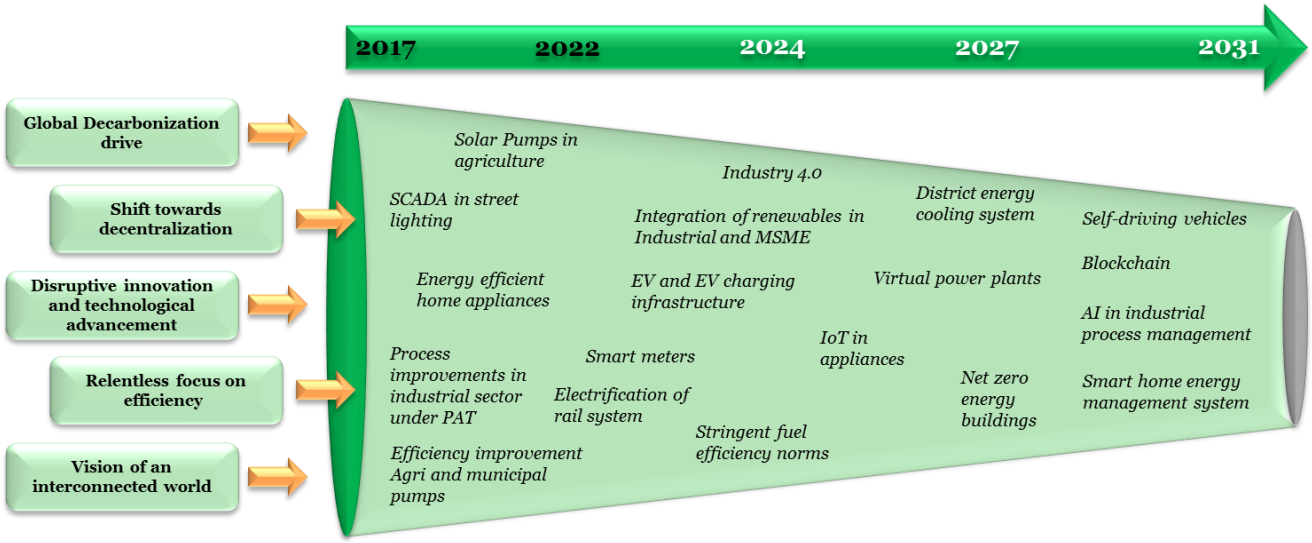
Mapping of Energy Efficiency Programs and Policy Landscape

The current policy and program implementation landscape of the country shapes the energy consumption of the demand sectors. Taking cognizance of the importance of mapping the programs and policies in the country and their potential impact on the sources of energy in a demand sector, the chapter presents a complete overview of the government initiatives, direct and indirect, that have been undertaken to address the issue of energy efficiency and move towards an energy sufficient economy. Apart from the national programs, the implementation of some of these programs at the state level, which are being carried out by the State Designated Agencies (SDAs), DISCOMs and municipalities have also been outlined.



Future Technological Advancements impacting energy consumption

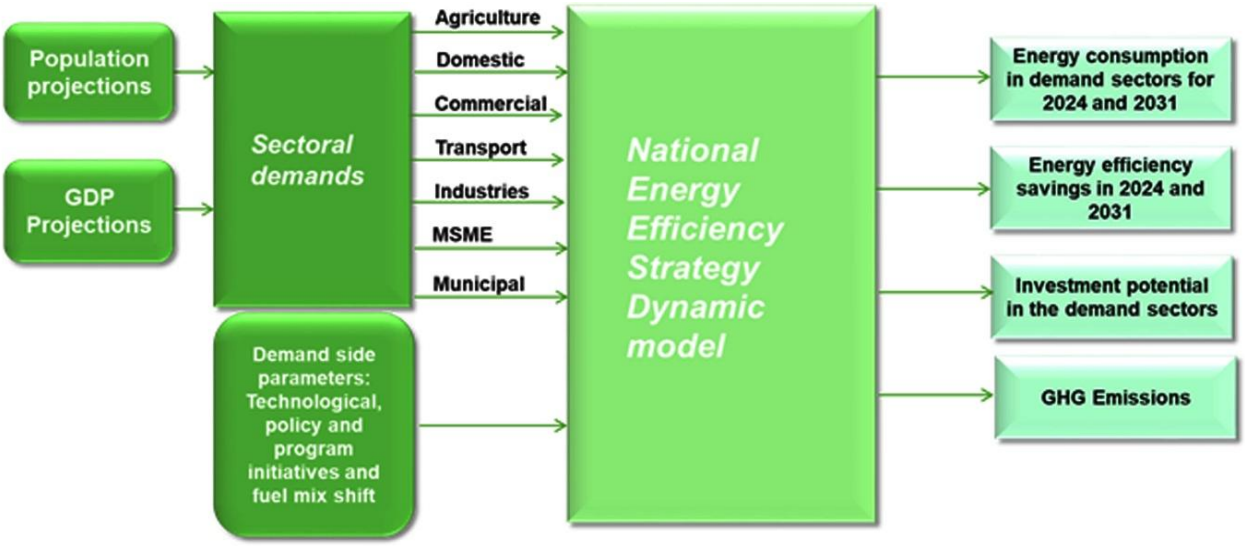
Energy underpins every aspect of modern life, driving economic growth and prosperity and as a result has a direct link to people's standard of living. The emerging technological innovations are creating new opportunities for progress of energy efficiency. It is creating exciting new opportunities for integrated solutions where efficiency and renewable energy work together to deliver clean energy outcomes at the lowest cost. The future technologies that would impact energy consumption in each of the demand sectors is explored.



Some of the key future technologies/initiatives such as Electric Vehicles, Smart Meters, Blockchain, Integration of RE in industries and de-carbonization of industrial process are analyzed for their applications, impact on energy consumption, policy landscape, challenges in their uptake and recommendations for their promotion.

Estimation of Energy Efficiency potential

The role of energy efficiency would be crucial in complying by India's emission intensity reduction targets. The principal step towards estimation of energy saving target is the forecast of energy consumption under various scenarios. The forecast of energy consumption of the country for various demand sectors has been estimated in this chapter, the methodology of which is illustrated below:



The three scenarios developed for energy consumption forecast includes these major assumptions:

Assumptions by 2031	Technological Improvement & penetration	Policy/ program/ scheme initiatives	Change in Fuel mix
Scenario 1: Least effort	Current technological improvements and penetration	Current implementation of programs	Current fuel mix
Scenario 2: Medium effort	Moderate technological improvements and technology penetration as per govt./other agencies target	Successful achievement of program targets	Moderate fuel mix shift from fossil fuel to RE/ electricity based consumption
Scenario 3: High effort	Ambitious technological improvements and penetration over govt./other agencies target	New programs or overachievement of existing programs	Ambitious fuel mix shift towards RE based consumption in sector

The energy saving potential of the country is estimated to be 86.9 Mtoe by year 2031 with the highest saving potential in Industrial sector (in the Moderate Savings Scenario).

	Energy Consumption (Mtoe) – 2031		
Sectors	**Least Effort Scenario**	**Medium Effort Scenario**	**High Effort Scenario**
Agriculture	64.4	58.7	54.5
Commercial	29.5	24.5	23.1
Domestic	98.6	86.5	83.5
Municipal	8.0	7.0	6.4
Industrial	443.4	396.0	371.2
Transport	232.9	217.2	209.1
Total	**876.8**	**789.9**	**747.8**

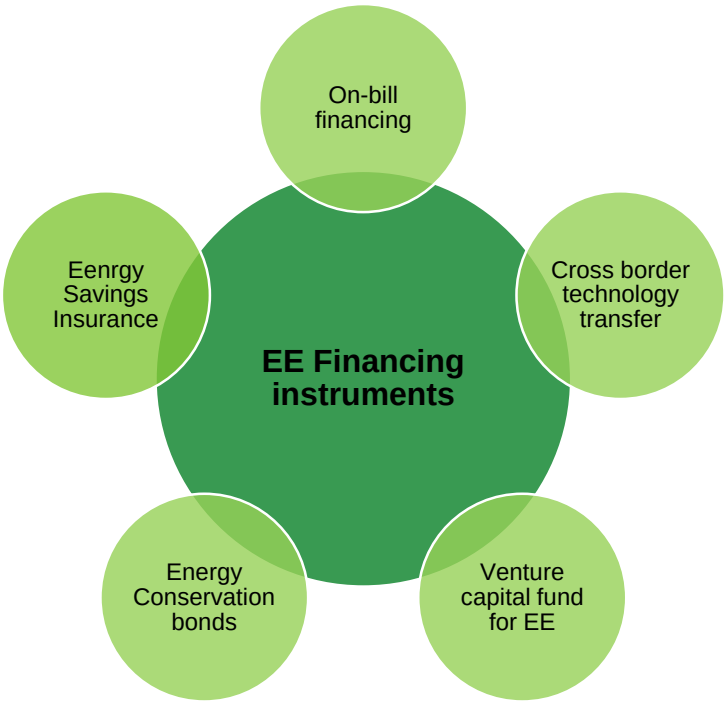
Sectors	Energy Savings (Mtoe) – 2031			
	Moderate Savings Scenario		Ambitious Savings Scenario	
	Mtoe	%	Mtoe	%
Agriculture	5.7	9%	9.9	15%
Commercial	4.9	17%	6.4	22%
Domestic	12.1	12%	15.1	15%
Municipal	0.9	12%	1.5	19%
Industrial	47.5	11%	72.3	16%
Transport	15.8	7%	23.8	10%
Total	**86.9**	**10%**	**129.0**	**15%**

Estimation of Energy Savings Investment Potential and Analysis of Financing Instruments

The energy saving investment potential of the country is estimated to be 840,852 INR Cr. by the year 2031 under the moderate savings scenario, with the industrial sector constituting highest energy saving investment potential.

Sectors	Energy Savings Investment by 2031 (INR Cr.) – Moderate Savings Scenario	Energy Savings Investment by 2031 (INR Cr.) – Ambitious Savings Scenario
Agriculture	91,467	158,229
Commercial	81,154	105,701
Domestic	120,233	145,133
Municipal	14.822	24,159
Industrial	307,137	463,729
Transport	226,039	365,706
Total	**840,852**	**1,262,656**

Various financing instruments such as the ones currently existing in India and across the world are explored based on their applicability and limitations. Five financing instruments are found to be highly suitable for Indian markets i.e., Energy Savings Insurance, On-bill Financing, Cross-Border Technology Transfer and Energy Efficiency Financing Facility, Venture Capital Fund for Energy Efficiency and Energy Conservation Bonds.



Target setting in line with India's SDG and NDC commitments

As per NDC commitments, a comparison of GHG emission and emission intensity reduction targets is established for different countries. European Union, USA and China are among the leading countries having achieved more than 40 percent emission reduction target by 2015. India has achieved 18% emission reduction target by 2015.

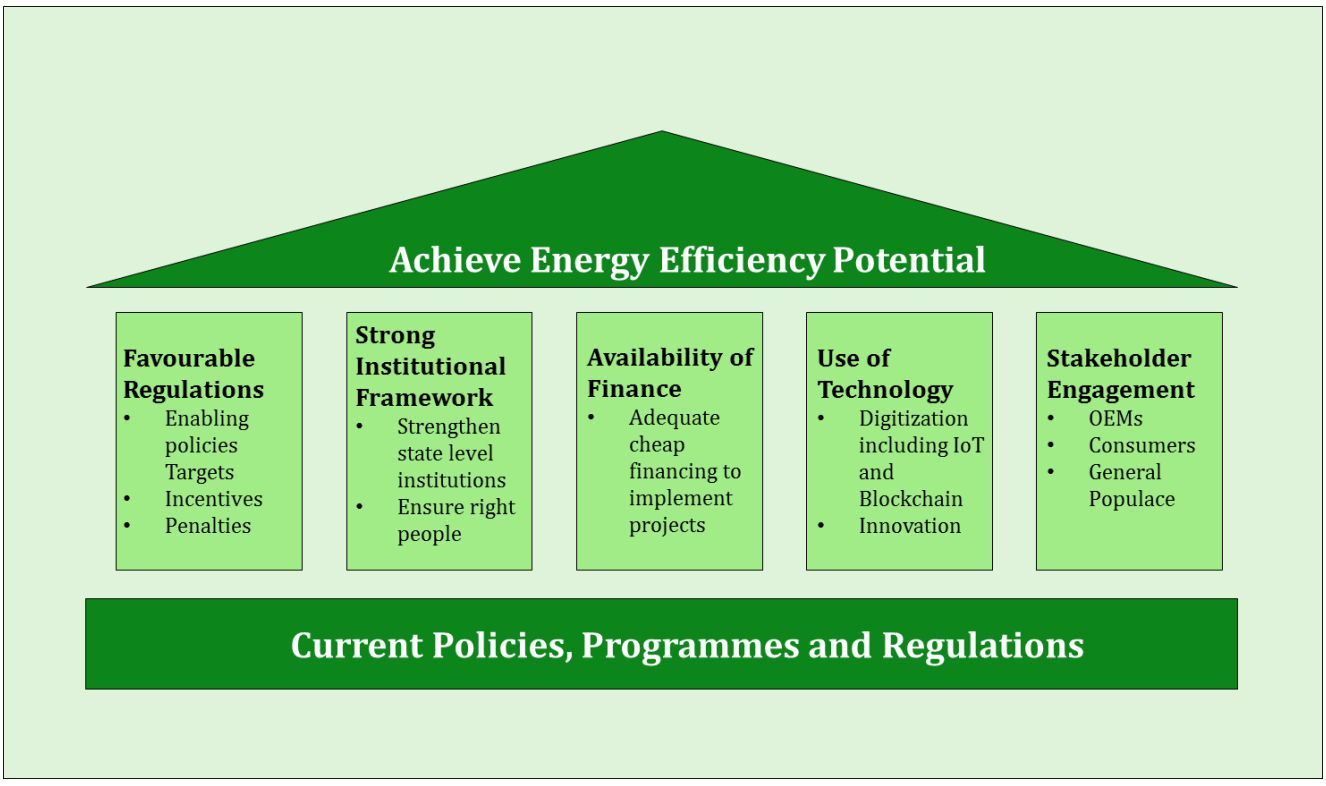
Country	Base Year	Target year	Target Type	Target reduction	Base year metric	Metric in 2015	Target to be achieved	% achieved
European Union (28) (MtCO2e)	1990	2030	GHG	40%	5400	4000	3240	64.81%
USA (MtCO2e)	2005	2025	GHG	28%	6600	5830	4752	41..66%
Russia (MtCO2e)	1990	2030	GHG	30%	3900	2130	2730	151.28%
China (Exchange rates – EI)	2005	2030	Intensity	65%	1.44	0.99	0.504	48.07%
India (Exchange rates - EI)	2005	2030	Intensity	35%	0.96	0.9	0.624	17.86%
Japan (MtCO2e)	2005	2030	GHG reduction	25.40%	1300	1200	969.8	30.28%

The target energy emissions in India for 2030, in absolute terms should be less than or equal to 6,807 MtCO2e. The achievement in emission intensity (energy and non-energy) reduction by 2030 is estimated to be 36%, under the moderate savings scenario, out of which the contribution of energy efficiency is 50%. Thus, it is deduced that India's NDC commitments would be met under Moderate scenario, which includes ongoing and future anticipated activities on energy efficiency.

Sectors	Moderate Emission Reductions (MtCO2e) -2030	Ambitious Emission Reductions (MtCO2e)-2030
Agriculture	14	34
Commercial	34	44
Domestic	101	134
Municipal	7	11
Industrial	185	238
Transport	97	141
Total Reduction due to EE	**438**	**623**
Overall Reduction (incl. RE)	**889**	**1053**
NDC target achievement	Yes (36% emission intensity reduction)	Yes (38% emission intensity reduction)

Implementation framework for National Strategic Plan for Energy Efficiency

The strategic context developed to achieve the desired energy efficiency savings as mentioned above, hinges on five key pillars.



The strategy formulation for each demand sector is viewed through the prism of these five pillars. The interplay between them and the existing regulations and policies will pave the way for a robust energy efficiency framework in the country. The strategies formulated for each sector and their conformance with each of the strategy pillars mentioned above is shown below:

Strategy	Elements				
	Favorable Regulations	Institutional Framework	Finance	Use of Technology	Stakeholder Engagement
Agriculture					
Greater co-ordination among stakeholders including integration with water conservation efforts	✓	✓		✓	✓
Integrate Energy Efficiency in Agriculture Studies				✓	✓
Cheaper finance for energy efficient equipment		✓	✓		
Research and Development				✓	
Mandating Energy Efficient Technology Standards and Guidelines	✓			✓	✓
IoT in Agriculture: Moving towards smart farming practices				✓	✓
Buildings					
Development of codes for residential buildings and simplified codes for commercial buildings with lower connected load	✓	✓			
Mandatory implementation of ECBC in states	✓	✓			✓
Integration of EE in Government housing schemes and cheaper financing for EE houses	✓	✓	✓		✓
Synergy between BEE, IGBC and GRIHA rating system	✓	✓			✓
Automated Building Management Systems in higher connected load				✓	✓

Strategy	Elements				
commercial buildings					
Promoting EE technologies in High rise residential buildings				✓	✓
Industry					
Creating a National Energy Efficiency Repository with benchmarks		✓			✓
Increasing the width and depth of the PAT programme including a voluntary component	✓	✓			✓
Creation of a unified carbon reduction programme	✓	✓	✓		✓
Mandatory energy management cell with certified Energy Manager/Energy Auditor for all medium and large scale industries		✓			✓
Central Monitoring of all funded programs in the MSME		✓	✓		✓
Promoting use of energy efficient equipment among MSME units				✓	✓
Promoting industry 4.0 technologies				✓	✓
Transport					
Integrated transport planning with Mandate to support movement towards EE transportation	✓	✓		✓	✓
Promoting shared last mile connectivity solutions				✓	✓
Legislation to improve ease of doing business for new business models	✓				

Strategy	Elements				
Increase CAFÉ standards	✓	✓		✓	
Stakeholder Engagement		✓			✓
Cross-sectoral					
Considering DSM as a resource in IRP	✓	✓	✓		✓
Capacity Building of DISCOMs		✓			✓
Mandatory use of Smart Meters		✓		✓	
Increased consumer engagement		✓			✓
Framework to introduce Time of Day Tariffs			✓	✓	✓
Increasing the scope of existing programs with stricter enforcement and penalties	✓	✓	✓		✓
Institutional Framework for Data Collection		✓			✓
State wise Targets	✓	✓	✓		
Independent SDAs and Building Capacity of SDAs		✓	✓		✓
Funding for Laboratories			✓		✓
State Specific stakeholder engagement programmes		✓			✓
Integration of harmonic products in S&L	✓	✓	✓	✓	✓
Additional cess on import of inefficient equipment	✓		✓		
Voluntary Reward Programme for consumers	✓		✓		✓
Setting up of a committee of financial institutions at the state level		✓			✓

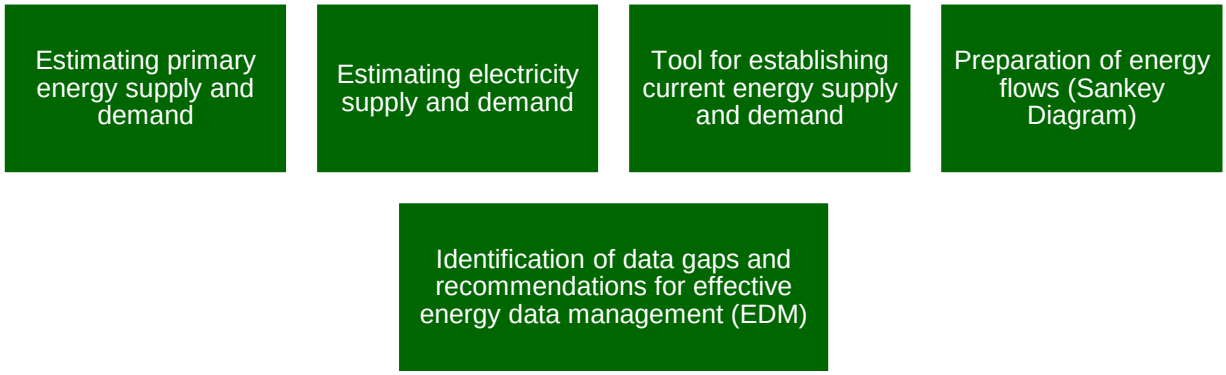
1

ESTABLISHING INDIA'S CURRENT ENERGY SUPPLY AND DEMAND

1.1. Introduction

A robust baseline energy data set is essential in analyzing and forecasting energy supply and demand scenarios of the country. The objective of this chapter to streamline the data from sectoral to the national level and bring consistency in data collection and analysis. The tasks consists of establishing current energy supply and demand of the country, both in terms of electricity and primary energy, broken down at the state and sectoral level. The energy data are also collated to form the energy balance of the country that represents the flow of various energy fuels (such as coal, gas, oil etc.) into different demand sectors (such as industry, agriculture etc.). While collecting data, it was identified that the data reporting practice across the ministries are inconsistent and the aggregation requires reference to multiple sources and documents. Such data inconsistencies and gaps are also reported along with recommendations for effective energy data management (EDM). The current (baseline) year has been assumed to FY 2016-17.

The following sections have been covered in this chapter:



The coverage of current energy supply and demand data across country, state and sector includes:

Table 1: Coverage of current supply and demand data

	National	State	Sector
Primary energy supply	✓	NA	✓
Primary energy demand	✓	✓	✓
Electricity supply	✓	✓	✓
Electricity demand	✓	✓	✓

Effective strategy formulation in the energy sector relies on rigorous analysis of available, accurate, reliable and comprehensive data

1.2. Primary Energy

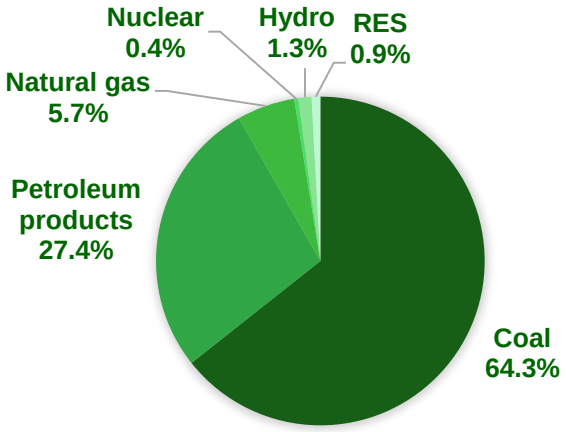
1.2.1. Primary energy supply

The total primary energy supply of the country for FY 2016-17 has been estimated to be 815.0[2] Mtoe based on the data collected from relevant nodal ministries of various fuel sources. Coal and oil are the major primary energy supply sources in India contributing to 64% and 27% of the primary energy supply respectively. The share of various fuels in the primary energy supply is represented below:

Table 2: Share of various sources in primary energy supply in FY 2016-17

Source	Energy (Mtoe)
Coal	524.5
Petroleum products	223.3
Natural Gas	46.5
Hydro	10.5
Nuclear	3.3
RES	7.0
Wind	4.0
Solar	1.2
Biomass	0.4
Small Hydro	0.7
Other RES (Bagasse + Waste to Gen)	0.9
Electricity import/export	(0.1)
Total	**815.0**

Figure 1: Share of various fuels in energy supply in FY 2016-17

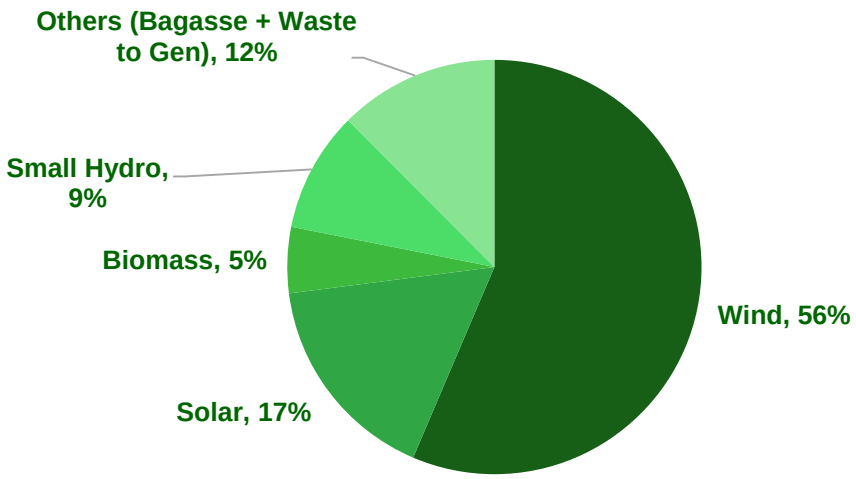


The energy mix in India is dominated by fossil fuels, as almost 97.4 % of the energy supply comes from coal, oil and natural gas. This share has gaining since the year 2000, as economic growth has fueled the demand in the industry and transport sector, while at the same time households have

[2] Data Sources: Ministry of coal (CCO), Ministry of Petroleum and Natural Gas (PPAC), Ministry of Power (CEA). Data of coal, petroleum products, nuclear, hydro and RES is provisional.

slowly moved away from the traditional uses of solid biomass in cooking and space heating to other fuels such as liquefied petroleum gas (LPG). The large consumption of petroleum products is explained by the dominance of road freight traffic in the country. Natural gas continues to play a minor role in the energy mix, where it is mainly used for power generation and feedstock, and fuel for the production of fertilizers (it also has a small share in the residential and the transport sector).

Figure 2: Share of various fuels in RES supply in FY 2016-17



Wind energy, with a share of 56%, has the maximum contribution from the RES supply, followed by solar (17%) and small hydro (9%). The share for RES would increase further in the future, keeping in mind the government's target of 227 GW of generation capacity by 2022, revised from the earlier target of 175 GW.

The state-wise segregation of primary energy supply has not been covered due to insufficient data availability.

1.2.2. Primary energy demand

The total energy demand by various sectors for FY 2016-17 is estimated to be 540.9[3] million toe. Balance of primary energy was lost in process of power generation, power transmission & distribution, auxiliary consumption (at power plants), in losses (and internal use) at refineries and natural gas processing terminals and also represented by stock difference of coal and other usages.

[3] Energy Statistics 2018 (Ministry of Statistics and Program implementation), Annual Report 2017-18 (Ministry of coal) and TEDDY 2016-17.

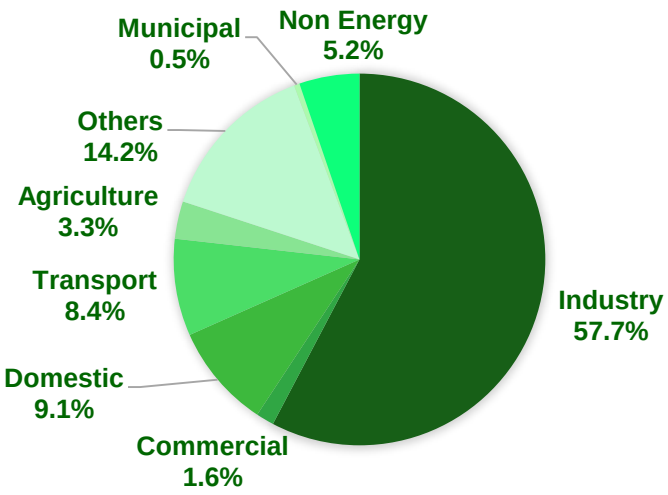
Table 3: Share of various sectors in primary energy demand in FY 2016-17

Sector	Energy (Mtoe)
Industry	312.2
Transport	45.6
Residential	49.1
Commercial	8.5
Agriculture	17.7
Others	76.9
Non-Energy - Industry	28.3
Municipal	2.6
Total	**540.9**

The industrial sector continues to be the highest consumer of primary energy, with a share of 57.7 %. Industrial energy demand has almost doubled over the last 15 years, with large-expansion in energy-intensive sectors like Iron and steel being one of the major drivers. The residential (domestic) sector comes in at second, with a consumption of 49.1 Mtoe. The energy demand in the domestic sector has been on the rise since the late 2000s, with increasing demand for appliance ownership, especially of fans and televisions in urban and rural areas, and an increase in refrigerators and air-conditioners in urban areas.

The transport sector, with a consumption of 45.6 Mtoe is heavily dominated by road transport, which accounts for nearly 90% of passenger and almost two-thirds of freight movement. Rail transport fuel use is still dominated by diesel, but electrification efforts continue, with the government planning to completely electrify the rail network by 2022.

Figure 3: Share of various sectors in primary energy demand in FY 2016-17



The state-wise segregation of primary energy consumption data is not reported by any of the ministries. In order to segregate the national primary energy demand into states, the State Gross Domestic Product (SGDP) is used. The rationale behind adoption of this methodology is the fact that the primary energy consumption of a state is also based on the economic activities by sectors. The methodology is illustrated below:

Niti Aayog releases a document reporting State Gross Domestic Product (SGDP) by economic activity for all the states[4]. The economic activities includes manufacturing, construction, agriculture, forestry etc. The economic activities are converted into demand sectors i.e., industrial, municipal, commercial etc. using assumed weightages. The state GDP is then calculated for the demand sectors and the proportion of each demand sector in a state is calculated. Similarly, once the national demand for a demand sector is established, the division into states is done based on the SGDP.

The expected outcomes from the methodology for state–wise segregation of primary energy are:

- Segregation of total primary energy into states
- Segregating the consumption by various demand sectors in a state

[4] SGDP Data, NITI Aayog

Table 4: State-wise primary energy consumption in sectors in FY 2016-17

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Miscellaneous	Total P.E. (Coal, Gas, Oil)	Electricity	Total
NORTHERN REGION										
Chandigarh	0.07	-	0.23	-	0.04	0.00	0.06	0.40	0.15	0.55
Delhi	1.75	-	7.88	-	1.22	0.00	1.91	12.76	2.54	15.30
Haryana	1.06	-	10.97	-	1.62	0.03	2.66	16.34	3.70	20.04
Himachal Pradesh	0.18	-	3.67	-	0.29	0.01	0.89	5.04	0.91	5.94
Jammu & Kashmir	0.20	-	1.77	-	0.49	0.01	0.43	2.89	0.72	3.62
Punjab	0.50	-	7.03	-	1.18	0.04	1.70	10.46	4.31	14.78
Rajasthan	1.05	-	14.63	-	2.39	0.06	3.54	21.67	5.24	26.91
Uttar Pradesh	2.18	-	19.37	-	4.47	0.11	4.69	30.82	7.29	38.11
Uttarakhand	0.19	-	6.97	-	0.28	0.01	1.69	9.13	1.16	10.29
Sub-Total(NR)	**7.16**	**0.00**	**72.53**	**0.00**	**11.98**	**0.26**	**17.57**	**109.50**	**26.03**	**135.53**
WESTERN REGION										
Chhattisgarh	0.38	-	7.78	-	0.51	0.01	1.89	10.57	2.03	12.60
Gujarat	1.03	-	36.43	-	1.57	0.06	8.83	47.93	8.80	56.73
Madhya Pradesh	0.57	-	9.09	-	2.23	0.08	2.20	14.17	4.74	18.91
Maharashtra	4.46	-	53.99	-	4.91	0.08	13.08	76.51	12.14	88.65
Daman & Diu	-	-	-	-	-	-	-	0.00	0.21	0.21
D & N Haveli	-	-	-	-	-	-	-	0.00	0.68	0.68

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Miscellaneous	Total P.E. (Coal, Gas, Oil)	Electricity	Total
Goa	0.08	-	1.93	-	0.10	0.00	0.47	2.58	0.39	2.97
Sub-Total(WR)	**6.51**	**0.00**	**109.23**	**0.00**	**9.32**	**0.23**	**26.46**	**151.76**	**28.99**	**180.75**
SOUTHERN REGION										
Andhra Pradesh	0.87	-	10.19	-	3.21	0.07	2.47	16.81	4.71	21.53
Telangana	1.39	-	10.63	-	2.11	0.03	2.58	16.74	4.33	21.07
Karnataka	3.47	-	18.89	-	2.99	0.04	4.58	29.98	5.99	35.97
Kerala	1.28	-	9.08	-	2.11	0.02	2.20	14.69	2.02	16.71
Tamil Nadu	2.77	-	25.10	-	3.17	0.05	6.08	37.16	8.61	45.77
Puducherry	0.05	-	0.85	-	0.04	0.00	0.21	1.15	0.28	1.43
Lakhshadweep	-	-	-	-	-	-	-	0.00	0.00	0.00
Sub-Total(SR)	**9.83**	**0.00**	**74.73**	**0.00**	**13.64**	**0.22**	**18.11**	**116.53**	**25.95**	**142.48**
EASTERN REGION										
Bihar	0.59	-	4.85	-	1.54	0.03	1.17	8.18	1.33	9.51
Jharkhand	0.27	-	6.80	-	0.79	0.01	1.65	9.51	2.03	11.54
Odisha	0.42	-	9.73	-	1.19	0.02	2.36	13.72	1.72	15.44
West Bengal	1.49	-	18.10	-	4.59	0.05	4.38	28.61	4.57	33.18
Sikkim	0.02	-	0.80	-	0.03	0.00	0.19	1.04	0.04	1.08
A & N Islands	-	-	-	-	-	-	-	0.00	0.02	0.02

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Miscellaneous	Total P.E. (Coal, Gas, Oil)	Electricity	Total
Sub-Total(ER)	**2.80**	**0.00**	**40.27**	**0.00**	**8.14**	**0.11**	**9.76**	**61.08**	**9.70**	**70.78**
NORTH EASTERN REGION										
Arunachal Pradesh	0.02	-	0.32	-	0.05	0.00	0.08	0.47	0.04	0.51
Assam	0.29	-	4.82	-	0.72	0.02	1.17	7.02	0.64	7.66
Manipur	0.03	-	0.19	-	0.05	0.00	0.05	0.32	0.05	0.37
Meghalaya	0.03	-	0.62	-	0.09	0.00	0.15	0.89	0.14	1.03
Mizoram	0.02	-	0.25	-	0.04	0.00	0.06	0.37	0.03	0.40
Nagaland	0.03	-	0.16	-	0.05	0.00	0.04	0.29	0.05	0.34
Tripura	0.04	-	0.62	-	0.06	0.00	0.15	0.87	0.08	0.95
Sub-Total(NER)	**0.45**	**0.00**	**6.99**	**0.00**	**1.06**	**0.03**	**1.69**	**10.23**	**1.03**	**11.25**
Total(All India)	**26.8**	**0.0**	**303.8**	**0.0**	**44.1**	**0.9**	**73.6**	**449.1**	**91.7**	**540.9**

In the northern region, the three states with the most primary energy consumption are Uttar Pradesh (38.11 Mtoe), Rajasthan (26.91 Mtoe) and Haryana (20.04 Mtoe). In the west, Maharashtra with an energy consumption of 88.65 Mtoe, Gujarat with 56.73 and Madhya Pradesh with 18.91 round off the top 3. Tamil Nadu, Andhra Pradesh and Telangana with primary energy consumption of 45.77 Mtoe, 21.53 Mtoe and 21.07 Mtoe are the three highest consuming states in the south. In the eastern region, West Bengal, Odisha and Jharkhand with consumptions of 33.18 Mtoe, 15.44 Mtoe and 11.54 Mtoe make the top three. The north-eastern states have a cumulative primary energy consumption of 11.25 Mtoe, with the major share coming from Assam, Meghalaya and Tripura, who have a consumption of 7.66 Mtoe, 1.03 Mtoe and 0.95 Mtoe.

1.3. Electricity

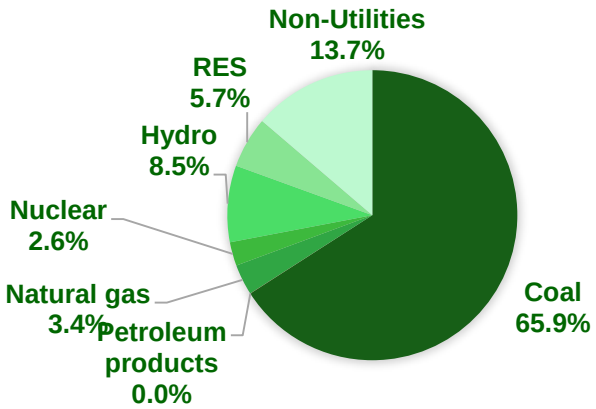
1.3.1. Electricity supply

The total electricity generation for FY 2016-17 was estimated to be 1433.2[5] BU or 123.2 Mtoe. The share of various fuel sources is mentioned in the table below:

Table 5: Share of various fuels in electricity generation in FY 2016-17

Type of fuel	Electricity (TWh)
Coal	944.8
Petroleum products	0.2
Natural gas	49.1
Nuclear	37.9
Hydro	122.2
RES	81.9
Electricity export	0.0
Non-Utilities	197.0
Total	**1433.2**

Figure 4: Share of various fuels in electricity generation in FY 2016-17



Coal accounts for the highest share in electricity generation with 66% of the share, followed by hydro (8.5 %) and Renewable Energy Sources (RES) with 5.7% of the share. The share for RES has been gaining over the years, with total utility scale of solar and wind installed capacity having reached 58 GW in September 2018. Solar and Wind individually stood at 24 GW and 34 GW respectively[6]. Although the Indian renewable market has performed exceptionally over the past couple of years,

[5] Includes electricity generation by non-utilities and net import/export. Data source: Ministry of Power, CEA, All India Statistics, General Review 2017

[6] Bridge To India (Oct 2018), https://bridgetoindia.com/renewable-energy-going-through-a-period-of-peaks-and-troughs/

issues like safeguard duty imposition and ceiling on bid tariffs are challenges that still plague the sector.

The state-wise electricity generation data is demonstrated below:

Table 6: State-wise electricity generation by fuel in FY 2016-17 (in GWh)

State	Hydro	Thermal			Nuclear	RES	Total
		Steam	Diesel	Gas			
NORTHERN REGION							
Chandigarh	0	0	0	0	0	4	4
Delhi	0	3774	0	3684	0	161	7618
Haryana	3674	22606	0	199	0	1672	28150
Himachal Pradesh	9066	0	0	0	0	2392	11458
Jammu & Kashmir	4408	0	0	0	0	379	4787
Punjab	9389	28403	0	199	0	1835	39826
Rajasthan	3530	48616	0	1972	0	8455	62573
Uttar Pradesh	961	51548	0	0	0	4037	56547
Uttarakhand	6932	825	0	0	0	875	8632
Central Sector NR	35523	70534	0	6828	12011	0	124896
Sub Total (NR)	**73482**	**226305**	**0**	**12882**	**12011**	**19810**	**344491**
WESTERN REGION							
Chhattisgarh	326	45299	0	0	0	1597	47222
Gujarat	1138	77987	0	10817	0	9961	99902
Madhya Pradesh	3302	42225	0	0	0	3622	49149
Maharashtra	5457	105653	0	4236	0	13388	128734
Daman & Diu	0	0	0	0	0	5	5
D. & N. Haveli	0	0	0	0	0	0	0
Goa	0	0	0	0	0	0	0
Central Sector WR	2953	83856	0	3550	12584	0	102943
Sub Total (WR)	**13177**	**355019**	**0**	**18603**	**12584**	**28574**	**427957**
SOUTHERN REGION							
Andhra Pradesh	1118	39631	0	5767	0	3866	50383
Telangana	1528	15937	0	0	0	1299	18765
Karnataka	7437	34193	0	0	0	12522	54152

State	Hydro	Thermal			Nuclear	RES	Total
Kerela	6416	0	73	0	0	770	7260
Tamil Nadu	4511	36486	38	2784	0	11614	55432
Puducherry	0	0	0	237	0	0	237
Lakshadweep	0	0	25	0	0	1	26
Central Sector SR	0	67391	0	149	13321	0	80861
Sub Total (SR)	**21010**	**193639**	**137**	**8937**	**13321**	**30072**	**267116**
EASTERN REGION							
Bihar	0	0	0	0	0	205	205
D.V.C.	178	36999	0	0	0	0	37177
Jharkhand	52	9156	0	0	0	25	9232
Odisha	4614	25005	0	0	0	564	30183
West Bengal	1504	34362	0	0	0	2149	38014
Sikkim	501	0	0	0	0	52	553
A &N. Islands	0	0	139	0	0	23	162
Central Sector ER	3619	64252	0	0	0	0	67871
Sub Total (ER)	**10467**	**169774**	**139**	**0**	**0**	**3018**	**183398**
NORTH EASTERN REGION							
Arunachal Pradesh	0	0	0	0	0	23	23
Assam	412	0	0	1516	0	121	2049
Manipur	0	0	0	0	0	0	0
Meghalaya	868	0	0	0	0	82	950
Mizoram	0	0	0	0	0	34	34
Nagaland	0	0	0	0	0	110	110
Tripura	0	0	0	770	0	23	793
Central Sector NER	2961	124	0	6385	0	0	9470
Sub Total (NER)	**4241**	**124**	**0**	**8672**	**0**	**394**	**13431**
Central Sector All India	**47334**	**317950**	**0**	**19974**	**37916**	**0**	**386041**
Total All India	**122378**	**944861**	**275**	**49094**	**37916**	**81869**	**1236392**
Net Import/Export							**196889**
Total Energy Available in the country							**1433281**

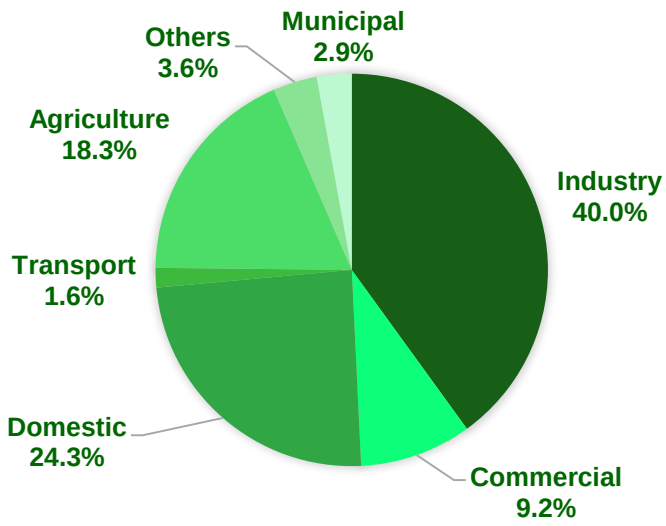
1.3.2. Electricity demand

The total electricity generation for FY 2016-17 is estimated to be 1066[5]BU or 91.7 Mtoe. Industrial sector is the major consumer of the electricity and it represented about 40% of the total demand, followed by domestic (24.3%) and agriculture sector (18.3%).

Table 7: Share of various sectors in electricity consumption of FY 2016-17

Sector	Electricity (TWh)
Industry	426.7
Commercial	98.4
Domestic	259.3
Transport	17.2
Agriculture	195.5
Others	38.7
Municipal	30.6
Total	**1066.5**

Figure 5: Share of various sectors in electricity consumption of FY 2016-17



The industrial sector continues to be the largest consumer of electricity in the country, with a consumption of 36.60 Mtoe that accounts for close to 40% of the total demand. The domestic sector, as mentioned in the previous section, has been riding the wave of increasing demand on the account of a prospering economy that has increased the spending power of the middle class and increased the sale of white goods like refrigerators and air conditioners. The electricity consumption in the agriculture sector is mainly due to the usage of electric pumps, which account for close to 90% of the agriculture pumps used in the country. The share is expected to decrease in the future, with the government launching the ambitious Kisan Urja Suraksha Evam Utthaan Mahabhiyan (KUSUM) scheme, where the government aims to install 27.5 lakh solar pumps (17.5 lakh stand-alone and 10 lakh grid connected).

The state-wise electricity consumption data is demonstrated below:

Table 8: State-wise primary energy consumption in sectors in FY 2016-17 (in GWh)

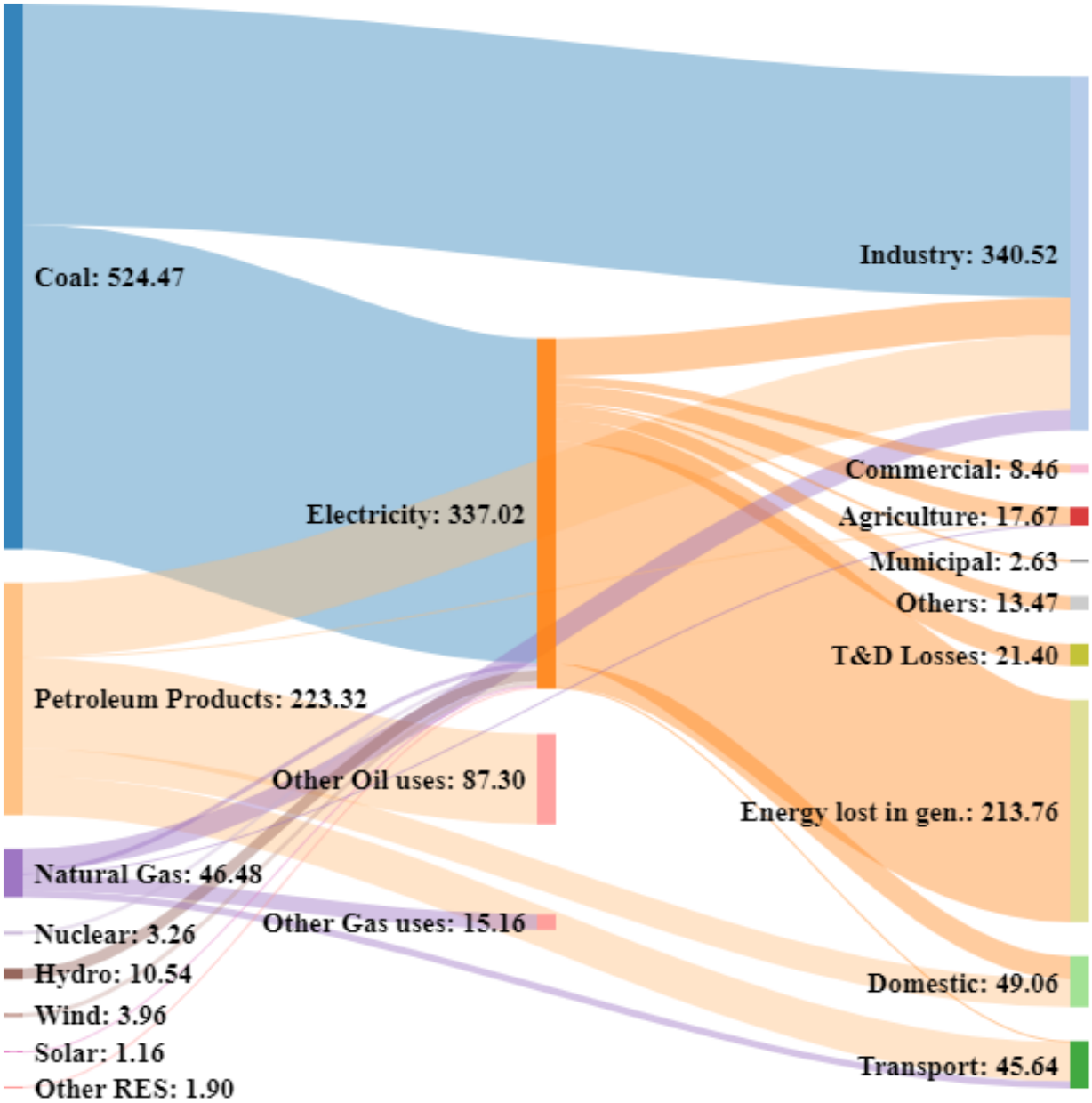
State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Miscellaneous	Total Elec. (Mtoe)
NORTHERN REGION								
Chandigarh	713	525	401	26	0	2	98	1765
Delhi	13927	8038	4682	1076	540	33	1248	29545
Haryana	7545	4179	15007	897	336	10732	4286	42983
Himachal Pradesh	2109	716	6877	589	0	58	199	10548
Jammu & Kashmir	3179	1043	2077	660	0	344	1120	8423
Punjab	12877	3903	18758	673	171	12999	792	50173
Rajasthan	11475	4646	19216	2335	158	22543	599	60972
Uttar Pradesh	30701	5851	25043	2648	1713	14305	4530	84792
Uttarakhand	2596	1279	8148	413	15	159	896	13507
Sub-Total(NR)	**85122**	**30180**	**100210**	**9318**	**2933**	**61176**	**13768**	**302708**
WESTERN REGION								
Chhattisgarh	5415	1353	10712	373	924	4544	315	23635
Gujarat	14526	4984	65809	2236	808	12649	1287	102299
Madhya Pradesh	11908	3099	14336	1695	1998	21301	805	55143
Maharashtra	30323	15861	51122	4496	2589	32058	4756	141206
Daman & Diu	96	57	2291	11	0	3	8	2466
D & N Haveli	107	33	6904	12	0	10	889	7954
Goa	1097	401	2931	5	0	20	51	4506
Sub-Total(WR)	**63472**	**25787**	**154105**	**8828**	**6319**	**70586**	**8112**	**337209**
SOUTHERN REGION								
Andhra Pradesh	12480	2794	21959	846	1411	12385	2944	54819
Telangana	10793	5533	17095	1120	601	13538	1632	50311
Karnataka	12284	7014	23659	3614	257	21810	1070	69708

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Miscellaneous	Total Elec. (Mtoe)
Kerala	10934	4708	6165	621	229	325	475	23456
Tamil Nadu	25982	10799	45008	3774	866	13038	697	100164
Puducherry	712	213	2162	87	0	62	47	3283
Lakhshadweep	37	12	0	1	0	0	0	50
Sub-Total(SR)	**73222**	**31072**	**116049**	**10063**	**3363**	**61157**	**6864**	**301791**
EASTERN REGION								
Bihar	5940	1302	3048	105	589	389	4092	15464
Jharkhand	4543	590	16758	262	1325	111	0	23588
Odisha	6755	1657	9048	234	1112	300	874	19979
West Bengal	14626	6200	23862	1418	1581	1721	3689	53096
Sikkim	140	68	202	5	0	0	29	445
A & N Islands	136	71	23	7	0	0	38	274
Sub-Total(ER)	**32139**	**9887**	**52941**	**2031**	**4607**	**2520**	**8721**	**112847**
NORTH EASTERN REGION								
Arunachal Pradesh	178	44	132	14	0	0	81	449
Assam	3383	1031	2215	87	0	38	663	7418
Manipur	324	46	36	22	0	2	102	532
Meghalaya	459	105	917	40	0	0	133	1654
Mizoram	236	43	14	59	0	0	21	373
Nagaland	356	74	81	16	0	0	100	627
Tripura	478	86	64	125	0	38	117	908
Sub-Total(NER)	**5415**	**1428**	**3459**	**363**	**0**	**79**	**1217**	**11961**
Total(All India)	**259371**	**98356**	**426764**	**30603**	**17221**	**195518**	**38683**	**1066516**

1.4. Energy Flow (Sankey Diagram)

The primary energy and electricity data that has been established for FY 2016-17 can be used to form the energy flow of the country that represents the flow of various energy fuels (such as coal, gas, oil etc.) into different demand sectors (such as industry, agriculture etc.). In order to do the same, a Sankey diagram is created. A Sankey diagram is a graphic illustration of flows - like energy where they can be combined, split and traced through a series of events or stages. The width of each stream represents the amount of material or energy in the flow.

Figure 6: Sankey Diagram of energy supply and demand for FY 2016-17 (in Mtoe)



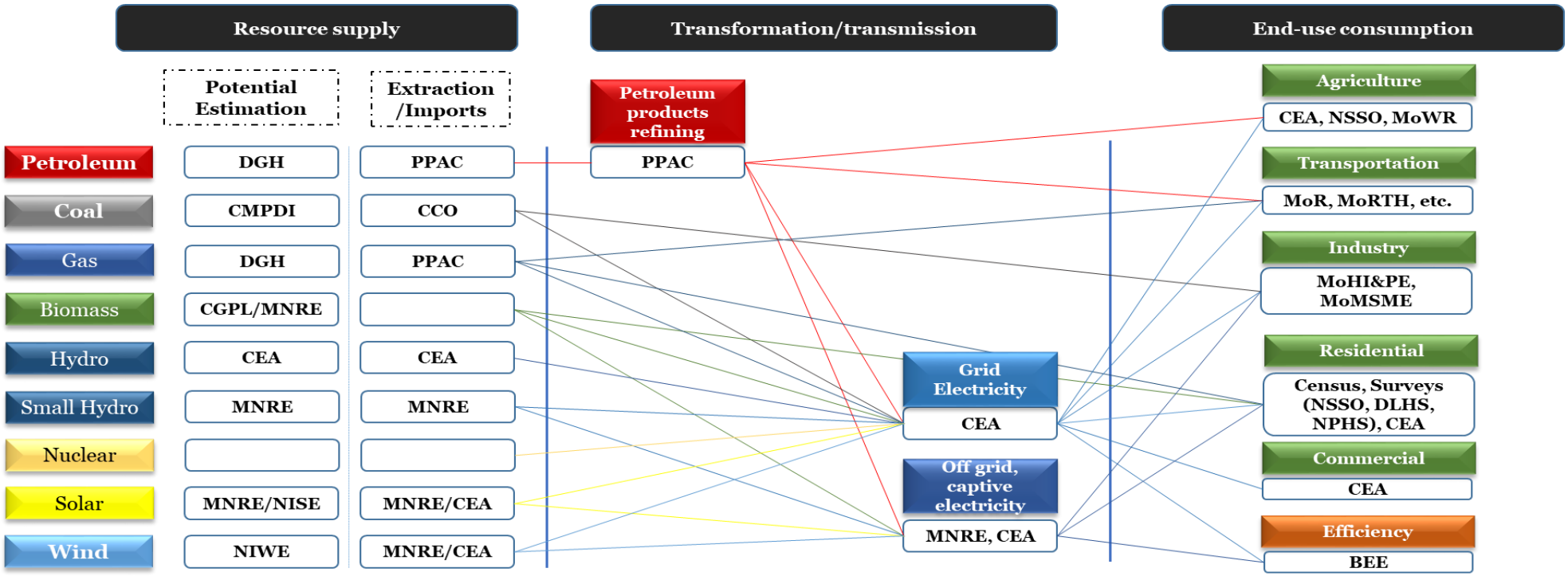
1.5. Data gaps and recommendations on effective Energy Data Management (EDM)

1.5.1. Organization of India's Energy Management Data

As data collection in India is carried out by multiple agencies, co-ordination among these organizations can be challenging with each entity operating within its own standard operating procedure and jurisdiction. Efficiently managing energy data often hits a roadblock in the form of inconsistency in data compilation, use of different definitions and conversion factors across organizations and existence of data gaps. India's energy data management is fairly decentralized as shown in the figure below[7]:

[7] An Assessment of Energy Data Management in India (Oct 2014), Prayas (Energy Group)

Figure 7: India's energy data management structure



Institutions involved in the management of India's energy data fall into three groups: first, there are energy-related line ministries and their subordinate agencies or offices. These include the Ministry of Power (Central Electricity Authority and Bureau of Energy Efficiency), the Ministry of Coal (Coal Controller's Organization), the Ministry of Petroleum and Natural Gas (Petroleum Planning and Analysis Cell, the Directorate General of Hydrocarbons and Petroleum Conservation Research Association), the Ministry of New and Renewable Energy, and line ministries dealing with major energy consuming sectors such as agriculture, industry and transport. Second, India has statistical agencies such as the Ministry of Statistics and Program Implementation (MoSPI) and state-level Directorates of Economics and Statistics. The third group consists of the planning institutions like the National Institution for Transforming India (NITI Aayog) and various state level planning departments. There is an absence of a central institute with the responsibility of collecting, analyzing and dissemination of the national energy data.

1.5.2. Identification of data gaps

While establishing the energy demand and supply for the baseline year, the analysis relied on multiple data sources available on the public domain and published by various ministries and institutions that consisted of data gaps. A summary of the data gaps identified during data collection exercise is presented below:

Table 9: Identified data gaps in primary energy reporting

Energy Source	Data Sources	Data Source	Data Gap
Coal	Coal Controller Organization (CCO), Ministry of Coal	**Supply:** • Annual production and dispatch of raw coal and lignite • Annual import and export • Projected production target for CIL (Coal India Limited) till 2021 **Consumption:** • Sector wise offtake of total available coal State wise and within state, sector wise offtake of raw coal and lignite	**Consumption:** • State and sector wise offtake of imported coal • Production projections unavailable for 2027
Oil and Natural Gas	Petroleum planning and analysis cell (PPAC), Ministry of Petroleum and natural gas, Directorate General of Hydrocarbons (DGH)	**Supply:** • Domestic crude production (ONGC (Oil and Natural Gas Corporation), OIL (Oil India Ltd.), JV (Joint Ventures)) • Import of crude • Import and export of petroleum products • Reserve Replacement Ratio (RRR) data available for overall production • Data available for drilling done in specific basins for Shale Gas/Oil • Only policy framework mentioned for underground coal gasification **Consumption:** • State wise sales of petroleum products • Sector wise break up of consumption (national level) is available for about 64% of the total consumption	**Supply** • Recovery factor and replacement factor for In-place oil and gas reserves • Company wise Reserve Replacement Ratio (RRR) missing • Proposed E&P data on Underground Coal gasification unavailable • Proposed commencement of Shale Gas production not specified **Consumption:** • Sector wise consumption of petroleum products at state level • Complete sector wise consumption at national level
Bioenergy	Ministry of New and Renewable Energy (MNRE)	-	Non-reporting of biofuel and biogas energy supply and consumption in sectors

Table 10: Identified data gaps in electricity supply reporting

Energy Source	Data Sources	Data Available	Data Gaps
Nuclear	Central Electricity Authority (CEA), Nuclear Power Corporation of India Limited (NPCIL)	Generation and capacity factor	Data mismatch of nuclear generation and capacity factor
Solar	Ministry of New and Renewable Energy (MNRE), CEA		• Non-reporting of installed CSP (Concentrated Solar Power) plants in the annual reports • No segregation of generation of solar from Solar photo voltaic and CSP • Non-reporting of penetration of Conc. Solar Thermal (in residential and commercial sector) • Data mismatch of SPV (Solar photo voltaic) capacity addition YoY • Data mismatch of YoY off-grid capacity addition
Wind	MNRE, CEA, National Institute of Wind Energy (NIWE)		• Data mismatch with respect to installed wind capacity

Table 11: Identified data gaps in demand sectors data reporting

Sector	Data Source	Data Available	Data Gap
MSME	-	Cluster level energy consumption data estimated based on survey of sample units **Source:** Cluster profile report of over 90 clusters prepared under BEE and other bilateral and multilateral agency funded project	Data regarding actual energy consumption is not available on public domain for national and state level
Domestic	CEA for electricity MOSPI for other fuels such LPG, PNG, Kerosene PPAC, Ministry of Petroleum and natural gas	General review, 2017, CEA provides national level and state level electricity consumption in domestic sector Energy statistics 2018 (MOSPI), provides consumption of fuels at national level	No data available in public domain for fuel consumption such as LPG, PNG, Kerosene at state level
Industries	DC's (Designated Consumers) under PAT (Perform,	**PAT Data:** Baseline data for 109 nos. DCs (72 industries and 37	Data for year 2016-17 is not available for DC's covered in PAT cycle 2 and 3

Sector	Data Source	Data Available	Data Gap
	Achieve and Trade), BEE	commercial buildings) of PAT cycle – 4 is available for 2016-17	No energy consumption data available in public domain regarding non-DC's (not covered in PAT) industries at national and state level
Municipal	CEA for electricity	General review, 2017, CEA provides national level and state level electricity	State level data on solar street lights, solar pumps etc.
Agriculture	CEA for electricity MOSPI for other fuels such diesel etc.	General review, 2017, CEA provides national level and state level electricity. Energy statistics 2018 (MOSPI), provides consumption of fuels at national level	No data available in public domain for fuel consumption at state level
Commercial	CEA for electricity	General review, 2017, CEA provides national level and state level electricity	No data available in public domain for fuel consumption such as diesel, NG and other fuels at national and state level
Transport	MOSPI	Energy statistics 2018 (MOSPI), provides consumption of fuels and electricity at national level. National and state level sales data of various vehicle categories	No data available in public domain for fuel and electricity consumption at state level

1.5.3. Stakeholder Consultation

The data gaps and inconsistencies were encountered while designing the dynamic model for the National Energy Efficiency Strategy and in order to address the data gaps, stakeholder consultations were conducted with concerned officials of the ministries and agencies identified below:

- Coal Controller's Organization (CCO)
- Petroleum Planning and Analysis Cell (PPAC)
- Ministry of Micro, Small and Medium Enterprises (MoMSME)
- Ministry of Statistics and Programme Implementation (MOSPI)
- Ministry of Statistics and Programme Implementation (MOSPI) – Annual Survey of Industries
- Department of Heavy Industries (DHI), Ministry of Heavy Industries and Public Enterprises
- Central Electricity Authority (CEA)

1.5.4. Recommendations on effective energy data management (EDM)

As shown above, the energy data management in India is decentralized, mirroring the existing political and administrative structure in the country. Some of the identified data gaps include: inconsistencies in reporting from various ministries, delay in data reporting and ambiguity in use of conversion factors by different agencies while reporting energy consumption data In addition to that, there is no agency in the country at present that captures the primary energy supply and demand data in the country at the state level for each demand sector. The following are some of the recommendations suggested that could fill the gaps in energy reporting in the country:

Setting up of a nodal agency: It is pertinent that an empowered agency should be set up that not only collects data from various sources, but also reconciles it and ensures smooth data management

Improved technology and statistical methods: Automation in data collection and management should be explored as an option, which includes automated metering, online data submission and interactive data dissemination. This would improve accuracy and completeness in data collection as well as facilitate the collection of primary data for energy supply and demand at the state level, which is not reported by any agency in the

Systematic data quality checking: Quality assurance mechanisms make it possible for agencies to carry out systematic quality checks. Quality assurance needs to be conducted at multiple stages of energy data management

Maintaining commonality in standardization: A common code of standardized definitions and classifications should be followed. Principles and codes of practices from the U.N. Statistical Commissions could be adopted in India.

Improved data dissemination: It is also important to disseminate data in convenient, user-friendly and easy-to-access formats. High degree of data integration, uniform data maintaining standards, end-user oriented data formats and increasing usage of modern technology would be required to achieve this.

2

MAPPING OF ENERGY EFFICIENCY PROGRAMS AND POLICY LANDSCAPE

2.1. Introduction

The objective of this chapter is to undertake a comprehensive mapping of energy efficiency programs so as to align the National Strategic Plan for Energy Efficiency with various other cross cutting instruments which impact (or are impacted by) energy efficiency scenarios in the country. There are several programs initiated at the national, state and sectoral levels to achieve the goal of energy efficiency and improving availability of key services in India. The macro level impact of each of these programs is tabulated in order to assess the impact generated by the initiative. The existing policies and programs have been considered while projecting the future energy demand and supply across sectors and fuel types respectively.

The impact of the implementation of various national level policies and programs have also been captured at the state level, especially the activities that are being carried out by the state designated agencies (SDAs), municipalities and DISCOMs. The village/panchayat level programs as well as other indirect policies like Montreal protocol and the Kigali meeting have also been included in this chapter.

A broad overview of the major activities undertaken under the scope of this task have been mentioned below:

Multiple domestic programs governing various demand sectors have been reviewed that govern the energy efficiency sector in India and these programs have shaped the initiatives taken to conserve energy and reduce the energy intensity of the country. A broad summary of the initiatives taken by various ministries is presented in the next page:

Table 12: Summary of Key policies and programs in India

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
1	Ministry of Power (MoP)	Agricultural and Municipal Demand Side Management (AgDSM and MuDSM)	Bureau of Energy Efficiency (BEE)	• Reduce the energy intensity of agriculture pumping sector (AgDSM) and municipal pumping sector (MuDSM) by carrying out efficiency up gradation of pump sets.	• Implementation of pilot projects in Andhra Pradesh and Karnataka with expected energy savings to the tune of over 5.6 MU and 21.3 MU respectively under the AgDSM scheme in the 12th five year plan. • Countrywide more than 1.5 million LED Street lights have been deployed which has helped realize 51.47 MW of avoided power capacity under the MuDSM scheme in the 12th five year plan.
2	Ministry of Power (MoP)	Perform, Achieve and Trade (PAT)	Bureau of Energy Efficiency (BEE)	• A regulatory instrument to reduce specific energy consumption in energy intensive industries, with an associated market based mechanism to enhance the cost effectiveness through certification of excess energy saving which can be traded.	• For PAT Cycle-I, The achievement in respect of 427 DCs was 8.67 MTOE, around 1.25% of total primary energy supply of India) which was over achievement of around 30 percent. This energy saving also translates in to a coal savings of 20 million tonnes and about 31 million tonne of CO2 emission reduction (1.93% of India's total CO2 emission). • PAT in its second cycle seeks to achieve an overall energy

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
					consumption reduction of 8.869 MTOE for which energy reduction targets have been assigned and notified to DCs in these 11 sectors (eight existing sectors and three new sectors). This energy savings will translate in to avoiding of about another 30 million tonnes of CO2
3	Ministry of Power (MoP)	Capacity building of DISCOMs	Bureau of Energy Efficiency (BEE)	• The objective of the program is capacity building of DISCOMs for carrying out load management program, development of DSM action plan and implementation of DSM activities in their respective areas.	• DSM Cell were established in all of the 34 DISCOMs post signing of the MoU to work as a dedicated unit for various activities associated with DSM
4	Ministry of Power (MoP)	Energy efficiency and technology up gradation in SMEs	Bureau of Energy Efficiency (BEE)	• Driving nationwide awareness and capacity building programs in MSMEs • Development of tool kits, manuals and guidelines for large scale replicable EE technologies • Identifying synergies among different financing schemes and mechanisms for MSMEs • Redesigning the program documentation requirements • Design of demand aggregation based ESCO models to MSME sector • Developing Standardized M&V Techniques	• Under the 12th Plan, BEE undertook various measures to overcome the barriers and challenges identified in the 11th Plan. 63 units out of the 100 industry units agreed to implement the EE measures and adopt energy efficiency technologies. • It is notable that the M&V of the verified units has yielded Energy Savings of about 275 toe per annum, Cost Savings of about INR 1.2 crore per annum

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
					and GHG reductions of about 750 tCO2 per annum.
5	Ministry of Power (MoP)	Standard and Labelling	Bureau of Energy Efficiency (BEE)	• A key objective of this scheme is to provide the consumer an informed choice about the energy saving and thereby the cost saving potential of the relevant marketed product. The scheme targets display of energy performance labels on high energy end use equipment & appliances and lays down minimum energy performance standards	• Over the last five years, concerted efforts of BEE under its Standards & Labelling program have led to an avoided generation capacity addition of 22990 MW
6	Ministry of Power (MoP)	Energy Conservation Building Codes (ECBC)	Bureau of Energy Efficiency (BEE)	• The ECBC sets minimum performance standards for building envelope, which includes roof and windows, lighting systems, air conditioning system, electrical distribution system and water heating and pumping system.	• Presently, 10 States namely, Andhra Pradesh, Haryana, Karnataka, Kerala, Union Territory (UT) of Puducherry, Punjab, Rajasthan, Telangana, Uttarakhand and West Bengal have notified ECBC for their states. 20 others states are at advance stages of adopting the ECBC.
7	Ministry of Environment, Forest and Climate	ECOMARK labelling scheme[8]	Bureau of Indian Standards (BIS)	• To provide an incentive for manufacturers and importers to reduce adverse environmental impact of products.	

[8] ECOMARK scheme in India (2012), International Journal of Pharma Medicine and Biological Sciences

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
	Change (MoEFCC)			• To reward genuine initiatives by companies to reduce adverse environmental impact of their products. • To assist consumers to become environmentally responsible in their daily lives by providing information to take account of environmental factors in their purchase decisions. • Ultimately to improve the quality of the environment and to encourage the sustainable management of resources.	
8		National Mission on Enhanced Energy Efficiency (under NAPCC)	Bureau of Energy Efficiency	• NMEEE aims to strengthen the market for energy efficiency through implementation of innovative business models in the energy efficiency sector	-
9		National Solar Mission (under NAPCC)	Ministry of New and Renewable Energy	• The Mission will adopt a 3 - phase approach, Phase 1 (up to 2012 - 13), Phase 2 (2013 - 17) and Phase 3 (2017 - 22). The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level.	Achievements as of March 2017[9]: Grid Solar Power: 10602.83 MW Off-grid Solar application: 462.5 MW Solar water heating systems: 12 million sq. mt Conc. Solar thermal: 52448 sq. mt (35 MW)
10		National Mission on Sustainable Agriculture (under NAPCC)	Ministry of Agriculture and farmers welfare, Department of Agriculture Co-operation and Farmer's Welfare	• **Rain-fed Area Development (RAD):** RAD is the most important component of the Mission. This element intends to adopt an area-based approach for	1.02 lakh hectare covered under rain fed area development[10]

[9] Standing Committee on Energy (2016-17), Sixteen Lok Sabha, National Solar Mission – An Appraisal
[10] National Mission for Sustainable Agriculture, https://nmsa.dac.gov.in/RptActivityAchievement.aspx

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				development and conservation of natural resources along with farming systems. • **On-Farm Water Management (OFWM)** will focus primarily on enhancing water use efficiency by promoting efficient on-farm water management technologies and equipment, primarily like drip and sprinkler technologies, efficient water application and distribution system, secondary storage and drainage development. • **Soil Health Management (SHM):** The sole priority of this management system is on residue management, organic farming practices by ways of creating and linking soil fertility maps • Climate Change and Sustainable Agriculture Monitoring, Modelling and Networking (CCSAMMN)	
11	Ministry of Urban Development (MoUD)	Green Urban Mobility Scheme	Ministry of Urban Development	• Sustainable Urban Mobility: infrastructure for Bus based transport – depots, maintenance facilities, ITS etc. and Strategies for Urban Freight management • Sustainable vehicles and fuel: Shift to electric/hybrid vehicles for public transport and Shift to Non-fossil fuel for public transport projects	-
12	Ministry of	Smart Cities Mission	Ministry of Housing and Urban	• The objective of the mission is to	-

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
	Housing and Urban Affairs		Affairs	promote cities that cater core infrastructure and provide its citizens a decent quality of life, a clean and sustainable environment and application of 'Smart Solutions'	
13		Metro Rail Policy	Ministry of Housing and Urban Affairs	• To ensure that least cost mass transit mode is selected for public transport, the policy mandates Alternate Analysis, requiring evaluation of other modes of mass transit like BRTS (Bus Rapid Transit System), Light Rail Transit, Tramways, Metro Rail and Regional Rail in terms of demand, capacity, cost and ease of implementation.	-

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
14	Ministry of Housing and Urban Affairs, Ministry of Power	Municipal Energy Efficiency Program (MEEP)	Energy Efficiency Services Limited (EESL)	• Energy audit and energy consumption optimization are mandatory reforms under Atal Mission for Rejuvenation and Urban Transformation (AMRUT). Accordingly, the objective of the MEEP is to provide an overarching framework in order to facilitate engagement between Urban Local Bodies (ULBs) and State Governments/ UTs with EESL in the area of Energy Efficiency Program in Public Water Works & Sewerage Systems in 500 nos. of Indian cities. It is also desired that using the mandate and core competency of EESL, the preparation and implementation of projects in Municipal Energy Efficiency are fast-tracked.	-
15	Ministry of Petroleum and Natural Gas (MoPNG)	Pradhan Mantri Ujjwala Yojana (PMUY)	Ministry of Petroleum and Natural Gas (MoPNG)	• LPG connection is released in the name of adult woman of the BPL family, subject to the condition that no LPG connection exists in the name of any family member of the household. • The scheme covers the cash assistance up to Rs 1600/- for providing new LPG connection and this cash assistance is provided by the Central Government.	5.25 Crore LPG connections released under PMUY
16	Ministry of Road Transport and	Green Highways Policy	Green Highways Division, National Highway Authority of India (NHAI)	• Develop a systematic framework for Integrated Green Corridor Development	6,32,710 plants have been planted as of 2018-19 (Government agency: 273582, Private agency:

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
	Highways (MoRTH)			along National Highways • Build resilient ecosystem in the form of "Green Corridors" along National Highways for : Combating global warming and climate change effects, Optimum GHG sequestration, Ex situ conservation of native RET species of the region • Make Green Highways Mission self-sustained. • Develop unique green corridors with aesthetic appeal • Reduce the impacts of air, noise pollution and dust • Reduce soil erosion at embankment slopes	359128)[11]
17	Ministry of Micro, Small and Medium Enterprises (MoMSME)	Zero effect Zero Defect	Ministry of Micro, Small and Medium Enterprises (MoMSME)	• Develop an Ecosystem for Zero Defect Manufacturing in MSMEs. • Promote adaptation of Quality tools/systems and Energy Efficient manufacturing. • Enable MSMEs for manufacturing of quality products. • Encourage MSMEs to constantly upgrade their quality standards in products and processes. • Drive manufacturing with adoption of Zero Defect production processes and	-

[11] Green Highways Division (National Highways Authority of India), http://nationalgreenhighway.org/ongoing-national-highway-development-project

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				without impacting the environment. • Support “Make in India” campaign. • Develop professionals in the area of ZED manufacturing and certification.	
18		TEQUP	Ministry of Micro, Small and Medium Enterprises (MoMSME)	• Capacity Building of MSME Clusters for Energy Efficiency/Clean Development Interventions and other technologies mandated as per the global standards • Implementations of Energy Efficiency Units (EET) in MSME units • Setting up of Carbon Credit Aggregation Centers (CCA) for introducing and popularizing clean development mechanism (CDM) in MSME clusters • Encouraging MSMEs to acquire product certification/licenses from National/International bodies and adopt other technologies mandated as per the global standards	-
19		NMCP	Ministry of Micro, Small and Medium Enterprises (MoMSME)	• The objective of NMCP is to develop global competitiveness among Indian MSMEs. This program targets at enhancing the entire value chain of the MSME sector through the following components: promoting information technology and communication tools in MSME sector, design clinic schemes for MSMEs, marketing assistance and	-

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				technology up-gradation scheme for MSMEs, bar code under market development assistance scheme, etc.	
20	Ministry of Railways	Dedicated Freight Corridor (DFC) Program	Dedicated Freight Corridor Corporation of India Limited	• Reduce unit cost of transportation by speeding up freight train operations and higher productivity • Segregate freight infrastructure for focused approach on both passenger and freight business of railways • Introduction of high end technology & IT packaging of freight services • Increase rail share in freight market • Create additional rail infrastructure • Introduction of time tabled freight services and guaranteed transit time	Total length of Eastern DFC completed: 1318 km Total length of Western DFC completed: 1504 km
21	Ministry of Power (MoP)	24x7 Power for All	Ministry of Power (MoP)	• 24x7 - Power for All (24x7 PFA) is a Joint Initiative of Government of India (GoI) and State Governments with the objective to provide 24x7 power available to all households, industry, commercial businesses, public needs, any other electricity consuming entity and adequate power to agriculture farm holdings by FY 19	-
22	Ministry of Power (MoP)	Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)	Rural Electrification Corporation (REC)	• Under Saubhagya scheme, free electricity connections to all households (both APL and poor families) in rural areas and poor families in urban areas	35, 41,473 household connection released as of October 2018[12].

[12] Gram Swaraj Abhiyan (Household Electrification Dashboard), http://saubhagya.gov.in/dashboard/gsa

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				will be provided. There are around 4 Crore un-electrified households in the country and they are targeted for providing electricity connections by December 2018	
23	Ministry of Power (MoP)	Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY)	Rural Electrification Corporation (REC)	• Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) has been launched for the rural areas with the following components: (i) Separation of agriculture and non-agriculture feeders in the rural areas; (ii) Strengthening and augmentation of sub-transmission and distribution (ST&D) infrastructure in rural areas; (iii) Rural electrification. Under this scheme, a number of projects on renewable energy sources have been sanctioned	82% electrification achieved, 50% of which are metered[13].
24	Ministry of Power (MoP)	Street Lighting National Program (SLNP)	Energy Efficiency Services Limited (EESL)	• Mitigate climate change by implem1enting energy efficient LED based street lighting • Reduce energy consumption in lighting which helps DISCOMs to manage peak demand • Provide a sustainable service model that obviates the need for upfront capital investment as well as additional revenue expenditure to pay for procurement of LED lights	67 lakh street lights replaced resulting in decrease of 3.12 MtCO2e[14]

[13] Deendayal Upadhyaya Jyoti Yojana, http://www.ddugjy.gov.in/portal/index.jsp
[14] Streetlight National Programme Dashboard, https://slnp.eeslindia.org/

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				• Enhance municipal services at no upfront capital cost of municipalities	
25	Ministry of Heavy Industries and Public Enterprises	National Electric Mobility Mission Plan 2020 (NEMMP)	National Automotive Board	• Demand side incentives to facilitate acquisition of hybrid/electric vehicles • Promoting R&D in technology including battery technology, power electronics, motors, systems integration, battery management system, testing infrastructure, and ensuring industry participation in the same • Promoting charging infrastructure • Supply side incentives	0.22 million electric vehicles sold as of 2018[15]
26	Ministry of New and Renewable Energy (MNRE)	National Policy on Biofuels	National Biofuel Coordination Committee	• Reinforcing ongoing ethanol/biodiesel supplies through increasing domestic production • Setting up Second Generation (2G) bio refineries • Development of new feedstock for biofuels • Development of new technologies for conversion to biofuels. • Creating suitable environment for biofuels and its integration with the main fuels.	Currently the ethanol blending percentage in petrol is around 2.0% and biodiesel blending percentage in diesel is less than 0.1%
27		National Wind-Solar Hybrid Policy	Ministry of New and Renewable Energy (MNRE)	• To provide a framework for promotion of large grid connected wind-solar PV hybrid system for optimal and efficient utilization of transmission infrastructure	-

[15] FAME – India (National Mission on Electric Mobility), https://fame-india.gov.in/dashboard.aspx

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				and land, reducing the variability in renewable power generation and achieving better grid stability. • Policy also aims to encourage new technologies, methods and way outs involving combined operation of wind and solar PV plants	
28		National Biogas and Manure Management Program	Ministry of New and Renewable Energy (MNRE)	• To provide clean cooking fuel for kitchens, lighting and meeting other thermal and small power needs of farmers/dairy farmers/users including individual households • To provide biogas plant produced slurry (liquid/ semi-solid or dried) as an organic enriched bio-manure to help reduce use of chemical fertilizers such as Urea, linking biogas slurry with enrichment units • To help in combating and reduction in causes of climate change by preventing emissions of Green House Gases (GHG) such as carbon dioxide and methane into the atmosphere	49.6 lakh household size biogas plants have been installed since the inception of the National Biogas Program in the country.[16]
29		Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM)	Ministry of New and Renewable Energy (MNRE)	• Solarization of existing grid-connected agriculture pumps to make farmers independent of grid supply and also enable them to sell surplus solar power generated to DISCOM and get extra	-

[16] MNRE fixes annual target to launch 65,180 biogas plants (Mar 2018), https://www.business-standard.com/article/news-ani/mnre-fixes-annual-target-to-launch-65-180-biogas-plants-118032201423_1.html

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				income • Solarization of tube-wells and lift irrigation projects of Government sector • Installation of standalone off-grid solar water pumps to fulfill irrigation needs of farmers not connected to grid	
30		Atal Jyoti Yojana (AJAY)	Energy Efficiency Services Limited (EESL)	• The rural, semi-urban and urban areas that face less than 50% grid connectivity in Uttar Pradesh, Assam, Bihar, Jharkhand, and Odisha will be illuminated with solar LED street lights. These solar lights will be installed on major roads, markets, and public conveniences in remote areas to sustainably enhance the citizens' quality of life.	-
31		Unnat Chulha Abhiyan (UCA)	Ministry of New and Renewable Energy (MNRE)	• To develop and deploy improved biomass cook-stoves for providing cleaner cooking Energy solutions in rural, semi-urban and urban areas using biomass as fuel for cooking. • To mitigate drudgery of women and children using traditional Chulha for cooking. • To mitigate climate change by reducing the black carbon and other emissions resulting from burning biomass for cooking.	36,940 family type and 849 community type improved cook stoves have been distributed[17].

[17] Government making efforts to reduce dependence on traditional biomass cooking (Mar 2018), http://pib.nic.in/newsite/PrintRelease.aspx?relid=177870

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
32	Ministry of Shipping	Sagarmala	Ministry of Shipping	• Reducing cost of transporting domestic cargo through optimizing modal mix • Lowering logistics cost of bulk commodities by locating future industrial capacities near the coast • Improving export competitiveness by developing port proximate discrete manufacturing clusters • Optimizing time/cost of EXIM container movement	-
33	Ministry of Heavy Industries and Public Enterprises	National Auto Policy	Department of Heavy Industries	• To promote clean, safe, efficient and comfortable mobility for every person in the country, with a focus on environmental protection and affordability • To drive the R&D efforts in the automotive sector towards indigenous research, design and engineering in both automotive vehicles and components • To support the growth of the automotive industry in India and become one of the major contributors to the country's GDP and comprise a considerable proportion of the manufacturing sector GDP by 2026 • To scale-up exports to 30-40% of the overall output over the next decade and improve the brand recognition, competitiveness and technological	-

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				advancement of the Indian automotive industry across the world	
34	Ministry of Agriculture and Farmers welfare	National Innovations on Climate Resilient Agriculture (NICRA)	Indian Council of Agricultural Research (ICAR)	• To enhance the resilience of Indian agriculture to climatic variability and climate change through strategic research on adaptation and mitigation • To validate and demonstrate climate resilient technologies on farmers' fields • To strengthen the capacity of scientists and other stakeholders in climate resilient agriculture • To draw policy guidelines for wider scale adoption of resilience-enhancing technologies and options	• Existing best bet practices for climate resilience demonstrated in 150 vulnerable districts. • Selection of promising crop genotypes and livestock breeds with greater tolerance to climatic stress. • Infrastructure at key research institutes for climatic change research strengthened. • Adequately trained scientific man power to take up climate change research in the country and empowered farmers to cope with climate variability
35		On Field Water Management (OFWM)	Department of Agriculture Co-operation and Farmer's Welfare	• Increase the area under micro irrigation technologies to enhance water use efficiency in the country. • Increase productivity of crops and income of farmers through precision water management.	8.3 lakh ha of farmland under the ambit of the program[18].

[18] Agriculture Cooperation & Farmers Welfare, http://agricoop.gov.in/divisiontype/rainfed-farming-system/programs-schemes-new-initiatives

Sl. No.	Ministry	Policy/Program	Implementing Agency/Ministry	Objective(s) and components related to energy efficiency	Achievements
				• Promote micro irrigation technologies in water intensive/consuming crops like sugarcane, banana, cotton etc. and give adequate focus to extend coverage of field crops under micro irrigation technologies. • Make potential use of micro irrigation systems for promoting fertigation.	
36	Ministry of Textiles and Ministry of Power	SAATHI	Energy Efficiency Services Limited (EESL)	• The rural, semi-urban and urban areas that face less than 50% grid connectivity in Uttar Pradesh, Assam, Bihar, Jharkhand, and Odisha will be illuminated with solar LED street lights. These solar lights will be installed on major roads, markets, and public conveniences in remote areas to sustainably enhance the citizens' quality of life.	-

Key policies and programs mentioned above along with other programs are mentioned in the next section with the impact they have on demand sectors and sources of energy.

2.1.1. Review of national programs governing energy efficiency sector and their impact on each fuel and sector

The first step in reviewing the policies and programs includes outlining the impact the policy/program has/would have in certain sectors. The analysis then shifts to the impact on the source of energy due to the implementation of the program. The programs and policies covered thus far and their impacts are outlined in the section below:

Agricultural and Municipal Demand Side Management

Launch year: 2016

Implementing agency: Bureau of Energy Efficiency (BEE)

The Agriculture Demand Side Management (AgDSM) and Municipal Demand Side Management (MuDSM) schemes were initiated during the XI plan and are being implemented in many states presently. The objective of the program is to reduce the energy intensity of agriculture pumping sector (AgDSM) and municipal pumping sector (MuDSM) by carrying out efficiency up gradation of pump sets. Studies reveal that about 30%-40% energy savings is possible in by adoption of Energy Efficient Star Labelled Pump Sets.

Table 13: Impact of AgDSM and MuDSM on sectors

Sector	Subsector	Impact
Municipal and Gram Panchayat	Pumping	Replacement of pumps used for water supply and sewage will improve the energy efficiency of municipal bodies and gram Panchayats
Agriculture	Pumping	The replacement of agricultural pumps with control panels will improve the energy efficiency of the sector as well as provide farmers with good quality, star rated pumps.

Table 14: Impact of AgDSM and MuDSM on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Reduction in the consumption of Electricity

National Mission for Enhanced Energy Efficiency

Launch Year: 2008

Implementing agency: Bureau of Energy Efficiency (BEE)

National Mission for Enhanced Energy Efficiency (NMEEE) was formulated in the year 2008. A host of activities have been undertaken by the nodal implementation body Bureau of Energy Efficiency (BEE), Ministry of Power, categorized as four broad initiatives under the NMEEE[19]:

[19] National Mission for Enhanced Energy Efficiency, S.P. Garnaik, Bureau of Energy Efficiency

- **Perform, Achieve and Trade (PAT)** – a program mandated, market based mechanism designed to accelerate energy savings in energy intensive and large industries by incentivizing energy savings

- **Market Transformation for Energy Efficiency (MTEE)** – initiative to accelerate the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable

- **Energy Efficiency Financing Platform (EEFP)** – a platform to promote finances for energy efficiency projects in all sectors by capturing future energy savings

- **Framework for Energy Efficient Economic Development (FEEED)** – a framework for developing fiscal instruments to promote energy efficiency

Table 15: Impact of NMEEE on sectors

Sector	Subsector	Impact
Domestic	Lighting and Appliances	Bachat Lamp Yojana contributed as a catalyst in market transformation from a CFL market size of 180 million in 2008 to 400 million in 2012, while directly contributing about 15% towards this total growth in CFL market. The experience gained under BLY II for development of the technical specifications has been made available by BEE to support organizations like EESL (Energy Efficiency Services Limited), and REC in framing LED specifications as well as their LED distribution programs as well as to government department/ministries like MeitY (Ministry of Electronics and Information Technology) for their program interventions and incentive programs, investment approvals etc. in LED based lighting products.
Industries	Heavy	Will result in lower energy consumption and adoption of efficient technologies of production

Table 16: Impact of NMEEE on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Reduction in the consumption of Electricity

EEFP and FEEED have had a **cross sectoral impact** as the schemes focus on financing energy efficiency activities/ESCOs (Energy Service Company). The impacts of the schemes have been:-

- **Capacity building of FIs (Financial Institutions) and ESCOs / EE Project Developers**: The outcomes achieved under EEFP (including MoUs with FIs, development of training material, training / capacity building activities etc.) have collectively contributed towards developing the capacity at the participating banks and FIs. There have been similar efforts through other IDA (International Development Association) funded projects supported by BEE and SIDBI (Small Industries Development Bank of India) for training and capacity building of FIs.

- Platform for interaction among EE Financing Stakeholders (Banks, NBFCs (Non-banking financial corporations), ESCOs, EE Project Developers and Consumers): The MoUs signed

with FIs result in an incremental addition in the level of commitment from the respective FIs towards efforts to promote EE Financing. This includes participation of relevant officials from these FIs in various training and capacity building initiatives.

- **Operationalization of PRGFEE and Potential De-risking of EE Financing Portfolio:** Partial Risk Guarantee Fund for Energy Efficiency **(**PRGFEE) is a risk sharing mechanism to provide FIs (banks/NBFCs) with a partial coverage of risk involved in extending loans for EE projects. Under PRGFEE, the support has been provided to government buildings, private buildings (commercial or multi-storey residential buildings), municipalities, SMEs and industries.

24x7 Power for All

Launch Year: 2017

Implementing Agency/Ministry: Ministry of Power (MoP)

24x7 - Power for All (24x7 PFA) is a Joint Initiative of Government of India (GoI) and State Governments with the objective to provide 24x7 power available to all households, industry, commercial businesses, public needs, any other electricity consuming entity and adequate power to agriculture farm holdings by FY 19[20]

The program aims to achieve 100% electrification of the country as well as improve the energy efficiency of the states and increase renewable energy. In states that have already achieved 100% electrification, it focuses on improving the quality of power.

Table 17: Impact of 24x7 Power for All on sectors

Sector	Subsector	Impact
Domestic	Lighting and Appliances	Power penetration to the households will result in an increase in sales of lighting and appliances.
Industries	Large Industries & MSMEs	Access to quality power will boost the industrial growth and development. It will lower the dependence on backup power of Industries
Commercial	Buildings	Electrification and Supply of quality power to buildings will provide better work environment and will reduce dependence on backup power.
Municipal and Gram Panchayat	Cross Sectoral	Increase in reliability of water and power supply will improve the functions of municipalities
	Lighting	Electrification will increase the reliability of street lighting
Agriculture	Pumping	24x7 power will reduce the dependence of farmers on intermittent power for irrigation.

Table 18: Impact of 24x7 Power for All on sources of energy

Source of energy	Impact on Energy Consumption

[20] Rural Electrification Corporation (REC), http://www.recindia.nic.in/

Source of energy	Impact on Energy Consumption
Electricity	Increase in the consumption of electricity
Solar Power	Increase in consumption of solar is envisaged in the plan

Pradhan Mantri Sahaj Bijli Har Ghar Yojana–SAUBHAGYA

Launch Year: 2017

Implementing Agency/Ministry: Rural Electrification Corporation (REC)

Under Saubhagya scheme, free electricity connections to all households (both APL and poor families) in rural areas and poor families in urban areas will be provided. There are around 4 Crore un-electrified households in the country and they are targeted for providing electricity connections by December 2018.

Table 19: Impact of Saubhagya scheme on sectors

Sector	Subsector	Impact
Domestic	Appliances	The scheme aims to reach all un-electrified households. The appliances which would be covered are battery banks, LED lights, fans and power plugs, smart meters etc.

Table 20: Impact of Saubhagya scheme on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of Electricity
Solar Power	Households in remote areas will be provided with Solar Photovoltaic (PV) standalone system. Increased solar energy penetration.

Pradhan Mantri Ujjwala Yojana (PMUY)

Launch Year: 2016

Implementing agency: Ministry of Petroleum and Natural gas

This Scheme is for provision of clean cooking fuel to rural households. Under this scheme, 5.25 Cr LPG connections have been provided to BPL (Below Poverty Line) families with a support of Rs.1600 per connection[21].

Table 21: Impact of Pradhan Mantri Ujjwala Yojana on sectors

Sector	Subsector	Impact
Domestic	Cooking	Use of clean fuel for cooking as well as increase in the sale of accessories for cooking like stoves, cylinders, hose, and regulators

[21] Pradhan Mantri Ujjawala Yojana (PMUY), http://www.pmujjwalayojana.com/

Table 22: Impact of Pradhan Mantri Ujjwala Yojana on sources of energy

Source of energy	Impact on Energy Consumption
LPG	Increase in the consumption of LPG

National Electric Mobility Mission Plan 2020 (NEMMP)

Launch Year: 2013

Implementing Agency: Ministry of Heavy Industries & Public Enterprises

Launched by Department of Heavy Industries in 2013 with the aim of promoting Electric and Hybrid Vehicles. The NEMMP provided the vision and the roadmap for faster adoption of xEVs (Electric and Hybrid Vehicles). As a part of the mission, DHI has formulated the scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME). The scheme had 4 focus areas[22] i.e., technology development, demand creation, pilot projects and charging infrastructure.

Table 23: Impact of NEMMP on sectors

Sector	Subsector	Impact
Transport	Vehicular	The government has incentivized changing to Electric Vehicles by providing subsidies and supporting pilot projects

Table 24: Impact of NEEMP on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity for charging electric vehicles
Petrol	Reduction in consumption of petrol due to switch to electric vehicles
Diesel	Reduction in consumption of diesel due to switch to electric vehicles

Metro Rail Policy 2017

Launch Year: 2017

Implementing agency: Ministry of Housing and Urban Affairs

The Metro Rail Policy sets out guidelines and business models available for setting up metro rail networks in cities. The policy presents an opportunity for private investments across a range of metro operations making PPP component mandatory for availing central assistance for new metro projects. This policy will help set up metro rail networks in cities across India[23].

Table 25: Impact of Metro Rail Policy 2017 on sectors

Sector	Subsector	Impact
Transport	Vehicular	The metro rail network will improve usage of public transport

[22] National Electric Mobility Mission Plan (NEMMP) 2020 (Aug 2012), DHI
[23] Metro Rail Policy – 2017, MoHUA

Table 26: Impact of Metro Rail Policy 2017 on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity for operation of the metro Rail and its stations
Petrol	Reduction in consumption of petrol due to switch to metro Rail
Diesel	Reduction in consumption of diesel due to switch to metro Rail

National Solar Mission

Launch Year: 2010

Implementing agency: Ministry of New and Renewable Energy (MNRE)

The National Solar Mission was launched on January 11, 2010. The Solar Mission recommends the implementation in 3 stages leading up to an installed capacity of 20,000 MW by the end of the 13th Five Year Plan in 2022.

Table 27: Impact of National Solar Mission on sectors

Sector	Subsector	Impact
Domestic	Lighting and Appliances	Remote locations that are not currently serviced by electricity can set up standalone solar power to generate electricity
Agriculture	Pumping	Fields located in remote locations can use solar pumps for irrigation

Table 28: Impact of National Solar Mission on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in the consumption of Electricity
Solar Power	Increase in the consumption of Solar Power

Smart Cities Mission

Launch Year: 2015

Implementing agency: Ministry of Housing and Urban Affairs

The mission will cover the development of 100 smart cities across India in a span of five years. The components of the mission for the development of smart cities are city improvement (retrofitting), city renewal (redevelopment) and city extension (Greenfield development). Additionally, Smart Solutions will be applied covering larger parts of the city. SCM is carried out through a special purpose vehicle (SPV), registered under the Companies Act, 2013, instead of through a municipal corporation. It encourages private investment as well. Deadlines set in 2015 for completion of 100 smart cities within five years by 2019-20, have been extended till 2022-23 for finishing projects in cities selected in round four. Smart Water projects have been completed in six cities while projects are under

implementation or tendering in 43 cities. Similarly, Smart Waste Water projects in 46 cities have been completed or are under implementation[24].

Table 29: Impact of Smart Cities Mission on sectors

Sector	Subsector	Impact
Municipal	Public Waterworks	Improved efficiency in pumping and improved water supply services
	Public Lighting	Improved lighting infrastructure with LEDs and control systems
Transport	Public transport	Improved utilization of public transportation would lead to less usage of petroleum products
Domestic	Lighting and appliance	Prevalent usage of smart solutions would lead to energy savings from domestic lighting and appliances

Table 30: Impact of Smart Cities Mission on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in the consumption of Electricity as the connected load will increase, however it will be urbanization in a sustainable manner
Solar Power	Increase in the consumption of Solar Power
Petrol and diesel	Decrease in consumption of petroleum products on account of increasing public transport share in road transport

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Launch Year: 2015

Implementing agency: Ministry of Housing and Urban Affairs

Atal Mission for Rejuvenation and Urban Transformation was launched in June 2015 to provide various amenities to the poor and disadvantaged in India. The mission aims to provide basic facilities like water supply, sewage, urban transport and parks. The ULBs (Urban Local Bodies) will be implementing the projects under this mission. The ULBs will also include some smart features in the physical infrastructure components of the city. The Mission covers 500 cities that includes all cities and towns with a population of over one lakh with notified municipalities. Total outlay for AMRUT is Rs. 50,000 crores for five years from FY 2015-16 to FY 2019-20. Moreover, the potential smart cities will be given first preference because the Smart Cities Mission and AMRUT are complementary[25].

[24] Smart Cities Mission, http://smartcities.gov.in/content/

[25] Atal Mission for Rejuvenation and Urban Transformation (Jun 2015), MoUD

Table 31: Impact of AMRUT on sectors

Sector	Subsector	Impact
Municipal	Public Waterworks	Improved efficiency in pumping and improved water supply services
Transport	Public transport	Improved utilization of public transportation would lead to less usage of petroleum products

Table 32: Impact of AMRUT on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Increase in the consumption of electricity as the connected load will increase, however it will lead to urbanization in a sustainable manner
Petrol and diesel	Decrease in consumption of petroleum products on account of increasing public transport share in road transport

Municipal Energy Efficiency Program (MEEP) by EESL

Launch Year: 2016

Implementing agency: Energy Efficiency Services Limited (EESL)

To facilitate market transformation and replicate Municipal Energy Efficiency Program on a large scale in India, MoUD (Ministry of Urban Development), Government of India signed an MoU with Energy Efficiency Services Limited (EESL), on 28th September, 2016 under AMRUT. This will enable replacement of inefficient pump sets in Public Water Works & Sewerage Water Systems with energy efficient pump sets at no upfront cost to the Municipal Bodies.

Currently, the project is in the phase of preparing DPRs for the 500 cities identified. About 200 DPRs (Detailed Project Reports) have been prepared and a summary of the findings has been used to make the projections in the energy demand of the sector[26].

Table 33: Impact of MEEP on sectors

Sector	Subsector	Impact
Municipal	Public Waterworks	Improved efficiency in pumping and improved water supply services

Table 34: Impact of MEEP on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Reduction in the consumption of electricity as inefficient pumps are being replaced with energy efficient pumps

[26] MEEP Dashboard, http://meep.eeslindia.org/dashboard/

Heritage City Development and Augmentation Yojana (HRIDAY)

Launch Year: 2015

Implementing agency: Ministry of Housing and Urban Affairs

The Ministry of Housing and Urban Affairs, Government of India, launched the HRIDAY scheme in 2015 to preserve and develop heritage cities. The scheme aims to improve the infrastructure and facilities in the cities while maintaining the heritage and essence of the city. The scheme will broadly focus on four theme areas i.e. Physical Infrastructure, Institutional Infrastructure, and Economic Infrastructure & Social Infrastructure for reviving and revitalizing the soul of Heritage City. One of the objectives of the scheme is the implementation and enhancement of basic services with focus on sanitation services like public conveniences, toilets, water taps, street lights and the use of latest technologies to improve tourist facilities/amenities. As on March-2018, installments amounting to Rs. 261 Crore have been released to city mission directorates for execution of approved projects[27].

Table 35: Impact of HRIDAY on sectors

Sector	Subsector	Impact
Municipal	Public Waterworks	Improved efficiency in pumping and improved water supply services.
	Public Lighting	Improved lighting infrastructure with LEDs and control systems

Table 36: Impact of HRIDAY on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Increase in the consumption of electricity as the connected load will increase, however it will lead to urbanization in a sustainable manner

Street Lighting National Program (SLNP)

Launch Year: 2015

Implementing agency: Energy Efficiency Services Limited (EESL)

Launched in January, 2015 EESL plans to replace 3.5 crore LED lights by March 2019 under this program. EESL has joined hands with the ULBs, municipal bodies, and State and Central governments to implement LED street lights with future-ready technology. The LEDs are 50% more efficient energy efficient than incandescent bulbs and High-Pressure Sodium (HPS) lighting, along with being weather-resistant. Till date, over 6 million conventional street lights have been replaced with LED lights, leading to an annual energy saving of more than 4000 million kWh, and reducing around 3 million tonnes (MT) of CO2 emissions[28].

[27] Heritage City Development and Augmentation Yojana, MoUD
[28] SLNP Dashboard, https://slnp.eeslindia.org/

Table 37: Impact of SLNP on sectors

Sector	Subsector	Impact
Municipal	Public Lighting	Improved lighting infrastructure with LEDs and control systems

Table 38: Impact of SLNP on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Decrease in the consumption of electricity as energy intensive lights are being replaced by LEDs

National Policy on Biofuels

Launch Year: 2018

Implementing agency: Ministry of New and Renewable Energy (MNRE)

The Policy aims at utilization of biofuels and envisages a greater role for it in the energy and transportation sectors of the country in coming decades. The policy will bring about accelerated development and promotion of the cultivation, production and use of biofuels to increasingly substitute petrol and diesel for transport and be used in stationary and other applications, while contributing to energy security and climate change mitigation, apart from creating new employment opportunities and leading to environmentally sustainable development[29].

This policy will reduce crop burning and will help to effectively employ crop not suitable for consumption to produce biofuels.

Table 39: Impact of National Policy on Biofuels on sectors

Sector	Subsector	Impact
Transport	Vehicular	The policy will allow use of ethanol produced by agricultural surplus to be used in petrol. Till now only ethanol produced by sugarcane was allowed.

Table 40: Impact of National Policy on Biofuels on sources of energy

Source of energy	Impact on Energy Consumption
Petrol and Diesel	It will reduce the consumption of petrol and diesel as the blending ratio increase in the future.

National Wind-Solar Hybrid Policy

Launch Year: 2018

Implementing agency: Ministry of New and Renewable Energy (MNRE)

[29] National Policy on Biofuels, MNRE

The main objective of the Policy is to provide a framework for promotion of large grid connected wind-solar PV hybrid system. This will lead to optimal and efficient utilization of transmission infrastructure and land, reducing the variability in renewable power generation and achieving better grid stability. The policy also aims to encourage new technologies involving combined operation of wind and solar PV plants[30].

Table 41: Impact of National Wind-Solar Policy on sources of energy

Sources of energy	Impact on Energy Consumption
Solar Power	It will increase the consumption of solar power for large grid connected projects
Wind Power	It will increase the consumption of wind power for large grid connected projects

Deendayal Upadhyaya Gram Jyoti Yojana

Launch Year: 2015

Implementing Agency/Ministry: Rural Electrification Corporation (REC)

Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) has been launched for the rural areas with the following components: (i) Separation of agriculture and non-agriculture feeders in the rural areas; (ii) Strengthening and augmentation of sub-transmission and distribution (ST&D) infrastructure in rural areas; (iii) Rural electrification. Under this scheme, a number of projects on renewable energy sources have been sanctioned[31].

Table 42: Impact of DDUGJY on sectors

Sector	Subsector	Impact
Domestic	Buildings, Appliances	Feeder separation to ensure sufficient power to farmers and regular supply to other consumers[32]
Commercial		
Agriculture	Pumps	

Table 43: Impact of DDUGJY on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity
Solar Power	Households in remote areas will be provided with solar photovoltaic standalone system

On Farm Water Management (OFWM)

Launch Year: 2006

Implementing agency: Ministry of Agriculture and farmers welfare, Department of Agriculture Co-operation and Farmer's Welfare

[30] Draft National Wind-Solar Hybrid Policy, MNRE
[31] Deendayal Upadhyaya Gram Jyoti Yojana, http://www.ddugjy.gov.in/portal/SBD_for_Standalone.jsp
[32] PM to Launch Deendayal Upadhyaya Gram Jyoti Yojana in Patna (Jul 2015), http://pib.nic.in/newsite/PrintRelease.aspx?relid=123595

The Government of India has been implementing centrally sponsored scheme on Micro Irrigation (MI) with the objective to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like drip & sprinkler irrigation technologies and encourage the farmers to use water saving and conservation technologies[33].

The scheme has performed well in terms of reduction in input cost and significant cost saving has been observed for irrigation in all the surveyed states. Irrigation cost is reduced by 20%-50% with average of 32.3%. Reduction in electricity consumption after installation of MI system. Average electricity consumption has been reduced by about 31% after using the micro irrigation system.

Table 44: Impact of OFWM on sectors

Sector	Subsector	Impact
Agriculture	Pumping	The use of low pressure pumps in drip irrigation results in usage of lower power

Table 45: Impact of OFWM on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Reduction in the consumption of electricity

Green Highways Policy, 2015

Launch Year: 2015

Implementing agency: Ministry of Road Transport and Highways

The policy envisages creation of eco-friendly highways with participation of the community, farmers, NGOs, private sector, institutions, government agencies and forest department. It also highlights the promotion of green fuels such as bio-CNG, bioethanol and bio-diesel and green modes of transport such as e-rickshaws and electric buses[11].

Table 46: Impact of Green Highways Policy on sectors

Sector	Subsector	Impact
Transport	Vehicular	The government has incentivized switching to electric vehicles by providing subsidies and supporting pilot projects

Table 47: Impact of Green Highways Policy on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity for charging electric vehicles
Petrol	Reduction in consumption of petrol due to switch to electric vehicles and bio-fuels
Diesel	Reduction in consumption of diesel due to switch to electric vehicles and bio-fuels

[33] Pradhan Mantri Krishi Sinchayee Yojana, http://pmksy.gov.in/microirrigation/Aboutus.aspx

Miles to Smiles

It has 9 specific components: HI Stop HI Jal– toilets and drinking water facilities at petrol pumps along highways, HI Fastag- convert all toll booths to e-toll systems, HI FM- Highway Advisory Services, HI Nirbhaya- security for women travelling on highways and buses with IT enabled safety measures, HI Swachh- dustbins at toll plazas for garbage collection, HI safe zebra crossing, HI Navik mobile application, HI help toll free number 1033, HI Green- for green initiatives such as tree planting, bio-fuel buses, bio-diesel petrol pumps, electronic hybrid vehicles, e-rickshaws and Green highways Policy[34].

Table 48: Impact of Miles to Smiles on sectors

Sector	Subsector	Impact
Transport	Vehicular	The government has incentivized changing to electric vehicles by providing subsidies and supporting pilot projects

Table 49: Impact of Miles to Smiles on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity for charging electric vehicles
Petrol	Reduction in consumption of petrol due to switch to electric vehicles and bio-fuels
Diesel	Reduction in consumption of diesel due to switch to electric vehicles and bio-fuels

National Biogas and Manure Management Program

Launch Year: 1981

Implementing agency: Ministry of New and Renewable Energy (MNRE)

National Biogas and Manure Management Program is a Central Sector Scheme, which provides for setting up of Family type Biogas Plants mainly for rural and semi-urban/households[35] to generate a clean gaseous fuel, particularly for cooking and meeting lighting needs, and replace the use of fuel-wood, thereby reducing deforestation[36].

Table 50: Impact of National Biogas and Manure Management Program on sectors

Sector	Subsector	Impact
Domestic	Cooking and lighting	Use of clean fuel for cooking as well as low dependence on LPG supply and electricity

[34] TERI Energy Handbook, 2015-16

[35] National Biogas and Manure Management Programme, https://cag.gov.in/sites/default/files/audit_report_files/Union_Civil_Performance_Renewable_Energy_Report_34_2015_chap_8.pdf

[36] https://mnre.gov.in/sites/default/files/schemes/New-National-Biogas-Organic-Manure-Program%28NNBOMP%29-upto-2020-1.pdf

Table 51: Impact of National Biogas and Manure Management Program on sources of energy

Sources of energy	Impact on Energy Consumption
LPG	Lower dependence on LPG
Electricity	Decrease in the consumption of Electricity

Unnat Chulha Abhiyan (UCA)

Launch Year: 2014

Implementing agency: Ministry of New and Renewable Energy (MNRE)

Unnat Chulha Abhiyan (UCA) is a program of the Ministry of New and Renewable Energy to develop and deploy improved biomass cook - stoves for providing cleaner cooking energy solutions in rural, semi - urban and urban areas using biomass as fuel for cooking.

Table 52: Impact of UCA on sectors

Sector	Subsector	Impact
Domestic	Cooking	Use of clean fuel for cooking which will result in lower emission of black carbon from burning of biomass

Table 53: Impact of UCA on sources of energy

Source of energy	Impact on Energy Consumption
LPG	Lower dependence on LPG

Technology and Quality up gradation support to Micro, Small and Medium Enterprises (TEQUP)

Launch Year: 2010

Implementing agency: Ministry of Micro, Small and Medium Enterprises

The first objective of the scheme is to sensitize the manufacturing MSME (Micro, Small and Medium Enterprises) sector in India to the use of energy efficient technologies and manufacturing processes so as to reduce cost of production and the emissions of GHGs (Green House Gases)[34].

Major activities under the scheme include[37]:

- Capacity Building of MSME Clusters for Energy Efficiency/Clean Development Interventions and other technologies mandated as per the global standards
- Implementations of Energy Efficiency Units (EET) in MSME units
- Setting up of Carbon Credit Aggregation Centers (CCA) for introducing and popularizing clean development mechanism (CDM) in MSME clusters
- Encouraging MSMEs to acquire product certification/licenses from National/International bodies and adopt other technologies mandated as per the global standards

[37] DC-MSME Scheme, http://www.dcmsme.gov.in/schemes/TEQUPDetail.htm

Table 54: Impact of TEQUP on sectors

Sector	Subsector	Impact
Industries	MSME	Use of EET's would put MSME's in the same league as global producers and make the sector competitive

Table 55: Impact of TEQUP on sources of energy

Source of energy	Impact on Energy Consumption
Electricity	Reduction in the consumption of electricity

Sagarmala

Launch Year: 2015

Implementing agency: Ministry of shipping

The Sagarmala program envisions significant reduction of logistics cost of bulk commodities by locating future industrial capacity near the coast and optimizing the modal mix. The 4 major tenets of the program are[38]:

- Port modernization and new port development: De-bottlenecking and capacity expansion of existing ports and development of new greenfield ports
- Port connectivity enhancement: Enhancing the connectivity of the ports to the hinterland and optimizing cost and time of cargo movement
- Port-linked industrialization: Developing port-proximate industrial clusters and Coastal Economic Zones to reduce logistics cost and time of EXIM (Export Import) and domestic cargo
- Coastal community development: Promoting sustainable development of coastal communities

Table 56: Impact of Sagarmala on sectors

Sector	Subsector	Impact
Transport	Railway	Share of rail in freight transport would increase, leading to efficient movement of goods within the country
Industries	Heavy industries	Proximity to ports and well-connected railway networks would help reduce cost and dependency on HCVs (Heavy Commercial Vehicles) to ferry goods from one location to another

[38] SagarMala, Ministry of Shipping, http://sagarmala.gov.in/about-sagarmala/vision-objectives

Table 57: Impact of Sagarmala on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity as more and more diesel locomotives will be replaced by electric ones
Petrol	Reduction in consumption of petrol due to switch to rail transport
Diesel	Reduction in consumption of diesel due to switch to rail transport

Dedicated Freight Corridor (DFC) program

Launch Year: 2006

Implementing agency: Dedicated Freight Corridor Corporation of India Limited

Dedicated Freight Corridor (DFC) is a strategic initiative to augment rail capacity across the major trunk routes in India. DFC can cater to the need of multi-faceted Indian economy, ranging from agriculture to manufacturing and knowledge economy businesses, all sectors depending on the movement of freight in some way.

Table 58: Impact of DFC Program on sectors

Sector	Subsector	Impact
Transport	Railway	Share of rail in freight transport would increase, leading to efficient and movement of goods within the country
Industries	Heavy and MSME	Development of economic zones along the corridors

Table 59: Impact of DFC Program on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity as more and more diesel locomotives will be replaced by electric ones
Petrol	Reduction in consumption of Petrol due to switch to rail transport
Diesel	Reduction in consumption of Diesel due to switch to rail transport

Green Urban Mobility Scheme-2017

Launch Year: 2017

Implementing agency: Ministry of Housing and Urban Affairs

The scheme would focus primarily on three objectives:

- Sustainable urban mobility: Infrastructure enabling bus systems, safe pedestrian pathways, cycling track, public bike sharing, Integrating modes with physical & soft infrastructure e.g.

cashless payment systems & ITS (Intelligent transport system) and strategies for Urban Freight management

- Sustainable vehicles and fuels: Shift to electric/hybrid vehicles for public transport, Shift to Non-fossil fuel for public transport projects

- Projects demonstrating reduction in GHG emissions

Table 60: Impact of Green Urban Mobility Scheme on sectors

Sector	Subsector	Impact
Transport	Vehicular	Electric and hybrid vehicles in public transport would lead to significant reduction in emissions.

Table 61: Impact of Green Urban Mobility Scheme on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity as more and more public buses are replaced by electric buses
Petrol	Reduction in consumption of petrol as citizens adopt public transport
Diesel	Reduction in consumption of diesel as electric vehicles replace diesel buses

National Auto Policy 2018

Launch Year: 2018

Implementing agency: Department of Heavy Industry

Some of the key policy guidelines included are:

- Roll out of a comprehensive long-term (10 year) roadmap that will define the emission standards applicable after BSVI with a target of harmonizing with the most stringent global standards by 2028, across all vehicle segments

- Adopt reduction in CO2 through Corporate Average Fuel Economy (CAFE) regulations: Roadmap will define corporate average CO2 g/km targets for all passenger vehicle manufacturers from 2020 onwards

- Introduce a composite criterion based on length and CO2 emissions to classify vehicles for taxation: Vehicle length based classification will target reduction in vehicular congestion and CO2 emissions based classification will align with the overall vision of reducing Green House Gas (GHG) emissions. Monitor and review the thresholds based on market evolution and target of increasing share of greener vehicles

- Define a list of target technologies in the areas of green mobility, emission control, safety etc. with corresponding components and equipment that will be eligible for import duty reduction

- Conduct a detailed study on requirement of public infrastructure for Green Vehicles to determine the quantity, density and mix of green mobility infrastructure required in the country as per target adoption plans. Also, standards for green vehicle infrastructure in terms of power supply, connectors, refueling etc. will be proposed

Table 62: Impact of National Auto Policy on sectors

Sector	Subsector	Impact
Transport	Vehicular	Improved efficiency standards for vehicles coupled with push for alternate fuels and e-vehicles will significantly reduce energy demand and emissions in the transport sector

Table 63: Impact of National Auto Policy on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity as the policy advocates the push for use of green vehicles in public and private transport
Alternate fuels	Increase in consumption alternate fuels like methanol and hydrogen
Petrol	Reduction in consumption of petrol as consumers shift to cleaner fuels
Diesel	Reduction in consumption of diesel as consumers shift to cleaner fuels

National Mission on Sustainable Agriculture (NMSA)

Launch Year: 2013

Implementing agency: Ministry of Agriculture and farmers welfare, Department of Agriculture Co-operation and Farmer's Welfare

Aims at enhancing food security and protection of resources such as land, water, biodiversity and genetics. The mission focuses on new technologies and practices in cultivation and development of specific genotypes of crops that have enhanced CO2 fixation potential and are less water consuming[39].

Table 64: Impact of NMSA on sectors

Sector	Subsector	Impact
Agriculture	Pumps	Improved crop types would lead to lower usage of water and hence reduced pumping demand

Table 65: Impact of NMSA on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity as water usage would be less for improved crops
Diesel	Reduction in consumption of diesel as water usage would be less for improved crops

[39] National Mission for Sustainable Agriculture Being Launched in Twelfth Plan (Dec 2013), http://pib.nic.in/newsite/PrintRelease.aspx?relid=101133

National Innovations on Climate Resilient Agriculture (NICRA)

Launch Year: 2011

Implementing agency: Indian Council of Agriculture Research (ICAR)

Some of the key attributes of the program include:

- Real-time contingency crop plan implementation both on station and on farm in a participatory mode: To sustain the productivity of pearl millet, cluster bean, sesame under normal are drought conditions. To improve the productivity of mustard, chickpea and wheat under rain fed conditions

- Rainwater harvesting (in-situ and ex-situ) and efficient use: Demonstration on efficient in-situ moisture conservation practices to conserve more moisture (ridge and furrow planting, compartmental bundling etc.).Efficient and multiple use of harvested water or enhancing water use efficiency (lifesaving irrigation, sprinkler irrigation). Ground water recharging through bore well and open well, defunct well

- Efficient energy use and management: Introduction of modern tools / implements and to create awareness in the farming community about their use for different crops (establishing custom hiring centre and ensuring services in the village)

- Alternate land use for carbon sequestration and eco-system services: To develop alternate land use system / farming system for carbon sequestration and ecosystem services. The package included land configuration, crops or varieties/cropping system, rain water harvesting and recycling, timely operations through custom hiring center and alternate land use and ecosystem services

Table 66: Impact of NICRA on sectors

Sector	Subsector	Impact
Agriculture	Pumps	Improved irrigation methods, rain water harvesting and introduction of modern tools.

Table 67: Impact of NICRA on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity as water usage would be less due to improved water harvesting mechanisms
Diesel	Reduction in consumption of diesel as water usage would be less due to improved water harvesting mechanisms

Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM)

Launch Year: 2018

Implementing agency: Ministry of New and Renewable Energy (MNRE)

The scheme, being formulated by the Government of India, will aim towards installation of solar water pumps in remote areas for irrigation needs of farmers and supplement an extra source of income by selling surplus solar power to DISCOMs. The specific targets of the program include[40]:

- Installation of grid-connected solar power plants each of capacity up to 2 MW in the rural areas
- Installation of standalone off-grid solar water pumps to fulfill irrigation needs of farmers not connected to grid
- Solarization of existing grid-connected agriculture pumps to make farmers independent of grid supply and also enable them to sell surplus solar power generated to DISCOM and get extra income
- Solarization of tube-wells and lift irrigation projects of Government sector

Table 68: Impact of KUSUM on sectors

Sector	Subsector	Impact
Agriculture	Pumps	Energy savings due to installations of solar pumps

Table 69: Impact of KUSUM on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity
Diesel	Reduction in consumption of diesel

Perform, Achieve and Trade (PAT)

Launch Year: 2008

Implementing agency: Bureau of Energy Efficiency (BEE)

The Perform, Achieve and Trade (PAT), a market based energy efficiency trading mechanism and is being implemented in three phases. PAT cycle I ran from 2012-15, covering 478 facilities from eight energy intensive sectors. These eight sectors account for roughly 38 percent of India's total primary energy consumption. The second phase of the PAT scheme (PAT cycle II) runs from 2016-19 covering 707 units from 11 energy intensive sectors. PAT cycle II focuses on deepening and widening PAT cycle I with the inclusion of 61 new DCs (Designated Consumers) from the existing 8 sectors and the addition of 170 DCs from three new sectors; railways, refineries and electricity distribution companies (DISCOM).

[40] KUSUM Scheme – harnessing solar power for rural India (Mar 2018), http://pib.nic.in/newsite/PrintRelease.aspx?relid=177489

Table 70: Impact of PAT on sectors

Sector	Subsector	Impact
Industries	Heavy	Will result in lower energy consumption and adoption of efficient technologies of production

Table 71: Impact of PAT on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity
Diesel	Reduction in consumption of diesel

Zero effect, Zero Defect (ZED)

Launch Year: 2016

Implementing agency: Ministry of Micro, Small and Medium Enterprises

The ZED (Zero effect, Zero defect) scheme is an integrated and holistic certification system that will account for quality, productivity, energy efficiency, pollution mitigation and technological depth including design and IPR in products and processes for Medium and small industries[41].

Table 72: Impact of ZED on sectors

Sector	Subsector	Impact
Industries	MSME	Will result in lower energy consumption and adoption of efficient technologies of production

Table 73: Impact of ZED on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity
Diesel	Reduction in consumption of diesel

Sustainable and Accelerated Adoption of efficient Textile technologies to Help small Industries (SAATHI) Scheme

Launch Year: 2017

Implementing agency: Energy Efficiency Services Limited (EESL) and Office of the Textile Commissioner

Under this initiative, Energy Efficiency Services Limited (EESL) would procure energy efficient Power looms, motors and Rapier kits in bulk and provide them to the small and medium Power loom units at no upfront cost. The use of these efficient equipment would result in energy savings and cost savings to the unit owner and he would repay in installments to EESL over a 4 to 5 year period. This is the aggregation, bulk procurement and financing model that EESL has successfully deployed in several

[41] Zero Defect, Zero Effect, MoMSME, https://www.zed.org.in/

sectors like LED bulbs, Smart Meters and Electric Vehicles. The unit owner neither has to allocate any upfront capital cost to procure these equipment nor does it have to allocate additional expenditure for repayment as the repayments to EESL are made from the savings that accrue as a result of higher efficiency equipment's and cost savings. The aggregation of demand and bulk procurement will also lead to reduction in capital cost, benefits of which will be passed on to the Power loom units so that their repayment amount and period would reduce[42].

Table 74: Impact of SAATHI on sectors

Sector	Subsector	Impact
Industries	Textiles	Will result in lower energy consumption and adoption of efficient technologies of production

Table 75: Impact of SAATHI on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity

Atal Jyoti Yojana (AJAY)

Launch Year: 2018

Implementing agency: Energy Efficiency Services Limited (EESL)

The Ministry of New and Renewable Energy (MNRE) launched the Atal Jyoti Yojana (AJAY) to illuminate dark regions across five states through solar power. It is a sub scheme under off –grid and decentralized solar application scheme of Ministry of New and Renewable Energy (MNRE), Govt. of India. The rural, semi-urban and urban areas that face less than 50% grid connectivity in Uttar Pradesh, Assam, Bihar, Jharkhand, and Odisha will be illuminated with solar LED street lights. These solar lights will be installed on major roads, markets, and public conveniences in remote areas to sustainably enhance the citizens' quality of life.

Table 76: Impact of AJAY on sectors

Sector	Subsector	Impact
Municipal	Public lighting	Will result in lower energy consumption as Solar LED street lights would be used in public areas, which would have otherwise been lit up using conventional grid based lighting system

Table 77: Impact of AJAY on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity as Solar LED lights are used

[42] Ministries of Power & Textiles join hands under new initiative SAATHI (Sustainable and Accelerated Adoption of efficient Textile technologies to Help small Industries) (Oct 2017), http://pib.nic.in/newsite/PrintRelease.aspx?relid=171894

Energy Conservation and Building Codes (ECBC)

Launch Year: 2007

Implementing Agency: Bureau of Energy Efficiency

The ECBC sets minimum performance standards for building envelope, which includes roof and windows, lighting systems, air conditioning system, electrical distribution system and water heating and pumping system. The new ECBC code launched in 2017 had the following new features[43]:

- International benchmark code specific to Indian conditions- climatic and construction and will pave the way for future net zero energy buildings
- Wider scope in comfort systems and controls, integration of low energy comfort systems, natural ventilation, set points and controls
- Day lighting and shading requirement with relaxed U-values

Stringent lighting requirements with focus on better controls and compliance for new construction, core and shell, tenant lease type, etc.

Table 78: Impact of ECBC on sectors

Sector	Subsector	Impact
Commercial	Lighting and HVAC	Will result in lower energy consumption as better building designs and construction norms would require lower use of artificial lights and lower heating as well as cooling requirements.

Table 79: Impact of ECBC on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity

National Manufacturing Competitiveness Program (NMCP)

Launch Year: 2005

Implementing Agency: Ministry of Micro, Small and Medium Enterprises

The objective of NMCP is to develop global competitiveness among Indian MSMEs. This program targets at enhancing the entire value chain of the MSME sector through the following components: promoting information technology and communication tools in MSME sector, design clinic schemes for MSMEs, marketing assistance and technology up-gradation scheme for MSMEs, bar code under market development assistance scheme, etc.[44].

[43] http://www.aeee.in/wp-content/uploads/2017/05/ECBC-presentation-by-BEE.pdf
[44] Scheme for Promotion of Information and Communication Technology (ICT) in MSME Sector

Table 80: Impact of NMCP on sectors

Sector	Subsector	Impact
Industries	MSME	The introduction of energy efficient technologies as well as introduction of Quality Management Standards (QMS) and Quality Technology Tools (QTT) would result in lower consumption of energy in the sector

Table 81: Impact of NMCP on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Reduction in consumption of electricity as better technology is introduced for production and management purposes

Transformation of Aspirational Districts Program (TADP)

Launch Year: 2018

Implementing agency: NITI Aayog

The program aims at transforming 115 districts that were selected from 28 states. At the core of the program lies three crucial aspects that aim to foster these districts into the mainstream of development and growth. They are: Convergence (of Central & State Schemes), Collaboration (of Central, State-level 'Prabhari' Officers & District Collectors), and Competition among districts. Driven primarily by the States and instituted for the States, this initiative focuses on the strengths of each district, and identifies the attainable outcomes for immediate improvement, while measuring progress and ranking the selected districts[45].

Table 82: Impact of TADP on sectors

Sector	Subsector	Impact
Domestic	Lighting	With improvement in basic infrastructure being one of the thematic areas of the program, the access to electricity for less developed districts would result in improvement in lighting technology used
Industries	MSME	Improvement in infrastructure would also provide a push to the local industries in the district, which in turn would lead to more village and local entrepreneurs popping up.
Agriculture	Pumps	The program also focuses on agriculture and water resources, with better water management practices leading to lower pumping demand

Table 83: Impact of TADP on sources of energy

Sources of energy	Impact on Energy Consumption
Electricity	Increase in consumption of electricity as more houses and communities are grid connected with basic infrastructure

[45] Aspirational Districts – Unlocking Potentials (Jan 2018), NITI Aayog

2.1.2. State level policies

Andhra Pradesh

Electric mobility policy, 2018-2023: The Industries and Commerce (P&I) Department of the Andhra Pradesh Government issued the Electric Mobility Policy 2018-23 for the state. Andhra Pradesh EV Policy gives incentives to consumers, auto makers, battery manufacturers and charging infrastructure firms. It includes policies for both private as well as government players to purchase or lease electric vehicles such as waiver of road tax and subsidies. The state intends to be a frontrunner in building a sustainable transport system by investing in electric mobility[46].

Andhra Pradesh solar policy, 2015: The Andhra Pradesh Solar Policy, 2015 was issued by the government of Andhra Pradesh on 12.02.2015. The policy follows the previous solar policy of the state, Andhra Pradesh Solar Policy, 2012 that was valid till 2017. During the course of the policy, Andhra Pradesh was bifurcated into Telangana and Andhra Pradesh. The policy had also not achieved the target of 2000MW by 30th June, 2014. Hence, the state government decided to issue a new solar policy. The policy targets a minimum total solar power capacity addition of 5,000 MW in the five years after it was issued (till 2020). The policy has various incentives for the development of solar parks and solar rooftop projects. Solar Power projects that are commissioned during the operative period of the policy shall be eligible for incentives for a period of ten years from commissioning[47].

Andhra Pradesh wind power policy, 2015: The Andhra Pradesh Wind Power Policy was issued on 13.02.2015. Considering the wind power potential existing in the state of Andhra Pradesh, the policy plans to achieve 4000 MW capacity addition through wind power during the next 5 years period, i.e. 2015-2020. The policy aims to attract private investment in setting up wind power projects in the state[48].

Delhi

Delhi solar policy, 2016: The Department of Power, Government of NCT of Delhi issued the Delhi Solar Policy, 2016. Delhi is completely landlocked and solar power is the primary source of renewable power for the same. The policy aims to reduce the reliance on unsustainable energy while increasing its energy security and lowering average energy prices in the long term. Promote rapid growth of rooftop solar power via a combination of generation targets, regulations, mandates and incentives[47].

Delhi Energy Conservation Building Code (ECBC), 2018: Energy Efficiency & Renewable Energy Management Centre, Government of NCT of Delhi released the draft Delhi Energy Building Code for comments in February, 2018. It provides guidelines for the minimum requirements for the energy-efficient design and construction of buildings in Delhi. The guidelines recommend installation of renewable energy generation on commercial buildings across the city[49].

Delhi Electricity Regulatory Commission (Demand Side Management) Regulations, 2014: The regulations are applicable to distribution licensees in Delhi. The regulations intend to reduce the cost

[46] State Electric Mobility/Energy Storage Policy
[47] State Solar Power Policy
[48] State Wind Power Policy
[49] Delhi Energy Conservation Building Code 2018

of electricity to the distribution licensee as well as its customers by economical and efficient use of resources. DSM Regulations provide the framework for designing; development implementation of DSM related activities in the state[50].

Gujarat

Gujarat Solar Power Policy, 2015: The Gujarat Solar Power Policy, 2015 was issued by the government of Gujarat on 13.08.2015. The policy aims to scale up solar power in the state in a sustainable manner. It aims to promote clean and green power to reduce the state's carbon emission and reduce its dependence on fossil fuels. It also aims to encourage development of local manufacturing facilities in line with "Make in India" policy[47].

Gujarat Waste to Energy Policy 2016: The Energy and Petrochemicals Department of the Government of Gujarat issued the Gujarat Waste to Energy Policy 2016 on 28.03.2016. The policy intends to facilitate and promote utilization of Municipal Solid Waste as a renewable resource for generation of electricity at a low cost and in a sustainable way and thus also contribute to Swachh Bharat Abhiyan[51].

Gujarat Wind Power Policy 2016: The Gujarat Wind Power Policy, 2016 was issued on 02.08.2016 by the Energy and Petrochemicals Department, Government of Gujarat. The state of Gujarat has a long coast line and good wind speeds which can be harnessed in the form of wind energy. The policy intends to increase the private investment in wind power projects in the state[48].

Haryana

Haryana Solar Power Policy, 2014: The Haryana Solar Power Policy, 2014 was issued on 04.09.2014 by the government of Haryana. The objective of the policy is to promote the use of solar power in the state. The policy aims to use solar power for creating steam for cooking and industrial applications. It lists specific type of solar projects that will be encouraged in the state[47].

Jharkhand

Jharkhand State Solar Power Policy, 2015: The Jharkhand State Solar Power Policy, 2015 was issued by the Department of Energy, Government of Jharkhand on 10.08.2015. The policy intends to encourage participation of the private sector to set up solar power plant projects in the state as well as scale up the solar power generation of the state to 2650 MW by 2020. The policy also aims to encourage local manufacturing facilities and increase employment in the state[47].

Himachal Pradesh

Himachal Pradesh Solar Power Policy, 2014: The Department of Non-Conventional Energy Sources, Himachal Pradesh issued the Himachal Pradesh Solar Power Policy, 2014 on 04.03.2014. The policy aims to harness the potential of solar power for various uses in the state. The state receives ample sunlight for commercial as well as domestic applications of solar energy. The policy lists the different types of solar power plants and power projects that will be encouraged by the state. The nodal agency for the policy is Himurja[47].

[50] DERC DSM Regulations 2014

[51] State Waste to Energy Policy, MNRE

Jammu and Kashmir

Solar Power Policy for Jammu and Kashmir: The Department of Science and Technology, Government of Jammu and Kashmir issued the Solar Power Policy for Jammu and Kashmir on 18.03.2013. The policy intends to encourage the generation of green and clean power in the state via the use of solar energy and to contribute to meeting the targets of the Jawaharlal Nehru National Solar mission. The solar power projects under the policy have to be of minimum 1MW[47].

Karnataka

Karnataka Electric Vehicle and Energy Storage Policy 2017: The Government of Karnataka issued the policy on 25.09.2017 to promote electric mobility in the state and attract investments in the sector. The policy envisages Karnataka to be the preferred destination for electric mobility. The policy aims to attract investments of Rs. 31,000 crore in the state. All initiatives and incentives for promotion of electric mobility are outlined in the policy document[46].

The Karnataka Solar Policy 2014-2021: Government of Karnataka has issued the 'The Karnataka Solar Policy 2014-2021' on 22.05.2014. The government of Karnataka had issued an earlier solar policy in 2012. Karnataka is a state rich in sunlight and has about 240-300 clear sunny days with a solar radiation of 5.4 to 6.2 kWh/m^2/day. It was the first southern state to notify its first solar policy in 2011. The policy aims to achieve 2000 MW solar power in the state by 2021 via different types of projects such as Grid connected projects and rooftop projects[47].

Kerala

Kerala Solar Energy Policy 2013: The Government of Kerala has issued the Kerala Solar Energy Policy 2013 on 25.11.2013. The policy intends to increase the share of solar power in the energy mix of the state and to ensure optimal usage of the available solar potential in the state. The state plans to achieve a capacity of 2500 MW by 2030. The Agency for Non-conventional Energy and Rural Technology will be administrating the policy in the state[47].

Madhya Pradesh

Policy for Implementation of Solar Power Based Projects in Madhya Pradesh, 2012: The policy was issued by the Government of Madhya Pradesh in 2012. The policy states that the state is heavily dependent on conventional energy sources and thus, has taken the measure to increase renewable energy in the state. The state receives plenty of sunlight on 300 days in year. The policy intends to encourage private investment in solar power projects in the state. The policy defines the incentives and benefits provided to the participants from the private sector in solar power in the state[47].

Wind Power Project Policy, 2012: Considering the huge potential of untapped wind energy in the state, the government issued the Wind Power Project Policy, 2012. The policy defines all projects that will be allotted under the policy will be on a Build, Own and Operate basis. Rules and regulations for allotment of projects and incentives for setting up of wind power projects are listed in the policy[48].

Policy for implementation of Small Hydel-Power based electricity projects in Madhya Pradesh, 2011: The policy was issued by the New and Renewable Energy Department, Government of Madhya Pradesh on 3.11.2011. The policy is applicable to all small hydel power projects up to 25 MW. The policy intends to promote pollution free small hydel power generating projects by private sector participants and to define the incentives available to the private sector.

Maharashtra

Maharashtra's Electric Vehicle Policy – 2018: Based on the recent developments in technology and the potential benefits of electric vehicles, the Government of Maharashtra issued the Maharashtra's Electric Vehicle Policy – 2018. The policy envisages 5 lakh electric vehicles in the state, an investment of Rs. 25,000 crores in EV, EV and component manufacturing, battery manufacturing, assembly enterprises and charging infrastructure equipment manufacturing. The policy lists all incentives applicable to electric vehicles in the state[46].

Odisha

Odisha Solar Policy- 2013: The Science and Technology Department, Government of Odisha, issued the Odisha Solar Policy in 2013. The principal objective of the policy is to promote the use of solar energy in the state to support development and address the problem of energy security. The policy details the scope and potential of the state to harness solar power. The policy lists incentives for setting up solar projects including waiver of Electricity duty on solar power plants[47].

Rajasthan

Rajasthan Solar Energy Policy, 2011: The Energy Department, Government of Rajasthan issued the Rajasthan Solar Energy Policy, 2011 on 19.04.2011. Rajasthan receives maximum solar radiation intensity in India with very low average rainfall. The policy intends to increase the development of solar projects in the state[47].

Tamil Nadu

Tamil Nadu Solar Energy Policy, 2012: The Tamil Nadu Solar Energy Policy, 2012 was issued by the Energy Department, Government of Tamil Nadu in 2012. The policy intends to achieve energy security and reduce carbon emissions by increasing the solar power generation in the state. It introduces many initiatives like promotion of rooftop solar, net metering, solar water heating systems, and solar parks[47].

Telangana

Telangana Solar Power Policy, 2015: The Telangana Solar Power Policy 2015 was issued by the Government of Telangana and is valid for 5 years. The state receives plenty sunlight that can be harnessed. The policy aims to promote a sustainable fuel mix by increasing the use of solar power. Private and public investment is encouraged in solar power generation in the state via the policy including encouraging the development of solar parks[47].

Uttarakhand

Solar Energy Policy of Uttarakhand, 2013: The Government of Uttarakhand issued the Solar Energy Policy of Uttarakhand, 2013 0n 27.06.2013. The policy endeavor's to create an enabling environment to attract public and private for investment in generation of solar energy projects. The policy describes the different solar projects that are encouraged in the state. The Uttarakhand Renewable Energy Development Agency (UREDA) is the nodal agency for the implementation of the policy[47].

2.1.3. Energy efficiency programs by State Designated Agencies (SDAs)

SDAs are statutory bodies set up at the state level to implement the EC Act under the overall supervision of the BEE. They are the nodal agencies at state level and need to coordinate and cooperate with BEE at the central level to ensure a smooth and speedy implementation of the Act in the country. The key responsibilities of SDAs include:

- Updating and maintenance of list of Designated Consumers and ensure the submission of energy return form by each DC every year.
- Maintaining the list of Designated Energy Auditors (DEAs).
- Develop a Market mechanism for ESCerts and promote transfer of knowledge in energy efficiency.
- Exchange of information among all stakeholders relating to ESCerts trading mechanism through a central on-line integrated information system
- Inspection of Designated Consumer for compliance to energy consumption norms and standards and makes provisions for levying penalty for the defaulters.
- Enable tracking, monitoring and reporting energy reduction details.
- Access information available on PAT NET to calculate and levy penalty on designated consumers.
- Provide information to BEE through PAD (PAT Assessment Document)
- Gather, monitor and analyze data reported by DCs to identify any uneven aberrations in energy savings so as to conduct on site audits.
- Obtain audit details conducted by DENAs through PAT NET.
- Receive trading details and obligations from trading exchanges.
- Act as the body responsible for adjudicating matters related to penalizing the DCs for noncompliance.

A snapshot of some of the SDAs and the various energy efficiency programs conducted by them are presented below:

Energy management center, Thiruvananthapuram

Some of the programs undertaken by the EMC are as follows[52]:

[52] http://knowledgeplatform.in/wp-content/uploads/2016/03/41.-State-Designated-Agencies-Page-391-407.pdf

- EMC jointly with KSEB (Kerala state electricity board) distributed 12.7 million CFLs as part of the Bachat Lamp Yojana project. Kerala was the first state in the country which implemented BLY and achieved 300 MW reduction during peak hours

- EMC jointly with Bureau of public Enterprises, conducted energy manager training program for engineers in Public Sector Undertakings (PSUs) and 35 PSUs designated energy managers in their units

- EMC catalyzed HT/EHT consumers in the state to implement recommendations of mandatory energy audit and achieve savings of 2.5 million units

Maharashtra energy development agency (MEDA)

Some of the programs undertaken by MEDA are as follows[52]:

- Providing financial assistance for implementing LED streetlights in 'C' class municipal councils

- Mandatory use of environment friendly resources in construction of new government/semi government buildings to promote green buildings

- MEDA carried out the highest number of energy conservation demonstration projects (29 in no.) in government buildings financed by MEDA for FY 2013-14. Apart from this, MEDA also carried out seven energy conservation demonstration projects in municipal corporations/councils

- Apart from the above mentioned initiatives, MEDA was also the first SDA to notify DSM regulations for state regulatory commission and start a waste heat recovery scheme.

Karnataka renewable energy development limited (KREDL)

Some of the programs undertaken by KREDL are as follows[52]:

- Implemented energy audit measures in 4 government buildings with annual energy savings of 446759 kWh and a net savings of Rs 33.12 lakh for the FY 2013-14

- Replaced 590 nos. of inefficient irrigation motor pumps by star rated energy efficient pumps in the jurisdiction of Hubli Electricity Supply Company limited in FY 2013-14

- Replaced 277 nos. of inefficient irrigation motor pumps by star rated energy efficient pumps in the jurisdiction of Bangalore Electricity Supply Company limited in FY 2013-14

- Replaced 301 nos. of inefficient irrigation motor pumps by star rated energy efficient pumps in the jurisdiction of Chamundeshwari Electricity Supply Company limited in FY 2013-14.

Arunachal Pradesh Energy Development Agency (APEDA)

Some of the programs undertaken by APEDA are as follows[52]:

- Mandatory use of energy efficient lighting system in government buildings, aided institutions, boards and corporations

- Mandatory use of star labelled room air conditioners and frost free refrigerators in government buildings, aided institutions, boards and corporations

Some of the highlights of LED demo projects by APEDA are as follows:

Table 84: Highlights of LED demo project by APEDA

Project location	Number of LEDs provided	Annual energy savings (in kWh)	Implementation year
LED street light demo (3 no. towns)	197	69028.8	2013-14
LED street light demo (8 nos. villages)	1700	416976	2013-14

Andhra Pradesh State Energy Conservation Mission (APSECM)

Some of the programs undertaken by APSECM are as follows[53]:

- Around 1.88 crore LED bulbs have been distributed with energy savings of 706 MU in FY 2015-16
- Installation of 5.25Lakhs LED street lights was completed i.e. 95%, as against the target for installation of 5.7 Lakh LED street lights in all the Municipalities & Municipal Corporations of the state by November 2016
- In Financial year 2015-16, around 2.25 Lakh LED street lights have been installed and accrued energy savings of 41.5 MU
- In Financial year 2015-16, around 626 energy efficient pump sets have been installed with Energy savings of 5 MU.

An overview of the impact of energy efficient measures are as follows:

Table 85: Impact of Energy Efficiency measures by APSECM

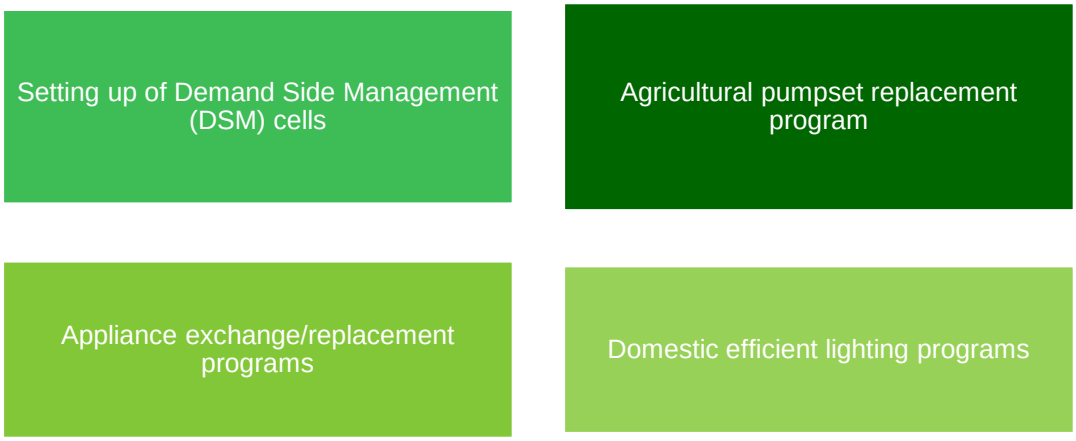
Sl. no.	Energy efficiency project	Total target	Expected annual energy savings	Reduction of Carbon emissions per annum
1	UJALA	2.32 crore domestic LED distribution	1710 MU	1450000 tonnes of CO2
2	LED based street lighting	5.55 lakh LED street lights	48 MU	41000 tonnes of CO2
3	AgDSM	Replacement of 5 lakh ordinary pumps	1000 MU	850000 tonnes of CO2
4	Domestic efficient fans program	Distribution of two lakh 5 star rated fans	21 MU	18000 tonnes of CO2

[53] http://knowledgeplatform.in/wp-content/uploads/2017/02/35.-State-Designated-Agencies.pdf

2.1.4. Energy efficiency programs by DISCOMs

DISCOMs are the interface between consumers and regulators, and hence hold a crucial position in the success of any state DSM programme. They stand to benefit from the demand side management programs along with the consumers. DISCOMs in a few states have been significantly active in undertaking DSM activities like awareness drives, load research, and energy audits, and also innovative demand side management programs like appliances exchange, thermal energy storage, and demand response. Mentioned below are some of the demand side management (DSM) measures that have been undertaken by DISCOMs.

Figure 8: Demand side management initiatives by DISCOMs



Some of the progressive DISCOMs and the programs undertaken by them are mentioned below:

Eastern Power Distribution Company of A.P Limited

Distribution of LED Bulbs under "DELP" Scheme: As a part of energy conservation measures the DELP (DSM Based Efficient Lighting Program) scheme of EESL is implemented in APEPDCL w.e.f February, 2015. 2 bulbs each were distributed to all domestic consumers. As on 25.11.2016, a total of 75, 40,961 Nos LED bulbs were distributed to 37, 71,228 Nos consumers. The estimated energy savings are 551 MU (Million kWh)[54].

Domestic Efficient FAN Program: APEPDCL proposed to implement the Domestic Efficient Fan Program (DEFP) as a pilot program in Narasapuram Town and its adjoining areas in West Godavari District, AP with the financial support of M/s Energy Efficiency Services Limited (EESL). The expected Energy Savings per fan works out to 90 Units per annum. After distribution of 1 lakh fans, the expected energy savings will be 9.125 MU and expected cost savings will be Rs.3.39 crore. per annum[54].

Bangalore Electricity Supply Company Limited (BESCOM)

Surya Raitha Solar water pumping system to irrigation pumps sets, a pilot project in BESCOM: In September 2014, the Government of Karnataka (GoK) envisaged a sustainable solution to the problem of agricultural power by way of Surya Raitha scheme. The scheme proposed to provide net metered solar water pump systems of high energy efficiency. Farmers who were

[54] http://knowledgeplatform.in/wp-content/uploads/2017/02/11.-Electricity-Distribution-Companies.pdf

previously drawing energy from the grid were encouraged to export excess energy generated by their solar water pumping system and earn additional revenue for net energy exported thereby completely eliminating drawl of energy from BESCOM grid for their agricultural pump sets[54].

Distribution Energy Efficiency Project (DEEP) by providing Dynamic Reactive Compensation (DRC) for power factor improvement scheme on 11 kV feeders: BESCOM has proposed to implement Distribution Energy Efficiency Project (DEEP) by providing Dynamic Reactive Compensation (DRC) for power factor improvement scheme on selected 11 kV feeders on pilot basis. DEEP system consists of Multifunction Measurement and Control unit (MFM), GSM/GPRS modem, capacitors, capacitor-duty contractors and isolation transformers.

TATA Power Delhi Distribution Limited

Rebate based AC replacement program: Total 9089 nos. of non-star rated ACs have been replaced under AC replacement scheme till the validity of the scheme which expired on August 31, 2016. This has led to a deemed load reduction of 5.94 MW and deemed savings of 7 MU annually y. This equates to reduction of 1781 MT of CO2.

DSM based energy efficient lighting program: 14 lakh 7 W LED bulbs were distributed at up front and EMI payment modes to customers which would lead to an annual deemed savings of 44.1 MUs and 14685.3 Million Tonnes of CO2 reduction.

2.1.5. Energy efficiency programs by Municipalities

Municipal energy efficiency saves scarce commodities and stretches tight budgets, giving citizens improved access to electricity, water, heat and air conditioning. Energy efficiency in municipal water supply systems can save water and energy while reducing costs and improve service at the same time. Some of the programs undertaken by progressive municipalities are mentioned below:

Vadodara Municipal Corporation

Some of the energy efficiency measures taken by VMC are as follows[55]:

- Replacement of 45000 36W FTL with 15 W LEDs in 2013-14. This move had an energy saving potential of 66% with annual electricity bill saving of 2.94 Cr
- Design based lighting. Which includes dimming of lights during off peak hours. The program was started in the year 2002 for all the main roads in Vadodara. The program resulted in 58% energy efficiency by improving 300% service delivery, as compared to conventional installations. A total energy saving of 80.34 lakh kWh was achieved in 2013-14
- VMC was also the first city in the country to install and implement SCADA (Supervisory control and data acquisition) in street light service. This program was implemented in 2008 with installation of microprocessor based intelligent street light controller with GSM technology for remotely monitoring and controlling street lights
- Annual programmable time switches in street lights were installed in the year 2012-13, which resulted in energy savings of 7.32 lakh kWh during 2013-14
- A program for conversion of HPMV (High pressure mercury vapour lamps) into HPSV (High pressure sodium vapour lamps) was carried out which resulted in energy savings of 16.24 lakh kWh during 2013-14

[55] http://knowledgeplatform.in/wp-content/uploads/2016/03/20.-General-Category-Sub-sectors-of-EC-Award-Page-142-157.pdf

A summary of the savings from different energy efficiency measures are mentioned below:

Table 86: Energy efficiency measure taken by Vadodara Municipal Corporation

Steps taken	Description	Investment	Total Quantity	Annual Savings
Replacement	36 W tube light fixtures into 15 W LED fixtures	Rs. 15 crore	45000 nos.	56.67n lakh kWh
Inventory	Design based lighting on main roads with GSM & Microprocessor based energy saver unit	Rs. 2.64 crore	220 units	80.34 lakh kWh
Procurement	Annual programmable time switches for automation	Rs. 76.3 lakh	700 nos.	6.15 lakh kWh
Conversion	125 W HPMV into 70 W HPSV (saving of 58 W)	No cost	692 nos.	1.61 lakh kWh
Conversion	250 W HPMV into 150 W HPSV (saving of 113 W)	No cost	3225 nos.	14.63 lakh
Inventory	Low watt loss ballast for sodium fitting (saving of 5 W)	No cost	30424 nos.	6.39 lakh kWh

A snapshot of energy savings achieved by VMC from 2009-10 by implementation of various energy efficiency measures are given below[55]:

Table 87: Energy savings achieved by Vadodara Municipal Corporation between 2009-2014

Year	Actual kWh consumption	kWh without energy efficiency (lakh unit)	kWh saving by implementing energy saving measures (lakh unit)	Amount savings (in lakh Rs.)	Reduction in CO2 emission in metric tonne
2009-10	234.83	304.81	69.68	278.53	5.95
2010-11	238.28	333.39	95.11	380.44	8.08
2011-12	230.41	337.31	106.90	478.92	9.09
2012-13	236.00	350.78	114.78	550.95	9.7
2013-14	236.70	415.70	165.78	862.06	14.09
Total savings of five years			**552.55**	**2550.89**	**46.97**

Greater Vishakhapatnam Municipal Corporation

Street lighting project: The project aimed at overall reduction in the energy consumption and electricity load on street lighting along with improving the quality of lighting from that of conventional lighting. A summary of street lighting fixtures inventory details are mentioned below[56]:

[56] http://knowledgeplatform.in/wp-content/uploads/2016/01/Greater-Visakhapatnam-Municipal-Corp_1st-Prize.pdf

Table 88: Greater Vishakhapatnam Municipal Corporation LED replacement measures

Sl. No.	Existing conventional lights				Replaced LED lights			
	Category	1st phase Qty (Nos)	2nd Phase Qty (Nos)	Total	Category	1st phase Qty (Nos)	2nd phase Qty (Nos)	Total
1	40 W Tube light	60395	6236	66631	20 W LED	59687	25	59712
2	70 W SV Lamp	4084	286	4370	40W LED	4078	50	4128
3	150 W SV Lamp	18392	2464	20856	70 W LED	18426	884	19310
4	250 W SV Lamp	8778	1797	10575	120 W LED	9486	365	9851
5	400 W SV Lamp	126	-	126	210 W LED	98	6	104
Total:		**91775**	**10783**	**102558**		**91775**	**1330**	**93105**

A comparison of the energy consumption charges, before and after installation of LED lights in 2014 and 2015 is shown below[56]:

Table 89: Greater Vishakhapatnam monetary savings from LED installations

Sl. No.		Before LED installation		After LED installation		
	Month	Units in Lakhs	Amount in Lakhs	Month	Units in Lakhs	Amount in Lakhs
1	Jan-14	23.80	194.63	Jan-15	12.70	93.07
2	Feb-14	23.89	186.14	Feb-15	12.72	94.93
3	Mar-14	17.08	174.09	Mar-15	11.85	90.19
4	Apr-14	19.60	161.96	Apr-15	12.34	102.21
5	May-14	18.01	140.30	May-15	10.92	81.68
6	Jun-14	17.22	145.07	Jun-15	10.79	96.21
7	Jul-14	16.80	144.21	Jul-15	10.09	90.89
8	Aug-14	17.57	145.82	Aug-15	11.33	103.65
9	Sep-14	18.81	166.02	Sep-15	11.78	111.45
Total		**172.78**	**1458.24**		**104.52**	**864.28**

Directorate of local bodies, department of local self-government, Rajasthan

The department of local self-government (LSG) is the controlling department of all municipalities for all administrative purposes. The functions of monitoring and co-ordination for all the 190 municipal bodies of the state is also carried out by this department. The directorate of local bodies, works at the behest of this department and looks after the day-to-day functioning of all the ULBs

Street lighting project: The state government signed a MoU (Memorandum of Understanding) with Energy Efficiency Services Limited for replacing conventional type sodium lights and tube lights with LED lights. Energy savings observed under this project are mentioned below[57]:

Table 90: Energy savings in department of local self-government, Rajasthan

Energy saving observed	
Energy consumption before implementation of project (2014-15)	399.23 Lakh kWh
Energy consumption after implementation of project (2015-16)	155.25 Lakh kWh
Saving in consumption	243.98 Lakh kWh
Saving in %	61%
Energy cost incurred before implementation of the project (2014-15)	Rs 3193.84 Lakhs
Energy cost incurred after implementation of the project (2014-15)	Rs 1242 lakhs
Financial saving in Rs	Rs 1951.84 Lakhs
Financial saving in %	61%

By 2015-16, installation of LEDs had been completed for 11 ULBs which include Jaipur, Ajmer, Pushkar, Dholpur Bhiwadi, Ratangarh, Ratan nagar, Pali, Churu, Mount Abu and Udaipur.

Pune Municipal Corporation (PMC), water supply energy efficiency project

The objective of the undertaking was to demonstrate that harnessing efficiencies at the juncture between municipal water and energy could immensely help ULBs to address their urban water and energy challenge at the same time. As a result of the implementation of this program, PMC experienced annual energy savings of 37.8 lakh kWh and annual cost savings of over 1.48 crore. The savings achieved were significantly higher than those that were projected in the initial energy audit report[58]. Additional benefits from the program are summarized below:

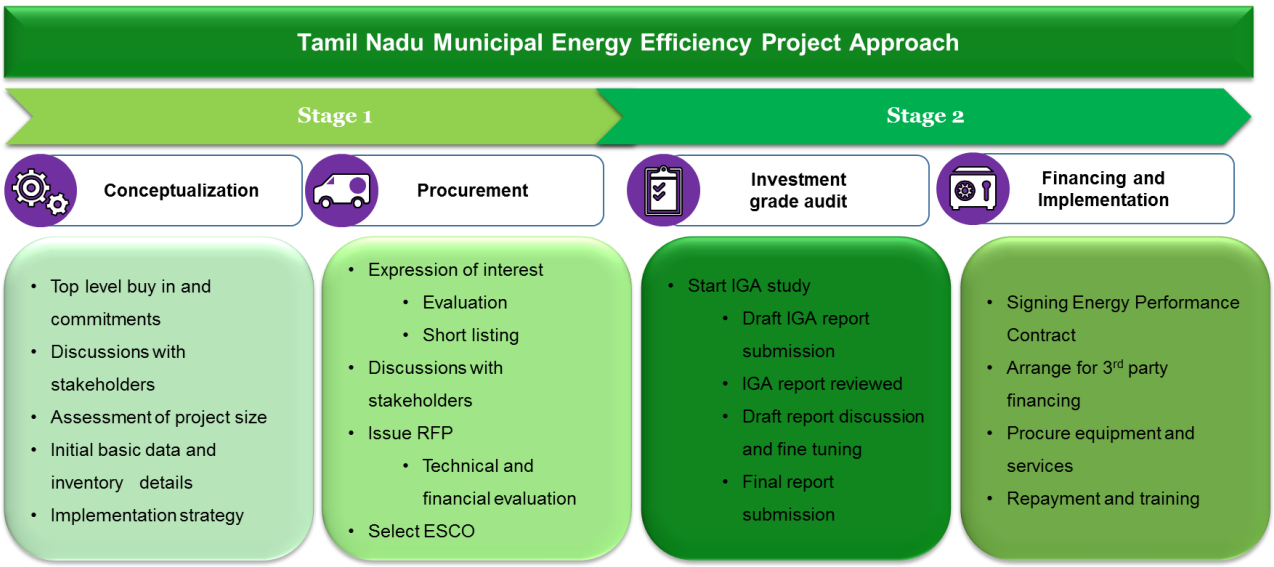
- 10 per cent additional delivery of water to the community without adding to the capacity
- Saving additional money by qualifying for a rebate program offered by the Maharashtra State Electricity Board. Under the program, a rebate was offered to the facilities maintaining a good power factor and reducing usage during peak hours. Example: Parvati Water Works increased its rebate by almost 8 per cent since fiscal year 2003–04, from Rs 48.57 lakh to Rs 86.27 lakh.
- PMCs program led the way in Maharashtra as various other ULBs like Thane, Nagpur and the Municipal Corporation of Greater Mumbai undertook similar efforts.

Bundled municipal energy efficiency program, Tamil Nadu

The program was set up as an experimental project that bundled municipalities for implementation of energy efficiency in water pumping and street lighting by Energy Service Companies (ESCOs) through Energy Performance Contracts (EPC). The conceptualization, planning and implementation of the project was carried out in two stages as shown below[58]:

[57] http://knowledgeplatform.in/wp-content/uploads/2017/02/16.-General-Category-sub-sec.pdf
[58] Mainstreaming Energy Efficiency in Urban Water and and Wastewater management in the wake of climate change (2017), MoUD

Figure 9: Tamil Nadu Energy Efficiency Project Structure



2.1.6. Energy efficiency programs by Panchayats

A list of demonstration projects and village campaigns carried out across the country are mentioned below:

Table 91: List of energy efficiency demonstration projects and village campaigns

State	Year	Details of Village Campaign	Number of appliances covered through the project	Projected energy savings in (kWh)
Andaman & Nicobar	FY 2012-13	LED village campaign at Caddlegunj village at Farrargunj Tehsil, S/Andaman in 142 households	5W LED Bulbs – 120 nos., 6W LED Bulbs - 240 nos., 8W LED Bulbs – 120 nos.	24440
		Installation of LED street lighting in Caddlegunj village	116W LED Street Lights – 25 nos	6460
	FY 2015-16	LED village campaign at Tapong village in Kamorta Island	8W LED Bulbs – 150 nos., 12W LED Bulbs – 225 nos.	25733
		Installation of LED street lighting at Tapong village	25W LED Street Lights – 25 nos.	5475
		Installation of LED street lighting at Kinyuka village under Sansad Adarsh Gram Yojana (SAGY)	25W LED Street Lights – 50 nos.	-
Andhra	FY 2015-2016	LED Street Lighting project in Gram	LED Street Lights- 540	-

State	Year	Details of Village Campaign	Number of appliances covered through the project	Projected energy savings in (kWh)
Pradesh		Panchayats has been implemented in 6 villages in on 50-50 funding basis limited to Rs. 1 lakh contribution from each side		
	FY 2016-2017	LED street Lighting Project in Gram Panchayats has been implemented in 4 villages in FY2016-17 on 50-50 basis covering the entire village street lights.	-	-
Arunachal Pradesh	FY 2012-2013	LED village Campaign in 8 villages	Installation of 1600 nos. of 16W LED bulbs	416000
Assam	FY 2014-2015	LED village campaign in 2 villages. Freely distributed 7W LED bulb and installed 18W LED Street lights	-	147387
Gujarat	FY 2016-2017	5000 nos. LED Street Lights in selected village of Gujarat (18w) installed in 40 nos. of villages	5000 LED street lights	675000
Karnataka	FY 2016-2017	LED street lights project at 45 villages in BESCOM Jurisdiction under Phase – I (Govt. of Karnataka fund)	3750	480004
		LED street lights project at 30 Villages in BESCOM Jurisdiction under Phase –II (Govt. of Karnataka fund)	3014	591298
Kerala	During XII plan period	LED Village campaign at Alappuzha, Nilambur and Vithura	4600	15400

A brief mention about some of the progressive panchayat schemes are mentioned below:

Bhintbudrak, Tapi distrit, Gujarat

Bhintbudrak is one of the richest in terms of dairy products in the state of Gujarat, with each family owning up to six buffaloes. With the high availability of dung in this village, Surat Milk Union Limited (SUMUL) dairy started a community biogas plant, with a network of pipeline grid through the village,

supplying cooking biogas to the village. The slurry output from the plant was vermin-composted to produce organic fertilizer, and sold. Villagers received cooking gas for two hours in the morning and two hours in the evening[59]. In addition to that, the sale of the organic fertilizer made the whole process more feasible. A brief overview of the project is presented below:

Table 92: Bhintbudrak project overview

Parameter	Description
Ownership	Village co-operative society
Number of beneficiaries	121
Feedstock	Cattle dung
Capacity	4000-4500 kg per day
Size of digester	2*85 m^2
Digester type	Floating type
Auxiliary systems	Mechanized mixing of dung and water, pressure regulating tank, network of pipes for distribution, water supply from nearby tank, emergency diesel generator, vermin compost sheds
Input rate	3.5 tonne per day
Water	1:1
Slurry	Vermi compost made out of a fraction of total output slurry of 2.5 tonnes per day
Gas supply	Underground pipes from the plant to the beneficiaries
Gas availability	2 hours each in the morning and the evening

The reduction in GHG happens due to the conversion of methane (CH4) into cooking fuel which further helps in prevention of deforestation for firewood. This has resulted in an annual carbon credits worth of USD 3900, at around USD 10 per tonne of CO2[60].

Pilicode gram panchayat, Kerala

Pilicode gram panchayat in Kerala, along with the Energy Management Centre (EMC), Kerala's SDA, and Kerala State Electricity Board (KSEB) conducted a DSM program spanning one year, resulting in a bimonthly reduction of 1,20,328 units power consumption in the panchayat[61]. An awareness program was carried out by approximately 650 volunteers, trained in energy conservation, wherein they visited each household to create awareness about power consumption of different types of lighting appliances and usage during peak hours i.e. 6 pm to 10 m. The panchayat set a goal to be 'filament bulb free' and worked with EMC and KSEB to distribute subsidized LED bulbs to all households, shops and establishments. Street lights and lighting in all government buildings were replaced with LED fixtures. Government buildings also replaced inefficient ceiling fans with 5-star rated fans.

[59] Raising the Sustainability Quotient (Jan – Mar 2014), Bombay Chamber of Commerce and
[60] Biogas for Rural Communities (May 2011), CTARA – IIT Bombay
[61] State Energy Efficiency Preparedness Index (2018), AEEE

Energy efficiency in gram panchayats, Odisha

The project which was carried out from September 2009 to December 2011 covered 5 villages: Khuard, Uparkundi, Purunapani under Jaleswar Block and Badakhudi & Chakrada under Basta block of Balasore District. Some of the activities that were carried out as a part of the program are as follows[62]:

- Raising awareness about energy saving practices through focus group trainings by targeting gram panchayats and SME entrepreneurs, school meetings and village meetings
- Identifying energy champions in each village and formation of VEC (Village Energy Committee), which develops the sustainable village energy plan
- Installation of energy meters in different households to know the electricity consumption in households, before and after interventions
- Developing a plan for cost sharing mechanism with the local community to foster local ownerships through the VECs
- Exploring possible linkages and co-financing from various agencies to address the issues of introducing smokeless chulha, solar street lights, etc.

Rashtriya Gram Swaraj Yojana

The scheme is to be implemented from 2018 to 2022 and would help Panchayati Raj Institutions (PRIs) to develop governance capabilities to achieve Sustainable Development Goals (SDGs) through inclusive governance and focusing on the optimum utilization of available resources. Under the Gram Swaraj Abhiyan campaign that was implemented between 14th April and 5th May 2018, EESL reached out to 16000 villages, which had a significantly large number of low income households, through the flagging off of the UJALA van that made LED bulbs available to these households at Rs. 50[63].

2.1.7. Other policies/programs

Montreal protocol and Kigali meeting

In the mid-1980s, scientists discovered a thinning of the ozone layer that forms naturally in the stratosphere, over Antarctica. The reason for this ozone depletion was pinned on the increasing presence of a group of chemicals in the atmosphere called chlorofluorocarbons (CFCs) which were commonly found in white goods such as refrigerators, room air conditioners, fire extinguishers and aerosol cans. Serious health and environment consequences were also linked to ozone depletion as a result of which in 1987, world leaders signed the Montreal Protocol, an agreement for the complete phase out of Ozone depleting substances (ODS). The Montreal Protocol has been ratified by 197 countries and is one of the most successful international environmental treaties in history[64].

[62] http://www.sgpindia.org/documents/Energy_Efficiency.pdf
[63] https://www.eeslindia.org/DMS/gsy.pdf
[64] United Nations Environment - Ozone Parliament, http://ozone.unep.org/montreal-protocol-substances-deplete-ozone-layer/32506

The Montreal Protocol identified both first generation and second generation ozone-depleting substances[65]. The treaty was designed to restore the ozone layer by ending production of ODSs and by encouraging alternative substitutes through a systemic phase-out.

Table 93: First generation ODS

Chemical group	Production phase out dates	Deadline met
Halons	January 1, 1994	Yes
CFCs	January 1, 1996	Yes
Carbon tetrachloride	January 1, 1996	Yes
Hydrobromofluorocarbons (HBFCs)	January 1, 1996	Yes
Methyl chloroform	January 1, 1996	Yes
Chlorobromomethane	August 18, 2003	Yes
Methyl bromide	January 1, 2005	Yes

The Kigali meeting amended the 1987 Montreal protocol by aiming to phase out Hydro fluorocarbons (HFCs) by the late 2040s. The agreement has three different roadmaps for different countries[66]:

- Developed economies like the USA and EU would start to limit their use of HFCs within few years and make a reduction of at least 10% 2019 onwards. Overall, these economies would have to reduce HFCs to about 15% of 2010-12 baseline levels by 2036
- China, Brazil and other developing economies would have to freeze HFC levels by 2024, cutting it to 20% of 2020-22 baseline levels by 2045
- India, along with countries like Iran, Pakistan, Saudi Arabia, etc. belongs to the 3rd group of countries that would have to freeze HFC levels by 2028and reduce them to about 15% of 2024-26 baseline levels by 2047

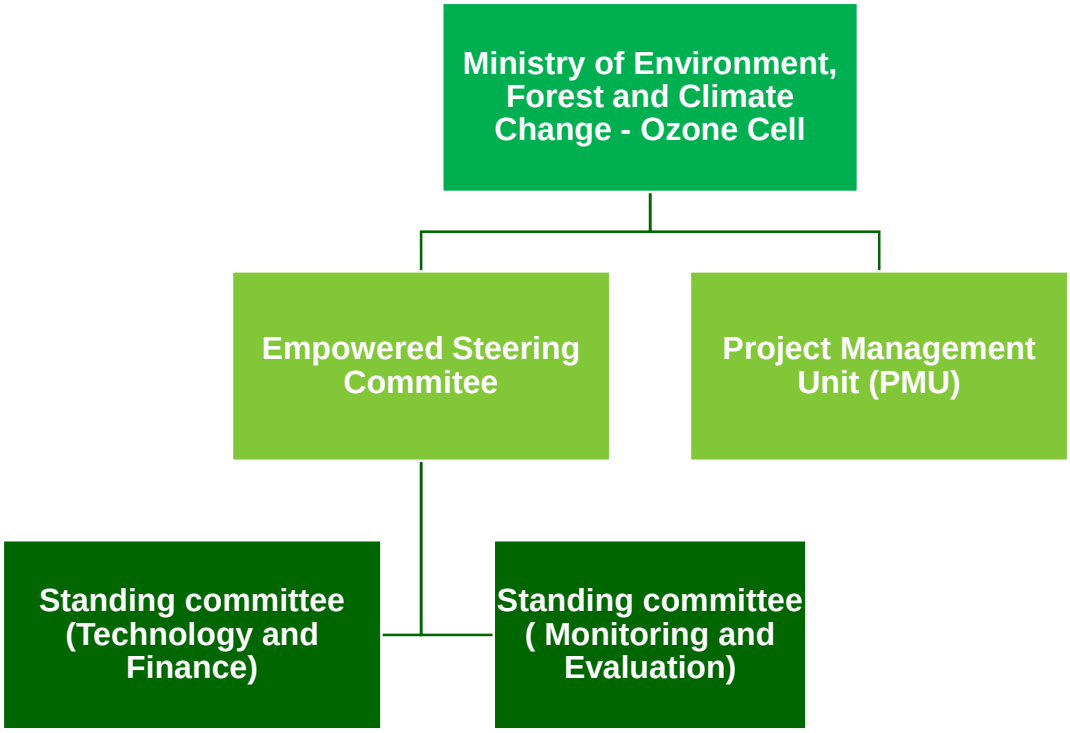
Steps taken by India after ratifying the Montreal protocol

Institutional framework

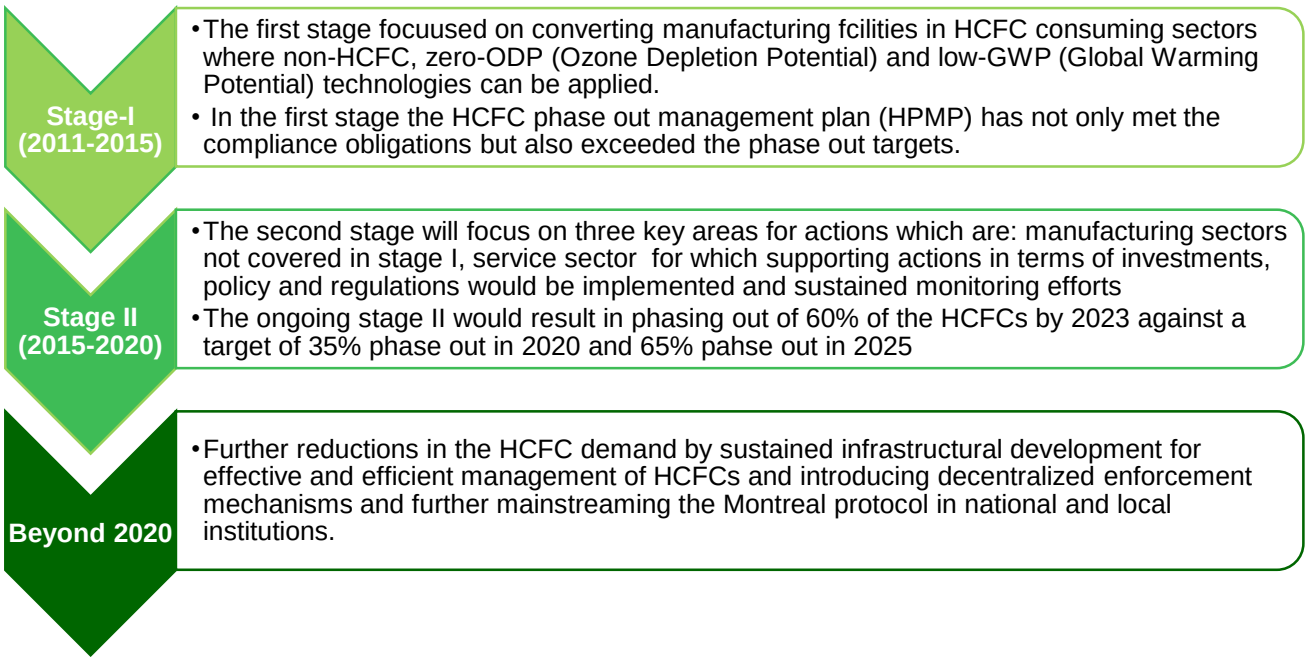
The Government of India designated the Ministry of Environment, Forests and Climate Change (MoEFCC) as the nodal ministry for the Montreal Protocol. Within MoEFCC, the Ozone Cell functions as a special directorate, dedicated to managing and coordinating the implementation of the Montreal protocol in India. The various functions of the Ozone cell include notifying various regulations pertaining to the Montreal protocol, handling issues related to international co-operation, maintaining and managing data on the production, imports, exports and consumption of ODS, working together with scientific, technical and other public institutions for technical matters, etc. The institutional arrangement for implementation of the Montreal protocol in India is depicted below[67]:

[65] The Montreal Protocol and its implications for climate change (Oct 2009), Environmental and Energy Study Institute
[66] https://www.insightsonindia.com/wp-content/uploads/2016/10/Kigali-Agreement.pdf
[67] India HCFC Phase-out management plan (HPMP Phase – 1) for compliance with the 2013 and 2015 control targets for consumption of Annex – C, Group – I substances, Ozone Cell, MoEF

Figure 10: Institutional arrangement for implementing Montreal Protocol in India



Strategic roadmap for HCFC phase out management plan (HPMP)



2.1.8. Conclusion

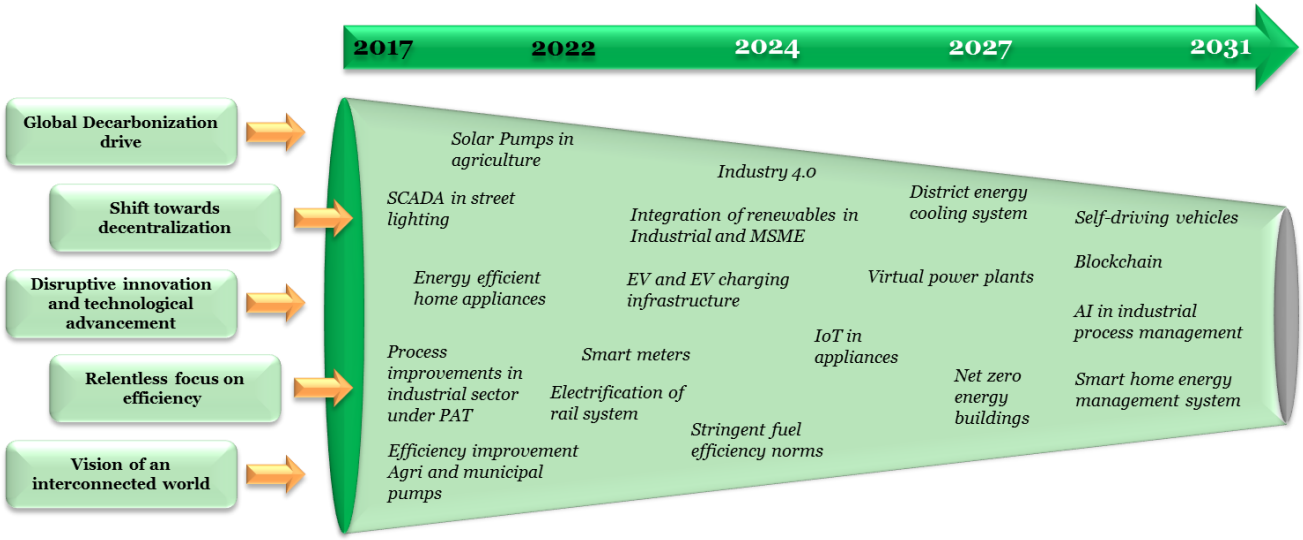
A detailed mapping of various programs and policies, at the national, state, municipal and panchayat level have been analyzed based on their impacts on sectors and sources of energy. The impacts that have been stated above are used as inputs while developing sectoral models and estimating the energy demand and saving potential, the latter of which is presented in the next chapter.

3

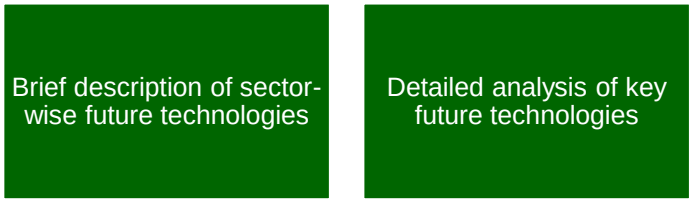
FUTURE TECHNOLOGICAL ADVANCEMENTS IMPACTING ENERGY EFFICIENCY

3.1. Introduction

Energy underpins every aspect of modern life, driving economic growth and prosperity and as a result has a direct link to people's standard of living. The emerging technological innovations are creating new opportunities for progress of energy efficiency. It is creating exciting new opportunities for integrated solutions where efficiency and renewable energy work together to deliver clean energy outcomes at the lowest cost. In this chapter, we have explored key future technologies that would impact each of the demand sectors. Some of the key trends that would drive significant transformation includes global De-carbonization drive, a shift towards decentralization, disruptive innovation and technological advancement, relentless focus on efficiency and vision of an interconnected world.



The following sections have been covered in this chapter:



3.2. Sector-wise future technologies/innovative interventions

This section covers a brief description of sector-wise future technologies that might impact energy consumption.

3.2.1. Agriculture sector

Efficient Star Rated Pumps

With an estimated 21 million agricultural pump sets connected to the power grid in India, irrigation becomes a substantial cost in agriculture. Locally made pump sets used for irrigation are both inefficient and unreliable, causing massive water waste and higher energy consumption. While the

efficiency of a local pump is usually in the range of 25-35%, the efficiency of a star rated energy efficient pump sets (EEPS) is in the range of 45% - 50%. Studies reveal that there is an energy saving potential of 25% - 40% from replacement of inefficient pumps with efficient pumps.

Solar Pumps

The introduction of solar pumps would change the fuel mix in the water pumps sub-sector, which has been predominantly served by diesel and electricity. With the adoption of solar pumps, farmers would no longer have to be dependent on grid supply for their irrigation requirements and also have an option to generate a supplementary source of revenue by selling excess electricity generated back to the DISCOM. The government has lately launched Kisan Urja Suraksha evam Utthaan Mahaabhiyan (KUSUM) scheme to promote solar farming among farmers.

Precision Farming

The use of information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource comes under the general purview of precision farming. Precision farming involves looking at the increased efficiencies that can be realized by understanding and dealing with the natural variability found within a field.

Industry 4.0 in agriculture

Beyond the introduction of new tools and practices, the real promise of Agriculture 4.0 in terms of productivity increase resides in the ability to remotely collect, use, and exchange data. A first range of application is the use of IoT to collect and publish information on the production processes and the farm.

Artificial Intelligence

The emergence of new age technologies like Artificial Intelligence (AI), Cloud Machine Learning, Satellite Imagery and advanced analytics will create an ecosystem for smart farming. Fusion of all these technologies is enabling farmers achieve higher average yield and better price control.

Smart Control Panels

Smart control panels would provide easy control for the farmers by allowing remote monitoring and would contribute in reducing hours of pump usage, resulting in energy savings. EESL has advanced the AgDSM program and has started distributing Smart Control panels along with Energy efficient pump sets (EEPS).

3.2.2. Transport sector

The prospective technological advancements in the transport sector are provided for road, air and rail transport.

Road transport

Alternative fuel vehicles

Penetration of alternative fuel vehicles such as electric vehicles, fuel cell vehicles and biodiesel vehicles would impact the energy mix and emission profile of the country.

Vehicle to vehicle and vehicle to infrastructure communication

Smart and efficient transfer of information between vehicle and infrastructural setup using in-vehicle telematics.

Alternative combustion

Use of Homogenous Charge Compression Ignition (HCCI), Premixed Charge Compression Ignition (PCCI) and other alternative combustion techniques along with computational fluid dynamics (CFD) and chemical kinetic modelling.

Fuel efficiency

Increasing fuel injection pressure up to 3000 bars to improve thermal efficiency and reduce emissions. Improvement of thermodynamic cycles for engines with thermal efficiency >70%.

Improvement in battery technology and infrastructure

High capacity Lithium ion/ Ni-MH (Nickel Metal Hydride)/ Lithium-air batteries. Building public chargers and quick change battery stations.

Self-driving and situationally aware vehicles

Self-driving vehicles with autonomous driving capabilities with limited or no human interventions.

Air transport

Airframe system and materials

Computational fluid dynamics for design analysis and flow diagnostics combined with additive manufacturing (3-D) printing.

Alternative fuel

Development of next generation energy solutions based on low cost alternative fuels. Alternate energy would include Biomass to fuel or bio jet, synthetic paraffin kerosene, biodiesel, etc.

Nano technology

Advanced nano-modified composites, engineered materials and carbon nano tubes, adaptive materials for better aerodynamics and drag reduction.

Automation

Deployment of ATM (Air traffic management) automation systems with decision support functionality and SWIM (System Wide Information Management) for efficient management of flight operations.

Engine

Design and development of engine components, materials and subsystems like Advanced Direct Drive (ADD), Geared turbofan, Counter-Rotating Fan and other new engine core concepts.

Rail transport

Energy efficient traction with regeneration

Every type of electric traction rolling stock must have regenerative capability and feedback to the grid with development of suitable energy recovery devices.

Development of hydrogen fuel cell based locomotives

Development of hybrid electric-cum-fuel cell locomotives. The initial focus can be on low power shunting engine of a rail car.

Tapping piezo-electric power (floors) for energy needs

Development of suitable technology to derive piezoelectric power from the floors of station area made of piezoelectric crystals.

Captive development of alternate fuels for traction

Alternate fuels like Bio-diesel, CNG/LNG are cheaper than diesel and have potential to replace diesel as a preferred choice for traction fuel.

High speed technologies

Capability to model panto-catenary interaction at high speeds, especially with multiple locomotives attached to the train with high speed bogie and suspension arrangement.

3.2.3. Domestic and Commercial Sector

District cooling system

District cooling distributes thermal energy in the form of chilled water from a central source to residential, commercial, institutional and industrial consumers for use in space cooling and dehumidification. Thus, the cooling effect comes from a distribution medium rather than being generated on site at each facility. A district cooling system consists of a central chiller plant, the distribution/piping network and the consumer systems.

Induction Cook Stoves

Induction cook stoves have steadily gained a foothold in urban Indian households, much in the similar fashion that gas stoves were replacing oil-filled stoves about a couple of decades ago. Gas

stoves were bought by Indian households for being efficient, economical and non-polluting, and today the characteristics of the induction cooker are the same and at the same time it scores several times better on almost all counts than LPG.

Access to reliable electricity supply in rural areas remains a major barrier to the penetration of electricity based cooking. Although just over one percent of rural households used an electric or induction stove in 2015, only 0.01 per cent of households used it as primary cooking energy[68].

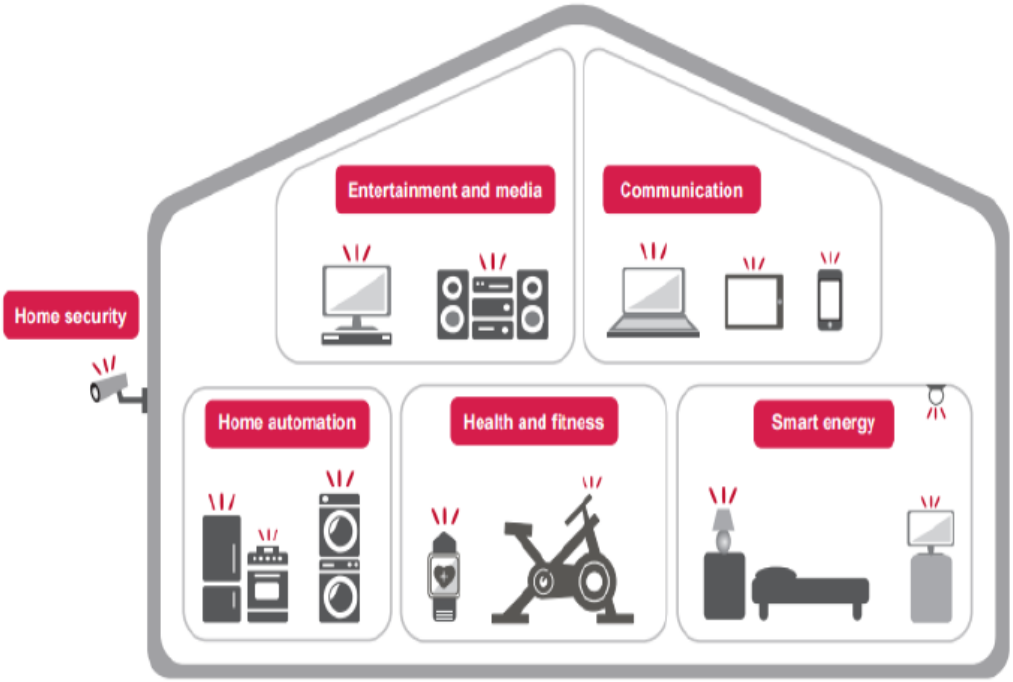
Net Zero Energy Buildings

Net or nearly zero energy buildings (NZEB) are highly efficient buildings with extremely low energy demand, which is met by renewable energy sources. Such buildings produce as much energy as they consume, accounted for annually. In order to achieve their net zero energy goals, NZEBs must first sharply reduce energy demand using energy efficient technologies, and then utilize renewable energy sources (RES) to meet the residual demand. In such buildings, efficiency gains enable the balance of energy needs to be supplied with renewable energy technologies. This is the most logical approach to reach NZEB goal[69].

Smart home automation systems

A smart home is one that incorporates advanced sensing and automation systems to provide the inhabitants with monitoring and control regardless of whether they are inside or outside the home. For example, a smart home may have controls for lighting, temperature, multi-media, security, window and door operations, as well as many other functions[70].

Figure 11: An illustration of a smart home



[68] Access to clean cooking energy and electricity – Survey of States (Sep 2015), CEEW
[69] Net Zero Energy Buildings, http://www.nzeb.in/definitions-policies/definitions/
[70] M2M/IoT enablement in Smart Homes (Mar 2017), TEC

3.2.4. Municipal

Supervisory control and data acquisition (SCADA)

This system can be applied to city water supply and sewage systems. In 2014, the Bangalore Water Supply and Sewerage Board (BWSSB) signed a contract with Yokogawa India Limited to set up a SCADA system for monitoring the city's water supply network and wastewater systems. SCADA system maximizes the pump performance and can be utilized for the management of Public Waterworks in India.

Adaptive Lighting

Adding smart controls to street lighting can increase the energy efficiency can yield an additional saving of 15%-30% of energy. Adaptive lighting is the alteration of the output or duration of lighting in response to demand, real-world lighting conditions, or other parameters. There are various methods where adaptive lighting can be applied like constant lumen output (CLO), Lumens on the Road (LOR), etc.

Central Control Monitoring System (CCMS)

Central Control Monitoring System (CCMS) is a system to remotely monitor the operation and utilization of streetlights and to thus, monitor the energy consumption. Groups of streetlights are equipped with communication modules and energy monitoring modules, which update the system. It monitors the voltage, current, power factor and cumulative Kwh and kVAh.

3.2.5. Industrial

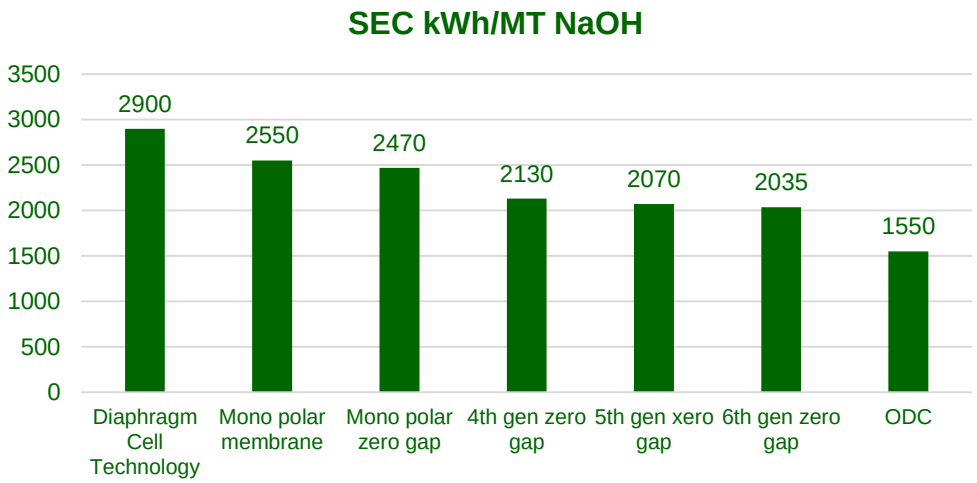
Chlor Alkali sector

The size of Indian Chlor-Alkali sector stands at 3.3 Million tonnes, which is 4% of the world market. In PAT cycle-I, 22 designated consumers, located across the country had been identified and assigned mandatory energy reduction targets. It has been observed that the overall increase in production grew at a CAGR of ~3% annually from 2008-09 to 2015-16. Similarly, the share of electrical usage from CPPs have increased, thereby reducing the dependency on grid. The import of electricity from the grid has decreased by almost 35% in 2015-16 when compared to 2009-10.

The Chlor-alkali sector has witnessed a shift in technological aspects i.e., from the up gradation of mercury cell technology to the latest generation of membrane cell zero gap technologies. With the development of the ODC technology, it is expected to reduce the specific energy requirement of the process to as low as 1550 kWh/MT caustic soda[71]. Comparing this technology to that of the early mercury cell technology, the specific energy requirement is reduced to more than half of its predecessor technologies. A comparison of various technologies for specific energy requirements to manufacturing caustic soda is shown below:

[71] Outcome evaluation study for PAT Cycle-1, BEE-GIZ

Figure 12: Benchmark of various technologies for NaOH production



Some of the significant energy efficient technologies and best practices that can be adopted in the Chlor-alkali sector are as follows:

- Upgrading to 6th generation (Zero type) Cell in Electrolyzer
- Installation of Back Pressure Turbine to eliminate throttling from HP to LP steam and recover power
- Recovery of waste heat for process heating and/or power generation
- Feeding of 48% caustic soda lye at 90^{o}C directly to caustic concentration unit from caustic evaporation unit
- Installation of VAM to recover waste heat from 48% CSL
- Installation of screw chiller
- Optimization of electrolyzer for current consumption by monitoring cell voltages and replacing membranes in time.

Fertilizer sector

Fertilizer industry in India with the total production of about 38.6 million tonnes of fertilizer products is second largest producer of fertilizers in the world. In PAT Cycle-I, 29 designated consumers located in various states had been identified and assigned mandatory energy reduction targets.

The 29 designated consumers that were considered under PAT Cycle-I were only ammonia/urea producers. A significant change in the sector has been the adoption of natural gas as feedstock of fuel oil and naphtha. This increased the efficiency of the plants by a good margin. Some of the plants were re-vamped to make use of natural gas as feedstock. This switch from fuel oil to natural gas has brought about a significant reduction in SEC. Some of the significant energy efficient technologies and best practices that can be adopted in the fertilizer sector are as follows:

- Replacement of Urea stripper with Bi-metallic stripper, replacement of trays in Urea reactor with high efficiency trays, suction cooling of CO2 compressor, installation of MP Pre-decomposer for recovering heat from vapors of decomposer, installation of pre-concentrator before vacuum concentration section and HP Urea hydrolyser.

- Vapor absorption refrigeration (VAR) to utilize low level heat to generate chilled water and using the same to reduce section temperature of air/process gas at suction of respective compressor, use of radial-axial flow converters, additional heat recovery from furnace flue gases, and additional purification of synthesis gas.

Cement sector

The Indian cement industry is one of the most energy intensive industries which has a robust growth trajectory over the past decade. India is the 2nd largest cement producer as well as consumer in the world led by the enormous growth in the infrastructure and construction sector for the last two decades. Under the first PAT Cycle, 85 DCs were notified and assigned mandatory energy reduction targets.

Some of the significant energy-efficient technologies and best practices that can be adopted by the cement sector are as follows:

- Installation of waste heat recovery systems

- Installation of vertical grinding mills, VAM, high recuperation efficiency hydraulic cooler

- Installation of high efficiency screw compressor.

- Increasing the usage of AFR in the kiln, the number of stages of pre-heater

- Installation of high efficiency 3rd generation air-separator.

Aluminum sector

The best specific energy consumption figures for different process paths are mentioned below. The SEC values shown below are taken by considering the best practices implemented in that process per tonne of product in order to compare with various processes[71].

Table 94: Global vs Indian best practices in the aluminum sector

Production	Global Best	Global Average	India Average	India Best Numbers	Unit
Alumina Refinery	0.20	0.267	0.33	0.23	TOE/tonne of Alumina
Aluminum Smelting	113599	14145	14361	14558	kWh/tonne of molten aluminum

Some of the significant energy-efficient technologies and best practices that can be adopted by the aluminum sector are as follows:

- Implementation of slotted anode in pots
- Reduction in stub to carbon voltage drop
- Eco-contact to reduce voltage drop at conductor joints
- Use of self-developed fuel “CRYSTAL” additive for dozing inside the furnace
- Intelligent soot blowing system, installation of VFD and highly efficient screw compressor.

Iron and Steel sector

The iron and steel sector in India is on an upswing because of the strong global and domestic demand. In 2015-16, India produced 90 MT of crude steel and attained the position of 3rd largest steel producer in the world, after China and Japan. The best specific energy consumption in the world achieved in the world by a plant is 5.38 GCal/tcs. The best specific energy consumption of Indian plant is 5.67 GCal/tcs in the financial year 2016-17. The India and global best specific energy consumption for iron and steel is mentioned in the table below[71]:

Table 95: Global Vs Indian best practices in Iron and Steel Industry

Particulars	Units	Global best	India Best	India Average
Specific energy consumption	GCal/tcs	5.38	5.67	7.171

The best specific energy consumption for various process path are mentioned in the table below. The minimum specific energy consumption mentioned are arrived at by adding the best specific energy consumption in individual sections where best practices on energy saving are implemented and is not related to a single plant[71].

Table 96: Best specific energy consumption for various process flow path on world's best practices

Process path	GCal/tonne of steel
Blast furnace-basic oxygen furnace-thin slab casting	3.53
Smelt reduction-basic oxygen furnace-thin slab casting	4.25
Direct reduction iron-Electric Arc furnace-Thin slab casting	4.06
Scrap-Electric Arc Furnace-Thin slab casting	0.62

Some of the significant energy-efficient technologies and best practices that can be adopted by the iron and steel sector are as follows:

- Use of 100% pellets as iron burden reduce coal consumption, improves better metallization of pellets, reduces fines generation and iron ore loss and improves work environment.
- High top pressure blast furnace also provides an ideal opportunity for recovering energy from the large volumes of pressurized top gas. TRT can be used to generate electricity from this high top pressure.
- Waste heat recovery from DRI process reduces massively the need for external fuel like coal for generating the same amount of electricity.

- Direct rolling of hot continuous cast billet to produce TMT bars and therefore, completely avoided uses of furnace oil in reheating furnace

- Insulation of hot surface in after burning chamber and dust settling chamber in 500TPD kiln. Surface to be covered with Rockwool and GI sheet cladding to reduce hot surface temperature from 150°C to 60°C

Paper and pulp

The Indian paper and pulp sector accounts for about 3% of the world's production of paper. The paper and pulp sector has been categorized on the basis of raw materials usage: wood based units, agro based units, recycled fiber based units and 100% market based pulp. Presently the share in production of paper from wood based raw materials, agro and recycled/waste paper is 31%, 22% and 47% respectively. The table below gives the electrical and the thermal energy consumption of paper sector (raw material wise), the global and Indian trend[71]

Table 97: Specific energy consumption (Global vs India)

Industry group	Particulars	Unit	Global avg.	India avg.	Industry benchmark
Wood based Mills	Specific electrical energy consumption	kWh/tonne of paper	1000-1100	1400-1500	1200
	Specific steam consumption	Tonne of steam/tonne of paper	7-9	12-13	9
Agro based mills	Specific electrical energy consumption	kWh/tonne of paper	-	1200-1400	1000
	Specific Steam consumption	Tonne of steam/tonne of paper	-	12-14	10
Recycled fiber based mills producing unbleached grades	Specific electrical energy consumption	kWh/tonne of paper	500	450-500	400
	Specific steam consumption	Tonne of steam/tonne of paper	2.5	4-5	3.5
Bleached grades	Specific electrical energy consumption	kWh/tonne of paper	600-650	680-800	570
	Specific steam consumption	Tonne of steam/tonne of paper	4-4.5	6-7	5

Some of the significant energy-efficient technologies and best practices that can be adopted by the paper and pulp sector are as follows:

- Chemical pulp mill: Lime kiln oxygen enrichment, carbon dioxide washing aid, digester blow heat recovery system, use of pulping aids to improve yields.

- Paper machine: Use dryer bars and stationary siphons in rimming dryers, use a dryer management system, wet dry end broke surge tanks, variable speed thick stock basis weight control, paper machine hood heat recovery.

- Utility plant: Black liquor in recovery boiler, modified soot blower operation, distributed boiler control system, recovery heat from boiler blow down and upgraded boiler burner.

Textile sector

India's textile industry has been predominantly cotton-based since its inception with about 65% of fabric consumption in the country being accounted for by cotton. Some of the significant energy-efficient technologies and best practices that can be adopted by the textile sector are as follows:

- Use of variable speed drives in humidification plants and optimization of blade angle and their types matches with efficient operation, approach for direct drive instead of belt drive.
- Installation of photo cells for speed frames
- Use of electromagnetic ballasts instead of conventional electromagnetic chokes
- Reuse of condensate and recovery of heat from hot water.

Thermal power plant

The thermal power sector is one of the most energy intensive industries and was one of the 8 sectors that contributed to about 46% of the total savings target under PAT Cycle-I. For the overall thermal power sector, the number of cold/warm startup have increased by almost one-third and the number of hot startups have reduced by 23%. The variation in the number of cold/warm/hot startups can be attributed to various factors:

- Decreasing PLF of the power sector/load scheduling
- Resource unavailability (fuel, water, etc.)
- Environmental compliances
- Surplus electricity resulting in lower peak demands, hence, decreased hot startups.

Also, over the past years, there has been a decrease in the consumption of liquid and gaseous fuels, while the consumption of imported coal has doubled. Some of the significant energy-efficient technologies and best practices that can be adopted by the thermal power plant sector are as follows:

- Dynamic coal balancing
- Intelligent soot blowing system
- Installation of Vapour Absorption Machines (VAM)

3.2.6. MSME

Cross sector technologies

The technology drivers that are most probable to find cross-sector applications are listed below:

Table 98: Technology drivers in MSME

Sr. No.	Technology	Energy saving potential	Cross-sector applicability
1	Installation of VFD on motors	High	High
2	Improvement of insulation in thermal systems	High	High
3	Energy efficient pumping	High	High
4	Installation of energy efficient boilers	High	High
5	Energy efficient compressed air systems	High	High
6	Energy efficient cooling towers	Medium	High
7	Waste heat recovery in furnaces, ovens, etc.	High	High

In addition to above technologies, there are several futuristic technology drivers involving Industrial IoT and Industry 4.0 that also have cross-sector applications. They are:

- Rapid prototyping
- Artificial intelligence/ machine learning
- Robotics
- Digital traceability

Sector specific technologies

Sector-specific technologies are unique to respective sector and industrial processes. A list of key technologies for the key energy intensive sectors in presented below.

Foundry

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	Lid mechanism for Induction furnace	Energy efficient induction melting furnace with energy meter
2	Replace of Cooling Tower Fan blades from Aluminium to Fiber Reinforced Plastic (FRP)	Replacing inefficient conventional cupola by induction furnace
3	Conversion to Divided Blast Cupola	Induction Ladle Refining Furnace

Forging

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	Fuel switching from Furnace Oil to Natural Gas for Forging Furnaces	Replacement of existing F.O. fired furnace with energy efficient induction billet heater
2	Application of veneering module at LPG fired normalizing furnace	Installation of Microprocessor Based Pneumatic Clutch Operated, Screw Friction Presses

Engineering and auto-components

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	PLC based control system for furnace temperature control	CNC Milling/ Turning/ Machining centers
2	Waste heat recovery in ovens and furnaces	Servo controlled die-casting machines

Chemicals and pharma

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	Optimization of excess air in natural gas fired boiler	Replacement non IBR boiler with energy efficient IBR boiler
2	Optimization of air circulation pattern of tray dryer to maximum utilization of the heat in the dryer	Replacement of conventional horizontal agitator system with energy efficient agitator systems
3	Interlocking of blower with combustion cycle to avoid idle operation and residual heat loss	Flash Dryers or Rotary Vacuum Dryers (Product Drying)

Ceramics

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	Improvement in insulation in kiln, Spray Dryer resulting in saving in fuel consumption	Preheating of input slurry of spray dryer through solar energy resulting in saving in spray dryer fuel consumption
2	Installation of recuperator in tunnel kiln thereby preheating combustion air from flue gas	Installation of Natural Gas Turbine for electricity generation and use of exhaust flue gas of turbine in spray dryer

Plastics

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	Radiant barrel heater for molding machines	Installation of all-electric (all-servo) based molding machines
2	Accumulator controllers for hydraulic power packs	Micro-processor controlled tape stretching lines

Steel re-rolling

Sr. No.	Energy efficient retrofitting	Energy efficient equipment/replacement
1	Installation of hydraulic pusher for reheating furnace	Shell-in-shell type recuperator for reheating furnace
2	Modified coal firing system with atomizing air	Installation of anti-friction roller bearing and universal spindles and couplings

3.3. Analysis of key future technologies

This section covers a detailed analysis of key future technologies. In this section, each of the future technology is analyzed for their applications, impact on energy consumption, policy landscape, challenges in their uptake and recommendations for their promotion.

3.3.1. Electric Vehicles

Overview

The automobile industry worldwide is gradually witnessing a transformation towards alternative fuel solutions such as Electric Vehicles (EVs). EVs represent one of the most promising pathways to increase energy security, reduce carbon emissions, and improve air quality. Accordingly, major investments, incentives and policies are being introduced globally to propagate the development, manufacturing and adoption of EVs. Some of key rationale for this transformation are:

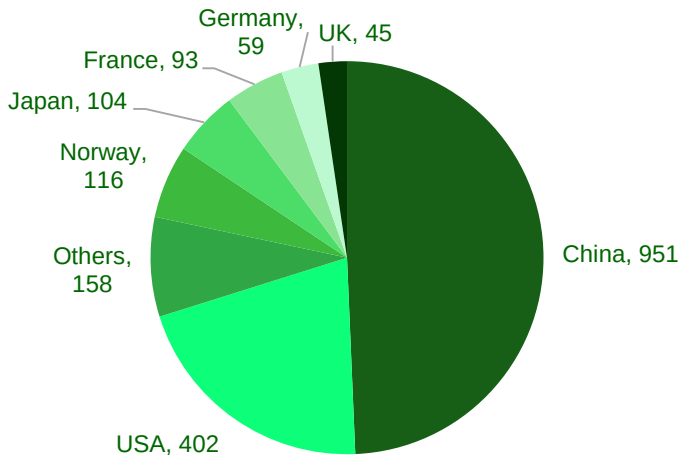
- Many Indian cities are among the world's most polluted and vehicular pollution is a prime reason
- India is obligated to bring down its share of global emissions and meets NDC targets by 2030
- India imports 82% of its oil requirements and there is scarce availability of fossil fuels in India
- India is estimated to spend USD 85 billion in FY 2018 on oil imports and automobile sector forms a bulk of this demand

As per SIAM reports, the electric vehicle penetration would reach 30-40% sales[72] by 2030. This would mean an electric load requirement of approximately 60 TWh by 2030.

Global Progress

India's EV industry is at a very nascent stage when compared with the other international markets. The early adopters of BEVs across the world includes China, USA, Japan, Canada and the six leading European countries which constitutes 95% of the BEV population. There are approximately 1 million BEVs in China as of 2017.

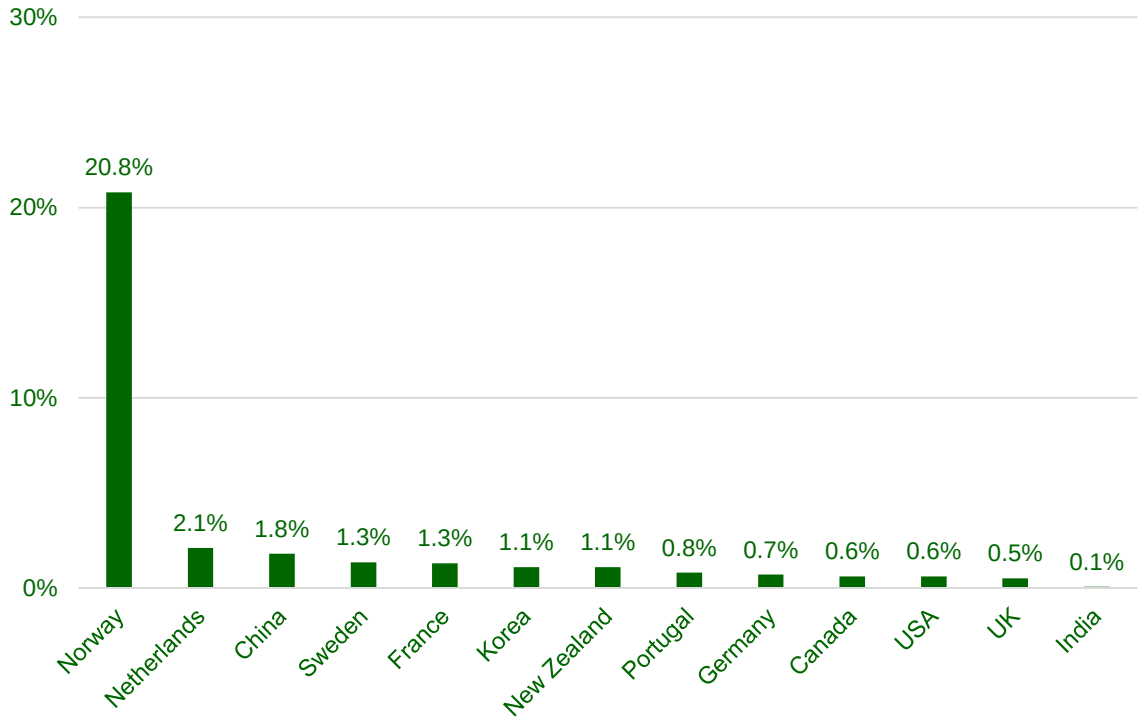
Figure 13: BEV Car stock by country (000s)



The market penetration of BEVs is highest in Norway wherein 21% of the total cars are BEVs. The market share of BEV cars in India as of 2017 is 0.1%.

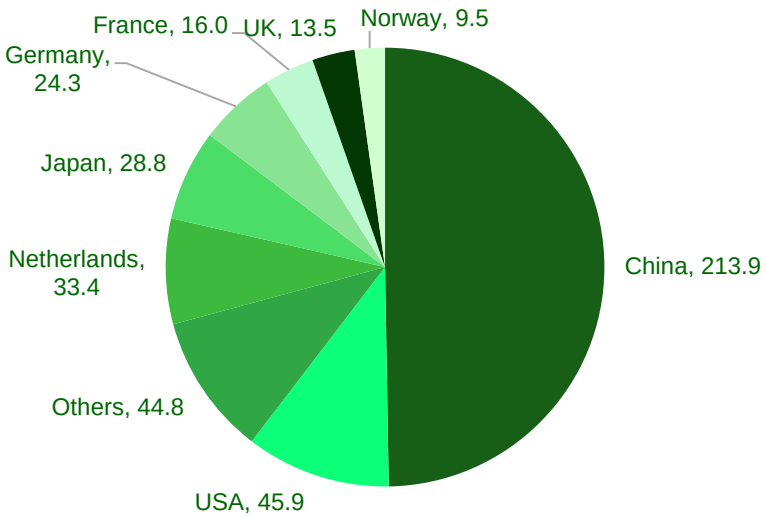
[72] https://auto.economictimes.indiatimes.com/news/industry/electric-vehicle-can-see-30-40-penetration-by-2030-siam/60468095

Figure 14: Market share of BEV cars (%)



China is a world leader in setting up of publicly accessible chargers with 213,900 chargers as of 2017. The number of publicly accessible chargers (slow and fast) in India is estimated to be 222 as of 2017[73].

Figure 15: Publicly accessible chargers by country - Slow and Fast (000s)



[73] Global EV Outlook 2018 – IEA, https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/globalevoutlook2018.pdf

Policy Initiatives

The key policy advancements over the years on the EV technology has been tabulated:

Table 99: Key policy advancements on the EV technology

Year	Initiative	Description
2010	MNRE initiative to promote EVs	India took an important step to promote electric vehicles (EVs) in 2010: Ministry of New and Renewable Energy (MNRE) proposed a 20% capital subsidy for EVs that resulted in a big uptake, mostly in the e-bikes segment
2011	National Mission of Electric Mobility (NMEM) by the Govt. of India	• To promote electric mobility through development and adoption of EVs • Approval to set up National Council for Electric Mobility (NCEM) and National Board for Electric Mobility (NBEM) • To form National Automotive Board (NAB) to provide technical advisory support
2013	National Electric Mobility Mission Plan 2020 (NEMMP 2020) by the Ministry of Heavy Industry	unch of NEMMP to achieve the following by 2020: • ~7 million sales of EVs • ~USD 2 billion savings in fuel • ~1.3%-1.5% reduction in CO2 emissions • Generate ~60,000-65,000 additional jobs
2015	Faster Adoption & Manufacturing of (Hybrid &) Electric Vehicles (FAME) by the Ministry of Heavy Industry	• Launch of FAME India pilot phase: • Envisaged budget of 7.95 billion INR (122 million USD) across two years • Allocation of incentives by technology / benefit • Eligible vehicle categories - 2W, 3W, 4W, LCV, HCV and Retrofit • Restricted to major metros, capitals, Smart Cities, cities in North-eastern states • **Govt. is planning to launch FAME-2** keeping the demand-side incentives and aggregation subsidies in mind
2018	40% Electric Mobility Sale by 2030	Recent target suggested by SIAM, which seems practical and achievable
	Clarification released by MoP on charging of an EV	MoP has issued a clarification declaring that EV charging would not be considered as resale/trading of electricity and hence, activity of setting up EV Charging Stations doesn't require any licence
	Technical and safety standards for charging stations	CEA has developed the draft technical and safety standards for charging stations and has uploaded on their website for public comments and opinions

Some of the recent public initiatives about EV technology includes:

- **FAME I scheme extended till Sep 30, 2018:** DHI has issued a notification on April 13, 2018 declaring that FAME I scheme will be extended till Sep 30, 2018

- **National committee on charging station standards:** EESL has been appointed as the steering department for the committee

- **State-level policies that might come in 2018:** Gujarat, Telangana and Andhra Pradesh, states with an automobile manufacturing base, are working on EV policy in line with the Karnataka EV policy and might release it shortly

- **Energy Efficiency Services Limited (EESL) procurement:** EESL is aggregating demand for EV and EVSE and has released tenders for their bulk procurement. Phase 1 of the project is in its last stage and EESL is on its way to execute Phase 2

Table 100: EESL EV and EVSE deployment targets

EESL deployment targets	
EV deployment	EVSE Deployment
• **Phase I: 500 Cars** • **Phase II: 9500 Cars**	• Phase I: 100 AC (Slow chargers) and 25 DC (Fast chargers) • Phase II: 1800 AC (Slow chargers) and 200 DC (Fast chargers)

- **No permits required for EVs to ply on roads:** EVs and alternative fuel run vehicles have been exempted from permit requirements

Barriers and Challenges in EV adoption

Despite of the initiatives and policy reforms, the growth in the EV technology has been sluggish. The key barriers and challenges includes:

- **High upfront capital cost:** The single major factor for slow penetration of EVs is their high price which is around 2 times more than a comparable conventional vehicle. Most of the personal vehicle buyers consider upfront purchase price, fuel efficiency, maintenance and service cost, comfort features as the key buying criteria.

- **Charging Time:** The charging time required to charge an EV is significantly high i.e., 35-40 minutes for fast charging and 8 hours for slow charging compared to an ICE vehicle i.e., 5 minutes.

- **Range per charge:** The other important concern of EVs is their range per charge. To offer a higher range, higher battery capacity in the vehicle is needed which lead to increase in the EV price roughly proportionately and increases the price gap. This would in turn would need more frequent charging, especially for commercial fleets where the vehicle would run for upto 200~250 kms per day.

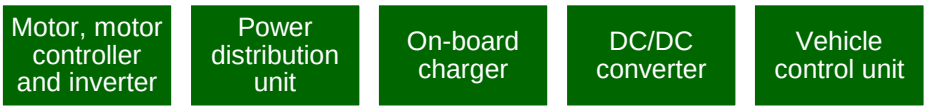
- **Lack of Charging Infrastructure:** A widespread and easily accessible charging network will be most crucial for mass adoption of electric vehicles to cater to the range anxiety of consumers.. Unlike conventional vehicles which cannot be refueled without dedicated fueling infrastructure at designated locations, one of the positive aspects with electric vehicles is that these can be charged at many places like homes, workplaces, malls, parking spots etc. However, proper and suitable charging infrastructure will need to be in place at such locations. The number of charging points in the country as of 2017 is only 222. With the

growth I number of EVs and viable business models, businesses will be willing to set-up and operate charging infrastructure.

- **Need for consensus on charging standards:** There is need to have consensus on the charging standards that would be adopted by India. Some of the various options available for adoption of charging standards in the country includes CHAdeMO (Japan) Combined Charging Standard (CCS) (Europe and United States), GB/T (China) and Supercharger (Tesla Motors – United States). In India, Bharat Standards are being followed which is highly influenced by GB/T fast charging standards.

- **Lack of Manufacturing Base:** A world class manufacturing base with a competitive strength in terms of scale, quality, cost and technology for electric vehicles and their critical components will be a must to achieve the stated goal of hundred percent electric regime. However, very few auto OEMs in the country has set up an EV manufacturing base.

The biggest bottle-neck to derive the cost down of EVs will be the battery pack or commonly called as battery. Today, a pack forms on an average 40-50% of the cost of a typical mass segment electric vehicle. The Indian companies doesn't manufacture battery packs and these are imported. The other major cost components of the electric powertrain are electric drivetrain viz. motor & motor controller and power electronics viz. inverter, on-board charger, DC/DC converter etc. These components form on an average 30-35% of the cost of a typical mass segment electric vehicle. It will be imperative to have these components locally produce to reduce the cost of EVs and to create a sustainable manufacturing supply chain. The major constituents by value of the electric drivetrain and power electronics are:



The charging infrastructure manufacturing capacities of the companies are also not significant. One of the components of charging infrastructure that isn't manufactured in India is the connectors.

- **Lack of Public Awareness:** There is need to have consensus on the charging standards that would be adopted by India. Some of the various options available for adoption of charging standards in the country includes CHAdeMO (Japan) Combined Charging Standard (CCS) (Europe and United States), GB/T (China) and Supercharger (Tesla Motors – United States). In India, Bharat Standards are being followed which is highly influenced by GB/T fast charging standards.

Strategies

This section presents fiscal and non-fiscal strategies for the uptake of EVs as proposed by SIAM[74]. It also presents recommendations on creating a charging infrastructure.

[74] Whitepaper on Electric Vehicles (Dec 2017), SIAM

Table 101: Fiscal strategies for the uptake of electric vehicles

Sl. No.	Fiscal Measures	Vehicle Segment	Purchaser	Recommendation
1	GST	All	All	GST rate for EV may be brought down from 12% to 5%
2	Road Tax	All	All	Road tax be fully exempted. Motor vehicle Act can act as an enabler
3	Interest Rate of Finance	All	All	Favorable treatment similar to priority sector lending should be considered for EVs
4	Income Tax Deduction	All	Individual	One time income tax deduction of 30% of vehicle price from total taxable income to individual purchasers, who have not availed any bank finance for the purchase. A maximum vehicle price of INR 25 lakhs may be considered
		All	Individual	For individuals who have availed bank finance to purchase a personal EV, income tax deduction of up to 1 lakh on the interest component for loans taken may be given every year during the tenure of the loan, like government's scheme on home loans
		All	Institution & Corporates	Accelerated depreciated of 40% instead of 15% on EVs be considered for income tax deduction as is being given for plant and machinery

Table 102: Non-fiscal strategies for the uptake of electric vehicles

Sl. No.	Non-Fiscal Measures	Vehicle Segment	User Type	Recommendation
1	Power Tariff	All	All	Power tariff for charging of EVs could be 50% of the existing domestic tariff rate for home and workplace charging
2	Toll Charges	All	All	Toll may be fully exempted
3	Entry Tax	PV & Buses	Commercial	State entry taxes may be fully exempted
4	Parking Fees	2W, PV	Individual	Parking fees may be exempted for all personal EVs
5	Demand Aggregation	All	All	Govt. purchase for demand aggregation
6	Phased Conversion	3W, PV and Buses	Commercial	Phased mandate of conversion of public fleets in cities (including e-commerce delivery vehicles) to electric. CNG fleets in India is an example that could be emulated with a phased plan

Sl. No.	Non-Fiscal Measures	Vehicle Segment	User Type	Recommendation
7	Permits	3W & PV	Commercial	Permit cost may be fully exempted
8	2W Taxi	2W	Commercial	2W EVs be allowed to be used as Taxis, nationwide. Motor Vehicle Act may be amended to that effect
9	Leasing	All	All	Leasing of EVs could be made attractive for individual consumers
10	Insurance Rate	PV and CV	Institution & Corporates	Bulk insurance at concessional rate for commercial fleets

Table 103: Recommendations on creating the charging infrastructure

Sl. No.	Recommendations
1	Through support and regulations, launch home, multi-units dwelling and workplace charging schemes/policies. Demand aggregation of home and workplace chargers (AC charging) can be a great lever to reduce prices as well as to have such chargers installed on a mass scale
2	Foe corporates/employers, accelerated depreciation on such infrastructure can be provided under the tax relief. Individual users can be provided income tax relief to the extent of charging equipment cost
3	At workplaces, employers can be incentivized to allow employees charge at subsidized rate. Creation of charging infrastructure may be considered as part of Corporate Social Responsibility (CSR) to encourage investments by corporates
4	Regulations should be passed that will mandate provision of AC slow charging points in parking areas of residential buildings, workplaces spaces, shopping malls, commercial complex etc. To ensure that #NEWINDIA is built in line with the vision, “Smart Cities” need to have charging infrastructure as an integrated piece of development
5	Different segment of vehicles (2W, 3W, PVs, CVs) may require different type of charging standard (& connector), however, the charging infrastructure, at-least at public places, should be common to the extent possible to reduce the infra cost
6	Energy companies (like IOCL, HPCL, IGL etc.) may invest in providing a charging network, specially the fast charging stations at inter-city routes like state and national highways. This could also be based on renewable electricity source
7	Battery swapping infrastructure for 3-wheelers and buses may considered. Standard for battery swapping may be formulated to ensure safety and functional requirements
8	For city buses, depot & opportunity charging mechanisms need to be carefully evaluated based on techno-commercial feasibility and route planning.
9	Regulations need to be put in place to ensure availability of stable and good quality power for EV charging
10	Linking public chargers with an IT network for interoperability and proper usage.

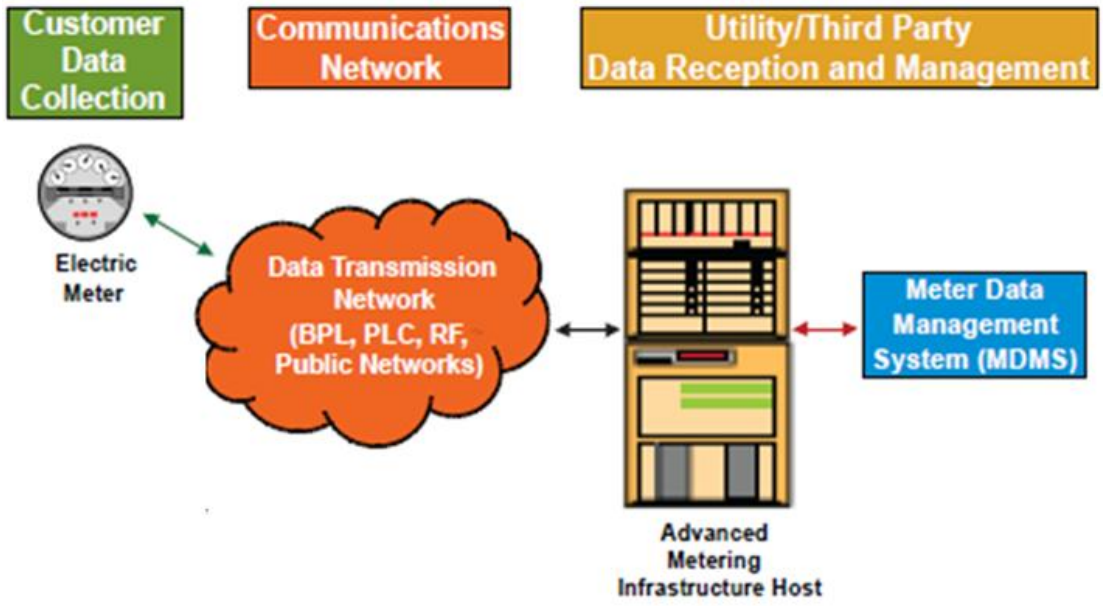
3.3.2. Smart meters

Overview

A smart meter is capable of communicating the real time energy-consumption of an electrical system in very short intervals of time to the connected utility. In the electronic meters/electromechanical meters, the cumulative number of electricity units were recorded at the end of a month (or more) whereas a smart meter is connected to the utility which is capable of transmitting the electricity usage on a real-time basis. Smart meters thus facilitate real-time pricing, automated recording of the electricity consumption and a complete eradication of errors due to manual readings and reduce labor cost and enable instant fault detection.

Smart meters are the heart of Advanced Metering Infrastructure (AMI). AMI typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and electric utility, data reception and management systems that makes the useful information available to these parties.

Figure 16: Building Blocks of AMI



Applications of a smart meter/AMI

The central electricity authority (CEA) has recently (June 2016) specified the functional requirements of AMI in India along with detailed technical specifications for single and three phase whole current smart meters. As per these requirements, the AMI system should comprise of the following core components and shall support the following minimum functionalities:

Table 104: Functionalities of AMI

Core components of AMI	Minimum functionalities of AMI
• Smart Meters • Communication infrastructure • Head End System (HES) • Meter Data Management System (MDMS) • Web application to view updated real time data • Mobile application to enable customer participation	• Remote meter data reading at configurable intervals (push/pull) • ***Time of day (TOD)/TOU metering*** • Pre-paid functionality • ***Net Meter Billing*** • Alarm/Event detection, notification and reporting • Remote load limiter and connection/ disconnection at defined/on demand conditions • Integration with other existing systems like IVRS, billing & collection software, GIS mapping, consumer indexing, new connection & disconnections, analytics software, outage management system etc. • Security features to prevent unauthorized access to the AMI

It goes without saying that the AMI functional requirements stipulated by CEA supports energy accounting, auditing, theft detection, outage detection, prepayment and several other important functions that will help address commercial losses, revenue assurance, reliability of supply all of which are indispensable problem for Indian electric utilities in the foreseeable future. More importantly, AMI provides the platform for enhanced consumer engagement wherein the customers can take a more proactive role in managing their energy use and communicate their feedback to utility services. This will pave the way for enhanced DSM and also transform the dynamics of power supply industry as whole.

Policy Initiatives for Smart Meters/AMI roll out in India

Smart meters are the heart of AMI and smart grid systems. In August 2015, the Bureau of Indian Standards (BIS) at the direction of the Ministry of Power (MoP), Government of India, published the new Smart Meter Standard, IS 16444: AC Static Direct Connected Watthour Smart Meter – Class 1 and 2 Specification covering single phase energy meters; three phase energy meters; single phase energy meters with Net Metering facility and; three phase energy meters with Net Metering facility. Another standard IS 15959: Data Exchange for Electricity Meter Reading, Tariff and Load Control — Companion Specification has been revised and published as IS 15959: Part 2-Smart Meter in March 2016.

MoP has recently announced the Government's vision to rollout smart meters on fast track for customers with a monthly consumption of 500kWh and above in Phase-1 by December 2017 and for customers with monthly consumption of 200kWh and above in Phase-2 by December 2019[75]. This is one of the salient goals envisaged for operational efficiency improvement of DISCOMs under the UDAY scheme, which is the largest ongoing power sector reforms in the country. This goal is also reiterated in the recent National Tariff Policy Amendments announced by MoP.

According to Mr. Piyush Goel, Minister of State (Independent Charge) for Power, Coal and New & Renewable Energy, "India is close to implementing smart meters and at prices that will not pinch the pockets of consumers."

[75] Considering 20% metered consumers in India consume >500 unit per month and MOP directive – Strategy for rollout of AMI in the states/UTs (Sep 2016), MoP

In addition to this, the Government of India has established the National Smart Grid Mission (NSGM), under the administrative control of the MoP, to achieve the smart grid developmental goals by adopting a coordinated and collaborative approach. NSGM is primarily tasked with the development and implementation of smart grid pilot projects across the country. There are about 15 pilots initiated across the country, all of which aim to implement AMI with different functionalities as per the needs and priorities the state. Also, the Forum of Regulators (FoR) published the 'Model Smart Grid Regulations' in 2015 to initiate and regulate smart grid investments by India's electric utilities.

Barriers and Challenges in Smart Meters/AMI adoption

In the present scenario, the following are the challenges for smart meters/AMI rollout in India.

Functionalities and Standards

- What functionalities and design should be adopted?
- Are the current standards comprehensive and relevant to Indian context?

Economics

- Who will pay for the smart meter and rest of AMI? Utilities or third party?
- Poor financial health of DISCOMs
- Justification of business case? Quantification of benefits?
- Perceived impact on consumer bills

Regulations

- Lack of Smart Grid Regulations – targets for AMI roll out (despite the existence of model smart grid regulations, the state electricity regulatory commissions are yet to adopt this and notify comprehensive smart grid regulations)
- Data privacy - who all will have access to the meter data? What are norms for access?
- What are the cost recovery options? Should the DISCOM treat AMI traditionally as CAPEX (capital expenditure) or recover through On-bill charges from the beneficiaries only?
- Are there any options for "opt-out"? Will it be mandatory for consumers?

Capacity and resources

- Manpower limitations for deployment, usage, and management in the DISCOMs
- DISCOMs averse to complete outsourcing of AMI solutions

Communications

- Limitations in last mile connectivity (smart meter to DCU/HES)
- Is the license free RF spectrum adequate considering massive roll out targets?
- Selection of last mile communication technology?
- Interoperability standards to integrate AMI systems
- Communications is the Achilles Heel for successful utility scale roll out of AMI in India.

Strategies

The DISCOMs across the country are expected to roll out 35 million smart meters by the end of 2019 under the UDAY Scheme as a result of the government's vision under the existing policy framework. The investment required to achieve this vision is a whopping USD 1.34 billion.

Table 105: Investment potential for national smart meter roll out

Total no. of electricity connections in India (approx.)	***250 million***
No. of establishments expected to be covered under UDAY (200 – 500 kWh and > 500 kWh monthly consumption) by Dec 2019	*35 million*
Total investment potential for 35 million smart meter roll out under UDAY (@ USD 38.5[76] per smart meter)	*USD 1.34 billion*
Total investment potential for all 250 million connections (@ USD 24.6 per smart meter)	*USD 6.15 billion*

DISCOMs are perceived as the weakest link in the electricity value chain as they have accumulated losses of approximately USD 58 billion and outstanding debt of approximately USD 66 billion (as on March, 2015)[77]. Considering the huge capital investment required for the rollout of millions of smart meters, the present financial condition of the majority of DISCOMs can be perceived as the principal barrier in achieving the government's vision.

In this scenario, the 'AMI as a Service' concept can be very effective in overcoming the financing barriers for expanding the AMI footprint in the country. The concept allows utilities to engage energy service companies, AMI technology suppliers, financial institutions and other third party service providers to outsource (lease) the entire AMI solution (viz. smart meters, HES/DCU, MDMS, communication network elements, software applications, installation, system integration, operation and maintenance etc.) as a turn-key service for monthly/quarterly/semi-annual/annual compensation. Innovative business models driven by leasing and other variants of services can be adopted to establish a self-sustaining AMI market in the country. While the Indian utilities have historically shied away from outsourcing operations, such attitudes can be on the verge of shifting. The complexity of smart grid deployments and systems integration and a shortage of qualified internal human resources within the utilities are just a few of the drivers behind this concept.

The governments and utilities must leverage the economies of scale in rolling out smart meters. They should be able aggregate at a national scale through a designated agency, undertake bulk procurement of smart meters and then lease them out for DISCOMs for installation.

The DISCOMs can recover the smart meter costs through on-bill charges levied on the beneficiary consumers and compensate the service providers for their upfront investment. The DISCOMs can engage different service providers for smart meters and the rest of AMI.

[76] On October 2017, State-run ITI Ltd quoted a rate of USD 38.5 per smart meter and emerged as the lowest bidder for procurement of 5 million smart meters followed by Genus Power and KEONICS in a reverse auction conducted by EESL.
[77] UDAY for financial turnaround of Power DISCOMs (Nov 2015), http://pib.nic.in/newsite/PrintRelease.aspx?relid=130261

3.3.3. Integration of Renewable energy in Industrial processes

Overview

A large scope exists for integrating solar energy in industries for process heat as well as for cooling requirements. After steam has been utilized in the process, through provisions for heat recovery; hot water can also be supplied for cleaning and other lower heat requirements.

Solar concentrators could produce high temperature steam and heat through exchangers, which can be used in a variety of heat and applications and can provide an economically and environmentally friendly alternative to conventional fossil fuel technologies. General processes for various industries have been analyzed. Comprehensive industry document series have been referred to for an in depth study of the general processes in various industries in this chapter. Some general processes and their applicability in various industrial sectors is shown below.

Table 106: Typical industrial processes for various industries

S.N.	Industrial sector	Process												
		Cleaning	Drying	Evaporation	Distillation	Pasteurization	Sterilization	Cooking	Process heating	Boiler Feed Water Heating	Heating / Cooling	Lighting	DG power	CPP (Coal or Gas)
1	Automobile	X							X		X	X	X	
2	Aluminium	X							X	X	X	X		X
3	Breweries	X	X	X	X	X	X	X	X	X	X	X	X	X
4	Cement								X	X	X	X		X
5	Ceramic	X	X					X	X		X	X	X	
6	Chemical	X	X	X	X		X		X	X	X	X	X	X
7	Dairy	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Fertilizer		X	X					X	X	X	X		X
9	Food processing	X	X	X	X	X	X	X	X	X	X	X	X	
10	Telecom										X	X	X	
11	Integrated steel plants								X	X	X	X		X
12	Steel re-rolling								X	X	X	X		X
13	Foundry								X		X	X		X
14	Leather		X	X				X	X	X	X	X	X	
15	Mining											X	X	
16	Nonferrous metals	X							X	X	X	X		X
17	Petrochemicals	X		X	X		X		X	X	X	X		X
18	Petroleum offshore rigs	X									X	X	X	
19	Petroleum refineries	X	X	X	X		X	X	X	X	X	X	X	X

S.N.	Industrial sector	Process												
20	Pharmaceuticals	X	X	X	X		X	X	X	X	X	X	X	X
21	Plastics and Polymer	X	X	X	X				X	X	X	X	X	X
22	Pulp and Paper		X						X	X	X	X		X
23	Rubber		X	X					X	X	X	X	X	X
24	Sugar	X	X	X					X	X	X	X		X
25	Textile (Spinning)	X	X						X	X	X	X	X	X
26	Textile (Dyeing and weaving plants)	X	X						X	X	X	X	X	X
27	Electroplating / Galvanizing	X	X						X		X	X	X	
28	Tea and Tobacco processing	X	X		X				X	X	X	X		
29	Wood and Furniture	X	X									X	X	
30	Glass	X							X	X	X	X	X	
31	Bricks / Building materials	X							X		X	X	X	
32	Electronics and Electrical equipment's										X	X		
33	Chlor-Alkali	X							X		X	X		X
34	Lime Kilns		X						X	X	X	X	X	
35	Machinery	X									X	X	X	
36	Agro mall	X	X								X	X	X	
37	Jute	X	X						X	X	X	X	X	X

This mapping helped in identifying the different low grade and high grade heating / cooling applications to find a fit for the solar application.

Solar thermal applications in Industries

The heat produced from solar energy can be used for various industrial applications like process heating, drying, distillation/desalination, water heating, space heating, refrigeration, and so on.

Textiles

Textile finishing requires hot water ranges 40oC to 110oC at different stages of the process. The hot water of this range can easily be generated through the use of solar energy. Various solar technologies were identified which can be used in different stages of the process to meet the hot water requirements. The recommended technologies are mentioned in the table below:

Table 107: Solar mapping in textiles finishing

Process	Type of Energy Required	Temperature Required ˚C	Recommended Solar Technology
De sizing	Thermal	60-90	ETC
Scouring	Thermal	90-110	ETC / Concentrators
Bleaching	Electrical	----	Solar PV
	Thermal	90-93	ETC
Mercerizing	Electrical	----	Solar PV
	Thermal	60-70	FPC
Dyeing	Thermal	70-90	FPC
Finishing	Thermal	40-100	ETC

Pulp and paper industry

This industry employs a lot of thermal processes which require high volumes of hot water and storage systems. Also there are other thermal processes which require significant process heat well below 250°C temperature. The preservation techniques which adopt various cooling applications also contribute for the significant portion of the heat energy consumed in this industry. Apart from these, there is also huge demand for drying applications which are critical for processing the final products. A variety of solar drying systems can be very effective in reducing significant conventional energy consumption normally required for drying applications. The table below shows the mapping of solar energy technologies with the potential processes of this industry.

Table 108: Mapping of Solar technologies in Paper and pulp industries

Process	Type of Energy Required	Application Media	Temperature Required ˚C	Recommended Solar Technology
Debarking and Chipping	Thermal	Hot Water	40-60	FPC
Digesting and Washing	Thermal	Hot Water	> 90	ETC, Solar Concentrators
	Electrical			Solar PV
Pulping	Thermal	Process Heating	>120	Solar Concentrators
	Thermal	Boiler Feed Water	70	FPC
Bleaching	Thermal	Process Heating – Boiler Feed Water Heating	70	FPC
	Thermal	Process Heating – Steam	> 120	Solar Concentrators
Paper Drying	Thermal	Hot Air Supply	> 120	Solar Air Heating Systems

Automobiles industry

The process sequence given above shows that only few operations like machine shop and paint shops use significant thermal energy. The temperature requirement in machine shops is well beyond 300°C and in paint shops are <150°C. Therefore solar thermal energy applications are more appropriate for use in paint shops for pretreatment, drying and air conditioning purposes. Solar Photovoltaic technology may be applicable in the areas of press shop, body shop and assembly shops that operate on automated machines powered by electricity. An automobile manufacturing facility consumes approx. 4litres of water per car mostly in the paint shop. The paint shop requires water of differing quality and temperatures. The hot water at 30-45°C is generally required for rinsing the body during pre-treatment. The table below shows the application for relevant processes in a paint shop.

Table 109: Solar technology mapping in automobiles sector

Process	Energy/ Fuel being used	Application Media	Temperature Requirement ˚C	Recommended Solar Technology
Press Shop – Electric and Pneumatic Machines	Electricity, Compressed Air	-	-	Solar PV system
Body Shop – Electric and Pneumatic Machines	Electricity, Compressed Air	-	-	Solar PV system
Paint Shop – Pre Treatment	Electricity and Boiler Fuels	Hot water	40	FPC
Paint Shop – Air Conditioning	Electricity and Boiler Fuels	Hot/Cold air Supply	5 - 50	ETC Based Chillers
Paint Shop – Evaporation and Drying	Boiler Fuels	Hot Air Supply	80-100	Solar Air Heating Systems
Assembly shop – Automated Robots and Machines	Electricity, Compressed Air	-		Solar PV system

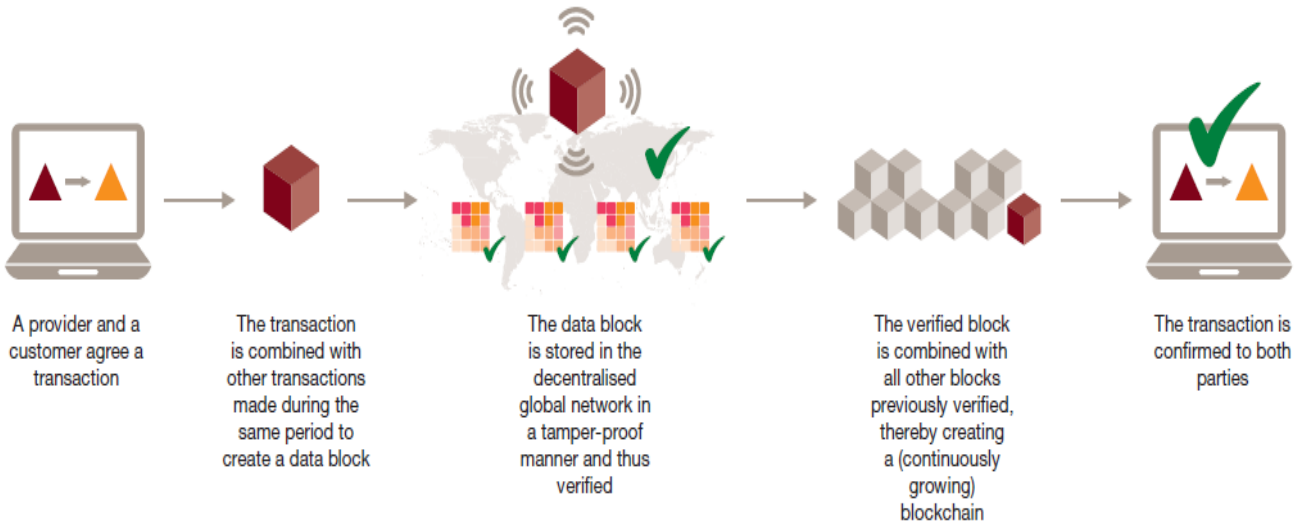
3.3.4. Blockchain

Overview

The Blockchain can be defined as an open, transparent, and decentralized database78 which forms a chain structure in which all transaction data are packed into blocks, and the blocks are connected in chronological order. There are multiple use cases that have been envisaged for the technology as it penetrates various sectors in the future like Energy and utilities (Smart utility metering system and decentralized energy data platform), Financial services (Anti-money laundering and P2P transactions), Government and public services (Land ownership records, tamper proof voting records and digital identity of citizens), Healthcare (Storage of healthcare records and population health and clinic studies), etc. The process flow of a generic Blockchain is shown below:

[78] Blockchain: Blueprint for a New Economy (2015) 1st ed.; O'Reilly: Farnham

Figure 17: The Blockchain Process



Blockchain applications for energy offer the greatest breakthrough potential where there are rapid changes and emerging issues and there is alignment of energy sector trends with the core capabilities of Blockchain. The five core capabilities of Blockchain in energy sector are as follows[79]:

Table 110: Core capabilities of Blockchain in Energy Sector

Emerging energy sector issues	Core Blockchain capabilities	Promising energy sector applications
Falling Technology Costs; Decentralization; Changing U.S. Energy Supply System; Evolving **Grid Control Capabilities**	Decentralized Systems can be Self-Administered; Architecture Sets Permissions, Regulated by Rules-based System	Distributed Energy Resources
Vehicle Electrification; Falling Battery Costs; Decentralization; **De-carbonization**	Enables "Smart" Contracts for Streamlining and Automating Contract Terms (i.e. Deposits, Payments, Proof of Performance Actions); Removes Need for Trusted Third-Parties; Regulators and Governments Can Observe or Record Details;	Electric Vehicle Deployment
Decentralization; Digitalization; Changing U.S. Supply System; Emerging Global Natural Gas **Markets**	Businesses Partners can Access Records; Removes Need for Trusted Third-Parties; Regulators and Governments Can Observe or Record Details;	Energy Trading

[79] Promising Blockchain Applications for Energy: Separating the Signal from the Noise (Jul 2018), Energy Futures Initiative

Emerging energy sector issues	Core Blockchain capabilities	Promising energy sector applications
De-carbonization; Digitalization; Changing U.S. Supply System; **Evolving Carbon Markets**	Removes Need for Trusted Third-Parties; Regulators and Governments Can Observe or Record Details; High Process Transparency and Enforceability, Opening Access to Emerging Markets	Carbon Tracking and Registries
Global Population Growth; Shifting Global Markets; **De-carbonization; Electrification**	Supports Digital Payments; High Process Transparency and Enforceability, Opening Access to Emerging Markets	Energy Transactions for Emerging Markets

Global Progress

The Brooklyn Micro grid Project (TransactiveGrid)

Since April 2016, an initial pilot project run in Brooklyn has been exploring how to integrate buildings equipped with distributed energy resource systems (in this case: solar energy) in a decentralized peer-to-peer power grid. The rooftop photovoltaic systems installed on five of the buildings participating in the neighborhoods project generate solar energy. All energy not used by the buildings themselves is sold to five neighboring households. All buildings are interconnected through the conventional power grid, with transactions being managed and stored using a central Blockchain. This set-up demonstrates what a future distributed power grid managed autonomously by a local community might look like.

LO3 Energy: Exergy

The Exergy project developed by the US-based company LO3 Energy is a research project aimed at heating homes using the heat generated in data centers. Heat generated from computing and the use of other electrical devices is to be captured and stored with the help of a technical module, in order to be re-used in other applications. The concept builds on a storage system for thermal energy operating in conjunction with an interface directly delivering the heat to existing heating systems in homes. The system is supported by a Blockchain system which allows participants to purchase (stored) heat via a cryptographically secured system[80].

RWE and Slock.it: Block Charge

The Ethereum-based start-up company Slock.it from Germany and RWE have launched two projects in which they are working to simplify the charging of electric vehicles. The first project explores how a Blockchain-based system integrating smart contract functionality can be used to charge electric vehicles. Blockchain technology can provide a common, simple and secure payment system in this context. The project's vision is for electric vehicles to interact automatically with charging stations to manage the billing process for the electricity received during a charging session. Ultimately, the project partners envisage that every car will have a chip with a crypto currency installed, which will

[80] http://lo3energy.com/projects/

permit the vehicle to autonomously manage the payment process for electricity.7 Slock.it and RWE are currently working on a prototype which is to undergo testing at a later stage.

Applications

Blockchain in distributed energy resources (DER)

Blockchain can help create a framework for improving visibility and control of DERs to meet increasingly complex grid operations needs as variable renewables and other DER are added to the electricity system. A Blockchain, leveraged by DER entities, grid operators and utilities can create a trusted, secure system for managing the record, status, and transaction of the distributed resources[81]. Distributed Energy Resource Management Systems (DERMS) can be available to analyze load behaviors and create pathways for optimizing the benefits of these aggregated resources[82].

Blockchain based infrastructure for EV charging

The availability of EV chargers remains a key barrier to market penetration. In 2016, the number of electric vehicles on the road outnumbered publicly available chargers by more than six to one[83], as most drivers rely on their own private charging systems. Estimates suggest that $2.7 trillion will need to be invested in charging stations to enable EVs to reach their forecast potential of over half a billion vehicles by 2040[84]. Blockchain's core technology – efficient and secure management of large volumes of transactions in distributed networks – coupled with the lack of a robust EV charging infrastructure and no accepted standard for billing, scheduling, and payments software make Blockchain a viable solution for EVs to "leapfrog" the build-out of a massive new wires network for managing transactions. Innogy, a subsidiary of Germany's largest utility, RWE, has already launched over 1,200 charging stations supported by Blockchain[85].

Power trading based on Blockchain

Where individual Blockchain applications are combined, a decentralized energy transaction and supply system can become possible for the future. Energy that is generated in distributed generation facilities would be transported to end users via smaller networks. Smart meters would measure the amount of energy produced and consumed, while energy-trading activities and crypto currency payments would be controlled by smart contracts and executed through the Blockchain.

Traders buy and sell energy on the exchanges and banks act as payment service providers, handling the transactions made by the parties involved. Blockchain-based energy processes would no longer require energy companies, traders or banks (for payments). Instead, a decentralized energy-transaction and supply system would emerge, under which Blockchain based smart contract applications empower consumers to manage their own electricity supply contracts and consumption data.

[81] Distributed Energy Resources – Connection, Modeling and Reliability Considerations (Feb 2017), NERC

[82] Blockchains for decentralized optimization of energy resources in microgrid networks, Eric Munsing

[83] Global EV Outlook 2017, IEA

[84] https://www.bloomberg.com/news/articles/2017-10-11/tesla-ev-network-shows-a-2-7-trillion-gap-morgan stanleysays? cmpid=socialflow twitter-business&utm_content=business&utm_campaign=socialfloworganic& utm_source=twitter&utm_medium=social

[85] Share&Charge, https://shareandcharge.com/en/

Barriers and challenges in Blockchain adoption

Regulatory uncertainity

- The energy sector is heavily regulated with detailed requirements flowing from a mix of consumer, competition, safety and other concerns, affecting all parts of the value chain. If blockchain is to reach its full potential greater coordination between regulators may play an important role.

Technological uncertainity

- A key issue is that blockchain remains at a relatively early stage of development with most projects still at the pilot stage. Proof of concepts is only just being carried out and is still limited in scope. Rival technologies are also emerging which their proponents claim could have leapfrog potential, overcoming potential limitations of blockchain.

Cyber security

- Blockchain has not been immune to security concerns, most notably with the DAO (Distributed Autonomous Organisation) hack. Based on Ethereum, the DAO had the ambition of creating a humanless venture capital firm that would allow the investors to make all the decisions through smart contracts. Launched in April 2016, it raised a reported US$150 mln but a few months later on June 2016 it was hacked and approximately US$60 mln was diverted into the hacker's account.

Integration with legacy systems

- One of the key challenges for companies considering blockchain is to assess its value over existing alternatives and to also assess how it can integrate with existing systems. It is important that when making choices about blockchain technology that companies consider how it will integrate with the current architecture, and make the appropriate product selections and designs in accordance with this.

3.3.5. Decarbonizing industrial processes

Overview

The industrial sector accounts for a lion's share of global GHG emissions. From 1990 to 2014, the overall increase in direct GHG emissions from this sector was a whopping 70%, which comes to 2.2% per year on average. This was faster than the increase in global GHG emissions, which was comparatively 30%, or 1.1% per year on average. Direct GHG emissions from industrial processes, along with indirect GHG emissions resulting from the generation of electricity used by industry, accounted for 28% of global GHG emissions in 2014[86].

In 2014, CO2 emissions were the maximum contributor to GHG emissions from industrial processes. The other 10% comprised of methane (e.g. from black carbon production), fluorinated gases (used in refrigeration), and nitrous oxide (e.g., from the production of glyoxylic acid and nitric acid).

Scope of technological interventions in the sector along with applications

Innovation strategies in the industrial sector is predominantly shaped by the structure of the sector. With little room for product differentiation in the bulk basic materials segment, industries rely mostly on process innovation. These process innovations tend to follow predefined technological trajectories through incremental innovation aimed at enhancing productivity. Through learning by doing, the engineers operating the factories generate incremental process innovations that trigger partial

[86]https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability%20and%20resource%20productivity/our%20insights/how%20industry%20can%20move%20toward%20a%20low%20carbon%20future/decarbonization-of-industrial-sectors-the-next-frontier.a

reinvestments. A broad overview of the various low carbon innovation technologies in various sub-sectors are mentioned below[87]:

Table 111: Broad overview of low carbon innovation technologies in various sub-sectors

Sector	Technology	Incremental or radical innovation & technical description		Benefits	Bottlenecks
All sectors	Carbon capture and storage (CCS)	Incremental	Typical end of the pipe technology, can be incremental, but typically needs significant additional space and technology, which can make it radical; needs infrastructure to transport captured CO2	Less CO2 emissions	Additional energy demand, costs, infrastructure, acceptance by local public
	Material Efficiency & Recycling	Incremental	Reduce the (primary) material intensity of supplying material services through improved product design, product re-use, high-quality recycling, and different business models	Resource efficiency and less CO2 emissions	Low resource vs. high labor costs, traditional supply chain organization
Iron and Steel	Recirculating Blast Furnace & CCS	Radical	Currently under R&D, needs high integration into existing plants which might need major changes in plant/site setup	Less CO2 emissions	Higher energy demand, costs, infrastructure, acceptance
	Smelt reduction & CCS	Radical	Makes obsolete coke ovens, Blast Furnace (BF) & Basic Oxygen Furnace (BOF) of conventional steel factories	Less CO2 emissions	Costs, infrastructure, acceptance
	Direct Reduced Iron (DRI) with H2	Radical	Makes obsolete coke ovens, BF & BOF of conventional steel factories, but is combined with electric arc furnace; needs H2 supply infrastructure	Less CO2 emissions with potentially excess electricity converted to H_2	Costs, infrastructure & technology

[87] How to decarbonize energy intensive processing industries (2016), Proceeding ECEEE Industrial Efficiency

Sector	Technology	Incremental or radical innovation & technical description		Benefits	Bottlenecks
	Electro winning	Radical (at very early stage of developme nt)	Makes obsolete coke ovens, BF & BOF of conventional steel factories, needs large electricity supply; technology only on lab scale available	Less CO2 emissions with lower capex	Only available in lab; low coal/CO2-prices and high electricity prices
Aluminum	Advanced (inert) anodes	Incremental	Technology development necessary	Less CO2 emissions with lower energy demand	Availability of technology, research needed
Chemicals	Advanced steam crackers & CCS	Incremental	Advanced furnace materials, gas turbine integration, use of membrane technology for separation, catalytic cracking	Less CO2 emissions	Costs, infrastructure, acceptance
	Electro plastics (with RES-Methane)	Incremental	Needs conversion to bio or electricity based feed stocks (and respective supply infrastructures)	Less CO2 emissions (depending on RES share)	Costs, availability of renewable electricity and hydrogen
	Electro plastics (with Fischer Tropsch)	Radical	Needs integration into existing plants to use excess heat	Less CO2 emissions (depending on RES-share of electricity)	Costs, availability of renewable electricity and hydrogen
	Bio-based polymers	Radical	New process technologies, new feedstock (with limited experience at most companies), may need new platform chemicals	Less CO2 emissions with partially new properties	Relative high costs of biomass, economies of scale
Cement	Geo polymers	Radical	Requires a new way of making cements with different input materials	Less CO2 emissions	Requires new resource streams; unproven long term performance; stringent norm compliance
	Self-healing	Radical	Requires new production techniques to manage	Less CO2, longer	Requires new resource

Sector	Technology	Incremental or radical innovation & technical description		Benefits	Bottlenecks
	concrete	(requires change in production techniques and systems)	bacteria that regenerate concrete to enhance durability	durability, lower cost long term	streams; unproven long term performance; stringent norm compliance
	CCS	Incremental	End of the pipe technology; needs infrastructure to transport capturedCO2	Less CO2 emissions	Cost
Paper & Pulp	CCS	Incremental	End of the pipe technology; needs infrastructure to transport captured CO2	Less CO2 emissions	Cost
Refinery and petro chemicals	Bio refinery development	Radical (at very early stage of developme nt)	Bio refineries could potentially replace refineries. Bio refineries can merge with paper and pulp industry	Less CO2 emissions	Feedstock availability and cost (competition for biomass)
	Electro fuels/ plastics	Radical (at very early stage of developme nt)	Fuels and chemicals can be replaced with electricity and CO2 based solutions. Might also merge with bio refinery	Less CO2 emissions	Electricity cost
	CCS	Incremental	End of the pipe technology; needs infrastructure to transport capturedCO2	Less CO2 emissions	cost

Barriers and Challenges in decarbonizing industries

Iron and Steel

- At present, iron ore sinter tends to be favoured in hot metal production as it is cheaper than pelletised iron ore and attracts higher levels of free allocation even though it is more polluting than pelletised iron ore.
- Uncertainty over energy prices, price visibility over a long period, and the degree of protection from indirect carbon cost are considered to be important factors in low carbon investment
- The is limited access to infrastructure for additional energy, hydrogen and CCS required to decarbonise the sector. Industry is not in a position to develop the necessary infrastructure.

Cement

- The lack of a carbon price signal in cement sales prices due to the modest net CO_2 cost in cement production provides no incentive to consume cement wit a lower carbon footprint.
- There is a lack of readily deployable CO_2 mitigation technologies. Carbon capture technology is currently being piloted only at a handful of cement plants.

Glass

- There is a lack of alternative materials to glass: most flat glass products cannot be substituted and polycarbonate glass, for example, is prohibitively expensive.

3.4. Conclusion

A brief mapping of sector-wise future technologies and a detailed analysis of various key future technologies is presented in this chapter. As a result of these prospective technologies, the energy demand would witness transformation. Going forward, there should be introduction of enabling mechanisms in the market that could steer these technological changes. Recommendations that could accelerate the adoption of some of the key technologies is also presented.

4

ESTIMATION OF ENERGY SAVING POTENTIAL

4.1. Introduction

The primary energy demand and supply as well as the electricity demand and supply for the country as a whole and individual states have been defined in chapter 1. However, the various policies and programs discussed in the previous chapter have an impact on the energy demand, which have been incorporated while developing the dynamic model (to be discussed in the next chapter) and energy efficiency potential for each of the demand sectors have been estimated based on three scenarios which are mentioned below:

Figure 18: Scenarios for energy demand calculation

Assumptions by 2031	Technological Improvement & penetration	Policy/ program/ scheme initiatives	Change in Fuel mix
Scenario 1: Least effort	Current technological improvements and penetration	Current implementation of programs	Current fuel mix
Scenario 2: Medium effort	Moderate technological improvements and technology penetration as per govt./other agencies target	Successful achievement of program targets	Moderate fuel mix shift from fossil fuel to RE/ electricity based consumption
Scenario 3: High effort	Ambitious technological improvements and penetration over govt./other agencies target	New programs or overachievement of existing programs	Ambitious fuel mix shift towards RE based consumption in sector

The Moderate energy savings is the energy savings that would be achieved under the implementation of current policies and programs and when the current technological penetration is assumed till 2031. The Ambitious energy savings is the maximum energy savings possible in the sector when technology up gradation happens at a faster rate and policies and programs are overachieved. The table below shows the savings for all the sectors along with the savings potential.

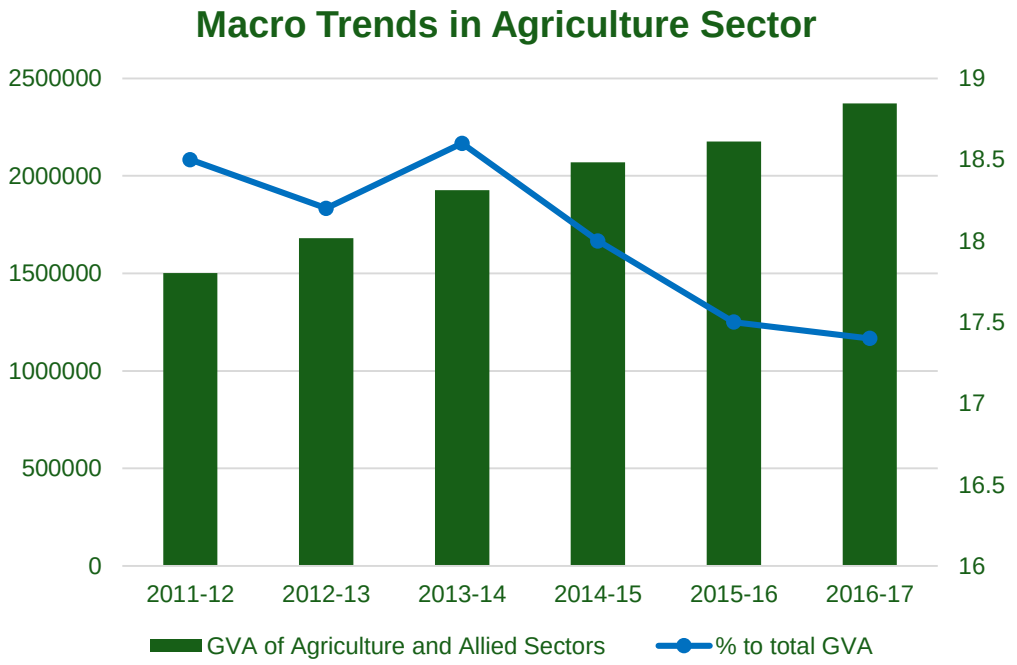
Table 112: Energy savings potential

Sector	Moderate Savings Scenario		Ambitious Savings Scenario	
	Mtoe	%	Mtoe	%
Agriculture	5.7	9%	9.9	15%
Transport	15.8	7%	23.8	10%
Domestic	12.1	12%	15.1	15%
Commercial	4.9	17%	6.4	22%
Municipal	0.9	12%	1.5	19%
Industries	47.5	11%	72.3	16%
Total	86.9	10%	129	15%

4.2. Agriculture

Agriculture has always played an important role in India's economy, and continues to do so, with 54.6% of the population being engaged in agriculture and allied activities and its contribution of 17.4% to the country's Gross Value Added (GVA) in 2016-17 (current prices)[88].

Given the importance of agriculture sector, Government of India took several steps for its sustainable development. Steps have been taken to improve soil fertility on a sustainable basis through the soil health card scheme, to provide improved access to irrigation and enhanced water efficiency through Pradhan Mantri Krishi Sinchai Yojana (PMKSY), to support organic farming through Paramparagat Krishi Vikas Yojana (PKVY) and to support for creation of a unified national agriculture market to boost the income of farmers. Further, to mitigate risk in agriculture sector a new scheme "Pradhan Mantri Fasal Bima Yojana (PMFBY) has been launched for implementation from 2016[18].



[88] Annual Report 2016-17, Ministry of Agriculture

Policy and Program advancements in the sector

Agriculture Demand Side Management (AgDSM)

The objective of the program is the replacement of inefficient agricultural pumps with BEE star rated pumps across India

National Mission on Sustainable Agriculture (NMSA)

NMSA caters to the key dimensions of 'Water Use Efficiency', 'Nutrient Management' and 'livelihood diversification' through adoption of sustainable development measures and gradually shifting to environmental friendly technologies

National Innovations on Climate Resilient Agriculture (NICRA)

The program, spearheaded by ICAR, works towards the enhancement of resilience of Indian agriculture to climatic variability and climate change through research on adaptation and mitigation

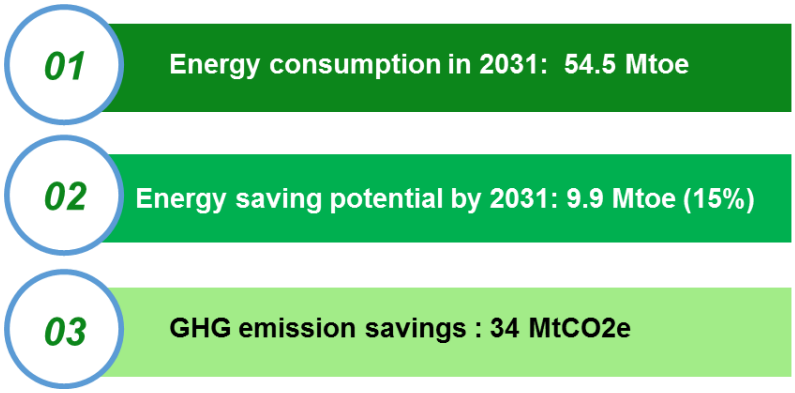
Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM)

The program focusses on the penetration of solar pumps for making farmers independent of grid supply and also enable them to sell surplus solar power generated to DISCOMs to generate extra income

National Mission on Agricultural Mechanization (NMAM)

The program focusses on enhancing farm productivity at village by introducing appropriate farm mechanization and establishment of farm machinery banks for custom hiring.

Results under moderate savings scenario



4.3. Transport

The transport sector of any country works as the backbone of the nation's economy. A good transport infrastructure is crucial for the socio-economic development of the country. India's transport network is vast and diverse comprising of 5,603,293 kilometres and 115000 km of track over a route of 65000 km with 7500 railway stations, geographically connecting the country along its length and breadth.

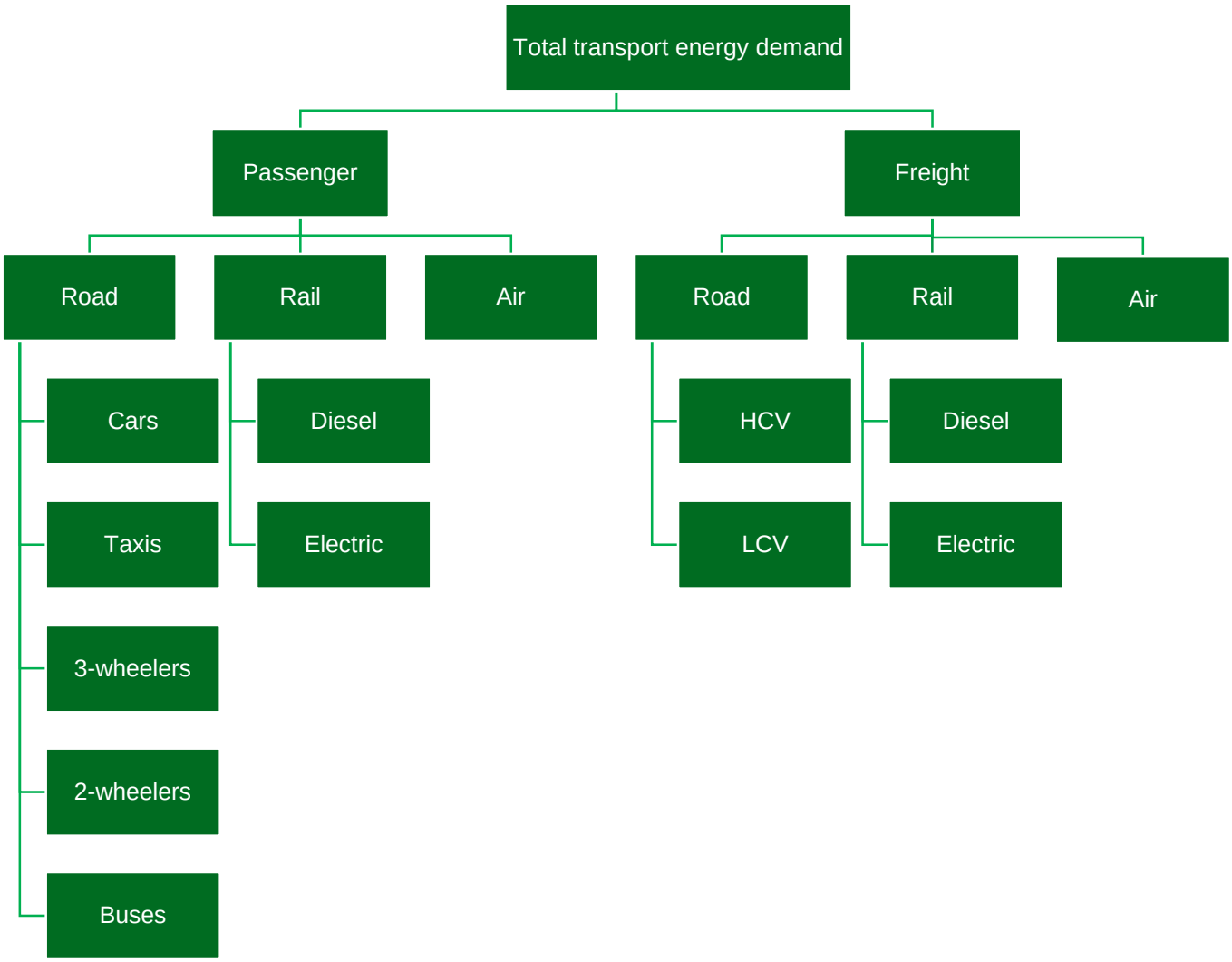
India also has an established aviation industry with the government owned Airports Authority of India (AAI) operating 126 airports and civil enclaves out of a total of 449 airports and airstrips located throughout India. Around 80 airports/aerodromes receive regular commercial flights. The cities of Delhi, Hyderabad, Kochi, Bengaluru and Mumbai are served by privately (or joint-venture) operated airports. Airports in India handled 295 million passengers in 2017. India is the fifth largest civil aviation market in the world behind the USA, China, Japan and the United Kingdom.

The stock of road length in India was reported at 56.03 lakh km as on 31st March, 2016, out of which 62 per cent were surfaced road. Various road development programs of recent past have yielded

significant expansion of quality road network in India. Expansion of the National Highways has been remarkable as it increased from 70,934 km in 2010-11 to 1, 01,011 km in 2015-16, recording an annual growth rate of 7.3 per cent[89].

For the purpose of calculating the energy demand of the transport sector, the sector has been divided into two basic components, the passenger and freight sector. These sectors have been further subdivided as shown in the figure below:

Figure 19: Total energy demand distribution in transport sector



[89] Road Transport Yearbook 2015-16, MoRTH

Policy and program advancements in the sector

Green Urban Mobility Scheme, 2017

The three tenets of the program include sustainable green urban mobility, sustainable vehicle and fuels and focus on projects demonstrating reduction in GHG emissions

National Electric Mobility Mission Plan 2020

Formulated in 2013, the NEMMP 2020 program aims to promote hybrid and electric vehicles through implementation of the FAME scheme under NEMMP.

Metro Rail Polcy 2017

Mass rapid transport systems tend to reduce per capita vehicle ownership and usage. The metro rail policy lays down regulatory norms to be follwed by cities to build metro

Dedicated Freight Corridors (DFC)

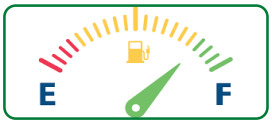
The DFC is a strategic initiative to augment rail capacity across the major trunk routes in India. The initiative also has major implications for achieving emission reductions

National Policy on Biofuels, 2018

The policy looks to ensure that a minimum level of biofuels become readily available in the market to meet the demand at any given time.

Sagarmala

The 4 major componenets of the program include port modernization, port connectivity enhancement, port linked industrialization and coastal community development



Fuel efficiency standards

The rolling out of the proposed BS VI standards are far fetching in scope and incorporate substantial changes to BS III and BS IV emission standards

Results under moderate savings scenario

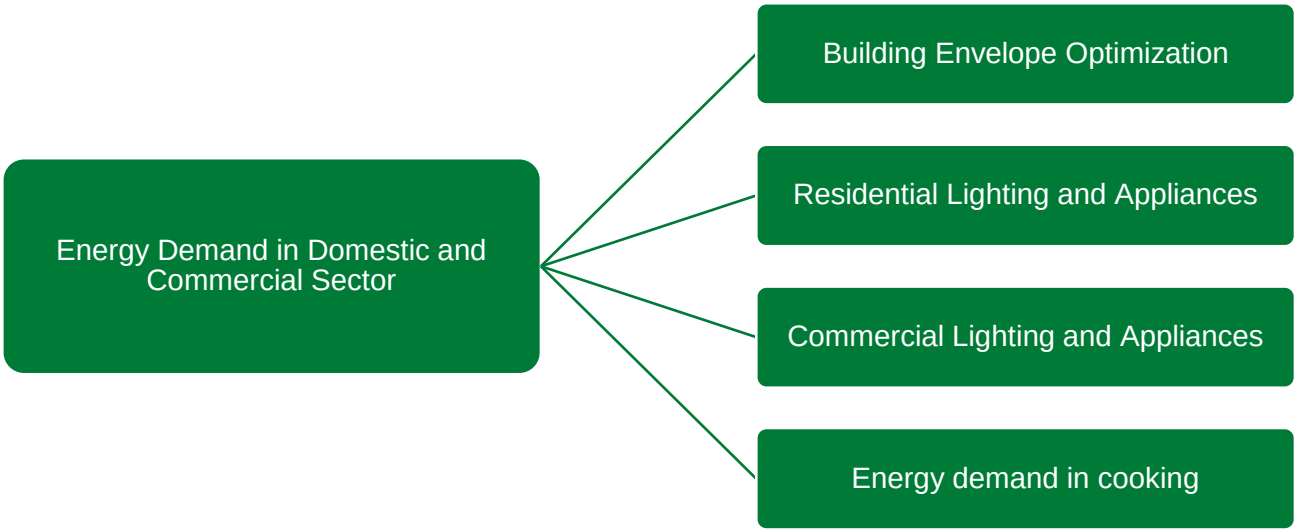
01 Energy consumption in 2031: 217.2 Mtoe

02 Energy saving potential by 2031: 15.8 Mtoe (7%)

03 GHG emission savings : 97 MtCO2e

4.4. Domestic and Commercial

The energy demand in domestic and commercial sector has been broken down into 3 sub categories on the basis of energy usage. These categories are:



Building envelope optimization: The building envelope is the skin of a building which is supported by the skeleton of the building structure. It acts as a thermal barrier between the enclosed conditioned space and outside environment through which the thermal energy is transferred. By minimizing the heat transfer through the building envelope the need of energy used for space heating and cooling can be reduced considerably. Hence by judicially designing the building envelope parameters i.e. orientation, shape, walls, fenestrations, shading device and roof, the HVAC load can be reduced in commercial buildings. Most of the commercial buildings have energy performance index (EPI) of 200 to 400 kWh/sq. m/year. Energy-conscious building design has been shown to reduce EPI to 100 to 150 kWh/sq. m/year in India[90].

Commercial Lighting and Appliances: Energy consuming equipment in the commercial sector includes lighting, heating, ventilation and air conditioning (HVAC) and other office related equipment. HVAC is responsible for the greatest share in electricity consumption and its demand is primarily from air-conditioning. Lighting loads represent the second highest consumption category. The 'Others' category is comprised of internal loads such as servers, service-specific machines and equipment, etc.

Energy demand in cooking: According to the World Energy Outlook report[91], 819 million people in India use traditional biomass cook stoves for their cooking needs. Access to clean cooking energy has the transformative potential to curb the health risks posed by traditional cook stoves while also reducing the time spent by women on unpaid domestic work. For over three decades, successive central and state governments in India have made efforts to increase the penetration of clean cooking energy solutions like liquefied petroleum gas (LPG), improved biomass cook stoves (ICS), biogas plants and piped natural gas (PNG), among others.

Residential lighting and appliances: With the increase in electrical appliance ownership in rural and urban households due to increasing income level and reliable access. The rate of increase for

[90] Benchmarking Energy Use in Buildings and Cleanrooms (2011), ISA Vision Summit
[91] World Energy Outlook 2016, IEA

appliance uptake and subsequent increase in demand depends on reliable and affordable access to power.

Policy and program advancements in the sector

Energy Conservation and Building Code (ECBC)

The code, intoduced by Bureau of Energy Efficiency (BEE) sets minimum performance standards for building envelope like roofs and windows, lighting system, air conditioning system, electrical distribution system and water heating and pumping system.

Pradhan Mantri Awas Yojana

The policy would provide central assistance to implementing agencies through states and UTs for providing houses to all eleigible families by 2022.

Standard and Labelling Program

The program, spearheaded by the Bureau of Energy Efficiency (BEE), aims to provide information to the consumer about the energy saving and cost saving potential of marketed appliances

Unnat Chulha Abhiyan

The program works towards developing and deploying improved biomass cook-stoves for providing cleaner cooking Energy solutions in rural, semi-urban and urban areas using biomass as fuel for cooking

24x7 Power for All

A joint initiative of central and state government, the aim is to provide electricity access to all by 2022

Unnat Jyoti by Affordable LEDs for All (UJALA)

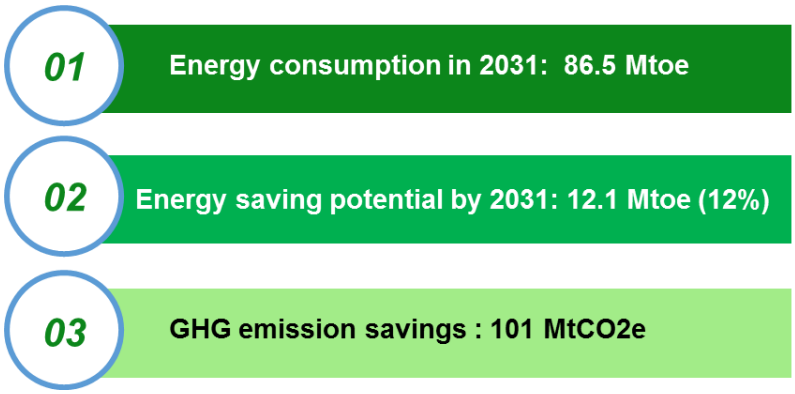
The program aims at reducing energy consumption in lighting which helps DISCOMs to manage peak demand which is done by increasing the demand of LED lights by aggregating requirements across the country.

Pradhan Mantri Ujjwala Yojana

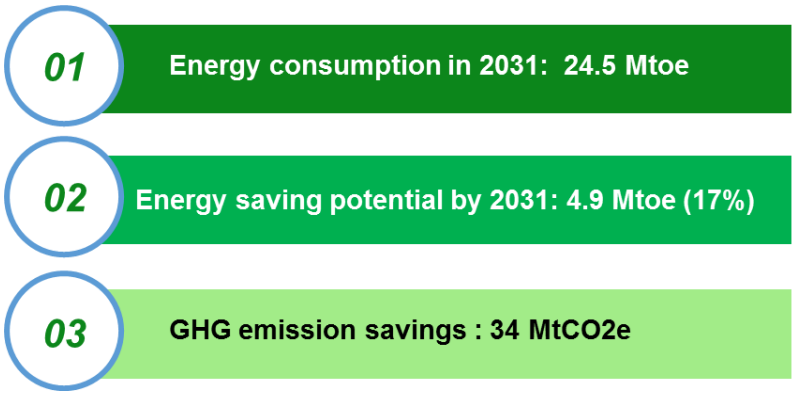
The scheme aims to provide clean cooking fuel to rural households at a subsidy of Rs. 1600 per connection. The total connections made under PMUY up to date is 5.25 Cr.

Results under moderate savings scenario

Domestic



Commercial

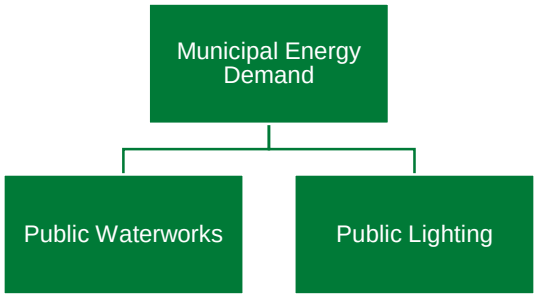


4.5. Municipal

India has one of the largest municipal systems in the world. The municipal bodies have many functions delegated to them by state governments under the municipal legislation that are related to public health, welfare, regulatory functions, public safety, public infrastructure works, and development activities.

Municipalities incur significant costs to procure energy for providing local public services like street lighting and water supply. Through cost-effective actions, energy and monetary savings of at least 25% can be achieved in water systems alone. Municipal energy efficiency saves scarce commodities and stretches tight budgets, giving citizens improved access to electricity, water, heat and air conditioning.

Among the functions carried out by the Municipality, majority of its energy demand comes from providing the services of public waterworks and public lighting. The two sectors have tremendous potential for energy conservation and many programs in the country have been launched to improve their energy efficiency.



Public Waterworks: A substantial section of India's population has no direct access to reliable, clean and affordable water services. Energy cost accounts for 40 to 60 % of cost linked only with water supply in urban areas. The inefficiencies in this sector are due to aging infrastructure and over designing of systems. There is also inefficient equipment being utilised which results in higher use of energy to deliver water to end users. Energy efficiency interventions can significantly reduce this cost depending on the type and age of pump sets being used for bulk water supply.

Public Lighting: Most Urban Local Bodies (ULBs) have either inadequate or poor street lighting and have a high maintenance cost of 10-15% of the budget of the ULB. Public lighting consumed about 7500 MU of electricity in 2012-13, energy efficient street lighting has the potential to deliver substantial energy savings to Urban Local Bodies (ULBs). Retrofitting the entire conventional streetlights with LEDs could has a potential to save about 50% of total energy consumed. Furthermore, the operational optimization can lead to additional 15-20% energy savings. The savings will help municipalities expand street lighting to many additional areas.

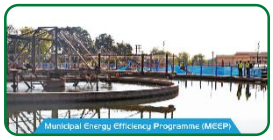
Policy and program advancements in the sector

Smart Cities Mission

The Smart Cities Mission (SCM) is an initiative by the Government of India launched in June 2015 to drive economic growth and improve the quality of life of people by enabling local development and harnessing technology.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Atal Mission for Rejuvenation and Urban Transformation was launched in June 2015 to provide various amenities to the poor and disadvantaged in India. The mission aims to provide basic facilities like water supply, sewage, urban transport, parks.



Municipal Energy Efficiency Program (MEEP)

The program aims to replace inefficient pump sets in Public Water Works & Sewerage Water Systems with energy efficient pump sets at no upfront cost to the Municipal Bodies.

Street Lighting National Program (SLNP)

Launched in January 2015 EESL plans to replace 1.34 crore LED lights by March 2019 under this program. The LEDs are 50% more energy efficient than incandescent bulbs.

Results under moderate savings scenario

01 Energy consumption in 2031: 7 Mtoe

02 Energy saving potential by 2031: 0.9 Mtoe (12%)

03 GHG emission savings : 7 MtCO2e

4.6. Industrial

The energy consumption of industrial sector in India for FY 2016-17 was 312.2 Mtoe, an increase of 5.6% over 2015-16 energy consumption. Despite the increase in energy consumption by the industrial sector, the percentage consumption of energy by the sector has not increased dramatically and has stayed about 57% of the total primary energy consumed. Within the industry sector aluminum, cement, chlor-alkali, fertilizer, iron and steel, pulp and paper, petrochemical, refinery and textiles are the largest energy consumers, accounting for around 51% of total energy use in the industry sub-sector.

Over the years, the energy intensity of the industry sector has been reducing as several of the units across sectors have moved to more efficient processes and adopted state-of-the art technologies. There is an autonomous improvement in the Energy Efficiency (EE) of industry that has been occurring over the past many decades. This improvement is driven by several factors including the high cost of input energy in industrial processes, a high share of the manufacturing cost, increased competitiveness among industry and the introduction of newer and efficient technologies.

Policy and program advancements in the sector

National Manufacturing Policy

The objective includes enhancing the share of manufacturing in GDP to 25% and creating 100 million jobs over a decade or so. The policy is based on the principle of industrial growth in partnership with the States.

Perform, Achieve and Trade (PAT)

A regulatory instrument to reduce specific energy consumption in energy intensive industries, with an associated market based mechanism to enhance the cost effectiveness through certification of excess energy saving which can be traded.

National Design Policy

The polcy advocates the setting up of specialized design centers which provide common facilities and enabling tols like rapid product development, high performance visualization, etc.

4.7. MSME

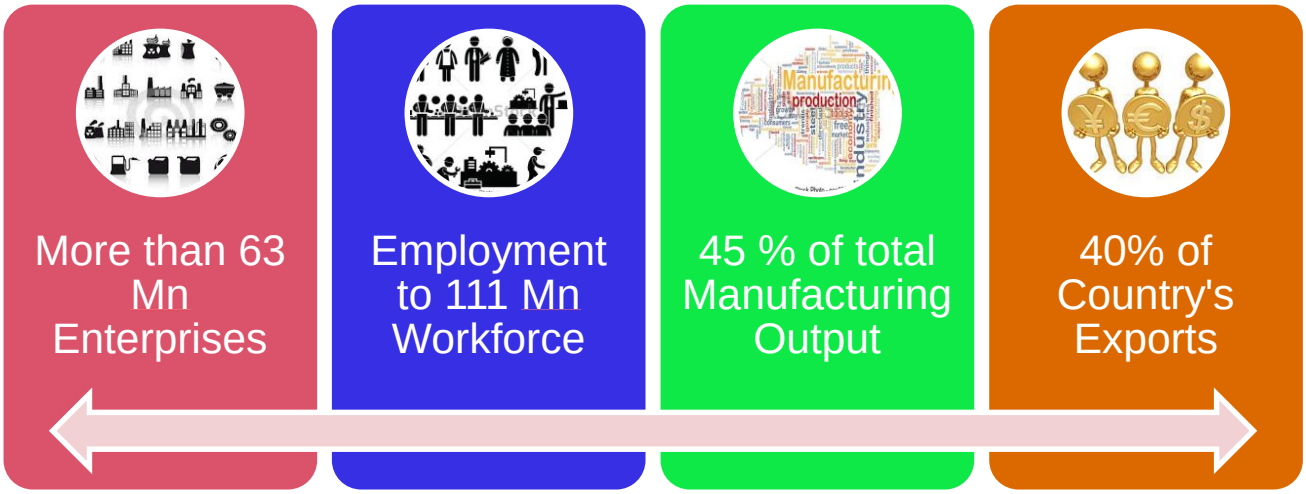
Micro, Small and Medium Enterprises (MSMEs) in India are defined by The Micro, Small and Medium Enterprises Development Act, 2006, on the basis of investment in core plant and machinery (for manufacturing sector) and equipment (for service sector) as shown below.

(Upper limit on investment in core plant and machinery, and equipment; Rs Million)

Category	Manufacturing sector	Service sector
Micro	2.5	1.0
Small	50	20
Medium	100	50

MSMEs contribute to over 28% share of national GDP[92] by producing over 6000 different products. MSMEs in India play an integral role in the overall India economy in terms of their significant contribution, as shown below[92].

Figure 20: The contribution of MSMEs to India's economy



MSMEs are the second largest provider of employment after the agriculture sector in India. As can be seen from above, MSMEs contribute significantly in manufacturing output, employment generation and contribution to the national Gross Domestic Production (GDP) in Indian economy.

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MSMEs can very well be termed as backbone of Indian industrial economy.

MSMEs in India are generally located in concentrated geographic 'clusters' which produce similar products. The geographical location and the product type combination are often used to identify the cluster, for example, Rajkot foundry cluster, Ludhiana knitwear cluster, etc. These clusters are dispersed across the national territory, and serve the needs of local market, often acting as

[92] Annual Report 2017-18, Ministry of Micro, Small and Medium Enterprises (MSMEs)

ancillaries to bigger industries or OEMs. The last All India Census of MSMEs (Fourth) was carried out in 2006-07, and it established the share of unregistered MSMEs at only 6% of the total number of enterprises.

Of the 63 million enterprises, about a third, i.e. 19.7 million (31%) are categorised as manufacturing segment, while the remaining are service and trade enterprises. As per various estimates, the number of industrial clusters in India stands around 400, and there are additional 2000 artisan based clusters that are engaged in traditional crafts.

Energy consumption in MSMEs

Energy consumption in manufacturing processes forms a significant share of MSMEs' overall production cost, with sometimes the share of energy cost being as high as 50% of total manufacturing cost. The Report of the Working Group on Power for Twelfth Plan (2012-2017) has provided an estimate of the energy consumption of the entire MSME sector. According to this report, the MSME manufacturing sector consumed about one-quarter of the total energy consumed by the industrial sector. However, a more detailed breakdown of energy consumption data by sector is not provided.[93]

The BEE's National Program for SMEs and SAMEEEKSHA (a collaborative platform supported by BEE, Ministry of MSME, SDC, Shakti Foundation and TERI) are the most recent and comprehensive exercises for establishing actual energy consumption by the most energy intensive MSME clusters.

As per BEE's estimates, there are about 180 energy intensive MSME clusters in the country, which consume approximately 40% of overall energy consumption by industrial MSMEs in 400 clusters, estimated at 68 MTOE in 2017.

[93] Factors Influencing the Uptake of Energy Efficiency Initiatives by Indian MSMEs (Aug 2018), CEEW and SSEF

Policy and program advancements in the sector

National Manufacturing Competitiveness Programme (NMCP)

NMCP is the umbrella program for MSMEs which aims at increasing competitiveness of the MSME sector by addressing issues of access to technology, high share of energy cost due to technological obsolescence, product design, IPR issues, market penetration, quality certification, etc.

Credit Linked Capital Subsidy for Technology Upgradation (CLCSS)

CLCSS provides 15% subsidy for additional investment up to INR 1 crore for technology upgradation by MSEs. Technology upgradation would ordinarily mean induction of state-of-the-art or near state-of-the- art technology.

Technology and Quality Upgradation Support to MSMEs (TEQUP)

The scheme advocates the use of energy efficient technologies (EETs) in manufacturing units to reduce the cost of production and adopt clean development mechanism.

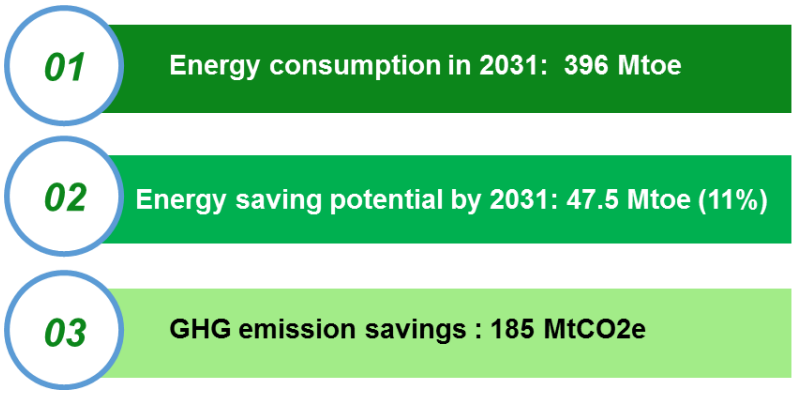
GEF UNIDO BEE Program

The GEF UNIDO BEE program aims to increase the uptake of energy efficient and renewable energy technologies in 12 MSME clusters in India under 5 sectors – Brass, Ceramics, Dairy, Foundry and Hand-tools.

GEF World Bank BEE SIDBI Project

The Project initially started for 5 energy intensive MSME clusters in the first phase has now increased the program footprint to 15 clusters in the third phase.

Results under moderate savings scenario (Industrial and MSME)



4.8. State wise energy saving target by 2031

The state wise energy saving target has been calculated by segregating the total energy saving potential in each of the sector into the respective states, based on the methodology used for finding out the primary energy demand in each state in chapter 1. The energy saving target thus calculated (in Mtoe) are as follows:

Table 113: State energy saving target (in Mtoe) by 2031

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Total
Chandigarh	0.031	0.026	0.037	0.001	0.014	0.000	0.110
Delhi	0.726	0.400	1.156	0.032	0.438	0.001	2.754
Haryana	0.422	0.208	1.710	0.026	0.571	0.309	3.247
Himachal Pradesh	0.089	0.036	0.595	0.017	0.101	0.004	0.841
Jammu & Kashmir	0.116	0.052	0.272	0.019	0.170	0.012	0.641
Punjab	0.397	0.194	1.207	0.020	0.414	0.373	2.605
Rajasthan	0.501	0.231	2.272	0.069	0.831	0.646	4.550
Uttar Pradesh	1.188	0.292	3.003	0.078	1.600	0.431	6.591
Uttarakhand	0.101	0.064	1.070	0.012	0.096	0.006	1.350
Chhattisgarh	0.209	0.067	1.214	0.011	0.203	0.131	1.836
Gujarat	0.563	0.248	5.873	0.066	0.569	0.371	7.689
Madhya Pradesh	0.392	0.154	1.440	0.050	0.831	0.617	3.485
Maharashtra	1.742	0.790	8.146	0.132	1.777	0.914	13.502
Daman & Diu	0.002	0.003	0.027	0.000	0.000	0.000	0.033
D & N Haveli	0.002	0.002	0.083	0.000	0.000	0.000	0.087
Goa	0.042	0.020	0.305	0.000	0.035	0.001	0.403
Andhra Pradesh	0.479	0.139	1.685	0.025	1.156	0.367	3.850
Telangana	0.573	0.276	1.688	0.033	0.749	0.386	3.705

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Total
Karnataka	1.117	0.349	2.919	0.106	1.045	0.619	6.156
Kerala	0.548	0.235	1.341	0.018	0.738	0.016	2.896
Tamil Nadu	1.233	0.538	4.042	0.111	1.122	0.377	7.423
Puducherry	0.028	0.011	0.144	0.003	0.014	0.002	0.201
Lakshadweep	0.001	0.001	0.000	0.000	0.000	0.000	0.001
Bihar	0.272	0.065	0.713	0.003	0.551	0.020	1.623
Jharkhand	0.164	0.029	1.149	0.008	0.312	0.007	1.669
Odisha	0.247	0.083	1.466	0.007	0.445	0.016	2.264
West Bengal	0.679	0.309	2.811	0.042	1.638	0.063	5.541
Sikkim	0.007	0.003	0.114	0.000	0.011	0.000	0.136
A & N Islands	0.003	0.004	0.000	0.000	0.000	0.000	0.007
Arunachal Pradesh	0.010	0.002	0.046	0.000	0.016	0.001	0.075
Assam	0.143	0.051	0.700	0.003	0.250	0.007	1.153
Manipur	0.014	0.002	0.027	0.001	0.019	0.001	0.064
Meghalaya	0.016	0.005	0.098	0.001	0.030	0.000	0.151
Mizoram	0.010	0.002	0.035	0.002	0.014	0.000	0.062
Nagaland	0.014	0.004	0.024	0.000	0.018	0.001	0.061
Tripura	0.019	0.004	0.087	0.004	0.021	0.002	0.137
Total(All India)	**12.1**	**4.9**	**47.5**	**0.9**	**15.8**	**5.7**	**86.9**

5

ESTIMATION OF ENERGY SAVING INVESTMENT POTENTIAL AND ANALYSIS OF FINANCING INSTRUMENTS

5.1. Introduction

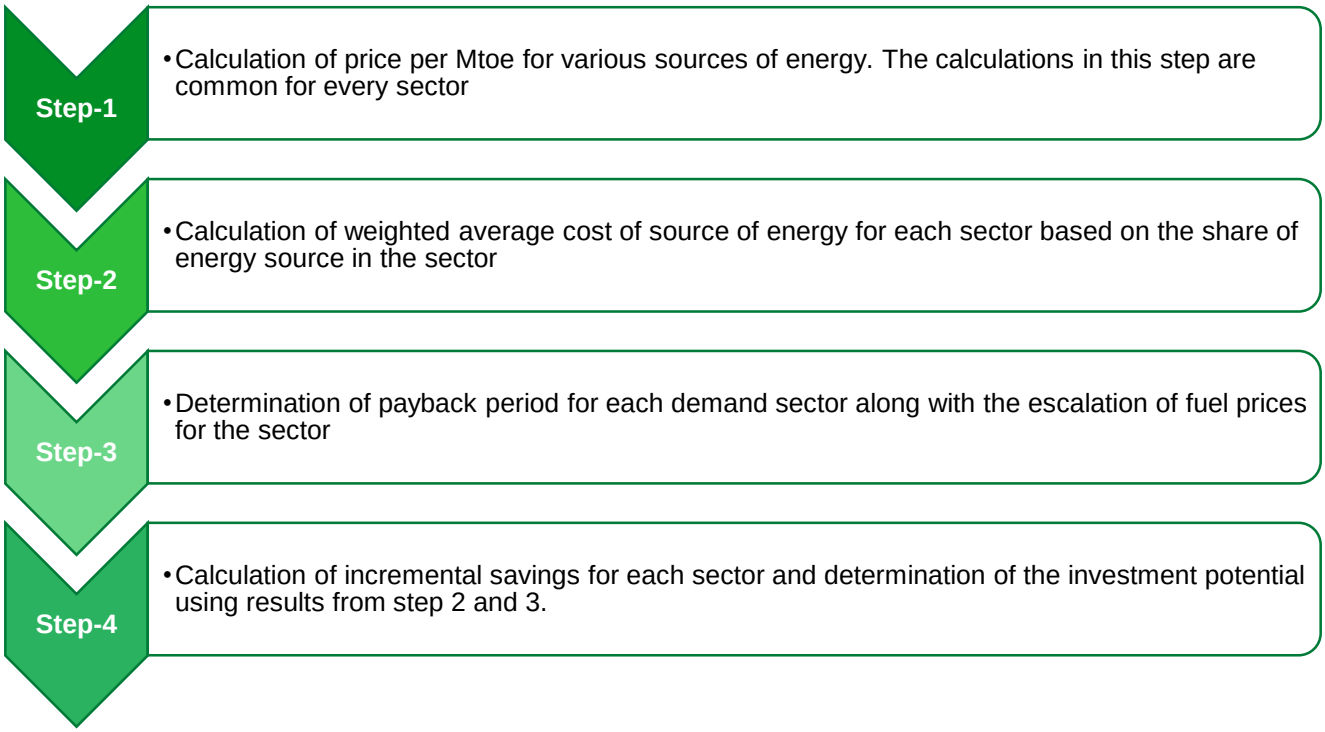
After calculating the energy efficiency potential in the previous chapter, it is important to determine the investments that would have to be made to achieve the said potential. This chapter outlines the sectoral investment potential for each of the demand sectors as well as the state wise sectoral investments that would be required to achieve the energy savings found out in the previous chapter.

The chapter also covers the assessment of various financing schemes that are employed around the world to fund energy efficiency programs. These financing schemes are assessed based on cross sector applicability, ease of implementation, financial market maturity, minimum risk to investors and high potential impact, post which financial schemes that are applicable to demand sectors in the country are identified.

The following sections have been covered in this chapter:

5.2. Calculation of sectoral investment potential

The following are the steps involved while calculating the investment potential for each sector:



The energy saving investment potential of the country is estimated to be 840,852 INR Cr. by the year 2031, under the moderate savings scenario, with the industrial sector constituting highest energy saving investment potential.

Table 114: Energy saving Investment Potential (INR Cr.)

Sectors	Energy Savings Investment by 2031 (INR Cr.) – Moderate Savings Scenario	Energy Savings Investment by 2031 (INR Cr.) – Ambitious Savings Scenario
Agriculture	91,467	158,229
Commercial	81,154	105,701
Domestic	120,233	145,133
Municipal	14,822	24,159
Industrial	307,137	463,729
Transport	226,039	365,706
Total	**840,852**	**1,262,656**

5.3. Exploring financing instruments and options to achieve EE potential

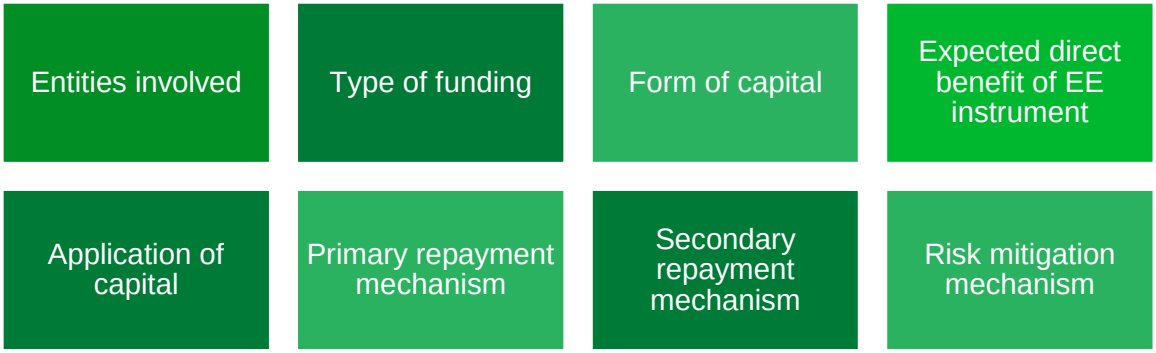
The transition towards an energy efficient economy requires huge capital investments, in energy efficient technologies, which at present is moving at a slow pace in India, due to risks perceived by investors of energy efficient projects. Barriers in implementation of energy efficiency projects can be broadly categorized into financial and non-financial barriers. Financial barriers are mainly centered around, issues related to unavailability of low cost financing whereas, non-financial barriers relates to the gaps in the technical know-how, required to implement energy efficiency projects. Some of the common financial barriers are presented in the next page.

Figure 21: Barriers in EE financing

5.3.1. Instruments for energy efficiency financing

The instruments discussed here are either operational or have been conceptualised in one form or the other, around the globe. The initial analysis and discussions of the instruments would provide various important insights regarding the objective at hand, i.e., to find more ways to finance energy efficiency measures in Indian context. The analysis of existing instruments in detail would clarify the barriers and challenges expected to be faced in Indian context. By employing permutations and combinations in the different attributed or the building blocks of any instrument, a lot many new instruments can be framed, but not all of these would be suitable for the Indian context.

The various attributes that define instruments for EE financing are as follows:



- **Entities involved**: This attribute describes the primary stakeholders involved in the various stages of the instrument implementation. These entities can be sub categorised into three:
    - **The Financier**: The financier in any instrument would be the entity, which directly provides the fund required for the successful implementation of the instrument. The instrument might be self-financed, or require no external source of financing, or the instrument might also require government support.
    - **The Program Manager / Service Provider:** A program manager would be an entity, which performs all the operations required for the successful implementation of the program. Involvement of a program manager would be imperative in case the implementation phase requires a complex operation procedure.
    - **The Beneficiary:** The beneficiary would be an entity, which receives the direct benefits of the EE financing instrument. This would be an entity, the benefit of whom the instrument focusses on. The beneficiary can be the end user or the customer, and also the ESCOs or the service provider in certain cases.
- **Type of Funding:** This attribute would consider whether the capital required for the instrument is provided in the form of debt, or equity or a mixture of both. In limited instances, the capital or some portion of the capital can also be in the form of grant or subsidy.
- **Form of Capital:** This attribute would represent the financial stake in the instrument held by the financier for the capital provided by them. This can be in the form of common shares, preference shares, long-term loans, mezzanine debt, etc.
- **Instrument Objective / Expected Direct Benefits in EE investment:** This attribute would entail the direct or the first benefit due to the investment made by the service provider. This may be defined as the first objective the instrument seeks to achieve by the application of funds.
- **Application of Capital in Implementation Phase:** This attribute would define the way in which the capital is expected to be applied by the program manager. The implementation phase of the project would start after this investment.
- **Primary Repayment Mechanism (between end user and service provider:** After investment made for the EE improvement measure, the beneficiary is expected to repay the financier for the benefits enjoyed by them. Primary payment mechanism defines the financial agreement for repayment between the beneficiary and the service provider (or program manager). This attribute has been further sub-divided into two components:
    - **Whether transferable**: This refers to the clause whence the repayment liability of the end user or the beneficiary is transferable to another entity, without any change in the payment terms.
    - **Modes of Repayment:** This defines the mode of repayment by the end user to the service provider for the EE investment.
- **Secondary Repayment Mechanism (between service provider and financer:** This is defined as payment terms for the cash flow from service provider to the financier. This attribute would define the return on investment for the financier.
- **Risk Mitigation:** This attribute describes if any risk mitigation strategy is present in the working model of the instrument

Table 115: EE Financing instruments in India and their attributes

Instrument	Brief Description	Entities Involved			Type of Funding	Form of Capital
		Financer	Program Manager / Service Provider	Beneficiary		
Energy Saving Certificates (ESCerts)	Designated consumers who implement energy saving projects and manage to save more energy than targeted, would obtain ESCerts. These can then be traded and sold to scheme participants who have an obligation to meet energy savings targets each year by surrendering ESCs or by paying a penalty.	External financing not required	Government	Industries - large organisations, building, DISCOMS	This instrument does not require any capital support	N/A
On-Bill Financing (OBF)	It refers to a financial instrument that is serviced by or in partnership with a utility company for EE improvements and repaid by the customer on its monthly utility bill.	FIs, institutional investors, Government / Public Entities	ESCOs/OEMs(Original Equipment Manufacturers), with involvement of DISCOMs/energy utilities	Individual Users, Agriculture, ULBs, MSMEs	Debt	Loans
Capital Subsidy (CS)	Capital subsidy is a grant provided by the local/state government to EE investment project, where a subsidy of a particular amount/ percentage is given to cover capital costs in incorporating EE improvement mechanisms.	Government	ESCO/Self	Any, except for large industries	Grant	Government Grant/ Subsidy
Revolving Loan Fund (RLF)	Revolving Loan Fund (RLF) are used to promote EE lending. Here the	Government	Any Financial Institution	Any sector with scope of EE improveme	Grant	Government grant

Instrument	Brief Description		Entities Involved		Type of	Form of
	loans are made to borrowers consistent with standard prudent lending practices. As loans are repaid by the borrowers, the money is returned to the RLF to make additional loans.			nt, or ESCOs/OEMs		
Accelerated Depreciation based Incentivization (ADI)	Accelerated Depreciation Based instruments are aimed at incentivising industries to implement EE schemes by allowing project developers to take the benefit of higher depreciation in the initial years.	N/A	Government	Any sector (except agriculture), and ESCOs/OEMs	N/A	N/A
Loan loss recovery/ Partial Risk Guarantee fund (PRGF)	The fund provides partial risk coverage to lenders meaning that the reserve will cover a pre-specified percentage of loan losses.	Governme nt	ESCO/Self	FIs	Grant	Govern ment grant
Venture Capital Fund for Energy Efficiency (VCFEE)	VCFEE provides risk capital support to EE investments in new technologies, goods and services. The fund provides last mile equity support to specific EE projects, limited to a maximum of certain percentage of total equity required, through Special Purpose Vehicles	Venture Capital Firms	VCFEE Fund Manager	Any, except for agriculture	Equity	Venture Funding

Table 116: EE Financing instruments in India and their attributes (contd.)

Instrument Objective	Application of Capital in Implementation Phase	Primary Repayment Mechanism		Secondary Repayment Mechanism	Provision for Risk Mitigation	Application in certain countries
		Whether Transferable	Modes of Repayment			
To obligate and incentivize organisations to implement EE mechanism	N/A	Yes, can be sold to other parties	N/A	N/A	Not required	EU (Emission Trading System), India (PAT), France (White Certificates*)
To finance users with low electricity bill defaults, who might have low credit worthiness to lend directly from FIs	Initial capital support to ESCO/User, credit risk abatement	Yes, new tenants can continue repayment	Linked to and included Electricity Bill	EMI / Instalments	Credit worthiness of customers linked to historical electricity bill payments	India (UJALA), USA (New York On Bill Recovery Loan Program, Electric Cooperative of South Carolina - Rural Energy Saving Program)
To kick start EE investment by providing initial capital support	Capital Subsidy/Grant	No	Capital subsidy is not required to be repaid		No	India (FAME), USA (EE and Block Grant Program, Self-Generation Incentive Program - California), Canada (Canadian Renewable Conservation Expenses)
To provide initial capital support or soft loans for motivating EE investment	Initial capital support	No	EMI/Instalments	N/A	No	Thailand (Thai Energy Efficiency Revolving Fund), India (Energy Efficiency Revolving Fund)
Tax Rebate for initial few years to	N/A	No	N/A		No	Canada (Accelerated Capital Cost

Instrument Objective	Application of Capital in	Primary Repayment Mechanism		Secondary Repayment	Provision for Risk	Application in certain
incentivize EE investment						Allowance), France (Amortizatio n Law for Energy Saving Equipment), Ireland (Accelerated Capital Cost Allowance Scheme), UK (Enhanced Capital Cost Allowance Scheme)
To reduce risk of Lenders and ensure low cost financing	Assuring capital recovery in case of default by end user	No	N/A	N/A	Risk transfer from end users to Governme nt	India, USA, China, Hungary, Czech Republic, Slovakia, Latvia, Estonia, Lithuania, Russia, Brazil, Poland, Bulgaria, Sri Lanka
To providing equity capital support to EE investment projects	Capital support in terms of equity investment	No	Dividend/ Capital Appreciation/ RoE	N/A	No	India

In addition to above, there are a few more EE financing instruments which find prominence in more mature EE markets. A brief snapshot of such EE financing instruments which are available in other EE markets and may be customized to suit Indian context is presented in the table below:

Table 117: EE financing instruments in other markets and their attributes

Instrument	Brief Description	Entities Involved			Type of Funding	Form of Capital
		Financer	Program Manager / Service Provider	Beneficiary		
Tax Based (Tax)	These instruments provide some form of tax incentive to user as a compensation for energy efficiency investment. These can be in the form of tax rebates, tax holidays or tax credits. This instrument is also used to incentivize manufacturers for engaging in production of energy efficient equipment.	N/A	Government	Transport, Buildings or Industries	N/A	N/A
Energy Savings Insurance (ESI)	ESI provides insurance cover to investors that the EE project would generate the projected financial savings. Basically an insurance contract is signed between either the building owner or third party service provider and the insurer. If actual savings would come out to be lower than projected figure, ESI insurer would bear the difference.	Insurance Fund Pool collected from various EE service providers	Insurance Companies, Local Financial Institutions, ESCO	Transport, Buildings or Industries. ESCOs are also included	Premium collected from various members (EE service providers)	N/A
Revenue Decoupling Models for DSM (RD)	Utilities receive differential rates per unit, depending on total electricity demand. The objective is non-reduction in revenues of utilities due to EE measures. Decoupling motivates utilities to push customers to incorporate EE measures	N/A	Government	DISCOMs	N/A	N/A

Instrument	Brief Description	Entities Involved			Type of	Form of
Energy Conservation Bonds (ECB)	These are debt instruments issued by a state or local government (or another eligible entity) that are either sold in the public market, placed with investors by an investment banking firm, or purchased directly by a bank	Government aided Financial Institutions	Banks	Any	Debt	Loans
Interest rate buys down fund (IRBDF)	Interest rate is typically bought down by a dedicated federal/ state non-revolving fund. The lower interest rate offered by the private banker motivates borrower for energy efficiency projects.	Government Subsidy	Banks	Any	Grant	N/A
Property Assessed Clean Energy (PACE)	PACE is a financing mechanism that enables low-cost, long-term funding for energy efficiency , repaid as an additional payment on a property's regular local property tax	FIs, institutional investors, Government	Municipalities & ESCOs /OEMs	Property owners	Debt	Loans
Cross-Border Technology Transfer and Energy Efficiency Financing Facility (CBTT)	It is a growth equity fund, aiming to invest in 10-20 companies, in both developed and developing countries, which have proven technological solutions for climate resilience and have demonstrated market demand and revenue. The Fund, together with an accompanying Technical Assistance Facility, will help companies to expand into new sectors and geographies, while the risks would be diversified by investing the larger part of the fund into proven commercial investment	Any	Financial Institution (Equity Fund Managers)	EE technology companies, ESCOs	Equity	Equity Shares, International Financing

Instrument	Brief Description	Entities Involved			Type of	Form of
	instruments.					
Green Receivables Fund (GRF)	In this instrument, an FI initially funds a portfolio of investment project, thus mitigating development risk during early stages, when private finance is not readily available. The institution then clubs the receivables from these projects and distributes them into several trances, which are then sold in the capital market to public/ private investors based on their risk profile.	1st Stage - Financial Institution & 2nd Stage - Capital Market	Financial institution	Any sector with scope of EE improvement , or ESCOs/OEMs	Debt	Loan
Securitization of Loans for Energy Efficient Appliances (SLEE)	This instrument focuses on providing low cost financing through securitization of energy efficiency loans. It would provide an opportunity to low income groups of consumers to invest in energy efficient appliances, since they would be financed at lower interest rate achieved by loan securitization. Securitization lowers costs by creating liquidity and freeing up capital to make more loans.	1st Stage - Financial Institution & 2nd Stage - Capital Market	Financial institution	Generally low and medium income groups	Debt	Loan
Peer to Peer Lending (PPL)	The instrument provides an online marketplace based platform where SMEs, with good track record could connect with individual investors looking for investment opportunities in	Mostly retail/ individual investors	An online peer-to-peer lending platform will facilitate the transactions	Generally SMEs	Debt	Peer to Peer Lending

Instrument	Brief Description	Entities Involved			Type of	Form of
	instruments with good returns.					
Stranded Project Financing Facility (SPFF)	Provides refinancing opportunities to Stranded projects, at below market rates through a revolving debt facility combined with an early stage venture investment model.	Private investors and government	N/A	EE projects in ASEAN countries, stranded due to capital unavailability	Both equity and debt	Government grants and private investment (equity and debt)
Forfaiting funds (FortF)	In this instrument, transfer of future receivables from one party (cessionary – an ESCO) to another (buyer – a FI) takes place. The original creditor (the ESCO) cedes his claims and the new creditor (the FI) gains the right to claim future receivables from the debtor (the client). The ESCO sells future receivables to an FI in return for a discounted one-time payment.	Financial Institution	N/A	ESCOs/ OEMs	Loan Amortization	Proceeds of transaction
Factoring Fund (FactF)	Factoring is an arrangement that converts receivables into ready cash and there is no need for the ESCO to wait for the payment of receivables at a future date. Further, there is no involvement of ESCO, post-sale of receivables	Financial Institution	N/A	ESCOs/ OEMs	Loan Amortization	Proceeds of transaction
Operation Lease/ Vendor Financing (OL)	Operating leases are not capitalized on a company's balance sheet and lease payments are treated as an expense for accounting purposes. The period of contract is less than the life of the equipment and the	Financial Institution	ESCOs/ OEMs	Any	Debt	Leasing

Instrument	Brief Description	Entities Involved			Type of	Form of
	lessor (investor) pays all maintenance and servicing costs.					
Capital/ Financial Lease (FL)	Under a capital lease, a lessee is required to show the leased equipment as an asset and the present value of lease payments as debt on its balance sheet.	Financial Institution	Financial Institution	Any	Debt	Leasing
Energy Improvement Mortgage (EIM)	An EIM is used to purchase existing homes that will have an energy efficiency improvement made. EIMs allow borrowers to include the cost of energy efficiency improvement in the mortgage without increasing the down payment. The money saved in utility bills will be used by borrowers to finance energy improvements.	Financial Institutions	N/A	Home buyers ready to invest in EE measures, at the time of purchase	Debt	Loans
Energy Efficient Mortgage (EEM)	EEM is a reduced rate mortgage that credits the energy efficiency of the building in the mortgage itself. The energy savings from a new energy efficient home is used to increase the home buying power of consumers and capitalizes the energy savings in the appraisal	Financial Institutions	N/A	New Home Buyers	Debt	Loans
Carbon finance (CF)	Carbon funds typically do not lend or grant resources to projects, but rather contract to purchase emission reductions similar to a commercial transaction, paying for them annually or periodically once they	Carbon Fund institutionalized by Government	Financial Institution	Buildings, Industries, or ULBs	Annual monetary support post project implementation	Annual/ monthly payments

Instrument	Brief Description	Entities Involved			Type of	Form of
	have been verified by a third party auditor. Carbon Finance increases the financial viability of projects, by adding an additional revenue stream, which reduces the risks of commercial lending or grant finance. Thus, carbon finance provides a means of leveraging new private and public investment into projects that reduce greenhouse gas emissions.					
Subordinate Debt (SD)	Also known as mezzanine financing, it is generally made available directly from insurance companies, subordinated debt funds, or finance companies. Alternatively, it is raised with public offerings of high-yield bonds to institutional investor	Financial Institutions, Insurance Companies, Subordinated Debt Funds		Industries, or transport	Debt	Mezzanine Debt

Table 118: EE financing instruments in other markets and their attributes (contd.)

Instrument Objective	Application of Capital in Implementation Phase	Primary Repayment Mechanism		Secondary Repayment Mechanism	Provision for Risk Mitigation	Application in certain countries
		Whether Transferable	Modes of Repayment			
To incentivize entities for EE investment by providing tax rebate / credit	N/A	No	N/A		No	Belgium (Tax Deduction for Energy Saving Instruments), France (Sustainable Development Tax Credit for EE Equipment Purchase), Netherlands (Energy investment Allowance), USA (New Energy Efficient Home Credit, Energy Improvement and Extension Act 2008), Manitoba (Manufacturing Investment Tax Credit), Britain (Company Cars Taxation)
To mitigate the risk of lower-than-expected energy saving after EE implementation	N/A	No	N/A	One time insurance cover payment	Insurance	USA (Energy Savings Insurance Scheme - Columbia), Mexico (Energy Savings Insurance Program)
To encourage utilities by non-reduction in their revenues due to EE measures implemented by end users	N/A	N/A	N/A		N/A	USA (Introduced under Clean, Renewable and Efficient Energy Act, 2008 in Michigan)

Instrument Objective	Application of Capital in	Primary Repayment Mechanism		Secondary Repayment	Provision for Risk	Application in certain countries
To provide initial capital support and low cost financing to end users for EE implement ation	Initial Capital Support	No	EMI/ Instalments	N/A	Risk transfer from end users to Government	Green Bonds by World Bank, USA (Qualified Energy Conservation bonds)
To reduce borrowing rates for end users without affecting their credit worthiness	Partial Interest payment to banks	No	EMI /Instalments	N/A	No	Japan (Low Interest Loans for Building Equipment Installation)
To finance property owners, who might have low credit worthiness to lend directly from FIs	Initial capital support to property owners	No	Linked to property tax	EMI / Instalments	Credit worthiness of customers linked to property tax payments	USA (Efficiency Maine Property Assessed Clean Energy Financing)
To provide equity financing for climate technology companies in developing countries, while keeping the financiers' risk low	Initial capital support to expand into new markets	No	Equity capital appreciation	Any	Portfolio diversificati on	N/A
To de-risk private investment in the early stages of project	Initial capital support to EE investment projects	No	EMI/ Instalments	Coupon/ Capital appreciation	Portfolio diversificati on	Under Concept Stage

Instrument Objective	Application of Capital in	Primary Repayment Mechanism		Secondary Repayment	Provision for Risk	Application in certain countries
development, while ensuring the involvement of FIs in the later stages						
To de-risk private investment in the early stages of project development, while ensuring the involvement of FIs in the later stages	Initial capital support for market penetration of energy efficient appliances	No	EMI/Instalments	Coupon/ Capital appreciation	Portfolio diversification	Under Concept Stage
1. To create opportunities for private investors to directly invest in EE projects of SMEs. 2. To create opportunities for SMEs to obtain loan without collateral requirements	Initial Capital Support	No	EMI /Instalments	N/A	Credit Risk Assessment provided by platform can be used to mitigate the risk of lending	Under Concept Stage
To provide refinancing opportunities to stranded EE projects (with good revenue generating	Refinancing	No	EMI/Instalments for debt, capital appreciation/dividend for equity)	N/A	Grant to be used to provide loss guarantee for PE investors	Under Concept Stage

Instrument Objective	Application of Capital in	Primary Repayment Mechanism		Secondary Repayment	Provision for Risk	Application in certain countries
capability, but stranded due to unavailability of low cost financing)						
To Alleviate the balance sheets of small Energy Performance Contract providers and primary investors and banks	One-time payment to ESCO against cession of receivables	N/A	N/A	EMI / Instalments from end user to FIs	Performance guarantee by ESCO	Latvian Building Energy Efficiency Fund
To Alleviate the balance sheets of small Energy Performance Contract providers and primary investors and banks	One-time payment to ESCO against cession of receivables	N/A	N/A	EMI / Instalments from end user to FIs	No	N/A
To provide the right to use an asset without any capital investments by end user	Asset buying by Lessor	No	Lease Payment	N/A	Asset as collateral	India (EV Program, EESL), LED Street Lighting Program, EESL
To provide the right to use an asset without any capital	Asset purchase by lessee, 100% financed by lesser	No	Lease Payment	N/A	Asset as collateral	N/A

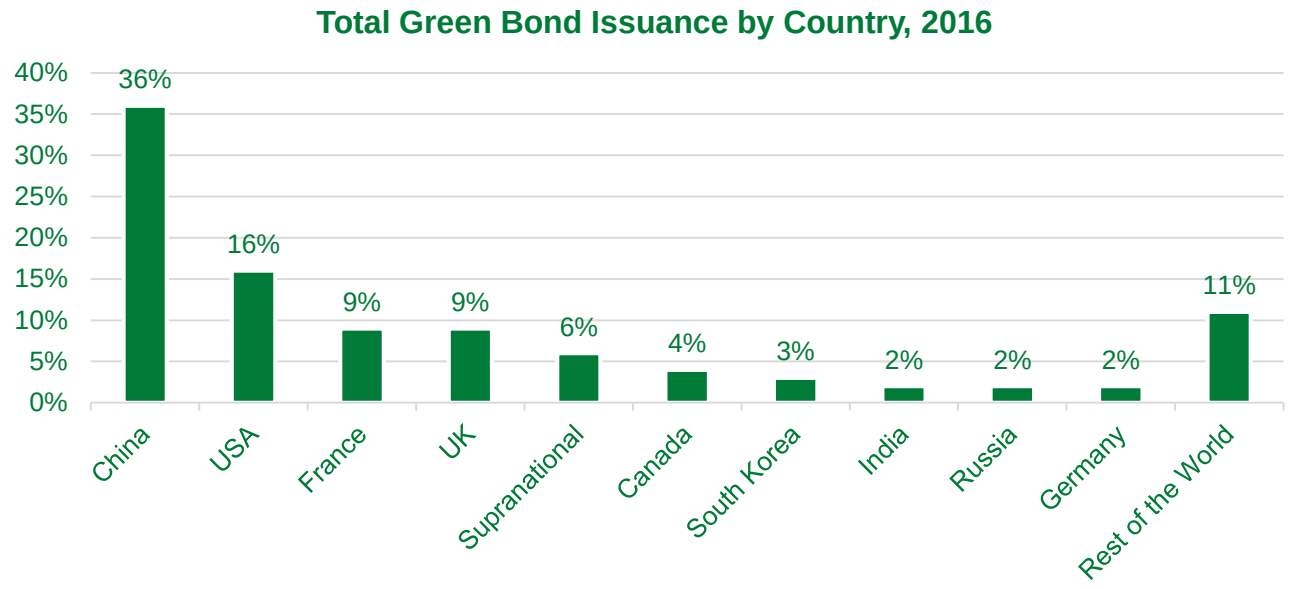
Instrument Objective	Application of Capital in	Primary Repayment Mechanism		Secondary Repayment	Provision for Risk	Application in certain countries
investments by end user						
To allow borrowers to include the cost of energy efficiency improvement in the mortgage without increasing the down payment.	Initial Capital Support to home owners	Non - Transferable	EMI/Instalments	N/A	Reduced risk due to coupling of mortgage based home loan with loan for EE	USA - Energy-Rated Homes of Vermont (ERH-VT) program, France (eco-mortgages)
To increase the home buying power of consumers w.r.t energy efficient homes	Initial capital support to home owners	Non - Transferable	EMI/Instalments	N/A	Reduced risk due to coupling of mortgage based home loan with loan for EE	USA (Federal Housing Administration Energy Efficient Mortgage (EEM) Program and VA Energy Efficient Mortgage (EEM) Program)
To increases the financial viability of projects, by adding an additional revenue stream	N/A	No	N/A	N/A	No direct risk support. However, payment against CO2 emission acts as additional revenue stream for the projects, boosting lender confidence.	European Union (EIB-KfW Carbon Program)
To provide initial capital support with lower class of debt (which would reduce the risk to the EE project)	Initial Capital Support	No	EMI/Instalments	N/A	No	Europe (The Green Logistics Program, EBRD)

5.3.2. Popular EE financing instruments used around the world

Green bonds

These are fixed-income debt securities that are used to raise funds from investors willing to invest in initiatives that are geared towards environmental benefits. Though there are currently no universally accepted guidelines that govern the green bond market, the International Capital Market Association (ICMA) has established the Green Bond Principles (GBP) that promote transparency in the green bond market. The total outstanding green bond issuance by country, as of 2016 is shown below[94]:

Figure 22: Green bond issuance, 2016



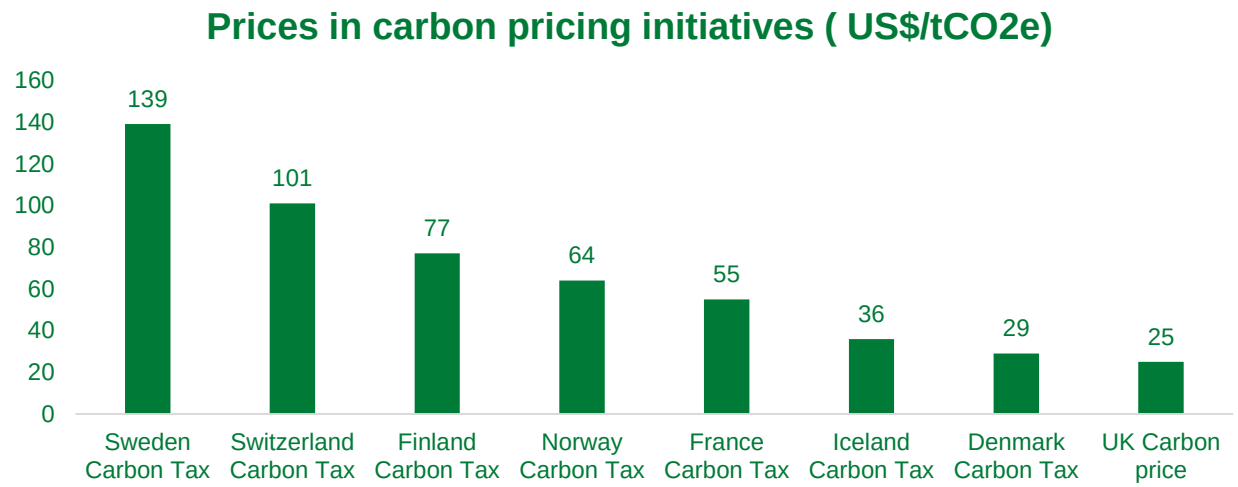
Carbon pricing

Carbon price, explained in the simplest terms, is the cost that is levied on carbon pollution to encourage polluters to reduce the amount of greenhouse gases that is emitted into the atmosphere. Carbon pricing acts as a two pronged approach to tackle the problem of pollution. It not only encourages changes adoption of low carbon alternatives, but also raises money to be used further for cleanup of the environment. Progressive prices in implemented carbon pricing initiatives from around the world are shown below[95]:

[94] The rise of green bonds (Oct 2017), ECLAC Washington Office

[95] State and trends of carbon pricing 2018, World Bank Group

Figure 23: Carbon pricing across countries



Carbon Finance

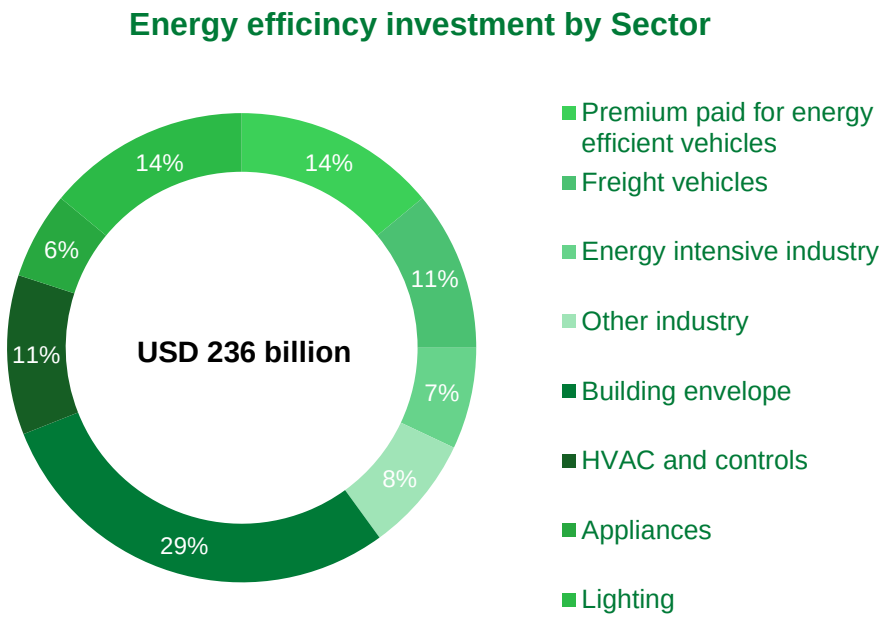
Carbon finance is the fund provided to a project to acquire appropriately certified greenhouse gas (GHG) emission reductions ("carbon" for short). The purchaser can then use these reductions to meet, for example, obligations to reduce carbon emissions which may have been incurred under EU or national legislation. Commitments of finance for the purchase of carbon have grown rapidly since the first carbon purchases began in 1996. Carbon funds are financial entities which facilitate the operation of carbon finance[96].

The European Union Emissions Trading Scheme (ETS), launched on 1 January 2005, is a system for trading carbon credits or "allowances" between the installations bound by the enabling legislation. It has become the cornerstone of EU efforts to reduce emissions cost-effectively. The carbon credits which the EIB´s carbon funds are concerned with are of the types are eligible for meeting EU ETS obligations.

5.3.3. Global energy efficiency investment scenario

As Europe remains the biggest source of investment for energy efficiency in the world, at the same time, investments in the United States of America as well as in the People's Republic of China has fallen. Overall, the Global investment in the sector has grown by 3% to USD 236 billion in the year 2017[97]. A sector wise break-up of these investments for the year 2017 are shown below:

[96] The EIB and Carbon Finance – FAQs, European Investment Bank
[97] Market Report Series – Energy Efficiency 2018, IEA



The global ESCO market has grown by 8% in 2017 and is currently a USD 28.6 billion industry. China continues to be the fulcrum for the global ESCO market, growing at 11% to nearly USD 17 billion in 2017[97]. The majority of ESCO projects take place in the non-residential buildings sector, followed by industry, while transport projects remain scarce. The prominence of the non-residential buildings sector reflects the availability of low-risk efficiency opportunities that are easily implemented and scaled up, such as lighting replacements, building envelope improvements and heating, ventilation and air conditioning (HVAC) upgrades.

In the past two years, the role of green banks has grown immensely in providing energy efficiency finance as well. Green banks are established by national or regional governments to provide finance and leverage private investment for projects that will benefit the environment and are commercially viable but struggle to attract finance. The investment of green banks in energy efficiency and low emission transport projects has been increasing and reached USD 430 million in 2017, of which the majority share of the investment was in the buildings sector, having received 81% of the proceeds[97]. The majority of this finance has been loans to small and medium-sized enterprises (SMEs) for building and equipment upgrades, plus new construction of energy-efficient single-family homes.

5.3.4. Framework for selection of EE financing instruments

In the earlier sections, we have discussed the existing barriers to EE financing and have also analyzed various instruments used in the global markets to promote energy efficiency. Further, an attempt has been made in this section to access the applicability of these financial instruments in Indian context and select the top 5 instruments which can play a larger role in promoting energy efficiency in the country. To this extent, a framework has been developed, which will rank the instruments in the order of their suitability for Indian market.

Purpose of the Framework

The purpose of this framework is to rank various financial instruments in the order of their suitability for Indian market and suggest top 5 instruments which can play a larger role in promoting energy efficiency in the country.

Application of Framework

This framework would be applied to all EE financing instruments discussed in the previous sections.

Formulation of Framework

The success of any financial instrument in a particular market depends largely on a multitude of factors. In order to be considered a success, a financial instrument must have the following qualities/ attributes:

- Should have cross sector applicability
- Should be easy to implement
- Must align with financial market maturity
- Should minimize the risk of investors (i.e. Residual Risk)
- Must have high potential impact

Below, we have defined these attributes in greater detail:

1. Cross sector applicability

The cross sector applicability of an instrument is defined as its ability to be adaptable across multiple sectors with scope for energy efficiency investment. This parameter requires the instrument to provide benefits to the beneficiary in multiple sectors such that the financier is also suitably compensated.

Under this attribute, following sectors have been considered across which cross-sector applicability shall be tested:

- Industries
- Municipal
- Transport
- Domestic and Commercial
- Agriculture

The marking of the instrument has been done in the following manner:

- When applicable across all the 5 sectors: 5 marks have been awarded
- When applicable across any 4 sectors: 4 marks have been awarded
- When applicable across any 3 sectors: 3 marks have been awarded
- When applicable across any 2 sectors: 2 marks have been awarded
- When applicable across any 1 sectors: 1 mark has been awarded
- When not applicable across any sectors: No marks have been awarded

2. Ease of Implementation

Ease of implementation of an instrument is defined as the relative ease with which an instrument can be operationalized under the given market conditions. To achieve the desired outcome, this

parameter has been further subcategorized into three different sub-parameters, described as following:

Number of stakeholders involved: Complexity of any instrument is directly affected by the number of stakeholders involved. This is because of the management issues that are associated with handling of multiple stakeholders. This may also lead to additional costs which would then be passed on to the beneficiary and increase the financial burden of managing the instrument.

The marking of the instrument has been done in the following manner:

- Where 4 or more than 4 stakeholders are involved: 1 mark has been awarded
- Where 3 stakeholders are involved: 2 marks have been awarded
- Where only 2 stakeholders are involved: 3 marks have been awarded

Legal and regulatory barriers: All policies and programs that come into play have to pass the barriers put forward by the existing legal and regulatory provisions prevalent in the country. So, the existing legal and regulatory provisions should not hamper the operational structure of the energy efficiency instrument. An instrument cannot be termed successful if it cannot dodge even one of the barriers.

The marking of the instrument has been done in the following manner:

- Where the existing legal and regulatory provisions prevents the operationalization of any instrument, no marks has been awarded, else 3 marks have been awarded against this sub-parameter.

Market readiness: It depicts the preparedness level of a market to accept the new EE instrument. Market readiness is deemed to be high when there is an already existing market of similar instruments in areas other than energy efficiency or if different segments/ components of the new instrument are operational as isolated instruments in the existing market.

The marking of the instrument has been done in the following manner:

- When market readiness is high: 3 marks have been awarded
- Where market readiness is medium: 2 marks have been awarded
- Where market readiness is low: 1 mark has been awarded

3. Alignment with financial market maturity

Alignment with financial market maturity depicts the degree of coherence between the form of capital employed by the EE instrument and the shifting market trend of different financial instruments. In India, debt based instruments have dominated the capital market for quite a long period of time, with most of the projects being debt funded. However, the market is slowly shifting towards equity based instruments, with more and more investments taking place in equity linked products. Thus, it is expected that in the long term, equity and sub-ordinate debt instruments would dominate the capital market when compared with debt based instruments and will provide the necessary capital requirement.

The marking of the instrument has been done in the following manner:

- If instrument is equity funded, or based on insurance cover: 3 marks have been awarded
- If instrument is both equity and debt funded: 2 marks have been awarded
- If instrument is debt funded: 1 mark has been awarded
- If instrument is funded by subsidy/grant, or no financial support has been provided: no mark has been awarded

4. Residual Risks

Any energy efficiency instrument, if introduced, is expected to reduce some risk to one or other of the stakeholders involved. Residual risk is defined as the overall left over risk of the system after the instrument has been implemented.

The various risks, which can crop up during the lifecycle of the instrument have been sub-categorised as follows:

- Refinancing risk: All long-term project face a refinancing risk, i.e., there is a risk that the project might not get additional funding requirement in later stages of project development. In this case, the initial investors and project managers would have to face the burden of the stalled project.
- Project implementation risk: While the refinancing risk points to the possible financial hazard to the project, project implementation risk points to the operational risk cropping up during the implementation phase of the project. This can either lead to reduced output from the project, or, in worst case, stalling of the project.
- Risk for financier/ Service provider: It refers to the risk of the financier/ service provider that the project might not return the expected RoI (Return on Investment).
- Risk of Default by End User: If the end user is an individual customer, or a small organisation, there is a high risk of default associated with them. EE financing generally entails financing to high-risk consumers, and thus this risk is prevalent in most of the EE project models.

The marking of the instrument has been done in the following manner, for each of the sub-category of the risks defined above:

- If the reduction in risk due to instrument is high, 3 marks have been awarded
- If the reduction in risk due to instrument is moderate, 2 marks have been awarded
- If the reduction in risk due to instrument is low, 1 mark has been awarded
- If the risk due to the instrument remains unchanged, no mark has been awarded

5. Potential Impact

The potential impact of an EE instrument would be assessed on how effective the project is in inspiring more future projects of the similar or bigger scale, and how effectively it affects the indirect stakeholders – the common public, the government, and the entities involved in other related sectors. The impact can be assessed by the level of awareness the program brings for the various stakeholders involved, and the depth of benefits expected to be enjoyed by the stakeholders during the operational phase of the project.

The rating would be done in the following manner:

- If expected benefits are high and large scale awareness is created by the instrument: 3 marks have been awarded
- If the expected benefits are of medium scale and it creates moderate awareness: 2 marks have been awarded
- If the expected benefits are low and only small scale awareness is created: 1 mark has been awarded

Weightages assigned to different parameters under this framework:

The present scenario of energy efficiency investment in India shows a grim picture – EE investment has been low in India as compared to other major economies in the world. The major reason for this lag is the lack of investor confidence due to high perceived risk that an instrument would under-perform in the market. So, the need of the hour is the de-risking for two market players – end users and the financiers.

If the potential impact of an instrument is high, then the end users would be more inclined towards implementing the EE measure. This would attract the investors to invest in the field. At present, majority of the investment being made in India for EE measures are through debt-based instruments. Debt repayment puts an extra burden of interest payment on the implementers. So, if an instrument is able to de-risk the equity investment, it would also reduce interest burden on implementers so that the potential impact would further improve. So, instrument which could reduce risk for the investors would be preferred. Accordingly, weightage of 25% each has been assigned to the two parameters – Potential Impact and Residual Risk.

The parameter ‘Alignment with Market Maturity’ would support the instrument implementation as early as possible in the Indian market and has been assigned a weightage of 20%.

The parameters ‘Cross Sector Applicability’ and ‘Ease of Implementation’ have been given lower weightages, since these two parameters could be developed in the future, once investment streamlines. So, an instruments would be attractive for the market even if these two parameters have lower score for them.

The table below summarizes the assigned weightages to various parameters of the framework.

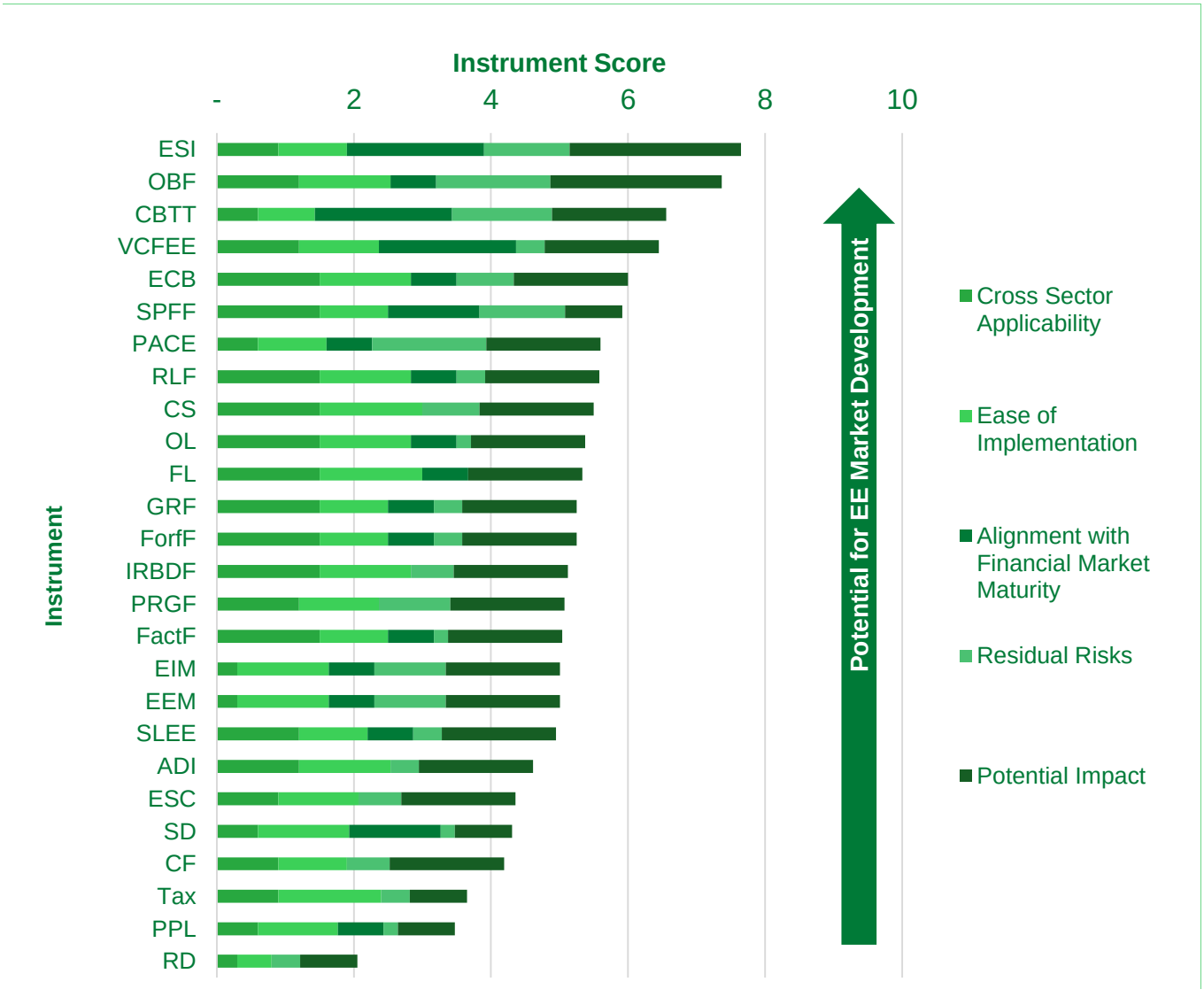
Table 119: Assigned weightages to different parameters of the framework

Parameter	Weightage
Cross sector applicability	15%
Ease of Implementation	15%
Alignment with financial market maturity	20%
Residual Risks	25%
Potential Impact	25%

Results of the framework:

The above framework has been used to study 26 different EE instruments, which are either in conceptualization stage or are operational in different parts of the world. Based on the defined parameters and their corresponding weightages, these instruments have been assigned scores and normalised, so that they could be compared on a relative scale. The figure below shows the relative scoring of various instruments obtained on a scale of 10.

Figure 24: Relative scoring of EE instruments



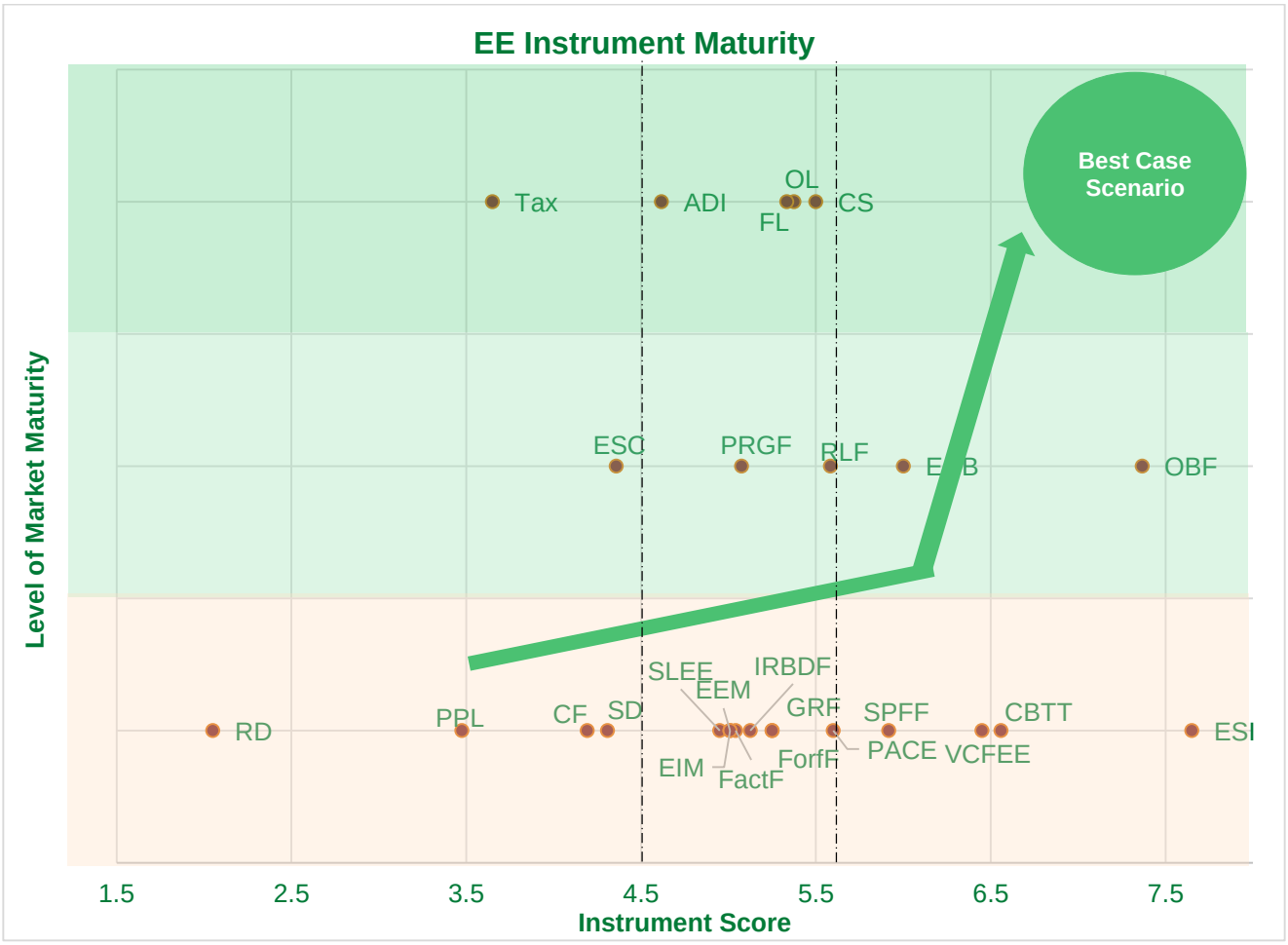
It is observed that the following five instruments have obtained the highest scores:

1. Energy Savings Insurance
2. On-bill Financing
3. Cross-Border Technology Transfer and Energy Efficiency Financing Facility
4. Venture Capital Fund for Energy Efficiency
5. Energy Conservation Bonds

These instruments, if implemented properly, can play a larger role in developing the EE market in India in the long-term. Apart from these 5 instruments, there are other instruments which have obtained moderate scores (such as Property Assessed Clean Energy, Revolving Loan Fund, Stranded Project Financing Facility etc.), but can contribute significantly to the EE market development provided that their weak spots are addressed.

The energy efficiency instrument maturity matrix reflects the current market maturity of various instruments relative to their scoring and suitability in Indian context. The level of market maturity of an instrument can be classified into three categories namely, established, new and under conceptualized.

Figure 25: Energy Efficiency Investment Maturity Matrix



Established instruments: This includes instruments which have been in place in the Indian market for long time and have reached a particular level of maturity, not only in terms of their ease of operationalization but also, in terms of their awareness among beneficiaries.

New instruments: This includes instruments which have recently been introduced in the Indian market.

Under Conceptualized: This includes instruments which are in the concept stage or have been implemented in countries other than India.

Thus, the figure in the previous page reinforces the need to introduce measures to aid the instruments in their transition from low score, low maturity level to high score high maturity level in order to realize the best case scenario for market development for energy efficiency in India.

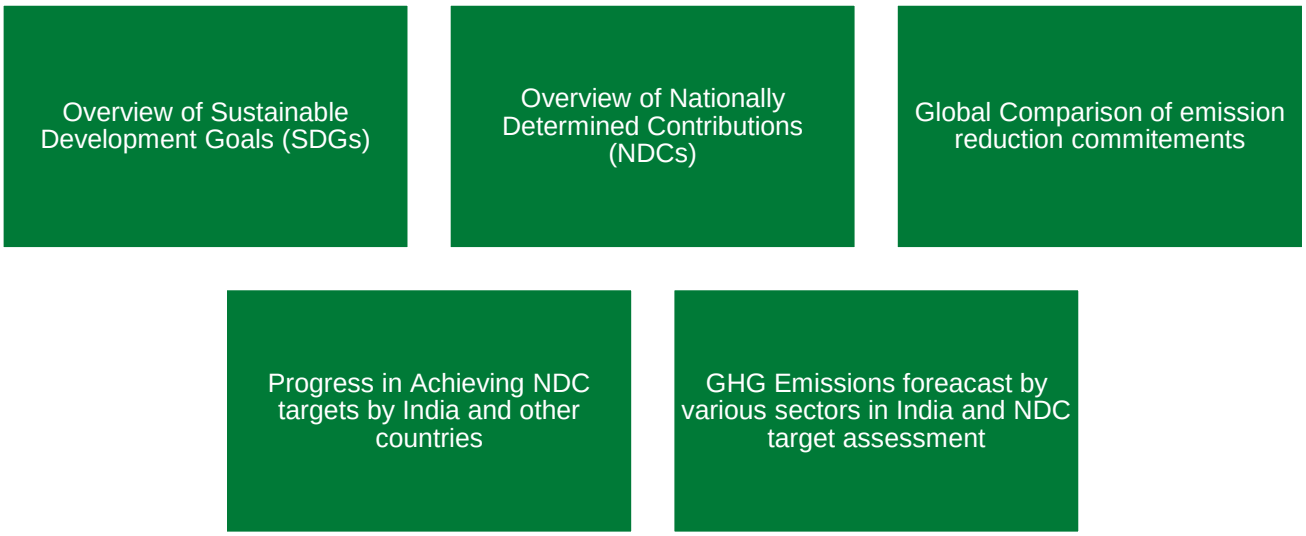
6

TARGET SETTING IN LINE WITH INDIA'S NDC AND SDG COMMITMENTS

6.1. Introduction

The emissions forecast and profiling across sectors is essential in devising the national strategy to meet country's emission reduction commitments. The objective of this chapter is to assess if the country would succeed in meeting the emission reduction commitments based on the energy consumption.

The following sections have been covered in this chapter:



India's total greenhouse gas (GHG) emissions represents 6% of the global emissions

6.2. Overview of sustainable development goals

Introduction

The 17 Goals of the 2030 Agenda for Sustainable Development, which was adopted by 193 nations in September 2015 at the UN Summit, officially came into force on the 1st of January, 2016. While these goals are ambitious in nature, they have charted out a path for nations to achieve development that is fair, equitable, environment friendly and above all, inclusive in nature. Human and environmental rights underpin the foundation of the SDGs that demand robust and integrated actions nationally, recognizing the role of different actors in the process.

India has played an important role in shaping the Sustainable Development Goals (SDGs) [98]. This has meant that the country's national development goals are mirrored in the SDGs. As such, India has been effectively committed to achieving the SDGs even before they were fully crystallized. As one of the forty countries that have volunteered to take part in the Voluntary National Reviews

[98] Voluntary National Review Report on the implementation of SDGs (2017), United Nations

Figure 26: SDGs having direct impact on energy demand

(VNRs) at the High-Level Political Forum (HLPF) 2017, India appreciates the focus on 'Eradicating poverty and promoting prosperity in a changing world'.

Among the various Sustainable Development Goals, the following goals would have a direct impact on the energy demand and consumption are:

Affordable and Clean Energy

The growing population coupled with the country's aspiration to reach a double digit growth in order to drive the lion's share of people above the poverty line has been driving India's energy consumption. This is evident from the fact that the country's per capita energy consumption has grown from 5439 KWh in 2011-12 to 6209 KWh in 2016-17. Improvement in EE policies and technologies will lead to huge potential savings that can be used to power sections which are energy poor.

Industry, Innovation and Infrastructure

Building Infrastructure

All forms of transportation -- roads, railways, civil aviation and waterways -- are being expanded rapidly. A total of 8,231 km of national highways have been constructed during 2016-17. Thus far, 70% of targeted rural habitations without road connectivity have been connected with all-weather roads. Further, development of 37 national waterways is planned over the next three years. This will have a positive impact on the reduction of overall logistics related costs and environmental impact. A total length of 8,000 km of pavements and cycle tracks will also be laid in 106 cities over the course of the next 5 years to promote non-motorized transport and reduce the carbon footprint. To strengthen the railways sector, 3,500 km of lines will be laid in 2017-18. The government has set an investment target of INR 25 trillion (USD 390 billion) for infrastructure development over a period of three years (2016-19).

By March 2018, renewable energy accounted for 70 GW out of the 345 GW of installed power generation capacity of India, making up 20.32 percent of the total power generation capacity pie. Solar accounted for 22 GW of the total installed capacity and recorded the largest increase with capacity installations rising 89% YoY (Year over Year). Wind currently accounts for 34 GW of total installed capacity and around 10% of overall power generation.

Molding the Manufacturing Sector

The National Manufacturing Policy focuses on sustainable job creation in this sector in partnership with sub-national Governments. The Policy has raised the targeted output from 16% of GDP in 2011 to 25% by 2022 along with creation of 100 million jobs.

National Investment and Manufacturing Zones (NIMZs) have been introduced as crucial instruments to boost and spur manufacturing activity across the nation. Eight NIMZs have been approved along the Delhi-Mumbai Industrial Corridor and three are being set up in the states of Andhra Pradesh, Telangana and Odisha. These Zones are envisaged as integrated industrial townships with state-of-the-art infrastructure, energy efficient technology as well as skill development facilities for providing an enabling ecosystem for manufacturing industries.

The Perform, Achieve and Trade (PAT), a market based energy efficiency trading mechanism and is being implemented in three phases. PAT cycle I ran from 2012-15, covering 478 facilities from eight energy intensive sectors. These eight sectors account for roughly 38 percent of India's total primary energy consumption. The second phase of the PAT scheme (PAT cycle II) runs from 2016-19 covering 707 units from 11 energy intensive sectors. PAT cycle II focuses on deepening and widening PAT cycle I with the inclusion of 61 new DCs (Designated Consumers) from the existing 8 sectors and the addition of 170 DCs from three new sectors; railways, refineries and electricity distribution companies (DISCOM). In continuation to the rolling cycles of PAT, the third cycle was notified on 31st March-2017. The baseline year was taken as 2015-16, and the target year will be 2018-19. The total number of DCs notified was 116 from 6 sectors namely Thermal Power Plants, Iron & Steel, Cement, Aluminum, Pulp & Paper and textile. No new sectors were added in this cycle. The total target was given as 1.06 million tonnes of oil equivalent, which corresponds to a reduction of around 3 million tonnes of CO_2[99]**.**The fourth cycle of PAT has been notified on 28th March-2018. The baseline year is taken as 2016-17 and the target year as 2020-21. A total of 106 DCs are likely to get a total reduction target of 0.6344 million tonnes of oil equivalent. These DCs are from 8 sectors consisting of 6 existing sectors and two new sectors. The new sectors are Petrochemicals and Buildings. Under building sector, hotels have been selected as the potential designated consumer sub-sector for this cycle. Other sub-sectors in the building sector may come up in future. Under Petrochemical, naphtha crackers and gas crackers has been considered under this cycle of PAT. The total expected CO_2 emission reduction from PAT-IV is around 2 million tonne.

The ZED (Zero effect, Zero defect) scheme is an integrated and holistic certification system that will account for quality, productivity, energy efficiency, pollution mitigation and technological depth including design and IPR in products and processes for Medium and small industries

Boosting Innovation and leveraging ICT (Information and Communication Technology)

Under the aegis of the Digital India Policy of the Government of India, DBT (Direct Benefit Transfer) has transformed service delivery in a majority of government programs with a cumulative disbursement of INR 1.6 trillion (USD 25 billion) to 329 million beneficiaries. The Bharat Broadband Network Ltd. Initiative aims to provide high-speed broadband connectivity to 2, 47,864 villages or clusters thereof in the country. There are currently 432 million internet users in India. Another important initiative is Digi Locker through which access is provided to 1.7 billion digitized documents (driving license, school certificates etc.).

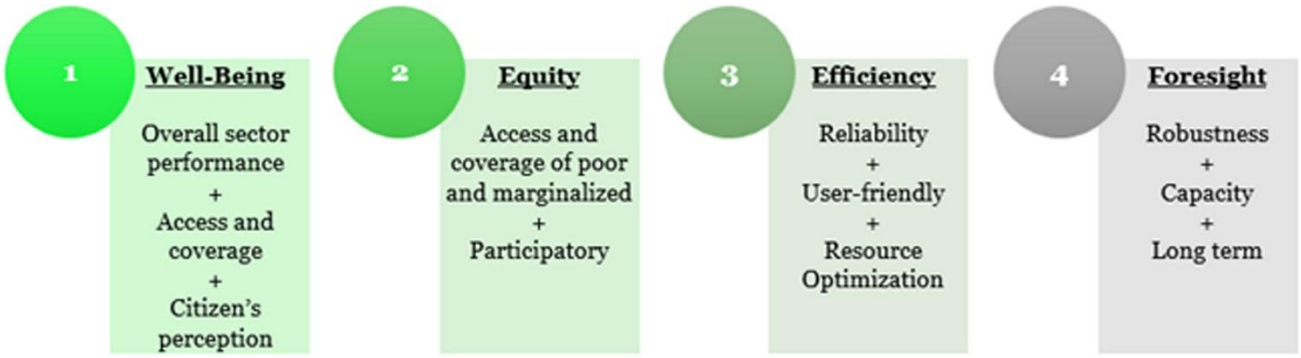
[99] Draft ROSHANEE document 2018, BEE

India is also emerging as a major research and development (R&D) hub in Information Technology and electronics. India accounted for 40% (USD 13.4 billion) of the global engineering research and development in 2016. [98]The STIP (Science Technology and Innovation plan) 2013, makes a point of departure from the earlier S&T policies when it stated "science, technology and innovation for the people" as the new paradigm of the Indian STI enterprise. The Roadmap along with the STIP 2013 presents the broad contours of the new inclusive innovation paradigm and the trajectory therein.

Sustainable Cities and Communities

Government of India's Smart Cities Mission focuses on redefining urban development initiatives that make cities more livable, inclusive, and centers of economic growth. The guiding principles for the smart cities program are:

Figure 27: Smart cities program guiding principles



In 2011, the Government of India has also recognized the concept of NZEB (Net Zero Emission Buildings) and formally taken initiatives to develop a roadmap to achieve the proposed NZEB vision by 2030[100]. By the year 2015, all the identified projects have been completed and made operational for demonstration.

Climate Action

Under the SDGs' (Sustainable Development Goals) framework, actions under the climate action goal are largely based on the outcomes of the climate change negotiations in the United Nations Framework Convention on Climate Change (UNFCCC). India's effort in integrating climate change measures in national policies have been focused on achieving pre-2020 commitment and its Nationally Determined Contribution (NDC) as also reflected by the national indicators. India agreed in Copenhagen (2009) to reduce its energy intensity by 20-25% by 2020 over 2005 level and in Paris (2015) to reduce its emission intensity by 33-35% by 2030 over 2005 levels. The National Plan on Climate Change (NAPCC, 2008) and State Action Plan/s on Climate Change (mainly looking at adaptation) are constrained by financial support, appropriate institutional structure, meaningful monitoring and clear road map, struggle to find a way forward[101].

[100] Strategy Roadmap for Net Zero Energy Buildings in India (Aug 2011), USAID, BEE

[101]: http://www.ifmrlead.org /wp-content/uploads/2015/10/NAPCC/REPORT_NAPCC%20Progress%20and%20Eval%20Report.pdf

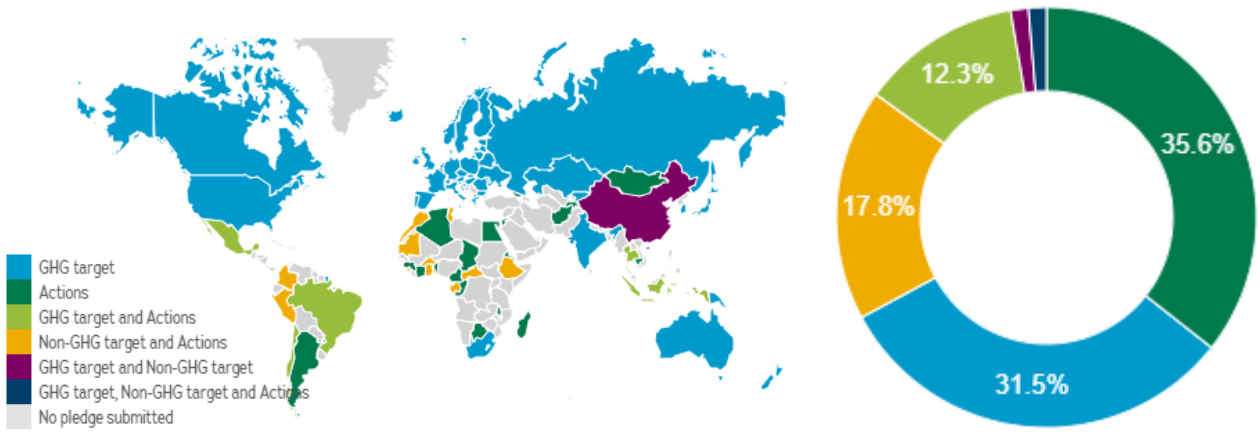
6.3. Overview of Nationally determined contributions

Intended Nationally Determined Contributions (INDC) identifies the actions a national government intends to take under the future UNFCCC climate deal that was agreed in Paris in December 2015[102]. INDCs are, therefore, the basis of global emissions reduction commitments that will be included in the future climate agreement. INDCs refers both to developed and developing countries' plans.

In their INDCs, UNFCCC Parties are requested to outline the steps they are taking/will take to reduce emissions at national level. Starting with Switzerland, till date 165 INDCs have been submitted. This reflects the commitments of countries who are responsible for around 96.4% of global emissions. The nature of commitments and the type of target for each country is varied.

Distribution of countries based on nature of commitment

Figure 28: Countries based on nature of commitment



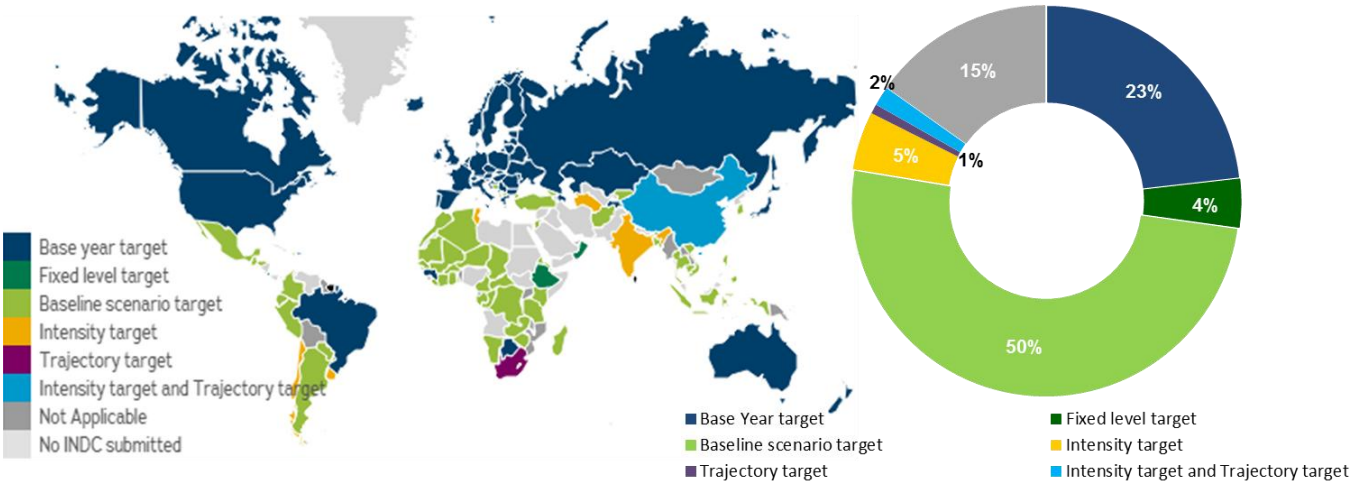
Most of the developed countries (Annex – I) countries have committed a GHG target. Whereas India has submitted a target that is based on emission intensity reduction, non-fossil fuel based capacity addition and afforestation.

Distribution of countries based on GHG target type

Countries have even differed based on the type of GHG target committed. Most of the countries have committed to a baseline scenario target (reduction as compared to BAU scenario). Many developed countries have also committed to a Base year target. China is one of the few countries which has submitted both intensity and trajectory targets.

[102] http://climateobserver.org/open-and-shut/indc/

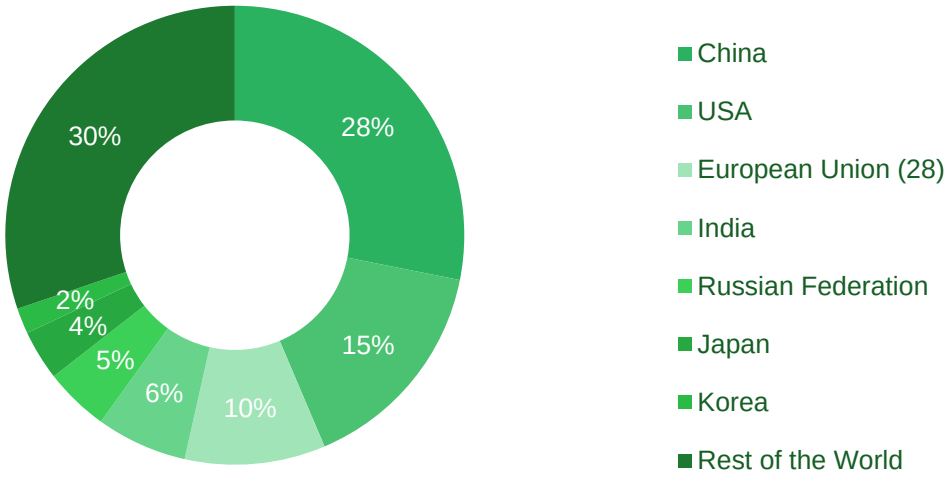
Figure 29: Countries based on GHG target type



6.4. Global comparison of emission reduction commitments

In the year 2015, the total CO_2 emissions from fuel combustion reached 32,294 $MtCO_2$. The top seven polluters China, United States, European Union (28 countries), India, the Russian Federation, Japan and Korea contributed to about 70% of this emission. Cumulatively, China and United States contribute to more than one third of the Global GHG emissions.

Figure 30: Contribution of leading polluters in global emissions



Though India's emissions per capita is below the global average of 4.4, measuring in at 1.58, when compared based on emission intensity (as shown below), China had the maximum emission intensity followed by India and Russia in 2015. The emission intensity of these countries is substantially above the world average of 0.43 $KgCO_2$ / US $ using 2010 prices[103].

[103] https://www.iea.org/publications/freepublications/publication/CO2EmissionsfromFuelCombustionHighlights2017.pdf

Figure 31: Emission intensity using exchange rates (kgCO2/US$ using 2010 prices)

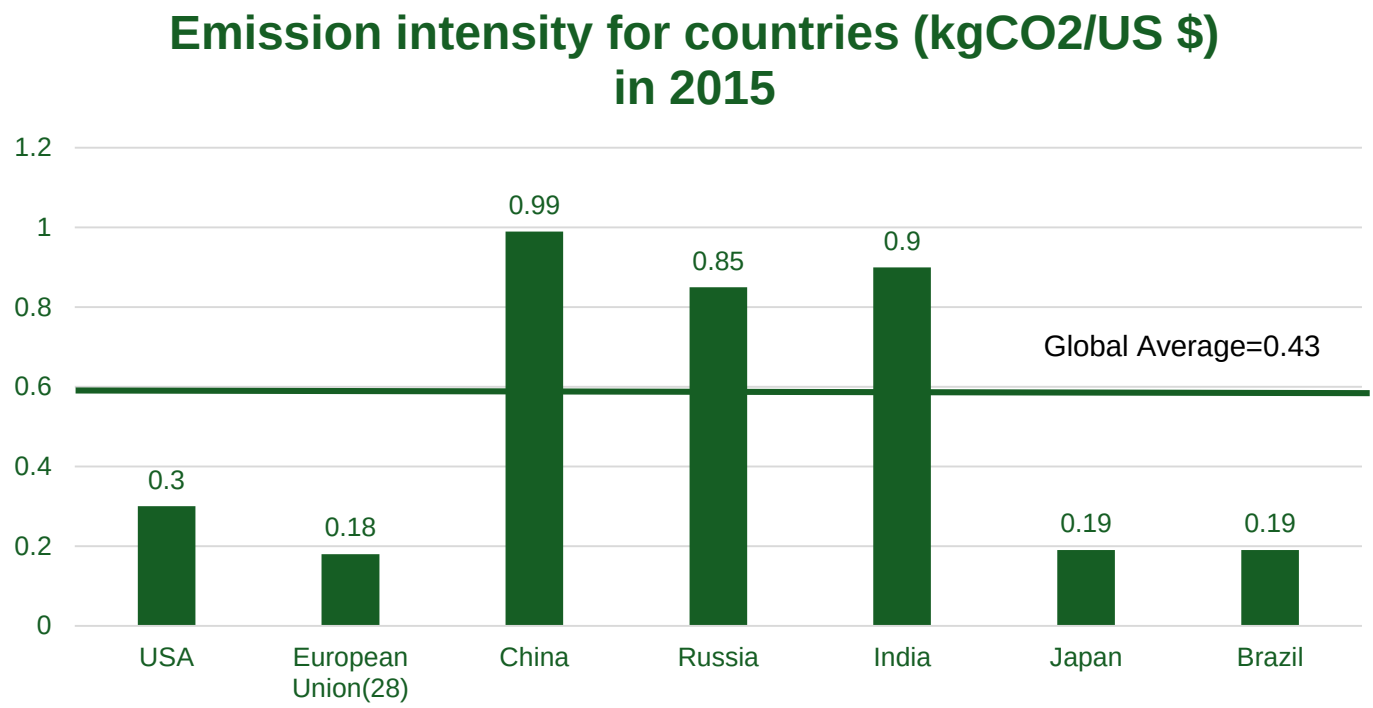


Table 120: Comparison of NDCs[104]

Country	*NDC summary*	*Sectors covered*	*Greenhouse gases covered*
European Union (28)	The EU and its Member States are committed to a binding target of at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly, as set out in the conclusions by the European Council of October 2014.	Energy, Industrial processes and product use, Agriculture, Waste, Land Use, Land-Use Change and Forestry	All greenhouse gases not controlled by the Montreal Protocol: Carbon Dioxide, Methane, Nitrous Oxide, Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride, Nitrogen tri fluoride
United States of America	The United States intends to achieve an economy-wide target of reducing its greenhouse gas emissions by 26%-28% below its 2005 level in 2025 and to make best efforts to reduce its emissions by 28%	The U.S. target covers all IPCC sectors.	GHGs included in the 2014 Inventory of United States - Greenhouse Gas Emissions and Sinks: Carbon Dioxide, Methane, Nitrous Oxide, Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride, Nitrogen tri fluoride

[104] Source: http://www4.unfccc.int/submissions/INDC/Submission%20Pages/submissions.aspx

Country	*NDC summary*	*Sectors covered*	*Greenhouse gases covered*
Russia	Limiting anthropogenic greenhouse gases in Russia to 70-75% of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests	Economy-wide, in particular, as determined by decisions of the UNFCCC Conference of the Parties on reporting: Energy; Industrial processes and products use; Agriculture; Land use, land-use change and forestry; Waste.	Carbon Dioxide, Methane, Nitrous Oxide, Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride, Nitrogen tri fluoride
China	China has nationally determined its actions by 2030 as follows: • To achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early; • To lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level; • To increase the share of non-fossil fuels in primary energy consumption to around 20%; and • To increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.	Not specified for GHG targets, but various sectors mentioned for policies and actions such as energy, buildings, transportation, industrial processes, agriculture, forestry and land use	Carbon dioxide
Brazil	Brazil intends to commit to reduce greenhouse gas emissions by 37% below 2005 levels in 2025.	Brazil's target covers all sectors	Carbon Dioxide, Methane, Nitrous Oxide, Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride
India	India communicates its Intended Nationally Determined Contribution for the period 2021 to 2030: • To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level. • To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF). • To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2	Not specified; various sectors mentioned for mitigation and adaptation strategies such as energy, industry, transportation, agriculture, forestry, waste.	Not Specified

Country	NDC summary	Sectors covered	Greenhouse gases covered
	equivalent through additional forest and tree cover by 2030.		
Japan	Japan's NDC towards post-2020 GHG emission reductions is at the level of a reduction of 26.0% by fiscal year (FY) 2030 compared to FY 2013 (25.4% reduction compared to FY 2005) (approximately 1.042 billion t-CO2 eq. as 2030 emissions)	All sectors and categories encompassing the following: • Energy ○ Fuel Combustion (Energy industries, Manufacturing industries and Construction, Transport, Commercial/ Institutional, Residential, Agriculture/Forestry/Fishing, and Other) ○ Fugitive emissions from fuels -CO2 transport and storage • Industrial processes and product use • Agriculture • Land Use, Land-Use Change and Forestry (LULUCF) • Waste	Carbon Dioxide, Methane, Nitrous Oxide, Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride (SF6), Nitrogen trifluoride (NF3)

6.5. Progress in achieving NDC commitments by India and other countries

As discussed in the previous sections, the NDCs are based on different parameters which make it difficult to compare the commitments. In the subsequent section, an attempt has been made to compare the GHG emission targets at an absolute level based on certain assumptions[103]:

Table 121: Progress in NDC achievements

Country	Base Year	Target year	Target Type	Target reduction	Base year metric	Metric in 2015	Target to be achieved	% achieved
European Union (28) (MtCO2e)	1990	2030	GHG	40%	5400	4000	3240	64.81%
United States of America (MtCO2e)	2005	2025	GHG	28%	6600	5830	4752	41..66%
Russia (MtCO2e)	1990	2030	GHG	30%	3900	2130	2730	151.28%
China (EI in GDP and PPP)	2005	2030	Intensity	65%	1.44 (exchange rate)	0.99 (exchange rate)	0.504	48.07%

Country	Base Year	Target year	Target Type	Target reduction	Base year metric	Metric in 2015	Target to be achieved	% achieved
					0.72 (PPP)	0.49 (PPP)	0.252	49.14%
Brazil (MtCO2e)	2005	2025	GHG	43%	750	1357.18	427.5	-188.2%
India (EI in GDP and PPP)	2005	2030	Intensity	35%	0.96 (exchange rate)	0.90 (exchange rate)	0.624	17.86%
					0.30 (PPP)	0.28 (PPP)	0.195	19.05%
Japan (MtCO2e)	2005	2030	GHG reduction	25.4%	1300	1200	969.8	30.28%

Notes and Assumptions:

1. LULUCF (Land use, Land-use change and Forestry) data has been taken into account to calculate MtCO2e

Commentary on global progress in achieving emission reduction targets

European Union (28): The EU target reduction of 40% falls 19% short of the desired levels as of 2015. The EUs 2050 goal of decreasing its emission by 80-95% below 1990 levels is also not in line with the Paris agreements long term warning goal.

The EU recognizes that it is not on track to meet its 2030 levels and thus the new long term greenhouse gas emission strategy, which the commission seeks to prepare by the first quarter of 2019, will offer an opportunity to achieve the NDCs.

United States of America: Despite the US administrations intent to withdraw from the Paris agreement, wind and solar have reached record shares in the electricity mix in 2017 and fossil fuel electricity has experienced its steepest decline since the 2008 financial crisis.

With the recent increase in tariffs for imported solar cells and modules and the EPA (Environmental Protection Agency) deciding to limit emission reductions to actions at the individual plant level rather than requiring states to meets emission standards, the US NDC target looks far-fetched.

Russian Federation: While it looks more than likely that Russia would achieve its NDC target, it can be argued that the target wasn't ambitious in the first place as it would not require GHG emissions to decrease from current levels.

The Russian federation remains the only big emitter to not have ratified the Paris agreement. With the current approach, Russia risks losing out on global competitiveness in the long term when the market is moving towards low-carbon technologies.

China: China ratified the Paris Agreement in 2016 and has put stringent policies in place to achieve its NDC targets. China's 13th five year plan stipulates a maximum 58% share of coal in its national energy consumption by 2020.

CO2 emissions rose in 2017 after a declining trend from 2014 to 2016, which says that it is still too early to suggest if they have reached their peak[105]. Despite this, Chinese officials have claimed that the country has met its 2020 carbon intensity in 2017, 3 years ahead of schedule.

Brazil: Emissions are expected to rise until 2030. To achieve its target and rapidly decrease its emission levels once they peak, Brazil will need to turn around the current trend of weakening climate policy by improving policy implementation in the forestry sector and accelerate mitigation actions in the LULUCF (Land Use, Land-Use change and Forestry) sector.

Recent developments in energy infrastructure and reversal of deforestation policies are evidence of Brazil's worsening climate change policies which will pull them further away from their NDC targets.

India: With the emission intensity achieved by India in 2015, India is expected to achieve its climate action targets submitted under the Paris Agreement. Under current implemented policy projections by the Asian Development Bank (ADB), GHG emissions are expected to reach levels of around 5285 MtCO2e in 2030, which is more than double of the 2010 levels.

Table 122: ADB GHG emission projections

GHG Emission projections by ADB[106]				
Member Country	NDC covered emission (MtCO2e/year)			
	2010	2030		% change
		High	Low	
India	2043	5285	3802	158.68

The "high" scenario is the high emission case which is taken as the higher emission end of the range (7567 MtCO2e) of the NDC pledge whereas the "low" scenario is the low emission case which is taken as the lower end of the range (4644 MtCO2e) of the NDC pledge .The growth in emissions is in line with the emission intensity pledges of 2020 and 2030 as well.

Japan: Coal power is projected to increase to 34% by 2020 from 32% in 2015, if Japan fails to reintroduce nuclear power and push for renewables. Nevertheless, Japan looks set to reach its 2020 pledge but may fall short of fulfilling its NDC.

Japan's new Basic Energy Plan and a long term energy strategy focusses on whether new nuclear reactors could be constructed by 2050 and reduction of costs from renewable electricity.

6.6. GHG Emission profiling of India

In order to assess the India's progress towards ambitious commitment of 33-35% reduction in emission intensity by 2030, it is essential to account for emissions inclusive all constituents (not just emissions from energy sources). The economy-wide emissions can be divided into two categories, i.e., energy and non-energy. Energy emissions contributes a large portion of the overall emissions.

[105]https://www.reuters.com/article/us-china-climatechange-carbon/china-meets-2020-carbon-target-ahead-of-schedule-xinhua-idUSKBN1H312U

[106] https://www.adb.org/sites/default/files/publication/189882/sdwp-044.pdf

Non-energy emissions such as agriculture, waste, IPPU and LULUCF sectors accounts for a minor portion of the overall emissions[107].

The target energy emissions in India for 2030, in absolute terms should be less than or equal to 6,807 MtCO2e (assuming a GDP growth rate of 8.0%)[108]. The achievement in emission intensity (energy and non-energy) reduction by 2030 is estimated to be 36%, under the moderate savings scenario, out of which the contribution of energy efficiency is 50%. Thus, it is deduced that India's NDC commitments would be met under the moderate scenario, which includes ongoing and future anticipated activities on energy efficiency.

Table 123: GHG emission target projections

Sectors	Moderate Emission Reductions (MtCO2e) -2030	Ambitious Emission Reductions (MtCO2e)-2030
Agriculture	14	34
Commercial	34	44
Domestic	101	134
Municipal	7	11
Industrial	185	238
Transport	97	141
Total Reduction due to EE	**438**	**623**
Overall Reduction (incl. RE)	**889**	**1053**
NDC target achievement	Yes (36% emission intensity reduction)	Yes (38% emission intensity reduction)

[107] GHG Platform India

[108] It has been assumed that the Emissions Intensity from Non-Energy sector in 2015 would remain constant up to 2030.

7

IMPLEMENTATION FRAMEWORK FOR NATIONAL ENERGY EFFICIENCY STRATEGY

7.1. Introduction

To achieve the energy efficiency potential targets as well as for India to stay within its NDC targets mentioned in the preceding chapters, it is necessary to structure a robust implementation strategy that paves the way for energy security and sufficiency in the country. To that effect, the chapter presents a compendium of global best practices identified on the basis of their reported success in scaling up EE at national, state and local levels. The best practices cover energy efficiency laws, regulations, financing mechanisms, institutions, innovative business models, implementation/delivery mechanisms and several other programmatic interventions that are recognized for their ability to overcome critical barriers and create favorable market conditions for EE. The chapter also contains a detailed review of the international strategic plans for 5 countries: Australia, Canada, South Africa, United Kingdom and Japan. The policies and programs in these countries have been studied according to the various demand sectors, with a comparison with the present state of policy and program interventions in India for the respective sectors. In the end, implementation strategies for each of the demand sectors as well as those strategies that cut across sectors and have an overall impact for influencing the energy efficiency landscape in the country are presented.

A broad overview of the tasks covered in this chapter are:

7.2. Best practices for scaling up energy efficiency

Each best practice includes an overview of the concept, initiative, significance and benefits, examples of their effective implementation, achievements, lessons learned, and the critical success factors. The selected practices are not intended to be a comprehensive overview of all the successful policies and initiatives, but rather a selection of those that are the most applicable to emerging economies involved in expanding their energy efficiency markets. This compendium will serve as a library of successful program and policy models that may be easily replicated or suitably adapted for implementation in the emerging markets.

7.2.1. Promotion of energy management system standards through government policies and programmatic efforts

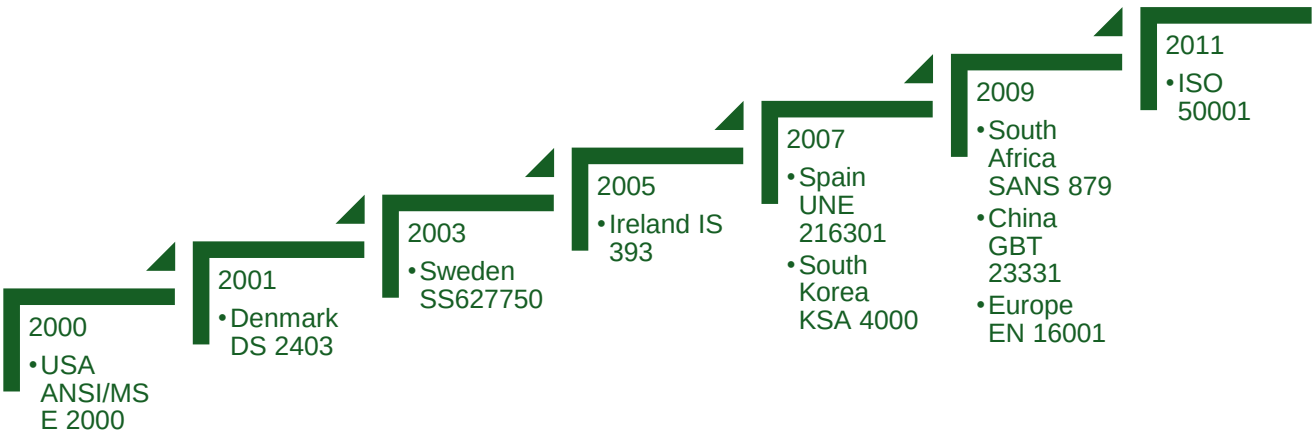
Overview

Experience has shown that organizations can save around 10-30% of their annual energy consumption and reduce energy costs through better energy management, often just by making operational changes[109]. An Energy Management System (EnMS) allows organizations to systematically manage energy performance with established procedures and practices. EnMS aims to integrate energy performance into daily management practices and business systems, leading to a lasting change in organizational culture. Implementation of EnMS requires organizations to assess

[109] https://www.researchgate.net/publication/238066344_Setting_the_Standard_for_Industrial_Energy_Efficiency

baseline energy use, actively monitor, control and manage energy use and costs, reduce emissions and continue to improve energy use/product output over time[110]. A number of standards for Energy Management Systems (EnMS) exist or are applied in the EU countries, Korea, South Africa, USA, and China. Promotion of standardized EnMS has been an important strategy for governments in these countries to address critical barriers for scaling up energy efficiency.

Figure 32: Progression of International Standards

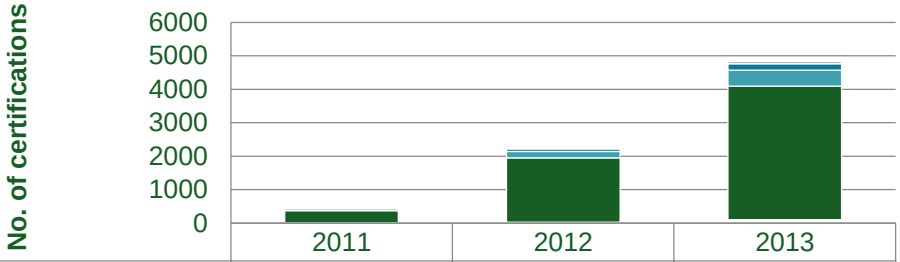


ISO 50001:2011 is the latest international standard for energy management system, developed by the International Organization for Standardization (ISO). It is a classical management system standard for manufacturing and services, and can be adopted by different organizations of all sizes in both public and private sectors. ISO 50001 is an outcome of the efforts of more than 50 governments to gather the best EnMS practices for use by organizations in managing their energy more productively. This global energy management system standard requires all levels of an organization, especially top management, to track energy performance on par with other critical business indicators, and all staff are empowered and encouraged to identify energy saving opportunities. ISO 50001 is based on the Plan-Do-Check-Act management system model of continual improvement used by other international standards, such as ISO 9001 and ISO 14001. The latest survey of ISO 50001 certifications has shown that total uptake has increased to 4826 in 2013 as compared to 2236 in 2012 and 459 in 2011. European region accounts for a major share of ISO 50001 certificates with over 80% in 2013. Germany leads the uptake with over 50% of the total certifications in 2013.

Analyses of companies adopting ISO 50001 in USA has found that savings averaged 10% within 18 months, and annual savings ranged from $87,000 to $984,000[111]. These results were often achieved using only no-cost or low-cost operational measures. Similar successes are emerging from facilities in South Africa's automotive and steel sectors and in Canada's cement, chemicals, electronics, and mining sectors[112].

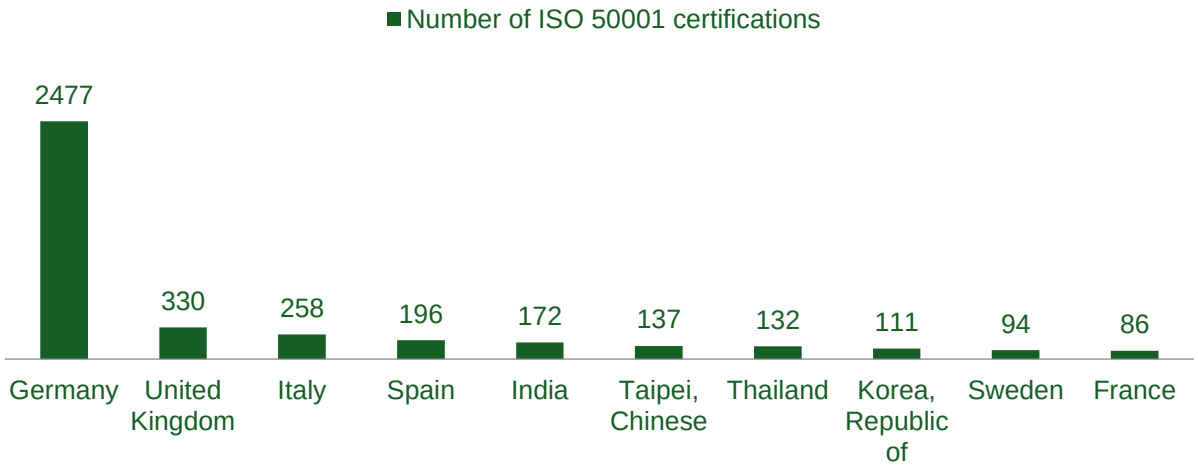
[110] https://www1.eere.energy.gov/manufacturing/pdfs/webcast_2009-0122_energy_mngmnt_stnds.pdf
[111] http://www.cleanenergyministerial.org/Blog/the-value-of-energy-management-systems-and-iso-50001-42890
[112] http://www.cleanenergyministerial.org/Our-Work/Initiatives/Buildings-and-Industry/Energy-Management/Case-Studies

Regional share of ISO 50001 certifications



	2011	2012	2013
Middle East	8	18	62
Central and South Asia	26	76	189
East Asia and Pacific	49	191	478
Europe	364	1919	3993
North America	1	9	34
Central / South America	11	10	34
Africa	0	13	36

Top-10 countries for ISO-500001 certifications – 2013



Experience of government policies and programs to drive EnMS uptake

Experience in the EU countries, USA, Korea and India has indicated that government policies, in the form of specifically designed programmatic interventions, stimulate the market uptake of standardized EnMS (ISO 50001). Such programs typically include financial incentives, regulations concerning energy use, rewards and recognition programs, access to guidance information and technical tools. Government programs focusing on technical assistance help companies overcome barriers related to lack of information and technical expertise for implementation of EnMS. Financial incentives and reward programs aim to create value for organizations by improving profitability and giving recognition.

Examples of government programs promoting uptake of EnMS standards[113]

Country	Financial / fiscal incentive	Regulations (binding targets for energy performance)	Technical assistance	Rewards & recognition
Germany	Exemptions on energy tax and renewable levies on electricity	Energy intensity target for industries – 1.3%	Energy efficiency networks (EEN) for sharing experiences in energy management Subsidized energy audits	N/A
Sweden, Denmark and Ireland	Fiscal incentives (reimbursement of energy/carbon tax) under voluntary agreements (except in Ireland)	N/A	Technical support through agreement support managers	N/A
USA	N/A	N/A	Certification process e-guide for ISO 50001 Quick Plant Energy profile Strategic Energy Management Checklist Energy Performance Indicator Tool System Assessment Standards	Silver, Gold and Platinum recognitions under Superior Energy Performance program
Korea	N/A	N/A	Training courses Technical information Pilot EnMS certification programs	N/A
India	White certificates trading under PAT scheme	Binding targets on energy intensive industries (2012-15) under PAT scheme	Energy audits and benchmarking of specific energy consumption	National Energy Conservation Awards

Learnings from international experience

Fiscal incentives have been very effective in accelerating the uptake of ISO 50001 EnMS. Access to incentives help reduce costs, improve profitability and get the attention of top management. Without these incentives, the uptake depends on government driven technical assistance programs combined with market recognition and rewards. Technical assistance and capacity building measures such as guidance documents, establishment of clear certification rules /process, energy audits, and training play a key role in implementation of EnMS by the industry. Consultations and continuous dialogue with industry, industry associations and other relevant stakeholders have helped Governments to implement initiatives and programs that address the specific barriers in the national context[114].

[113] https://pubarchive.lbl.gov/islandora/object/ir%3A125483/datastream/PDF/download/citation.pdf
[114] https://www.oecd.org/sti/ind/DSTI-SU-SC(2014)14-FINAL-ENG.pdf

7.2.2. EE obligations, resource standards and integrated resource planning (IRP)

Overview

A survey by the World Energy Council, in 2012-13, has indicated that more than 70 countries in the world have adopted some form of quantified energy efficiency improvement targets. Targets does not necessarily mean obligations but they have certainly emphasized the commitment of governments towards energy efficiency and also helped in streamlining the policy and planning for effective scale up.

An energy efficiency obligation (EEO) is a regulatory mechanism that requires obligated parties to meet quantitative energy efficiency improvement targets in a predefined time frame. Typically, EEO is placed on energy utilities, who are in the business of distribution and retail sales of energy commodities, and even on end users of energy. EEO for utilities require them to reduce the demand for energy by promotion of demand side measures. EEO for end users require them to improve energy performance indicators by implementing end-use energy efficiency measures. A survey by IEA in 2012 has found dozens of jurisdictions around the world with some form of the EEO.

Typically EEOs implemented across the globe share the following features:

- A quantitative binding target for energy efficiency improvement
- Target enforced by laws and regulations with the threat of financial penalties
- Clear definition of obligated parties that must meet the target
- A systematic process for compliance verification

Snapshot of EEO features in select countries across the globe

Country	Target	Obligated parties	Enforcement mechanism	Compliance mechanism	Performance incentives
Australia - New South Wales	0.4% of total electricity sales in 2009 Increasing to 4.0% in 2014	Electricity retailers and customers who purchase power directly from wholesale market	Combination of legislation and regulation Financial penalty for non-compliance	Self-achievement of savings Or Purchase of energy efficiency certificates	Trading of energy efficiency certificates among obligated parties
Canada – Ontario	1330 MW reduction in peak demand by 2014 6,000 GWh of energy savings by 2014	Electricity distribution licensees	Combination of legislation and regulation	Self-achievement of savings verified by third party and approved by regulator	CAD 0.3 to 1.8 per unit allowed for goal achievement ranging from 80% to 140%
China	0.3% of electricity sales and maximum load in the previous year	Government-owned grid companies	Regulation issued by central government agency	Self-achievement of savings verified by third party	None

Country	Target	Obligated parties	Enforcement mechanism	Compliance mechanism	Performance incentives
Italy	6 Mtoe cumulative in 2012	Distributors of electricity and natural gas	Combination of legislation and ministerial decrees Financial penalty for non-compliance	Self-achievement of savings Or Purchase of energy efficiency certificates	Trading of energy efficiency certificates among obligated parties
Poland	53,452 GWh by 2016	Electricity, natural gas, and district heating companies and brokers	Combination of law and regulation Financial penalty for non-compliance	Self-achievement of savings Or Purchase of energy efficiency certificates	Trading of energy efficiency certificates among obligated parties
United States, California	6,965 GWh, 1537 MW, and 150 million tonne in 2010-2012 for investor-owned utilities; 700,000 MWh for publicly owned utilities	Investor-owned and publicly owned electricity and natural gas utilities	Combination of legislation and regulation Financial penalty for non-compliance	Self-achievement of savings rigorously verified by third party contractors	Capped at 450 million USD for investor owned utilities
India - Profit Achieve and Trade (PAT) Scheme	6.6 Mtoe cumulative by 2015	Large energy intensive industries including electricity generating utilities	Combination of legislation and regulation Financial penalty for non-compliance	Self-achievement of savings Or Purchase of energy efficiency certificates	Trading of energy efficiency certificates among obligated parties

In most of the jurisdictions, the incremental costs incurred by the utilities towards compliance of EEO have been considered as operational costs of conducting business and recovered through consumer tariffs. In USA, more than 25 states have adopted EEO for electricity and natural gas utilities, known as 'Energy Efficiency Resource Standards (EERS)'. Many of these states have made necessary amendments in the legal framework of electricity/gas supply and distribution in order to emphasize 'energy efficiency' as a resource alternative (a virtual power plant) for the energy utilities while meeting their demand. Such amendments have strengthened the regulatory framework by empowering regulators to notify energy efficiency resource acquisition targets that mandated energy utilities to procure a certain percentage of overall energy requirements from energy efficiency resources. For example, the California Public Utilities Code, which is the California state law for operation of utilities was amended in 2003 that required all utilities in California to first meet their unmet resource needs through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible. The EERS adoption and compliance by electric utilities in USA has evolved 'integrated resource planning' (IRP) to its full potential. IRP is a utility plan for meeting forecasted annual peak and energy demand, plus some established reserve margin, through

a combination of supply-side and demand-side resources over a specified future period. IRP has been practiced in USA for more than 25 years through state legislations and regulatory oversight[115].

Examples of IRP in USA

Utility	IRP year	Target
Arizona Public Service	2012 IRP	Increase in the energy efficiency portfolio share (in the overall energy mix) from 4.7% in 2012 to 15.4% by 2027
PacifiCorp	2011 IRP	Increase in the DSM portfolio share from 0.9% in 2011 to 11.2% by 2027

The targets for EEO schemes have varied widely in terms of how they are set. The prominent practice has been to denominate the target in terms of final energy consumption by specifying the form of final energy. Targets for utilities are usually set in the form of energy served by them and stipulate the quantum of savings in the final energy consumption or % of total final energy consumption. Targets for end users are usually stipulated in terms of the quantum of final energy consumption in one common energy unit or units of electricity or weights of specific fuels. Such targets for end users could be affected by changes in the production output of end users. In order to overcome this challenge, India has set the targets in the form of specific energy consumption of individual obligated entities.

Many EEO schemes are accompanied with performance incentives in order to drive compliance. There are prominently two different incentive mechanisms adopted in the EEO schemes. One mechanism awards financial incentives for all obligated entities for every unit of energy saved beyond the target with capped limits of maximum incentive. The second mechanism allows partial compliance of targets through purchase of 'certificates' in addition to self-achievement. The 'certificates' are tradable instruments issued by appropriate authority or third parties for a specific quantum of energy savings achieved by the obligated entity, over and above the target savings. These certificates are allowed to be traded among obligated parties for partial compliance.

Learnings

The emphasis on energy efficiency as a 'resource alternative' has allowed it to compete directly with energy supply options in resource procurement and wholesale markets.

Enforcement is the key to the success of any form of energy efficiency obligations. The international experience indicates that a strong legal framework enacted through legislative actions is the pillar of effective enforcement of such obligations. In addition, high levels of penalty for non-compliance, incentives for performance beyond targets, a systematic procedure for obligated parties to report claimed energy savings to an appropriate authority and a process for checking and verifying these savings by independent/qualified/certified third parties are the basic tenets of good compliance regimes.

Targets under EEO schemes should reflect the achievable (market) potential for energy savings rather than the technical (theoretical), and economic (cost effective) potential. Targets for end users should be based on the baseline assessment of energy performance indicators conducted for each and every obligated entity/user. It is not feasible to define a single target/norm/standard unless there

[115] Rachel Wilson and Bruce Biewald; Best Practices in Electric Utility Integrated Resource Planning; The Regulatory Assistance Project; 2013

is significant homogeneity amongst end user group. Therefore, the energy efficiency improvement targets should be “user specific”.

An appropriate funding mechanism is another critical success factor for the EEO schemes, especially when the obligated parties are energy utilities, who are not the direct beneficiaries of accrued energy savings. Cost recovery through tariffs will enable a sustainable funding mechanisms for utilities in meeting their individual energy saving targets.

A successful IRP should include consideration in detail of the following elements: a load forecast, reserves and reliability, demand-side management, supply options, fuel prices, environmental costs and constraints, evaluation of existing resources, integrated analysis, time frame, uncertainty, valuation and selecting plans, action plan, and documentation.

7.2.3. Standard offer program (SOP) design for EE resource acquisition by utilities

The Standard Offer is a mechanism under which utilities purchase energy savings and/or demand reductions at a predetermined rate per kWh or per kW (termed as Standard Offer rates). Any energy user (utility customer) or energy service company (ESCO) that can deliver energy and/or demand savings is paid fixed amounts per kWh or kW by the utility upon realization/verification of energy savings. The fundamental idea of the Standard Offer approach is that it treats EE projects and investments in a manner analogous to generation of electricity, and considers the energy savings and demand reductions as resources (virtual power supply) that the utility will pay for. This essentially means that the Standard Offer rates are considered as feed-in tariffs for energy efficiency resources thus creating favorable market conditions to compete directly with other resources (viz. thermal, hydro, nuclear, and renewable sources) available with utilities while planning for long /short term energy demand. Standard Offer approach indirectly emphasizes energy efficiency as an alternative resource and further streamlines the evaluation process of energy efficiency project proposals and disbursement of incentives/payments. The greater transparency, shorter processing times, and reduced transaction risk of the Standard Offer approach would facilitate mobilization of commercial financing, essential to achieve substantial scaling up of EE/DSM investments.

The Standard Offer Program (SOP) designs have been widely adopted in USA, South Africa, India and many other countries. Standard Offer programs in California have resulted in over 385 GWh of electricity savings and 50 MW of demand reduction in 2010-11116. In South Africa, Standard Offer programs have generated cumulative savings of 726 GWh and 104 MW of demand reduction117. Eskom, which is the national integrated electric utility of South Africa, published a list of pre-approved EE/DSM technologies or measures that are eligible for payments under the SOP.

[116] CPUC 2010-2011 Energy Efficiency Annual Progress Evaluation Report
[117] ‘Standard Offer Programs – Review of International Experience’, Shakti Sustainable Energy Foundation, 2014

Published standard offer technology category rates in Rm/MW and c/kWh

Target technologies and end use applications	Rm/MW	c/kWh
Energy efficient lighting systems	5.25	42
LED lighting technologies	6.86	55
Building management systems	5.25	42
Hot water systems	5.25	42
Process optimization	5.25	42
Industrial and commercial solar water systems	8.736	70

Learnings

Publishing the list of eligible technologies for various end use applications and established standard Offer rates have broadened the scope of uptake for Standard Offer programs in South Africa. Also allowing ratepayers (customers), energy service companies, equipment and appliance manufacturers, dealers/suppliers, customer cooperatives and non-government organizations as eligible applicants have further widened the scope for uptake of Standard Offer programs.

In India, deemed savings approach, simplified M&V and adopting conventional feed-in-tariff establishment methods in the valuation of standard offer rates have been the critical success factors for rising uptake of Standard offer programs by utilities.

7.2.4. On-bill financing for utility driven EE programs

On-bill financing is a mechanism whereby a utility company includes the repayment for energy efficiency improvements on the customer's monthly bill. In many ways, on-bill financing is uniquely positioned to reduce first cost barriers in several energy efficiency markets. On-bill financing leverages the customer's existing relationship with the utility to avail convenient access for funding energy efficiency retrofits.

A recent market update[118] on 'Financing Energy Improvements on Utility Bills', has indicated that on-bill programs are operating or preparing to launch in at least 25 states in USA, as well as in Canada and the United Kingdom. The programs reviewed under this market update have delivered over $1.8 billion of on-bill financing to consumers for energy improvements.

In India, electricity distribution licensees in Delhi NCR and Rajasthan have recently launched the DELP on-bill financing model that aims to overcome the first cost barriers for adoption of self-ballasted LED retrofit lamps by the residential consumers. The scheme envisages to achieve 504 million units of annual reduction of electricity consumption. The Energy Efficiency Services Limited (EESL) has been providing the technical and financial support for these projects.

[118] State and Local Energy Efficiency Action Network's (SEE Action) Financing Solutions Working Group, 2014

Learnings

Some of the main challenges faced by utilities worldwide for widespread adoption of on-bill financing for energy efficiency improvements are:

- Low participation rates
- Upfront costs to utilities for modifying their billing systems
- Nonpayment or defaulters
- Finding capital to finance on-bill programs

International experience suggests there cannot be “one size fits all” solution and utilities worldwide have adopted varying program design options to overcome some of the key barriers for widespread adoption of on-bill financing.

Given that on-bill programs are mostly voluntary in nature, the participation rate depends on the eligibility criteria/conditions, eligible measures, terms of agreement (between utility and customer for structuring the on-bill financing transaction), and cost of financing.

Typically on-bill financing programs have been targeted at small business enterprises and residential consumers to provide and expand access to energy efficiency funds. The utility bill payment history is utilized to assess the creditworthiness of participants.

Measures with low payback periods and zero interest loans have greater participation rates. Several on-bill programs in USA and India are “bill neutral” to the consumer, meaning that the consumer’s net utility bill (after accounting for both financing charges and for reduced energy costs) is lower than it had been in the past.

The terms of on-bill financing agreement (between utility and customer) typically involve two key design questions:

- Whether nonpayment can lead to the disconnection of energy service? and
- Whether the on-bill financing loan payments are paid off when the building occupants change, or is attached to the meter and is paid by the subsequent occupants?

The threat of utility service termination may secure the consumer’s payments towards the on-bill financing loan. However, regulated utilities must review and amend the existing regulations for service termination to include nonpayment of on-bill financing loan payments.

Tying the on-bill financing obligations to a utility meter rather than occupant / owner can facilitate automatic transfer of obligations to subsequent occupants. However, this design can also increase the risk of split incentives among existing and subsequent occupants/owners.

Legislative and regulatory actions mandating utilities to provide on-bill financing options to select class of consumers have been prominent in many states in USA (viz. Illinois, South Carolina, New York, California etc.) to drive widespread adoption of on-bill financing mechanism.

Ratepayer funds and revolving funds established by budgetary allocations/grants are the major sources of capital for on-bill financing programs in USA. These sources can be leveraged to provide zero interest loans to participants but limited availability may impose challenges for expansion. Third party capital available from multilateral/bilateral/commercial banks and energy service companies (ESCO) are best suited for scaling up on-bill financing programs. Credit security and treatment of partial utility bill payments are key design options for on-bill programs seeking third party capital.

Utilities that rely on private capital to fund their on-bill financing programs also need to consider the potential impact of using just the utility bill payment history and service termination as the criteria to approve participant applications in the program. Programs that have successfully leveraged private capital, in USA, have provided robust credit security mechanisms (e.g., a loan loss reserve or partial risk guarantee which reduces the risk of poor repayment performance to private capital providers).

One of most important program design considerations that has evolved from the experience of on-bill financing programs worldwide is to address who gets paid first in the event that a consumer only makes partial payment of the utility bill. Specifically, in the event of a partial utility bill payment, does the on-bill financing charge get repaid before other utility charges are paid, or is the payment distributed "pro rata" (proportionally) across all charges, or is the on-bill financing charge subordinated (i.e., is collected after all other utility charges are paid in full)? The payment priority of the on-bill financial charge relative to other charges is particularly important for those programs that seek to access third party capital. Private investors will seek senior or pro rata treatment for repayment of the on-bill financing charge and may look unfavorably upon subordination of the financing charge relative to other charges.

7.2.5. Establishment of a nodal institution with statutory powers for promotion and regulation of EE

Worldwide experience has shown different institutional models for governing EE. Some the most commonly observed models[119] are as below.

Institutional model	Examples
Government agency with broad energy related responsibilities	U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy Danish Energy Authority Japan—Energy Efficiency Division (METI)
Government agency focused on clean energy - energy efficiency, renewable energy, sustainable energy, global climate change	Mexico CONAE Australian Greenhouse Office Czech Republic—Czech Energy Agency France—ADEME Netherlands—NOVEM Sweden—Swedish Energy Agency
Government agency focused on energy efficiency only	Thailand - The Department of Alternative Energy Development and Efficiency (DEDE)

[119] An Analytical Compendium of Institutional Frameworks for Energy Efficiency Implementation, ESMAP, 2008

Institutional model	Examples
	Brazil's National Electrical Energy Conservation Program (PROCEL) New Zealand—Energy Efficiency Conservation Authority (EECA) India's BEE Pakistan's ENERCON Bangladesh's SREDA
Independent statutory authority with a government appointed board to promote energy efficiency or clean energy	The Sustainable Energy Authority of Ireland (SEAI) UK Energy Saving Trust Srilanka Sustainable Energy Authority (SLSEA)
An independent corporation owned by the government	The Korea Energy Management Corporation (KEMCO) South Africa – National Energy Efficiency Agency
A public–private partnership (PPP), by government and nongovernment entities	Polish National Conservation Agency Germany – DENA
A nongovernment organization (NGO)	Austrian Energy Agency Croatia Energy Institute

A statutory basis through constitutional enactment confers a definite institutional advantage for nodal energy efficiency agencies, especially if the legal basis includes provisions for regulation, funding or other resources[120].

Learnings

Worldwide experience indicates that there is no single institutional model. Experience has shown that the institutional mechanisms must be designed and adapted to fit local needs and situations. The choice and design of energy efficiency nodal agency should reflect historical development, country context, and alignment with sector and energy efficiency objectives, policy implementation requirement, existing institutions and many other factors. Statutory bodies with strong leadership, financial independence, sufficient resources, good external co-operation and private sector involvement are the critical factors and core competencies that contribute to successful energy efficiency nodal agencies.

7.2.6. Establishment of a public sector corporation to lead investment related actions of EE

Worldwide experience indicates that the public sector resources are crucial to scale up EE investments and lead the market related actions in capturing the EE potential in the overall economy. The nodal agencies generally do not have the mandate (unless they are independent corporations) to undertake large scale EE investments and they also have many competing demands for their internal

[120] 'Energy Efficiency Governance Handbook', IEA 2010

funds/resources. Implementing policy driven regulations, awareness, capacity building and other programmatic interventions always take priority over large scale investments.

Establishment of a public sector corporation with adequate seed capital for the sole purpose of leading the market related investments has proven to be very successful in scaling up EE. Such institutions can leverage the public sector equity to raise sufficient debt funds in order to overcome the critical financial barriers for large scale EE investment opportunities. They provide resources for design, procurement, and commissioning and project management of EE projects and also offer services and solutions under their own business models.

Dubai's 'Etihad Energy Services' and India's 'Energy Efficiency Services Limited (EESL)' are some of the relevant examples of public sector corporations established to lead investment related actions of energy efficiency.

Learnings

Experience indicates that public sector corporations can effectively aggregate demand and substantially reduce the high initial costs thereby creating commercially viable investment opportunities and facilitating higher uptake of solutions by end users.. They need a working relationship with commercial financing institutions, well established resources and a clear business strategy to drive large scale investments using innovative business and implementation models such as energy performance contracting. Apart from leading the investment related efforts, such corporations can also engage the private sector energy service companies (ESCOs) and energy efficient technology / equipment manufacturers to invest and support in the development of energy efficiency services infrastructure in the country.

7.2.7. Adapting ESCO financing and energy performance contract structures to fit local market conditions

Energy service companies (ESCOs) help end users and energy utilities identify, package, finance, implement and monitor energy savings projects. Typically, this is done through energy performance contracting (EPC), where the ESCO is paid over time from the energy savings. ESCO financing provides a way to facilitate access to commercial financing by leveraging reduction in energy bills over the life of the project. ESCOs can also serve as market aggregators, by allowing financiers to support a portfolio of energy efficiency projects.

In the developed countries, such as the USA, Germany, France, Japan, Canada, Finland and Denmark, ESCOs have performed EPC projects by taking on the performance risk of energy efficiency improvements, guarantee cost savings to the end user, and use the energy bill savings resulting from the projects to pay off the initial investment at no up-front cost to the end user or utility.

Learnings

Familiarity with EPC models adopted in the developed can be important in understanding the range of options, but those models need to be adapted incrementally to work in developing countries. Where local EPC experience exists, it may be prudent to build on successful transactions and institutionalize those aspects that have worked well. It may also be worth considering efforts to bundle projects to reduce transactions costs and make such projects more attractive to target markets and vendors. ESCO promotion and development is a long term undertaking and must have

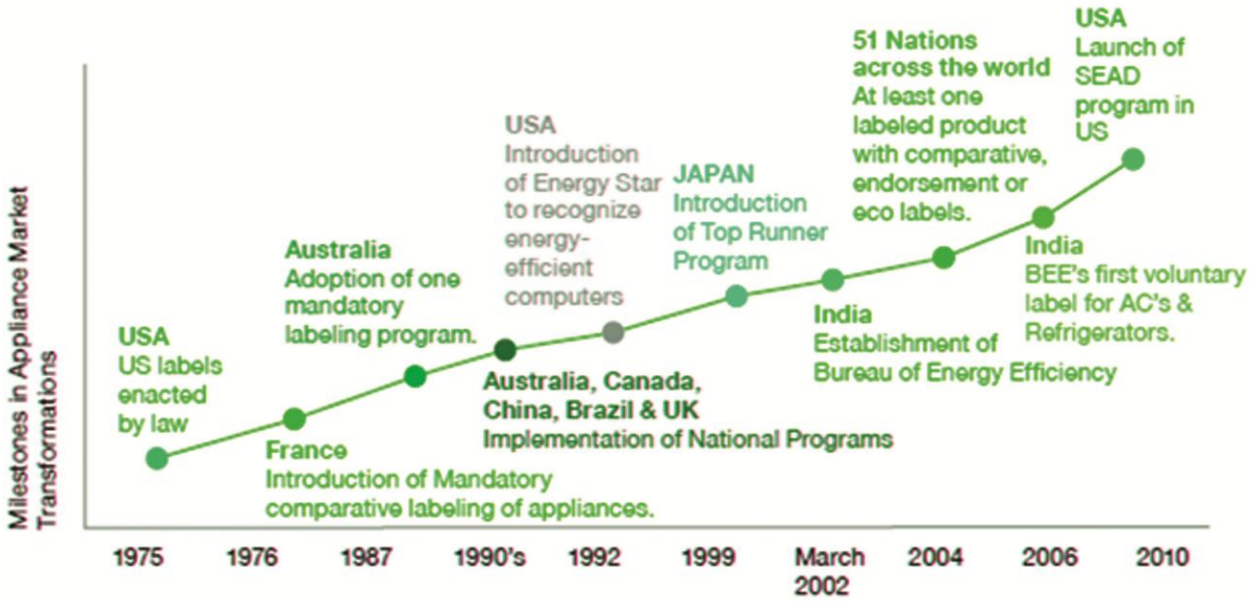
significant government support in order to succeed[121]. Often it may be advisable to begin with simpler models first and develop more complex transactions as the market develops. Considerations for target markets, long-term financing requirements and potential sources, substantial market organization and development, massive dissemination of early successes, proactive resolution of common legal, financial, accounting/tax and other issues associated with EPCs, etc. are all necessary. While the traditional EPC models has been more common in the developed world, simpler models may be more appropriate in developing countries, at least until the market has a chance to evolve to more sophisticated contractual arrangements over time.

7.2.8. Minimum energy performance standards (MEPS) and labels for appliances and equipment

Standards and labels work in tandem to improve efficiency of end use appliances. Together, standards and labeling (S&L) programs are market transformation mechanisms that aim to promote energy efficiency in appliances and equipment markets.

Review of global programs suggest that many developed and developing countries started adopting MEPS and labels early (15 – 40 years) and have progressed and covered number of product categories in their programs. In addition, mandatory labelling measures seems to have increased substantially as compared to voluntary measures in many product categories[122]. A survey by World Energy Council in 2012-13 indicates that 90% of the 71 countries surveyed have introduced mandatory labels.

Figure 33: Milestones in appliances market transformation



In EU, Japan, Korea, Thailand, China, USA, and many others countries, a strong legal and regulatory framework has provided the statutory basis for specifying standards, institutionalization and effective implementation of S&L programs. Apart from this, clear allocation of sufficient and stable funds has

[121] Public Procurement of Energy Services
[122] IEA, 2013

helped USA, China, EU, and Korea to establish adequate resources (testing laboratories) and support effective program development and monitoring.

Australia places a great deal of importance on accurate performance information. The government requires technical information about products' energy performance before bringing them into the country or into the market. Under a check-testing program, appliances from retail outlets are tested in accredited independent laboratories to verify that the information provided on the label is accurate[123].

In the Republic of Korea, fines apply to products that enter the consumer market without meeting minimum energy performance standards, and product labels inform consumers about the energy consumption of devices even during sleep, passive, and "off"-mode status.

In the Japan's Top Runner program, mandatory standards (as applicable to various products and appliances) are established for given target years, based on the performance of the most efficient product available in the market.

Learnings

Effective monitoring and compliance mechanism is important to increase market uptake of labelled appliances. These countries have separate fund earmarked for monitoring the uptake of labeled appliances in the market. Stringent penalties have ensured a strong compliance regime in many countries.

7.2.9. Leveraging economies of scale through demand aggregation and bundled procurement to moderate high upfront costs of EE technologies

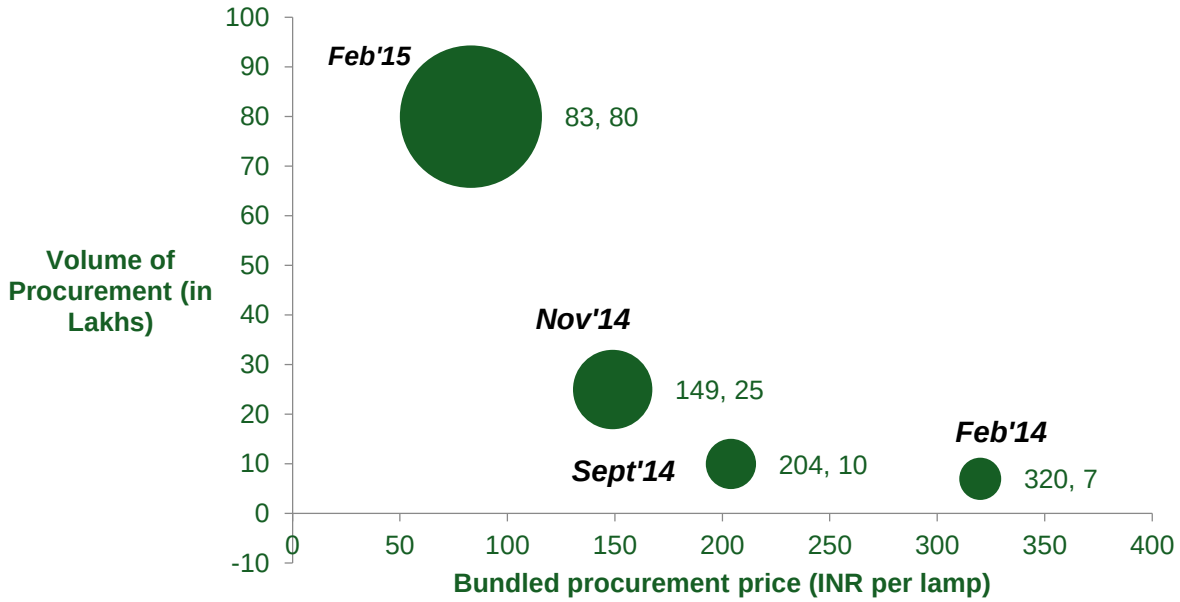
One of the major barriers for accelerating the penetration of energy efficient technologies in any country is the high upfront cost. Demand aggregation is often considered as an important strategy to significantly enhance volumes, improve economies of scale and reduce the upfront cost in the process. Bundling demand allows for bulk procurement in public sector institutions and markets, which hold significant potential for improved EE and represents a large and important market in all countries. The common ownership and homogeneous nature of many of the facilities, particularly those with common functions (schools, hospitals), offer unique opportunities for bundling many projects together, allowing procurement at a large scale and attracting new suppliers into the energy efficiency business.

In India, a central core committee formed in 2009 recommended several demand aggregation strategies to enhance market volumes and reduce the high upfront cost of LEDs for general lighting illumination purposes[124]. The EESL, in 2014-15, successfully bundled LED lighting demand at utility scale in its flagship scheme – DSM based efficient lighting program (DELP), which replaced incandescent bulbs with self-ballasted LED lamps in households. In a span of one year, EESL bundled more than 70 lakh LED lamps under one procurement cycle to reduce the upfront cost from INR 320 per lamp to INR 83 per lamp thereby achieving a whopping 75% reduction due to demand aggregation.

[123] World Resources Institute 2013

[124] The economic case to stimulate LED lighting in India, 2010, Ministry of Power, Govt. of India

Figure 34: Bundled demand Vs upfront cost



Learnings

Bundled procurement must be carefully orchestrated with robust technical standards, quality control mechanisms, and testing infrastructure to have sustained benefits. In many cases, the manufacturers may hesitate to participate in bundled procurement tenders because of the inherent wholesaler dealer conflicts.

7.2.10. Mandatory building energy codes

Buildings are significant consumers of energy, but their performance can be improved by the enactment and enforcement of building energy codes. These codes set thresholds for building energy consumption through design and construction standards that apply to energy systems, equipment, and the building envelope.

The Chinese codes provide two options for compliance: a prescriptive path, which provides detailed specifications for individual building components, and a performance path, which requires that the proposed new building not consume more energy (in its design) than a reference building. The code includes provisions with design standards for all major climate zones and the main construction processes, including design, construction, acceptance, operation, and retrofit.

Many countries (Australia, Canada, France, Germany, Italy, Japan, South Korea, USA, UK, etc.) couple building energy codes with incentives and robust policy packages, such as green loan programs, financial schemes and incentives, and public incentives including tax credits, and some countries have offered incentives such as relaxed building height and size restrictions, such as in Japan. France's scheme for new residential buildings, called the Prêt à Taux Zéro+, or "Zero-Interest Loan +" provides loans to homeowners for their primary residence to encourage home buyers to

purchase highly energy-efficient homes. Other enforcement mechanisms (viz. China) include building permit refusal, fines and fees for noncompliance[125].

Many countries such as France, China, Canada, USA etc. are also using third-party inspectors to help code enforcement.

Countries such as USA and China have established well developed compliance evaluation systems[126], to assess compliance with codes.

Learnings

Enforcement and high compliance rate is critical to achieving intended energy savings with mandatory building energy codes. Stringency of codes does not matter when the compliance rate is low. Using third-party inspectors to help code enforcement agencies build capacity and roll out code implementation rapidly. Coupling building codes with incentives can effectively complement or motivate compliance. Compliance evaluation can help state and national governments track the progress of ECBC implementation.

7.2.11. Public procurement of energy efficient appliances

Public procurement holds significant potential for EE improvement and represents a large and important market in any country.

In Japan, the Green purchasing (Governmental purchasing program) agenda was introduced through legislation in 2000. The law requires the central government to develop a green procurement policy and implementation plan and to set up a competent authority to publish guidelines and product criteria. Since 2001, the government has designated over 250 green procurement products in 19 product categories. Eco Mark criteria and labeled products are widely adopted in the governmental green purchasing program. Through implementing this law since 2007, all central government ministries, 47 prefectural governments, 12 designated cities, and 68% of 700 local governments and cities have been practicing green purchasing[127].

In China, the Ministry of Finance (MOF) and National Development and Reform Commission (NDRC) introduced the government's energy efficient procurement policy in 2004. It requires public institutions to give priority to energy-saving products, provided they offer the same functions as the standard products. The procurement policy for energy-saving products was made mandatory in 2006. By 2011, the Chinese government expanded or updated the energy efficient product list nine times. The list has expanded from the initial eight product categories in 2004 to 28 product categories in 2011, including 22 energy-saving categories and 6 water-saving categories. Among them, nine categories are specified as mandatory[128].

[125] Global Approaches: A Comparison of Building Energy Codes in 15 Countries, ACEEE, 2014

[126] Refers to a set of processes and procedures through which factual information is provided, assessed, and checked to determine whether buildings effectively meet respective energy code requirements. It is also important to note that compliance evaluation is different from regular compliance checks that are used to enforce energy codes. Compliance checks are part of the code enforcement procedures; code officials or third-party inspectors check and verify if a single building complies with the requirements of the codes at the design and construction stages and then issue building permits. In contrast, compliance evaluation assesses the overall compliance rate of all buildings and may involve using statistical methods instead of checking every single building.

[127] Public procurement of energy efficient products, ESMAP, 2012

[128] ESMAP,2012

Learnings

Governments should consider using a holistic approach, from policy development and planning to tools and outreach to tracking. Some of the most critical elements of success relate to having established a clear policy, supporting tools (e.g., labels, LCC calculators, qualified product lists) to help lower transaction costs of procurement by public sector agencies.

7.2.12. Revolving loan funds (RLF) to finance EE investments

RLF is fundamentally a source of money from which low cost loans are made to borrowers consistent with standard, prudent lending practices. As the borrowers repay loans, the money is returned to the RLF to make additional loans. In that manner, the RLF becomes an ongoing or "revolving" financial tool.

In USA, the American Recovery and Reinvestment Act (ARRA) provided funding of $3.1 B for State Energy Programs (SEP). The ARRA legislation encouraged the creation of long term funding mechanisms such as RLF, in order to extend the impact of the ARRA funds. In this regard, many states applied for ARRA funding and have setup RLFs for financing EE projects. Public sector institutions have been the major borrowers of these RLFs. Typically the interest and fees paid by the borrowers support RLF administration costs and the fund's capital base remains intact. Energy savings performance contracts and On-bill recovery programs have been the favorites for approval among these RLFs.

Learnings

RLF has the potential to overcome the high cost financing barriers that are derailing the institutional investments for EE. It supports the EE investors to build the business case for cost effectiveness, sustainability and helps to create a long term self-sustainable financial mechanism that can extend the impact of initial budgetary allocations by governments.

7.2.13. DSM regulations and incentives

In a regulated industry, such as the electricity supply and distribution, 'DSM Regulations' provide the mandate as well as an objective framework to plan, finance and acquire DSM resources.

In USA, the DSM regulations notified by regulatory commissions, in many states, have provided the following key strategies to promote utility driven DSM.

- Aggressive energy saving and demand reduction targets to capture the full potential for cost-effective savings
- Utilities can recover the prudently incurred costs of EE programs through consumer tariffs
- Incentives to break the link between sales and recovery of authorized fixed costs
- Processes and protocols for independent evaluation and measurement of energy savings

In addition to the above strategies, the DSM regulations in USA have also provided guidelines, templates and tools (listed below) for the various stages of the DSM program planning and

implementation cycle. These measures have played a key role in building the technical capacity of utilities to evaluate DSM resources and investments.

- California Standard Practice Manual for establishing cost effectiveness of DSM programs
- California Energy Efficiency Evaluation Protocols
- E3 Avoided Cost Calculator for establishing cost effectiveness of DSM programs

Learnings

Targets, cost recovery mechanism, incentives and capacity building are some of the key strategic areas addressed through DSM regulations in order to scale up utility driven EE programs and investments.

7.2.14. Vehicular fuel efficiency standards and labels

In many countries, the transport sector is responsible for the fastest rate of growth in the consumption of fossil fuels relative to other sectors such as buildings and industry. In order to address this issue and reduce the energy intensity in the transport sector, countries have adopted several measures to promote fuel efficiency in vehicles. Some of the major measures are indicated in the table below.

Measures	Countries
Fuel economy standards and labels	USA, Japan, Australia, China, Korea, Brazil, Chile etc.
Fiscal incentives (fuel taxes and differential vehicle fees and taxes)	EU, Japan, China etc.
New technology incentives (R&D funding and subsidies)	USA, Japan, China, EU, India etc.

Learnings

The fuel economy standards should be developed in an inclusive manner by holding extensive consultations with a range of stakeholders from industry, state governments, and consumer and environmental groups.

7.2.15. Upstream and midstream incentives

Incentives are policy tools that motivate purchase, retail stocking, and production decisions toward energy efficient products. Incentives complement mandatory standards and labeling policies by accelerating market penetration of products that are more energy efficient than required by existing standards. They can also prepare the market for expanding appliances in the mandatory regime or for stringent future mandatory requirements. Incentives can be directed at different points in the appliance's supply chain. One point may be more effective than another depending on the technology's maturity, market penetration and other local conditions. Incentives targeting end users /consumers are referred to as “downstream”, targeting retailers and distributors are referred to as “midstream,” and targeting Manufacturers are referred to as “upstream”. Examples of Midstream programs are:

Country	Program	Timeframe	Incentive form	Recipient	Administrator	Funding	Product
US Texas	Distributor Air Conditioning Market Transformation	2001- to 2004	Rebate	Retailers	Utility	Rate funded	Central air conditioning units
US California	California Business and Consumer Electronics (BCE)	2007 till present	Rebate	Retailers	Utility	Rate funded	Televisions and Computer Monitors

Examples of Upstream programs

Country	Program	Timeframe	Incentive form	Recipient	Administrator	Funding	Product
China	Promotion products program	2008- to present	Upstream subsidy	Manufacturers	Government	General budget	CFLs, ACs, TV, water heaters, washing machines, refrigerator
India	Super Energy-Efficient Equipment Program (SEEP)	In development	Upstream subsidy	Manufacturers	Government	General budget	Ceiling fans
Sweden	Ground source heat pump technology procurement program	1993	Upstream technology procurement	Manufacturers	Government	General budget	Ground source heat pumps
US	Federal Energy-Efficiency Tax Incentives for Manufacturers	2005-11	Upstream tax credit	Manufacturers	Government	General budget	Residential refrigerators, clothes washers, dishwashers

Learnings

Upstream incentives are particularly effective for reducing the upfront cost of technologies that are at an early stage of penetration. Upstream incentives are offered to manufacturers to streamline their production lines and increase production at a lower price. The main advantage of these programs is that they can influence a large portion of the market through fewer actors and therefore have lower transaction costs. Moreover, by reducing the price before products reach the market, the incentive has more impact on purchase price than a downstream incentive.

The main disadvantages of upstream programs are that financial incentives offered to manufacturers are not seen by consumers and that robust monitoring and verification are required to ensure the incentive is passed through to the consumers[129]. Another drawback is that implementing these programs successfully requires estimating how much it will cost to the manufacturer to produce more efficient products so that the program administrator can negotiate a fair price for the incentive.

Midstream incentives encourage retailers to stock or sell a larger percentage of highly efficient products. These programs influence customers at their point of decision and help address the lack of availability of highly efficient products. They can be particularly effective when a consumer is replacing equipment in an emergency and the purchase decision depends on the immediate availability of a product. Targeting midstream actors can also be advantageous in split incentive situations. Midstream programs also educate and motivate retailers to promote highly efficient technologies in general and to use electricity bill savings as a selling point for the products. A midstream program can be particularly effective when a program budget is small and the price of equipment is high. Because the profit margin for distributors and retailers tends to be small, even a small increase in profit from an incentive can give a retailer significant motivation to sell more-efficient equipment. However, focusing on the midstream point in the supply chain means more transaction costs than an upstream program (although fewer than in a downstream program).In addition, midstream programs tend to focus on a selection of distributors and retailers and therefore may not reach all the distribution channels. As a result, these incentives only affect the portion of the market that is reached by the participating retailers and/or distributors. Furthermore, it could be argued that choosing which retailer or distributor participates in a program is effectively “picking winners” and penalizing other retailers who are not chosen.

7.3. Review of International strategy plans

This section presents a review of international strategy plans and the applicability of their programs to Indian EE market.

[129] Friedmann, Rafael. “A Fresh Look at Evaluation to Support Energy Efficiency in the 21st Century.” Proceedings of the IEPEC 2011 Conference. Boston, Mass.: International Energy Program Evaluation Conference.

United Kingdom

The measures of the country towards Energy Efficiency are summarized below.

Table 124: UK EE measures and adaptability to India

Sector	Measure	About the program
Cross Sectoral/ Public Bodies	Climate Change levy (CCL) and Climate Change Agreements	• The CCL was introduced in 2001 and is levied on the supply of energy to business and public sector consumers. Each of the four main groups of taxable commodities (electricity, gas, coal and liquefied petroleum gas) has its own main rate per unit of energy. The main rates of the CCL are intended to change business behaviour to reduce energy consumption and ensure the UK fulfils its EU obligations under the Energy Tax Directive (ETD).
	The Green Deal	• The Green Deal enables consumers to take out loans to pay for energy efficiency improvements in their homes, with repayments made through their energy bill. Repayments are made on a "Pay As You Save" (PAYS) basis: after the improvement has been made, the consumer begins to save energy, their energy bills are less than they would have been without the improvement, and these savings are used to repay the loan. The scheme has been since discontinued.
Household Sector	Smart metering	• The Government of UK has put in place license conditions requiring energy suppliers to take all reasonable steps to roll out smart meters to all domestic properties and smaller non-domestic premises in Great Britain by the end of 2020.
	Buildings Regulations	• The Building Regulations set minimum energy performance standards for new buildings and when 'building work' is carried out to existing properties. Since 2002 the building regulations have been responsible for energy efficiency standards being strengthened by 6% compared to the 2010 requirements for new homes and 9% for non-domestic, in 2013.
	Energy Company Obligation (ECO)	• The Energy Company Obligation replaced the Carbon Emissions Reduction Target (CERT) and Community Energy Saving Programme (CESP) from January 2013, and, like its predecessors, required domestic energy suppliers over a certain size to achieve carbon and notional bill savings by promoting and installing energy efficiency measures into domestic homes.
Industrial	Carbon Trust	• The Carbon Trust, originally set up and funded by the UK Government from 2001 to 2012 (and now a self-financing private company), promotes its Carbon Trust Standard to businesses. Obtaining the standard requires the measurement, reduction and management of emissions/energy use.
Transport	Low emission vehicles	• The UK Government has a broad range of measures in place to support the UK's growing ultra-low emission vehicle (ULEV) market. This includes consumer grants of up to £4,500 towards the cost of ultra-low emission cars, as well as up to £8,000 for ultra-low emission vans, up to £7,500 for ultra-low emission taxis and up to £1,500 for ultra-low emission motorcycles.

Sector	Measure	About the program
	Rail Electrification	• The Department for Transport has set out its policy for rail infrastructure investment, including electrification and the associated funding for nominated schemes through its Rail Investment Strategy. • This Strategy is produced every five years with the most recent one published in June 2012 covering rail investments in the period 2014 to 2019.

Canada

The measures of the country towards Energy Efficiency are summarized below.

Table 125: Canada EE measures and adaptability to India

Sector	Measure	About the program
Cross Sectoral/ Public Bodies	The Energy Efficiency Act, 1992	• The Act enforces minimum efficiency standards nationwide for energy-consuming products, making it illegal to sell or import products which fail to adhere to these standards. It allows for stringent implementation of such standards through seizing, inspection and testing of suspicious products. It also places heavy fines up to CAD 50,000 on individuals who fail to follow said standards[130].
	ecoENERGY innovation Initiative Research and Development	• This initiative had the objective of advancing Canadian leadership in clean energy technologies by investing $268 CAD million over a five year period (2011-2016) in various priority areas[131].
	Ontario's Five Year Climate Change Action Plan	• This action plan broadly describes a number of projects in the pipeline from 2016-2020 which will reduce the emissions and increase the energy efficiency in the city of Ontario, moving it towards a more sustainable future. There are in excess of 50 separate projects within this action plan
	Integrated Community Energy Solutions (ICES)	• This is an ambitious project of the Canadian government to reduce the energy demand at the community level through increasing the energy efficiency of utilities such as water supply, electricity distribution as well as reducing the energy demand of community relevant sectors such as transport, industry and land use[132].
	Pan Canadian Framework on Clean Growth and Climate Change	• The Canadian government consulted tens of thousands of Canadians from all walks of life from 2016 to 2017 and using the insights gained from thousands of suggestions, they formed a nationwide framework for the reduction of emissions and guidelines to combat climate change and achieve the targets set by the Paris

[130] Justice Laws Website (Canada), Energy Efficiency Act, 1992: http://laws-lois.justice.gc.ca/eng/acts/e-6.4/
[131] Government of Canada, ecoEnergy Innovation Initiative: https://www.canada.ca/en/news/archive/2015/02/ecoenergy-innovation-initiative.html
[132] QUEST Canada: http://www.questcanada.org/rh/aa539c1b53703fb55223c353998566be.pdf

Sector	Measure	About the program
		Agreement in 2015[133].
Household Sector	ecoENERGY Retrofit – Homes	• Starting back in 2009, this scheme involved giving grants to households for energy efficiency upgrades. A maximum of $5,000 CAD could be issued as a grant if the following steps were taken for the household: A licensed and independent energy advisor performs a pre-retrofit residential energy assessment, homeowner completes selected upgrades within 18 months, have the home re-assessed
	R-2000 Building standards	• These standards are voluntary and are so far not mandatory in any province of Canada however in many provinces, the adoption of these standards is incentivized by tax rebates and other financial assistance[134].
Industrial	Accelerated capital cost allowance	• An accelerated capital cost allowance (ACCA) is a CCA rate that is greater than the rate, which would reflect the useful life of the asset class. The government has provided ACCA tax incentives since 1994 under which companies in the industrial sector can invest in energy efficient systems and generate electricity themselves.
	Pulp and Paper Green Transformation Program	• This unique program launched in 2009 gave the Canadian pulp and paper industry credit on the basis of a producer's productivity at the rate of $0.16 per liter of "black liquor". These companies had until 2012 to invest the earned credit into energy efficiency programs that would reduce their emissions and make economic sense for the companies[135].
	Canadian industry program for energy conservation (CIPEC)	• As a part of the ecoENERGY Efficiency for Industry, the CIPEC is a partnership between private industry and the federal Government to promote and improve Canada's industrial energy efficiency and reduce greenhouse gas emissions from energy use in the industrial sector. The programme started in 1975 and it is a voluntary programme to promote energy efficiency in the industrial sector. The programme involves sector specific task forces that promote and develop voluntary energy efficiency targets and develop action plans for energy efficiency in their sector. The programme currently has the participation of 1400 companies.

[133] Pan Canadian Framework on Clean Growth and Climate Change (2016), Canada's Plan to address Climate change and grow the economy

[134] New Home Construction Incentives, Prince Edward Island Canada, https://www.princeedwardisland.ca/en/information/transportation-infrastructure-and-energy/new-home-construction-incentives

[135] Pulp and Paper Green Transformation Program, Natural Resources Canada, https://www.nrcan.gc.ca/forests/federal-programs/13141

Australia

The measures of the country towards Energy Efficiency are summarized below.

Table 126: Australia EE measures and adaptability to India

Sector	Measure	About the program
Cross Sectoral/ Public Bodies	Energy efficiency in Government Operations Act	• In 2006, the government recognized the need to increase the efficiency of its own activities in their office buildings. Every year the government spent $450 million AUS on energy alone and any efforts to decrease the consumption of energy would be a step towards environmental and energy security as well as economic growth[136].
	National Australian Built Environment Rating System (NABERS)	• This is the national building rating system for maintaining environmental standards. The system analyses the energy efficiency, water usage, waste management and indoor environment quality of a building and tenancy. The system is meant to translate complicated billing mechanisms such as electricity and gas bills into a simpler to understand star rating system from one to six stars[137].
	Promotion of energy productivity skills and energy audit	• Under these schemes the government conducted a study to identify the necessary skills, knowledge and experience required to provide energy efficiency and energy productivity services. It proposes an improvement pathway for professionals reflecting the needs of the industry. It analyzes the current courses offered and capacity building opportunities for developing energy productivity skillset of existing professionals and increasing the number of energy auditors and experts in this field[138].
	Emissions Reduction Fund	• This fund enables businesses, farmers and land managers to earn incentives for reducing their emissions by issuing Australian Carbon Credit Units (ACCUs) to these business-owners which can be later sold to the government through competitive reverse auctions. The methods followed for assessing the emissions reductions varies for each industry but a major emissions reductions through reduced energy consumption (i.e.. greater energy efficiency) is a major deciding factor in the issuing of these credits. The fund has a total allocation of $2.55 billion AUD. This plan covers the energy used by small businesses, farmers, home-owners as well as credits the installation of energy efficiency cooling and lighting technologies[139]

[136] Energy Efficiency in Government Operations Policy – Australia (2007), Australian Government
[137] https://www.nabers.gov.au/public/WebPages/Home.aspx
[138] Energy Productivity skills and training pathway – Australia (Oct 2017), Energy Efficiency Council
[139] Department of Environment and Energy - Australia, http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/about

Sector	Measure	About the program
Household Sector	The equipment energy efficiency (E3) program	• This program involving the Australian Government, State Governments and New Zealand is responsible for starting the energy efficiency standards and energy labelling of appliances across these territories. It was started over 30 years ago and continues to be one of the primary means of improving domestic energy efficiency in the nation.
Industrial	Energy strategy for Australian directors and executives	• This scheme is aimed at engaging with high level management and executives of businesses to assist them in developing energy efficient programs and policies within their own organizations. This is supported by the gas efficiency guide for businesses which explains to executives and managers how to better use gas as a resource for their businesses and increase their efficiency.
	Boosting small business energy efficiency through accelerated depreciation	• This scheme provided up to $20,000 in asset cost deductions for businesses with a turnover of under $10 million AUS for energy efficiency upgrades to their businesses
	National Energy Productivity Plan (NEPP)	• In 2015, the Government of Australia published its National Energy Productivity Plan (NEPP) to increase its energy productivity by 40% within the period 2015-2030. The NEPP is a far reaching plan having an impact on almost every economic sector of Australia and has six key pillars of activities: Energy initiatives, empowering customers, helping business Compete, Consumer protections, Competitive modern markets, Innovation support.
	Carbon pricing mechanism	• From FY2012-2015, the carbon price was fixed by the government and trading options were limited. This was followed by Flexible Price period with trading, of which the first three years (FY2015-2018) will be restricted by imposing price floors and price ceilings. After 2018, there will be full trading of all types of units and no price controls[140].
	Clean Energy Finance Corporation	• The CEFC partners with co-financiers provides loans at discounted rates for energy efficiency projects such as efficient water heating systems, high efficiency motors and ventilation etc. These schemes are applicable to industry, domestic and agribusiness projects[141].

[140] Industrial Efficiency Policy Database – Australia, http://iepd.iipnetwork.org/policy/carbon-pricing-mechanism-cpm
[141] CEFC Annual Report 2017-18, Clean Energy Finance Corp

Japan

The measures of the country towards Energy Efficiency are summarized below.

Table 127: Japan EE measures and adaptability to India

Sector	Measure/Proposed Measure	About the program
Cross Sectoral	Act on the rational use of energy (Energy Conservation Act)	• The Law is the pillar of Japanese energy conservation policy. It was enacted in 1979 in the light of the oil shock with a purpose of promoting effective and rational use of energy. It covers the following sectors: energy management in the industrial, commercial, residential and transportation sectors; energy efficiency standards for vehicles and appliances[142].
	Subsidy Scheme for Energy Efficiency	• With the objective of increasing the cost effectiveness of investments in energy efficiency, Japan provides subsidies to promote energy efficiency. The subsidies are managed via The New Energy and Industrial Technology Development Organization (NEDO) which is a government organization to promote the development and introduction of new energy technologies.
Residential and Commercial sectors	Top Runner Program	• The Top Runner Programme was introduced in a 1990 amendment of the Act on the rational use of energy, which certifies manufacturers and other entities that satisfy "Top Runner" criteria. Criteria for the energy-saving performance regarding their products within the target fiscal years (within 3 to 10 years) are set based on the performance of the products with the highest (according to latest level) energy consumption efficiency (top runner performance). The programme applies to machinery, equipment, and building materials, as well as LED lamps and three phase induction motors. The last amendment, in November 2014, added windows to the programme.
Industry and Mining	Mandatory Energy Management	• This measure is implemented under the aegis of The Act on the Rational Use of Energy where the promotion of energy management is the main measure. About 14,000 factories (90% of Japanese industries) are designated as either Class 1 (high energy use) or Class 2 (lower energy use). The requirements for energy management are more stringent for Class 1 factories. • The requirements for Class 1 are: appointment of an energy manager, regular reporting and preparation of a mid- and long-term energy efficiency plan. The latter is not required for Class 2 factories. The Act prescribes both the establishment of an energy management system as well as mandatory energy planning and identification of energy efficiency measures.

[142] http://www.lse.ac.uk/GranthamInstitute/law/law-concerning-the-rational-use-of-energy-energy-conservation-act-law-no-49-of-1979/

Sector	Measure/Proposed Measure	About the program
	Keidanren Voluntary Action Plan	• The Keidanren Voluntary Action Plan (VAP) on the Environment was a unilateral, voluntary and non-binding commitment devised by the Nippon Keidanren (Japan Business Federation). The VAP was an important component of the Kyoto Protocol Target Achievement Plan adopted in 2008 by the Japanese government. It included a non-binding target to reduce CO2 emissions in industry and the energy sector below their 1990 levels by 2010. The programme has currently ended. • VAP was comprehensive in its coverage, accounting for about 40% of total emissions in Japan in 1990 and 80% of industrial emissions. In the VAP, separate sector plans were drafted by respective industrial branch/sector organizations in consultation with government and the companies in the sector.
	Fiscal Incentives for Energy Efficiency	• In the industrial sector, Japan has implemented a tax system to promote investment in energy efficiency technology. This system allows individuals and corporations to claim a tax credit or a flexible depreciation for eligible equipment. The tax credit is equivalent to 7% of relevant equipment acquisition costs to be deducted from the corporate tax amount and the special depreciation covers 30% of the equipment acquisition cost in the initial year[143].
	Japanese Voluntary Emissions Trading System (JVETS)	• The Japanese Voluntary Emissions Trading Scheme (JVETS) was introduced in September 2005 by the Ministry of Environment Japan (MOEJ) to support greenhouse gas emissions (GHG) reduction activities by Japanese companies that are not included under the VAP

[143] Energy Policies of IEA Countries (2008), Japan Review, OECD/IEA

South Africa

The measures of the country towards Energy Efficiency are summarized below.

Table 128: South Africa EE measures and adaptability to India

Sector	Measure/Planned Measure	About the program
Cross Sectoral/ Public	The National Energy Act, 2008	• The National Energy Act, 2008, is the enabling legislation that empowers the Minister of Energy to ensure that diverse energy resources are available in sustainable quantities & at affordable prices in the South African economy to support economic growth & poverty alleviation, while also taking into account environmental considerations.
	Eskom's Energy Conservation Scheme	• Eskom's Energy Conservation Scheme (ECS) is a response to the Government's Power Conservation Program (PCP). The Power Conservation Programme (PCP) is being brought in to help manage the current electricity supply shortages. Through the use of high tariffs, the scheme penalizes electricity customers that do not reduce their consumption by an allocated percentage
Residential	Eskom's Lighting Exchange Program	• Eskom's demand-side management programme assists communities to manage their cost of electricity by installing energy saving technologies whilst at the same time reducing pressure on the national grid. A total of 614 238 compact fluorescent lamps (CFLs) were installed in North West and Gauteng during 2018 so far. Since 2015, a total of 4,922,700 CFLs have been installed. The initiative has put back more than 238 Megawatts into the grid, and created much needed employment in local communities.
Industry and Mining	Eskom's Energy Efficiency and Demand-side Management (EEDSM) incentive program	• The Energy Efficiency and Demand-side Management funding program is aimed at promoting the implementation of more energy-efficient technologies, processes and behaviours amongst all electricity consumers. The program has been in place since 2004 and over the years, it has evolved and been extended.
	Energy Efficiency Tax Incentive Regulations	• The Energy Efficiency Tax Incentive Regulations involve a tax break that can be earned by companies who are able to provide evidence of energy efficiency savings. Evidence of energy efficiency savings must be provided to the Tax authorities by handing in energy efficiency saving certificates. These are issued by the National Energy Development Institute (SANEDI) after they have approved report holding evidence on achieved savings

7.4. Strategies for achieving EE potential in India

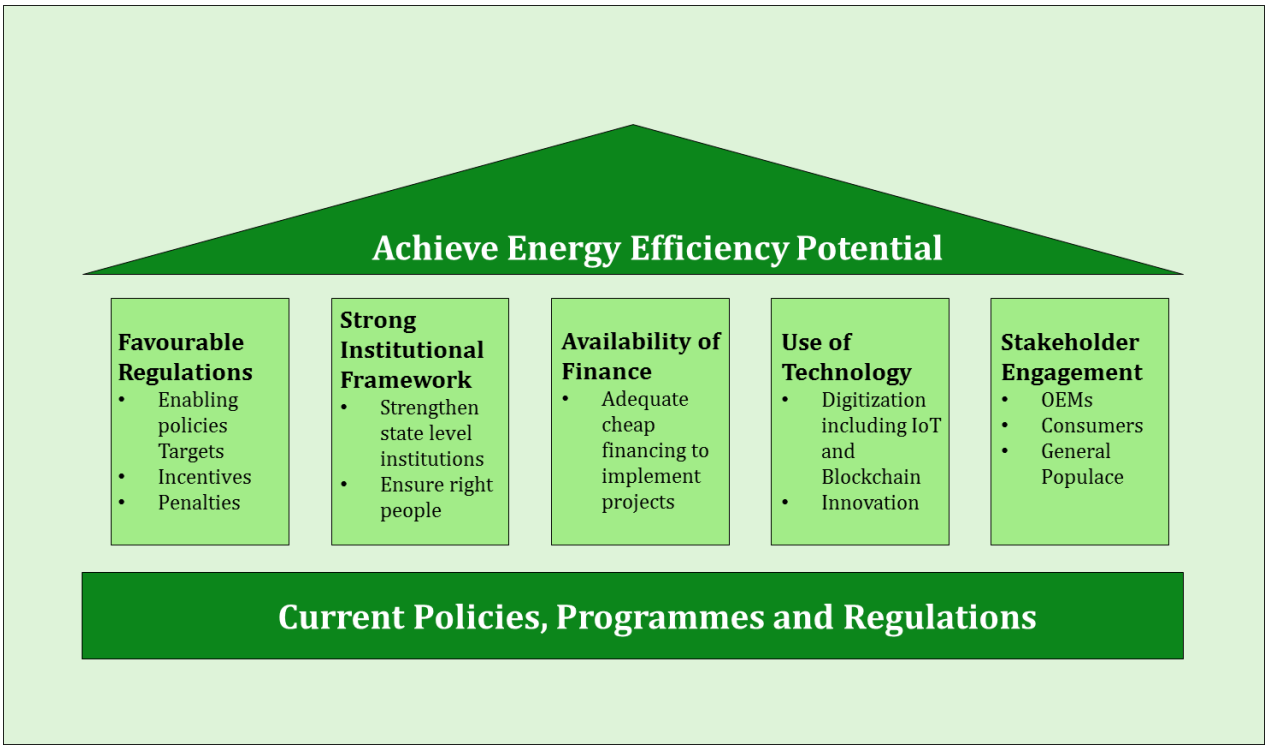
India has a huge opportunity to optimize energy use across sector. The total energy efficiency potential in the country is 86.9 Mtoe. To achieve this potential, there is a need for a consolidated approach and strategy.

The key objective of this strategy would be maximize the impact of policy and program to achieve the wider energy efficiency potential in the country.

7.4.1. Elements of the strategy

Any strategy developed, should address the challenges faced in implementation of energy efficiency and overcome the gaps in current policy and programs. Further, it is important to engage all stakeholders and address the challenges across the entire value chain. India currently has multiple good policies and programs for promotion of energy efficiency in the economy. These as well as the future programs would be strengthen through favorable regulations, strong institutional framework, increasing availability to finance, use of technology and increased stakeholder engagement.

Figure 35: NSPEE strategy framework



All the elements of the strategy are interdependent and should not be looked at in isolation. For example, a regulation could mandate industry to contribute a small proportion of their profits for research and development. This would have direct impact on finance and use of technology elements.

7.4.1.1. Favorable regulations

Good regulations have the capacity to act as catalyst for the growth of any sector. Regulations including policies, acts and directives provide other stakeholders a clear signal about the legislative body's intention to promote a given sector and/or technology. This direction enable stakeholders especially suppliers and service providers to prepare long term strategies and allocate capital. These regulations can take many forms including:

- **Policies**: A policy is a course of actions or directions set out to meet certain predefined objectives. The private sector could then take a cue from the policy defined by the government to plan their activities. For example, the Energy Conservation Act provided the regulatory mandate for standards & labeling of equipment and appliances; energy conservation building codes for commercial buildings; and energy consumption norms for energy intensive industries.

- **Targets:** The government agencies then based on the policies defined can establish targets for various government sectors. These targets or mandate encourage the stakeholder to meet the broader objectives set out by the government. For example, Bureau of Energy Efficiency under EC Act set out mandates for large industry to meet certain energy intensity targets under its PAT program.

- **Incentives:** Incentives encourage positive behavior from various stakeholders. These incentives can take two forms:

    - Target based incentives which encourage stakeholder to achieve more

    - Subsidies which allow stakeholders to manage risks especially financial.

- **Penalties:** Penalties discourage stakeholder from taking decisions which are not in line with the broader objectives set out by the government. For example, the PAT program also specifies penalties for industries which do meet the target set out by the government.

These forms of regulations also operate in combination as seen from the example of EC Act and PAT program.

Possible Strategies:
For achieving India's energy efficiency potential, there is a need to analyze the present ecosystem governing energy efficiency such as policies, laws, institutions and arrangements. On the policy front, there is no overarching energy efficiency policy. This has hampered the adoption of efficient practices across energy consuming sectors. It is envisaged that an omnibus policy should be announced to cover all the energy producing and consuming sectors.

7.4.1.2. Institutional framework

Strong institutions are the cornerstone of any large intervention. The institutions should have enough well trained and capable resources to successfully implement the intervention. Further, the institutions should have necessary mandate and authority to work with stakeholders and enforce the strategy.

In India, the institutionalization of energy conservation began in the mid-1980s, when the government formed an 'energy conservation cell' within the Department of Power. The cell was vested with responsibilities to facilitate a coordinated strategy on energy conservation. In 1989, an autonomous organization called the 'Energy Management Centre', was established to assist in the national energy conservation programmes[144]. In 2001, the Energy Conservation Act 2001 (EC Act) was enacted to set up the Bureau of Energy Efficiency (BEE) (from the assets of erstwhile Energy Management Centre) as a nodal agency with specific powers and functions to facilitate, regulate and promote energy efficiency in all sectors of the economy. The EC Act also provided with multiple functions and statutory powers to the central and state governments to facilitate and enforce efficient use of energy and its conservation. The state government was required to designate agency for the implementation of functions assigned to it under the EC Act. In this regard, state designated agencies (SDA) have been notified in 29 states and seven union territories and the profile of these agencies differ from state to state [Renewable Energy Development Agency (44%), Electrical Inspectorate (25%), Distribution Companies (12%), Power Departments (16%) and others (3%)].

In addition, the 29 state electricity regulatory commissions (SERC) and around 60 electricity distribution licensees are crucial institutions to promote DSEE through utility driven DSM. In view of the need to establish DSM cells within the utilities with adequate resources and capacity to plan and implement programmes, more than 15 SERCs have already notified DSM regulations to guide and regulate utility driven DSM activities and investments.

The Small Industries Development Bank of India (SIDBI) and the Indian Renewable Energy Development Agency (IREDA) are the key financial institutions promoting customized DSEE financing products among micro, small and medium enterprises (MSMEs) and other key economic sectors.

The Bureau of Indian Standards, which is the body responsible to certify product quality and technical standards, has been playing a key role in establishing standards for energy efficient appliances and equipment in various end use applications.

Possible Strategies:

It now important to strengthen the state agencies and enable them to drive the energy efficiency agenda ahead. There is need for strong enforcement mechanism at state levels which would lend further strength of the national and local level program.

Another key strategy should be to remove duplicity of bureaucracy. For example, currently OEMs need to first certify that the products meet BIS standards and then apply to BEE under standard and labelling program. A single window for approvals along with standardization of laws and regulations would help large scale upscaling of energy efficiency initiatives.

7.4.1.3. Finance

Energy Efficient solutions are generally more capital expenditure intensive than conventional solutions. Even though the lifetime cost of EE solutions is lower, high initial investment deter many from implementing EE solutions. Financial institutions also have limited understanding of these solutions and are wary of funding EE projects. India has in the past through various capacity building initiatives, pilot project implementation and financial instruments including Energy Efficiency

[144] Strategy for energy Conservation in India (1995), Rajeev Gandhi Institute for Contemporary studies and Institution of Engineers (India)

Financing Platform (part of NMEEE), Partial Risk Sharing Facility (PRSF) attempted to increase the amount of finance available for implementation of EE projects.

Another key initiative was empanelment of ESCO and development of standard contracting documents for ESCO based project. However, these initiative were also marred by reluctance of financing institution to lend on project financing model due to lack of proper collateralization protocol of assets created under ESCO projects. For example, the borrowing agency would be the ESCO, but the asset would be created in the project proponents' property. Many large scale projects in India have distribution utilities and municipalities as project proponents. Poor financial health and track record of these institutions are also a key barrier for financial institutions funding these projects.

Possible Strategies:
To promote energy efficient solutions, it is therefore important that project proponents and service providers (ESCOs) have access to finance at cheaper rates. These financial solutions could take form of a revolving fund, risk guarantee or insurance facility or forming corpus for project implementation (similar to DSM fund within distribution utilities). The National Clean Environment Fund or another special cess levied could be utilized for seeding these mechanism.

7.4.1.4. Use of technology

Constant improvement backed by technology improvements would be key in achieving India's energy efficiency potential. India has instituted a structure to promote these new technologies including formation of Technology Development Board and committees within within Bureau of Indian Standards to ensure homologation of the new technologies. Further, it is also important to ensure development and/ or adoption of technologies specific to the Indian conditions. Industry specific center of excellence should be developed across the country. Industry associations should be encouraged to take lead in this process. India is a tropical country and significant energy consumption in the country is for cooling. Specific interventions should be undertaken to develop cost effective India specific solutions.

Innovative technologies including IoT and Block chain have the ability to bring an energy revolution across sectors. These technologies enable collection of data and improve connectivity which allows for better decision making and convenience. India has begun adopting these innovative solutions in various sectors including agriculture (smart control panels), municipal (CCMS), commercial (building management systems), domestic (intelligent appliances).

Possible Strategies:
Large scale implementation of the innovative technologies still looks to be years away due to challenges such as the need for skill development, capacity building and awareness, perceived concerns around investment outlay and cost benefit, inadequate knowhow, lack of infrastructure and lack of adequate cybersecurity norms. Improper implementation would result in lack in trust in technology. It is important for the government to take lead in mitigating the challenges mentioned through development of infrastructure and pilot projects to showcase these technologies.

7.4.1.5. Stakeholder engagement

Involvement of all key stakeholders would result in faster adoption and smoother implementation. For example for adoption of electric vehicles it is important to first have policies for promotion and adoption of EVs, institutional framework to train new breed of engineers and ensure homologation, OEMs to make the transition from ICE vehicles to EVs, ecosystem players to provide services like EV charging and consumers to buy the vehicles. The entire national level program would fail is any one of these stakeholder are not in line with the vision.

Possible Strategies:
The task is relatively easier when the programs and solutions are targeted towards organizations. The engagement could be increased through focused group discussions and meetings. However solutions targeted towards larger audience and general population would require larger engagement through use of mass and social media

7.4.2. Strategies for achieving energy efficiency potential

Various strategies have been proposed based on the elements discussed above. A sectoral approach has been adopted and the strategies have been listed below:

7.4.3. Agriculture

Agriculture sector though has significant energy consumption, the users of energy are not incentivized to optimize .their energy usage owning to the low cost of energy. The energy cost of the sector is heavily subsidized by the government. The current institutional structure is also focused on increasing productivity with minimal focus on reducing energy intensity. The following are the key strategies which could be adopted to reduce energy consumption in the sector:

Strategy	Elements				
	Favorable Regulations	Institutional Framework	Finance	Use of Technology	Stakeholder Engagement
Greater co-ordination among stakeholders including integration with water conservation efforts	✓	✓		✓	✓
Integrate Energy Efficiency in Agriculture Studies				✓	✓
Cheaper finance for energy efficient equipment		✓	✓		
Research and Development				✓	
Mandating Energy Efficient Technology Standards and Guidelines	✓			✓	✓
IoT in Agriculture: Moving towards smart farming practices				✓	✓

7.4.3.1. Greater co-ordination among stakeholders

There are many schemes simultaneously being implemented in the agriculture sector such as Pradhan Mantri Krishi Sanchayee Yojana (PMKSY) by Department of Agriculture, Cooperation and Farmers welfare[33], Kisan Urja Suraksha Evam Utthaan Mahaabhiyan[40] (KUSUM) scheme by Ministry of New and Renewable energy for solar pumps, AgDSM programmes by EESL[145]. The ministries along with the institutions such as National Bank for Agriculture and Rural Development (NABARD) and National Innovations on Climate Resilient Agriculture (NICRA) under the Indian Council of Agricultural Research (ICAR), apart from BEE, EESL and others also work in the sector. The programmes and organizations work in silos and there is not much co-ordination between the organizations and multiple schemes are being implemented at the same time that lead to confusion among the end consumer, i.e. the farmers. This is detrimental to the objectives of the schemes and programmes that are envisaged. Thus, it is recommended to have more co-ordination between the stakeholders.

Integrated efforts for Water and Energy Conservation

Several pilots conducted in the past, some with the help of donor assisted programs (Eg: USAID's WENEXA), have revealed that India's agriculture sector needs an integrated approach by considering both water and energy efficiency improvements to maximize resource (water and energy) savings and tackle the menace of inefficiency in a holistic manner. Studies have revealed that waterside interventions such as drip irrigation and other measures that improve irrigation efficiency can deliver energy savings almost equivalent to the pump set replacement. More importantly the integrated approach would also have substantial positive effects on the worsening ground water situation in the country.

Table 129: Energy saving potential of EE measures in agriculture pumps

Measure	Energy saving potential
Pump set replacement	15 – 25%
Piping and foot valve replacement	5 – 15%
Efficient irrigation systems (drip, sprinkler, etc.)	15 – 25%

In this regard, the state and central government institutions along with Indian electric Utilities can explore integrated DSM solutions with appropriate delivery models to maximize energy savings in the agriculture pumping loads.

7.4.3.2. Integrate energy efficiency in agricultural studies

There is a need to spread the knowledge of energy efficiency in the agriculture sector. An essential part of the process would be to include the study of energy efficiency in agriculture as a part of undergraduate and graduate programmes in agriculture based studies across the country. Institutions like ICAR can include specific courses for learning about energy efficiency in agriculture. This would help in disseminating information about energy efficiency and creating an awareness about the same with the workforce. ITIs can have specific courses that focus on skill development for climate smart agriculture[99].

[145] About AgDSM - EESL, https://www.eeslindia.org/EN/Agdsm/About/

The Bureau of energy efficiency (BEE) has taken steps to bridge this gap by collaborating with ICAR to create awareness for energy efficient pump sets and operational practices so as to adopt energy and resource efficient approaches. Through this collaboration, BEE and ICAR plan to improve the fuel energy and water resource use efficiency, thereby reducing the cost of cultivation so as to increase farmers' income. These steps are in line with the strategies of "Per drop more crop" and "Doubling Farmers' Income".

7.4.3.3. Cheaper finance for energy efficient equipment

The farmers need easier access to finance for buying energy efficiency equipment that includes not only pumps, but tractors and other equipment on the farm as well. It is noticed that the banks provide loans under priority sector lending to farmers but the interest rates are very high[146]. There needs to be finance available to the farmers for investing in energy efficiency equipment. This can be done via cooperatives set up for the purpose. It can also be integrated with the minimum support price.

7.4.3.4. Research and development

There is a need to increase the research and development in the sector. It is also envisaged to have agricultural projects under the National Clean Energy Fund. The initiatives taken need to encourage even higher efficiency in the agricultural pumps and focus on energy efficiency of tractors as well.

7.4.3.5. Energy efficient technology standards and guidelines

There is no standardization of technology guidelines for growing and harvesting of crops. Just like in buildings, there is an energy conservation building code the same can be implemented for crops across the country. This could include the most energy efficient equipment and procedures for each crop. One of the key initiative could be:

Mandatory use of smart control panels and star rated pumps for new agricultural connections

Most projects implemented under AgDSM in India have focused on replacement of existing inefficient agricultural pump sets with BEE star-rated energy efficient pump sets. Under the current AgDSM programmes being implemented in the country, smart control panels are also being provided along with the energy efficient pumps. The smart control panels benefit farmers by allowing remote monitoring and control of the pump sets[145]. However, there is no guidelines for new agriculture connections across the country. It is proposed to make the installation of only BEE star rated energy efficient pump sets and smart control panels mandatory for new agricultural connections.

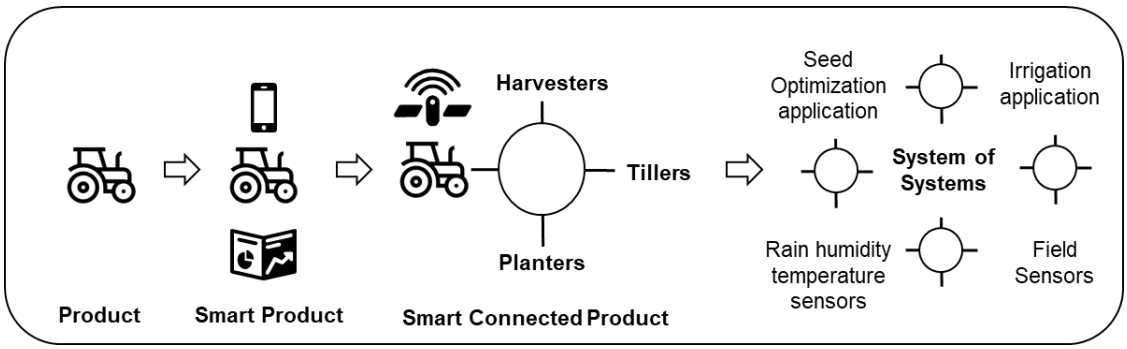
[146] India's banks crushed poor farmers with expensive tractor loans – but the Mercedes came cheap (Jun 2016), https://qz.com/india/709449/indias-banks-crushed-poor-farmers-with-expensive-tractor-loans-but-the-mercedes-came-cheap/

Figure 36: Smart Control Panels distributed in AgDSM in Andhra Pradesh

7.4.3.6. IoT in agriculture: Moving towards smart farming practices

The advent of digitalization in agriculture is dependent on the introduction and adoption of new tools and machines into the agricultural production system. Tractors are key instruments for beginning the usage of connected and localized technologies on the farm lands. This would include using localization technologies (GPS) and driver's assistance to optimize routes and shorten the harvesting and crop treatment, while reducing the fuel consumption over the period of time significantly.

Figure 37: Advent of Smart connected farm equipment's



It is envisaged that for accelerating the cause of enablement of IoT technologies in Indian agricultural farmlands, a consortium can to be established that would consist of various stakeholders from government agencies, agro, telecom, automotive and agro machinery manufacturing industries which would focus on building an ecosystem of active research, development, testing and implementation technology, infrastructure and applications of IoT for farming. The multidisciplinary participation in the consortium would help identify the trends and disruption in the agriculture landscape in the country in the future. Identification of such trends beforehand would further prioritize the adoption of IoT can bring to the sector and recognizing potential business models and innovations in the different sub sectors that can could have game-changing effects in the agri-machinery industries market chain.

7.4.4. Buildings

Building are an essential element in the modern lifestyle and form a significant portion of energy consumptions in the domestic and commercial sectors. In India, rapid urbanization and improved prosperity have increased consumption from building. The following can be key strategies which could be adopted for increasing the energy efficiency of buildings.

Strategy	Elements				
	Favorable Regulations	Institutional Framework	Finance	Use of Technology	Stakeholder Engagement
Development of codes for residential buildings and simplified codes for commercial buildings with lower connected load	✓	✓			
Mandatory implementation of ECBC in states	✓	✓			✓
Integration of EE in Government housing schemes and cheaper financing for EE houses	✓	✓	✓		✓
Synergy between BEE, IGBC and GRIHA rating system	✓	✓			✓
Automated Building Management Systems in higher connected load commercial buildings	✓			✓	✓
Promoting EE technologies in High rise residential buildings				✓	✓

7.4.4.1. Development of codes for residential buildings and simplified codes for commercial buildings with lower connected load

Currently the ECBC guidelines exist for commercial buildings like malls, institutions and office complexes which have a connected load of 100kW or above. The guidelines for residential buildings are yet to be launched. Specific codes need to be developed for residential sector. In the beginning the codes could be made mandatory for large residential complexes and townships. Simplified codes could also be developed for smaller apartments at a later stage. Similarly, for smaller buildings, there can be an incorporation of a simplified energy efficiency code for easier implementation and adoption.

7.4.4.2. Mandatory implementation of ECBC in states

Even though ECBC was first launched in 2007[147], till date less than half the states have notified the Energy Conservation Building Code (ECBC) and incorporated ECBC in municipal building bye-

[147] ECBC Code 2017, BEE

laws[61]. Thus, there is a requirement to make the ECBC of each state mandatory. There needs to be stricter enforcement of the rules and guidelines of the programme. A reporting framework should be established where the states are required to update their progress in implementation of ECBC in their state.

7.4.4.3. Integration of EE in Government housing schemes and cheaper financing for energy efficient buildings

The Government has launched many programs for increasing home ownership including the Pradhan Mantri Awas Yojana. This Mission has four components viz., In-situ Slum Redevelopment with private sector participation using land as resource, Affordable Housing through Credit Linked Subsidy, Affordable Housing in Partnership with private and public sector and Beneficiary led house construction/enhancement. Under these components, central assistance will be in the range of □1 lakh (US$1,400) to □2.30 lakh (US$3,200). Energy Efficiency can be made a component of these programme.

The amount of incentive for EE houses can be increased and programs initiated to incentivize buying energy efficient houses.

7.4.4.4. Synergy between BEE, IGBC and GRIHA rating system

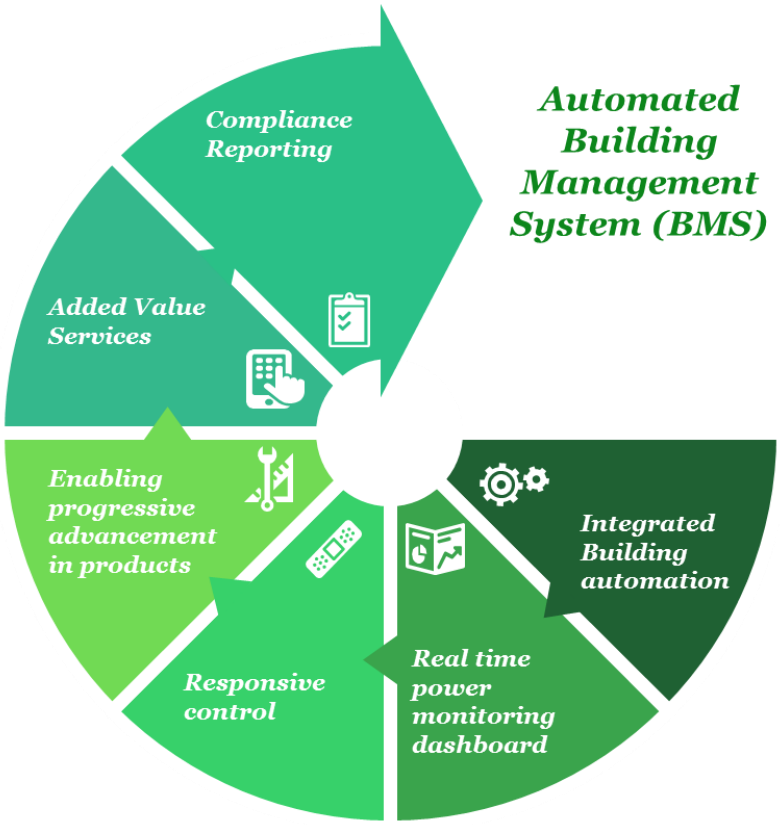
There are primarily three rating systems in India for buildings: BEE star rating system, Green Rating for Integrated Habitat Assessment (GRIHA) and Indian Green Building Council (IGBC). While the BEE star rating system takes cue from Energy Performance Index (EPI) as a parameter, the GRIHA rating system is based on 34 criteria categorized in 4 sections: (1) Site selection and site planning, (2) Conservation and efficient utilization of resources, (3) Building operation and maintenance, and (4) Innovation. IGBC was formed by the Confederation of Indian Industry (CII) joining hands with US Green Building Council (USGBC) and licensing their green building standard.

The best practices from the three rating systems can be incorporated into a single comprehensive system that addresses every aspect of energy efficiency in buildings and incorporation of new technologies in building operations and energy management systems.

7.4.4.5. Automated Building Management System (BMS) in higher connected load commercial buildings

Automated Building Management Systems (BMS) provide effective control and monitoring functions of heating, ventilation, cooling, hot water and lighting appliances, etc. improving the level of comfort for the inhabitants as well as fulfilling the purpose of saving energy.

Figure 38: Components of an Automated BMS



At first, the importance and benefits of adopting automated BMS's can be shared with stakeholders through regional workshops conducted by SDA's in the states, before including it into the ECBC in the future. This would ensure that the adoption of the systems would be quicker and more and more commercial spaces become BMS compliant in a short span of time.

7.4.4.6. Promoting energy efficiency technologies in high rise residential buildings

Indian cities are witnessing an immense demographic expansion due to migration from surrounding villages, leading to urban sprawl, housing demand, rise in cost of land. This has led to more and higher rise residential buildings being constructed in Indian cities which may or may not be adopting energy efficient technologies that could significantly decrease the burden on electricity demand in urban India.

Some of the technologies that could be introduced in high rise residential buildings and can be easily adopted would include energy efficient water pumping systems, cool roof technology, external solar shading, using elevator systems that are energy efficient and solar water heaters.

Spreading awareness about adoption of these technologies in residential buildings could be taken up at the state level by the SDA's, starting with the largest residential complexes with the highest electricity consumption. The SDA's can further conduct a financial appraisal (pre-operative expenses, equipment costs, project implementation charges, interest during construction period, contingencies, promoters contribution, term loans, working capital for yearly operation and maintenance and repairs) and suggest ways to implement EE technologies in the buildings.

7.4.5. Industry

Industry is one of the largest energy consuming sector in India. For many industries, energy is also a substantial input cost. Therefore the industrial consumers have an incentive to invest in energy efficiency. However, lack of knowledge, access to technology and high capital cost deters industries from investing in energy efficiency.

Strategy	Elements				
	Favorable Regulations	Institutional Framework	Finance	Use of Technology	Stakeholder Engagement
Creating a National Energy Efficiency Repository with benchmarks		✓			✓
Increasing the width and depth of the PAT programme including a voluntary component	✓	✓			✓
Creation of a unified carbon reduction programme	✓	✓	✓		✓
Mandatory energy management cell with certified Energy Manager/Energy Auditor for all medium and large scale industries		✓			✓
Central Monitoring of all funded programs in the MSME		✓	✓		✓
Promoting use of energy efficient equipment among MSME units				✓	✓
Promoting industry 4.0 technologies				✓	✓

7.4.5.1. Creating a national energy efficiency registry with benchmarks

There is no central database with information related to energy use of different industries. The data needs to be collected on a regular basis from DISCOMs/industry itself. This will help in ascertaining the actual energy usage and the improvements that are required in the use of energy. Benchmarking can be done on the basis of the type of industry and production capacity.

7.4.5.2. Increasing the width and depth of the PAT program

The baseline energy consumption of 621 DCs in PAT cycle 2 covers around 52.7% of the total industrial energy consumption (including the newly added sectors) in India[148]. Thus, there is a scope to further increase the reach of the programme. It is proposed to cover at least 80% of total industrial

[148] Impact Assessment study on National Mission for Enhanced Energy Efficiency (NMEEE), Feb 2017, PwC

energy consumption including targeting not only the large consumers, but smaller consumer's energy.

Voluntary PAT program

The PAT programme currently covers 621 DCs which constitute about half the industrial energy consumption in the country. Apart from widening the scope of the PAT programme, a voluntary PAT programme can be initiated for consumers not identified under the programme. The non-DC participants can be allowed to access the ESCerts Markets. They may also be given a favorable tax benefits for achieving energy efficiency in the sector. Voluntary certification can be considered as positive branding for industries, and help in achieving greater energy efficiency in the sector.

7.4.5.3. Creation of a unified carbon reduction program

Energy Saving Certificates (ESCerts) are issued to overachievers of energy efficiency from the Designated Consumers (DCs) identified under the PAT programme from energy-intensive sectors of the industry and are required to be bought by under achievers of energy efficiency. Renewable Energy Certificates (RECs) on the other hand are awarded to RE generators per 1MWh of electricity injected into the grid via renewable sources. These can be purchased by distribution companies, Open Access consumer, Captive Power Plants to meet their Renewable Purchase Obligations. These two instruments can be an integral part of forming a unified carbon reduction programme for the country like 'The Carbon Plan'[149] set out by the UK government in 2011. However, the scope of these two instruments would have to be increased to achieve even further energy savings.

7.4.5.4. Mandatory energy management cell with certified energy manager/energy auditor all medium and large scale industries

Under the PAT programme, DCs presently either have in-house energy managers (EMs) and energy cells, or some of the smaller DCs have outsourced the functions of EM while retaining managerial control[148]. It is unclear whether other industrial consumers that are not covered under PAT have an energy management cell. Hence, it is proposed to have an energy management cell with certified EA/EM for all industries above Rs. 10 crore capex.

7.4.5.5. Central monitoring of all funded programs in MSME

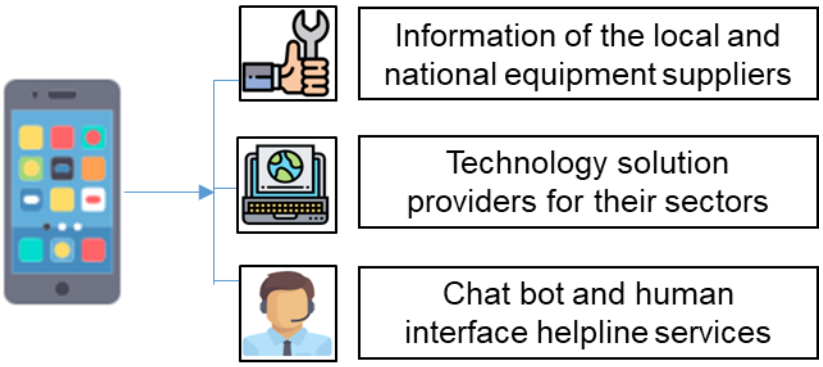
As is the case in agriculture, there are many agencies running energy efficiency programmes in silos and are not coordinating with each other. There is a need to consolidate all the programmes and monitor them centrally.

7.4.5.6. Promoting use of energy efficient equipment among MSME units

Even though the SIDBI website has a detailed list of equipment's that are energy efficient, most MSME associations are unaware of this list and the vendors who supply such equipment. A mobile app, which not only provides details of the equipment but also technology and the service providers, can be set up.

[149] The Carbon Plan – Delivering our low carbon future (Dec 2011), HM Government

Figure 39: An MSME app for manufacturers



7.4.5.7. Promoting industry 4.0 technologies

The inclusion of industry 4.0 technologies carries with itself benefits like cost reduction, higher efficiency and energy savings in critical manufacturing processes. Under the wide gamut of technologies that come within the scope of industry 4.0, there are 8 core technology pillars that define the mega trend and would be the focus areas going in into the future:

Figure 40: 8 tenets of Industry 4.0

Being the 6th largest manufacturing country in the world, industry 4.0 presents a great opportunity for India to realize its long term vision and increase the share of manufacturing in India's GDP from the current 17% to 25%. A collaborative approach, on the part of the government, industry and academia is the ideal way forward to drive India's manufacturing sector to adopt the 8 technology tenets mentioned above.

7.4.6. Transport

With increased industrialization and prosperity, the transportation needs for both passenger and freight have increased and would continue to increase in future. Beside road transportation is also a key sector affecting local pollution levels. Greening the sector would have far reaching effects beyond decreasing energy intensity.

Strategy	Elements				
	Favorable Regulations	Institutional Framework	Finance	Use of Technology	Stakeholder Engagement
Integrated transport planning with Mandate to support movement towards EE transportation	✓	✓		✓	✓
Promoting shared last mile connectivity solutions				✓	✓
Legislation to improve ease of doing business for new business models	✓				
Increase CAFÉ standards	✓	✓		✓	
Stakeholder Engagement		✓			✓

7.4.6.1. Integrated transport planning and mandating support movement towards energy efficient transportation

India is facing rapid urbanization, and hence there is a need to plan the transport systems in the cities, state and national corridors. Many developed countries have integrated transport planning departments as a part of the transport authority. The department's main objective is to optimize transport for the citizen and to provide an uncongested path to travel. This requires a joint planning of public and private transport which ranges from buses, metro's, trains, taxis, auto rickshaws to private 4 wheelers and 2 wheelers. A planned transport network that integrates all modes of rail, water and road transport should be designed keeping in mind traffic congestion and fuel efficiency.

Energy Efficient Transportation

Though the country has taken initiatives to support the movement towards energy efficient transport such as rolling out of electric vehicles to government fleets (National e-Mobility Programme by EESL), there needs to be a regulation/policy that will support the shift to electric vehicles in the country. Currently, electric vehicles provide a promising path to reduce energy consumption. They also have no tail pipe emission, which will lead to a significant reduction of the pollution in the cities. Many states have released policies on electric vehicles, but there is no such policy from the central government. Many automobile manufacturers will have to invest significantly to change their line of production and produce electric vehicles in the country. A mandate from the central government will align all the developments in the sector and lead to a smoother adoption of electric vehicles.

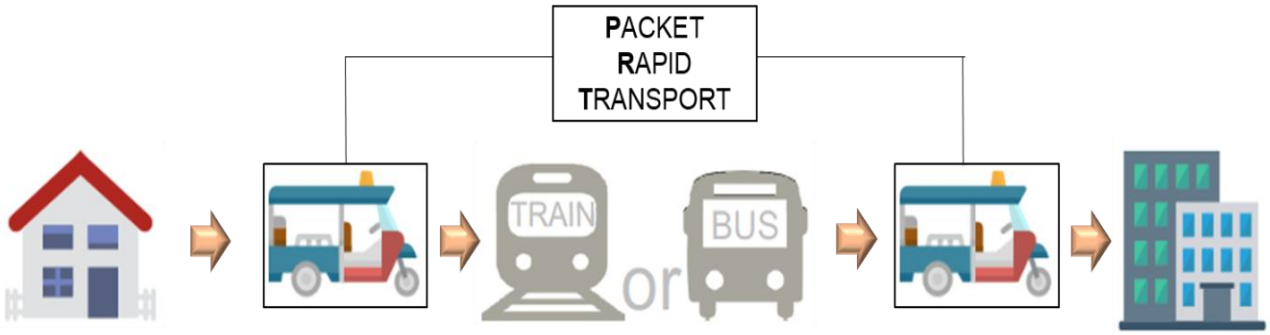
7.4.6.2. Promoting shared last mile connectivity transport solutions

Last Mile Connectivity refers to getting people from a transportation hub like a railway station, bus depot or metro station to their final destination or vice versa. Indian cities have a huge potential for last mile connectivity solutions. 50 cities in India are planning metro rail systems, which increases requirement of connectivity to final destination.

A solution that can be adopted in this regard is the introduction of **packet rapid transport** models for cities where metros are being constructed and densely populated tier-1 and 2 cities. Already in place

in countries like Philippines and conceptualized by the SoftBank Group, the PRT model is ideal for the Indian condition, where the last mile connectivity is dominated by three wheelers.

Figure 41: Packet Rapid Transport



The PRT system consists of Electric three wheelers that can be hailed through a mobile app during off-peak hours and during rush hours they operate in a specific neighborhood around metro, bus or suburban train stations.

7.4.6.3. Legislation to improve ease of doing business for new business models

India's most populated cities are facing severe road traffic congestion. There is a need to adopt new business models such as shared mobility and connected ecosystem among others. However, the legislation is unclear on the legality of these business models. The Motor Vehicle Act does not have any clauses referring to these business models and may need to be updated accordingly. The business models need to be considered by the ministry as a means to reduce pollution and increase the ease of travelling from one place to another. There is a need to update the laws and regulations for allowing these opportunities to exist within the framework of the law so that they can be safe and regulated.

7.4.6.4. Increase CAFÉ standards

Corporate average fuel economy (CAFÉ) norms for 2022 or 2023 have been applied officially since April 1, 2017. Under the CAFE norms, the automakers are required to manufacture cars which are 30% or more fuel efficient from 2022 and 10% or more between 2017 and 2021. Many auto manufacturers have been able to easily adopt the CAFÉ norms. However, with the advent of electric vehicles, it is imperative to tighten these norms so as to encourage automotive manufacturers to focus on producing electric vehicles.

7.4.6.5. Stakeholder engagement

Development of skills

With the advent of new technologies such as electric cars, buses and new business models such as shared mobility there is a need to develop the manpower to be equipped to support the proliferation of these technologies. The courses for the new technologies need to be designed and offered at government/private institutions. This would lead to a faster adoption of these technologies.

Engagement of the general population

As transportation services are utilized for transport of people, it is important to engage with general population. Communication and engagement strategy should be adopted to encourage use of public transport and make the population aware of new technologies like electric vehicles.

7.4.7. Cross Sectoral

Many strategies would have result in energy intensity across sectors. These strategies include better management and engagement of distribution utilities in implementing energy efficiency measures.

Strategy	Elements				
	Favorable Regulations	Institutional Framework	Finance	Use of Technology	Stakeholder Engagement
Better Engagement and Management of EE Programs in DISCOMs					
Considering DSM as a resource in IRP	✓	✓	✓		✓
Capacity Building of DISCOMs		✓			✓
Mandatory use of Smart Meters		✓		✓	
Increased consumer engagement		✓			✓
Framework to introduce Time of Day Tariffs			✓	✓	✓
Other Strategies					
Increasing the scope of existing programs with stricter enforcement and penalties	✓	✓	✓		✓
Institutional Framework for Data Collection		✓			✓
State wise Targets	✓	✓	✓		
Independent SDAs and Building Capacity of SDAs		✓	✓		✓
Funding for Laboratories			✓		✓
State Specific stakeholder engagement programmes		✓			✓
Integration of harmonic products in S&L	✓	✓	✓	✓	✓
Additional cess on import of inefficient equipment	✓		✓		
Voluntary Reward Programme for consumers	✓		✓		✓
Energy Efficiency in School Curriculum					✓

Strategy	Elements				
Enablement of new technologies	✓		✓	✓	
Center of excellence for industries		✓		✓	✓
Setting up of a committee of financial institutions at the state level		✓			✓

7.4.7.1. Better engagement and management of EE programs in DISCOMs

Considering DSM as a resource in IRP

Given that the market driven DSM mechanisms have gained significant momentum, India is at the cross roads for adopting the right policy approach that can effectively complement the market mechanisms in capturing the DSM potential and also delivering the promise of DSM. Demand side resources lack the kind of impetus laid for promotion of renewable energy sources in the current legal and policy framework governing the Indian power sector. There is a need to explicitly recognize 'demand side resources' as alternative resource option in the energy resource basket of electric Utilities. There are broadly two options available for the policy makers to achieve this.

- In the first option, the 'demand side resources' can be defined and emphasized as stand-alone independent resource apart from the conventional and renewable energy sources. This however requires legislative action to empower the state regulatory commissions for effective enforcement and consideration of DSM by the Utilities and central /state governments.

- In the second option, the 'demand side resources' can be recognized as a qualifying resource under the definition of renewable energy sources in the existing legal and policy framework.

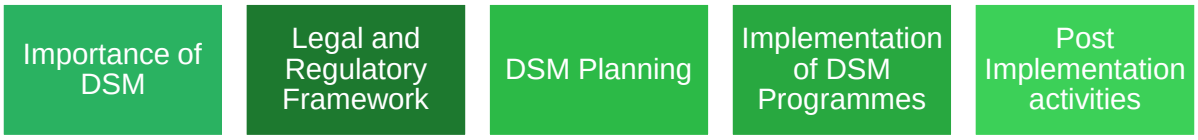
In addition, there is a need for consideration of demand side resources at the planning stage to enable integrated resource planning by the electric Utilities and central /state governments. The importance of IRP cannot be over stated, especially in the India's power market conditions, because it not only creates a market for demand side resources but also saves on the enormous fixed costs otherwise paid by utilities towards the committed capacity for generation, transmission and distribution. This ensures that the enhanced penetration of demand side resources in the overall energy resource mix of Utilities effectively optimizes power resource costs and results in the reduced cost of power for consumers. This is one of the important promises of demand side management.

Capacity building of DISCOMs

There is a need to enhance existing skills of DISCOM employees and to support them in acquiring new skills through training or other capacity building activity, in order to improve an existing, or establish a new DSM cell within the DISCOM. Currently, DISCOMs relate energy efficiency programmes as revenue loss making programmes.

Capacity building is a very important activity for implementing DSM programmes. International experience has indicated that utility driven DSM can provide cost effective resources, improve resource efficiency and further contribute to the reduction of Utility costs. DSM resources comprises

of many effective load management techniques and energy efficiency programs that can provide cost effective mechanisms and market based incentives to all the stakeholders to enhance resource efficiency and transform the power sector in the country. Key modules for a training programme would include:-



Well-designed DSM measures can flatten the overall load curve, reduce energy costs for both the utility and its customers, improve the service quality of the utility through enhanced system reliability, promote efficient end use of electricity by utility customers and enhance customer satisfaction. DSM programmes can also substitute fossil fuel based power plants and result in fewer greenhouse gas emissions.

Mandatory use of Smart Meters

A smart meter is a type of electricity meter that communicates directly with the DISCOM. It gives the user accurate analysis of the distribution if energy use and thereafter the user can improve their use of energy and reduce overall energy demand. Smart meters are being rolled out in the country in the states of Bihar, Uttar Pradesh and Haryana by EESL[150].

Increased consumer engagement

DISCOMs can encourage efficient utilization of electricity by promoting the use of IoT enabled devices such as smart speakers and mobile applications that monitor the consumption of electricity.

Framework to introduce Time of Day Tariffs

Time of day tariffs can reduce the peak demand of electricity of DISCOMs. In Karnataka, the electricity regulatory commission has made time of day tariffs mandatory for industries with a contracted demand of more than 500KVA[151]. The time periods defined by Karnataka Electricity Regulatory Commission are illustrated below

Figure 42: Time Periods for ToD tariffs in Karnataka

Similarly, the Delhi DISCOMs have sent their proposals to Delhi Electricity Regulatory Commission for time of the day metering[152]. There is a need to standardize the practice of time of day tariffs across the country. A framework needs to be developed that guides a DISCOM to adopt time of day tariff for not only industrial consumers, but all types of consumers.

[150] EESL and Bihar DISCOMs enter MoU to install 1.8 million smart meters (Aug 2018), https://mercomindia.com/eesl-bihar-discoms-mou-smart-meters/

[151] Time of day tariff system mandatory for big HT consumers (May 2012), https://www.thehindu.com/news/national/karnataka/time-of-day-tariff-system-mandatory-for-big-ht-consumers/article3371289.ece

[152] DISCOMs seek to shift peak hours (Dec 2017), https://timesofindia.indiatimes.com/city/delhi/discoms-seek-to-shift-peak-hours/articleshow/62245497.cms

IT Cells of DISCOMs should be trained for new technologies such as IoT and Blockchain as they would play a huge role in reducing commercial losses

7.4.7.2. Increasing the scope of existing programs with stricter enforcement and penalties

India has undertaken many initiatives for reducing the energy demand in the country. Many of these initiatives have the potential to cover a wider scope. India has a good standard and labelling program, but is currently limited to a few appliance. Even though the standards for many appliances have been established, the mandatory level of compliance of the appliances needs to be raised. Market uptake of appliances with higher level of efficiency (4 & 5 star) has been lower as the mandatory level for uptake is generally 2 to 3 star. For example, even though 4 and 5 star air conditioners were introduced, the market was dominated by 2 to 3 star air conditioners[153]. Hence there is a need to increase the minimum requirement of star rating for appliances. Along with the same, all appliances need to be covered under the mandatory scheme such as fans, washing machine, laptops and other equipment used in household. Further, the PAT programme currently covers 621 designated consumers (DCs) which account for about only half of the industrial energy consumption[148]. There is a need to scale up the programme to cover at least 80% of the industrial energy consumption. Similarly, AgDSM programmes are currently under way in only few states, the same can be expanded across all states. The programmes also face delays due to the slow implementation and lack of ownership of all the entities involved in the programme. Hence, to improve the implementation and effectiveness of these programmes it is proposed to:-

Increase the reach of the current successful programmes such as PAT, Streetlighing, AgDSM, UJALA

Impose stricter enforcement guidelines to be implemented by the lead ministry in the programmes with quarterly follow-up and reporting. A framework to be established for the same.

Penalties to be applied for implementing partners for delay in implementation

7.4.7.3. Institutional framework for data collection

During the course of the preparation of this report, significant data gaps were encountered in India's energy data reporting, as mentioned in the first chapter. The type of data gaps ranged from mismatch of data between various national agencies to unavailability of data at the state level for primary energy supply and demand. The following recommendations were made to improve the energy data collection and data reporting structure in the country:

- **Setting up of a nodal agency**: It is pertinent that an empowered agency should be set up that not only collects data from various sources, but also reconciles it and ensures smooth data management.

- **Improved technology and statistical methods:** Automation in data collection and management should be explored as an option, which includes automated metering, online data submission and interactive data dissemination. This would improve accuracy and

[153] Strengthening governance of India's appliance efficiency standards and labelling programme, WRI

completeness in data collection as well as facilitate the collection of primary data for energy supply and demand at the state level, which is not reported by any agency in the country.

- **Systematic data quality checking:** Quality assurance mechanisms make it possible for agencies to carry out systematic quality checks. Quality assurance needs to be conducted at multiple stages of energy data management.

- **Maintaining commonality in standardization:** A common code of standardized definitions and classifications should be followed. Principles and codes of practices from the U.N. Statistical Commissions could be adopted in India.

- **Improved data dissemination:** It is also important to disseminate data in convenient, user-friendly and easy-to-access formats. To achieve this require a high degree of data integration, uniform data maintaining standards, end-user oriented data formats and increasing usage of modern technology.

7.4.7.4. State wise targets

To increase the ownership of the states in implementing energy efficiency measures, it is proposed to include state-wise targets for reduction of energy use across sectors. An order can be issued by the central government to the states to report all energy consumption and supply data along with special measures taken to implement energy efficiency measures on a yearly basis. This can be implemented in a similar way to that of the European Union which has directed the countries in the union to report the data. They have issued the Energy efficiency directive (EED) to all the countries that puts forward legally binding measures to step up Member States' efforts to use energy more efficiently at all stages of the energy chain. The central government can set up a similar framework with the Indian states with the following data points being collected and updated periodically:

Sector wise energy consumption, in comparison to the energy consumption in the previous year

Status of all energy efficiency programmes and the target of the same

Future plan for energy efficiency in the next year (short term) and next three years (medium term)

Disbursement of funds allocated for energy efficiency should be linked to the achievement in the previous years.

7.4.7.5. Independent SDAs and improving the capacity of SDAs

Under section 15(d) of the EC Act, 2001 State Designated Agencies (SDAs) have been notified by the State Governments by assigning additional responsibilities to the existing state government departments. The different state departments which are acting in the capacity of an SDA comprise of – Renewable Energy Development Agencies, Distribution Companies/Utilities, Electrical Inspectorate, Power Department and Standalone Energy Efficiency Agency. At present, there are total 35 SDAs[154] in the country, out of which 16 are Renewable Energy Development Agencies, 5 are State Government Power Departments, 7 are Electrical Inspectorate Offices and 5 are Distribution Companies and 2 are standalone SDA.

[154] Assessment of the impact of energy efficiency activities taken by State Designated Agencies during XII five year plan, PwC

It is noticed that since the SDAs have multiple functions, they have multiple responsibilities along with energy efficiency and energy conservation. This impacts the activities envisaged for energy efficiency. It has been observed that the standalone SDAs have been more effective in implementing energy efficiency activities in the states[154]. Thus, it is essential to have SDAs with a standalone mandate for energy efficiency for a more focused approach to energy efficiency and for a more effective implementation of the programmes. This can be mandated by the Ministry of Power.

In most SDAs, it is noticed that all energy efficiency schemes such as buildings, industries, standards and labelling are looked after by a single person only. The staff at the SDAs needs to be increased and separate portfolios need to be assigned to the staff based on the qualification. To build an effective team at the SDA it can be envisaged to conduct scheme specific training for manpower so that they are better placed to implement the schemes in their states. It is proposed that this is taken up by BEE in a similar way that they have taken up capacity building of DISCOMs in the country. In addition to the above, the consumer awareness activities implemented by BEE and SDAs need to be synchronized and a National Energy Efficiency Awareness Strategy could be implemented to bring the awareness activities of all SDAs in line with those envisaged by BEE.

7.4.7.6. Funding for laboratories for testing appliances under S&L

Under the Standard and Labelling programme, monitoring and compliance is limited by the availability of qualified test laboratories that can test the appliances. Though BEE has taken steps to empanel laboratories[153] for the programme, there is scope to increase the number of laboratories for testing the appliances. The same may be encouraged by providing easy finance for setting up the laboratories by private players. In addition, funds from labelling fees could be made available for this purpose.

7.4.7.7. State specific stakeholder engagement program

It is observed that lack of communication and co-ordination between government departments and other stakeholders in the states results in delays in implementation of energy efficient programmes[61]. To encourage faster implementation of programmes it is proposed to have a state specific stakeholder engagement programme led by the SDAs. The stakeholders in the state could include-

7.4.7.8. Integration of harmonic products in S&L

Manufacturers of electrical appliances face many challenges in designing products when there are different standards available. Bureau of Indian Standards (BIS) is the National Standard Body of India established under the BIS Act 1986 for the harmonious development of the activities of standardization, marking and quality certification of goods.

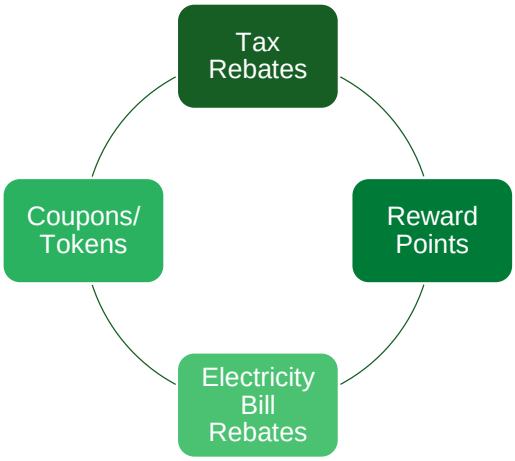
Harmonics Standards

With increase in solid state devices and use of capacity in many equipment, energy losses due to harmonics would rise. The new improved standards for equipment should have a special emphasis on harmonics other than energy efficiency.

7.4.7.9. Additional cess on import of inefficient equipment

India follows an open trade policy where most products can be imported without any license. Machinery, electronics and telecom imports account for about $106 billion in imports which amounts to almost 23% of India's imports[155]. It is possible that the equipment that is being imported does not utilize fuel efficiently and there is scope for improvement in this. A cess can be imposed on substandard equipment that is being imported into the country by the customs department. This will reduce the import of inefficient equipment. A similar exercise was carried out by the Mauritius government where to reduce the number of energy inefficient appliances being imported in the country, a levy of additional 25% was applied on appliances whose efficiency was below a certain threshold. The threshold has since been raised over the years[156].

7.4.7.10. Voluntary reward program for consumers



There is a lack of knowledge in the consumers about energy efficiency and its benefits. An innovative way to spread information about energy efficiency measures as well as to increase the adoption of these products is to reward the consumers who adopt these measures. In Ireland, Electric Ireland has listed measures[157] that qualify for credits in their home electricity or gas bill. Similarly, DISCOMs in India can come up with similar reward programmes. The DISCOMs can award 'points' to the customer for such measures. The points can keep accumulating (like miles in airline programmes) that can be redeemed later for rewards.

In transport, there is a need to align all public services like buses, trains, metro and cabs via the same card which will provide rebates to consumers that use the card (like the Delhi Metro card provides a rebate of 10% over cash). These will incentivize the adoption of energy efficient methods.

7.4.7.11. Energy efficiency in school curriculum

As mentioned earlier, there is less knowledge of energy efficiency for consumers. It is proposed that the same is incorporated in the school curriculum from class 1 onwards. It can be started with simple dos and don'ts and can be more detailed chapters in higher classes. This will lead to widespread knowledge about energy efficiency and the students will encourage household members to follow energy efficiency practices.

7.4.7.12. Enablement of new technologies

New technologies such as IoT and Blockchain are proving to be essential to energy efficient appliances. IoT is present in various new appliances such as smart meters, smart control panels on pumps, Smart Street lighting among others. Blockchain is still in a nascent stage but has a huge potential for application in DSM in India. The government needs to act quickly to set standards in

[155] The good and the not so good imports, https://www.thehindubusinessline.com/opinion/columns/ajay-srivastav/the-good-and-the-not-so-good-imports/article24658336.ece
[156] Energy Efficiency (Labelling of Regulated Machinery) Regulations 2017, http://eemo.govmu.org/English/Documents/Energy_Labelling.pdf
[157] https://www.electricireland.ie/docs/roi-business-help---efficiency/energy-efficiency-qualifying-measures.pdf?sfvrsn=16c2bd0d_4

these technologies for easier inter-operation of equipment. This will lead to a faster development of such technology and will lead to a structured approach to the introduction of these innovations. The government can run pilot programmes that can test the effectiveness of the technology. This can be undertaken by the Department of Science and Technology.

Regulations for new technologies

Introduction of these technologies also has the potential to increase the energy consumption if inefficient communication technologies are used. India could set-up policy in line with One-Watt Initiative by the International Energy Agency.

Further, to boost the sector, the government needs to establish certain guidelines. The European Union recently enforced the General Data Protection Regulation (GDPR) guidelines in May 2018. This has resulted in strict guidelines for use of data by companies. The basic rule set by the government is that the consumer needs to give consent to companies to use their data[158]. Thus regulating the industry will increase the rate of adoption of the technologies as they would be approved by the government.

7.4.7.13. Center of excellence for industries

There is scope for improving the energy efficiency in the industry by establishing sector specific centers of excellence for industries. These centers of excellence can be funded by mandating all industries to contribute 1% of profits to their sector specific center of excellence. This would increase the research and development in energy efficient equipment and processes with a specific focus on the sector which would lead to an overall decrease in energy demand of the sector.

7.4.7.14. Setting up a committee of financial institutions at the state level

The EE sector, despite having a huge potential for investment, has not been able to attract huge investments in the recent past like the renewable sector. The SDAs can play a crucial role in this regard and can act as a catalyst in facilitating finance to EE projects in the state.

The SDAs will constitute a committee of key financial institutions within the state. The SDAs would then refer EE projects to the committee members for financing. Only those projects that face financing issues would be evaluated by the committee and members of the committee may choose to finance these projects after careful evaluation, with recommendations from the SDA.

7.5. Actionable instruments for achieving proposed strategies

As mentioned in the section above, the energy efficiency potential in the country can be achieved by various interventions that can be carried out across the demand sectors, as well as measures that cut across sector. In this section, a short, medium a long term timeframe has been considered for actionable instruments under each of the strategies mentioned above. The timeline in this context refers to the period over which the proposed strategy should come into fruition and become an integral part of the functioning of the sector, or across sectors. The table below outlines these timelines:

[158] Securing the IoT through effective regulation (May 2018), TrendMicro

Table 130: Strategy timeline for Agriculture sector

Agriculture		
Strategy	Actionable instruments	Timeline
Integration of energy efficiency with water conservation efforts and greater co-ordination among various stakeholders	Explore integrated DSM solutions with appropriate delivery models to maximize EE in the agro pumping loads	Short Term
	Creation of an inter-departmental task force aimed at aligning the objectives and goals of various existing programs	Medium Term
Availability of EE pump sets	Mandatory star labelling of pumps and phase out of non-star pumps	Medium Term
Integrate Energy Efficiency in Agriculture Studies	Specific courses in institutions like ICAR, Specific courses in ITIs that focus on skill development in dealing with climate smart agricultural technologies	Medium Term
Cheaper finance for energy efficient equipment	Developing an energy lending portfolio comprising several energy specific loan products	Long term
	Introduction of region-specific products based on demand assessment through micro finance institutions and SHG bank-linkage	Medium Term
	Designing training programs for staff in financial institutions	Medium Term
Increasing Research and Development in the agriculture sector	Inclusion of agro projects under the National Clean Energy Fund	Short Term
	ICAR institutes and SAUs to create consortium in which the private org. can become members and access technology	Medium Term
	A single window system for export of products and services will improve the competitiveness of sector R&D.	Medium Term
Mandating EE Technology Standards and Guidelines	Development of an energy conservation code for agro sector	Medium term
	Regulation for installation of only BEE star rated EE pump sets and smart control panels mandatory for new agricultural connections	Long Term
	Solar pumps should mandate using only the most efficient appliances	Medium Term
	Investment in efficient irrigation pumps including solar/electric pumps for irrigation.	Medium Term
IoT in agriculture: Moving towards smart farming practices	Building a forum of stakeholders interested in research, development, testing and implementation of technology, infrastructure and applications of IoT for farming	Short Term

Agriculture		
	Identifying trends and disruptions anticipated in Indian farming practices in the future	Medium Term
	Running pilot projects across varying climatic conditions in the country	Medium Term
	Funding large scale projects post successful implementation of pilot projects	Long Term

Table 131: Strategy timeline for Buildings Sector

Buildings		
Strategy	Actionable instruments	Timeline
Mandatory implementation of residential building codes and simplified codes for commercial buildings with lower connected load	Mandatory implementation for the recently released ECBC-R codes	Long Term
	For smaller commercial buildings, incorporation of a simplified energy efficiency code for easier implementation and adoption.	Medium Term
	Energy Auditors for building or ECBC	Medium Term
Mandatory implementation of ECBC in states	Establish a reporting framework for where the states are required to update their progress in implementation of ECBC in their state.	Medium Term
	Make ECBC implementation mandatory in all states by 2022	Medium Term
Integration of EE in Government housing schemes and cheaper financing for EE houses	Optimum unit planning under PMAY to enhance thermal and visual comfort by day light integration, cross ventilation, window shading, low thermal transmittance of envelope and cool roof	Long Term
	Site planning to optimize building orientation, WWR and heat island effect for enhanced comfort levels within the building	Long Term
	Optimum building height to minimise common services' provision, operational energy and maintenance cost and enhanced RE integration potential	Medium Term
	Targeting low LCOC rather than low initial building cost by building for affordable maintenance and operation as well	Medium Term
	Introduction of incentives for purchasing EE houses	Long Term
Synergy between BEE, IGBC and GRIHA rating systems	The best practices from the three rating systems can be incorporated into a single comprehensive system that addresses every aspect of EE in buildings and incorporation of new technologies in building operations and EM systems	Medium Term & Long Term
Automated Building Management System (BMS) in higher connected load commercial buildings	Mandatory installation of automated building management systems in commercial buildings of a higher connected load to begin with. The policy can then be made mandatory for residential townships	Medium Term

Buildings		
	and complexes	
Promoting energy efficiency technologies in high rise residential buildings	Drive awareness programmes across state capitals through SDA's	Short Term
	Identify residential complexes in the capital cities where there is a huge scope for energy savings	Short Term
	Collaborate with housing societies to implement small scale EE projects.	Medium Term
	Prepare case studies of successful EE implementations in housing complexes around the country	Medium Term
	Programme expansion to other densely populated cities in the state	Long Term

Table 132: Strategy timeline for Industrial Sector

Industry		
Strategy	Actionable instruments	Timeline
Creating a National Energy Efficiency Repository with benchmarks	Formation of a nodal agency that has representatives from the identified stakeholders	Medium Term
	Dissemination of periodic reports and analysis, providing support to line ministries on EE activities and programmes	Long Term
Increasing the width and depth of the PAT programme including a voluntary component	Increasing the scope of the PAT programme and adopting BAT to cover at least 80% of total industrial energy consumption	Medium Term
	A voluntary PAT programme to be initiated. The non-DC participants would be allowed to access the ESCerts Markets and given a favourable tax benefits for achieving EE	Medium Term
Creation of a unified carbon reduction programme	Combining REC and PAT Certificate- Meta Registry	Medium Term
	Trading mechanisms for inter trading between Escerts and RECs	Medium Term
Mandatory energy management cell with CEMs/CEAs all medium and large scale industries	List of sector experts so that other sectors can be benefited	Short Term
	Creation of an energy management cell with certified EA/EM for all industries above Rs. 10 crore capex	Medium Term
	Running capacity building programs to develop the required manpower to effectively function in EM cells in the industries	Medium Term
Central Monitoring of all funded programs in the MSME	Creation of a PMU within the nodal ministry to monitor the close to 30 schemes that are being run in the country	Short Term
	The cluster associations to work closely with the	Medium Term

Industry		
	PMU to help and promote new EE & RE technologies	
	Organizing industry and tech. specific workshops in the clusters	Medium Term
Promoting use of energy efficient equipment among MSME units	Creation of a comprehensive database of national and international vendors in the country supplying EE equipment	Short Term
	Creating an App which helps connect MSME's connect with equipment suppliers and technology solution providers around them	Short Term
	Spreading awareness of the app among MSME cluster associations	Short Term
Promoting Industry 4.0 in manufacturing industry	Creation of fund for R&D in industry – 1% of turnover	Short Term
	Strengthen the vocational training infrastructure and partnering with the private sector to include elements of Industry 4.0 in vocational training	Short Term
	Establishing a network of Test labs that will work closely with industry bodies, government, academia	Medium Term
	Financial incentives like tax breaks to make it more affordable	Medium Term

Table 133: Strategy timeline for transport sector

Transport		
Strategy	Actionable instruments	Timeline
Integrated transport planning with Mandate to support movement towards EE transportation	Inter departmental planning of transport networks in the country that that integrates all modes of rail, water and road transport, focus on promoting public transport as the preferred form of transport	Medium Term
	Develop a national policy on electric vehicles	Medium Term
	Roll out of the proposed FAME-II scheme	Medium Term
	Introduction of ToD tariff rates for EVs	Short Term
	Pilot projects on V2G and integration of RE and EVs in the grid	Short Term
	Pilot projects on ancillary services of EV landscape and large scale energy storage systems	Short Term
Promoting shared last mile connectivity transport solutions	Location Survey of Indian cities apart from metros to scout for ideal locations to implement shared last mile connectivity solutions	Short Term
	Implementation of pilot projects	Medium Term
	Large scale projects with participation of private players and solution providers	Long Term
Legislation to improve ease of doing business for new business models	Developing regulations that allow for smooth functioning of shared mobility providers in the form of: • Facilitating coordination and eliminating	Medium Term

Transport		
	overlapping functions in planning and execution of urban mobility initiatives • Integrated fare setting across modes so that various services are priced according to the affordability of the users • Facilitating efficiency in regulation of shared mobility and their permit system in city	
Increase CAFÉ standards	CAFE standards in India to define corporate average CO2 emission targets for OEMs and these are to be benchmarked against standards implemented in other countries	Medium term
	Provision for carbon trading in the auto sector	Long Term
Increasing stakeholder engagement	Designing courses and training modules that are future ready and lead to deployment of a skilled workforce	Short Term
	Introduction of an integrated information system by NSDC that creates a marketplace for demand aggregation of labour in the industry	Medium Term
	Driving consumer awareness for green mobility solutions by designing an effective communication and awareness strategy for the general public	Short Term

Table 134: Timeline for cross sectoral strategies

Cross-sectoral		
Better Engagement and Management of EE Programs in DISCOMs		
Strategy	Actionable instruments	Timeline
Considering DSM as a resource in IRP	Demand side resources to defined and emphasized as stand-alone independent resource apart from the conventional and RE sources	Medium Term
	Considering Demand Side Resources at the planning stage to enable IRP by the electric Utilities and central /state governments	Medium Term
	Promotion of 'DSM Resource Purchase Obligations' and more importantly to ensure effective enforcement of such obligations	Medium Term
	Grid interactive demand response by smart appliances, buildings/industrial consumers, or EV chargers	Long Term
Capacity Building of DISCOMs	IT Cells of DISCOMs to be trained for new technologies such as IoT and Blockchain to tap their role in reducing commercial losses	Short Term
	Establishing DSM Cell in DISCOMs	Short Term
Increasing the scope of existing programs with stricter enforcement and penalties	Impose stricter enforcement guidelines to be implemented by the lead ministry in the programmes with quarterly follow-up	Short term
	DELP type programs to be implemented for 10 most energy intensive appliances	Medium Term
	Penalties to be applied for implementing partners for delay in	Short term

Cross-sectoral		
	implementation	
	Increase the reach of the current successful programmes such as PAT, Streetlighing, AgDSM, UJALA	Medium term
	Improvement in Efficiency of biomass cook stoves and gas stoves.	Medium Term
Institutional Framework for Data Collection	Setting up of a Nodal Agency that advocates data collection and dissemination, covering the entire energy value chain of the country	Medium Term
Setting State wise targets	Mandatory reporting of sector wise energy consumption, Status of all EE programmes and the target of the same and EE roadmap	Medium Term
Independent SDAs and capacity building of SDAs	SDAs with a standalone mandate for EE for a more focused approach to EE	Medium term
	National Energy Efficiency Awareness Strategy to be implemented	Medium term
Funding Laboratories	Increase in the number of laboratories for testing appliances	Medium Term
Stakeholder engagement programmes	State specific stakeholder engagement programme led by the SDAs.	Short Term
Integration of harmonic products in S&L	Addressing the issues faced by manufacturers for conformance with BIS and S&L standards.	Short Term
	Inclusion of harmonic standards into the S&L	Short Term
Additional cess on import of inefficient equipment	A cess to be imposed on substandard equipment that is being imported into the country by the customs department	Medium Term
Additional cess on import of inefficient equipment	A cess to be imposed on substandard equipment that is being imported into the country by the customs department	Medium Term
Voluntary Reward Programme for consumers	Reward programmes by DISCOMs to consumers for adopting certain pre-ordained measures	Short Term
Energy Efficiency in School Curriculum	Knowledge about energy efficiency to be imparted at the primary school level, from class 1 onwards	Short Term
Enablement of new technologies	Mandatory standards and labeling programs for all ceiling fans, VFRs and Chillers	Short Term
	Moving towards cleaner cooking fuel like electric cook stoves	Short Term
	All key appliances, equipment, and vehicles should be covered by mandatory standards and labelling programs by 2020	Medium Term
	Setting standards for new technologies like Blockchain and IoT	Medium Term
	Policy on communication protocol for newer technologies	Medium Term
Center of Excellence for industries	Increasing R&D in specific sectors in the industry by setting up a centre of excellence , dedicated to particular sectors	Medium Term
Setting up a committee of financial institutions at the state level	Constituting a committee of financial institutions at the state level, with SDAs referring EE projects to the committee that face financial issues in getting implemented	Medium Term

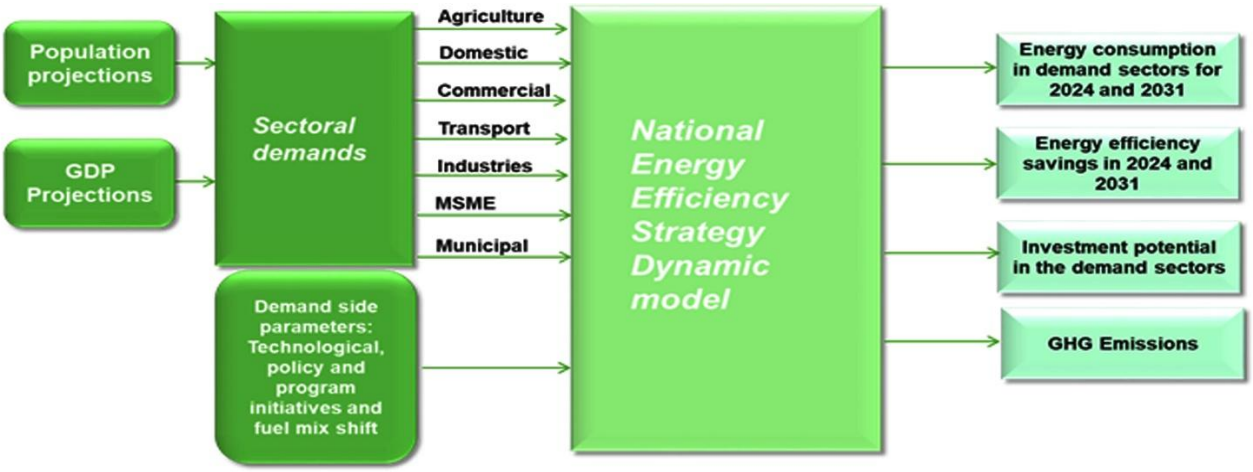
APPENDIX

Appendix A. - Development of the dynamic tool

The National Energy Efficiency Strategy document focuses on multiple sectors and thus a flexible model was designed to adapt to the unique aspects and data availability of each of the demand sector. The underlying approach for the entire analysis hinged on three pivots:

Multiple input sources (reports available in public domain and stakeholder consultations)	Bottom up analysis and top down validations to the extent data allowed	Assumptions based on discussion with sector experts and sector reports

For this study, the model database extends from the base year of 2016-17 to 2030-31 and has been updated to validate and align the energy consumption across the sectors. Discussions with sector experts were carried out in order to delineate which end use options lend themselves to efficiency improvements and to incorporate insights regarding the levels of improvements that can be envisaged across technologies, processes and end-use equipment over 14 year period considered for this study. Extensive secondary data was collected from reports available in the public domain, from government sources as well as international and national independent organizations that regularly publish reports and journals on energy consumption and efficiency in the country. The design of the model adopted for the study is shown below:



The various intended beneficiaries of this tool would include central and state ministries and government agencies, various government and non-government think-tanks, expert agencies, policy makers and sector experts. The tool projects the energy consumption, energy saving potential energy efficiency investment potential and GHG emissions from 2016-17 till 2030-31 under various scenarios for the demand sectors as illustrated in the design model shown above. The tool also calculates the primary energy and electricity consumption for the country as well as the states for the base year, with a provision for the user to update the data every year as and when the energy data is published from various sources.

This would allow the beneficiaries to get a comprehensive view of the country's energy profile in the current scenario as well as the possible scenarios that could take place depending on the various energy pathways that have been incorporated into the model.

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