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Energy efficiency policies in China and India

Research Paper

Waste not want not

June 2016

Waste not, want not:
Energy efficiency policies in China and India

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Suggested citation

UNDP-TERI (2016). Waste not, want not: Energy Efficiency Policies in China and India. United Nations Development Programme: China.

This research paper is published in English and Chinese. UNDP China has strived to ensure the consistency between the two versions of the paper. The English version should prevail in case of any ambiguity or conflict in terms of the two versions.

UNDP China welcomes comments on the research paper via email to Ms. Samantha Anderson (samantha.anderson@undp.org).

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FOREWORD

Improving energy efficiency is a crucial component in fighting global warming. The International Energy Agency estimates in the efforts to keep global temperatures below 2°C, energy efficiency measures will contribute over 40% of the world's greenhouse gas mitigation. Energy efficiency has multiple co-benefits beyond GHG reduction including increased energy access and security, reduced pollution, poverty reduction and economic growth as resources are redirected to more productive activities.

With fast growing economies and growing carbon emissions, China and India, the world's two largest countries, have begun implementing important energy efficiency measures that are contributing to rapid decreases in energy intensity per unit of GDP. Because of their current development status, India and China are now making policy interventions that will have long-term impacts on setting both countries onto a more sustainable development path. Avoiding traditional high-carbon, high pollution development benefits both their own populations and the world. Differences in resource availability and governance structures mean that each country has approached energy efficiency implementation differently; there are lessons to be learned from each approach, for each other, and for the rest of the world.

In 2014, a joint study by The Energy and Resources Institute (TERI), the National Centre for Climate Change Strategy and International Cooperation (NCSC), the Central University of Finance and Economics (CUFE), Zhejiang University, and the United Nations Development Programme (UNDP) titled *Low-carbon development in India and China* was released. UNDP has continued to support knowledge exchange between Chinese and Indian researchers on a number of low-carbon development topics through webinars and policy briefs. We are now pleased to share this new research paper *Waste not, want not: Energy efficiency policy in China and India*, which examines policies put in place in both countries that are encouraging increased energy efficiency in multiple sectors.

On Earth Day this year a record number of UN member states signed the Paris Agreement, which gives us hope that there is now real momentum to tackle climate change. Energy efficiency policy is one of the best tools we have for keeping that momentum going.

Agi Veres

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ACKNOWLEDGEMENTS

We would like to thank the Embassy of Norway in Beijing for their financial support of this project and all the reviewers, in particular Manuel Soriano and Rakshya Thapa, for their valuable suggestions.

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Abbreviations

AgDSM	Agricultural Demand-side Management
AQSIQ	Administration of Quality Supervision, Inspection and Quarantine
BAT	Best Available Techniques
BEE	Bureau of Energy Efficiency
BHEL	Bharat Heavy Electricals Ltd.
BLY	Bachat Lamp Yojana
BOO	Build, Operate and Own
BSE	Bombay Stock Exchange
CII	Confederation of Indian Industry
CPC	Communist Party of China
CNY	Chinese Yuan or Renminbi, currency unit
CSC	China's State Council
DCs	Designated Consumers
DEPP	Differential Electricity Pricing Policy
DISCOMs	Distribution Companies
DSM	Demand side management
EACs	Environmental Appraisal Committees
EBC	Energy-Building Codes
ECAP	Energy Conservation Action Plan
ECBC	Energy Conservation Building Code
ECF	Energy Conservation Fund
EEFP	Energy Efficiency Financing Platform
EESL	Energy Efficiency Services Limited
EPC	Energy Performance Contracting
ESCO	Energy Service Company

ETS	Emission Trading Scheme
FEEED	Framework for Energy Efficient Economic Development
FEL	Fuel Economy Labeling
FES	Fuel Economy Standards
FYP	Five Year Plan
GDP	Gross Domestic Product
GoI	Government of India
GOA	Government Offices Administration
GRIHA	Green Rating for Integrated Habitat Assessment
HSR	High Speed Railways
IBTs	Increasing Block Tariffs
IEA	International Energy Agency
IGBC	The Indian Green Building Council
IGCC	Integrated Gasification Combined Cycle
IREDA	Indian Renewable Energy Development Agency
MIIT	Ministry of Industry and Information Technology
MoEFCC	Ministry of Environment, Forests and Climate Change's
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
MOHURD	Ministry of Housing and Urban-Rural Development
MoMSME	The Ministry of Micro, Small and Medium Enterprises
MoP	The Ministry of Power
MOR	Ministry of Railways
MOST	Ministry of Science and Technology
MOT	Ministry of Transport
MoUD	The Ministry of Urban Development
MPG	Miles Per Gallon of Fuel

MRT	Metro Rapid Transit
MSME	Micro, Small and Medium Enterprise
MTEE	Market Transformation for Energy Efficiency
Mtoe	Million tonnes of oil equivalent
NABARD	National Bank for Agriculture and Rural Development
NAPCC	National Action Plan on Climate Change
NBC	The National Building Code of India
NBS	National Bureau of Statistics
NDRC	National Development and Reform Commission
NEA	National Energy Administration
NEMMP	National Electric Mobility Mission Plan
NEP	National Electricity Policy
NEV	New Energy Vehicle
NIDA	NABARD Infrastructure Development Assistance
NMCP	National Manufacturing Competitiveness Programme
NMEEE	National Mission for Enhanced Energy Efficiency
NMSA	National Mission for Sustainable Agriculture
NTP	National Tariff Policy
PAT	Perform, Achieve & Trade
PRGF	The Partial Risk Guarantee Fund
SBI	State Bank of India
SCEF	State Energy Conservation Fund
SDAs	State Designated Agencies
SE	Super-efficient
SEEP	Super-Efficient Equipment Programme
SERCs	State Electricity Regulatory Commissions
SIDBI	Small Industries Development Bank of India

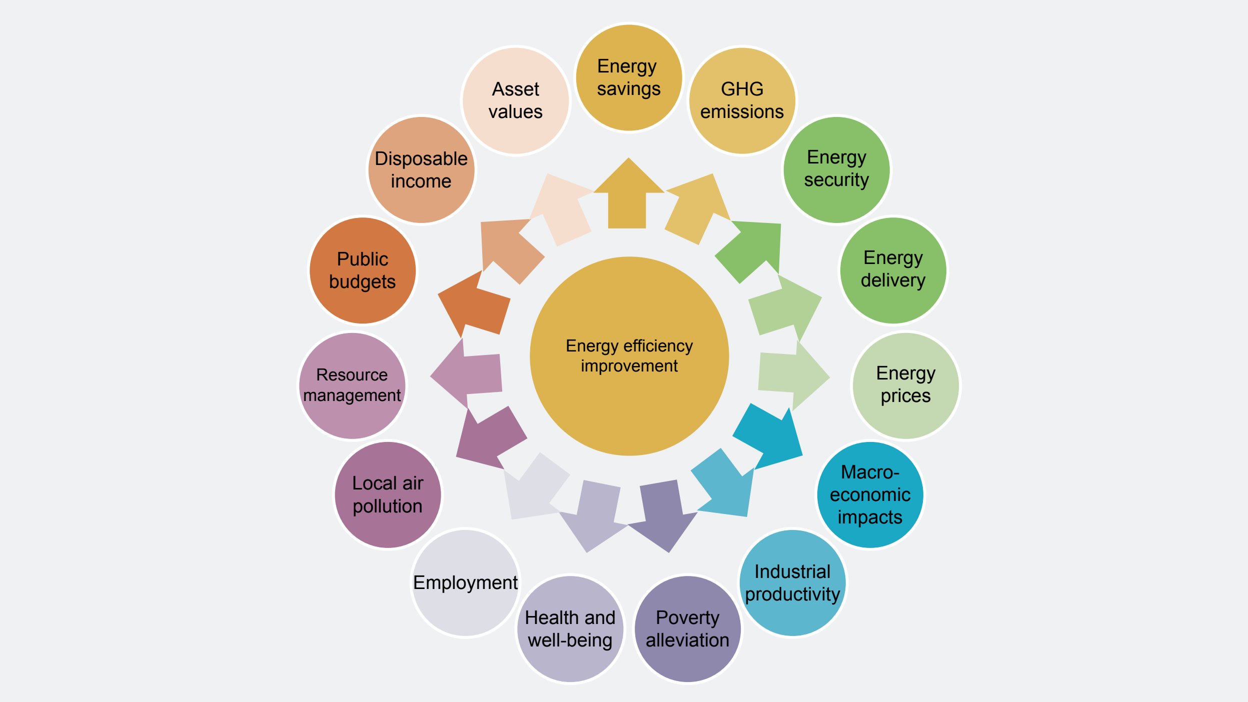
SPVs	Special Purpose Vehicles
T&D	Transmission & Distribution
TEC	Ton of Coal Equivalent
TEDDY	TERI Energy & Environment Data Diary and Yearbook
TEQUP	Technology & Quality Upgradation
ULBs	Urban Local Bodies
UMPPs	Ultra Mega Power Plants
VCFEE	Venture Capital Fund for Energy Efficiency

Introduction

Globally, energy efficiency has been recognized as being central to sustainable development. Target 7.3 of the Sustainable Development Goals states: By 2030, double the global rate of improvement in energy efficiency.[1]

Energy efficiency is an essential response to meet various challenges in the energy sector, and is increasingly recognized by decision-makers around the world, not just as a measure to manage energy and reduce greenhouse-gas emissions, in which the clear benefits of energy efficiency have been documented, but also as a measure to ensure energy security, improve local air quality, benefit from economic gains, and create employment opportunities among others (Figure 1). Policies, markets and institutional systems all have roles to play in achieving the goal of energy efficiency, which has become a policy imperative at the national as well as the global levels.

Figure 1: Multiple benefits of energy efficiency improvements



Source: IEA (2014)

[1]See here for more information on the Sustainable Development Goals: http://www.un.org/sustainabledevelopment/energy/

In this regard, improving the efficiency of energy use is a leading option to achieve better energy security, improve industrial profitability and competitiveness, and reduce the overall energy sector impacts on local air pollution and climate change, especially for emerging developing economies such as China and India, as they seek to exploit their resource base to reduce poverty and support sustainable growth:

- Energy access: Energy efficiency can help countries to expand access, effectively enabling them to supply power to more people through the existing energy infrastructure.

- Energy security: as a domestic measure that reduces reliance on imported energy, energy efficiency programs are typically a key part of national efforts to improve the security of future energy supplies.

- Development/growth: Many energy efficiency measures are cost effective. Costs vary among technologies and countries where energy efficiency measures are implemented, but often are only one-quarter to one-half the comparable costs of acquiring additional energy supply. Thus, energy efficiency has a variety of positive impacts that support economic growth, for example by improving industrial productivity and reducing fuel import bills.

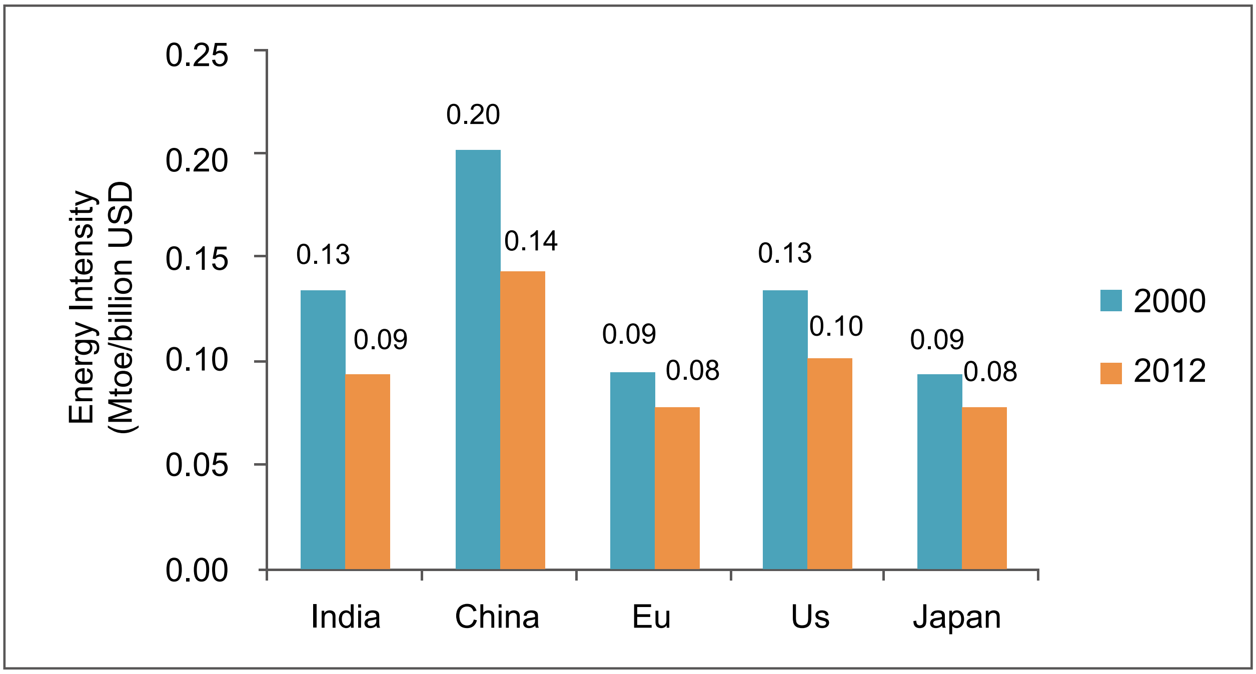
- Affordability/poverty alleviation: Energy efficiency can increase energy affordability for poorer families by reducing the cost of lighting, heating, refrigeration. etc. (IEA, 2015)

- Local pollution: Energy efficiency (both supply side and end-use) can help to reduce the use of energy – and lower associated emissions – while supporting economic growth.

- GHG emission mitigation: Realizing the economic potential of energy efficiency is a central pillar of a cost-effective strategy to mitigate climate change and achieve a peak in global greenhouse-gas emissions by 2020 (IEA, 2015). According to IEA's estimates, to achieve the 2 degree target, annual emissions need to be reduced by over 10 $GtCO_2$ by 2050 compared with business as usual, in which the contribution of energy efficiency (both from end-use sector and power sector) will exceed 40%.

Energy intensity (amount of energy used per unit of GDP produced) at purchasing power parity (PPP) is used as a proxy to explain the changes in energy efficiency since efficiency improvements in processes and technologies contribute to changes in energy intensity. Figure 2 depicts the energy intensities taken at GDP PPP for the time period of 2000 and 2012 for India, China, the European Union, the United States, and Japan. The maximum decline in energy intensity has been for China, followed by India. Over the ten year period, for the world overall, the value of energy intensity has remained approximately the same.

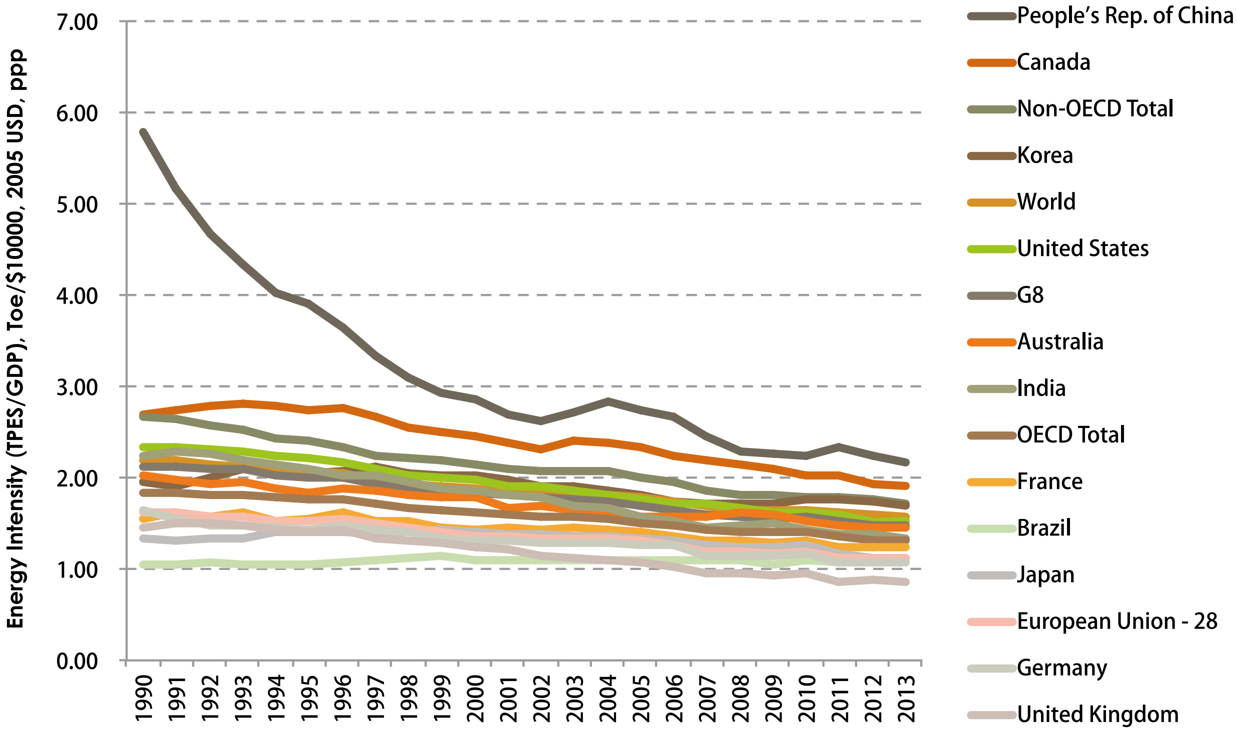
Figure 2: Energy intensity (Mtoe/ USD billion) for select countries/ country groups and the world for 2000 and 2012



Note: GDP is taken in 2005 USD in PPP terms
Source: IEA (2014)

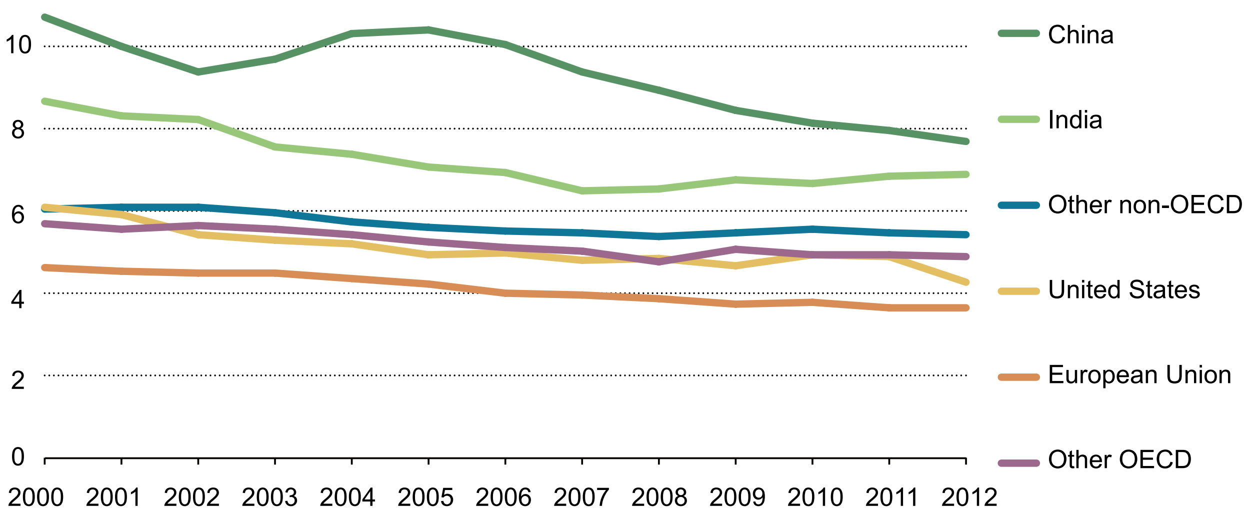
In terms of the industrial energy intensity of major economies, while energy intensity in China and India declined in the period of 2000-2012, their energy intensity still remains above many developed economies such as the European Union and the United States (Figure 3). Similarly, in terms of energy savings potential for iron and steel, based on available data, it is apparent that a huge potential for energy savings exists for both China and India.

Figure 3: Energy intensity per GDP by country since 1990



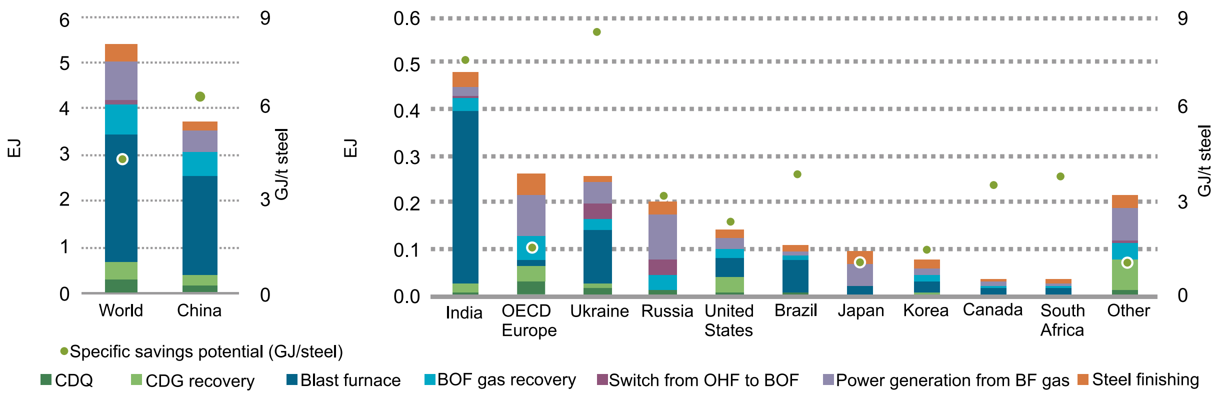
Source: IEA (2015a)

Figure 4: Trends of aggregated industrial energy intensity of major economies



Source: IEA (2015b)

Figure 5: Energy savings potential for iron and steel, based on best available techniques (BAT)



Source: IEA (2013)

Although the benefits of energy efficiency investments are obvious, scaling up those investments continues to pose challenges. Many barriers contribute to the limited uptake of energy efficiency opportunities. These include information failure, split incentives, subsidized pricing of energy, inadequate pricing of externalities, a shortage of financing, etc. For example, energy efficiency investment opportunities attract less attention from investors in both the private and government sectors when compared to opportunities to invest in new fossil fuel resources such as shale gas and oil (IEA, 2015). Many energy efficiency measures have difficulty attracting external financing as the returns they offer are small in scale or dispersed, and therefore not as attractive to investors as capacity or market expansion (Taylor et al., 2008). While market-based solutions do exist, an enabling policy framework is also needed to realise the substantial energy and cost savings to be realised through efficiency measures.

This report discusses recent trends in energy efficiency in China and India, including an analysis of the evolution of energy efficiency policies and the impact of those policies on selected sectors, and outlines key challenges and policy recommendations on improving energy efficiency.

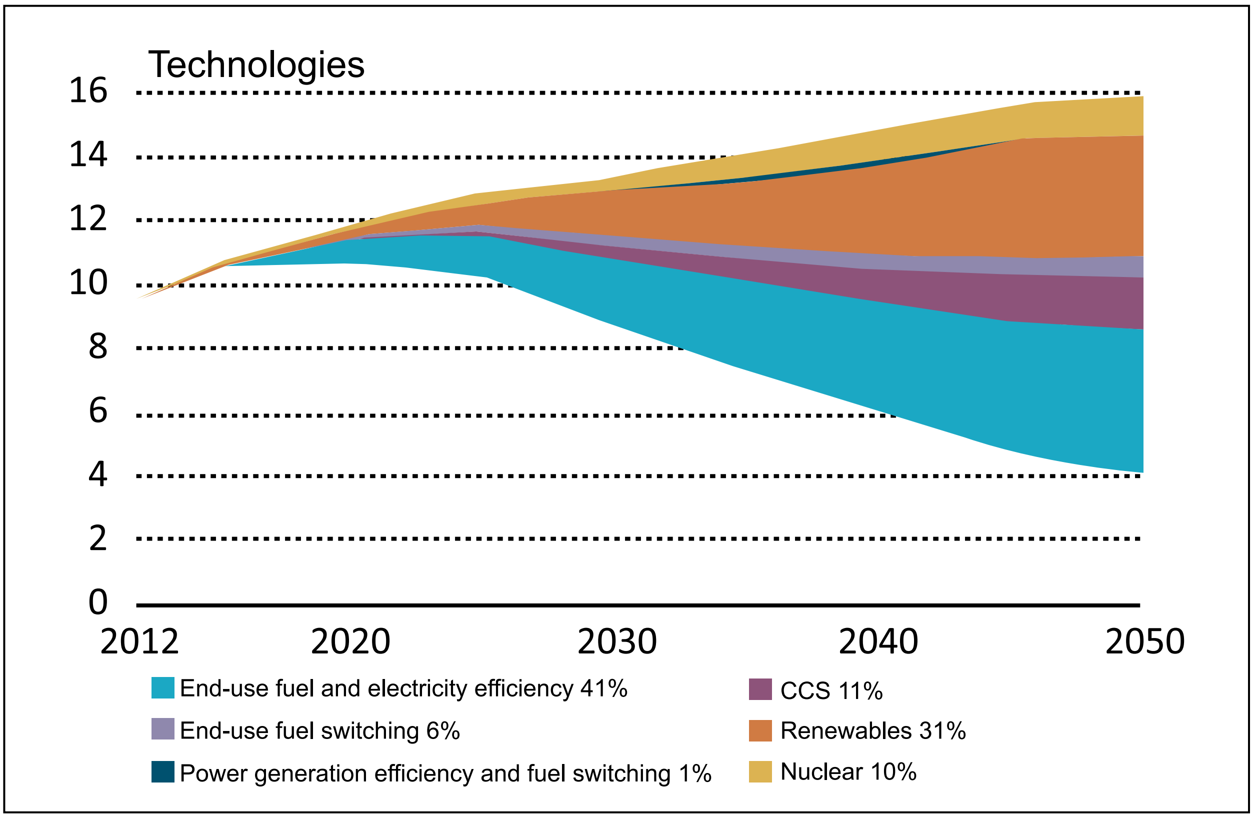
Energy efficiency policies in China: experiences and recommendations

1. Current status of energy efficiency in China

1.1 Overall energy intensity

China has successfully decoupled energy consumption from economic growth. From 1980 to 2015, while China's economy increased 25-fold, energy consumption increased only 6-fold. Energy intensity-measured as the amount of primary energy required to produce a unit of gross domestic product (GDP)- decreased by over 70% during the same period, from 3.4 tce per 10,000 CNY (in year 2005 CNY)((approx. USD 1504)[2] in 1980 to 0.93 tce per 10,000 CNY in 2015 (Figure 3). This is one of the best achievements in reducing energy intensity worldwide (Figure 4). As seen in Figure 4, China's energy intensity has reduced by around 60% since 1990. The second largest reduction was in the United Kingdom while India reduced its energy intensity by about 40% over the same period. For Brazil, its energy intensity has been increasing since 1990 instead of decreasing.

Figure 6: Contributions to China's emissions reductions

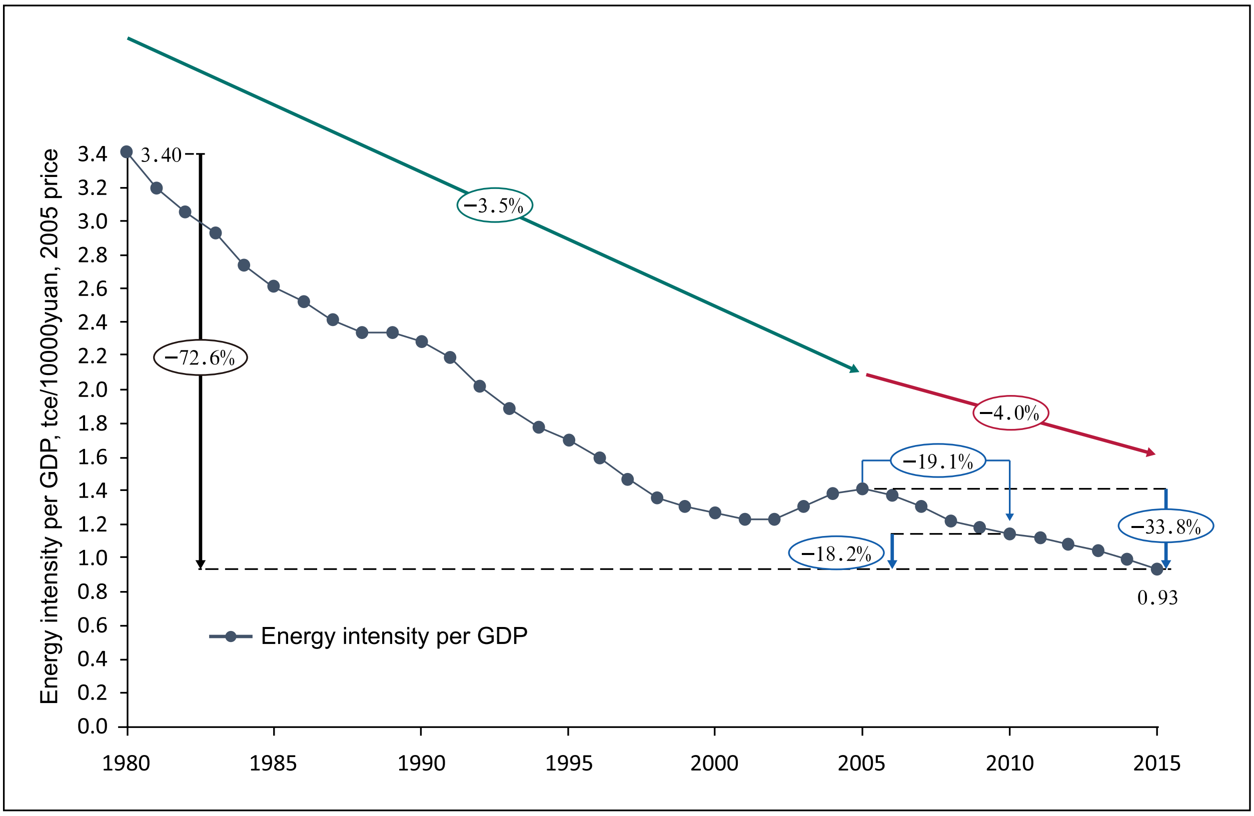


Source: IEA (2015b)

[2]*The exchange rate used here is the current rate 1 US$ to 6.647 CNY, July 2016.*

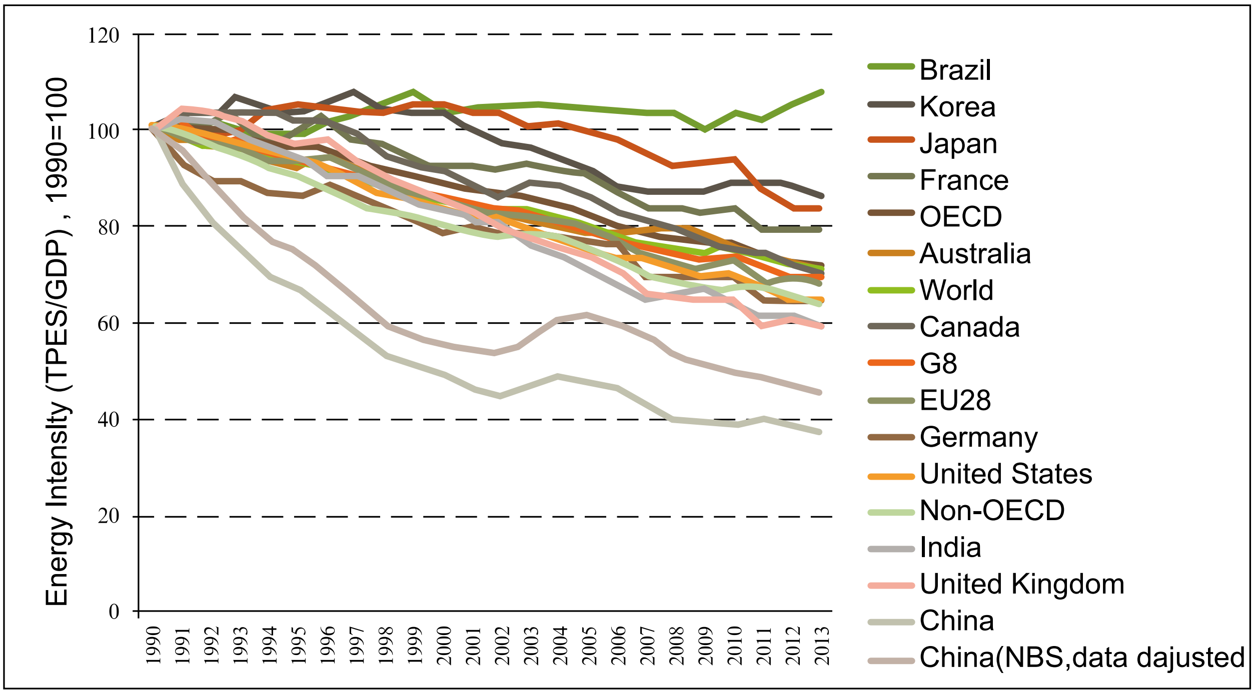
Since 2005, with China maintaining a double-digit growth rate, and despite rapid industrialization, the rate of GDP growth has been greater than that of energy consumption. Due to the energy efficiency and restructuring policies implemented since 2005, as indicated in Figure 3, improvement in China's energy intensity over the last 10 years (average rate of energy intensity reduction is 4% per year) has been higher than the trends over the period 1980-2005 (average rate of energy intensity reduction was 3.5% per year).

Figure 7: Trends in China's energy intensity per GDP over 1980-2015



Source: China Energy Statistics Yearbook (2015)

Figure 8: Changes in energy intensity per GDP by country



Note: GDP in 2005 USD and CNY based on PPP
Source: 1, IEA (2015a); 2, China Energy Statistics Yearbook (2015)

The drop in energy intensity was due not only to energy efficiency improvements, but also to structural changes in the economy that base a higher share of the economy on less energy-intensive industries. China's industrial structure has continued to optimize. By the end of 2015, the share of first, secondary and tertiary industries in China was optimized to 9%: 40.5%: 50.5% respectively, showing a significant improvement compared with 11.7%: 46.9%: 41.4% in 2015 (World Bank, 2015). The adjustment of the industrial structure has played a growing role in achieving the energy intensity reduction target.

Even so, due to its industrial structure and technology level, China's overall absolute energy intensity value is still much higher than many other countries. As shown in Figure 5, in 2013, China's absolute value of energy intensity per GDP (2005 CNY, based on PPP) was still 1.43 times that of the United States, 1.64 times that of the OECD total, 1.95 times that of the countries of the EU28, and 2.52 times that of the United Kingdom. China still has a significant potential to further decrease its energy intensity and improving its energy utilization efficiency.

1.2 Technology level and reduction potential

Although China began developing a modern industrial economy relatively recently, it has made impressive progress. The energy consumption of the most energy-intensive industrial products decreased in 2014 over 2000. For example, as shown in Table 1, coal consumption of thermal generators fell from 363 to 300 grams of standard coal per kWh; the comparable energy consumption[3] per tonne of steel in key steel manufacturing enterprises decreased from 784 to 654 grams of standard coal; and the overall energy consumption of copper metallurgy decreased by more than 60% from 1,277 kg to 420 kg of coal equivalent per tonne of copper.

However, although China has made remarkable progress on the energy efficiency of major energy-intensive industrial products since 2000, it still lags behind the specific energy consumption and energy intensity levels of developed countries levels. The gap in industrial energy efficiency levels between China and developed countries, as shown in Table 1 and Figure 6, is expressed in terms of not only industrial energy intensity, but also the main energy-intensive products. The energy consumption of nearly all energy-intensive industrial products is above developed-country levels, although this gap has narrowed in the period from 2000-2014. The AC power consumption of aluminum electrolysis, coal consumption in coal fired power generation, the comparable energy consumption of steel (large- and medium-sized enterprises), and the comparable energy consumption of cement, sodium carbonate, and caustic soda are not far below developed-country levels, while the energy consumption of all other products is more than 10% higher than the international level. Hence, a large potential exists to reduce energy consumption from the energy and industry sectors. For example, worldwide the iron and steel sector has the technical potential to reduce energy consumption by 5.4 EJ – about 19% of the sector energy consumption in 2010 – through the application of best available techniques (BAT) (Figure 7) (IEA, 2013). Around 67% of this potential is in China.

Table 1 International comparison of the energy consumption of energy-intensive industrial products, 2014

Energy Consumption Indicator	China				Advanced international level	2014 Gap	
	2000	2005	2010	2014		Energy use	%
Coal consumption of thermal generators (grams of coal equivalent/KWH)	363	343	312	300	290	10	3.45%
Coal consumption of thermal power supply (grams of coal equivalent/ KWH)	392	343	333	319	302	17	5.63%

[3]In Chinese, "可比能耗". This term is used in the steel industry as some steel enterprises do not cover the entire process of production, which makes calculating energy consumption per tonnes of steel difficult. This is used in other industries such as cement and alumina as well.

Comparable energy consumption of steel (large- and medium-sized enterprises) (kg coal equivalent/ton)	784	732	681	654	610	44	7.21%
AC power consumption of aluminium electrolysis (KWH/ton)	15418	14575	13979	13596	12900	696	5.40%
Comprehensive energy consumption[4] of copper metallurgy (kg coal equivalent/ton)	1277	780	500	420	360	60	16.67%
Comprehensive energy consumption of cement (kg coal equivalent/ton)	172	149	134	124	118	6	5.08%
Comprehensive energy consumption of plate glass (kg coal equivalent/weigh box)	25	22.7	16.9	15	13	2	15.38%
Comprehensive energy consumption of crude processing (kg coal equivalent/ton)	118	114	100	97	73	24	32.88%
Comprehensive energy consumption of sodium carbonate (kg coal equivalent/ton)	406	396	385	336	310	26	8.39%
Comprehensive energy consumption of calcium carbide (kg coal equivalent/ton)	3475	3450	3340	3272	3000	272	9.07%
Comprehensive energy consumption of paper and paper boards (kg coal equivalent/ton)	1540	1380	1200	1050	580	470	81.03%
Comprehensive energy consumption of ethylene (kg coal equivalent/ton)	1125	1073	950	860	629	231	36.72%
Comprehensive energy consumption of synthetic ammonia (kg coal equivalent/ton) (large-scale)	1699	1700	1587	1540	990	550	55.56%
Comprehensive energy consumption of caustic soda (kg coal equivalent/ton) (membrane method)	1439	1297	1006	949	910	39	4.29%

Source: Wang Qingyi, 2015 Energy Data, 2016

Note: Advanced international level is a particular term used in China to indicate the global average of developed countries.

[4] In Chinese, 综合能耗. This refers to the total energy consumption per enterprise to produce one tonne of product (copper, cement, etc.). The enterprise may not cover the entire production process.

2. Institutional framework for energy efficiency in China

2.1 Institutional arrangements

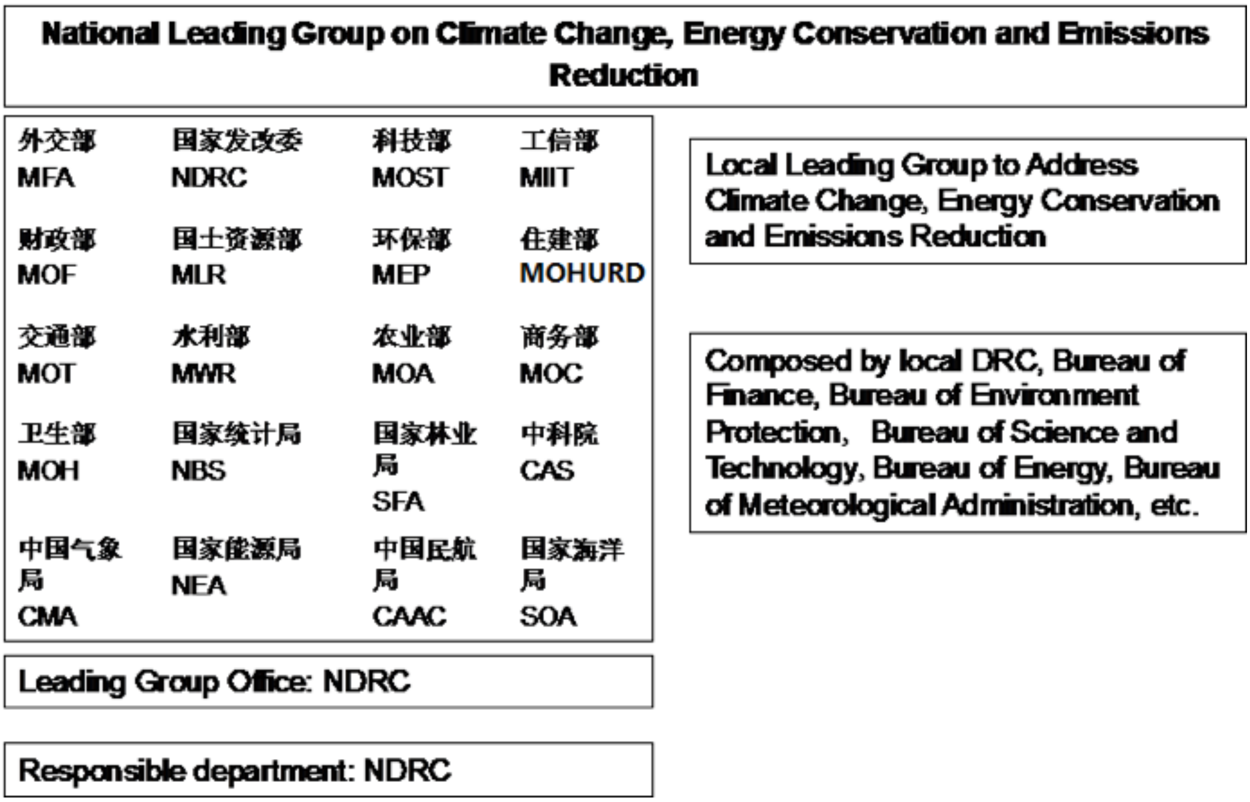
A range of institutions has been established to assess impacts, coordinate responses, and implement policies relevant to energy efficiency at different levels. At the national level, the National Leading Group on Climate Change, Energy Conservation and Emissions Reduction was established as a forum for national-level deliberation and coordination, consisting of leaders from more than 20 ministries, the Premier and Vice-Premier. The leader of this group is the Premier of the State Council, Li Keqiang. The Vice Premier of the State Council, Zhang Gaoli and State Councilor, Yang Jiechi serve as Vice Leader. The leading group is composed of more than 20 ministers, including the National Development and Reform Commission (NDRC), the Ministry of Foreign Affairs (MFA), the Ministry of Science and Technology (MOST), the Ministry of Industry and Information Technology (MIIT), etc. The leading group office is located in NDRC.

Energy efficiency is one of the basic responsibilities of NRDC, and generally includes energy conservation in relevant industries, comprehensive utilization of resources, energy consumption guidance and monitoring, and coordination of energy supply and demand. NDRC's Department of Environment and Resources and the National Energy Administration, which is subordinate to NDRC, are the main management institutes. The administration of the NEA has 12 inner organs, 6 regional regulars and 12 province-level regulation offices.[5]

NDRC cooperates with the relevant departments of the State Council to intensify the guidance, coordination and supervision for local energy conservation work. These national institutions are complemented by regional agencies and local research institutes in the 31 provincial administrative regions. Local governments take full responsibility for energy conservation in their administrative regions.

[5]For more information on the National Energy Administration, see http://www.nea.gov.cn/gjnyj/index.htm

Figure 9 National arrangements for addressing climate change and energy conservation



Source: author compilation,
http://www.ccchina.gov.cn/Detail.aspx?newsId=54967

2. 2 Overall energy efficiency policy framework

China has accounted for more than half the world’s entire energy savings over the past twenty years reflecting the government's policy priorities. Sustainable development, energy conservation and climate change began to be incorporated into China's national strategic planning in the mid-2000s in a number of ways (the following is based on Zou Ji, Fu Sha et al., 2016):

- The 2006 Eleventh Five Year Plan (FYP) set mandatory energy saving and emissions-reduction targets for the first time
- The 2007 Report to the 17th National Congress of the Communist Party of China (CPC) first clearly linked environmental conservation and energy and resource efficiency to economic development
- The 2010 Twelfth FYP first incorporated an active response to climate change, including the promotion of green development and low-carbon development
- The 2011 Report of the 18th National Congress of the CPC advocated integrating climate change and sustainability into all aspects of economic, political, cultural and social planning

- The 2015 Opinions on Accelerating the Building of Ecological Civilisation, published by the Politburo of the CPC Central Committee, established that energy savings and environmental conservation and regeneration as part of China's core development policies. The Opinion also promoted the advancement of an ‘ecological civilization’ with ecological progress and innovation as pillars of development

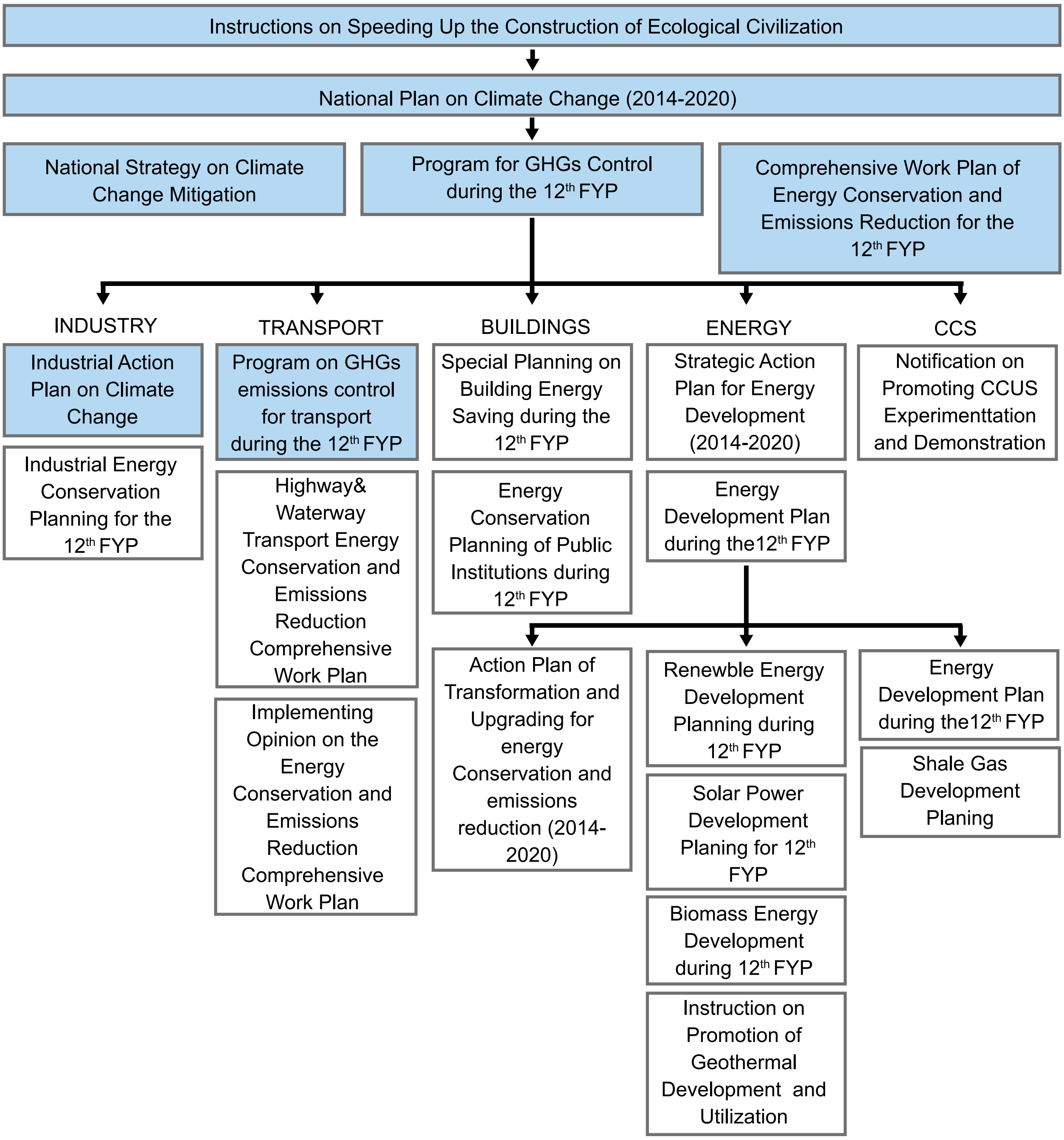
- China’s Intended Nationally Determined Contribution, submitted to the UNFCCC Secretariat in June 2015, sets an efficiency target for newly constructed coal power stations at an average coal consumption of around 300 grams per kilowatt hour; improving energy efficiency is also indicated as one of the major initiatives in developing low-carbon industrial sectors (Category 4) and in promoting energy saving buildings, transportation systems, urban infrastructure, etc. (Category 5).

China has already established a detailed policy framework to improving energy efficiency up to 2030. The Eleventh Five Year Plan (2006-2010) set an energy intensity reduction target of 20% below the 2005 level by 2010. The Twelfth FYP (2011-2015) imposed mandatory targets for the energy and carbon intensity of economic activity (16% and 17% reduction below 2010 levels respectively). The latest Thirteenth FYP further set up an energy intensity reduction target of 15% below 2015 levels and a carbon intensity reduction target of 18% below 2015 levels by 2020. The plan also states an absolute cap on energy use at 5 billion tons of standard coal equivalent.

These objectives have been further developed by the 2014 National Plan on Climate Change (2014–2020) and the Energy Development Strategy Action Plan (2014–2020) which includes targets to cap annual primary energy consumption and annual growth rates of primary energy consumption, and also highlights efficiency in all end-use sectors as a central feature of policy.

China has also incorporated climate change and energy conservation into sectoral planning frameworks to ensure appropriate action across the economy. In the context of the 2014 National Plan on Climate Change, China is developing a Work Plan for Greenhouse Gas Emission Control during the Twelfth FYP Period. This was then incorporated into sectoral development plans, climate change plans and/or energy conservation and efficiency plans in the industry, transport, construction and energy sectors, and into a plan for promoting CCS experimentation and demonstration, as shown in Figure 8. These plans include sector-specific measures, such as subsidies and mandatory indexes to implement national-level targets from the National Plan. The Workplan for Greenhouse Gas Emission Control during the Thirteenth FYP Period and sectoral Thirteenth FYPs are now under development but have yet to be published.

Figure 10: The planning system on GHG emissions control and energy conservation in China



Source: author compilation (Zou Ji, Fu Sha et al. 2016)
Note: Blue boxes indicate special planning to address climate change.

A range of legislative, executive, economic and market-based tools have been put in place. Some of the most important of these include (the following is summarized from Zou Ji, Fu Sha et al. 2016):

- Legislation and regulations. More than 30 national laws and 90 administrative regulations relating to low-carbon development have been passed, including energy conservation and renewable energy laws. Various local governments have also introduced sub-national climate change regulations in line with national legislation.

- Executive orders. This is the most common climate change and energy conservation policy tool in China. One of the key focal areas of executive orders has been to bring about mandatory energy savings and emissions reductions across government, enterprises and society. These orders include compulsory standards and/or required actions relating to industrial processes, transport, buildings and government procurement.

- Economic incentives. These include pricing systems and fiscal support. Pricing systems include differentiated power pricing in high-energy-consuming industries and punitive pricing on products exceeding energy-consumption standards. Fiscal support includes investment subsidies, preferential loans and funding for areas such as renewable energy development.

- Market mechanisms. Emission-trading schemes currently operate in seven pilot regions, including Beijing and Shanghai. They were launched in 2013 and 2014, with total trading volumes of 40 million tonnes of CO_2 by the end of August of 2015. The government is also formulating an overall plan to implement a carbon-trading system which is expected to launch in 2018.

- Low-carbon development pilot programmes. These have been deployed in six provinces and 36 cities, covering 57% of national GDP and 42% of the national population (in 2010), and covering a range of geographies, levels of economic development, and industrialization. The pilots include area-specific development plans for establishing low-carbon industrial, construction and transportation systems, as well as the establishment of systems for GHG emission controls.

3. Sectoral Interventions

This section discusses specific energy efficiency policies and actions in China, especially those put in place since 2011. Table 2 lists active energy conservation policies and programmes in the Twelfth FYP period, organized by sector. For the Thirteenth FYP, it is anticipated that all the policies and programmes listed in Table 2 will be updated and continue to be implemented. Sectoral plans have yet to be published. However, the overall goals as outlined in the Thirteenth FYP for energy and environment include:

- Deepen the energy revolution by establishing a modern energy system that is clean, low-carbon and efficient

- Build a coordinated and integrated energy network

- Keep annual energy consumption within five billion tonnes of standard coal

- Control carbon emissions, honor climate commitments and deeply participate in global climate governance.

In addition, China will begin to rely more on economic or market based instruments, such as the national carbon market (emissions trading scheme) that will be launched in 2017.

Table 2: Key energy conservation policies in the Twelfth FYP period

Sector	Policy	Policy instrument
Framework policy	Twelfth FYP Energy Conservation Target Responsibility System	Regulation
Industry	Ten Thousand Enterprise Energy Conservation Programme	Regulation
	Obsolete Capacity Retirement Programme	Regulation
	Energy Conservation Technology Fund	Incentive
	Differential Electricity Pricing	Economic instrument
	Small Business Closure Programme	Regulation
Building	Building Energy Efficiency Standards	Regulation
	Retrofitting Existing Residential Buildings	Investment
	Retrofitting Public Buildings	Investment
	Integrated Renewable Energy	Incentive
	Promotion of Green Buildings	Incentive
	Energy-Efficient Product Discount Scheme	Incentive
	Incandescent Lighting Phasing Out Programme	Regulation
	Differential Electricity Pricing	Economic instrument
	Ten Thousand Enterprise Energy Conservation Programme	Regulation
	Development of the Energy Services Industry	Incentive
	National Energy Conservation Campaign	Education
Transport	Commercial Vehicle Fuel Standards	Regulation
	Road Passenger Transport Capacity Control	Regulation
	Thousand Enterprise Low-Carbon Programme (transport)	Voluntary agreement
	Transport Energy Conservation Fund	Incentive
	Transport Energy Conservation Demonstration Projects	Investment
	Low-Carbon Transport System Development Programme (pilot)	Incentive
	Ten Thousand Enterprise Energy Conservation Programme	Regulation
	Energy-Efficient Product Discount Scheme	Incentive
Public	Public Sector Key Energy Conservation Projects	Investment
	City Green Lighting Project	Investment
	Compulsory Government Procurement of Energy-Saving Products	Procurement
	National Energy Conservation Campaign	Education

Source: Based on Lo & Wang 2013, revised and updated by author

3.1 Framework policy

(1) Target Responsibility System

The Energy Conservation Target Responsibility System, created in 2007, allocates mandatory energy intensity reduction targets to provinces and large enterprises. Provincial energy use per GDP is published annually, and electricity consumption per unit of GDP and the energy consumption per unit of industrial added value are published biannually. Energy conservation targets are part of the central government's evaluation criteria for local governments and large and medium sized state-owned enterprises (Lo & Wang, 2013).

Provincial energy intensity targets were lowered from the Eleventh FYP period to the Twelfth (see Table 3) and are expected to be lowered again in the Thirteenth FYP period. Provinces were also assigned variable targets (in the Eleventh FYP period, most provinces had a target of 20% reductions) with poorer provinces given lower targets. Assessments also became more frequent, and sectoral targets were also developed (see Table 4).

Table 3: Twelfth FYP provincial energy conservation targets

Target (%)	Provinces
18	Guangdong, Jiangsu, Shanghai, Tianjin, Zhejiang
17	Beijing, Hebei, Liaoning, Shandong
16	Anhui, Chongqing, Fujian, Heilongjiang, Henan, Hubei, Hunan, Jiangxi, Jilin, Shanxi, Shaanxi, Sichuan
15	Gansu, Guangxi, Guizhou, Inner Mongolia, Ningxia, Yunnan
10	Hainan, Tibet, Xinjiang

Source: Lo & Wang (2013), State Council (2011).

Table 4 12th FYP sectoral energy conservation targets[6]

Sector	Responsible agency	Key targets
Industry	Ministry of Industry and Information Technology (MIIT)	Reduce industrial energy intensity by 21%, conserve 670 Mtce of energy
Building	Ministry of Housing and Urban–Rural Development (MOHURD)	Conserve 116 Mtce of energy
Construction	Ministry of Housing and Urban–Rural Development (MOHURD)	Reduce energy intensity of the construction process by 10%
Transport	Ministry of Transport (MOT)	Using a 2005 baseline, reduce energy intensity of commercial vehicles by 10%, reduce energy intensity of commercial boats by 15%, reduce energy intensity of harbors by 8%
Public	Government Offices Administration (GOA)	Reduce per capita energy consumption by 15% and building energy use per unit area by 12%

Note: Energy intensity of transport is defined as energy consumption relative to the amount of freight or passengers carried and the distance traveled.
Source: Lo & Wang (2013)

[6]Thirteenth FYP sectoral targets are not available yet; however, they are expected to continue the priorities of the Twelfth FYP.

(2) Energy Efficiency Standards and Labeling

The One Hundred Energy Efficiency Standard Promotion Programme is being implemented by NDRC, the Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) and the Standardization Administration. AQSIQ is responsible for enforcement inspections for energy-efficiency labeling of products in the project.

As of September 2015, 105 compulsory energy consumption standards and 70 mandatory energy efficiency standards have been published (Ying, 2015). The standards include limiting unit product energy consumption for high consumption industries, and energy capacity and efficiency of end products, fundamental standards for energy saving, etc.

NDRC also promotes the adoption of energy-saving, low-carbon technologies through information sharing via the Catalogue on the Promotion of National Key Energy Saving Technologies (NDRC, 2015), currently in its eighth edition. The project has supported the consumption of 130 million sets of efficient, energy-saving household appliances, 2.65 million sets of energy-saving automobiles, 25 GW of efficient motors and 100 million energy saving bulbs (Ying, 2015).

As well, various Ministries issue standards for industries that fall into their area of responsibility. For example, the Ministry of Housing and Urban Rural Development has approved and issued the Standards of the Labels on the Energy Capacity and Efficiency of Buildings and Regulation on Energy Saving Technology in Heating Systems in Towns (MOHURD, 2012).

3.2 Power generation

Power generation provides and consumes energy simultaneously. Two major policy documents on power generation are the Clean Coal Action Plan (2015-2020) released by the National Energy Administration in May 2015 (NEA, 2015) and the Action Plan for the Upgrade and Transformation on Energy Conservation and Commission Reduction in Coal Power (2014-2020) released by the State Council in 2014 (CSC, 2014). Both strengthen the energy efficiency and pollutants emission standards applied to coal power plants. Coal consumption of new coal-fired power generation units should be less than 300 grams of standard coal per kilowatt-hour at the national level and reach the same level of pollutant emissions as natural gas power plants. By 2020, the coal consumption of thermal power generation units will be set at less than 310 grams per kilowatt-hour, and the units over 600 000 kilowatt-hour should be no more than 300 grams per kilowatt-hour.

In addition, the power sector reform in China that started in March 2015 created two major opportunities for use of renewable energy resources and the adoption of demand flexibility (i.e. operating optimally/efficiently at a wide range of load demands). First, retail sales were decoupled from traditional transmission and distribution utilities. New retail companies are also now entering the retail market increasing competition(NDRC & NEA, 2015). Second, two inter-provincial and a dozen of intra-provincial power transaction centers have been established in recent months, enabling direct power purchasing between generators and large customers(NDRC & NEA, 2016).

3.3 Industry

(1) Ten Thousand Enterprise Energy Conservation Programme

In April 2006, China's central government launched the Top Thousand Enterprises Energy Efficiency Programme, which targeted China's 1000 highest energy consuming enterprises. These enterprises accounted for approximately 50% of the total industrial sector energy consumption and 30% of total energy consumption in China. The Top Thousand enterprises are from nine sectors: iron and steel, petroleum and petrochemicals, chemicals, electric power, non-ferrous metals, coal mining, construction materials, textiles, and paper. The energy reduction goal for these enterprises was 100 Mtce after 5 years (NDRC, 2006).

The Top Thousand Programme set targets down to the provincial level. For example, NDRC signed an agreement with the Beijing Municipal Government. The Beijing Municipal Government then signed an energy-efficiency target contract with each of the ten enterprises in its jurisdiction (Price, et al.)

Achievement of the energy-saving targets has been added to the provincial government cadre evaluation system wherein the individuals responsible for implementation are evaluated each year on whether or not the targets under their jurisdiction have been achieved (NDRC, 2007). Use of the evaluation system in this manner provides strong incentives to government officials to assist the enterprises in achieving the energy-saving targets. The enterprises are required to report their energy consumption by fuel type quarterly to the National Bureau of Statistics (NBS) (NDRC, 2006).

The Ten Thousand Enterprises Programme which aimed to target the largest industrial consumers of energy during the Twelfth FYP period supersedes the Top Thousand Enterprise Programme from the Eleventh FYP period. It is a top-down programme in which energy-saving targets are allocated by the central government to regulated enterprises and requires that the enterprises meet energy management requirements. These include conducting energy auditing, collecting, analyzing, and reporting energy statistics, hiring energy management professionals, and long-term energy conservation planning (Lo, 2014).

The Ten Thousand Enterprise Programme defines energy-intensive enterprises as those that consume 10,000 tce (tonne of coal equivalent) or more annually (NDRC, 2011). 16,078 enterprises joined the programme, although with mergers and bankruptcies 13,328 participated in the 2014 evaluation. Enterprises can fail their assessment by either achieving less than 60 marks in total or failing to meet their energy saving targets, which is a veto criterion. However, the central government has not made the punishment clear, thereby leaving room for local variations. Nevertheless, 12,380 firms (92.8%) out of the 13,328 firms in the programme at the end of 2014 met their targets.The programme has conserved a total of 309 Mtce by 2014, 121% of the original target (NDRC, 2015b).

In general, these two programmes have been effective in stimulating energy conservation practices and investments among regulated enterprises in China. However, several concerns still exist regarding the effectiveness of the policy. One concern is the lack of penalties. Another concern for this programme is the uniformity in the allocation of energy conservation targets. Because industries and companies have different energy effciency potential, obtaining information regarding firms' energy efficiency potential during the target-setting exercise is a common practice internationally. Because of the large number of enterprises participating in the programme and the urgency of its implementation, NDRC does not seek information about energy efficiency potential. Thirdly, the programmes also suffer from a lack of flexibility, which may result in higher costs for compliance (Lo, 2014).

Table 5 Comparisons of the 'Ten Thousand Enterprise Program' and the 'Thousand Enterprise Program'

	Thousand Enterprise Program (11th FYP)	Ten Thousand Enterprise Program (12th FYP)
Entry criterion	>180,000 tce	>10,000 tce
Number of enterprises	1008	14641
Total energy conservation target	100 Mtce	250 Mtce
Average energy conservation	10,289 tce	17,146 tce
Maximum energy conservation	2,000,000 tce	2,150,000 tce
Minimum energy conservation	2100 tce	50 tce

Source: Lo & Wang 2013

(2) Capacity Retirement Programme

China continues to adjust its industrial structure by, for example, accelerating the phasing out of outdated and small capacity facilities in the power and industrial sectors. The central government first began shutting down small coal-fired power plants in 1999. However, high demand for electricity from 2002 to 2005 slowed this attempt to improve energy efficiency. In 2006, the mandatory retirement of inefficient capacity was expanded to 12 other energy-intensive industries under the auspices of the MIIT and NDRC. Funding was made available to local governments to ease the economic and social impacts of forced closures, although some local governments have protected inefficient industries due to fears of lost revenue and unemployment. 72,000 MW of coal-fired power generators, 122 million tons of iron production capacity, 70 million tons of steel production capacity and 330 million tons of cement production capacity were shuttered during the Eleventh FYP period (Lo, 2014).

In the Twelfth FYP period, the Capacity Retirement Programme was expanded to cover nineteen industries identified in Table 6. From 2011 to 2014, the cumulative elimination of backward steel production capacity totaled 77 Mtons, cement (clinker and grinding capacity) 600 Mtons, flat glass 150 million cases, achieving the target of backward production capacity elimination for the Twelfth FYP period one year early. Tightened requirements for funding were implemented in May 2011 to address extensive fraud in the Eleventh FYP period. Only enterprises that have been in a 'normal' state of production for the past three years qualify and funding is specifically to be used for helping workers transition to new employment, for debt repayment or other expenses directly related to closures (Lo & Wang, 2013).

Table 6 Changes to the Capacity Retirement Program

Industry	11th FYP target (million tons unless specified)	12th FYP target (million tons unless specified)	Change in percentage (%)
Iron	48	100	-47.5
Coke	42	80	-37.5
Citric acid	0.0475	0.08	-40.6
Industrial alcohol	1	1.6	-37.5
Steel	48	55	-12.7
MSG	0.182	0.2	-9
Aluminum	0.9	0.65	38.5
Cement	370	250	48
Ferroalloy	7.4	4	85
Calcium carbide	3.8	2	90
Paper	15	6.5	130
Glass	90 million cases	30 million cases	200
Copper		0.8	n/a
Lead		1.3	n/a
Zinc		0.65	n/a
Leather		11 million sheets	n/a
Printing and dyeing		5.58 billion m2	n/a
Chemical fiber		0.59	n/a
Lead battery		7.46 million kva	n/a

(3) Energy Conservation Funds

In addition to the Top Thousand and Ten Thousand Enterprises Programme, the Energy Conservation Fund (ECF) supports industries in improving their energy efficiency performance. The MOF established the Energy-Saving Technological Improvement Fund in 2006 to support the enterprises in the Top Thousand Programme in becoming more energy efficient. In 2011, it became easier for enterprises to apply for subsidies in three ways. First, the threshold for eligibility was lowered from projects that conserve 10,000 tce to ones that conserved 5,000 tce. Second, enterprises are free to choose appropriate technologies to achieve energy savings. Third, funding has been increased from 200 CNY (approx. USD 30)/tce to 240 CNY (approx. USD 36.1)/tce for eastern provinces and from 250 CNY (approx. USD 37.6)/tce to 300 CNY (approx. USD 45.1)/tce for central and western provinces. It is still difficult, however, for smaller businesses to obtain funding as larger enterprises are able to achieve greater net savings, the basis on which funding is awarded (Lo, 2013b).

(4) Differentiated Electricity Pricing

The Differential Electricity Pricing Policy (DEPP), designed to lower energy consumption in energy-intensive industries, was promulgated in June 2004. It first included six energy-intensive sectors including electrolytic aluminum, ferroalloy, calcium carbide, caustic soda, cement, and steel, with phosphorus and zinc smelting sectors added in 2006. Enterprises in these sectors were evaluated in terms of type of technology used and energy efficiency levels and subsequently grouped into four categories: encouraged, permitted, restricted, and eliminated. Electricity prices for enterprises in the “encouraged” and “permitted” categories were standard. Enterprises in the“restricted” and “eliminated” categories had to pay surcharges of 0.02 CNY and 0.05 CNY per kWh, respectively which were increased in September 2006.

(5) Energy Performance Contracting (EPC)

The State Council identified energy performance contracting (EPC) as one of the core mechanisms in resource conservation early on (State Council, 2004). Energy services companies (ESCOs) can provide integrated technical and financing solutions for clients to realise energy savings. However, there are major barriers to the effective deployment of ESCOs in China. The current barriers to EPCs in China are: 1) Lack of comprehensive monitoring and verification (M&V) protocols and technical and institutional capacity in M&V; 2) Lack of access to external financing and shortage of diversified sources of financing; and (3) Lack of clients' creditworthiness (PNNL et al., 2015). To support the energy services industry, in 2010, the central government allocated CNY 2 billion (USD 300 million) to support the application of EPC in energy end-use sectors and awarded qualified energy service companies (ESCOs) at a rate of CNY 240 (USD 36) for every tce saved per EPC project (MOF & NDRC, 2010). Provincial governments were required to supplement the central government's funding by providing at least CNY 60 (USD 9) per tce saved. As well, in 2011, the Ministry of Finance introduced a subsidy of CNY 300 (USD 45)/tce of energy saved for energy conservation projects run by ESCOs. If combined with the Energy Saving Fund an enterprise could claim up to CNY 600 (USD 90)/tce of subsidies if it satisfies the requirements for both programmes (Lo & Wang, 2013). Concessions on business tax, value-added tax and income tax are also granted to ESCOs. Currently, China has over 2,400 centrally registered ESCO companies worth CNY 125 billion (USD 18.8 billion). However, the industry is still in the early stage of development. The scale of individual companies is still small. Chinese ESCOs cover three areas: industry (82%); buildings (15%); and transportation (3%). China's public buildings represent less than 1% of the country's current EPCs (IFC, n.d.).

3.4 Buildings

The buildings sector accounts for approximately 25% of the total energy consumption in China and it is estimated that that will increase to 35% by 2020 because of rapid urbanization and increases in income (TU, 2014). The General Office of the State Council issued the Action Plan for Green Buildings in January 2013, which was jointly drafted by NDRC and the Ministry of Housing and Urban-Rural Development. The Ministry also issued the Special Blueprint of Conserving Energy in the Building Sector during the Twelfth FYP Period, which covers all public buildings operated by all levels of government. Specifically, China has implemented the following key measures to control energy consumption in buildings: energy codes for buildings, retrofitting existing buildings, appliance energy standards and labeling, and subsidies for energy-efficient and renewable energy appliances (Lo, 2013).

(1) Energy Building Codes

Energy-building codes (EBC) were issued by the Ministry of Construction (now the Ministry of Housing and Urban–Rural Development, MOHURD) in 1986 for residential buildings in China's cold northern regions. In 2000, EBC were extended to other regions where energy is more likely to be used for cooling in summer. These set national standards for design and building envelope materials as well as the heating and air- conditioning systems (HVAC). Local governments can also set more specific local standards (Lo, 2013).

The design standards setting out energy saving targets of 50% and 65% are based on the energy use of a typical building envelope and equipment the 1980s (MOHURD, 1993; Yang et al., 2011), as outlined in Table 7. The enforcement of EBCs has greatly improved since 2006. The compliance rate with building energy codes have improved from 53% (design stage) and 21% (construction stage) in 2005 to 99.5% and 95.4%, respectively, in 2010 according to MOHURD (Bin & Jun, 2012). The most recent inspection results reveal that the compliance rate in urban new buildings is close to 100% (MOHURD, 2013). Newly constructed energy-efficient buildings with a total area of 1.22 billion square meters would save 1140 million tce during the period 2005-2010. During the period from 2006 to 2010, the total area of energy-efficient buildings was 4.86 billion square meters, which implies a saving of 46 million tce (MOHURD, 2011).

Table 7 Compulsory energy-saving targets for new buildings with respect to reference buildings design

Building energy codes		Residential building			Public building (2005)
		Heating zone[a] (2010)	HSCW zone (2010)	HSWW zone (2003)	
Targeted subjects		District heating	Heating and air conditioning	Heating and air conditioning	Heating, air conditioning and lighting
Mandatory overall energy consumption threshold		Coal consumption for district heating was regulated in JGJ 26-95, ranging from 70.8 to 240 kWh/m^2 depending on the local climate in winter season	17.8–49 kWh/m^2 for space heating and 19.3–34.2 kWh/m^2 for air conditioning[b]	Non specified. methodology for energy consumption in reference design buildings are provided in detail instead.	Non specified. individual component (*U*-value, lighting efficiency, ventilation, shading humidity etc.) performance is regulated
Climate condition		HDD: 1431-7159	HDD: 1100–2500 CDD: 100–300		All China
Energy-saving targets		65%	50%[c]	50%	50%
Baseline	Data sources	Building energy use data surveyed in 1980 and 1981	Calculated building energy use based on assumptions		
	Building envelope	Typical building envelope in the 1980s			
	Equipment	Typical equipment used in the 1980s			

[a] Includes both severe cold and cold climate zones. This code has replaced the Civil Building Energy Saving Design Standards *JGJ 26-95*.
[b] Threshold of regulatory values for heating and cooling are set simultaneously, varying with HDD and CDD based on local climate (full detail is provided in Table A2).
[c] Yang et al. (2011) pointed out that there was no clear energy saving target in the general principles of the standard, but the quantification of the specific target cited in some texts was still 50% (see for example p. 39 chapter 5 titled "Integrated assessment of thermal performance for building envelope"). In addition, some local authorities put forward more stringent energy savings targets such as Shanghai which started officially the 65% savings targets for new housing construction from 2011 (SBSRI and SBMMMB, 2011). A number of local municipalities and provincial governments have set 65% energy savings target in their 11th FYP document such as Jiangsu and Hubei. And MOHURD has been consulting buildings experts across China to generalize this practice by raising the mandatory target from 50% to 65% energy savings in the next update of HSCW regulation, see MOHURD (2007).
(Source: Adapted from Yang et al. (2011), MOHURD (2010)).

Source: Jun & Bin (2015)

(2) Existing building retrofits

With approximately 76% of buildings in the northern regions consuming 100-200% of the energy of buildings of a similar latitude in developed countries, MOF and MOHURD jointly launched the Existing Building Retrofit and Heat Metering Reform programme in December 2007. The programme aimed to retrofit 150 million square metres of buildings in 15 northern provinces through energy efficient retrofits for building envelopes, such as using polystyrene insulation and double-glazed windows, more efficient heat generators and networks and for heat metering and temperature regulation (MOHURD, 2008). Local governments were offered rewards for implementation and bonuses for speed: CNY 55 (USD 8.3)/m^2 for severe cold regions and CNY 45 (USD 6.8)/m^2 for cold regions. With 182 million square metres retrofitted by the end of 2010, the programme exceeded expectations (Lo, 2013). In addition, by the end of the Twelfth Five Year Plan, each province, autonomous region and municipality, would be required to implement heat metering, consumption-based billing and retrofitting of at least 35% of all old residential buildings with MOHURD and the Ministry of Finance (MOF) the responsible ministries for the programme reporting to the State Council (Bin & Jun, 2012).

Energy demand, and electricity consumption in public buildings in China has been growing steadily (Fridley et al., 2008). As of 2012, total public sector building floor area was about 8.488 billion m^2, and consumed about 157 Mtce, accounting for 5.8% of total public energy consumption and 13.684 billion tonnes of water consumption (GEF, 2015). Electricity use intensity in public buildings is high, with annual electricity consumption per square meter about ten to twenty times higher than that of residential buildings (Bin & Jun 2012).

In 2007, the central government issued the Implementation Guidelines of Improving Building Energy Efficiency in Governmental Office Buildings and Large-Scale Public Buildings (CGPRC, 2007), and provided 24 provinces and cities with a total of CNY 99.05 million (USD 15 million) in financial support to establish building energy efficiency inspection platforms, including energy data collection, energy audits, public disclosure of building energy consumption information (Bin & Jun, 2012).

Several central level policies have been issued outlining requirements for energy efficiency in public institutions and buildings. The State Council issued the Regulations on Energy-Efficiency for Public Institutions (2008) which requires public institutions to improve their energy efficiency through supervision, management, planning and promotion of relevant measures related to energy efficiency. In the publication Guidance for Further Promoting Building Energy Efficiency in Public Buildings, it is stated that during the period of the Twelfth FYP (2011-2015) energy consumption per square meter in public buildings should be reduced by 10%, and by 20% in the case of such buildings in selected cities, and by 30% for large-scale public buildings in these cities. In the case of key cities implementing retrofits, the central government is to provide financial support which is calculated at roughly CNY 20 (USD 3) per square meter (MOF & MOHURD, 2011).

3.5 Appliance energy standards and labeling

Electric appliances consume large amounts of energy. China's voluntary energy labeling system covering 40 products was launched in 1998 and became mandatory in 2005. The 5-tier labeling programme which ranks appliances from 1 (internationally leading in efficiency) to 5 (barely meeting the energy standards) is called the China Energy Label. It was launched in 2004 and is now managed by the China Energy Label Centre under the China National Institute of Standardization.[7]

China has also set up specific programmes to phase out outdated, inefficient applicants. For example, China launched the Incandescent Lighting Phasing-out Programme in October 2012 with bans on importing and selling traditional light bulbs over 100W. China also has multiple subsidy programmes for a variety of energy efficient appliances (see Table 8)

Table 8 Energy-Efficient Product Discount Scheme

Item	Year	Subsidy (RMB/unit)
Light bulbs	2008	30%–50%
Air-conditioners	2009	300–650(USD 45-98)
Flat-panel TVs	2012	100–400(USD 15-60)
Washing machines	2012	70–260(USD 10.5-39)
Water heaters	2012	100–550(USD 15-83)
Refrigerators	2012	70–400(USD 10.5-60)
Desktop PCs	2012	260(USD 39)

Source: author compilation

[7]For more information, see www.energy.gov.cn

Subsidies for solar hot water have helped China grow into the world's largest market. The annual growth rate for the adoption of solar water heaters from 2000 to 2009 was already 21% without government subsidies. A rural subsidy programme was launched by MOF in April 2009 followed by an urban scheme in 2012. The rural programme provided up to 13% of the product price capped at 5000 CNY (USD 752) per unit for solar water heaters while the urban one offered up to 550 CNY (USD 82) per installation (Lo, 2013). China accounted for 70% of the world's installed capacity of 374.7GWth in 2013 (Mauthner et al. 2015)

3.6 Transportation

While the transport sector accounted for only 8% of China's total energy consumption in 2010, the sector used 46.5% of all of the gasoline consumed in China, 91.8% of the kerosene, 58% of the diesel fuel and 35.3% of the fuel oil (Lo & Wang, 2013). However, as private car use expands rapidly, energy use in this sector is projected to grow. As already the largest car market in the world, vehicle sales in China stood at 23 million in 2014 and are projected to rise to 50 million per year in 2020 (UNEP, n.d.). Policies to improve energy efficiency in this area include: fuel economy standards and labeling, vehicle taxation, subsidies for energy-efficient vehicles and electric vehicles, and expansion of public transportation.

(1) Fuel economy standards and labeling

In 2004, China issued its first vehicle fuel economy standards for light-duty passenger vehicles with a target of 6.9L/100km by 2015 (Lo, 2013). In fact, 6.7L/100km was achieved by 2015 and new targets have been set for 5L/100km and CO_2 emissions of 120g/km by 2020 (MIIT 2014). Standards are now in their fourth phase (2016-2020) (UNEP, n.d.). China also issued a fuel economy standard for light-duty trucks under 3500 kg in gross vehicle weight) in 2007 (Lo, 2013). Chinese fuel economy standards are now the world's 3rd most stringent after the EU and Japan (UNEP, n.d.). If China is able to achieve its new FES standards of 5L/100 km for passenger cars by 2020 and 3.5–4L/100 km by 2030, it could close the gap with the EU and Japan in as little as ten years (Wu & Hong, 2014).

China began issuing communications on standards for heavy-duty commercial vehicles in 2011 with Phase II standards issued in 2014. Standards for heavy-duty vehicles are generally considered more stringent than for passenger vehicles which have suffered from fragmentation and confusion in evaluation and counterproductive weight exceptions for electric and other low fuel consuming vehicles (UNEP, n.d.).

The Ministry of Industry and Information Technology (MIIT) also introduced fuel economy labeling (FEL) in 2010 for vehicles under 3500 kg. The newest standards were published in 2014 and took effect in 2016 (MIIT, 2014). However, initial reports suggest that there were significant gaps between laboratory testing of fuel consumption, which is used for the labels, and real world fuel consumption. As well, many manufacturers were not using the label (UNEP, n.d.).

(2) Vehicle Taxation

Vehicle taxation was first revised to incentivise energy efficiency 2006. An excise tax on automakers and a sales tax on consumers encouraged both the production and purchasing of vehicles with smaller engines (UNEP, n.d.). Taxes are based on size of engine. The rates have been revised multiple times over the years, most recently in October 2015, when the sales tax on vehicles with engines of less than 1.6L was cut to 5% until December 2016 as part of the government's attempt to stimulate slumping car sales (MoF, 2015). In addition, China has relatively high rates of taxation on gasoline, which stood at CNY 1.52 per liter as of January 2015 (MoF, 2015b).

(3) Subsidies to New Energy Vehicles

The government has been promoting energy-efficient and alternate fuel vehicles since June 2010, when purchases of energy-efficient automobiles (fuel consumption from 4.8L/100 km to 6.9L/100 km) were given a subsidy of CNY 3000 (USD 451) (Lo, 2013). The State Council has cancelled sales tax on NEVs from 2014-2017. Subsidies are also offered (see Table 9). Many large cities in China have limits to the number of license plates issued in one year, which are then awarded by lottery. Beijing instituted an exemption from the lottery for electric cars in 2014 to further encourage uptake (Beijing Passenger Vehicle Quota Information and Management System, 2016).

Table 9: NEV subsidies in 2016

Item	Subsidy (CNY/unit)
non-plug-in hybrid electric vehicles	3,000 (USD 451)
plug-in hybrid Electric vehicle with R(ALL-ELECTRIC RANGE)>50km,	35,000 (USD 5265)
pure electric vehicle 150<R<250	50,000 (USD 7400)
pure electric vehicle R>250	60,000 (USD 9027)

Source: State Council (2014b)

With 379,000 electric vehicles produced and 200,000 purchased domestically in 2015, China is already the largest market for new energy vehicles in the world and has set a target of 5 million electric vehicles on the roads by 2020 (MIIT, 2016). This growth has been supported by subsidies, preferential vehicle licensing, electrification of public fleet and incentives for industry (GIZ, n.d.) The Ministry of Finance is expecting to phase out subsidies for NEVs by 2021 and in fact has decreased subsidies by approximately 10% from 2013 to 2015 (MoF, 2015a,). Other steps that are being taken to improve the market conditions for NEVs include standardization of charging infrastructure, and ending local (municipal) protectionism for manufacturers to improve competition (GIZ, n.d.)

(4) Public Transportation

China has identified public transportation within and between cities as a priority in the New-type Urbanisation Plan released by the State Council in 2014. Chapter 16 states that public transport should be the main form of motorised transport, with full coverage in cities of over a million including public transport stops available every 500 metres (State Council, 2014a).

22 cities in China already have subway systems and those in Shanghai and Beijing and the busiest in the world. NDRC has approved 74 urban rail plans to be implemented between 2015-2020, and it is expected that 50 major cities in China will be covered by 6-7000 km of urban rail by 2020 (Author compilation from NDRC data, 2015).

4. Lessons learned, challenges and further recommendation

China began ramping up energy efficiency policies and programmes in the Eleventh Year Plan when it first set hard targets for energy and environmental indicators. The Twelfth FYP period has seen a continuation of those policies which are expected to expand and deepen in the Thirteenth FYP period. The main focus for these policies will continue to be on improving energy efficiency in the industrial sector. However, even though domestic energy consumption is a fraction of industrial, it is beginning to grow as standards of living rise. Targets for more energy efficient residential buildings and passenger vehicles reflect this reality.

China has made remarkable achievements in energy efficiency; however, in order to achieve the new energy conservation goals in the Thirteenth FYP and beyond, significant improvement is still needed.

The overreliance on regulation is an issue. When fewer enterprises are being regulated, top down schemes are more implementable as they can be easily monitored. These programmes and pilots continue to be fine-tuned, as assessment grows more rigorous and targets, subsidies and incentives all become more appropriate and precise. However, as the number of actors increases substantially in the Thirteenth FYP and beyond (especially with more policies needed in the sectors of building and transport), it is unclear whether this administrative approach will remain effective. At the same time, coordination between contradictory regulations and ensuring that there is consistent implementation, monitoring and evaluation can still benefit from government leadership.

There is interest in expanding market-based initiatives such as emissions trading schemes and ESCOs. For example, China has been piloting regional carbon trading markets in two provinces and five cities since 2013 and is planning on implementing a nationwide emissions trading scheme (ETS) during the Thirteenth FYP (NDRC, 2012). Effectively making use of this market based instrument to enhance energy efficiency will be a major step forward for China.

Another problem is the effect of the structural reforms begun in the Twelfth FYP period. Along with technological development, structural change will play a more and more important role in reducing energy intensity. Controlling unnecessary and unproductive production and shifting employment to light and higher added value industry as well as services are priorities for the Thirteenth FYP period. In addition, policies beyond the industrial sector will become more and more important.

Further improvements in the industrial structure and the Ten Thousand Enterprises Programme are essential as it is a central part of China's energy efficiency policy. Excess capacity is already beginning to be shut down and this will need to be supported. Meanwhile, for firms that are part of schemes such as the Ten Thousand Enterprises Programme, energy efficiency potential at the industry or firm level needs to be considered during the target allocation process. The government will need to incorporate information collection and/or negotiation for the next phase of implementation (2016–2020). Another option is to introduce flexible mechanisms, such as tradable white certificates.

Sufficient incentives to local government to bring about behaviour change will be needed. Local governments in the past were evaluated by the central government mainly on the basis of GDP growth. However, more recently local government performance is being tied to environmental targets as well (e.g. under the 2015 Environmental Protection Law or in the national and city cluster air pollution plans). Capacity building, energy consumption targets and renewable energy targets can help make the links between energy efficiency and its multiple co-benefits including poverty reduction and environmental protection.

Finally, there is a need for capacity building and communication beyond government. Wider implementation of energy efficiency requires capacity building among a broad range of actors, both within the policy domain and in the technical and service provider spheres. To maximize the prioritized benefits of a particular energy efficiency policy or programme, greater effort is needed to effectively communicate to diverse actors and audiences, including the general public.

Energy efficiency policies in India: experiences and recommendations

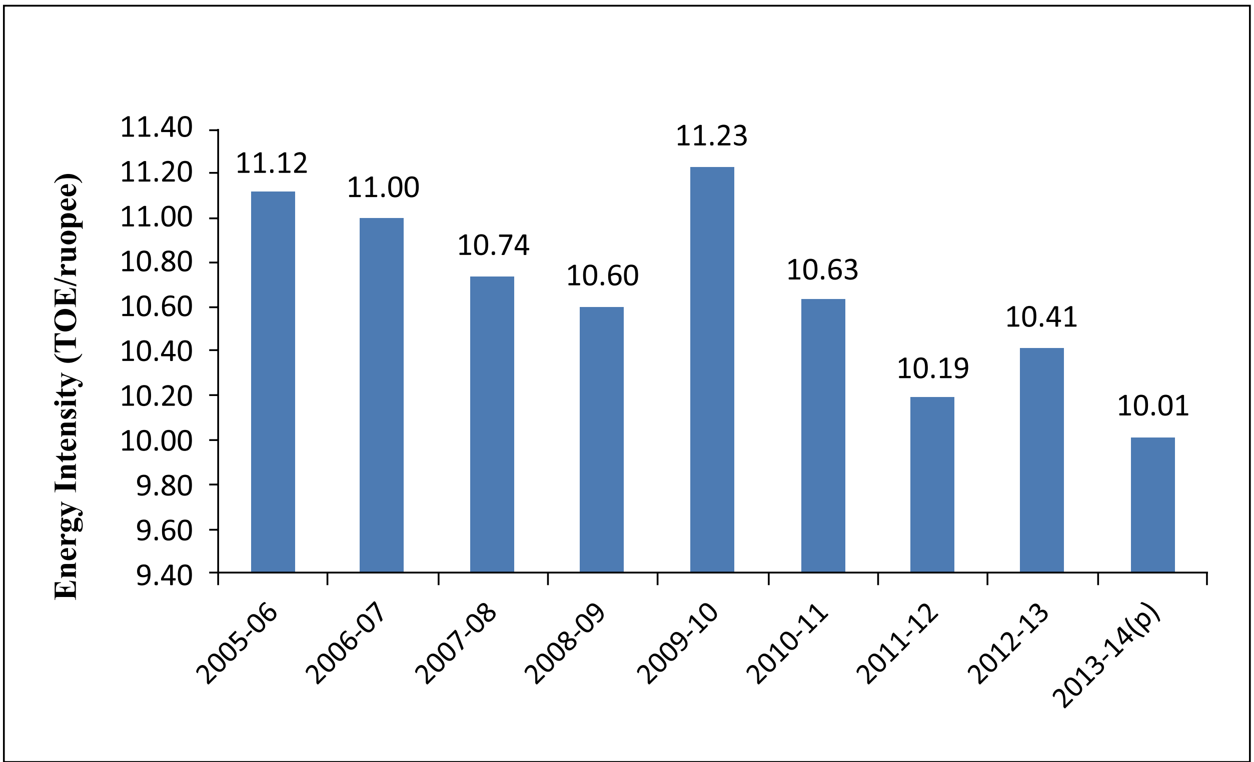
5. Current status of energy efficiency in India

Keeping pace with a rising economy, India's energy demands have been soaring. Estimates by The Energy and Resources Institute suggest that India's energy consumption, which was nearly 870 Mtoe (million tonnes of oil equivalent) in 2015, is expected to cross 2000 Mtoe by 2031. Given the limited availability of fossil fuels domestically, India will need to rely more on renewable energy and energy efficiency to achieve energy security. A study by the Ministry of Power (MoP) and TERI (2015) indicate that the Indian economy has the potential to conserve 23% of its energy consumption by 2031.

5.1 Overall trends

As shown in Figure 10, energy intensity for India has been declining consistently from 2005-06 onwards with a slight increase in 2009-10 and falling thereafter. The increase in energy intensity in 2009-10 can be attributed to lower economic growth but with similar energy consumption in the economy when compared to previous years.

Figure 11: Energy intensity in India (2006-2014)



Source: MoSPI (2015)

Understanding trends in different energy consuming sectors helps to clarify overall energy consumption. Table 10 gives data for energy consumption in India broken down by sector.

Table 10: Sectoral energy consumption in India from 2004 to 2012

Year	Agriculture (Mtoe)	Industry (Mtoe)	Transport (Mtoe)	Residential (Mtoe)	Commercial (Mtoe)	Other (Mtoe)	Non-energy uses (Mtoe)	Total (Mtoe)
2004	15.78	91.54	36.48	151.75	12.05	9.55	29	346.15
2005	15.41	101.12	38.71	154.26	12.76	9.8	29.08	361.14
2006	17.09	110.07	40.48	157.43	13.49	8.93	32.38	379.87
2007	16.89	119.03	47.74	159.8	14.1	8.74	33.9	400.2
2008	16.56	124.41	54.42	162.48	14.74	12.15	32.95	417.71
2009	18.24	139.93	59.55	166.62	16.59	17.92	33.24	452.09
2010	19.39	151.93	64.26	172.21	17.94	14.71	34.24	474.68
2011	21.33	162.48	69.55	175.9	19.04	9.29	35.61	493.2
2012	22.49	164.6	73.41	178.31	19.77	11.98	37.46	508.02

Source: IEA (2015c)

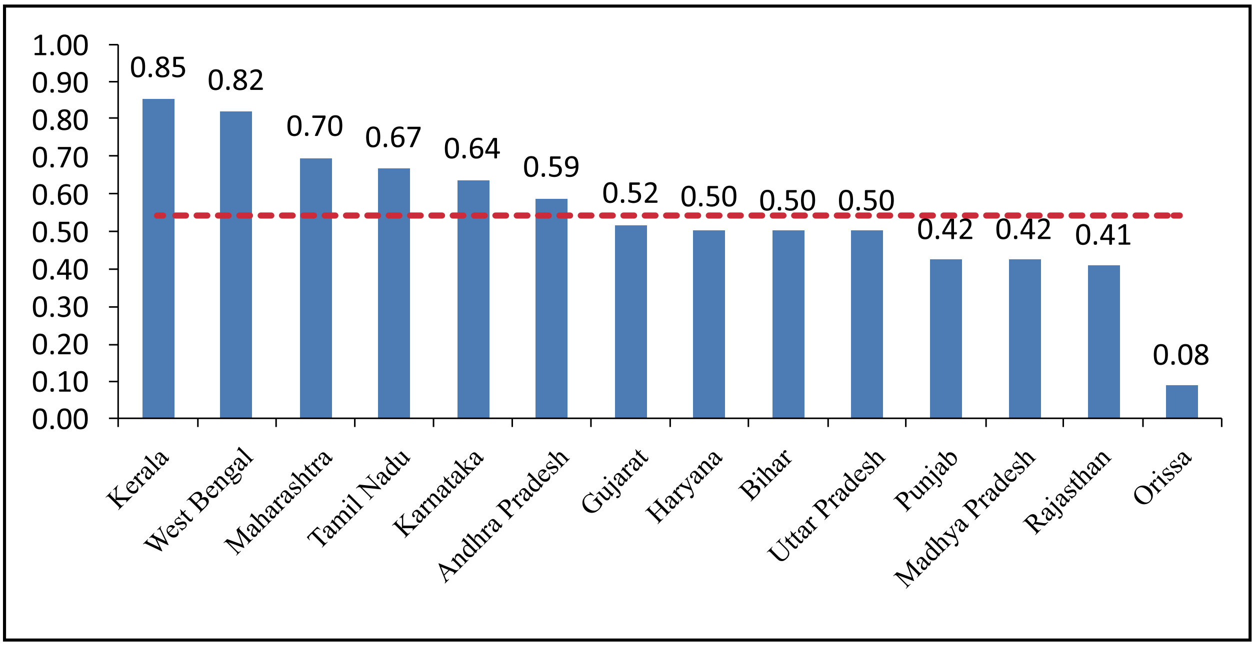
Total energy consumption in the last eight years has increased by 46% with a two-fold increase in energy consumption in the transport sector. Industry and commercial energy consumption also increased by more than 50%.

5.2 Indicators for Indian states

Annex 1 gives the data for electrical energy intensity in terms of electric power consumption per unit of state GDP and transmission and distribution losses for the states in India. Calculating the energy intensity for states of India is challenging given the difficulty in delineating boundaries, which render estimates of primary energy consumption unreliable. Data on electricity is a more reliable parameter to understand the breakdown of performance by state on energy efficiency and is used here. An electricity efficiency index shows the performance of the fourteen major states of India. For constructing the energy efficiency index, depending on data availability, two indicators are used– electrical energy intensity and transmission and distribution (T&D) losses. See Annex 1 for an explanation of the index methodology.

Figure 11 shows that within the fourteen major states, Kerala, West Bengal and Maharashtra perform best while Odisha (Orissa), Rajasthan and Madhya Pradesh are the bottom three states in terms of energy efficiency performance.

Figure 12: Energy efficiency index for fourteen major states of India

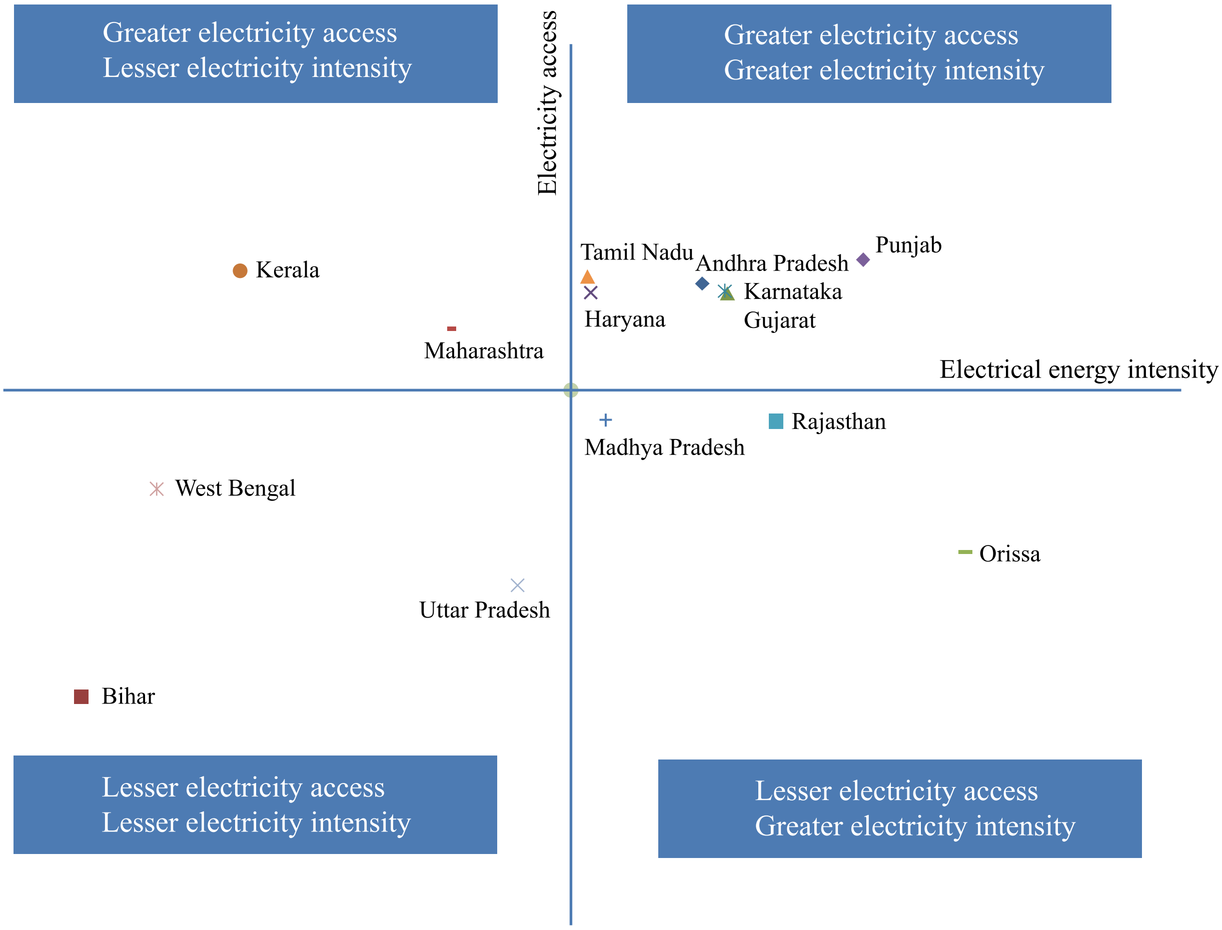


Source: Calculated based on data shown in Annex 1

Electricity intensity numbers alone do not reflect the economic context of individual states/ sub-national units that may vary in terms of economic activities as well as energy access. In the context of low carbon development, it is also important to look at the energy access situation in India along with indicators of clean energy. According to the World Energy Outlook, in 2013, 237 million people in India did not have access to electricity (IEA, 2013b). In order to understand the situation and facilitate a discussion at a more disaggregated level, indices[8] for electricity access and electricity intensity are plotted in an XY-scatter chart for fourteen major states in India (Figure 12). The mid-point for the four quadrants is plotted based on the average XY values for the two indices. It can be seen in the chart that relatively industrialized states[9] in India have high electricity intensity along with electricity access. According to the data, only Kerala and Maharashtra have higher rates of electricity access along with relatively lower electricity intensity. Their proactive measures towards achieving energy efficiency have been a result of better responses to national policies as well as the development and implementation of local programmes such as energy efficiency pump-sets for farmers, development of green cities, increasing the portfolio of clean energy, etc. These are lessons that other states in India should emulate.

[8]The index for electricity access is standardized also to bring the values in the 0-1 range.
[9]The fourteen major states are selected based on the growth of the states of India in terms of their gross state domestic product during the pre (1980–81 to 1990–91) and post-reform period (1991–92 to 1998–99) in India (see Ahluwalia [2000]).

Figure 13: Energy access and electrical energy intensity for fourteen major states



Source: Plotted based on data in Annex 2

6. Institutional framework for energy efficiency in India

According to the IEA (2010), energy efficiency governance is the combination of enabling frameworks, institutional arrangements, and co-ordination mechanisms, which work together to support the implementation of energy efficiency strategies, policies and programmes. Figure 13 shows the framework for energy efficiency governance in India following the framework suggested by the IEA (2010). Energy efficiency and demand side management (DSM) efforts have been initiated gradually at the state and central level through various provisions. Key institutions that drive energy efficiency policies in India are discussed.

Figure 14: Energy efficiency governance in India

Enabling Frameworks

- Energy Conservation Act, 2001
- Electricity Act, 2003
- National Mission on Enhanced Energy Efficiency
- National Electricity Policy, 2005
- National Tariff Policy, 2006
- Budgetary provisions and financing

Institutional Arrangements

- Bureau of Energy Efficiency
- State Designated Agencies
- Energy Efficiency Services Ltd
- Electricity Regulatory Commissions and utilities for demand side management
- National Campaign on Awarenss
- International cooperation

Coordination Mechanisms

- Forum of Regulators
- Energy Conservation Action Plan
- Prime Minister's Council on Climate Change

Source: Author compilation

6.1 Enabling frameworks

(1) Energy Conservation Act, 2001

The Government of India enacted the Energy Conservation Act in 2001 which serves as the key guiding document for energy efficiency in the country. The Energy Conservation Act, 2001 recognized "energy" as any form of energy derived from fossil fuels, nuclear substances or materials, hydro-electricity and includes electrical energy or electricity generated from renewable sources of energy or bio-mass connected to the grid.

The Energy Conservation Act, 2001 is the overarching framework for obtaining the benefits of energy savings and energy efficiency. The Act provides for the legal framework, institutional arrangements and a regulatory mechanisms at the Central and State level to drive energy efficiency in the country. Major provisions of the EC Act relating to Designated Consumers, Standard and Labelling of Appliances, Energy Conservation Building Codes, and the creation of institutional support through the Bureau of Energy Efficiency are discussed in the sections that follow. A snapshot of the Energy Conservation Act is found in Box 1.

(2) Electricity Act, 2003

The Electricity Act, 2003 consolidated the laws relating to generation, transmission, distribution, trading and use of electricity. Section 166 (5)(c) of the Electricity Act provided for the establishment of a committee in each district to promote energy efficiency and conservation.

National Electricity Policy and National Tariff Policy

The central government released the National Electricity Policy (NEP) in 2005 and the National Tariff Policy (NTP) in 2006 which gave specific direction to utilities and regulators in the context of DSM and energy efficiency.

(3) National Mission on Enhanced Energy Efficiency

The National Action Plan on Climate Change (NAPCC) guides India in dealing with the challenge of climate change and achieving economic objectives at the same time. The NAPCC identifies 8 national missions to advance climate and development goals including a National Mission for Enhanced Energy Efficiency (NMEEE). The NMEEE was launched with several targets from 2011 to 2015 for an annual fuel savings of at least 23 Mtoe which is a cumulative avoided electricity capacity addition of 19 GW, and a CO_2 emission mitigation of 98 Mt. The NMEEE aims at strengthening the market for energy efficiency by creating a conducive regulatory and policy regime and fostering innovative and sustainable business models in the energy efficiency sector.

Box 1: Energy Conservation Act of India

The Act provides for institutionalizing and strengthening delivery mechanisms for energy efficiency services in the country and provides much-needed coordination between various entities. The Act specifies the role of the central government and State Governments. The EC Act encourages the adoption of several measures by the central government for promoting energy efficiency. Section 16 of the Energy Conservation Act advocates the constitution of state energy conservation funds that would enable states to encourage energy efficiency and meet the expenses incurred.

Key powers granted under the Act to the Bureau of Energy Efficiency and the Government of India include: specification of energy consumption standards and energy audits for energy intensive industries; energy conservation building codes for commercial buildings; and accreditation of energy auditors. In addition, the Act also enjoins the Government and the Bureau to enhance awareness through labels for equipment/ appliances; engage in training, education, research and development, testing and certification; promote pilot and demonstration projects, innovative financing, energy audits and international co-operation programmes.

The NMEEE has four sub-missions under it viz. Perform, Achieve and Trade (PAT), Market Transformation for Energy Efficiency (MTEE), Energy Efficiency Financing Platform (EEFP) and Framework for Energy Efficient Economic Development (FEEED). PAT and MTEE are discussed in detail in further sections. EEFP aims at the creation of mechanisms that would help finance energy efficiency projects in all sectors by capturing future energy savings. FEEED aims at developing fiscal instruments to promote energy efficiency (BEE undated).

(4) Budgetary Provisions and Financing for Energy Efficiency

In terms of budgetary allocations, resources are provided every year to BEE for the implementation of its various schemes. The Union Cabinet approved implementation of the NMEEE framework in June 2010 with dedicated funds of INR 235 crore (approx. USD 39.2 million[10]). Table 11 gives the estimated investment for the NMEEE and expected impacts. In the Twelfth Five Year Plan (FYP), it was proposed that BEE take forward all the schemes so as to continue to achieve energy savings due to regulatory, financial and facilitative activities. New schemes are also being proposed to fast-forward the introduction of "super-efficient equipment" through the provision of incentives for every super-efficient equipment that is sold during a specified time-period and to accelerate the deployment of energy-efficient appliances through electricity distribution company-led DSM programmes. BEE also provides a one-time corpus of INR 2 crore (USD 0.4 million) to those states willing to set up a State Energy Conservation Fund (SCEF) managed by a designated agency in the individual states.

Table 11: Overall investment in NMEEE and the expected impact

Initiative	Investment Estimated (INR crores/USD billion) (1 USD = INR 60)	Fuel Saving (Million tons of oil equivalent)	GHG Emissions Saving (million tons)	Avoided Capacity (MW)
PAT	30,603 (USD5.10)	9.78	26.21	5623
DSM (including Agriculture DSM)	44,000 (USD7.33)	13.22	72.75	14335
Total	74,603 (USD12.43)	23	98.96	19,958

Source: Bureau of Energy Efficiency Presentation [11]

The National Bank for Agriculture and Rural Development (NABARD) has also been financing projects aimed at improving energy efficiency. In the state of Karnataka, NABARD designed a project to replace energy inefficient pumps with more efficient ones through a loan assistance programme under its Umbrella Programme on Natural Resource Management. It sanctioned INR 307.97 lakh (approx. USD 0.513 million) of loan and INR 20.39 lakh (approx. USD 33,983) of grant assistance to a private agency for implementing the power project in association with Bangalore Electricity Company. Under the NABARD Infrastructure Development Assistance (NIDA), NABARD is also financing green investments for solar power generation and improvement of electricity distribution networks (MoEF, 2014). The Indian Renewable Energy Development Agency (IREDA) also extends financial support, usually through different loan schemes, to specific projects and schemes for generating electricity and/or energy through new and renewable sources and conserving energy through energy efficiency. Under FEEED, the Government of India also approved INR 210 crore (approx. USD 35 million) under the Venture Capital Fund for Energy Efficiency (VCFEE), which is to provide equity capital

[10] Exchange rate used: I USD = INR 60
[11] Available from http://www.moef.nic.in/downloads/others/Mission-SAPCC-NMEEE.pdf; Accessed on 26 February 2016

for energy efficiency projects. The fund provides last mile equity support to specific energy efficiency projects and is limited to a maximum of 15% of the total equity required through Special Purpose Vehicles (SPVs) or INR 2 crore (approx. USD 0.4 million), whichever is less. In the infrastructure sector, various SPVs are formed such as Infrastructure Development Finance Company (IDFC), Power Finance Corporation (PFC), Indian Rail Finance Corporation (IRFC), which have been identified to raise funds for development of sector projects. INR 210 crore (approx. USD 35 million) had been set aside under the Twelfth FYP for the implementation of VCFEE The fund is registered with SEBI under its Alternative Investment Funds Regulation.

The Partial Risk Guarantee Fund (PRGF), under FEED aims to cover specified technology and the associated commercial risks for new technologies in energy efficiency and renewable energy that are not usually covered by commercial banks. PRGF has been established to provide commercial banks with partial coverage of risk exposure against loans made for energy efficiency projects to mitigate the risk perception associated with the lending for new technologies and new business models associated with energy efficiency projects. Guarantees provided are a maximum of 50% of the loan amount or INR 300 lakhs (approx. USD 0.5 million), whoever is less , In the case there is a default, PGRF will

- Cover the first loss up to 10% of the total guaranteed amount
- Cover the remaining default amount on a pari-passu basis up to the maximum guaranteed amount
- PFI shall be provided with a guarantee from the PRGFEE before the disbursement of a loan to the borrower.

Projects that are eligible include those that will achieve a demonstrable energy savings and mitigation in emissions of greenhouse gases; have a method for monitoring and verification of emissions and savings; be a new project; uses viable technology developed with competent energy audit/feasibility studies; is implemented by a BEE empanelled ESCO under a performance contracting mode and; complies with environmental, health and safety standards.[12]

The Government of India (GoI) has set up the Technology Innovation Fund that provides an example of commercial EE lending supported by the government. The Technology Information Forecasting and Assessment Council (TIFAC) under the Ministry of Science and Technology has created a revolving fund of INR 300 million (USD 5 million) for technology innovation and has placed it within SIDBI to provide assistance in the form of soft loans to MSMEs. The financial assistance is meant for development, up-scaling, demonstration and commercialization of innovative technology-based projects, including EE. This collaborative programme of TIFAC and SIDBI seeks to develop MSMEs' capabilities to innovate and bring high-risk innovations to the market. This fund was started in 2011. Under this collaborative programme, assistance up to 80% of a project's total cost, which would normally not be more than INR 10 million (USD 0.16 million), is provided. Higher assistance is considered selectively based on innovation content in the projects, and if the interest rate does not exceed 5% per year. The promoters' contribution is required to be a minimum of 20% of the total project cost (USAID, 2013).

[12]More information available at: http://iepd.iipnetwork.org/policy/partial-risk-guarantee-fund-energy-efficiency

BEE signed an agreement in July 2015 with the Rural Electrification Corporation on behalf of the consortium with EESL being tasked to operationalize PRGF for Energy Efficiency.[13]

Traditional finance in India has not managed to come up with a common framework to encourage companies to go green. However, despite the absence of green credit guidelines, some banks have taken initiatives independently. The country's largest bank, the State Bank of India (SBI) introduced a green home loan, with special concessions (reduced margins, softer interest rates, and zero processing fees) for environment-friendly housing projects rated by the Indian Green Building Council (Deka, 2016), which involves criteria for energy efficiency. The other well-known bank which finances green projects is the Small Industries Development Bank of India (SIDBI) which provides micro, small and medium enterprises financial assistance for technology innovative projects, with a preference being given to the green sector. SIDBI offers financial assistance for investments in energy efficiency projects to existing MSMEs under a Line of Credit from KfW Development Bank in the framework of the Indo-German Development Cooperation (SIDBI, 2013). This line of credit has led to the certification of some 22000 dwelling units and financing of 2000 with a soft loan (Bauer, 2014).

Issuance of green bonds is an innovative financing mechanism to raise long-term and low cost debt capital to finance projects involving 'green' aspects such as emission reduction, energy efficiency and/or renewable energy generation. In the past couple of years; IREDA, Yes Bank, Export-Import Bank of India, and IDBI Bank have successfully launched green bonds in India and abroad. These issues received enthusiastic responses from investors and were oversubscribed. The Securities and Exchange Board of India (SEBI) has suggested that for assigning the status of the bonds as green, energy efficiency (efficient and green buildings) may be one of the broad areas where proceeds of bonds could be invested (SEBI, 2015).

There is sufficient evidence to indicate that providing information regarding environmental performance has relevance for companies in enhancing their market value (Ganzi et al., 2004; Kadyan & Aggarwal, 2014 and Murphy, 2002). Listing companies on a stock exchange on the basis of their environmental performance can prod them to improve their environmental sustainability. One of the two sustainability indices under the Bombay Stock Exchange (BSE), Greenex, lists the top 25 stocks with energy efficient practices from the S&P BSE 100. It calculates the energy intensity of a company (total emissions upon total revenue) and publicly disseminates it on a real-time basis. This should help in promoting energy efficient practices and encourage impact investing in economically and environmentally sustainable businesses.

6.2 Institutional arrangements

(1) Bureau of Energy Efficiency

Under the provisions of the EC Act, the Government of India (GoI) established the Bureau of Energy Efficiency (BEE) to promote energy efficiency through various regulatory and promotional instruments and to assist in developing policies and strategies with the primary objective of reducing the energy intensity of the Indian economy. BEE was created by the Energy Conservation Act, 2001, as a statutory body under the Ministry of Power, in 2002 with the primary objective of reducing the energy intensity of the Indian economy. BEE has been a

[13]More information available at: http://www.thehindubusinessline.com/economy/macro-economy/bee-signs-agreement-to-kickstart-partial-risk-guarantee-fund/article7456338.ece

front-runner institution in pioneering several DSM and energy efficiency initiatives in India. BEE is the policy advisor to the central and state governments and assists in developing policies and strategies with an emphasis on self-regulation and market principles.

The major promotional functions of BEE includes :

- Create awareness and disseminate information on energy efficiency and conservation
- Arrange and organize training of personnel and specialists in techniques for the efficient use of energy and its conservation
- Strengthen consultancy services in the field of energy conservation
- Promote research and development
- Develop testing and certification procedures and promote testing facilities
- Formulate and facilitate implementation of pilot projects and demonstration projects
- Promote use of energy efficient processes, equipment, devices and systems
- Take steps to encourage preferential treatment for the use of energy efficient equipment or appliances
- Promote innovative financing of energy efficiency projects
- Give financial assistance to institutions for promoting the efficient use of energy and its conservation
- Prepare educational curricula on the efficient use of energy and its conservation
- Implement international co-operation programmes relating to the efficient use of energy and its conservation

(2) State Designated Agencies

The Electricity Act of 2003 has provisions for the implementation of energy efficiency measures through the institutional mechanism of BEE at the central level and through State Designated Agencies (SDAs) in every state. In this regard, several states have either set up SDAs as separate entities or as a part of a utility. SDAs act as a development agency, as a facilitator, and as a regulator/enforcing body to implement energy conservation measures at the state level.

(3) Energy Efficiency Services Ltd.

Energy Efficiency Services Limited (EESL) is an institution set up by the Ministry of Power, Government of India as a Joint Venture company of four Central Power Sector undertakings. EESL was set up to create and sustain markets for energy efficiency in the country.

(4) Electricity Regulatory Commissions and Utilities

At the state level, distribution utilities and Electricity Regulatory Commissions have the primarily responsibility of implementing DSM measures in their respective states. As required by the DSM regulations in some of the states, DSM cells for conducting various activities associated with DSM have also been constituted.

(5) National Campaign on Awareness

For spreading awareness, the Government launched a National Campaign on Awareness on Energy Conservation for stakeholder engagement and to spread awareness about the need for energy conservation and benefits to the individual, society and nation as a whole. Salient features of the scheme include: 1) spreading simple energy saving methods that can be applied in everyday life, 2) presenting a wider variety of energy conservation methods to improve energy consumption behaviour, including the prevention of energy waste and leakage, 3) spreading information about power and oil situations and rising prices and how to effectively meet this challenge through energy savings and substitution, and 4) involving SDAs in the outreach programme.

The Bureau of Energy Efficiency has also instituted National Energy Conservation Awards that are presented to industry and other organizations. BEE also organizes annual painting competitions on energy conservation for school children every year with the objective of promoting energy conservation among all sectors of the economy.

(6) International Cooperation

The Bureau of Energy Efficiency has several ongoing bilateral and multilateral programmes (BEE, 2014). Key bilateral programmes include the Indo-German Energy Forum, Indo-German Energy Programme, India-US Energy Dialogue and Indo-Japan Energy Dialogue. Other cooperation areas under development include with Canada, Russia, China, Switzerland, and the International Energy Agency.

6.3 Coordination mechanisms

(1) Forum of Regulators (FoR) Model Regulations

In 2010, the Forum of Regulators (FoR) came out with a set of model regulations to assist State Electricity Regulatory Commissions (SERCs) in drafting state-specific DSM regulations.

(2) Energy Conservation Action Plan

The Energy Conservation Action Plan (ECAP) was carved out for taking measures which would be necessary to build institutional and human capacity, enabling the SDAs to implement energy efficiency programmes and undertake evaluation and monitoring of the energy conservation activities implemented in the state.

7. Sectoral interventions

India's experience shows that a diverse range of policy instruments can be used for energy efficiency interventions. A snapshot of policy instruments used in energy efficiency relevant sectors is depicted in Table 12.

Several other interventions made for improving energy efficiency in power generation, industry, transport, buildings and agriculture sectors are discussed below.

Table 12:Table 12: Policy interventions for energy efficiency by sector

Sector	Policy	Policy instrument
Power Generation	Development of Ultra Mega Power Plants	Technology Programme
	Development of Coal Bed Methane	Technology Programme
	Renovation & Modernization and Life Extension of Power Plants	Technology Programme
Industry	Creation of Task Forces in Key Industrial Sectors	Visioning
	MSME Capacity Building and Knowledge Enhancement	Education
	Technology Demonstration Projects	Investment
	Perform, Achieve and Trade for Large Energy Intensive Industries	Regulation
	Enhancing Value Chain of Micro, Small and Medium Enterprises	Regulation
Building	National Building Code	Voluntary tool
	National Mission for Sustainable Habitat	Programme/ Mission
	Energy Conservation Building Code	Regulation
	Additional Floor Area Ratio Allowance for green buildings	Incentive
	Property Tax Rebates	Incentive
	Faster Environmental Clearance	Incentive
	Appraisal of Large Buildings	Incentive
	Green Buildings Rating System India (GRIHA)	Rating system
	Standards and Labeling for Equipment/ Appliances	Information
	Unnat Jyoti by Affordable LEDs for All (UJALA)	Market Development Programme
	Super-Efficient Equipment Program (SEEP)	Market Development Programme
	Bachat Lamp Yojana	Clean Development Mechanism
Transport	Faster Adoption and Manufacture of (Hybrid and) Electric (FAME) Vehicles Program	Programme/ Subsidies
	National Urban Transport Policy	Policy
	Bharat Stage Emission Standards	Standards
Agriculture	Agricultural Demand-side Management (AgDSM) Programme	Programme
	National Mission for Sustainable Agriculture	Programme
Cross cutting	Energy Conservation Awareness Programmes	Education
	National Mission on Enhanced Energy Efficiency	Programme/ Mission
	Energy Conservation Act	Act/ Legislation

7.1 Power generation

Coal is the dominant primary energy source used in power generation accounting for nearly two-thirds of total generation in India. Coal-based thermal plants are the backbone of the Indian power sector. But inefficiencies in the process of power generation and availability of poor quality coal at home have hindered achieving energy efficiency to a large extent. The sub-committee consisting of officials from NITI Aayog, the Ministry of Power, the Bureau of Energy Efficiency and the Central Electricity Authority have noted energy efficiency measures such as the use of super critical, ultra-super critical and Integrated Gasification Combined Cycle (IGCC) technologies for power generation (NITI Aayog, 2015).

The Ministry of Power launched a unique initiative in 2005-06 to facilitate the development of Ultra Mega Power Plants (UMPPs) for power generation using coal as a primary source. These large sized projects, approximately 4000 MW capacity, are being developed on a Build, Operate and Own (BOO) basis bringing in private investment into power generation. These projects will use Super Critical Technology to achieve higher levels of fuel efficiency, resulting in savings of fuel and lowering of green-house gas emissions. Higher stream parameters of 565/593 degree centigrade are being adopted for supercritical units which would lead to design efficiency of over 40% and lower CO_2 emissions by about 5% as compared to a typical 500 MW subcritical unit (Planning Commission, 2013). 16 such UMPPs are envisaged out of which four have already been awarded and two have been commissioned in Mundra, Gujarat and Sasan, Madhya Pradesh.

The Government of India has been taking initiatives to develop indigenous capacity/ capability in manufacturing supercritical boilers and turbine generators to increase indigenous manufacturing capacity vital to support large-scale induction of supercritical units envisaged for the country. Several joint ventures have been established in the country for setting up manufacturing facilities for supercritical boilers and turbines generators.

Coal beneficiation is a cost-effective and significant step towards improving power plant efficiency in India. This can produce higher quality coal that can burn more cleanly and with greater efficiency (Zamuda and Sharpe, 2007). Moreover, the Ministry of Environment, Forests and Climate Change's (MoEFCC) directive aimed at restricting the use of coal of not more than 34% ash content at thermal power stations located far away from pit heads, load centres and critically polluted areas is further contributing to the improvement of the economics of operations of power stations and thus achieving energy efficiency in coal fired plants.

The Government of India recognizes the potential of Coal Bed Methane/Coal Mine Methane as a feasible alternative energy source. It had formulated a Coal Bed Methane Policy in 1997. The Twelfth Five Year Plan also listed in-situ tapping of coal-bed methane as a key intervention. The Ministry of Coal and the Ministry of Petroleum & Natural Gas are working together for the development of Coal Bed Methane and the Government has offered 33 blocks in four rounds of bidding for CBM covering 17,416 sq. km of area. In the long-run, methane might substitute (or at least supplement) coal burned in power generation and diesel used in mine transport – mainly trucks. This will ensure efficient use of energy resources and sustainability of energy supply (UNDP, n.d.).

The Office of the Principal Scientific Advisor to the Government of India has prepared a mission document for the 9th national mission under the National Action Plan on Climate Change

(NAPCC) based on Clean Coal (Carbon) Technologies (Office of Principal Scientific Advisor, GoI undated). Initiatives to develop next generation coal-fired power plants using advanced super-critical boilers and integrated gasification combined cycle technologies would be part of the mission.

India has also been doing research on Integrated Gasification Combined Cycle (IGCC). This technology has higher efficiencies and lower emissions over the conventional pulverized coal technology (especially suitable when used with fluidized bed gasifier for Indian coal). While India has taken initial steps in setting up demonstration IGCC plants, such as the joint venture between Bharat Heavy Electricals Ltd. (BHEL) with Andhra Pradesh Power Generation Company and NTPC Ltd. in two separate projects; currently, there appears to be a lack of any progress on ground.

Box 2: Energy efficiency in power: A snapshot

Policies/ Programmes under implementation

- Use of high end technology solutions for efficiency enhancement of power plants including renovation & modernization and life extension.
- Development of Ultra Mega Power Plants (UMPPs) using super-critical technology for power generation using coal as primary source
- Thrust on coal beneficiation as a step to improve power plant efficiency
- Development of indigenous capacity/capability for manufacturing of supercritical boilers and turbine generators
- Development of coal-bed methane as alternative energy source for coal based power plants

Policies/ Programme under consideration

- New mission under NAPCC based on Clean Coal (Carbon) Technologies
- Further research, demonstration and adoption of IGCC power plants

7.2 Industry

The contribution of the manufacturing sector to the GDP of India has stagnated at approximately 16%. Manufacturing has to be made the engine of growth for the nation to provide employment for job seekers in India. The National Manufacturing Policy, 2011, aims to enhance the share of the manufacturing sector in GDP to 25% by 2025. It also aims to make growth in the manufacturing sector sustainable, particularly ensuring environmental sustainability through green technologies, energy efficiency, and optimal utilization of natural resources and restoration of damaged/degraded eco-systems.

The Bureau of Energy Efficiency has created task forces within several industrial sectors to improve their energy efficiency. It has the authority to mandate energy efficiency standards. It promotes, manages, finances and monitors energy efficiency efforts throughout the country.

In 2012, under the National Mission for Enhanced Energy Efficiency (NMEEE) in NAPCC, BEE launched a market based mechanism – called Perform, Achieve and Trade (PAT) – to reduce specific energy consumption[14] levels in large energy intensive industries through the certification of excess energy saving which can be traded. Under the mechanism, 478 Designated Consumers (DCs) within eight industrial sectors viz. power (thermal), iron & steel, aluminium, fertilizer, paper & pulp, textile and chlor-alkali, are given energy saving targets (Table 13). Overall, the SEC reduction targets aim to secure 4.05% reduction in energy consumption in these industries totalling an energy saving of 6.686 million tonne of oil equivalent. The co-benefit would be a reduction of about 25 million tonnes of CO_2 equivalent. In 2015, the mandated decrease in the specific energy consumption of the DCs under the PAT programme has led to a decline of 4%–5% of their specific energy consumption as compared to that in 2012 (MoEFCC, 2015). Assessed 427 DCs have resulted in savings of about 8.67 million tonnes of oil equivalent. This amounts to CO_2 mitigation of about 31 million tonnes (BEE 2016). Trading of energy saving certificates (ESCerts) under the PAT mechanism is yet to take place.

Table 13: PAT Cycle-I Notified Sectors

No	Sectors	Annual Energy Consumption Norm to be DC (Mtoe)	No. of Identified DCs	Annual Energy Consumption (Mtoe)	Share Consumption (%)	Apportioned Energy Reduction for PAT Cycle-1 (Mtoe)	No. of Assessed DCs	Savings (Mtoe)
1	Power (Thermal)	30000	144	104.56	63.38%	3.211	123	3.06
2	Iron & Steel	30000	67	25.32	15.35%	1.486	60	2.1
3	Cement	30000	85	15.01	9.10%	0.815	75	1.44
4	Aluminium	7500	10	7.71	4.67%	0.456	10	0.73
5	Fertilizer	30000	29	8.2	4.97%	0.478	29	0.83
6	Paper & Pulp	30000	31	2.09	1.27%	0.119	26	0.26
7	Textile	3000	90	1.2	0.73%	0.066	82	0.12
8	Chlor-Alkali	12000	22	0.88	0.53%	0.054	22	0.13
	Total		**478**	**164.97**	**100%**	**6.686**	**427**	**8.67**

Source: BEE(2016)

The power ministry has expanded the mission to include three more energy intensive industrial sectors viz. railways, oil refineries and electricity distribution companies and more than 900 industrial units under the PAT scheme.

[14]Energy used per unit of production

To encourage the energy efficient technologies and operational practices in micro, small and medium enterprises sectors in India, BEE has initiated the energy efficiency interventions in selected 25 clusters[15] during the Eleventh Five Year Plan period. During the Twelfth Five Year Plan period, implementations of 100 technology demonstration projects in 5 SME sectors are envisaged to facilitate large scale replication.[16]

To sensitize Indian MSMEs to upgrade their manufacturing processes towards usage of energy efficient technologies, the scheme Technology and Quality Up-gradation Support to Micro, Small and Medium Enterprises (TEQUP) was launched under the National Manufacturing Competitiveness Programme by the Ministry of Micro, Small and Medium Enterprises. From 2010-11 to 2015-16, 1073 product certificates have been reimbursed while 299 MSMEs have been assisted for energy efficiency technology (DCMSME, 2015).

Box 3: Energy efficiency in industry: A snapshot

Policies/ Programmes under implementation

The National Manufacturing Policy, 2011, aims to make growth in the manufacturing sector sustainable through green technologies and energy efficiency amongst others

- Energy Conservation Act, 2001 created the BEE with the primary mandate of reducing energy intensity of the Indian economy
- Perform, Achieve & Trade (PAT) programme under NMEEE in NAPCC to reduce specific energy consumption in energy intensive industries
- Energy efficient interventions in selected 25 SME clusters by BEE and implementation of technology demonstration projects in 5 SME sectors.
- Scheme on ‘Technology & Quality Upgradation Support to MSMEs (TEQUP)’ under NMCP launched by MoMSME aims to sensitize Indian MSMEs to upgrade their existing manufacturing processes towards usage of energy efficient technologies

Policies/ Programme under consideration

Expanding the coverage of the PAT scheme to more industrial units and including three more energy intensive industrial sectors.

[15]Bhubhneshwar (Utensils), Warangal (Rice Milling), Bhimavaram (Ice Plants), Vellore (Rice Milling), Ganjam (Rice Milling), Howrah (Galvanizing/ Wire Drawing), Jamnagar (Brass), Kochi (Sea food processing), Surat (Textiles), Bangalore (Machine Tools), Jagadhri (Brass and Aluminium Utensils), Vapi (Chemicals), Jorhat (Tea Gardens), Pali (Textiles), Morvi (Ceramics), Varanasi (Brick Kilns), East Godavari and West Godavari (Refractories), Batala, Jalandhar & Ludhiana, Alwar & Sawai Madhopur (Oil Mills), Gujarat (Dairy), Jodhpur (Limestone), Muzaffarnagar (Paper), Ahmedabad (Chemical Industries), Solapur (Textiles). Available at: https://beeindia.gov.in/content/Cluster-Manuals

[16]Available at http://powermin.nic.in/content/energy-efficiency

7.3 Transportation

A focus on alternative vehicle and transport technologies, along with the expansion of mass transit infrastructure and personal non-motorised mobility options could be significant in reducing emissions from the transport sector and moving ahead with enhanced energy efficiency. Two of the twelve focus areas of the Twelfth FYP of India include a vehicle fuel efficiency programme and improving the efficiency of freight transport, which would require a modal shift to a more efficient mode of freight transport.[17]

The first ever Passenger Car Vehicle (PCV) standards for fuel efficiency were issued[18] by BEE, Ministry of Power. There is a need to improve the fuel efficiency and emissions from the Heavy Duty Vehicles (HDVs) as the energy consumption and emissions from the transport sector is heavily dominated by the HDV sector. BEE has proposed a two pronged approach to accelerate reduction in the average fuel consumption of new cars introduced in the Indian market:

- Medium and long term fuel efficiency standards for new cars which would provide a regulatory signal to manufacturers to continuously reduce the average fuel consumption of cars sold by them over the next 10 year period
- Labelling of new cars that are sold in the market with the labels providing consumers with information on fuel consumption of the car model and the relative fuel consumption of the model compared to other models in the same weight class.

Following consultations with various ministries, industry and civil society, BEE arrived at a consensus on fuel efficiency standards for car manufactures to come into being in two phases - by fiscal year 2016-17 and by 2020-21 (MoP, 2014). The fuel efficiency of cars is expected to improve 10% and 15% in 2017 and 2022, respectively, compared to 2009-10 as the base year (Indian Express News Report, 2014).

To achieve better productivity and efficiency in transport during theTwelfth FYP, the rail share in freight transport is targeted to go up by at least 2%. Consistent efforts are on to increase the share of rail transport in freight movement and enhance the role of public transport for passenger traffic movement. Approval for the development of dedicated Eastern and Western freight corridors will improve overall transport efficiency including faster transit, energy efficient and environment-friendly transport (PIB, Ministry of Railways, 2015). The government is also actively trying to leverage the merits of inland waterways for transportation of cargo and passengers– a far more efficient mode of transport than either rail or road. The Ministry of Shipping is planning to declare 101 waterways as National Waterways (PIB, Ministry of Shipping, 2015).

The Government of India launched the National Urban Transport Policy, 2006 with the objective of encouraging public transport and non-motorized transport by offering central financial assistance and promoting the use of cleaner technologies among others. Public transport causes less pollution per passenger-km as compared to private transport options. Energy efficiency gains of a rail based transport system with respect to motorized private vehicles

[17] Energy intensity of rail freight is 0.18 MJ/ tonne-km, while the intensity for road freight is 1.6 MJ / tonne-km, i.e., a nine-fold difference.

[18] Notification dated 23 April 2015; Available from https://beeindia.gov.in/sites/default/files/ctools/Notification%2023.4.2015.pdf; accessed on 26 February 2016

has led to growing interest from policymakers for the planning and development of metro rail networks in some Indian cities. Adoption and promotion of cleaner fuels/ technologies such as use of compressed natural gas (CNG) are also being pushed to enhance energy efficiency. Around 30 cities have adopted CNG as motor fuel in varying scope (Roychowdhury, 2010).

The Government of India approved the National Mission on Electric Mobility in 2011 and subsequently the National Electric Mobility Mission Plan (NEMMP) 2020 in 2013. It aims to achieve national fuel security by promoting hybrid and electric vehicles in the country. There is an ambitious target to achieve 6-7 million sales of hybrid and electric vehicles year on year from 2020 onwards. In furtherance of the same, the Government of India has launched the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME India) scheme in the Union Budget for 2015-16 (PIB, Ministry of Heavy Industries & Public Enterprises, 2015). Given that electric vehicles have higher operational efficiencies than internal combustion engines, increasing the shares of electric vehicles is expected to increase the overall energy efficiency of the transport sector and reduce energy demands (Planning Commission of India, 2013).

Box 4: Energy efficiency in transport: A snapshot

Policies/ Programmes under implementation

- Passenger Car Vehicle standards for fuel efficiency have been adopted by the BEE, Ministry of Power.
- Two of the focus areas under the Twelfth FYP include a vehicle fuel efficiency programme and improving the efficiency of freight transport
- National Urban Transport Policy, 2006 puts stress on encouraging public transport and non-motorized transport
- Development and expansion of metro rail networks across Indian cities
- Adoption and promotion of cleaner fuels such as CNG in certain cities
- National Mission on Electric Mobility in 2011; National Electric Mobility Mission Plan (NEMMP) 2020 and Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME India) scheme to promote hybrid and electric cars in the country

Policies/ Programme under consideration

- Enforcement of medium and long term fuel efficiency standards for new cars
- Development of dedicated freight corridors
- Labelling of new cars on the basis of fuel consumption
- Leveraging the merits of inland waterways for transportation of cargo and passengers by declaring 101 waterways as National Waterways

7.4 Buildings

With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase from a low 14% in the 1970s to nearly 33% in 2004-2005. The energy saving potential for the residential sector is on average 20% and that for commercial buildings is 30% (MoUD, n.d.).

The National Building Code of India (NBC) serves as a Model Code for adoption by all agencies involved in building construction works. The latest revision to the code focuses on energy efficiency in the following aspects (MoUD, n.d.):

- Use of pozzolanas (such as fly-ash, rice husk ash, metakaoline, silica fume, ground granulated blast furnace slag, etc.) in concrete production
- Daylight integration (indoor lighting levels to be met via day lighting)
- Artificial lighting requirements (levels) for indoor spaces
- Ventilation standards (natural and mechanical) for optimal human health and well-being
- Electrical standards (minimum power factor, allowances for diversity, etc.)
- Select HVAC design norms

The National Mission for Sustainable Habitat under the NAPCC also encompasses promoting energy efficiency in residential and commercial sectors as one of the objectives. The mission emphasises the extension of the Energy Conservation Building Code (ECBC), use of energy efficient appliances and creation of mechanisms that would help finance demand side management. The sub-committee for the development of National Sustainable Habitat Parameters for Energy Efficiency in Residential and Commercial Buildings have developed ‘Generic’, ‘Climate specific’, ‘Latitude specific’ and ‘Best practices’ energy efficiency guidelines for buildings.

The Energy Conservation Act, 2001 identifies commercial buildings and establishments as one of the energy intensive industries/other establishments. It is also the basis for the formation of BEE. BEE started the formulation of the Energy Conservation Building Code (ECBC) in India. It was officially launched in 2007. It is applicable for new buildings as well as additions and alterations in existing buildings when the conditioned floor area exceeds 1000 sq. metre. ECBC sets minimum energy standards for new commercial buildings having a connected load of 100kW or contract demand of 120 KVA and above. The Twelfth Five Year Plan document estimates ECBC compliant buildings to be 20-30% more efficient than conventional buildings.

ECBC sets minimum energy efficiency standards for design and construction of new buildings and its components such as building envelope (walls, roofs, windows), lighting (indoor and outdoor), heating ventilation and air conditioning system, solar water heating and pumping, electrical systems (power factor, transformers). The Twelfth Five Year Plan targets a faster adoption of Green Building Codes (BEE, 2013). The MOEF has made it a mandatory requirement for all buildings with a built-up area above 20,000m^2 to be appraised by the Environmental Appraisal Committees (EACs) and the State Environmental Appraisal Committees (SEACs).

Many states in India also offer incentives in the form of additional floor space index (FSI) or floor-area ratio (FAR)[19] to developers of green buildings for no cost. A number of municipal corporations have begun to offer tax rebates on property taxes on the basis of the building meeting certain criteria under existing rating programmes (such as GRIHA)) (see annex 3 for examples). The Ministry of Environment, Forests and Climate Change also gives priority for obtaining environmental clearance to buildings meeting criteria of rating programmes (ASCI & NRDC, 2014).

The Ministry of New and Renewable Energy (MNRE) has been implementing a scheme for 'Energy Efficient Solar/Green Buildings' which aims at promoting the widespread construction of energy-efficient solar/green buildings in the country. This programme has a provision for annual awards to Urban Local Bodies (ULBs), to green buildings having maximum renewable energy installations and to architects and design consultants.

In order to promote a market pull for energy efficient buildings, BEE developed a voluntary Star Rating Programme for buildings which is based on the actual performance of a building, in terms of energy usage in the building over its area expressed in kWh/m^2/year. Currently, Voluntary Star Labelling programme for 4 categories of buildings (day use office buildings/ BPOs/Shopping malls/Hospitals) has been developed and put in the public domain (BEE, n.d.).

Appliances used in the buildings can also contribute to conserving energy. BEE initiated the Standards and Labelling Programme for equipment and appliances in 2006 invoking it for 19 appliances/equipment commonly used in commercial/ residential buildings; four of these products have been adopted under a mandatory list while others fall under a voluntary list at present. The programme helps in reducing the energy consumption of appliances without diminishing the services it provides to consumers. With time the amount of equipment under the programme will increase and the criteria will also made more stringent for certain products.

One of the missions under the NAPCC for India is the Market Transformation for Energy Efficiency (MTEE). Under MTEE, two programmes have been developed, namely, Bachat Lamp Yojana (BLY) and Super-Efficient Equipment Programme (SEEP). BLY is a public-private partnership programme comprised of BEE, Distribution Companies (DISCOMs) and private investors to accelerate market transformation in energy efficient lighting. Initially targeted to replace inefficient incandescent bulbs with CFLs, BLY is now replaced by Unnat Jyoti by Affordable LEDs for All (UJALA) (earlier called Domestic Efficient Lighting Programme (DELP)) for replacing household bulbs with light-emitting diode (LED) lamps.

EESL has launched an LED based home and street lighting programme in January 2015. The plan envisages a coverage of 100 cities by March 2017 and balance by March 2019, targeting 77 crore ordinary bulbs and 3.5 crore conventional street lights. Box 2 gives an overview of the Domestic Efficient Lighting Programme by EESL.

SEEP is a programme designed to bring accelerated market transformation for super-efficient appliances by providing financial stimulus innovatively[20] at critical point/s of intervention. Under SEEP, ceiling fans have been identified for improving energy efficiency. The goal is to leapfrog

[19]a measure of the built-up floor area of a building relative to the size of the plot it is built on

[20]Manufacturers bid for the amount of financial incentive as well as the total production quota through a reverse bidding mechanism with a pre-specified cap. The bidding mechanism is developed to allow multiple winners. The incentive is paid per unit super-efficient fan to the manufacturer after the product leaves the factory for the market (Chunekar & Singh, 2013).

to 50% better efficiency levels than the market average by providing a time bound incentive to fan manufacturers to manufacture super-efficient (SE) fans and sell the same at a discounted price. SEEP would also be extended to LED tube lights and LED bulbs in the Twelfth Five Year Plan (MoP, 2012).

Box 5: Energy efficiency in buildings: A snapshot

Policies/ Programmes under implementation

- Revisions to the National Building Code of India (NBC) focuses on energy efficiency
- National Mission for Sustainable Habitat under the NAPCC targets at promoting energy efficiency in residential and commercial sector buildings
- Energy Conservation Building Codes sets minimum energy standards for new and existing buildings
- Energy Efficient Solar/Green Buildings programme aims at promoting widespread construction of energy-efficient solar/green buildings in the country
- Voluntary Star Labelling programme for buildings to promote market pull for energy efficient buildings
- Standards and Labelling programme for 19 equipment and appliances
- Bachat Lamp Yojana (BLY) and Super-Efficient Equipment Programme (SEEP) programmes launched to bring about accelerated market transformation for energy efficiency
- EESL has launched a LED based home and street lighting programme
- Robust green building rating systems in place

Policies/ Programme under consideration

- Mandatory Standards and Labelling programme for all the included equipment and appliances
- Extending SEEP to LED tube-lights and LED bulbs.

Robust green building rating systems also exist in India. The Green Rating for Integrated Habitat Assessment (GRIHA) is one such tool that assesses the performance of buildings against certain nationally acceptable benchmarks. Developed by The Energy and Resources Institute, it has been adopted by the MNRE. This tool, by its qualitative and quantitative assessment criteria, is able to 'rate' a building on the degree of its 'greenness'. It is a 100 points system with 34 criteria. The Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII), has also played a key role in developing new green building rating programmes, certification services and green building training programmes.

Box 6: Domestic Efficient Lighting Programme

Energy Efficiency Services Limited (EESL) has taken up the project of distributing LED bulbs under its flagship initiative, the Domestic Efficient Lighting Programme (DELP). Under this scheme, superior quality energy efficient LED bulbs are sold to domestic consumers at designated centres. Consumers pay for the LED bulbs through their electricity bills at INR 10 per month. EESL purchases the electric bulbs through bulk competitive purchase. This procurement through tenders has been able to reduce the bulk procurement price from INR 310 for a 7 watt LED bulb in February 2014 to INR 53 for a 9 watt bulb in March 2016. EESL sells the bulbs at a price of INR 90-100, depending on state taxes. This is about one-half of the retail price of LED bulbs of equivalent quality. The consumers' electricity bills are estimated to reduce by about INR 160-400 per year with each LED, thus making the cost recovery in less than a year.

The target of the DELP is to replace all the 77 crore incandescent bulbs sold in India with LEDs. This will result in a reduced 20,000 MW load, energy savings of 100 billion KWh and greenhouse gas (GHG) emissions savings of 80 million tonnes every year. The annual saving in electricity bills for consumers will be INR 40,000 crore (approx. USD 6.7 billion), considering an average tariff of INR 4 per kWh.

The National DELP Dashboard is an integrated, real-time, and web-based dashboard which dynamically refreshes at an interval of 15 seconds to display in real-time the number of LEDs distributed at national level (see figure below). This is achieved by aggregating real-time feeds from multiple states where DELP is ongoing. The progress of scheme can be tracked on http://www.delp.in/

DELP Dashboard that provides real time information

Source: http://www.delp.in (Last accessed on 26th February 2016)

7.5 Agriculture

Provision of free or subsidized power in many Indian states has prompted unaccounted and uncontrolled use of electricity, resulting in the agricultural sector consuming one-fourth of the country's total electricity supply (Swain & Charnoz, 2012). Cheap or free electricity contributes to the adoption of inefficient and unreliable pump sets, resulting in massive water wastage and higher energy consumption. The Agricultural Demand-side Management (AgDSM) programme aims to reduce peak demand, shift the time during which electricity is consumed to off-peak hours and to reduce total consumption. It intends to replace inefficient agricultural pump sets with BEE star rated and high efficiency pump sets to reduce the amount of electricity needed to pump water in agriculture sector. After some pilot projects, Energy Efficiency Services Limited (EESL) is moving ahead with the implementation of AgDSM projects all over India (PIB Ministry of Power, n.d.).

To improve the efficiency of pumps, some states have also undertaken initiatives with an objective to improve overall efficiency in electricity supply (Swain & Charnoz, 2012). The Gujarat Electricity Board carried out pilot projects from 1978-88 aimed at the replacement of suction pumps, pipes and foot-valves. The Rural Electrification Corporation Ltd. sponsored six pump-set rectification projects in Tamil Nadu, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, and Haryana during the 1980s. Other states such as Maharashtra and Himachal Pradesh have also taken similar initiatives to improve pump-set and water efficiency leading to overall energy efficiency (D'Sa, 2010).

EESL has announced a national programme to replace inefficient agricultural pumps with efficient pumps using a business model that is similar to that used for LED bulbs, i.e. reaching out to farmers with an extended payment plan, and providing them with high quality, high efficiency pumps which have been purchased in bulk at competitive prices.

Box 7: Energy efficiency in agriculture: A snapshot

Policies/ Programmes under implementation

- Agricultural Demand-side Management (AgDSM) programme to replace inefficient agricultural pump sets with BEE star rated, high efficiency pump sets
- State level interventions to improve the energy efficiency of pump-sets
- National Mission for Sustainable Agriculture under the NAPCC adopting sustainable development pathways & adopting energy efficient equipment

Policies/ Programme under consideration

- Creating a regulatory mechanism to mandate the use of BEE star labelled pump-sets for new connections under the AgDSM programme

Under the NAPCC, the National Mission for Sustainable Agriculture (NMSA) has been catering to the key dimensions of 'Water use efficiency', 'Nutrient management' and 'Livelihood diversification' through the adoption of sustainable development pathways by progressively shifting to environmental friendly technologies, adoption of energy efficient equipment, conservation of natural resources, and integrated farming among other measures.

In India, efforts to develop, refine and disseminate conservation-based agricultural technologies have been underway for nearly two decades and have made significant progress (Bhan & Behera, 2014). It is being promoted under the NMSA as well. Conservation agriculture practices can also promote resource and energy conservation. Techniques such as laser levelling, direct seeding, minimum soil disturbance, permanent soil cover, and System of Rice Intensification have been able to improve resource use efficiency in crop production. Due to low/no tillage and reduced irrigation needs in conservation agriculture, energy efficiency is also achieved.

8. Lessons learned, challenges and ways forward

The pace of development is growing in India with emphasis on policies such as 'Make in India' and 'Startup India'. With growing industrial activities and rising standards of living as well as increasing access to electricity, energy consumption is rising and so is India's overall economic development. As India remains committed to save 10% of its current energy consumption by the year 2018-19 (MoEFCC, 2015), it is crucial that economic and human development continues to take place without increasing energy intensity through deployment of cleaner and energy efficient technologies.

India's experience shows that a combination of policy instruments have been used in India for energy efficiency policies. Figure 14 shows the policy instruments used for four key energy efficiency initiatives in India.

Figure 15: Instruments used for key energy efficiency policies in India

		Policy instruments						
		Information	Regulation	Data and transparency	Market development	Testing and verification	International cooperation	Public-Private Partnership
Programmes	Perform, Achieve and Trade		●		●	●		
	Standards and Labelling Programme	●			●			
	Domestic Efficient Lighting Programme			●	●			●
	Bachat Lamp Yojana				●	●	●	●

The Energy Conservation Act, 2001 provides a regulatory mandate for standards & labelling of equipment and appliances, energy conservation building codes for commercial buildings, and energy consumption norms for energy intensive industries. As a way forward, the scope of sectoral coverage can expand to residential buildings as well as heavy-duty vehicles. An aspect which will be crucial in India will be enforcement and implementation; this will be possible through adequate financing as well as capacity building (including skills).

The Bachat Lamp Yojana is an example where high quality CFLs were distributed at a subsidized price to residential households in exchange for incandescent lamps. It is also an example of an intervention involving a robust public-private partnership between the Government of India, private sector CFL suppliers and State-level Electricity Distribution Companies.

The Perform, Achieve and Trade mechanism is designed to facilitate Designated Consumers to not only achieve their legal obligations under the Energy Conservation Act 2001 but also to provide them with necessary 'market based incentives' to overachieve the targets set for them.

For commercial buildings, India's experience shows the use of incentives such as faster environmental clearances as offered to GRIHA certified green buildings. In addition, municipalities offer incentives such as property tax rebates as well as FAR relaxations.

In the appliance sector, the Standard and Labelling programme helps consumers to make informed purchases, and thereby understand the cost saving potential of the marketed household and other equipment. The S&L is an attempt to curb demand at the consumption level, by mandating certain norms for appliance manufacturers. As a way forward, the standard and labelling programme can be expanded to more appliances. A data repository can also be built for better monitoring and evaluation.

The Ministry of Finance (Procurement Policy Division) in consultation with the Ministry of Power (MoP) and the Bureau of Energy Efficiency (BEE) has issued an office memorandum for promoting the procurement of energy efficient appliances in all ministries/departments and their attached subordinate offices. The Public Procurement Bill, 2012—pending in parliament—seeks to regulate and ensure transparency in procurement by the central government and related entities. The mandate with respect to sustainability and energy efficiency can be further strengthened.

In terms of energy efficiency governance in India, it is seen that there are enabling frameworks and institutional arrangements in place. However coordination mechanisms need to be strengthened through activities such as target setting as well as evaluation. Currently, while there are targets set under programmes for energy intensive industries, there is no mechanism for setting and evaluating targets at the state-level in India. This is an area where China's experience will be helpful to design policies and interventions in India.

In terms of the institutional framework for energy efficiency in India, it is seen that there are enabling frameworks and institutional arrangements in place including state designated agencies at the sub-national level. There is however a need to empower these institutions through financial resources, policy mandates and a deeper programmatic approach. There needs to be more clarity in terms of coordination mechanisms which need to be strengthened through activities such as target setting as well as evaluation. The coordination between national and sub-national agencies need to be strengthened further along with adequate financing. There is also a need for connecting the third tier of government, especially municipalities. Several municipalities have taken initiatives to incentivise green infrastructure. Guidelines or a toolkit on incentives for energy efficiency promotion at the local level could be issued by the central government which can help municipalities put in place measures at for promoting energy efficiency. Useful lessons in this regard can be drawn from China's experience of low carbon pilots in provinces and cities.

The Domestic Efficient Lighting Programme serves as an example of transparency. There is a need to build capacity on data reporting on energy consumption especially for the states of India. While data on electricity is measured, there is a need for measuring data on other primary sources of energy. There is a need to encourage voluntary reporting on energy consumption by industries, central ministries and state governments. Making data on energy efficiency available in the public domain will also facilitate a broader public discussion and facilitate transparency.

Presently, a key source of finance in energy efficiency comes from public expenditure through budgetary allocation. There has been an active promotion of market based approaches keeping in mind the demand and supply dynamics of energy efficient appliances. Under the NMEEE, the government has also put into place initiatives such as the Energy Efficiency Financing Platform and the Framework for Energy Efficient Economic Development. SIDBI along with bilateral agencies have also been engaged in promoting energy efficiency in MSMEs.

Finance needs to be further augmented for sub-national agencies especially through State Energy Conservation Funds. Inadequate familiarity among banks with energy efficiency projects needs to be addressed by creating awareness. Energy efficiency initiatives can be included as a priority sector lending by the Reserve Bank of India. This will further help in raising capital in the energy efficiency sector. For energy efficiency, adequate public finance will also need to be allocated for research and development. In terms of finance, it is seen that the budgetary allocation for energy efficiency to the Bureau of Energy Efficiency is miniscule. There is a need to quantify the actual finance, both public and traditional, that goes into energy efficiency measures.

At present, under the NMEE initiative, the Super Energy Efficient Products (SEEP) programme, innovation is encouraged in the manufacturing sector in India to accelerate the shift to energy efficient appliances. The appliance selected in the Twelfth Five Year Plan is a 'fan'. SEEP will need to be expanded to more products and appliances. There is also need for putting in place large scale research programmes involving Ministry of Science & Technology, Department of Industrial Policy & Promotion, and research institutes.

In sum, the Indian experience highlights the importance of an enabling framework, institutional arrangements and market-based approaches in terms of creating demand for domestic electrical appliances especially lighting. Energy efficiency policies in India need to evolve beyond electrical appliances and the industrial sector into other domains such as transport and agriculture for which stronger initiatives at the sub-national level (state and local levels) will be crucial. Strengthening of coordination mechanisms such as planning involving the state and central agencies will be important.

Conclusion

China and India have both been successful at decreasing energy intensity per unit of GDP at PPP. Nevertheless, as both countries' economies continue to develop and standards of living rise, the continued promotion of clean energy in terms of energy efficiency and renewable energy, energy access and energy security while minimizing emissions is crucial to a sustainable future.

Both China and India have established enabling frameworks and institutional support for their energy efficiency goals. There is a great deal from both countries' experiences in this regard that can be shared with other developing countries as they too face similar energy challenges.

In spite of significant differences in their economic and governance structures, China and India share similar challenges in maximising the effectiveness of their energy efficiency policies. In terms of convergences, both China and India have emphasized energy efficiency in national policies and plans. Both countries have also focused on sectoral approaches to energy efficiency interventions. Reflecting their particular histories and governance patterns, China and India have diverged in their emphasis on regulation or markets to drive energy efficiency. China has had a greater focus on government intervention while India's greater focus has been on market based mechanisms. China could benefit from developing more market mechanisms to promote efficiency in the delivery of energy targets, while India could benefit from greater government regulation and support including at the sub-national level.

Finding the right balance between government regulation and market incentives is a key aspect for the implementation of energy efficiency targets. Monitoring and enforcement of existing policy is a concern as is incentives for implementation at the local level. The need for reliable data will continue to increase, particularly as solutions become more complex. Consistency of policies and coordination between stakeholders is critical. There is also a strong need for capacity building and communication with stakeholders in both countries. Finally, flexibility will be needed in developing policies to address emerging issues, such as the greater role of non-industrial sectors in energy consumption, structural changes in the economy, and incentives produced by new market mechanisms. Both countries can build on their respective successes and experiences and support each other through knowledge exchange to address weaker areas.

Annexes

Annex 1: Electricity efficiency data for various states in India in 2011-12

States	Electrical energy intensity (Toe/INR crore)	T&D losses as a % of total power availability
Andhra Pradesh	16.16	17.50
Arunachal Pradesh	6.71	46.30
Assam	5.70	33.50
Bihar	3.83	50.90
Chhattisgarh	27.28	16.50
Goa	9.56	12.40
Gujarat	16.65	21.80
Haryana	13.93	28.60
Himachal Pradesh	14.22	18.60
Jammu & Kashmir	9.03	61.80
Jharkhand	17.84	14.30
Karnataka	16.60	12.70
Kerala	6.96	17.20
Madhya Pradesh	14.24	34.50
Maharashtra	11.12	20.00
Manipur	3.86	40.50
Meghalaya	8.93	31.00
Mizoram	4.20	47.70
Nagaland	8.79	41.50
Orissa	21.37	44.60
Punjab	19.34	23.10
Rajasthan	17.62	27.90
Sikkim	6.21	31.10
Tamil Nadu	13.88	16.30
Tripura	3.05	39.10
Uttar Pradesh	12.49	32.40
Uttarakhand	12.30	28.70
West Bengal	5.33	23.20

Note: This list excludes the union territories of India

Source: Calculated based on Planning Commission (2014), CEA (2014)

Computation and standardization of individual indicator values is done so that the value of indices falls in the range of 0–1. This procedure makes the respective values of the chosen indicators unit less so that indicators are comparable for the construction of an aggregate index. In the index, the best performer hence gets a value of 1, while the worst performer gets a value of 0. Moreover, all values become uni-directional.

The standardization procedure using x as a variable is as follows:

$$x_{index} = [x - x_{min}]/[x_{max} - x_{min}]$$

Here xmin and xmax were the lowest and highest values for the variable x. The scores received by each state with respect to each indicator are then averaged. Since all three indicators relate to electricity equal weightage was assigned while constructing an aggregate index.

Annex 2: Data for electrical energy intensity and access for 2011-12

State	Electrical energy intensity (Toe/INR crore)	Electrical energy intensity (Index 0 to 1)	Households having access to electricity for lighting (% population)	Electricity Access (Index 0 to 1)
Andhra Pradesh	16.16	0.70	92.20	0.95
Bihar	3.83	0.00	16.40	0.00
Gujarat	16.65	0.73	90.40	0.92
Haryana	13.93	0.58	90.50	0.92
Karnataka	16.60	0.73	90.60	0.93
Kerala	6.96	0.18	94.40	0.97
Madhya Pradesh	14.24	0.59	67.10	0.63
Maharashtra	11.12	0.42	83.90	0.84
Orissa	21.37	1.00	43.00	0.33
Punjab	19.34	0.88	96.60	1.00
Rajasthan	17.62	0.79	67.00	0.63
Tamil Nadu	13.88	0.57	93.40	0.96
Uttar Pradesh	12.49	0.49	36.80	0.25
West Bengal	5.33	0.09	54.50	0.48
Average	13.54	0.55	72.63	0.70

Source: Census (2011) and CEA

Annex 3: Indian sub-national governments' incentives for green buildings

State/ Union Territory/ City	Incentive
Andhra Pradesh	• 10% – 20% rebate on property tax
Delhi	• 1% – 5% increase on FAR and FSI coverage • 10% rebate on property tax for obtaining green rating
Kerala	• Property tax and building tax rebate • Relaxation in FAR
Maharashtra	• FSI • Refund of development charges • Property tax rebate
Rajasthan	• 5% free of cost FAR for GRIHA projects for 4 or 5 star GRIHA rating
Punjab	• 5% free of cost FAR for buildings plot area (greater than 5000 m^2)
Noida	• Additional FAR of 5% is given (area greater than 5000 m2), if it is GRIHA 4 to 5 star or LEED platinum or gold rated
Bhubaneswar	• Refund of fee proportionate to 0.10 premium • FAR in case of platinum/gold rated green building

Source: Author compilation

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