Bhutan Energy Efficiency Baseline Study

Final Report

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Prepared for:

Department of Renewable Energy (DRE), Bhutan

and

United Nations Development Programme (UNDP), Bhutan

UNDP, Bhutan

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Acknowledgement

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Executive Summary

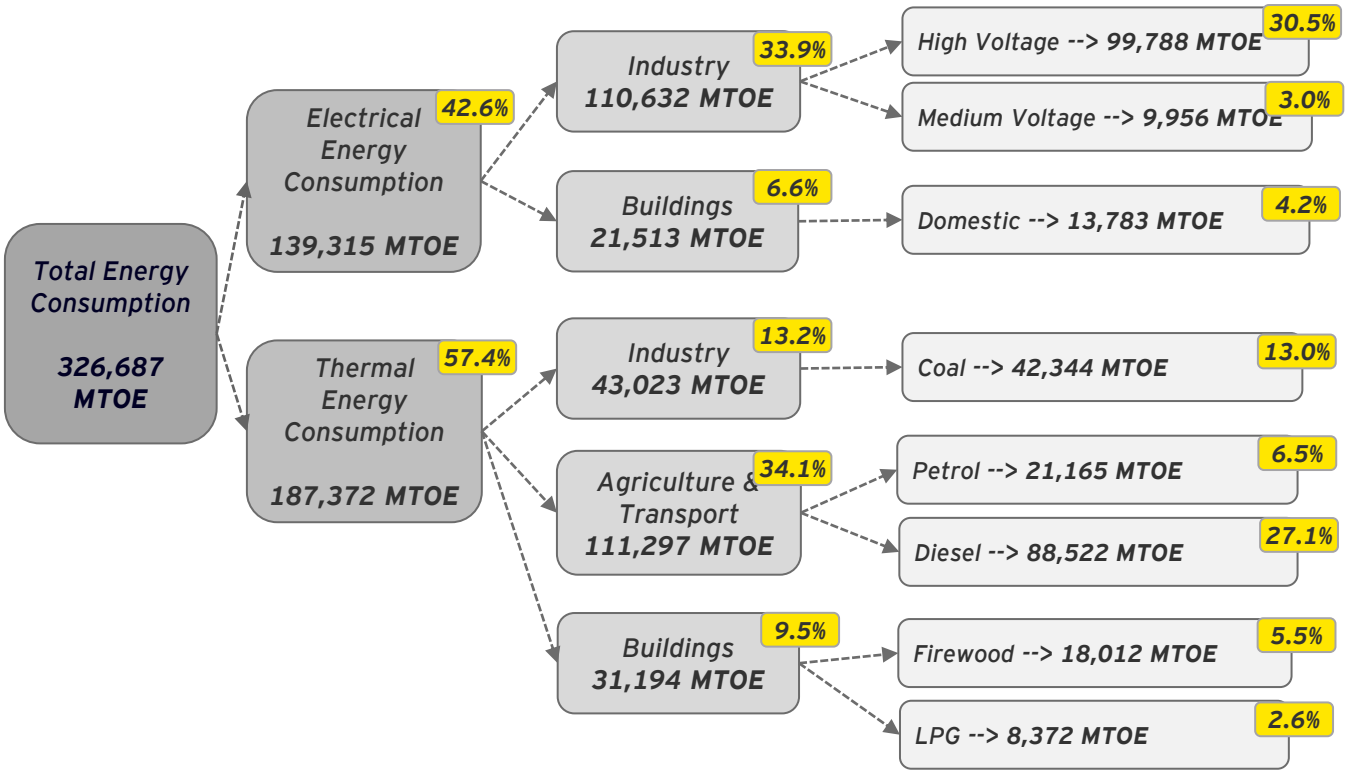
In view of the possible adverse effects of climate change on hydro power generation in Bhutan and the imminent need to ensure energy security, the Royal Government of Bhutan recognizes the need to develop a policy and regulatory framework that promotes and enhances optimization of energy use through demand side management measures.

With the support from United Nations Development Programme, Department of Renewable Energy, of the Ministry of Economic Affairs (MoEA), Royal Government of Bhutan (RGoB) has taken the initiative to prepare a report on "Bhutan Energy Efficiency Baseline Study" to assess the energy consumption and efficiency levels of the energy intensive sectors including industry, transport, buildings and agriculture. This report is also aimed at identifying energy efficiency policy interventions to enable the government to develop "National Energy Efficiency Policy". A brief summary of individual chapters covered in the report is as follows:

Energy Baseline 1

The section on "energy baseline" provides a snapshot of overall energy consumption and the sectoral energy consumption for priority sectors including industry, transport, buildings and agriculture. An inventory on 'baseline electrical' and 'baseline thermal' energy consumption is carried out in each identified sectors to identify the target sub-sectors. The analysis revealed that electrical energy consumption in high voltage Industries and thermal energy consumption in transport applications are the major energy-intensive consumption areas.

Baseline energy consumption with mapping of priority sub-sectors



2 Energy Efficiency Potential

The section on "energy efficiency potential" presents the details on on-site assessment carried out for sample target groups in industrial, building and transport sector. An evaluation is made on efficiency levels and a benchmarking exercise is carried out to quantify the possible energy efficiency potential available and the anticipated monetary savings as a result of reduction in energy consumption. The observed levels of energy efficiency reveal a scope for energy efficiency improvements in the identified sector. This section also presents the best-practice case studies in energy efficiency across different sectors.

3 Recommendations & Way Forward

In this section, the current status of legislation and policy measures and interventions in terms of policies, measures and / or programmes aimed at promoting and implementing energy efficiency across the identified key sectors are summarized. A brief overview is as follows:

Current Legislative Scenario

Assessment on current scenario of Bhutan energy efficiency legislation and policy covering the areas of overview of energy regulatory assessment, energy efficiency policy framework and status of energy efficiency implementation programmes adopted in Bhutan.

International policy overviews

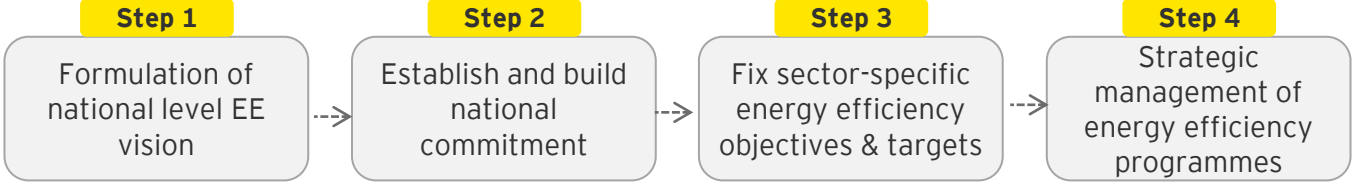
Assessment on energy efficiency policy overviews of the country(ies) that has similar energy profile to that of Bhutan. Also includes a detailed analysis on various sector-specific energy efficiency improvement programmes along with cross-sectoral policy measures adopted.

Barrier assessment

Assessment on barriers that act as a major hindrance to pursue investment in the areas of energy efficiency in Bhutan. Analysis reveal that a sound adaptive capacity through improving the understanding and need for energy efficiency, assessment of potential energy savings, and establishment of legal and institutional framework is essential for driving energy efficiency movement in Bhutan.

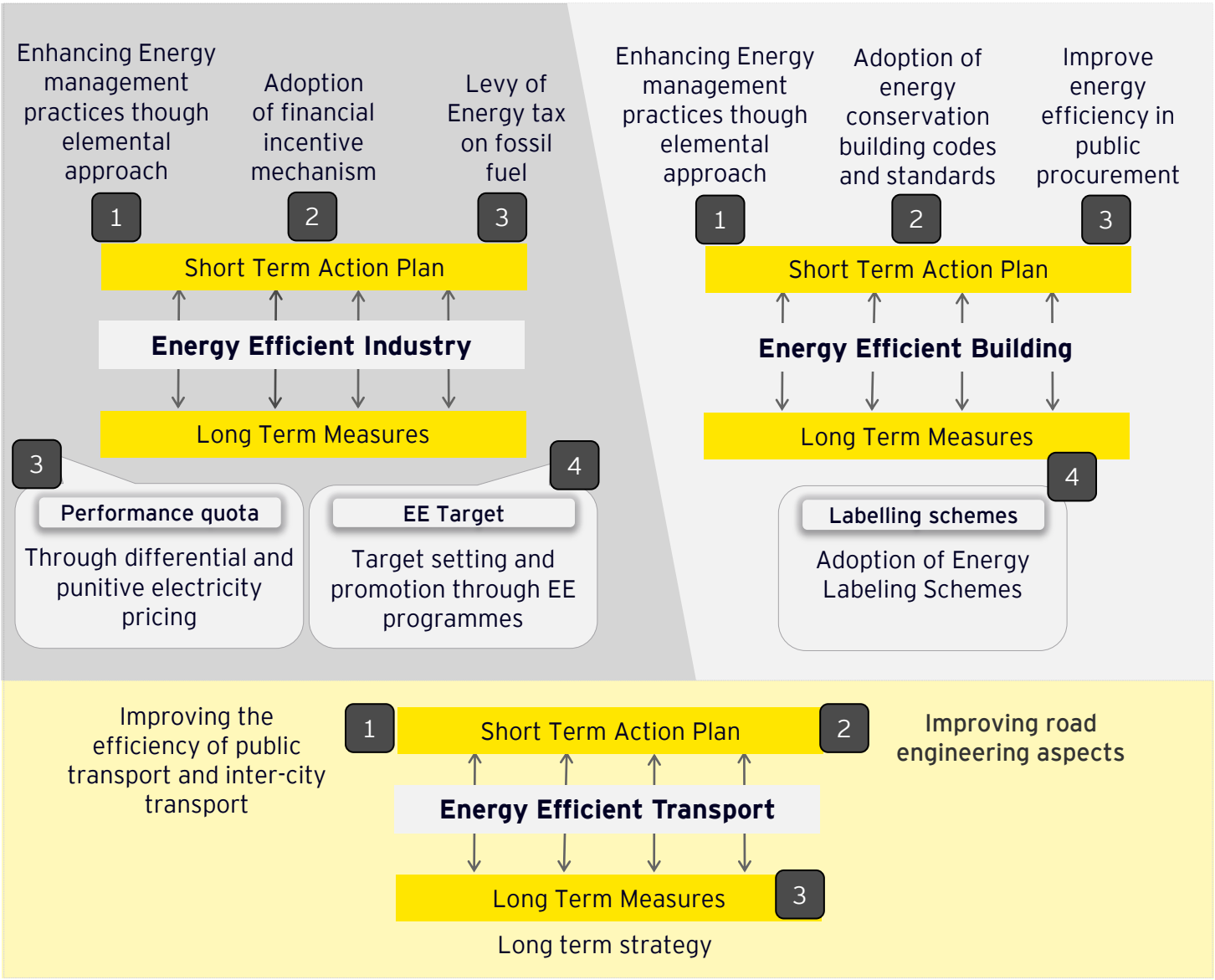
Strategic approach for energy efficiency promotion

This section of the report presents the step-wise approach for EE promotion in Bhutan providing strategic guidance for planning and management of energy efficiency programmes / initiatives.



Sector specific energy efficiency programmes

In this section, a set of energy efficiency target measures are presented for Bhutan for each priority sector and the these are assessed and developed taking into account the current regulatory and legislative scenario. These individual target measures can be developed as a target-oriented energy efficiency improvement programmes for progressive implementation in Bhutan.



4 Conclusions

Recommendations has been made on policy directions and the energy efficiency programmes. These are evaluated taking into account the existing regulatory scenario and level of adoption of energy efficiency management practices in individual sectors. The best practices from international experience and the rationale behind each policy and energy efficiency programmes were also analyzed in the evaluation process. For any EE programme that are planned for implementation, it is to be ensured that a realistic target, allocation of guaranteed resources and allowance of relatively long timeframe (the three critical determinants) are provided for a successful implementation.

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List of Abbreviations and Acronyms

ABI	Association of Bhutanese Industries
BAT	Best Available Technologies
BAU	Business As Usual
BCCI	Bhutan Chamber of Commerce and Industry
BCCL	Bhutan Carbide & Chemicals Ltd.
BDBL	Bhutan Development Bank Limited
BEA	Bhutan Electricity Authority
BEE	Bureau of Energy Efficiency
BEV	Battery Electric Vehicle
BFAL	Bhutan Ferro Alloys Ltd.
BFG	Blast Furnace Gas
BNBL	Bhutan National Bank Limited
BPCL	Bhutan Power Corporation Limited
BREEAM	BRE Environment Assessment Method
BRT	Bus Rapid Transit
BSB	Bhutan Standards Bureau
BTN	Bhutanese Ngultrum
CAGR	Compounded Annual Growth Rate
CFL	Compact Fluorescent Lamp
CNG	Compressed Natural Gas
COG	Coke Oven Gas
DC	Designated Consumer
DoT	Department of Trade
DRE	Department of Renewable Energy
DRI	Direct Reduction Iron
DSM	Demand Side Management
EC Act	Energy Conservation Act
EE	Energy Efficiency
EE&C	Energy Efficiency & Conservation
EES&L	Energy Efficiency Standards & Labeling
EI	Energy Intensive
EM	Energy Management
ENCON	Energy Conservation

List of Abbreviations and Acronyms

ESCO	Energy Service Company
EYPL	Ernst & Young Private Limited
GHG	Green House Gas
GJ	Gigajoule
GNH	Gross National Happiness
GWh	Gigawatt hour
HV	High Voltage
HVAC	Heating, Ventilation & Air-Conditioning
IEA	International Energy Agency
IEMMP	Integrated Energy Management Master Plan
IGBC	Indian Green Building Council
kCal	Kilo Calorie
kg	Kilogram
kl	Kilolitre
kmol	Kilo mole
kW	Kilowatt
kWh	Kilowatt hour
LEED	Leadership in Energy and Environmental Design
LPG	Liquefied Petroleum Gas
LV	Low Voltage
m^2	Square Meter
m^3	Cubic Meter
MM BTN	Million Bhutanese Ngultrum
MoA	Ministry of Agriculture
MoEA	Ministry of Economic Affairs
MSW	Municipal Solid Waste
MT	Metric Ton
MTOE	Metric Tons of Oil Equivalent
MTPA	Metric Tons Per Annum
MV	Medium Voltage
MW	Megawatt
MWh	Megawatt hour
NAPCC	National Action Plan for Climate Change

List of Abbreviations and Acronyms

NHDCL	National Housing Development Corporation Limited
NMEEE	National Mission for Enhanced Energy Efficiency
NSB	National Statistics Bureau
Pa	Pascal
PAT	Perform, Achieve & Trade
PCA	Penden Cement Authority Limited
R&D	Research & Development
RE	Renewable Energy
REDF	Renewable Energy Development Fund
RGoB	Royal Government of Bhutan
RSTA	Road Safety and Transport Authority
SARI/Energy	South Asia Regional Initiative for Energy
SASEC	South Asia Sub-regional Economic Cooperation
SEC	Specific Energy Consumption
SHDP	Sustainable Hydropower Development Policy
SME	Small and Medium Enterprise
SUV	Sports Utility Vehicle
tCO_2	Tons of Carbon dioxide equivalent
TERI	The Energy & Research Institute
TPD	Tons Per Day
TWh	Terawatt hour
UNDP	United Nations Development Programme
USD	United States Dollars
VFD	Variable-Frequency Drive
WC	White Certificate

Chapter 1: Introduction

1.1 Objectives of the study

The primary objective of this study is to establish Baseline Energy information, identify and quantify energy efficiency potential in the identified energy intensive sectors of Bhutan. The identified sectors include residential, governmental and commercial buildings, transport, industry and agriculture. Further, it is also intended to propose recommendations covering policy, regulatory and strategic measures that could be adopted as input by Royal Government of Bhutan for formulation of National Energy Efficiency Policy.

The broad context, drivers and energy scenario in Bhutan (as estimated prior to the study[1]) has been provided in Figure 1.1.

Figure 1.1: Overview of the study

CONTEXT

The Royal Government of Bhutan with assistance from United Nations Development Programme (UNDP) has planned to undertake an energy efficiency baseline study to enable the government to formulate a national Energy Efficiency (EE) policy.

DRIVERS

Compelled by the adverse effects of Climate Change especially on the hydropower generation, there is an imminent need for the Royal Government of Bhutan to develop a policy and framework which would focus on optimization and utilization of energy resources through demand side management (DSM) while pursuing its quest for GNH.

ENERGY SCENARIO*

Building	*The highest energy consumer, this accounts for 48.7% of the total energy consumption, of which 91% is in the form of biomass.*
Industry	*The second largest consumer which accounts for 25 % of the total energy.*
Transport	*Fully dependant on imported fossil fuel and the fuel imports have increased to 4.25 billion BTN in 2011 from 721 million BTN in 2002.*
Agriculture	*Employs 79% of the population and is mostly dependent on human and animal power*

*As estimated prior to this study[1]

1.2 Identified sectors and scope of study

With the above background, the Royal Government of Bhutan has undertaken the *"baseline energy efficiency study"* to establish the baseline information that provides insights on energy consumption pattern for various activities, types of energy used, efficiency level, constraints and energy saving potential. The study is also expected to provide recommendations and broad strategies for enhancing energy efficiency levels in the country in the four identified sectors.

Table 1.1: Focus areas covered in the study

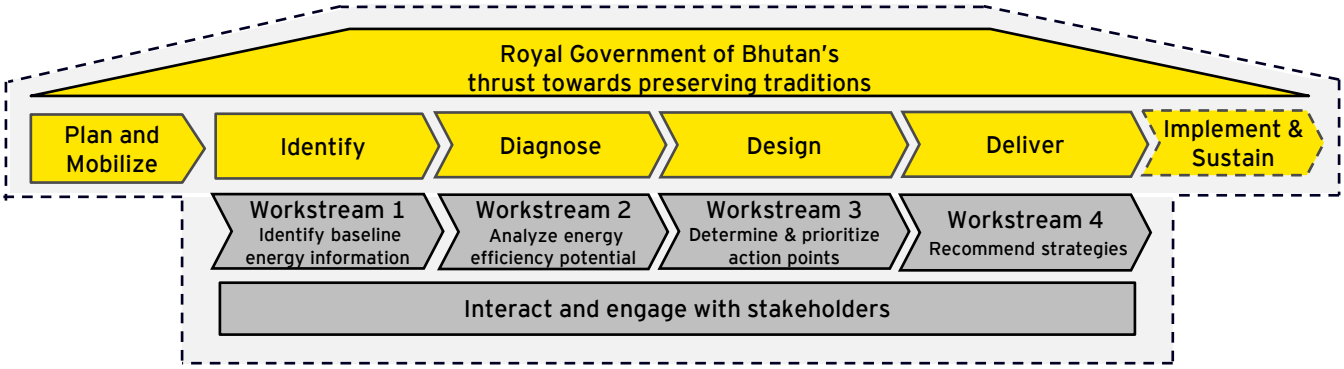
Identified energy intensive sectors			
Buildings	***Industry***	***Transport***	**Agriculture**
Key focus areas covered in the baseline energy efficiency study			
Baseline energy consumption	*Inventory of different energy systems in use.*		
Energy efficiency level	*Identification and quantification of energy efficiency potential, costs and benefits.*		
Energy efficiency interventions	*Identification of possible energy efficiency interventions and implementation strategies.*		
Recommendations	*Recommendations covering policy, regulatory, technological, economical, financial and social aspects.*		

1.3 Overall Approach

The following four workstreams were deployed in meeting with the objectives of the study:

- ***Workstream 1***: Identify energy baseline information in the identified four sectors of Bhutan;
- ***Workstream 2***: Analyze energy efficiency potential across sectors and technologies;
- ***Workstream 3:*** Determine and prioritize energy efficiency interventions and implementation strategies; and
- ***Workstream 4:*** Recommend strategies for enhancing energy efficiency levels in Bhutan;

Figure 1.2: Overall Approach



Identification of baseline energy information

Post the inception meeting, as the first step, specific questionnaires/data formats were developed to collect and compile energy data in each of the four sectors in Bhutan. Site visits were conducted across Thimphu, Phuentsholing, Bumthang and Mongar to collect data in varied geographies and further interact with stakeholders across industries, buildings, transport and agriculture sectors. Interviews and discussions were also scheduled with the various ministry / department officials in the Royal Government of Bhutan to get insights. The list of stakeholders met and interacted with as part of the study is provided in Annexure 1.

Apart from primary data, secondary data (relevant existing studies, survey reports) were also collected for the purpose of the study.

Analysis of energy efficiency (EE) potential

During this phase, the baseline energy efficiency data was analyzed and priority areas for energy efficiency were identified. The views of stakeholders identified were incorporated while conducting this analysis.

Based on the data collected and the interactions with identified stakeholders during site visits in each of the four sectors, the following steps were carried out in the process of identifying energy efficiency potential opportunities:

- Comparing the baseline technologies employed in each of the sectors with the Best Available Technologies (BAT). This was done through a comprehensive review of technologies available / deployed in comparable regions / geographies.
- Collection of input data for computation of energy savings through deployment of BAT and for conducting analysis through acceptable guideline sources (such as government authorities).
- Computing the energy saving potential of BAT scenario in each of the sectors.

Determination & prioritization of EE action points

In this phase, appraisal and prioritization of the action points was conducted through a robust appraisal process. Based on the output of the appraisal process a comprehensive energy efficiency enhancement implementation roadmap for Bhutan was developed. The appraisal process involved:

- Review of the existing energy and sector policies in Bhutan; Discussions with stakeholders conducted to understand the present barriers towards implementation.
- Comparing with policies worldwide in terms of countries with similar energy supply profile, best case energy efficiency policies and measures in identified sectors, drivers for such energy efficiency policies etc.,
- Based on the prioritization of action points and understanding of implementation barriers, recommendations were presented covering aspects such as fiscal incentives, regulatory mechanism and institutional framework.

Recommendation of strategies for enhancing EE

In the final workstep, relevant inputs from the stakeholders were considered and incorporated for finalization of the baseline report for enhancing energy efficiency in Bhutan.

1.4 Limitations of the study

Of the four sectors identified for the study, agriculture sector has not been concluded for potential evaluation and recommendations due to the following reasons:

- The electricity consumption is negligible in the agriculture sector. This is observed as most of the farm lands are naturally irrigated or fall under rain-fed areas. Though the Royal Government of Bhutan is considering the possibility of promoting irrigation based on electrical pumps, currently penetration of these pumps is limited which directly reflects the minimal electricity consumption.
- There is some fuel consumption through usage of tractors and tillers. However, the total number of power tillers and tractors at 1,087 and 282 respectively is minimal in the total vehicle inventory of 66,430 vehicles in Bhutan (As of 30th June 2012)[2].
- The forest cover in Bhutan is high and the Royal Government of Bhutan is committed to maintain the area under forests. Considering that the land available for agriculture is already constrained and there are emerging issues of food security, bio-fuel potential is limited, as indicated by representatives in the Government.

The other limitations cited as part of the study are:

- The baseline energy consumption has been computed for the year 2011. All energy consumption values mentioned in the report are for the year 2011, unless specifically indicated.
- The monetary contribution of energy costs in the baseline energy consumption has been undertaken considering factors such as electricity revenue from various consumer segments as indicated by Bhutan Power Corporation Limited (BPCL) and the monetary value of export/import of fuels data as indicated by Department of Trade, Royal Government of Bhutan. Care has been taken to ensure usage of representative values for computation of monetary contribution. However, it is to be noted that the evaluation is for indicative purposes only.
- The energy efficiency improvement potential mentioned in various sectors is an indicative figure based on comparison of Specific Energy consumption (computed through observed / collected data during site visits) with the representative best practice standards. A detailed energy audit is suggested to be conducted across these sectors, however, to ascertain the accurate energy efficiency potential available.

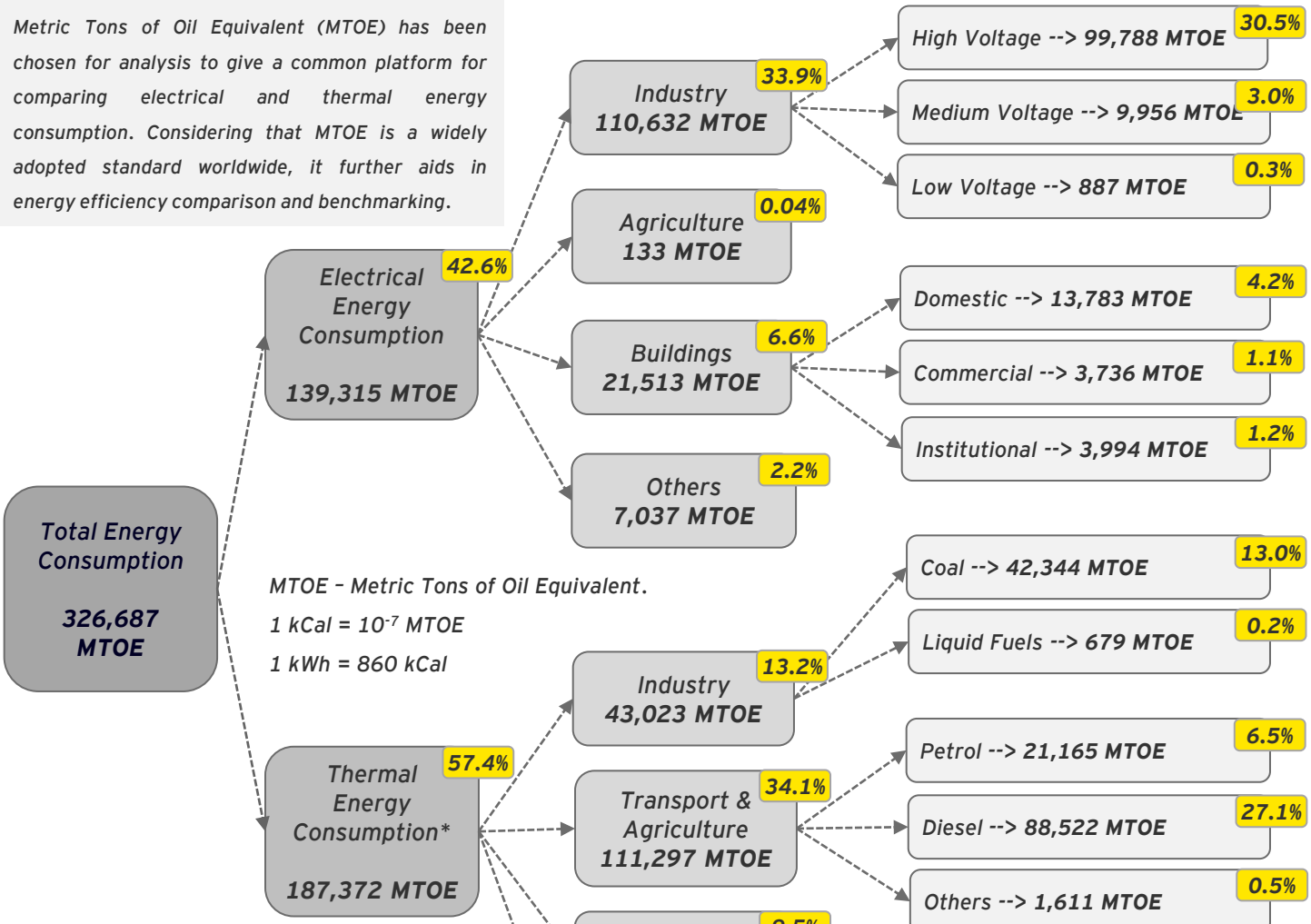
Chapter 2: Energy Baseline

2.1 Baseline Energy Consumption for the year 2011

The baseline energy consumption in Bhutan for the year 2011 stood at 326,687 Metric Tons of Oil Equivalent (MTOE). The electrical energy consumption stood at 139,315 MTOE (1620 GWh), contributing to 42.6% of the energy consumption while the thermal energy consumption* at 187,372 MTOE (1873 billion kCal) contributed to the rest. The sector and sub-sector split of energy consumption is provided in Figure 2.1.

Figure 2.1: Baseline Energy Consumption: Energy split[1]

Metric Tons of Oil Equivalent (MTOE) has been chosen for analysis to give a common platform for comparing electrical and thermal energy consumption. Considering that MTOE is a widely adopted standard worldwide, it further aids in energy efficiency comparison and benchmarking.



**The energy sourced through the consumption of fossil fuels and firewood is classified under thermal energy consumption. It is to be noted that the term "thermal energy consumption" does not signify end-use of energy in applications. Further, in the specific case of Bhutan, this term may be considered as "Non-Electrical Energy Consumption" in the four identified sectors.*

It is noticed from Figure 2.1 that the industrial sector is the highest consumer segment with 47.1% of the baseline energy consumption. The electrical energy consumption, which accounts for predominant energy consumption in the industry segment, stood at 110,632 MTOE while the thermal energy consumption accounts for 43,023 MTOE.

The transport and agriculture segment put together stands next with 111,430 MTOE translating to 34.1% of the baseline energy consumption. Except for 133 MTOE of electrical energy consumption in the agricultural sector, the rest of the energy is thermal consumption in the transport and agriculture segment (thermal consumption is predominantly through fuel consumption in transport sector; contribution of agriculture segment minimal as indicated in Chapter 2).

The buildings segment is the final sector in the list with contribution to 16.1% of the baseline energy consumption. While the thermal energy consumption in buildings stood at 31,194 MTOE, the electrical energy consumption was 21,513 MTOE.

There has been a minor contribution from other segments such as power house auxiliaries, street lighting, temporary connections etc., in the electrical energy consumption and bitumen, lubes etc., in the thermal energy consumption.

When the sub-sector energy consumption is further dwelled upon, the major energy consumption areas observed are (mentioned in Tables 2.1 to 2.4):

Table 2.1: Major areas of electrical energy consumption: Industry[2]

High Voltage Consumers → 99788 MTOE	***30.5%***
BHUTAN CARBIDE & CHEMICALS LTD, (BCCL)	
BHUTAN FERRO ALLOYS LTD (BFAL)	
DRUK FERRO ALLOYS	
DRUK WANG ALLOYS	
BHUTAN FERRO INDUSTRIES	
SAINT GOBAIN	
UGYEN FERRO ALLYOYS	
LHAKI STEELS & ROLLING MILLS	
BHUTAN CONCAST	
S.K.W TASHI METALS & ALLOYS	
SILICON PRIVATE LIMITED	
PCA PRIVATE LIMITED	
PUNATSANGCHU HYDRO PROJECT	

Medium Voltage Consumers → 9956 MTOE	***3.0%***
DRUK CEMENT COMPANY PVT. LTD	*BHUTAN ROLLING MILL PVT.LIMITED*
TASHI BEVERAGE LTD. PA	*OMZIN MANUFACTURING COMPANY*
MAJUR OXYGEN & GASSES	*BHUTAN STEEL INDUSTRIES*
YARAB PVT. LTD. DRAWING UNIT	*DRUK IRON & STEEL COMPANY LTD.*
RSA POLY PRODUCTS (P) LTD.	*K.K. STEEL PVT. LTD.*
RANGSHAR INDUSTRIES PVT. LTD.	*QUALITY GASES (PVT) LTD*
YARKEY POLY PRODCUTS PVT. LTD	*KARMA FEEDS*
RSA, PRIVATE LTD. Marble division	*KUENPHEN NORDEN CRUSHING UNIT*
BHUTAN MILK & AGRO PRIVATE LIMITED	*DAMCHEN TALC INDUSTRIES (SADUMADU)*
BHUTAN BREWERY COMPANY LTD.	*MET TRADE BHUTAN LTD*

Table 2.2: Major areas of thermal energy consumption: Industry[3]

Table 2.3: Major areas of energy consumption: Buildings[4]

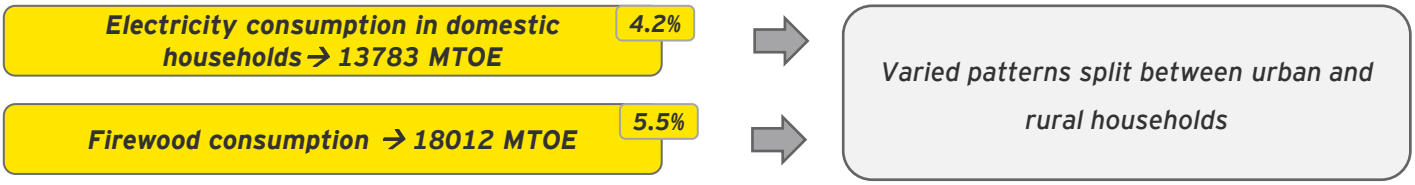
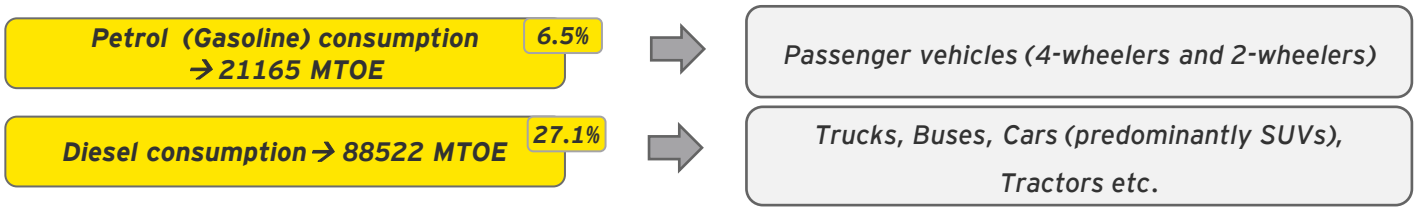


Table 2.4: Major areas of energy consumption: Transport & Agriculture[5]



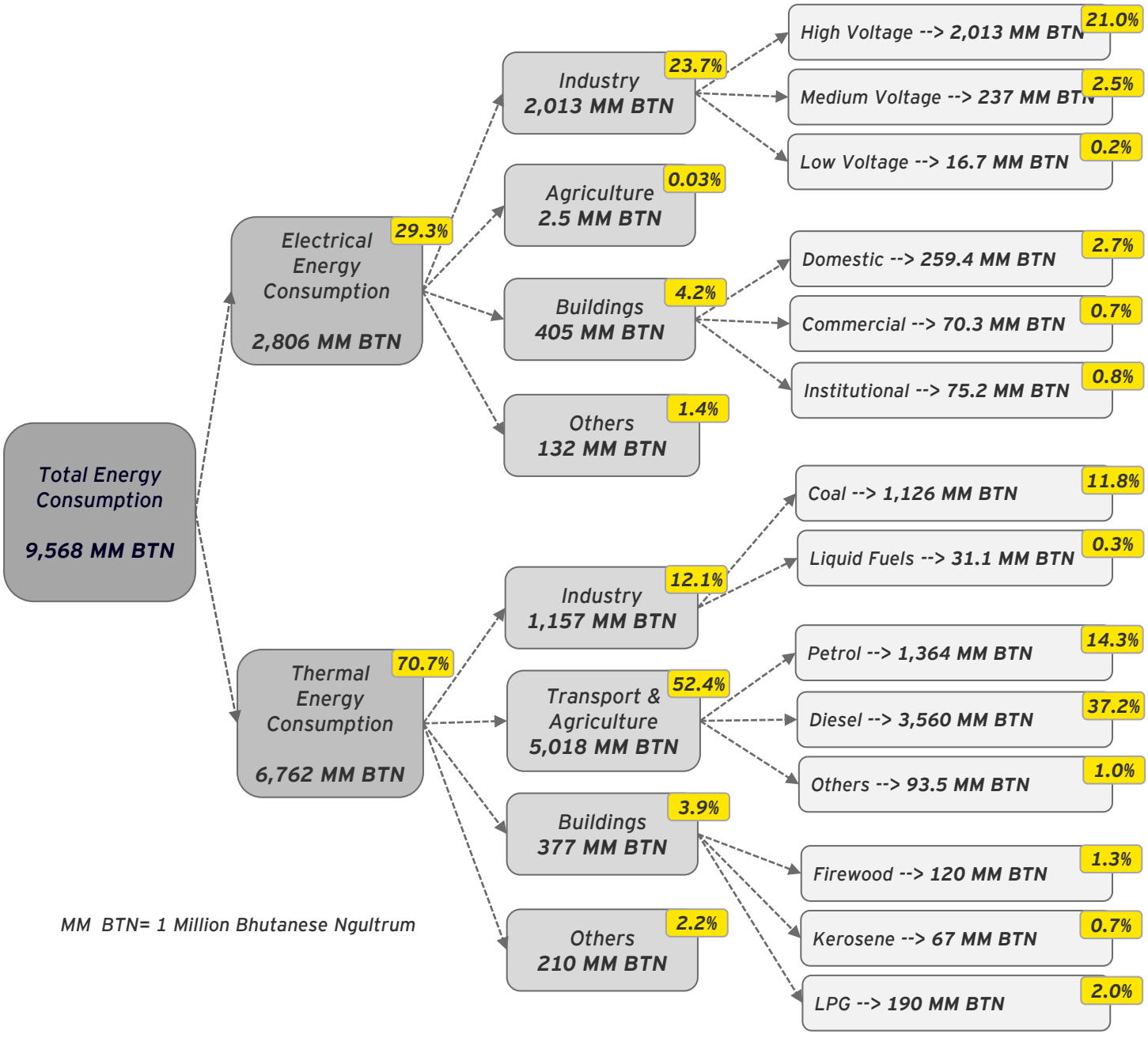
Further analysis on the energy consumption in the major areas identified are provided in the subsequent sub-sections.

When the baseline energy consumption is analyzed for monetary contribution among sectors, a varied pattern is observed as indicated in Figure 2.2. The total cost of baseline energy consumption stood at 9,568 Million Bhutanese Ngultrum (BTN). While electrical energy consumption accounted for 2,806 Million BTN, translating to 29.3% of the total cost, thermal energy consumption accounted for 6,762 Million BTN, contributing to the major 70.7% of the total cost.

The comparison of the energy split with the monetary split clearly indicates the reduced electricity costs due to low tariff. While the electrical energy consumption accounted for 42.6% of contribution in energy terms, its monetary contribution is significantly lesser at 29.3%. The thermal energy contribution on the other hand has increased substantially to 70.7% in cost terms, from 57.4% in energy terms.

More than half of the energy cost has been contributed by the consumption of petrol (gasoline) and diesel. While petrol accounts for 14.3% of the costs, diesel accounts for a significant 37.2% of the costs.

Figure 2.2: Baseline Energy Consumption: Monetary terms[6]

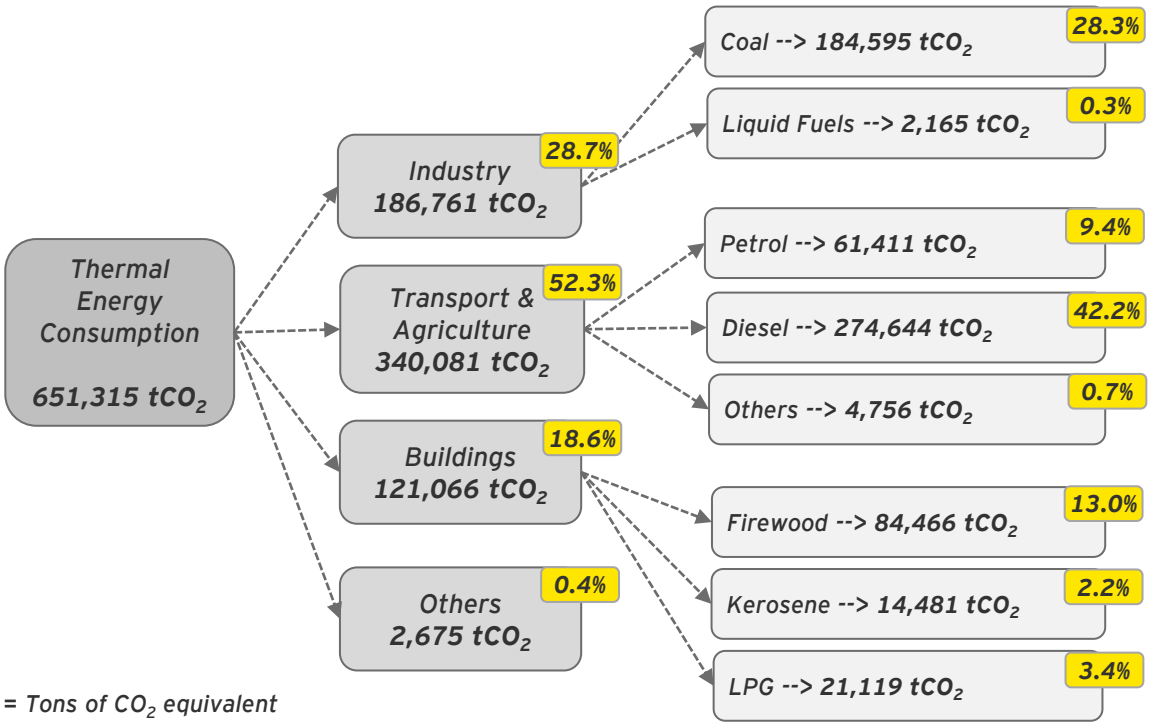


MM BTN= 1 Million Bhutanese Ngultrum

With petroleum products fully imported from India, the overall cost of these imports to the Bhutanese exchequer stood at 5,516 Million BTN. Apart from petrol, diesel and other fuels used in the transportation and agriculture sector, other major petroleum products consumed include kerosene and LPG used in households and buildings and diesel, furnace oil and kerosene oil used in Industries.

On the environment front, the electrical energy consumption which is through hydro electricity generation acts as a carbon sink. The carbon emissions as a result of the thermal energy consumption is documented in Figure 2.3

Figure 2.3: Baseline Thermal Consumption: Carbon emissions split[6]



tCO_2 = Tons of CO_2 equivalent

2.2 Analysis of baseline electricity consumption

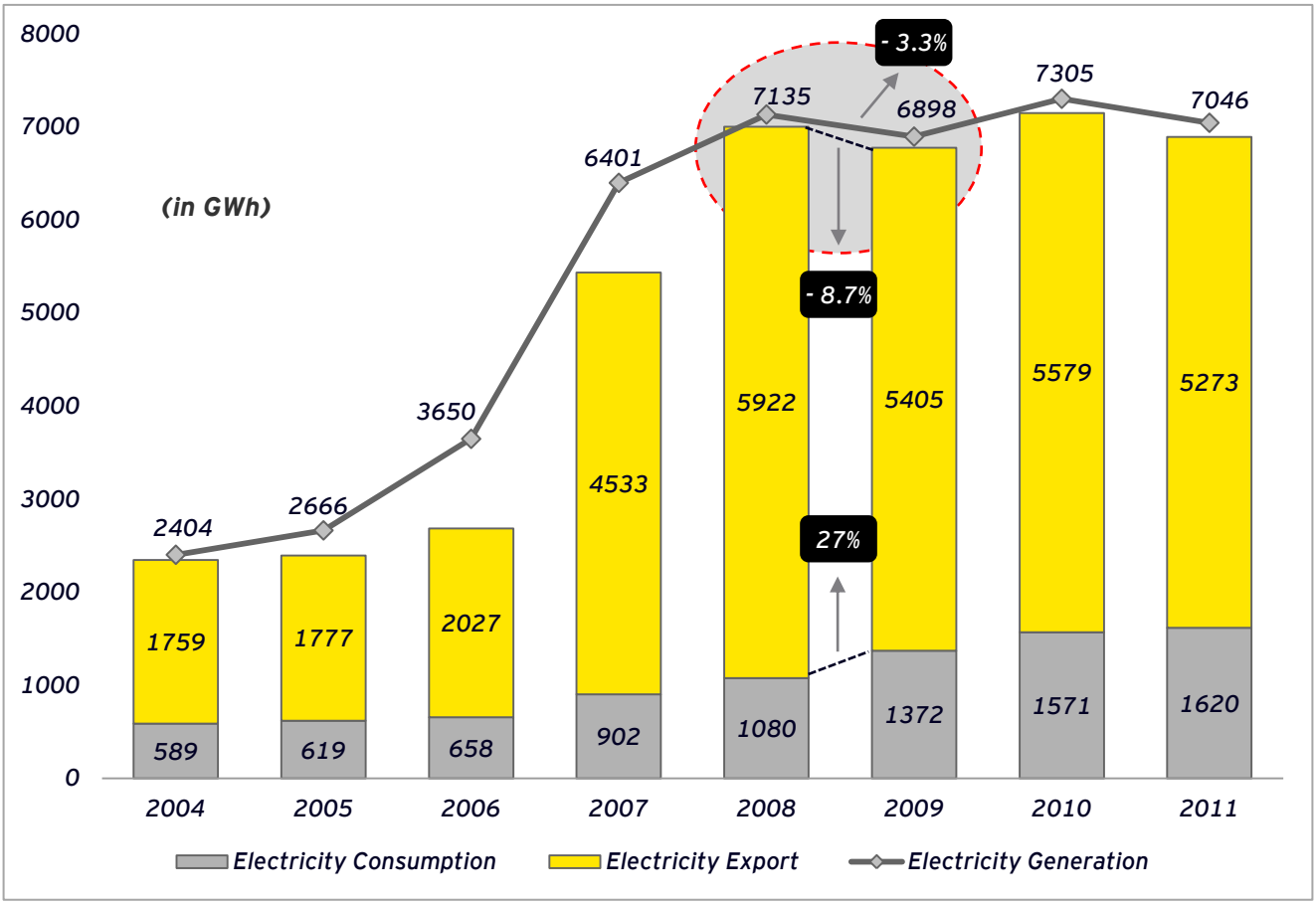
Over the years, with increased electrical connectivity and rising urbanization, the electricity consumption has seen rapid growth in Bhutan. The electricity consumption has been on a continuous upward trend with a Compounded Annual Growth Rate (CAGR) of 15.5% between 2004 and 2011. The electricity consumption in the year ending 2011 stood at 1620 GWh.

On the electricity generation front, post commissioning of the Tala Hydroelectricity project in 2007, consistently more than 70% of the electricity generated in Bhutan has been exported to India until 2011. In 2011, the electricity generation stood at 7046 GWh with about 5273 GWh of electricity exported to India. The electricity generation, consumption and export statistics between 2004 and 2011 are provided in Figure 2.4.

ANALYSIS SNAPSHOT

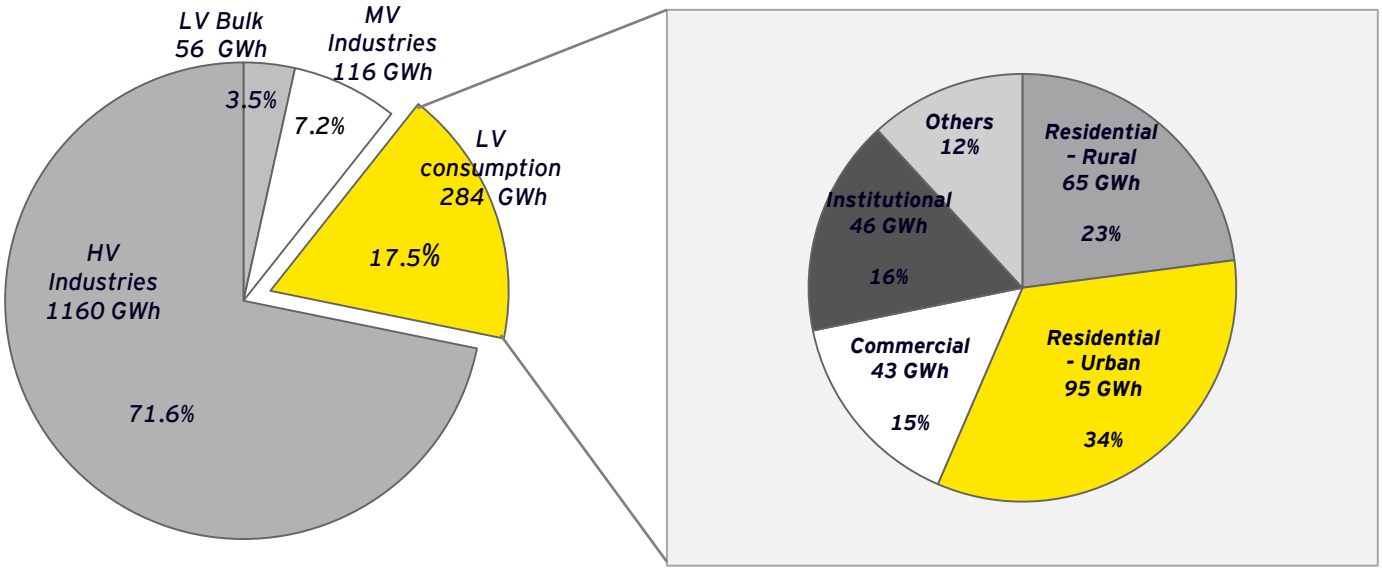
The need for energy efficiency is clearly captured by the years 2008 and 2009. It is noticed from Figure 2.4 that a drop in electricity generation by 3.3% has resulted in a enhanced reduction in electricity export to India by 8.7%. This is directly due to the constant increase seen in electricity consumption in Bhutan. This situation replicates itself for the years 2010 and 2011. Hence, any minor decrease in electricity generation due to seasonal variances has a much more pronounced impact on electricity export to India and thereby the revenue generated from export to the Bhutanese economy.

Figure 2.4: Bhutan Electricity growth statistics[6]



On the analysis of the electricity consumption it is noted that High Voltage (HV) and Medium Voltage (MV) Industries account for more than 79% of the electricity consumption in Bhutan in 2011. The total electricity consumption through HV and MV Industries stood at 1281 GWh.

Figure 2.5: Electricity consumption split[6]



The buildings sector comprising of Domestic, Commercial and Institutional in the LV consumption segment accounted for the next significant component of composition with more than 15% contribution to the consumption. On further analysis, it is noted that urban households (domestic consumers) top the consumption in buildings sector. Urban households consumed more than one-third of the 284 GWh consumption in the LV consumption segment. The detailed electricity consumption split is provided in Figure 2.5.

Analysis of baseline electricity consumption: Industry

As identified previously, electricity consumption in industry is one of the major energy segments contributing to 33.9% of the baseline energy consumption, with the HV and MV industries contributing to more than 79% of electricity consumption in 2011.

During the study it is noted that a group of seven ferro-alloy industries consumes 852 GWh and is the largest electricity consuming sub-segment accounting close to two-thirds of the electricity consumption in industry segment. The highest consumer is Bhutan Ferro Alloys Limited (BFAL) which consumed 265 GWh of electricity. Four other players (Silicon Private Limited, Druk Wang Alloys, Ugyen Ferro Alloys, Bhutan Ferro Industries) in the ferro-alloy industry consumed more than 100 GWh of electricity in 2011.

The second highest consumer in the industry segment is Bhutan Calcium Carbide Limited. As the only

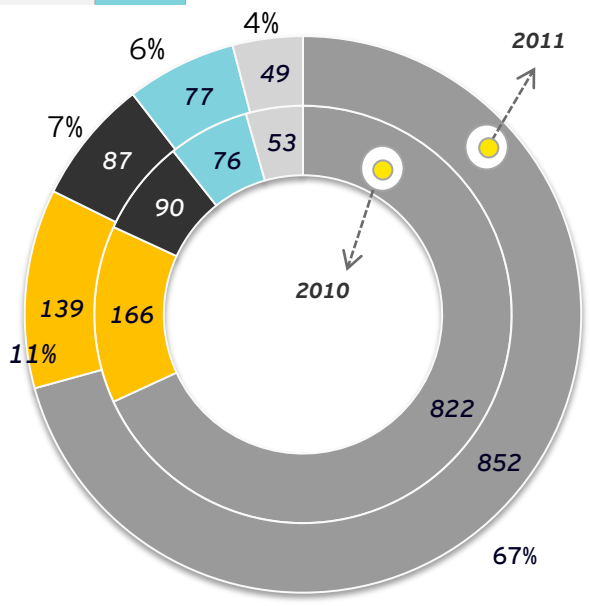
Figure 2.6: Electricity consumption in Industry: Major consumers[7]

SILICON CARBIDE	GWh
SAINT GOBAIN	77

CEMENT	GWh
PCA PVT LTD	49

IRON & STEEL	GWh
LHAKI STEELS & ROLLING MILLS	34
DRUK IRON & STEEL COMPANY LTD*	23
K.K. STEEL PVT. LTD*	15
BHUTAN STEEL INDUSTRIES*	13
BHUTAN CONCAST	3

CALCIUM CARBIDE	GWh
BHUTAN CALCIUM CARBIDE LIMITED	139



FERRO ALLOYS	GWh
BHUTAN FERRO ALLOYS LTD	265
SILICON PRIVATE LIMITED	122
DRUK WANG ALLOYS	118
UGYEN FERRO ALLOYS	105
BHUTAN FERRO INDUSTRIES	100
DRUK FERRO ALLOYS	96
S.K.W TASHI METALS & ALLOYS	46

* - Medium voltage consumers

Ferro Alloys Calcium Carbide Iron & Steel Silicon Carbide Cement

major representative of the Calcium Carbide industry in Bhutan, BCCL consumed 139 GWh of electricity. The two highest industry consumers, BFAL and BCCL together accounted for 404 GWh electricity translating to 31.6% of electricity consumption in the industry segment.

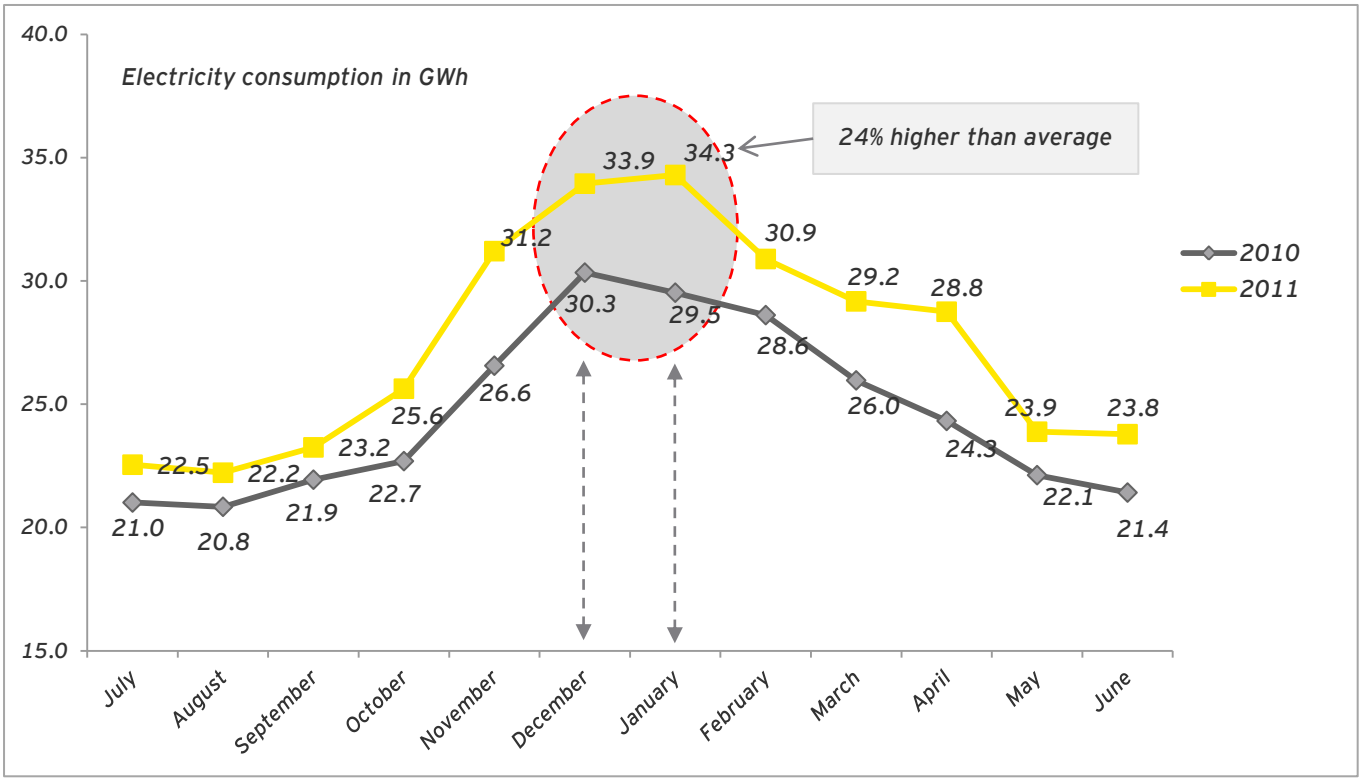
The iron and steel industry, represented majorly by 5 consumers (Lhaki Steels & Rolling Mills, Druk Iron & Steel Company Ltd., K.K Steel Pvt. Ltd., Bhutan Steel Industries and Bhutan Concast) accounted for 7% of the electricity consumption in HV and MV industries. These iron and steel industries together consumed 87 GWh of electricity as indicated in Figure 2.6.

The other major consumers were Saint Gobain, consuming 77 GWh of electricity, and Penden Cement Authority Pvt Ltd., consuming 49 GWh of electricity, representing the Silicon Carbide and Cement Industry respectively. With the commissioning of Dungsam Cement Corporation Limited's plant, the contribution of cement industry to the electricity consumption is expected to increase by more than 100 GWh in the upcoming years.

Analysis of baseline electricity consumption: Buildings

The buildings segment accounted for a little more than 250 GWh of electricity consumption in the year 2011. The electricity consumption pattern in Bhutan is dictated by consumption in HV and MV industries which in turn is determined by market forces. However, when the non-industry segment (predominantly buildings) is analyzed for monthly consumption a clear seasonal pattern emerges as indicated in Figure 2.7.

Figure 2.7: Electricity consumption in Non-Industry: Month-wise[8]



ANALYSIS SNAPSHOT

The peaking of electricity consumption in the months of December and January is observed in the non-industry segment (predominantly buildings sector) as indicated in Figure 2.7 coinciding with the peak winter season. In 2011, the highest consumption was observed in January where the electricity consumption was 24% more than average monthly consumption for 2011. A similar trend was observed in 2010 as well. This increased consumption, predictably due to the increased heating load, indicates the potential available for driving the usage of energy efficient equipments in households and setting up of standard energy efficient building codes.

While December and January peaking in electricity consumption, alternatively the summer months of July and August had the minimum electricity consumption.

To understand the sub-segment contribution to electricity consumption the building segment has be broadly classified into:

(a) Domestic Households: Urban Households & Rural Households

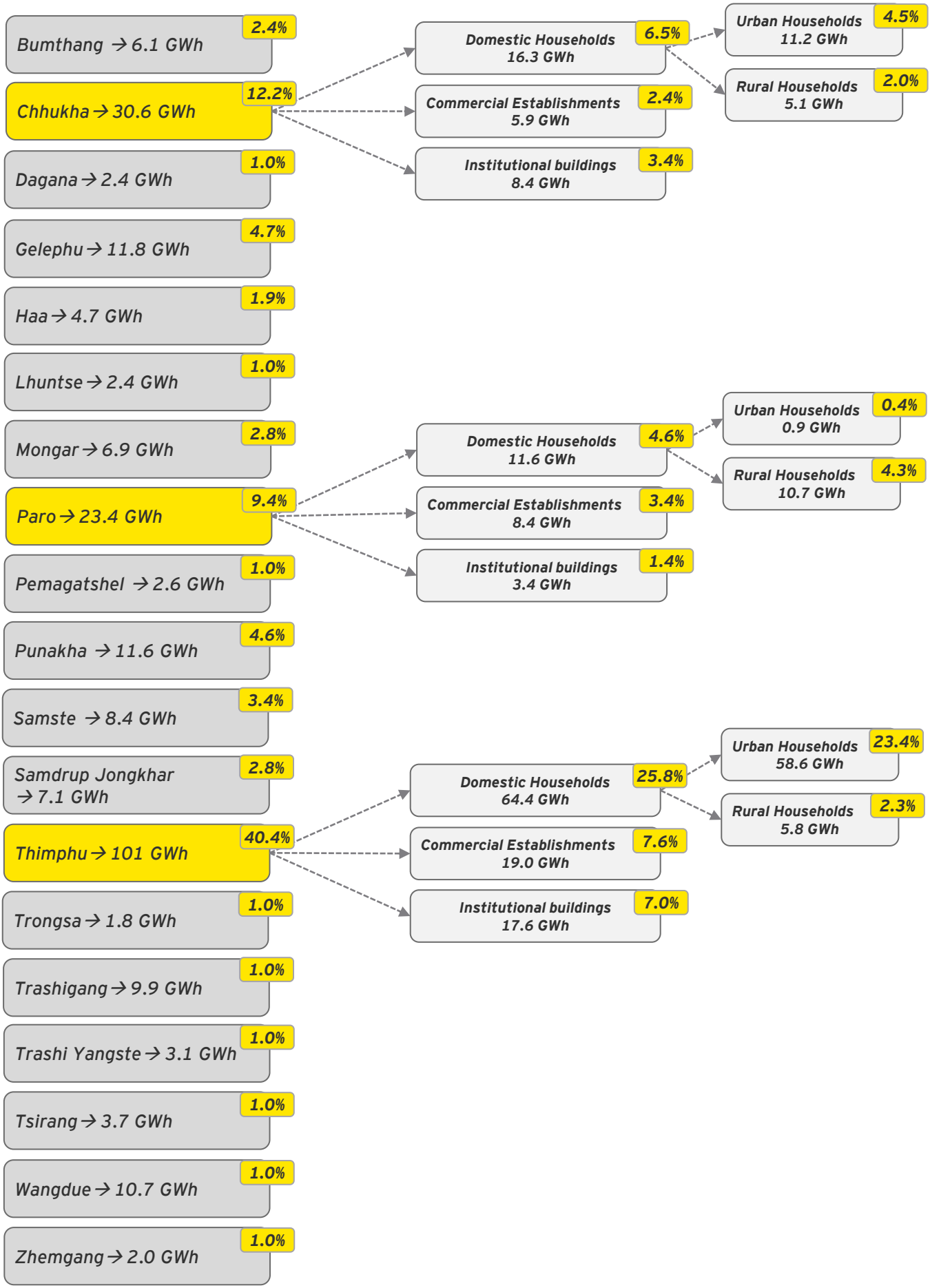
(b) Commercial Establishments

(c) Institutional buildings

The urban domestic households contribute to the maximum electricity consumption in the buildings segment. The urban households alone consumed 95 GWh of electricity of the 250 GWh of electricity consumed by buildings segment in Bhutan in 2011. The rural households stood next with a consumption of 65 GWh of electricity in 2011. The domestic households put together accounted for close to two-thirds of the electricity consumption in the buildings segment. The institutional buildings with about 46 GWh of electricity consumption along with the commercial establishments with about 43 GWh of electricity consumption accounted for the rest of the consumption in the buildings segment in 2011.

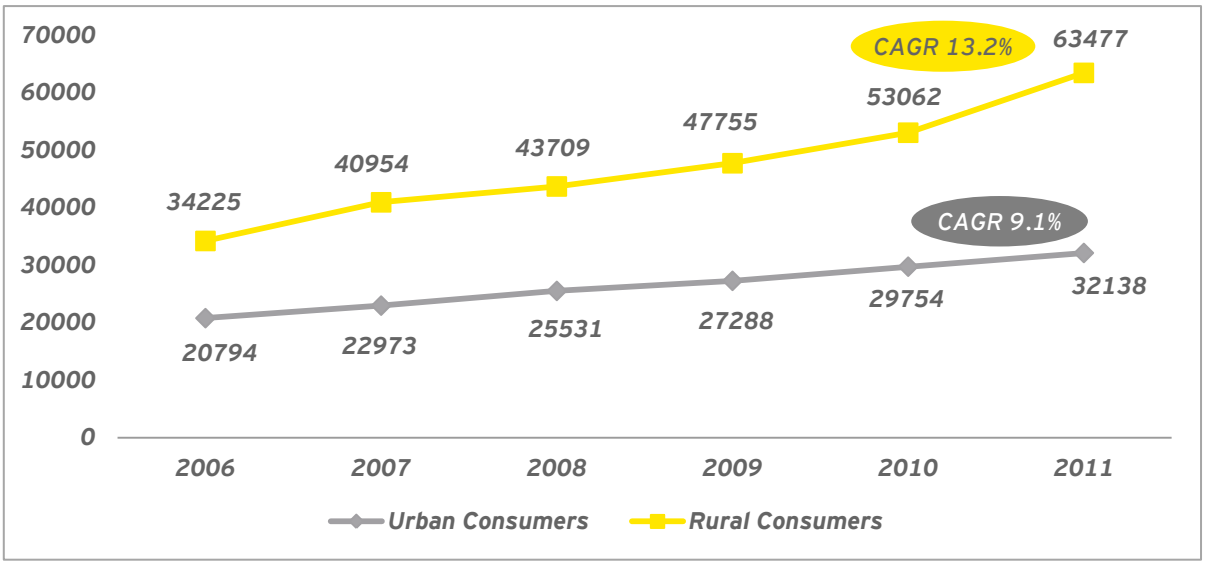
On region-wise analysis, it is noted that the buildings in Thimphu alone has consistently accounted for more than 40% of the electricity consumption in buildings segment. Buildings in Thimphu Dzongkhag consumed more than 101 GWh of electricity in 2011. Apart from Thimphu, Chhukha and Paro are the other Dzongkhags with high electricity consumption in the buildings segment consuming 30.6 GWh and 23.4 GWh respectively. The buildings in these three Dzongkhags put together accounted for 62% of the electricity consumption in the buildings segment in Bhutan in 2011. The detailed region-wise split in electricity consumption in buildings is provided in Figure 2.8.

Figure 2.8: Electricity consumption in Buildings: Region-wise split[8]



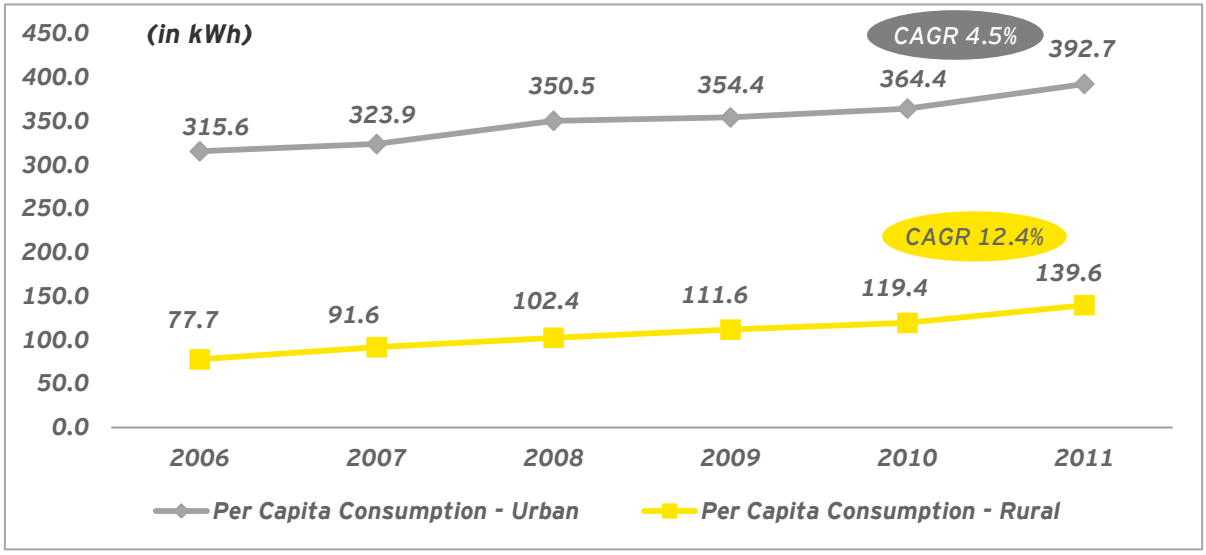
There has been substantial growth observed in the electrical connectivity to Bhutanese households. While the rural consumers of electricity has increased from 34,225 in 2006 to 63,477 in 2011 at CAGR of 13.2%, the increase in urban consumers has been more moderate from 20,794 to 32,138 at a CAGR of 9.1% as indicated in Figure 2.9. This is line with the Rural Electrification (RE) programme which aims at achieving near to 100% electrification by end of 2013 from achieved levels of 70% in 2007 (54% in rural households and 97% in urban households in 2007).

Figure 2.9: No. of Household Consumers trend[8]



Further, the per capital electrical consumption has been analyzed by projecting the rural and urban population based on the methodology adopted by National Statistics Bureau in the Dzongkhag Population Projections 2006-2015 report. The per capita consumption has increased at CAGR 12.4% between 2006 and 2011 for rural households and at CAGR 4.5% for urban households as indicated in Figure 2.10.

Figure 2.10: Per Capita Electrical Consumption trend: Households[9]



ANALYSIS SNAPSHOT

(a) In the urban residential households, which is the highest consumption segment in buildings, Thimphu Dzongkhag consumes more than 61% of the electricity. It is worth noting, however, Thimphu accounts for only 48% of the number of consumers. With average urban population per electricity connection at 5.6, which is among the lowest in the country, this is an indication that with growing affluence and access to electricity, the per capita consumption is probable to increase substantially.

(b) The per capita electricity consumption in the average urban household is close to 3 times that of the comparative rural household. However, the population per electricity connection is roughly the same in both urban and rural households at 7.5 and 7.3 respectively. With increasing access to electricity and electrical appliances, based on the trends observed, it is possible to expect that the per capital electricity consumption would increase even as the addition of new consumers flatten over the next ten years.

2.3 Analysis of baseline thermal consumption

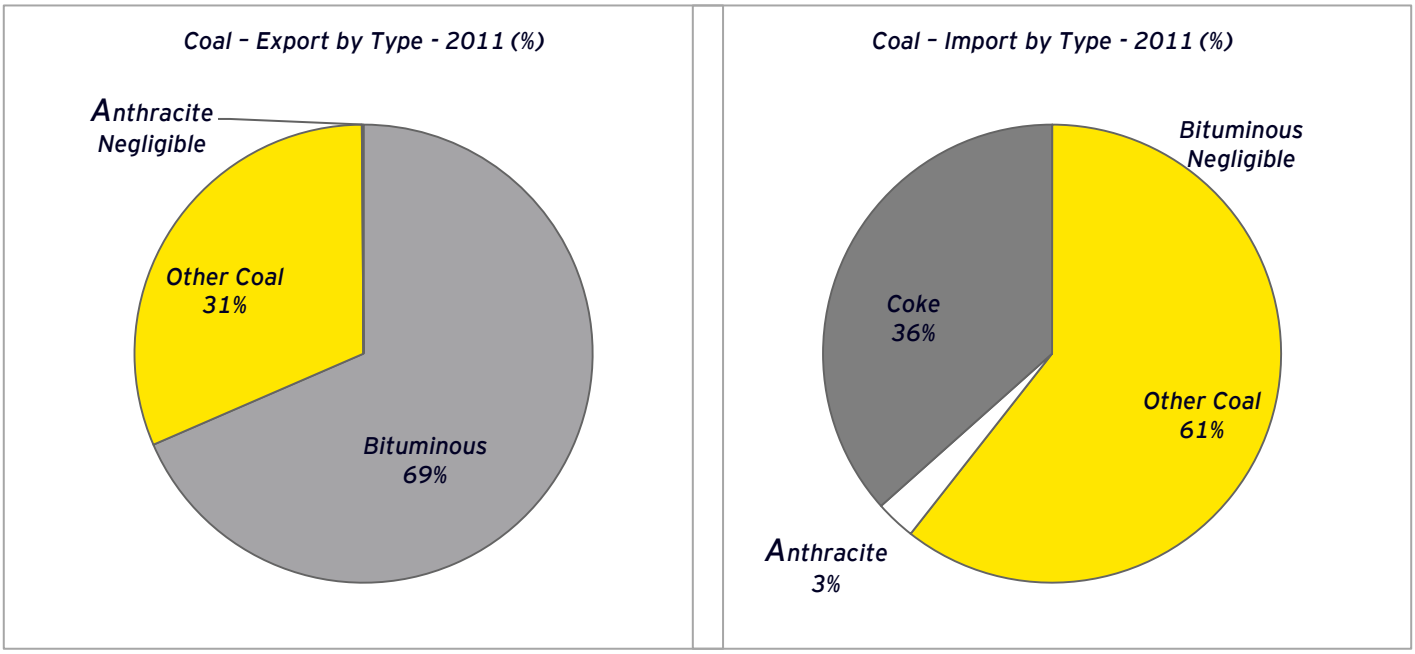
The baseline thermal consumption, as observed in Figure 2.1, is dominated by usage of petroleum products in transportation and agricultural sector, usage of coal in industries, and usage of firewood in the buildings segment. While the transportation and agricultural sector accounted for 59% of the baseline thermal consumption in Bhutan in 2011, the industrial segment contributed close to 23% followed by buildings segment to 16.6%.

Analysis of baseline thermal consumption: Industry

The thermal energy consumption in Industry is dominated by the use of coal. Liquid fuels represented by usage of diesel, kerosene oil and furnace oil account for less than 2% of the industry thermal energy mix.

In 2011, consumption of domestically-mined Bhutanese coal stood at 38,543 tons. There was substantial import of coal at 119,020 tons, while the export of coal stood at 80,481 tons. While the domestic production and subsequent exports is dominated presently by Bituminous coal, the imports largely consist of coal categorized as 'Other Coal' which has lesser calorific value when compared to Bituminous and Anthracite Coal. The coal export and import split based on type of coal for 2011 are provided in Figure 2.11.

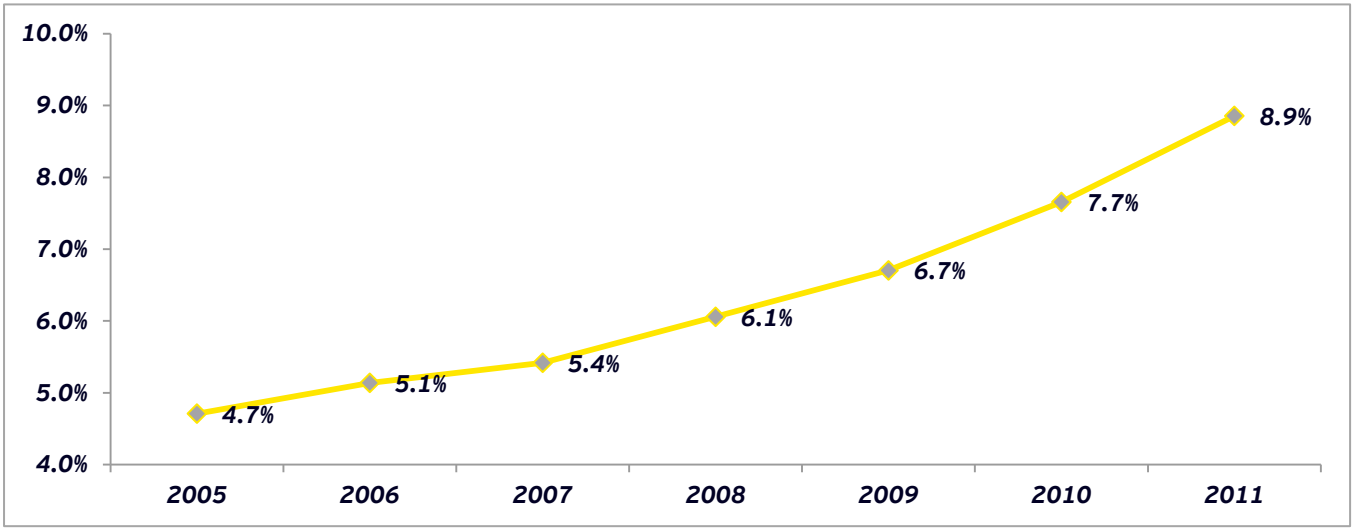
Figure 2.11: Coal Export and Import split by type[5]



Analysis of baseline thermal consumption: Transport & Agriculture

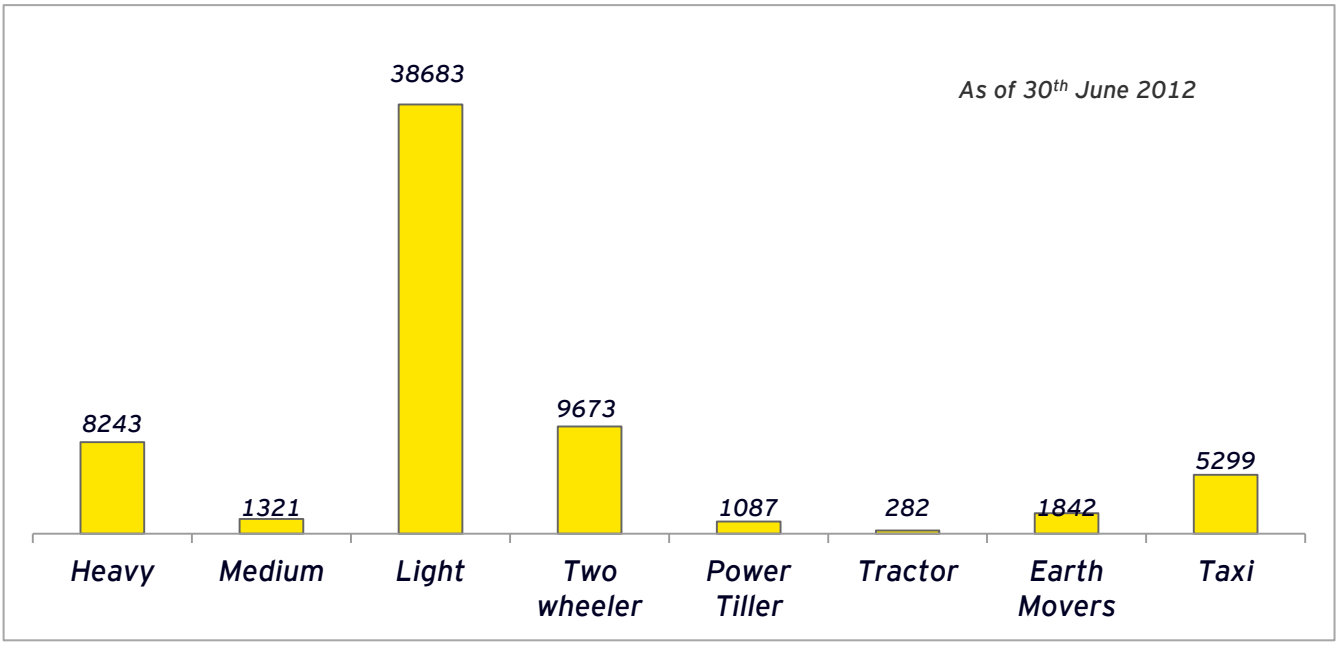
Fuel consumption in the transportation and agriculture segment (predominantly transportation sector) is the single largest energy consumption segment with 34.1% contribution to the baseline energy consumption in 2011, slightly higher than electricity consumed in industries segment. The vehicle inventory in Bhutan has seen on a steady increase between 2005 and 2011. The vehicle inventory to population percentage has in fact increased from 4.7% in 2005 to 8.9% in 2011. As of 2011, one of every eleven persons in Bhutan owned a vehicle. The trend of vehicle inventory to population percentage over the years is indicated in Figure 2.12.

Figure 2.12: Vehicle Inventory to population percentage trends[10]



As of 30th June 2012, more than 91% of the vehicles in Bhutan are privately owned. Light vehicle is the largest sub-category with 38,683 number of vehicles, contributing to 58.2% of the vehicle inventory. It is followed by two wheelers and heavy vehicles at 14.6% and 12.4% respectively. The vehicle inventory based on type is provided in Figure 3.13.

Figure 2.13: Vehicle Inventory by category[11]



On the public transportation front, it is noticed that the inventory of buses to the total population has increased by a CAGR of 8.4% between 2008 and 2012 while the ratio of total vehicle inventory to population has shown a steeper growth of 11.1%. This indicates, to an extent, the decrease in public transport access for people, in the recent years.

During the study it is noted that diesel is the most preferred fuel option in the transportation sector with consumption of 103,690 kilolitres in 2011. This diesel consumption is 3.87 times more than petrol (gasoline) consumption in Bhutan. The consumption of petrol is much lesser at a distant 26,761 kilolitres. The premium fuel variants such as Speed and Hi-Speed was observed to have minimum patronage from consumers. The fuel consumption figures in 2011 are provided in table 2.5.

Table 2.5: Fuel Consumption figures: Transportation and Agriculture[5]

Fuels	Consumption (Kilo Litre)
Diesel	103,690
Petrol (Gasoline)	26,761
Speed*	175
Hi-Speed*	268
ATF	1,455

*Speed and Hi-Speed are branded Premium fuels marketed by Bharat Petroleum which contain special performance additives

Analysis of baseline thermal consumption: Buildings

The predominant contribution of thermal energy (fuels) in the domestic segment is through the use of firewood. Consumption of firewood contributed to 18,012 MTOE, accounting for 58% of the thermal energy consumption in buildings segment as indicate in Figure 2.14.

The consumption of Liquefied Petroleum Gas (LPG) accounted for 8,372 MTOE followed by kerosene at 4,810 MTOE in 2011.

Between 2009 and 2011, the consumption of kerosene has seen a much more modest growth at 2.8% when compared to consumption of LPG which has grown substantially at 12.5% CAGR. The consumption trends of the fuels used in the buildings segment is provided in Figure 2.15. The consumption of firewood has decreased significantly from 50,770 tons in 2009 to 37,950 tons indicating a de-growth of 13.5% CAGR.

Figure 2.14: Thermal Energy Consumption in Buildings: Fuel category split[12]

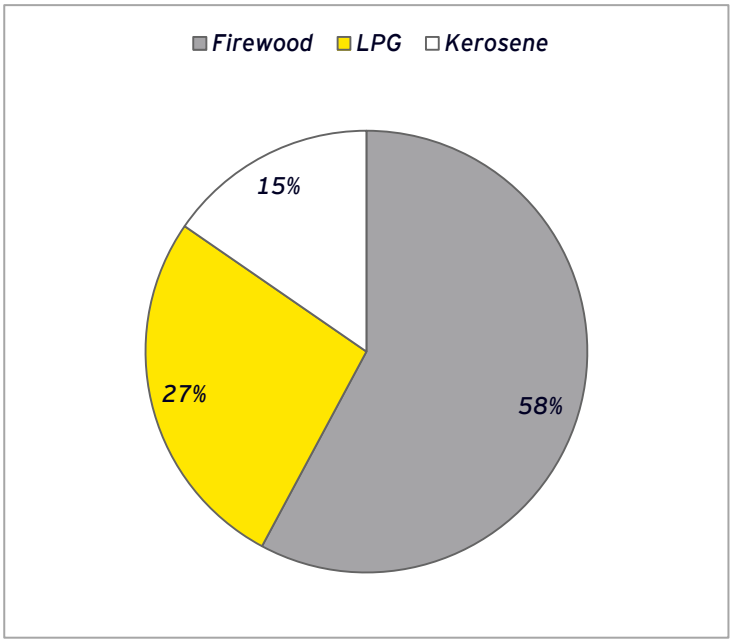
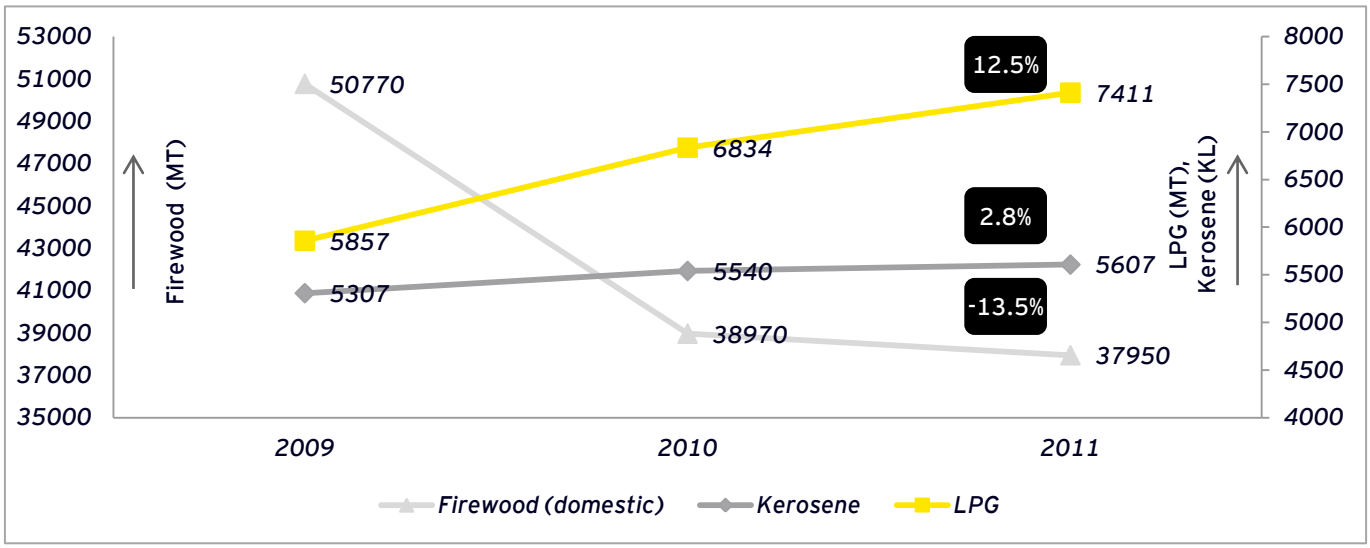


Figure 2.15: Fuel consumption in Buildings: Consumption trend[12]



The decrease in firewood consumption is observed in parallel with increased LPG usage along with increased penetration of electricity in rural areas indicating a significant shift in the consumption pattern among households.

Snapshots of Chapter 2: Energy Baseline

- *The baseline energy consumption in 2011 for Bhutan stood at 326,687 MTOE.*
- *Electrical energy contributed to 139,315 MTOE / 1620 GWh (42.6%) and thermal energy contributed to 187,372 MTOE / 1873 Billion kcal (57.4%).*
- *Industrial sector is the highest energy consumer segment accounting for 153,655 MTOE (47.1%) of the energy consumption followed by transport and agriculture sector (accounted predominantly by transport) put together at 111,430 MTOE (34.1%) and buildings sector at 52,707 MTOE (16.1%).*
- *In monetary terms, the baseline energy consumption accounted for 9.57 Billion BTN. Thermal energy consumption accounted for the major cost with 6.76 Billion BTN (70.7%) contribution.*
- *Any drop in electricity generation over subsequent years has resulted in enhanced magnitude of reduction in electricity export to India presenting a clear case for energy efficiency.*
- *13 consumers in High Voltage (HV) Industry segment account for 1160 GWh (71.6%) of the electricity consumption translating to 30.5% of the energy consumption.*
- *7 Ferro-Alloy Industries consumed 852 GWh accounting for two-thirds of the electricity consumption in the industries segment.*
- *Peaking of electricity consumption (24% higher than average in 2011) is observed in the months of December and January in the non-industry segment (predominantly buildings sector) coinciding with the core winter season.*
- *The domestic households (urban – 95 GWh, rural – 65 GWh) accounted for close to two-thirds of the electricity consumption in the buildings segment.*
- *Thimphu Dzongkhag has consistently accounted for more than 40% of the electricity consumption (101 GWh in 2011) in the buildings segment.*
- *Diesel consumption at 88,522 MTOE accounts for 27.1% of the energy consumption.*
- *The decrease in firewood consumption in the buildings segment is observed in parallel with increased LPG usage along with increased penetration of electricity in rural areas indicating a significant shift in the consumption pattern among households.*

Chapter 3: Energy Efficiency Potential

3.1 Energy Efficiency Potential in Industrial sector

During the study, site visits were conducted at six representative energy intensive industry facilities in Bhutan. These facilities, as indicated in Annexure 1, represent wide range of industry sectors such as Cement, Ferro-alloy, Calcium Carbide, Iron & Steel etc. A walk through assessment was conducted at most of these facilities and the company representatives were interviewed to understand the current perceived levels of energy efficiency and the barrier towards implementation of energy efficiency measures. Further, energy consumption and production data was collected from these facilities to derive the Specific Energy Consumption (SEC) of the processes. This SEC was then benchmarked for comparable processes internationally. The possible energy efficiency potential available and the anticipated monetary savings as a result of reduction in energy consumption in these facilities is indicated in Table 3.1

Table 3.1: Energy Efficiency potential in representative industry facilities

Industry name	Main Product	Installed Capacity (MT)	Production (MT)	Specific energy consumption (kWh/Ton)	Average Benchmark energy consumption (kWh/Ton)	Conservative Potential energy efficiency improvement*	Estimated potential per year (MWh)	Financial savings to the facility per year (MM BTN)	Financial savings to the country per year (MM BTN)
Druk Iron & Steel Pvt. Ltd.	MS Ingot	61200	23746	851	534[1]	30%	6062	10.4	1.8
Bhutan Steel Industries Limited	MS Ingot	8580	7777	800			1866	3.2	0.5
Bhutan Ferro Alloys Limited	Ferro Silicon (FeSi)	31000	27605	9000 (72-74% Si, 24-26% Fe)	8166[2]	9%	22360	34.4	10.3
Bhutan Carbide & Chemicals Ltd. (BCCL)	SiMn	NA	11139	6300	4875[2]	20%	14035	21.6	6.5
	Calcium Carbide	22000	24486	3800	3000[3]	20%	18609	28.7	8.6
Penden Cement Authority Limited (PCA)	Cement	400000	406559 (cement)	131.33	80[4]	35%	18688	28.8	8.6
			261405 (clinker)	1053 (kcal / kg of clinker)	667[4] (kcal / kg of clinker)	35%			

**The energy efficiency improvement potential mentioned is an indicative figure based on comparison of SEC with the best in industry standards. A detailed energy audit is suggested to be conducted at all these energy intensive industries to ascertain the accurate energy efficiency potential available.*

It is observed during site visits and interactions that there is substantial potential for implementation of energy efficiency measures in industrial facilities. Several industry representatives, during discussions, acknowledged the potential available for energy efficiency in industries. Table 3.1 reiterates this fact on the potential available in industries. There was broad consensus that there was limited awareness on energy efficiency among operators / workers in the industry and there were limited financial incentives to establish a business case for investing in energy efficient technology especially considering the low electricity tariff. In fact, there were also opinions from industry representatives that their respective industries were cost competitive primarily because of the lesser electricity tariff despite the inefficiency in energy use. Considering that the industries segment accounted for 47.1% of the baseline energy consumption in 2011, it is pertinent that energy efficiency policy to be developed by the Royal Government of Bhutan pays substantial importance towards driving energy efficiency in industries segment.

3.2 Energy Efficiency Potential in Buildings sector

As part of the study, various buildings in the residential (both urban and rural), commercial and institutional segment were visited and energy consumption data was collected. The buildings in varied temperature zones were considered for the analysis. The data collected was then compared with benchmark figures to estimate energy efficiency potential.

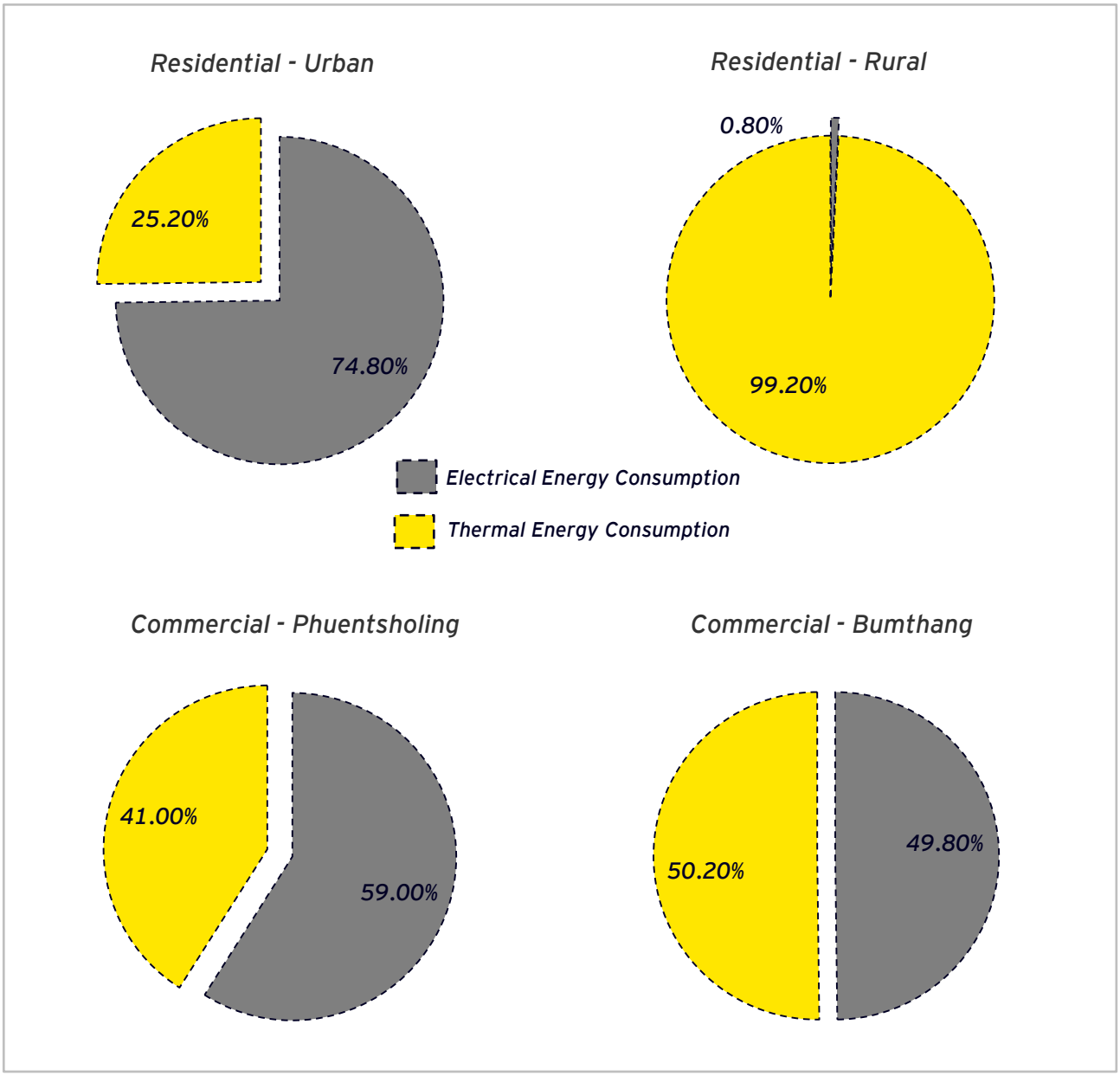
Table 3.2: Energy Efficiency potential in buildings segment – sample cases

Consumer Name	*Category*	*Specific energy consumption (kWh/m2/year)*	*Average Benchmark energy consumption* (kWh/m2/year)*[5]	*Estimated potential per year (kWh)*	*Financial savings to the consumer per year (BTN)*
Lhaki hotel	*Commercial*	*391.2*	*360*	*30427*	*61509*
Hotel Druk	*Commercial*	*610.4*	*571*	*45424*	*92419*
NHDCL	*Residential - Urban*	*121.7*	*115.6*	*281*	*450*
NHDCL	*Residential - Urban*	*131.9*	*115.6*	*318*	*407*
Director's house – Department of Labour, Phuentsholing	*Residential - Urban*	*132.4*	*115.6*	*351*	*457*
Kaila Guest House	*Commercial*	*361.0*	*324*	*11473*	*22142*
Yugarling resort	*Commercial*	*521.3*	*500*	*36160*	*73598*
Village Household	*Residential - Rural*	*5.1*	*1.9*	*438*	*373*
Village Household	*Residential - Rural*	*5.9*	*1.9*	*817*	*811*
Hotel Druk Zom	*Commercial*	*403.4*	*360*	*8876*	*17222*

**The energy efficiency improvement potential mentioned is an indicative figure based on comparison of SEC with the best in comparable standards. A detailed energy audit is suggested to be conducted at representative buildings segment to ascertain the accurate energy efficiency potential available.*

The split between the thermal and electrical energy consumption in some of the categories of the buildings that were visited (average considered) are provided below:

Figure 3.1: Energy consumption split in various building categories



It is noticed from figure 3.1 that the urban households that were covered during the site visit had their energy needs predominantly met through electricity rather than through fuel wood / kerosene / LPG. In contrast, some of the rural households that had recently been electrified were observed to be still dependant on firewood for their energy needs. When the commercial buildings were analyzed for the energy consumption split, a more uniform mix is observed. On an average, the commercial buildings in Phuentsholing had 59% and 41% of electrical and thermal energy split respectively while commercial buildings in Bumthang had a 49.8% and 50.2% electrical and thermal energy split.

It was observed during the site visits that the electrical appliances used in households and commercial establishments were predominantly non-standard and non-labeled. There were leakages observed in almost all of the hotels and residential households that were visited. On discussions with the various stakeholders it was understood that there was limited access to energy efficient building materials. Further, it was indicated that the purchase of electrical appliances was majorly driven by the product cost. These understandings present an enhanced case of driving energy efficiency in the buildings segment through tackling twin areas of energy-efficient building construction / architecture and the usage of energy-efficient appliances. Detailed observations made during the site visits in the buildings sector is provided in Annexure 2.

3.3 Energy Efficiency Potential in Transportation sector

During the study, an on-site assessment was conducted to identify the energy efficiency potential of vehicles in the transportation sector. The collected data was compared with benchmark data in these vehicle categories. It is understood that there is scope of energy efficiency potential in terms of improvement in mileage of vehicles as indicated in Table 3.3.

Table 3.3: Energy Efficiency potential in various vehicle categories

Vehicle Category	*Energy Efficiency level assessed (km/l)*	*Benchmark data for Energy Efficiency* (km/l)*[6]	*Estimated potential (%)*
Truck	*3.4*	*3.8*	*11%*
Car SUV	*9.2*	*13*	*29%*
Petrol Car	*13-14*	*15-16*	*7%*
Diesel Bus	*3.6*	*3.8*	*5%*

**The energy efficiency improvement potential mentioned is an indicative figure based on comparison of energy efficiency potential with the best in comparable standards. A detailed sample survey is suggested to be conducted for various vehicle categories to ascertain the accurate energy efficiency potential available.*

It is observed during the site visit that there is considerable amount of road damages on highways i.e., pot holes due to weather related damages and constant plying of heavy vehicles for transportation of raw materials for various construction activities. It is established through studies[7] that typically braking accounts for 2% of the fuel consumption during highway driving, while it increases to 6% during urban driving presumably due to increased breaking requirement. Road damages increase the fuel consumption due to braking and with proper road engineering, considerable fuel efficiency can be restored in vehicles.

Further, it is also noted that large number of vehicles from India refuel at Phuentsholing due to availability of comparatively cheaper fuel prices thereby substantially increasing the baseline fuel consumption in Bhutan. Considering that more than half the energy costs for Bhutan were due to petroleum products consumption in transport sector, the case for holistic approach towards energy efficiency in transportation sector becomes prominent.

3.4 Best Practice case studies

Some of the best practice examples in energy efficiency across sectors are listed below:

Table 3.4: Best practice examples in Cement manufacturing[8]

Technology / Measure	*Description*	*Energy / Fuel Savings (per annum)*	*Emission Reductions (tCO2/annum)*
Fuel switch project (1.2 MTPA)	*Partial substitution of Fossil fuel with alternative fuels like agricultural by-products, tyres and Municipal Solid Waste (MSW) in the manufacturing of Portland Cement*	*4,89,334 GJ, 18,966 tons of coal*	*46,291*
Energy Efficiency Improvement project (Plant Capacity: 4.2 MTPA)	*Upgradation of pre-heater section from 5-stages to 6-stages resulting in a reduction in specific fuel consumption*	*2,89,566 GJ, 11,223 tons of coal*	*27,393*
	Upgradation of Clinker Cooler by redesigning and retrofitting the grate system with Omega Plate type system, resulting in an increase in the cooler recuperation efficiency		
Fuel switch project (Production Capacity: 2.4 MTPA of Cement)	*Partial replacement of fossil fuel by millet husk, soya bean husk, cotton sepal, mustard husk and saw dust (biomass) as an alternative fuel, for pyro-processing, which is the primary energy intensive process in cement manufacturing*	*11,31,860 GJ, 43,870 tons of coal*	*1,07,074*
Waste Heat Recovery Power Project (Production Capacity: 2.8 MTPA of Cement)	*Installation of 6 WHR boilers (one for preheater exit gases and one each for clinker cooler exit gas and DG exit gas) and one 13.2 MW steam turbine generator. Electricity generated by the project activity would displace an equivalent amount of electricity supplied by the grid*	*77,396 MWh*	*70,796*

Table 3.5: Best practice examples in Iron & Steel industry[8]

Technology / Measure	*Description*	*Energy / Fuel Savings (per annum)*	*Emission Reductions (tCO2/annum)*
Waste Gas Recovery project (Blast Furnace Capacity: 0.9 MTPA)	*Generation of electricity (1X100 MW Power Plant) through combustion of waste gases from Blast furnace and Corex units*	*8,38,861 MWh*	*7,67,325*
Waste Gas Recovery project (Plant Capacity: Hot Metal: 2 MTPA; Crude Steel: 1.9 MTPA; Saleable Steel: 1.671 MTPA)	*Additional recovery of 50 Nm3 of LD gas per ton of crude steel by installation of N2 compressor, thereby partially replacing fossil fuels in power generation in CPP1 with a generation capacity of 126 MW*	*9,331 MWh*	*8,536*
Waste Gas Recovery project (Plant Capacity: 2 DRI Kilns – 500 TPD each)	*Utilization of the heat content of by-product gases {DRI Kiln gas, Blast Furnace Gas (BFG) and Coke Oven Gas(COG)} for generation of around 43.7 MW of power*	*3,72,874 MWh*	*3,41,077*
Waste Heat Recovery project (Plant Capacity: Sponge Iron Unit – 400 TPD)	*Heat extracted from hot gas in Waste Heat Recovery Boilers installed at the tail end of each 100 TPD DRI Kiln is used to transform water into high pressure, high temperature steam. The steam is used to run conventional condensing type steam TG for the generation of electricity*	*61,413 MWh*	*56,176*

Table 3.6: Best practice example in Ferro-alloy industry[8]

PROJECT 1 DESCRIPTION:

This energy abatement lever employed in an Indian Ferro Chrome manufacturing unit involves recovering carbon-monoxide from the enclosed type submerged arc furnace and utilizing it for power generation.

Consumer category	*Ferro Chrome*
Rated Capacity	*65000 TPA*
Actual Production	*58285 TPA*
Capacity Utilization	*89.67%*
CO generation	*1,981,707 kmol of CO_2/year*
Energy recovered from CO	*105,104 million kCal*
Electricity generation	*38,928 MWh*
Expected size of the plant (24 X7 generation)	*5 MW*

INVESTMENT

200 million BTN

ENERGY SAVINGS

38,928 MWh/annum (12%)

EMISSION REDUCTIONS

35608 tCO_2/annum

PROJECT 2 DESCRIPTION:

It was observed that the load on pumps and fans was variable in nature even though the plant had been operating In full load for the last 2 years. Subsequently, VFDs were installed on these equipments.

INVESTMENT

5.1 million BTN

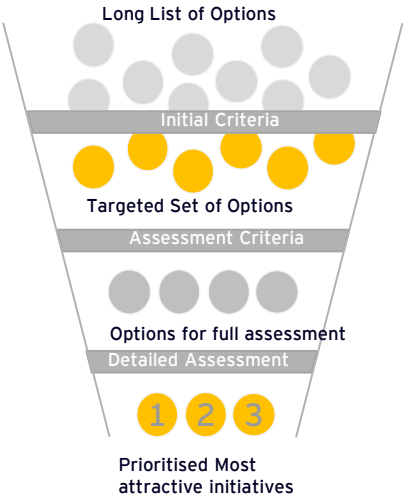
ENERGY SAVINGS

760.46 MWh/annum (0.2%)

EMISSION REDUCTIONS

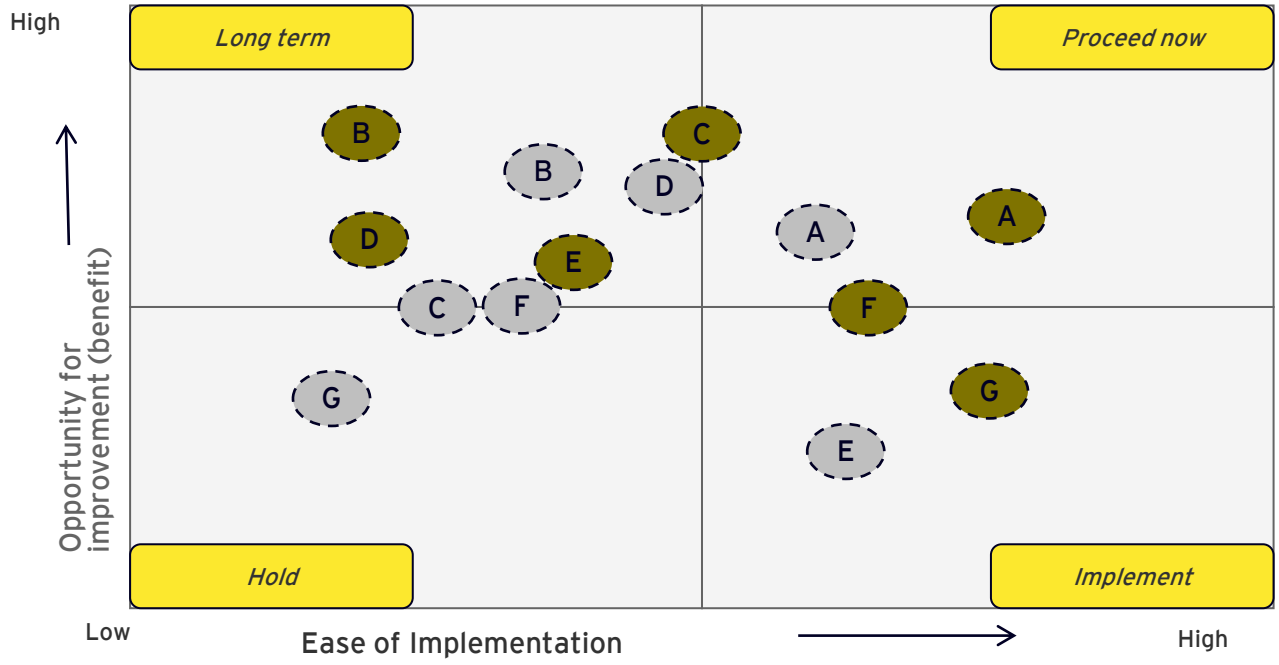
695.61 tCO_2/annum

For some of the measures that are broadly suggested for industries (including the best practice examples), a rough opportunity prioritization matrix has been developed. Opportunity prioritization matrices are used to prioritize initiatives after a current state analysis has been performed. There are four main areas of the opportunity prioritization matrix: Proceed now, Long term, Implement and Hold. By evaluating initiatives on the complexity and benefit, the chart allows to classify the projects into one of the four main categories.



- Initiatives that fall into the Proceed now category are considered to have a high level of benefit and are easy to implement. These initiatives lead to greater benefit than a Implement and require a similar amount of effort.
- Initiatives that fall into the Implement category are considered to be easy to implement and have a low level of opportunity improvement. Project teams look to implement these initiatives first as they are usually a process change in an existing practice.
- Initiatives that fall into the Long term category are considered relatively more challenging to implement but have a high improvement opportunity. These initiatives require more time, effort and investment.
- Initiatives that lay in the Hold category are considered to be easy to implement but are a low level of opportunity improvement. Initiatives in this category are as they are not worth the investment required.

*Figure 3.2: Opportunity prioritization matrix for industry**



Cement Industry	*Iron & Steel Industry*
A –Vertical Roller Mill for pre-grinding	*A – Coke Dry Quenching*
B – Use of alternate fuels and raw materials	*B – Coal Drying for coke oven*
C – Up gradation to 6-stage pre-heater	*C – Exhaust heat recovery system*
D - Installation of vapor absorption machine	*D – BF Top pressure recovery turbine*
E – Kiln shell heat loss reduction – Refrabricks	*E – Continuous casting machine*
F – Online condenser cooling system	*F – High frequency melting furnace*
G – Energy Optimized Conveyor belt system	*G – Raw material pre-heater for electric arc furnace*

**The opportunity prioritization matrix developed is indicative based on prior experience on industry standards. A detailed energy audit is suggested to be conducted at all the energy intensive industries to ascertain the accurate energy efficiency potential available and measures that could be taken.*

Table 3.7 (a): Best practice example in Transportation sector – Cable Car[8]

PROJECT DESCRIPTION:

Constructing and operating 6 cable car lines was proposed for Medellin, Colombia in 2003. The Metro cable is an aerial public transportation tramway that aimed at solving transportation needs of low-income people living in hillside areas. In 2004 this system started to operate and it has expanded through the years. Before the cable car was constructed, people had to use conventional buses with high accidental levels, elevated costs and considerable time loss to get to their workplace.

The real results of the project are outstanding; more than 450.000 people benefit directly or indirectly by the Metro cable. By 2011, 3 lines of the system had transported more than 47 million people, which represent a total saving for the people of approximately 29.25 million USD. Its operation avoids consuming 1.730.376 gallons of diesel fuel, a reduction in the emission of particulate material, carbon monoxide, hydrocarbons, sulfur dioxide and nitrous oxide.

Host country	*Columbia*
City	*Medellin*
Commissioning date	*2004*
Operational lifetime	*30 years*
Distance covered	*16 km*
No. of passengers	*113 per day*
Fuel saving	*1,730,376 gallons of diesel*
Commuters benefitted	*47 million*
Financial impact on the society	*29.25 million USD*

INVESTMENT	*ENERGY SAVINGS*	*EMISSION REDUCTIONS*
6.5 - 13 million USD per km	*2,33,333 GJ*	*17,290 tCO_2/annum*

Table 3.7 (b): Best practice examples in Transportation sector – Modal shift[8]

Technology / Measure	*Description*	*Energy / Fuel Savings (per annum)*	*Emission Reductions (tCO2/annum)*
Bus Rapid Transit (BRT) – Guatemala City	*The BRT reduces GHG emissions by improving the resource efficiency of transporting passengers in the urban area of Guatemala i.e. emissions per passenger trip is reduced compared to the situation without this project*	*72,35,465 GJ, 1,68,266 tons of diesel*	*5,36,148*
Modal Shift for car transport	*Involves modal shift from roadways to railways for finished goods transport i.e. car transport from their Manesar Plant to Mundra. The cars would have been transported by road, using trailers, which is a much more GHG intensive mode of transportation as compared to railways*	*3,10,391 GJ, 7,218 tons of diesel*	*23,000*
Bus Rapid Transit (BRT) – Lanzhou	*BRT is a bus-based mass rapid transit system that delivers fast, comfortable, cost-effective and resource efficient urban mobility. The baseline would be continuation of the current public transportation system where passenger demands are met by various modes of transport including conventional 12-meter CNG fuelled buses, CNG-fuelled taxis etc.*	*1,70,323 GJ, 3,961 tons of diesel*	*12,621*

Table 3.8 (a): Best practice examples in Buildings sector[8]

District Heating Project - China:
This project involves establishment of a centralized heating system with centralized heating-only boiler (HOB) houses in Hebei Province in China. These boiler houses will replace all decentralized, old boilers with rather lower heating efficiency year by year. In order to quantify savings in fossil fuel consumption a baseline case was established, which assumes continued operation or rehabilitation of existing isolated district heating network in the absence of the project activity.

Host country	*China*
Province	*Hebei*
Construction start date	*2009*
Completion of construction	*2011*
Consumer category	*Residential/Commercial*
Heating area	*8.75 million m^2*
Heat load	*529 MW*

INVESTMENT	*ENERGY SAVINGS*	*EMISSION REDUCTIONS*
120 million USD	*17,497,611 GJ*	*1,655,274 tCO_2/annum*

Intervention	*Category*	*Abatement Potential*
Type I: Solar Water Heater *Year 1: 3kW input power equivalent for solar water heater back up (project activity) and electric hot water storage heater (baseline)*	*Renewable energy project activity with a maximum output capacity equivalent of up to 15 MW*	*912 kWh / year*
Type II: Insulated Ceilings	*Energy efficiency improvement project activity which reduces energy consumption on the demand side up to the equivalent of 15 GWh per year*	*1494 kWh / year*
Type III: Compact florescent Light Bulbs	*Energy efficiency improvement project activity which reduces energy consumption on the demand side up to the equivalent of 15 GWh per year*	*257 kWh / year*

Table 3.8 (b): Best practice examples in Buildings sector[8]

Solar Community Kitchens – India:

The project activity includes the implementation and operation of solar community kitchens and similar solar steam applications in various regions in India. The project uses solar energy to prepare food and warm drinks for around 28,000 people on a regular basis. Doing so, the project substitutes conventional fossil fuel (diesel). Note: Kerosene is used only in household cooking stoves and not used in larger community kitchens to produced steam and therefore not considered as alternative or baseline fuel. The project has multiple direct contributions to sustainable development such as reduction of local air pollution, job creation, and improvement of working conditions.

Host country	*India*
State	*Multiple locations*
Commissioning date	*2005 (in Karnataka)*
Capacity (No. of people to be served)	*5000 (specific to Karnataka)*
Number of Scheffler units	*64*
Size of each solar dish / unit	*9.5 m^2*
Output at focus / unit (kW)	*2.5 kW*

INVESTMENT	*ENERGY SAVINGS*	*EMISSION REDUCTIONS*
65,50,000	*1,002 GJ*	*75 tCO_2/annum*

PROJECT DESCRIPTION:

The Project is designed to construct methane recovery and utilization system for 11,745 rural households. The main objective of the Project is to treat the raw manure from pigs by anaerobic digester with a volume of 10m^3. According to the Investigation report of on rural household biogas utilization in Luoyang city, each household raises 2.9 pigs on average. The anaerobic digester with a volume of 10m^3 can fully handle the manure of these pigs and to collect biogas generated during the treatment process for heat supply which will meet the thermal demands of the rural household itself by biogas stove with rated power of 3.26 KW each unit. Before implementing the Project, all the manure would be left to decay in the uncovered anaerobic mature management system, i.e. deep pit; the methane generated would be emitted to the atmosphere. In addition, the heat would in the absence of the project activity be generated in stove fired with coal. The scenario in the absence of the project activity is identical to the baseline scenario.

Host country	*China*
Number of households	*11,745*
Pigs raised / household	*2.9*
Rated power of biogas stove	*3.26 kW*
Rated pressure	*800 Pa*
Efficiency	*>= 58%*

ENERGY SAVINGS
4,558 GJ/annum

EMISSION REDUCTIONS
40,701 tCO_2/annum

Chapter 4: Recommendations and Way Forward

Royal Government of Bhutan realizes the need to promote and implement energy efficiency programmes and projects through a national energy efficiency policy. This section of the report summarizes the current status of legislation and policy measures and presents the interventions in terms of policies, measures and / or programmes aimed at promoting and implementing energy efficiency across the identified key sectors.

4.1 Bhutan energy efficiency legislation and policy – Current scenario

Overview of energy regulatory assessment in Bhutan 1

The Department of Renewable Energy (DRE) under the umbrella of Ministry of Economic Affairs (MoEA) is responsible for overall renewable energy and energy efficiency planning and regulation. The Electricity Act 2001 which is currently in practice governs the regulation of power sector and following are the key energy policy related measures that are taken or planned to enhance electricity supply.

Policy Measures	Focus areas
Energy Development Strategy (1994-2009)[1]	Focuses on increasing hydropower potential, increased electrification and promotion of private sector participation and investment to enhance electricity supply.
10th Five Year Plan (2008-2013)[2]	Focuses on achieving electrification rate of 100% by 2013.
Gross National Happiness (GNH)[3]	Focuses on promotion of sustainable development, preservation of cultural values, conservation of national environment and establishment of sound governance.
Sustainable Hydro Power Development (SHPD) Policy 2008[4]	Emphasize on the need to have a renewable energy policy for promotion of renewable energy sources in order to ensure national energy security
Economic Development Policy 2010[5]	

Currently, there are no other specific regulations adopted for energy efficiency or renewable energy.

Energy efficiency policy framework 2

Overview of energy policy assessment in Bhutan

Renewable Energy Policy[6]

The renewable energy policy which is in the final stage of its formulation focuses on energy security through promotion and development of renewable energy to meet current as well as future energy requirements. Under this RE policy, it is aimed to achieve 20 MW by 2025 with solar, wind, biomass and other RE technology accounting for 5 MW each.

Energy Efficiency Policy

Currently, there are no specific policies to promote energy efficiency and conservation (EE&C) in the identified four potential sectors and other including municipal and small and medium enterprise (SME) sector. After enactment of RE policy, development of national level energy efficiency policy is under consideration by MoEA.

Financing Mechanisms

Tax Incentives

Currently, there are no tax incentives or import duty concessions for energy efficient equipment or services

Funds for Energy Efficiency

Currently there are no active revolving funds for promoting EE&C.

Funds for Renewable Energy

Two sources funds have been identified in the draft RE policy through (1) budgetary support from RGoB and (2) renewable energy development fund stipulated under SHPD Policy 2008.

Accreditation of Service Providers

Energy Managers & Auditors

Accreditation system for energy managers and auditors are yet to be established.

Energy Service Companies (ESCOs)

ESCOs are yet to be established.

Energy Performance Standards

Energy efficiency standards and labelling (EES&L) for end use appliances are yet to established. A study conducted under the South Asia Regional Initiative for Energy (SARI / Energy) revealed huge energy saving potential at a low cost by the implementation of EES&L for domestic appliances.

Currently, there are no specific policies to promote EE&C in the identified potential sectors and in municipal & SME sector.

Status of Energy Efficiency Implementation Measures 3

EE Programs[7]	Focus areas
USAID Program	Partnership program with assistance primarily met through the SARI/Energy programme aimed at promoting energy efficiency standards and labelling for end-use domestic appliances.
The Energy & Research Institute (TERI) Program	Local program assisted by Govt. of India under the 9th Five Year Plan (2002-08) aimed at developing an Integrated Energy Management Master Plan (IEMMP) for Bhutan. This program was carried out in two phase. In the first phase, Bhutan Energy Data Directory 2005 was developed and published and in the second phase, wide range of issues related to energy sector was analyzed.
South-South Cooperation	Partnership program established in 2002 between Bhutan, Benin and Costa Rica aimed at creating and increasing awareness among public on all aspects of energy use in households and transport. Under this initiative, energy efficiency awareness programme was implemented by DRE during 2008-09 by means of broadcasting through local media and through distribution of pamphlets and brochures. A pilot program on replacement of inefficient firewood stoves with electric cookers was also studied for performance assessment.
DOE CFL Program	Local program aimed at providing CFLs at a subsidized rates. CFLs were provided by BPC to part of the customers covered by micro hydro power plants in Wangdue-phodrang, Trongsa, Zhemgang, Bumthang, Tsirang & Dagana areas.
Rural Clay Stove Program	Partnership program funded by Austrian Government during 2006 aimed at replacing inefficient rural stoves in villages with improved rural clay stoves. Under this program, improved room heating firewood appliance called "bhukhari" was also designed and studied for performance.

The level of EE policy measures adopted in Bhutan indicate a scope for assessment and improvement in energy performance in the identified four potential sectors. This also necessitates the need for identification of energy efficiency interventions in each of the sector and implementation drive through formulation of national level EE policy.

4.2 International policy overview

Before getting into the assessment of barriers in implementing EE measures and the assessment on EE policy intervention that could be adopted, it is essential to undertake an assessment on energy efficiency policy overviews of those country(ies) that has similar energy profile to that of Bhutan. The table below presents country-wise assessment on hydro power capacity and generation:

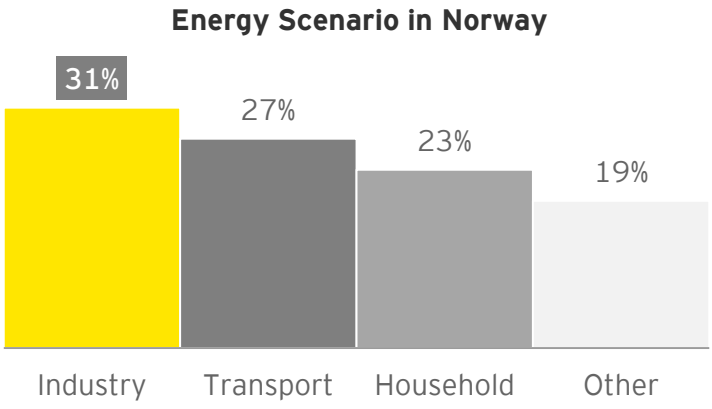
- Norway's electricity generation system is almost 100% hydro, with hydro accounting for 97% of electricity generation in 2009 and 99% in 2010.
- Followed by Norway, Brazil accounted for 84% and Venezula accounted for 74% of the electricity generation from hydro power in 2010.
- Other than the above, there are number of countries in Africa that generate 100% of their power from grid-based hydro power plants.

Country	Installed Capacity (GW, 2010 data)	Country	Hydropower's share of total generation (%, 2010 data)[8]
China	210	Norway	99%
Brazil	84	Brazil	84%
USA	79	Venezula	74%
Canada	74	Canada	59%
Russia	50	Sweden	49%
India	38	Russia	19%
Norway	30	India	18%
Japan	28	China	16%
France	21	Italy	14%

With the above background, in this section of the report, an assessment is carried out on policy and energy efficiency programmes adopted in Norway to get a comprehensive overview on policy directions in promoting energy efficiency.

Norway: Energy efficiency policies and measures[9]

Norway, like Bhutan has large hydropower capacity and production. It is the seventh largest producer of hydropower in the world. End use as electricity accounts for more than 50% of the consumption. In Norway, industrial sector accounts for the highest energy consumption followed by transport and household sector.



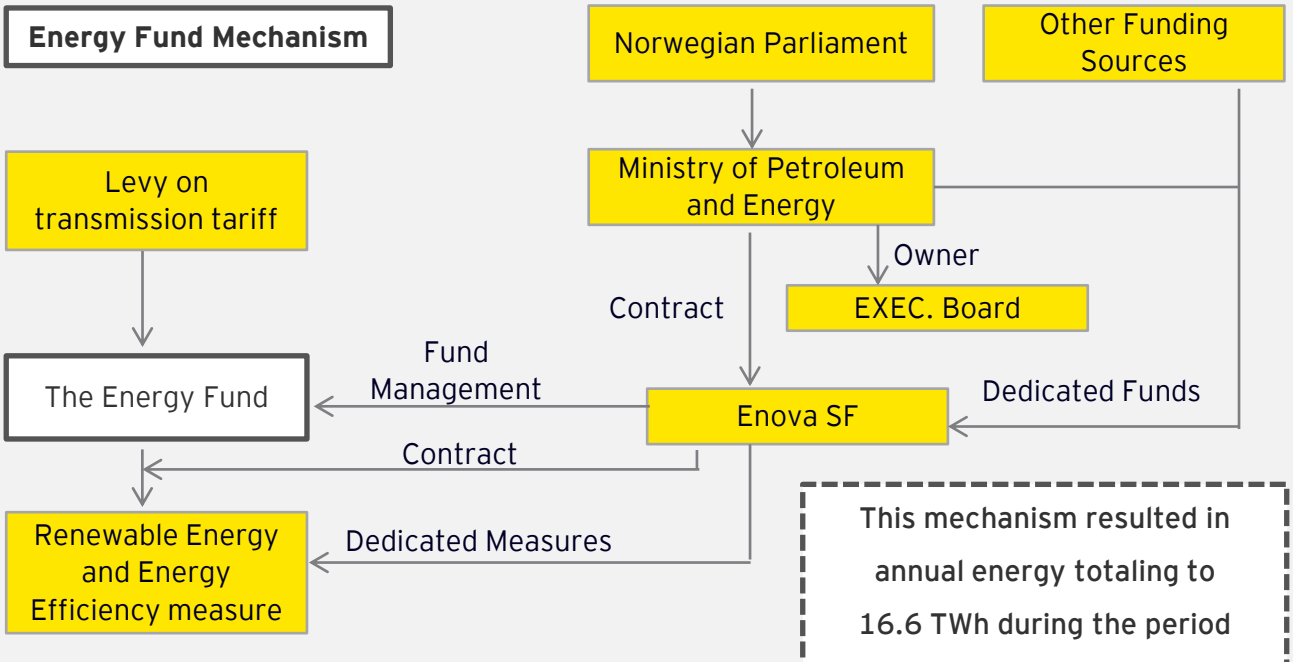
Energy Use Intensity Parameters					
Industry	0.09 Ktoe/Euro2005	Transport	30 toe/Mp-Km	Household	172 kWh/m2

ODEX – Bottom up energy efficiency Index

In ODYSSEE, an IEE project "Monitoring of EU and national energy efficiency targets" in Norway, an aggregate bottom-up energy efficiency index called ODEX is calculated. This indicator is developed to aggregate the trends in the detailed bottom-up indicators in one single indicator. This indicator has improved by 26% from 1990 to 2010. This results achieved indicate that the energy efficiency policies and measures implemented since 1990 have contributed to a decrease in energy use of 2010 by approximately 59 TWh.

Norway Energy Fund

Enova SF is a Norwegian Government Enterprise that is responsible for environmentally friendly production and promotion of energy savings, new renewables and eco friendly natural gas solutions. Enova SF administrates the "Energy Fund" and the revenue for the fund comes from a levy of tax ~ 0.008 £/kWh to the distribution tariffs which is made mandatory. The energy fund also received allocation from state budget.



- More efficient use of energy
- Increased use of energy carriers other than electricity, natural gas and fuel oil
- Increased production of energy from renewable energy sources
- Introduction and development of new technologies and solution in the energy market
- Establishment of market for efficient and environment friendly energy solutions
- Increased general knowledge in society regarding the possibilities for utilizing efficient and environment friendly energy solutions.

Sector-wise energy efficiency measures

Building sector

Building Regulations

The Building Regulations does not allow for installation of fossil fuel boiler as base load. Buildings that have area less than 500 m^2 have to be constructed in a way to cover at least 40% of useful heating demand with other energy sources than direct electricity heating or fossil fuel unless the heating demand is less than 15,000 kWh/year. Buildings with area greater than 500 m2 have to be constructed to cover at least 60% of useful heating demand with other energy sources.

Norweign Standards

It sets criteria for passive houses and low energy houses – residential buildings. It provides requirement for testing procedures, measurement methods and reporting of energy performance on completion for residential buildings. The buildings are classified as passive house & low energy houses.

Enova Recommends

As program designed to promote energy efficient products in the local market. The primary objective is to create awareness and influence the purchase decisions towards selection of energy efficient product. Windows was the first product and the insulation was the second product recommended under Enova.

Grants for energy savings in homes, buildings and outdoor equipments

The target group for the programme is public who take investment decisions for implementation of projects with energy targets. Advisers, architects, contractors, manufacturers and suppliers of goods serve as driving forces for the development and implementation of these projects

Transport sector

Transnova

The main objective of Transnova is to contribute to substitution of fossil fuels with low or non-emission fuels. in 2009, Transnova administered a one year funding programme for establishing charging points for electric vehicles, with a broad scope of applicants.

Battery electric vehicles

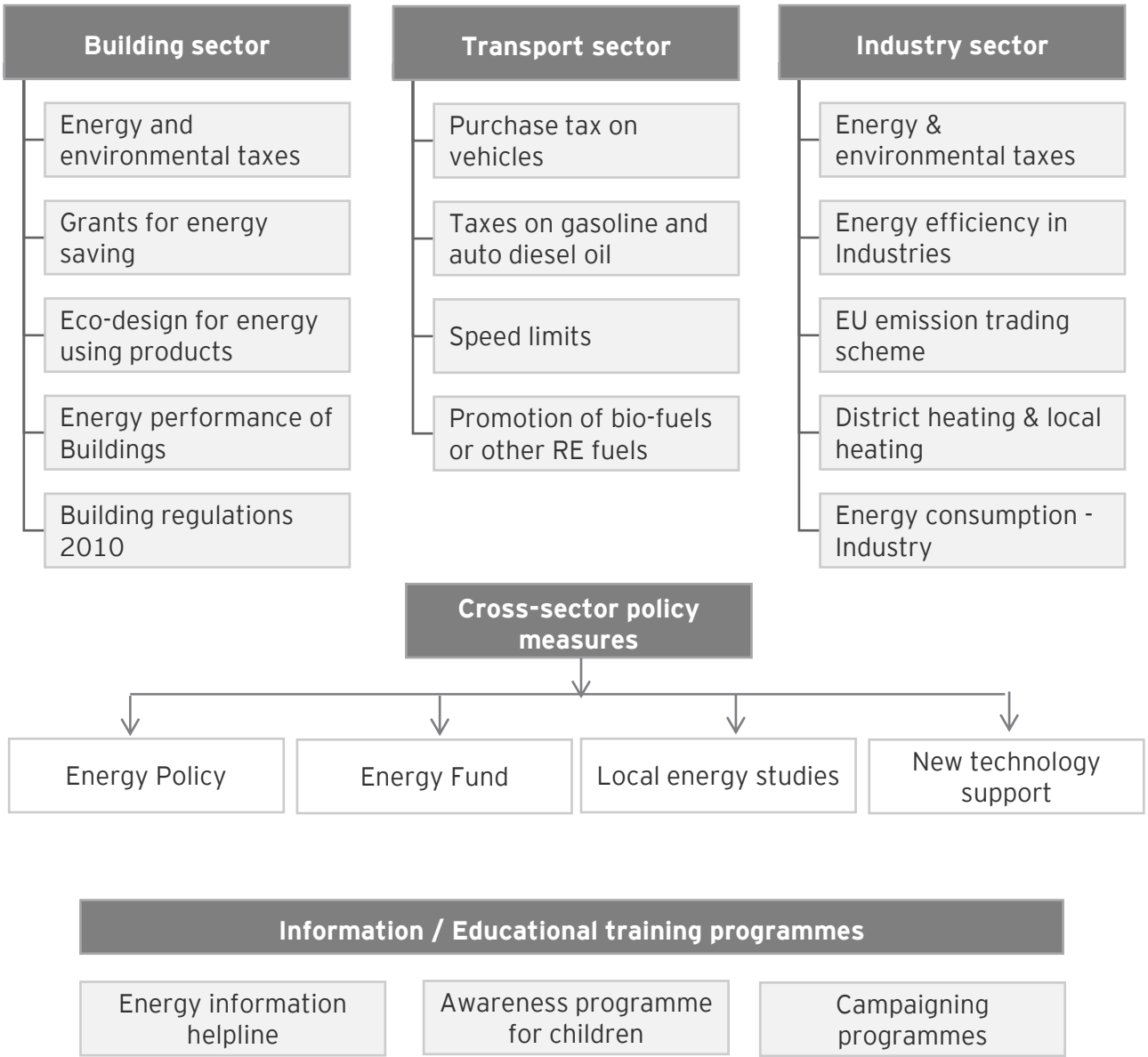
Battery electric Vehicles (BEV) program has been driven since 2001 and salient features include exemption from nonrecurring tax for vehicles, free parking and charging on public parking places, free drive in lanes for public transport and exemption from road toll.

Industry sector

Energy consumption – Industry

This program promotes competitiveness among Norwegian industry through efficient energy use. It is designed to provide investment support to companies that have projects with total potential energy saving of more than 0.5 GWh. These projects include energy-efficient solutions or processes, measures for energy recovery or use of waste heat and conversion to renewable energy sources. Maximum grant level allowed is 20% of the approved projects costs. This program also mandate companies to report energy consumption and production data once a year through web-based reporting scheme. Enova calculates specific energy consumption for different industry sector out of this data.

Medium and High Impact EE Policies and Programmes implemented in Norway



4.3 Assessment on barriers to Energy Efficiency

The adoption of energy efficiency and conservation measures in Bhutan is challenged by various barriers, in terms of regulatory, financial and policy as well. These barriers act as a major hindrance to pursue investment in the areas of energy efficiency. Barriers to EE are classified as follows.

Regulatory barriers

Lack of enabling EE policy framework and sector-specific EE programmes & standards

Lack of EE policy framework and absence of EE programmes and standards represent a barrier to overall uptake of energy efficiency and conservation programmes in Bhutan.

Subsidized electricity tariff

It has been identified as one of the pertinent barrier for promotion of energy efficiency measures in Bhutan as electricity is supplied to consumers at a subsidized rate. The low cost of electricity supply is aimed at fulfilling the social obligations and promotion of industrial development. On the contrary, this has lead to increased inefficiencies in the energy consumption. This barrier continues to remain as the primary bottleneck as pursuit of investment in energy efficiency is undermined or impacted by high investment cost and a long payback period.

The two barriers mentioned above are the driving barriers which influences the other barriers (dependant barriers) in promoting energy efficiency.

Institutional barriers

- Lack of formal institutional framework for developing and implementing energy efficiency strategies, policies and programs
- Emphasis on increasing energy supplies; not on reducing consumption
- Lack of "champions" for promoting EE
- Limited versatile knowledge and understanding of EE by consumers

Financial barriers

- Lack for funding and financial incentives to encourage private sector investments
- Limited experience of financial institutions in EE projects

End-use barriers

- Limited technical knowledge
- Low management priority
- Lack of internal funds for investments

Other barriers

- Limited market and demand for EE products & services
- Lack of ESCOs due to limited market
- Absence of mechanism for monitoring and verification of energy savings
- Limited EE technologies
- High penetration of low efficiency electrical appliances

Overcoming these barriers is a challenge and is likely to create new approaches to EE promotion. A strong adaptive capacity through improving the understanding and need for EE, assessment of potential energy savings, and establishment of legal and institutional framework is essential for driving EE movement in Bhutan. It requires active participation of government, financial institutions, end-users, businesses and other stakeholders.

4.4 Approach for energy efficiency promotion in Bhutan

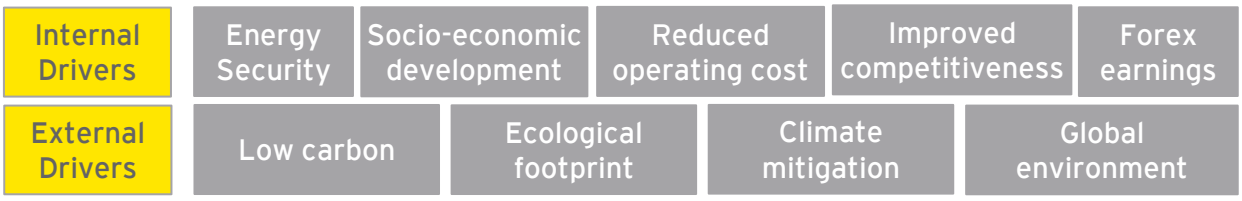
The baseline energy assessment reveals potential for energy saving from the identified sectors which has potential for additional revenue generation through export of electricity to India. This could be made available through adoption of sector-specific directives aimed at energy efficiency in the identified potential sectors. Taking account of specific socioeconomic context of Bhutan and the potential energy saving opportunities it is imperative that as a first step "national energy efficiency policy" need to be developed and implemented.

This section of the report presents the step-wise approach for energy efficiency promotion in Bhutan providing strategic guidance for planning and management of energy efficiency programmes / initiatives. The approach presented below is derived from international experience and best practices based on the comprehensive assessment carried out on energy efficiency policies and institutional arrangements in Asian Countries[10] while taking into account the existing energy scenario and regulatory framework of Bhutan.

Step 1: Formulation of national level energy efficiency vision

A comprehensive and innovative approach is adopted by both developed and developing countries to stimulate demand for energy efficiency and its management. The assessment made on various approaches adopted reveal an increasing evidence of multiple co-benefits and an in-depth comprehension and identification of key energy efficiency drivers, both internal and external, is an essential component of the vision formulation process.

Identification of key energy efficiency drivers pertinent to Bhutan



As a next step, it is essential to undertake a balanced analysis on national SWOT (Strengths, weakness, opportunities and threats) analysis and build scenarios of energy efficiency pathways. This will ensure national support and enable mobilization of adequate resources to translate the energy efficiency vision into practical actions and unlock the full energy efficiency potential. Further, key decision makers are to be involved in a formal stakeholder consultation process to enhance their understanding of the role of energy efficiency and to get wider support in consolidating the energy efficiency vision. In the process, it is paramount that National Energy Efficiency Vision is aimed at addressing developmental challenges that are specific to Bhutan.

Strategic approach for promotion of energy efficiency in Bhutan

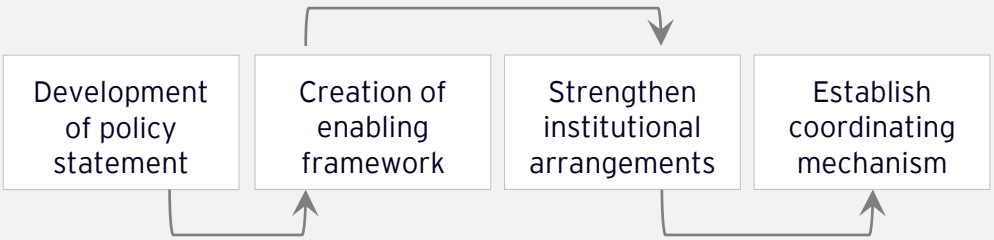
Step 1

Formulation of national level energy efficiency vision

1	Identification of primary energy efficiency drivers
2	Development of scenarios of energy efficiency pathways
3	Stakeholder consultation to invite feedback
4	Development of Vision

Step 2

Establish and build national commitment for implementing energy efficiency measures



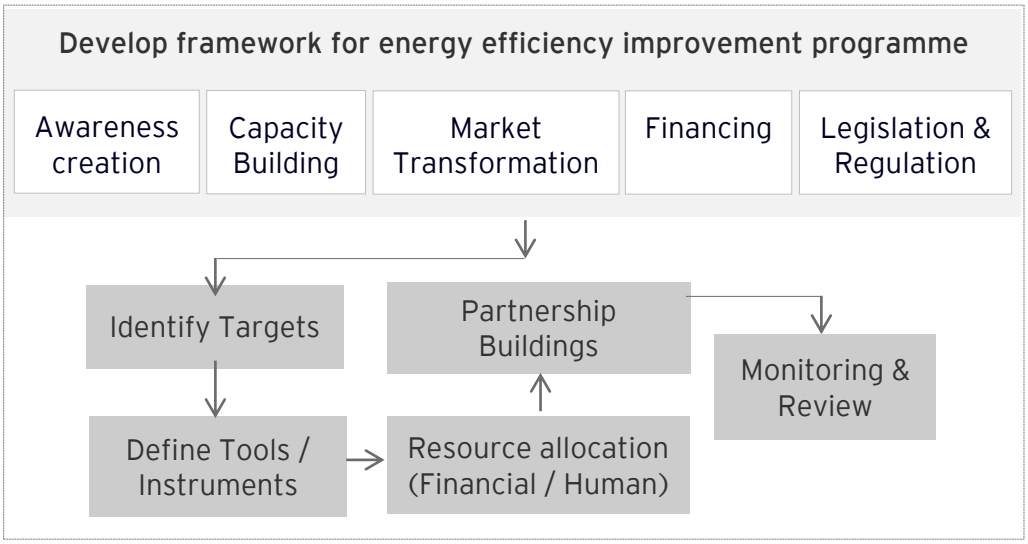
Step 3

Translate national level energy efficiency vision in to sector-specific energy efficiency objectives & targets

1	Establishment of national energy & economic data to identify priority sectors
2	Analysis of sectoral energy & economic data to identify targets
3	Analysis on consumption, output & service and establishment of baseline
4	Audit sample targets to estimate cost effective energy efficiency potential
5	Cumulate to serve as the basis to set national EE Targets

Step 4

Strategic management of energy efficiency programmes



Step 2: Establish and build national commitment for implementing EE measures

Bhutan is into vicious cycle of energy inefficiency with electricity being supplied at a subsidized rate below its cost to make it accessible and affordable. This remains challenging if subsidies are not targeted appropriately will tend to have negative effects on the socio economic development.

This is perceived as the major barrier in promotion of energy efficiency initiatives in Bhutan, as low energy prices do not promote end-users to consume subsidized energy judiciously and / or to adopt any kind of energy efficiency measures. It is further compounded by lack of confidence among manufacturers to innovate, unwillingness to research & development (R&D) efforts and to meet the higher demand for a given energy service of the end user, it creates undue pressure to the Bhutan government for the energy supply.

Bhutan Government's Intervention is vital	International experience and best practices reveal that for a transformation from vicious cycle of energy inefficiency to a regime of energy efficiency by overcoming barriers, national commitment is essential. This would enable decoupling of energy consumption from the economic growth.			
Initiatives adopted by countries in vicious cycle of energy inefficiency	Rationalizing energy tariffs	R&D Support	Promotion through EE standards	Incentives for adoption of clean and energy efficient technologies

Step-wise approach for establishing and building national commitment for EE measures

Energy Conservation (EC) Act and National EE policy

- Adoption of EC Act and development of EE policy
- Justify the need of the Bhutan Government's intervention to promote EE programme
- Establish purpose and content of the national EE policy
- Establish links with other existing policies like Energy Development Strategy, GNH, SHPD Policy and Economic Development Policy.

The elements of the EE policy that are required to be considered are presented in section 4.5.

Framework enablement

- Establish legal framework and funding mechanism for implementing energy efficiency strategy and action plan

International experience reveal that a strong mandate from the Government, consistent policy and long-term commitment for supporting EE goals are the key element for success for EE promotion

Strengthen institutional structure

- Strengthen Department of Renewable Energy's (DRE) (the nodal agency for promotion of EE & RE), capacity and processes
- Establish mandate to engage with stakeholders and mobilize resource either internally or through international development assistance

Coordinating mechanism

- Establish standard protocols and procedures that mandate for coordinating activities among relevant stakeholders

Step 3: Translate national level energy efficiency vision in to sector-specific energy efficiency objectives & targets

Through this report on Baseline Energy Efficiency Study and the reports developed on Comprehensive Energy Directory (Year 2005), Integrated Energy Management Master Plan (IEMMP, 2010) and South Asia Sub-regional Economic Cooperation (SASEC) energy efficiency initiative roadmap, Bhutan has made significant progress in establishing sectoral energy efficiency targets as per the steps presented below:

Progress made in establishing sectoral energy efficiency targets

Approach		Outcome achieved
► Identified target (energy intensive) sectors through establishment and analysis of national and sectoral energy data.	1	► Industry, transport and building are identified as priority sectors. Sectoral break-up (% based on MTOE) Industry: 47% | Transport: 34% | Building: 16%
► Analyzed consumption pattern, output & service and established baseline energy consumption of target sectors.	2	► Baseline data are established for identified sectors Electrical energy (% based on MTOE): Industry 33.9% | Building 6.6% Thermal energy (% based on MTOE): Industry 13.2% | Transport 34% | Building 9.5%%
► Identified the techno-economic energy saving potentials through sample audits and surveys conducted in target groups.	3	► The energy saving potentials are estimated for the target groups (six identified industries through sample audits)

Step-wise approach for implementing sectoral energy efficiency targets

Baseline review of large energy intensive consumers under each sector to determine actual energy saving potentials

4 ► The techno-economic energy saving potential evaluated is based on the audits and surveys carried out for "sample" target consumers identified in each sector. Moreover, the approach adopted for evaluation of energy saving potential is based on benchmarking exercise. For quantification of actual saving potential, it is essential to carry out baseline review of "large energy intensive consumers" under each sector based on primary data. Further, the energy saving opportunities are identified and evaluated on a case to case basis. An approach for baseline review based on best practices for industrial sector is presented in the following section.

Establish sector-specific and national energy efficiency target

5 ► Following the baseline review, sector-specific energy efficiency targets is evaluated and further cumulated to serve as the basis for setting national level energy efficiency targets.

Approach for baseline review based on best practices for industrial sector

Background:

In response to growing challenges of energy and climate change, the Government of India has implemented an Energy Efficiency Trading Scheme - Perform, Achieve & Trade (PAT) scheme, a market based mechanism which promotes energy efficiency in energy-intensive large industries. This PAT scheme is a policy tool adopted towards meeting the objectives of National Mission for Enhanced Energy Efficiency (NMEEE), one of the key mission developed under National Action Plan on Climate Change (NAPCC). The improvements achieved in energy efficiency are made cost effective through certification of energy savings that could be traded in the open market. Under this scheme, totally nine energy intensive industries have been identified and notified as designated consumers (DCs) based on energy consumption level (in MTOE terms).

Objective of baseline review:

- The baseline review is carried out before the target setting and after the baseline assessment phase.
- The primary objective of the baseline review phase is to quantify the actual energy saving that could be achieved taking into account the level of the technology adoption and energy performance of each of the designated consumer.

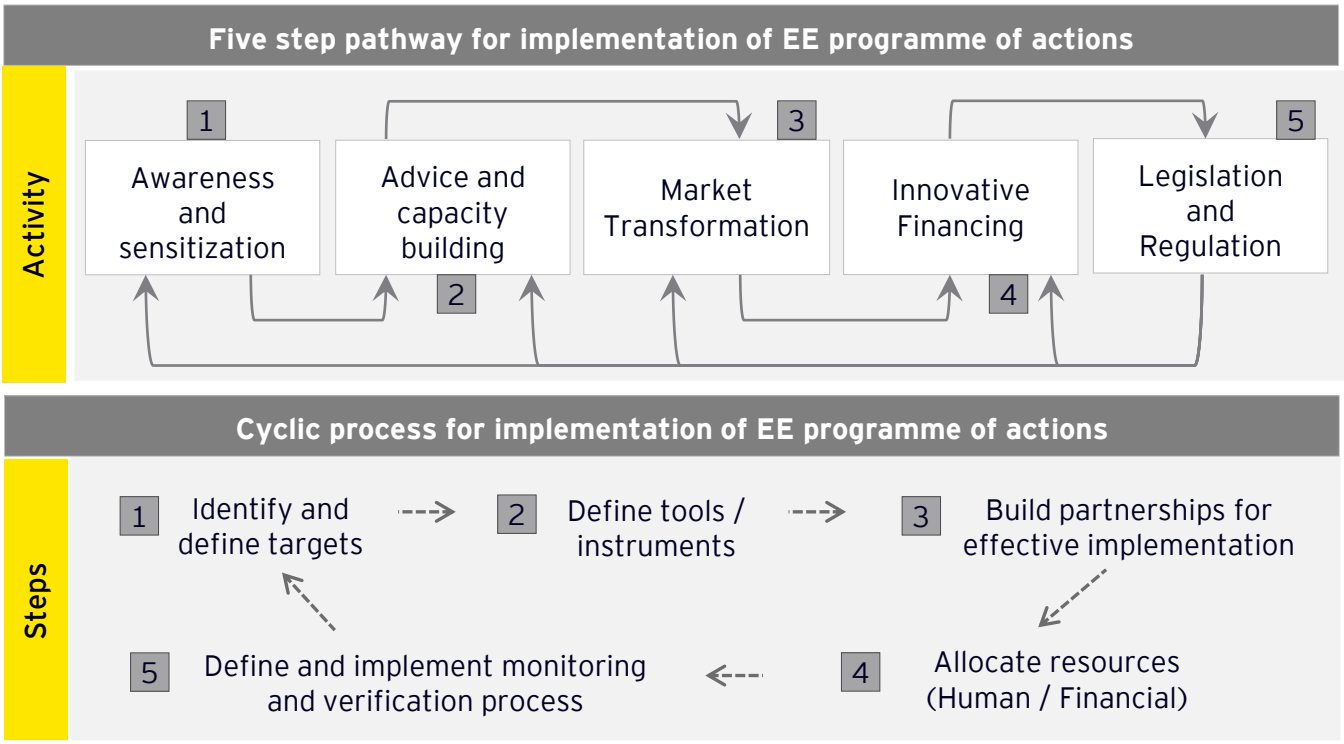
Steps adopted for baseline review in identified large energy intensive industries[11]

1	Review of energy consumption and production data of last five years
2	Assessment on type and quantity energy sources consumed, self generated energy sources, process technology, raw material, product output and other factors affecting energy consumption based on gate-to-gate approach
3	Identification of major energy intensive processes and equipments which accounts for more than 80% of the total energy consumption
4	Comparison of the energy performance data with design data
5	Understanding and compilation of various energy conservation (ENCON) options implemented by the industry for the last three years
6	Evaluation of saving potential based on process change, efficiency improvement and retrofitting measures.
7	Preparation of audit report summarizing the savings, investment and future energy conservation plans etc.

The outcome of baseline review is used as the basis for target setting.

Step 4: Development of framework for EE improvement programmes

The overall process of implementation of EE improvement programme for the quantitative targets of priority sector is complex as it aims at influencing a number of stakeholders. It is imperative that the path adopted for EE promotion needs the support and involvement of Government and various groups of stakeholders. The sector specific energy efficiency targets are driven through pragmatic EE improvement programmes. From an analysis carried out on various processes from international experience (best practices), it is evidenced that a five-step pathway is adopted for implementation of EE programmes and this is a common approach adopted across any sectors. Further, each activity proposed in the five-step pathway is may be carried out by a cyclic process which involves five key steps for implementation of EE programmes and these are presented below.



Based on the quantitative targets set for priority sectors, boundary & scope of coverage, its allocated resource and the timeframe for implementation, the five step pathway and the key steps to implement EE programmes are planned. The international experience reveals that though the target is set through methodological analysis, the resource allocated by most of the governments is found to be meager in comparison to the resource allocated for energy supply. The International Energy Agency (IEA) EA statistics indicate that most of the countries spend between 0.01 % to 0.05 % of their GDP on energy efficiency programmes. Moreover, linkages are not established between data on resources to sector specific policies and activities.

A realistic target, allocation of guaranteed resources and allowance of relatively long timeframe are the three critical determinants for a successful implementation of EE.

Approach for 5 step pathway

1 *Awareness and sensitization*

Creating awareness and / or sensitization about the potential benefits that could be accrued from energy efficiency is the key step in the process of implementation of EE programmes. It requires adoption of a "comprehensive communication strategy" to meet the needs of various specific targets groups within the priority sectors. This could further be enhanced by developing a reporting mechanism on energy consumption which would enable self-assessment of consumption patterns.

2 *Advice and capacity building*

This step enable better involvement and adequate capacity development of the target group. The target energy users, service providers and auditors are identified and provided with necessary assistance to upgrade their technical knowledge on energy-efficient technologies and energy management practices.

3 *Market transformation*

Market transformation is an essential component that needs to be focused when private sector is more active and government plays a minor role in the marketplace. In such a case, the equipment manufacturers and suppliers tend to influence and market less energy efficient products that are affordable to the end users. Government intervention is vital in triggering the market transformation towards EE and make energy efficiency more cost effective and affordable.

4 *Innovative financing*

Though market transformation creates cost effective energy market, the real challenge lies in target beneficiaries getting access to energy efficiency financing. This is primarily due to the fact that EE investments does not generate revenue but rather leads to energy cost reduction which does not attract financial institution's support. It requires adoption of "Dedicated Energy Efficiency Fund" targeting EE programme of actions through national legislation in order to support such EE financial investments.

5 *Legislation & regulation*

This step is essential in creating and making the internal energy market work which would ensure a minimum guarantee on the efforts made towards energy efficiency improvement. Moreover, adoption and compliance with a new legislation and regulation on energy efficiency will promote a base level of energy efficient practice in the sector. This step also involves the phase of creating awareness and mobilization of the resource for enforcing the regulation.

Mapping of target groups and tools / instruments		
Activity	**Target Groups**	**Tools**
Awareness and sensitization	Children & Youth, energy users, policy makers & economic players	Visual, audio and print media
Advice & capacity building	Energy managers, engineers, architects, technicians & operators	Training & capacity building programmes
Market transformation	Product manufacturers & suppliers, end users and economic suppliers	Minimum energy performance standard , Voluntary or mandatory labelling and Best Available Technologies
Innovative financing	End users, financial institutions and EE investors	Grants, subsidies, soft loans, tax allowances & accelerated depreciation
Legislation & regulation	Policy makers, energy users and economic players	Energy codes, labels & standards

Approach for cyclic process

The process of implementation of energy efficiency programmes involves adopting one by one the five steps of the path to promote energy efficiency.

	Activity	Approach
1	**Identify and define targets**	The target groups of priority sector(s) are identified and defined in this step. International experience reveals that countries that are in the process of initiating EE programme of actions, it is recommended to limit the target groups to large energy intensive user categories so as to remain focused on smaller groups which results in high energy saving.
2	**Define tools / instruments**	Suitable tools and methodologies for priority sector(s) type are identified in this step. Before defining the tool(s), thorough analysis on feasibility of adoption based on experiences from other countries needs to be carried out to demonstrate the effectiveness of the EE programme of actions.
3	**Build partnerships**	Once the tools and methodologies for the priority sector(s) are identified, next step is to identify the key partners for effective implementation on the targeted energy users.

	Activity	Approach
4	Allocate resources (Human / Financial)	In this step, in cooperation with the selected key partners, the resources required, both financial and human are evaluated to carry out the EE programme of actions. This step involves an iterative process where the resources employed are reviewed on a periodic basis, and if found inadequate, it may also be required to review the target energy saving and the end energy users.
5	Define and implement monitoring and verification process	This step plays a crucial role in monitoring and evaluating the EE programmes that are planned vis-a-vis the progress made and actual savings achieved. It is challenging to evaluate the impact of EE programmes in terms of quantification of energy savings achieved or the level of impact of awareness and sensitization. Therefore, it is essential to develop and adopt a measurable and quantifiable targets that will enable to evaluate the performance and overall success of the EE programme.

4.5 Identify and implement pragmatic sector-specific EE improvement programmes

After development of framework for implementation of EE programmes (step 4 under section 4.4), the sector-specific energy efficiency targets set (step 3 under section 4.4) is achieved through identification and implementation of sector-specific energy efficiency improvement programmes. It is essential that these EE programmes are sector-specific to ensure effectiveness of implementation targeted at energy intensive consumers.

In this section, a set of energy efficiency target measures are presented for Bhutan for each priority sector and the these are assessed and developed taking into account the following factors.

- baseline energy data of priority sectors
- existing regulatory & legal framework and the level of policy enforcement
- level of promotion of energy efficiency through performance standards and programmes
- level of adoption of financing mechanisms
- level of energy management practices adopted by end consumers in individual sector
- feedback received from department agencies and end consumers in the priority sector

The individual target measures can be developed as a target-oriented energy efficiency improvement programmes for progressive implementation (through adoption of five step pathway and cyclic process) in Bhutan. These target measures are proposed in two terms.

Short term EE measures - based on ease of implementation & resource requirements

The short term measures are focused towards achieving energy saving by improving energy management practices of the end consumers in the priority sector. Creating general awareness, increasing competencies of the end consumers through capacity building programmes and by direct government intervention in creating a market for energy efficiency are the essential components of short term measures.

Long term EE measures - based on change in regulatory framework and mechanism

The long term measures are based on target based approach and these are driven by applying rules and regulations in the form of EE codes, labels or standards directly on the end consumers in the priority sector. This measure will drive and accelerate the energy efficiency movement and will ensure improvement in overall energy scenario of Bhutan.

However, the deficiencies and bottlenecks associated with both the short and long term measures are to be evaluated before implementation.

Energy Efficient Industry

The concept of energy efficient industry is targeted towards removal of barriers to energy conservation and energy efficiency in industries. The target EE measures promotes energy efficiency through removal of barriers to dissemination of energy-efficient technologies, large scale application & implementation, promotion of more efficient energy use and financing for EE projects.

Short Term Measures – Industrial Sector

1 Target Measure 1

Enhance existing energy management practices through elemental approach

This target measure is aimed at enhancing the existing energy management (EM) practices of the industries through direct government intervention by adoption of the following measures:

- Undertaking extensive awareness creation programmes and advanced training & capacity building programmes for the key target groups including energy managers, engineers, technicians & operators etc.
- Providing effective assistance in development of EM capability through development and maintenance of EM tools, certification and quality assurance.
- Encouraging or mandating industrial consumers to implement comprehensive energy management procedures and practices that could include:
  - Development and adoption of a comprehensive energy management policy
  - Appointment of qualified energy managers both at management and plant levels
  - Establishment of monitoring and verification process and to mandate industrial energy consumers to report on energy consumption and efficiency
- Encouraging or mandating industrial consumers to undertake energy audits through competent authorities and mandate reporting on the progress made in implementation of EE programmes on an annual basis
- Encouraging participation among industrial consumers through energy award programmes.

2 Target Measure 2

Promotion through adoption of financial incentive mechanism

This target measure is aimed at enabling investment climate for EE projects and providing increased access to capital for EE financing for the industrial consumers through direct government intervention by adoption of following measures:

- Development of financial support and incentive scheme through creation of dedicated energy efficiency fund for EE&C (which is currently not active in Bhutan). A component of financial support could also be through direct budgetary support from the Government.

- A similar approach to that of Renewable Energy Development Fund (REDF) stipulated under Sustainable Hydro Development Policy for RE projects could be adopted for creation of revolving fund for EE & C.
- Financial incentives through revolving funds can take various forms: grants, subsidies, soft loans, tax allowances, accelerated depreciation, third party financing, lease purchase scheme and guarantee fund for EE projects which requires identification of target industrial consumers and classification of instrument type. An indicative mapping of instrument type and target groups based on the assessment carried out on intensive industrial consumer in Bhutan in presented below.

Mapping of instrument type and target groups

Financial Support		Financial incentive	
Instrument	Target Group	Instrument	Target Group
Co-financing / Direct investment support / Reimbursement	Existing and upcoming Industrial consumers	Tax Credit / Accelerated Depreciation	Upcoming Industrial consumers

3 Target Measure 3

Promotion through imposition of energy tax on fossil fuel usage

This target measure is aimed at achieving energy saving through reduction of fossil fuel usage at source by adoption of the following measure.

- Government initiative to impose tax on the fossil fuel usage by the industrial consumers to target both the components of purchase including procured in-house and imported.
- The revenue from tax collection could be used as a source of funding for revolving fund for EE projects. An indicative mapping of instrument type and target groups based on the assessment carried out on fuel usage data in intensive industrial consumer in Bhutan in presented below.

Mapping of instrument type and target groups

Financial Support		Key considerations	
Instrument	Target Group	Fossil fuel consumption	Target Group
Levy of energy tax @ Nu./MT of fossil fuel.	Industrial consumers	77081 MT (2011 data)	Majorly cement manufacturers

Long Term Measures – Industrial Sector

4 Target Measure 4

Promotion through adoption of energy efficiency standards and targets

After having improvement in energy management practices and established a means for EE financing, as a next level, government should consider driving energy efficiency movement through adoption of EE standards and targets programmes. In this approach, the high energy intensive industrial consumers are assessed and identified based on energy consumption (both electrical and thermal) and targets are set based on the performance level to comply with energy conservation norms and standards set by the Royal Government of Bhutan. The energy efficiency standards and targets programme are developed in different forms and an indicative step-wise approach based on international experiences from India, China, Russia & Japan is presented below. All these countries have made this programme mandatory and have included electricity sector as one of the identified sector.

Step-wise approach

- Establishing efficiency standards (industry specific energy performance standards based on best performing companies or international sectoral benchmarks) for energy intensive industries including ferro alloys, calcium carbide, cement, iron and steel, silicon carbide and other industrial consumers in HV & MV categories.
- This mechanism could be applied to both existing and new industrial consumers, taking into account different types of raw materials, fuels, and capacities.
- Assigning mandatory targets on their baseline energy consumption and allowing compliance period of 3 years to target industrial consumers for efficiency improvement.
- Mandating energy audits and reporting mechanism to report on the progress made.
- Co-financing and / or direct support to best local energy efficiency programmes.
- Guaranteeing of credits (tax benefits / accelerated depreciation) for EE projects.
- Introducing a penalty / reward mechanism to drive the EE programme .
- Creation of the national information system in field of energy efficiency increase (monitoring), awareness creation and training for responsible personnel.
- Establishing monitoring and evaluation procedures for verification either in the form of self-evaluation, local supervision, and national-level spot checking.

As indicated in step 3 under section 4.4, baseline review of energy intensive consumers in industrial sector needs to be carried out while adoption of EE standards and targets programme for EE improvement in industries. However, high up-front costs of energy efficiency solutions and the low cost of energy supply also needs to be taken into consideration before implementation.

5 Target Measure 5

Promotion through performance quota – Differential and punitive electricity pricing

This mechanism is aimed at permitting differential electricity pricing for energy intensive consumers in which electricity prices are set based on energy intensity level of the consumers. The primary objective of energy saving is achieved through promotion of energy efficient industries and phasing out of industries that are energy inefficient. An indicative step-wise approach for implementation based on experience from China is presented below:

- Identification of energy intensive consumers including ferro alloys, calcium carbide, cement, iron and steel, silicon carbide and other industrial consumers in HV & MV categories.
- Classification of identified industrial consumers into four different categories – "disallowed", "restricted", "allowed" and "encouraged" based on technology type.
- Establishing and announcing industry specific standard quotas for energy consumption.
- Fixing electricity pricing at normal rate for the allowed and encouraged industry category.
- Fixing electricity pricing at a premium rate for the disallowed & restricted industry category.
- Adopting punitive electricity pricing for those industries which do not comply and exceed the performance quota.

Mapping of instrument type and target groups

Performance quota

Instrument	Target Group
Differential and punitive electricity pricing	Existing and upcoming Industrial consumers

A detailed assessment on international policy overviews in industrial sector is provided in Annexure III

Energy Efficient Building

The concept of energy efficient building is targeted towards removal of barriers to energy conservation and energy efficiency in buildings. Different policy measures or EE improvement programmes are adopted depending on increasing the efficiency of new buildings or retrofitting of existing buildings. Additional policy measures and EE programmes also play a vital role in creating a market for energy efficient building products. Following are the legislative and policy options that have had seen record of success in promoting energy efficiency in buildings:

- Building codes and standards for new construction and allowance of performance based economic incentives
- Promotion through energy efficiency targets
- Adoption of labeling schemes for most energy efficient buildings and equipments
- Adoption of labeling schemes to provide required information to measure energy efficiency and annual energy costs for operation;
- Education and awareness campaign to promote market acceptance of energy efficiency technologies and energy-efficient designs
- Government-funded research and development on energy efficiency in buildings.

Short Term Measures – Building Sector

1 Target measure 1

Enhance existing energy management practices through elemental approach

This target measure is aimed at enhancing the existing energy management (EM) practices of the government and commercial buildings through adoption of the following measures:

- Undertaking extensive awareness creation programmes and advanced training & capacity building programmes for the key target groups including energy managers, building owners, technicians & operators etc.
- Establishment of monitoring and verification process and to mandate building managers / owners to report on energy consumption and efficiency
- Encouraging or mandating building owners to undertake energy audits through competent authorities and mandate reporting on the progress made in implementation of EE programmes on an annual basis
- Encouraging participation among building sector through energy award programmes

2 Target measure 2

Adoption of Energy Conservation Building Codes and Standards (ECBC)

The first step is development of energy conservation building code and standards aimed at promoting energy efficiency in building at the construction stage itself and this could be implemented by the following steps:

- The building energy code is made either voluntary or mandatory in nature and reference could be made to energy efficiency requirements for new construction in buildings.
- Reference to standards could be made to minimum mandatory requirements for equipments used in buildings such as furnaces or boilers (Bukhari), water heaters, appliances, insulation, lighting and heating requirements etc.
- Before adopting codes and standards, it is essential that testing protocols and methodologies to determine the energy usage of the entire building and energy use of the major components that contribute to total energy use. The benchmarks for new and existing buildings are to be developed. Ideally, compliance with these protocols will yield databases listing the performance of each product or building, and labels publicizing the tested performance.
- Classification of energy codes and standards could be made to include residential and non-residential buildings separately and further categorized into new constructions, refurbishment and renovations.
- Key factor towards driving the adoption of ECBC and standards is through widespread awareness programs targeting the end users. As an initial step, model government institutional buildings could be developed for dissemination of knowledge and awareness creation.

Mapping of instrument type and target groups

Building Codes & Standards

Instrument	Target Group
ECBC	New Construction Buildings
Awareness creation	Residential & Commercial Builders, Contractors

3 Target measure 3

Improve Energy Efficiency in Public Procurement

Energy efficiency in the public sector always has been a challenge where Government does not have direct control. The major challenge lies in overcoming the rigid public sector procurement practices that focus on first costs and a lack of discretionary budgets to make investments in energy efficient equipment.

Moreover, public are not aware of EE products or their performance, and the equipment that they employ is highly inefficient. Other constraints include:

- Lack of commercial orientation by the government
- No control over public procedures for equipment and service procurement

In order to promote energy efficiency in public procurement practices, government should consider driving procurement practices and procedures with public, service providers and equipment dealers. International experience reveals that many multipronged approach are adopted to encourage energy efficiency movement in public procurement and usage practices. It is also observed that although simple measures and universally applicable energy efficiency policies are lacking, impact of EE measures adopted by a number of countries shows that large-scale EE gains are possible in public procurement practices. An indicative approach that could be adopted to improve EE in public procurement practices is presented as follows.

Typical barriers & actions that could be taken to improve EE in public procurement practices[12]

Barrier	Indicative action to be taken by the government	Country Example
Lack of awareness and information including costs, benefits, risks & products	Initiate awareness campaigns, case studies, procurement guidelines, product catalogs/specifications, information dissemination and demonstrations	Brazil, Canada, China, France, Germany, Japan, Mexico, Sweden, U.S., Vietnam
Lack of technical capacity for audits, project design, procurement, implementation, monitoring and trust of EE potential	Create and engage nodal agency to provide technical assistance for EE projects, develop training / educational programs for energy service providers and establish procurement / contracting guidelines	Brazil, Canada, China, Germany, India, Japan, Mexico, Philippines, South Korea, Thailand, U.S., Ukraine, Vietnam
Restrictive procurement, contracting and financing rules	Adopt public policies for EE products and Energy Saving Performance Contracts (ESPCs) and create public EE funds	Brazil, Canada, China, France, Germany, Thailand, U.K., U.S.

In the above indicative actions, promotion through adoption of incentive mechanism for public procurement are not considered which could be adopted as a long term measure.

Long Term Measures – Building Sector

4 Target measure 4

Adoption of Energy Labeling Schemes

Over a long term, building labelling schemes (such as Green Building Programs) and incentive mechanisms could be brought in. This could be driven post maturity in the adoption of building code for energy conservation. The labelling schemes and incentive mechanisms could cover both new constructions as well as refurbishments.

A detailed assessment on international policy overviews in building sector is provided in Annexure IV

Energy Efficient Transport

Bhutan under the Development Partnership Program for South Asia has developed the Bhutan Transport 2040 Integrated Strategic Vision. Totally nine transport related strategies have been identified and a detailed action plan with strategic measures, cost estimate and timeplan for implementaion have been clearly defined.

Green Tax

Royal Government of Bhutan recently has introduced Green Tax with the retrospective applicability for vehicles imported from 20th June 2012. In addition, motor vehicles designed with engine capacity of 1800 cc or more would be subject to 20% Green Tax. Most of the other vehicles would be subject to a green tax of 5%. Electric vehicles are not subject to Green Tax.

Taking into consideration both the fuel and vehicle are imported items which are not manufactured in-house, Royal Government of Bhutan through its Transport 2040 Vision has taken necessary measures to address energy efficieny through other alternative means in the form of financial incentives and tax credits.

Key considerations related to energy efficiency from Bhutan 2040 Strategic Vision[13]

Transport strategies	Key considerations that will influence energy efficiency
Civil aviation strategy	Efficient regulation and compliance with international safety, security and environmental Standards
Inter-City and Rural Public Transport Strategy	Incentives for fuel efficient buses and taxis
	Tax incentives for new 8-12 seat buses
	Tax and regulatory incentives for larger 30-60 seat buses on major routes
Freight transport	Tax regulatory incentives for fuel efficient trucks
	Private sector to modernize fleet and introduce systems to increase fleet efficiency
	Introduction of training in transport management and logistics at technical institutes
	Feasibility studies of alternative freight modes in special applications
Urban transport	Traffic congestion limit through traffic engineering, control of vehicles, public transport
	Public transport and walking
Road Transport Regulation Strategy	Driver training
	Vehicle standards and testing:
	Introduce major incentives for fuel efficient and green Vehicles – electric vehicle recharging infrastructure, alternative Fuels

Short Term Measures – Transport Sector

Target measure 1

Improving the efficiency of public transport and inter-city transport

This target measure is aimed at making public transport more attractive by improving reliability, and frequency of service and this could be achieved through the following steps:

- increase efficiency of public transport services in the cities ,
- implement policies to stimulate the accelerated introduction of 'clean/green' vehicle fleets in public transport. Develop and provide policy recommendations to road transport authorities to change behaviour in favour of public transport use,
- provide integrated and 'seamless' passenger information services to stimulate use of public transport and to bring down barriers for access to public transport services.
- incentivize and provide subsidies for public transport usage.
- enable environment for private players participation in inter-city transport.

Short Term Measures – Transport Sector

Target measure 2

Improving road engineering aspects

This target measure is aimed at improving road engineering and thereby achieving fuel efficiency.

- Define procedures for upkeep and maintenance of local roads in a manner that sustains the operating conditions of the public transport system and enable introduction of new transport provision models. Transport Authority to take into account the needs of public transport when setting road maintenance priorities.
- Better coordination with departments such as National Resources Development Corporation Limited and Industries to ensure accountability of any damages caused to road during operation and transportation of goods respectively.

Long Term Measures – Transport Sector
Target measure 3
Long term strategy

Long term strategy to cover areas of

- Long term sustenance of efficient subsidized public transport;
- Urban planning and transportation infrastructure including feasibility of development of cable car networks;
- Schemes / Subsidies to promote fuel-efficient passenger vehicles and freight;
- Analyzing the economic impact of taxing fuels based on consumption levels and developing monitoring mechanisms

4.6 Way Forward

- Though impacted by the challenges due to affordable electricity prices in promoting energy efficiency, the Royal Government of Bhutan is actively involved in evolving mechanism and adopting measures to promote energy efficiency for national benefits.
- The lack of energy efficiency policy, limited resources and limited or no access to EE financing is hindering the efforts towards undertaking energy efficiency improvement programme. This should be the priority area of focus by Royal Government of Bhutan.
- The above is aggravated by the supply tariff being set at a lowest price. However, the export tariff through sale of electricity to India is comparatively higher than the average domestic tariff. This indicates a potential for reduction in energy consumption there by ensuring enhanced energy security and increased export revenues.
- The policy directions and the energy efficiency programmes proposed are evaluated based on existing regulatory scenario and level of adoption of energy efficiency management practices in individual sectors. The best practices from international experience and the rationale behind each policy and energy efficiency programmes were also analyzed in the evaluation process. For any energy efficiency programme that are planned for implementation, it is to be ensured that a realistic target, allocation of guaranteed resources and allowance of relatively long timeframe (the three critical determinants) are provided for a successful implementation.

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Annexure I – List of stakeholders

S.No	Name of Stakeholder
	Departments
1	Department of Renewable energy – DRE
2	United Nations Development Programme Bhutan – UNDP
3	Road Safety and Transport Authority – RSTA
4	Bhutan Electricity Authority – BEA
5	Bhutan Chamber of Commerce and Industry – BCCI
6	Bhutan Standards Bureau – BSB
7	Ministry of Agriculture – MoA
8	National Housing Development Corporation Limited – NHDCL
9	Bhutan Power Corporation Limited – BPCL
10	National Statistics Bureau – NSB
11	Hydro Met Service Division
12	Department of Trade – DoT
13	Bhutan National Bank Limited – BNBL
14	Bhutan Development Bank Limited – BDBL
	Industries
1	Penden Cement Authority Limited (PCA)
2	Bhutan Ferro Alloys Limited
3	Druk Iron & Steel Pvt. Ltd.
4	Bhutan Steel Industries Limited
5	Bhutan Carbide & Chemicals Ltd. (BCCL)
6	Druk Cement Company Pvt. Ltd.

Annexure II – Site Visit Observations

Observations made during on-site assessment

Industry		
Low cost of energy supply – Long pay back period	Absence of regulatory drive in enforcing EE measures	Awareness on EE measures only at Managerial level, not extended to middle and lower management groups
Limited adoption of EE measures- Installation of VFD's and EE motors	EE measures are driven only through corporate/industry initiatives	Specific energy levels indicate potential for energy saving opportunities
Areas of improvement		
Awareness creation	Advanced capacity building programme	Promotion through mandatory energy audit & Energy Award programmes

Buildings		
Electrical appliance employed are 100% imported	Usage of Non-standard and Non-labeled electrical appliances	Limited knowledge on energy efficiency
Purchase of appliances majorly driven by cost	Limited adoption of EE measures- Installation of CFL, auto power control & automated geysers at hotels	
Minimal access to energy efficient building materials	Leakages observed in all hotels and residential houses visited	
Areas of improvement		
Extensive awareness creation	Advanced capacity building programme	Incentive schemes

Transport	LPG & Kerosene (bound by quota) are directly purchased from oil marketing companies in India	No specific measures to safeguard energy security apart from buffer stock.	Stone queries resulted in road exploitation - observed between Thimpu to Bumthang and Thimpu – Phuentsholing	Potholes observed from Bumthang to Mongar due to snowfall	Specific energy levels indicate potential for energy saving opportunities

Annexure III – International Policy Overview - Industry

Policy overview - Industry

1 Energy Efficiency (EE)	2 Renewable Energy (RE)
Efficiency trading	Feed-in-tariffs
Standards & targets	Supply requirements
Technology requirements	Purchase requirements
End Use	Investment tax incentives
Investment tax incentives	Supply tax incentives
Other financial incentives	Other financial incentives

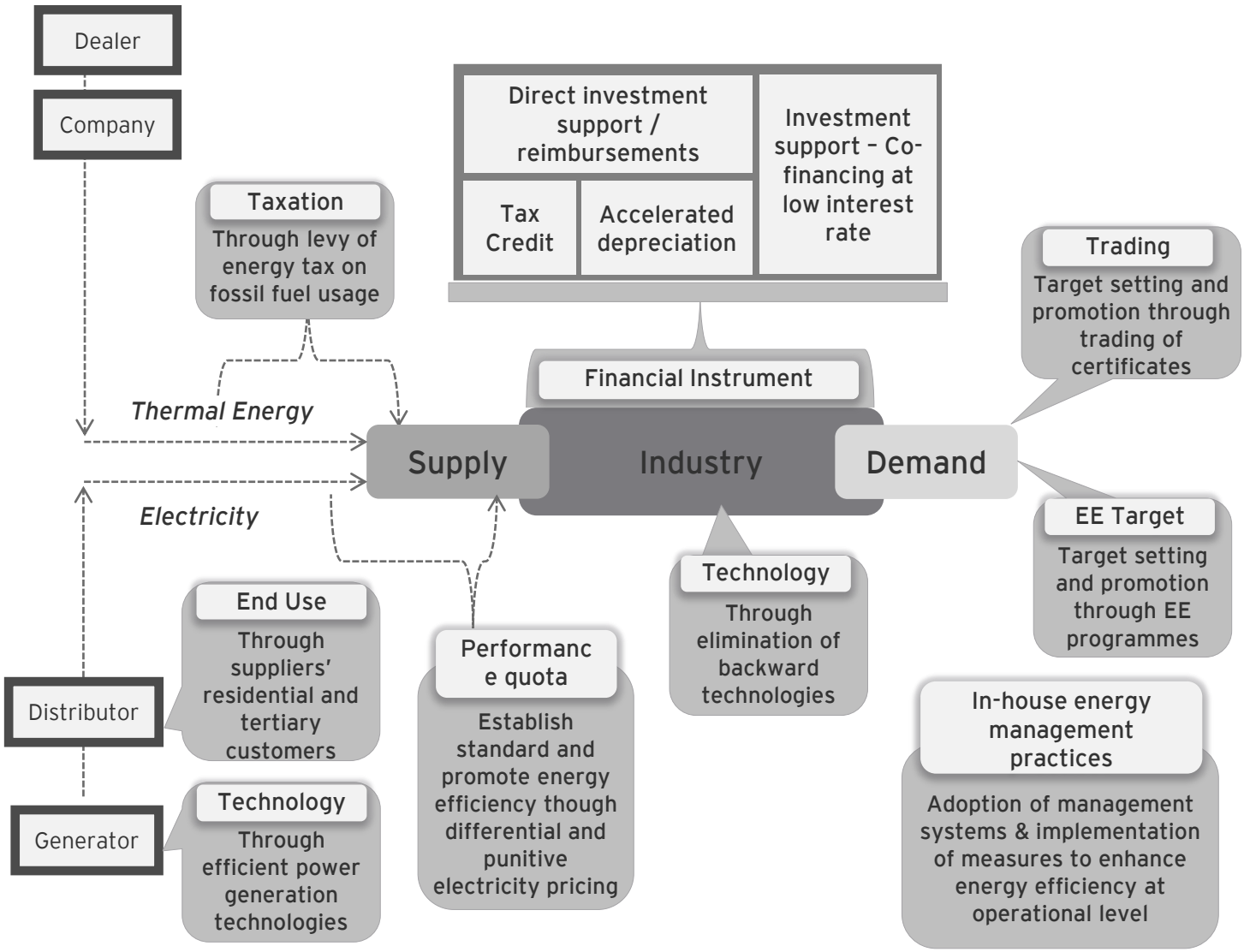
3 GHG (EE)	4 Others
Trading	Energy taxes
Emission targets	Energy policies
Technology requirements	

Quick glance

- Analysis on understanding of the policy framework related to "energy" and "climate change" in key countries.
- Broadly the policies are focused on four major segments which include (1) Energy efficiency, (2) Renewable Energy, (3) Greenhouse gas i.e. climate change and (4) Other including energy taxes and policies.
- The overarching framework policies, plans, strategies and goals have had been translated into specific policies, targets and implementation plans.

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency



Annexure III – International Policy Overview - Industry

Key Policies

	Activities	China	India	Japan	Russia	Turkey	US	Denmark	France	Germany	Italy	UK
Greenhouse Gas (GHG)	Trading	★					★	★	★	★	★	★
	Emission Limits / Targets						★					
	Technology requirement						★					
Energy Efficiency (EE)	Efficiency Trading		★									
	Standards & Targets	★		★	★	★						
	Technology requirements	★	★									
	End Use								★		★	
	Investment Tax Incentives			★	★	★	★					
	Other Financial Incentives					★				★	★	
Renewable Energy (RE)	Feed – in – Tariff	★	★	★		★		★	★	★	★	★
	Supply requirements			★			★				★	★
	Purchase requirements	★	★									
	Investment Tax Incentives	★		★			★					
	Supply Tax Incentives						★					
	Other Financial Incentives										★	
Others	Energy Taxes	★	★	★	★	★	★	★	★	★	★	★
	Energy Policy								★	★	★	★

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency

End Use	Technology requirements	Efficiency trading
Investment tax incentives	Other financial incentives	Energy taxes

France	
End Use	White Certificate (WC) Trading
Mandatory	Applies to supplier of energy
WC generated	~ 65 TWh
New Target	**255 TWh: Electricity & Gas 90 TWh: Vehicle combustion**

China	
Technology	Elimination of Backward Technology
Mandatory	Electricity, Al, Iron & Steel, Cement & Fertilizer
Energy saved	**118 Mtce**

Italy	
End Use	White Certificate (WC) Trading
Mandatory	Applies only to supplier of Electricity & energy service companies (ESCO)
WC generated	**~ 2 Million tonnes CO_2**

India	
Technology	IGCC and super-critical technology for new plants in power sector
Mandatory	Power sector
Target	**2012 – 2017: 60% of TPS added would be based on super-critical technology**

India	
Trading	Perform Achieve & Trade Scheme (PAT)
Mandatory	Identified energy intensive sector
Target	**10 Million mtoe by (2011-2014)**

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency

End Use	Technology requirements	Efficiency trading
Investment tax incentives	Other financial incentives	Energy taxes

Russia	
EE incentives	Federal law on energy conservation and improvement of energy efficiency and modifications in certain regulations of the Russian Federation"
Voluntary	Electricity & identified EI sector
Target	1) Investment tax credit 2) Accelerated amortization 3) State guarantees to ensure loans for energy efficiency projects.

Salient features

EE Classification	on all electrical appliances and computers produced within Russia and imported
Buildings & Construction	Comply with EE requirement as per Federal Regulations.

Turkey	
EE incentives	Support Scheme for EE in Industry
Voluntary	Identified EI sector
Success	1) Identified EE projects: 32 2) Completed: 13 3) 22 Voluntary Agreements had been made with industrial establishments aimed at reducing their energy intensity by an average of at least 10% for three years.

Salient Features

Investment support	For EE projects with a maximum payback period of five years
	Covers 20% of project costs up to a maximum of TRY 500,000
	For industries under voluntary agreements, reimbursement up to 20% of their energy costs (to a maximum of TRY 100,000) for the 1st year

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency

End Use	Technology requirements	Efficiency trading
Investment tax incentives	Other financial incentives	Energy taxes

Russia	
Incentives	Federal tax code
Mandatory	Electricity & identified EI sector
Features	Investment tax credit (for the period from 1 year to 5 years) for income tax, regional and municipal taxes is given on the loan amount, representing 100% of the equipment.

Italy	
EE Funding	Industry 2015: Industrial Innovation Projects
Voluntary	Identified EI sector
Target segment	1) Sustainable mobility 2) Industrial energy efficiency 3) Use of renewable energy
Investment flow	30 projects worth Euro 500 Million 1) 65 %:Bio-energy, Waste to energy & Solar PV 2) 35%: high-efficiency building materials, improved efficiency in end-use systems.

Japan	
EE incentives	Financial and Tax Incentives for Industry
Voluntary	Electricity & identified EI sector
Energy saved	2.46 million KL (crude oil equivalent)

Salient features

1. Investment support

Government-affiliated banks provides low-interest loans for financing the introduction of energy conservation and efficiency systems in industry

2. Tax incentive

Provided for businesses investing in specified energy conservation and efficient equipment, providing a special depreciation rate of 30% of the acquisition cost. For small businesses, the special depreciation rate is coupled with a 7% tax deduction off the acquisition cost.

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency

End Use	Technology requirements	Efficiency trading
Investment tax incentives	Other financial incentives	Energy taxes

China	
Energy Tax	Differential electricity pricing
Mandatory	Identified EI sector

Salient features

Differential electricity pricing

1. Identified industries: electrolytic aluminum, ferroalloy, calcium carbide, caustic soda, cement, steel, phosphorus and Zn smelting
2. Restricted enterprises: +0.1RMB/kWh
   Eliminated enterprises: +0.3RMB/kWh
3. Established and announced 22 industries' standard quotas of energy consumption

Punitive electricity pricing

Industries over the national or local standard are penalized based on electricity pricing

Japan	
Energy Tax	Energy Tax Reform on Fossil Fuels
Mandatory	Electricity & identified EI sector

Salient features

**Oil at ¥2,040 per KL;
LNG and LPG at ¥1,080 per MT;
and coal at ¥700 per MT.**

India	
Energy Tax	National Clean Energy Fund
Mandatory	Electricity & identified EI sector

Salient features

Rs.50 (~USD 1) per tonne levy on coal, lignite or peat, which are domestically produced or imported.

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency – Energy Efficiency Standards & Targets

China	
EE Targets	10,000 Enterprises Programme (formerly 1,000 Programme)
Mandatory	Electricity & identified EI sector
Energy saved	2006: 20Mtce, 2007: 38Mtce 2009: 100Mtce

Salient features

250 Mtce energy reduction by 2015 relative to 2010

Industries are required to:

1. Implement energy audits and benchmarking
2. Establish enterprise EMS
3. Expand energy manager pilots
4. Carry out energy usage reporting mechanisms
5. Accelerate retrofitting and elevate energy management levels

Russia	
EE Targets	Federal target-oriented Programme of the Russian Federation "Energy saving and increase of energy efficiency for the period till 2020"
Mandatory	Electricity & identified EI sector

Salient features

1. Mandatory targets for compared to BAU
2. Co-financing of the best regional energy efficiency programmes
3. Guaranteeing to the enterprises of granting credits for projects in the field of energy efficiency increase
4. Creation of the State information system in field of energy efficiency increase (monitoring), training for responsible personnel and awareness raising

Annexure III – International Policy Overview - Industry

Policy influence in promoting energy efficiency – Energy Efficiency Standards & Targets

China	
EE Targets	Industrial Energy Performance Standards
Mandatory	Electricity & identified EI sector

Salient features

Calcium Carbide	Cement	Crude Steel	Caustic Soda
Zinc	Copper	Ferroalloy	Coke

So far, 22 industry specific energy performance standards have been established.

Eg: X tce per tonne of cement / clinker.

These apply to existing plants and newly constructed plants, taking into account different types of raw materials, fuels, and capacities

Monitoring and evaluation will have three phases: self-evaluation, local supervision, and national-level spot checking

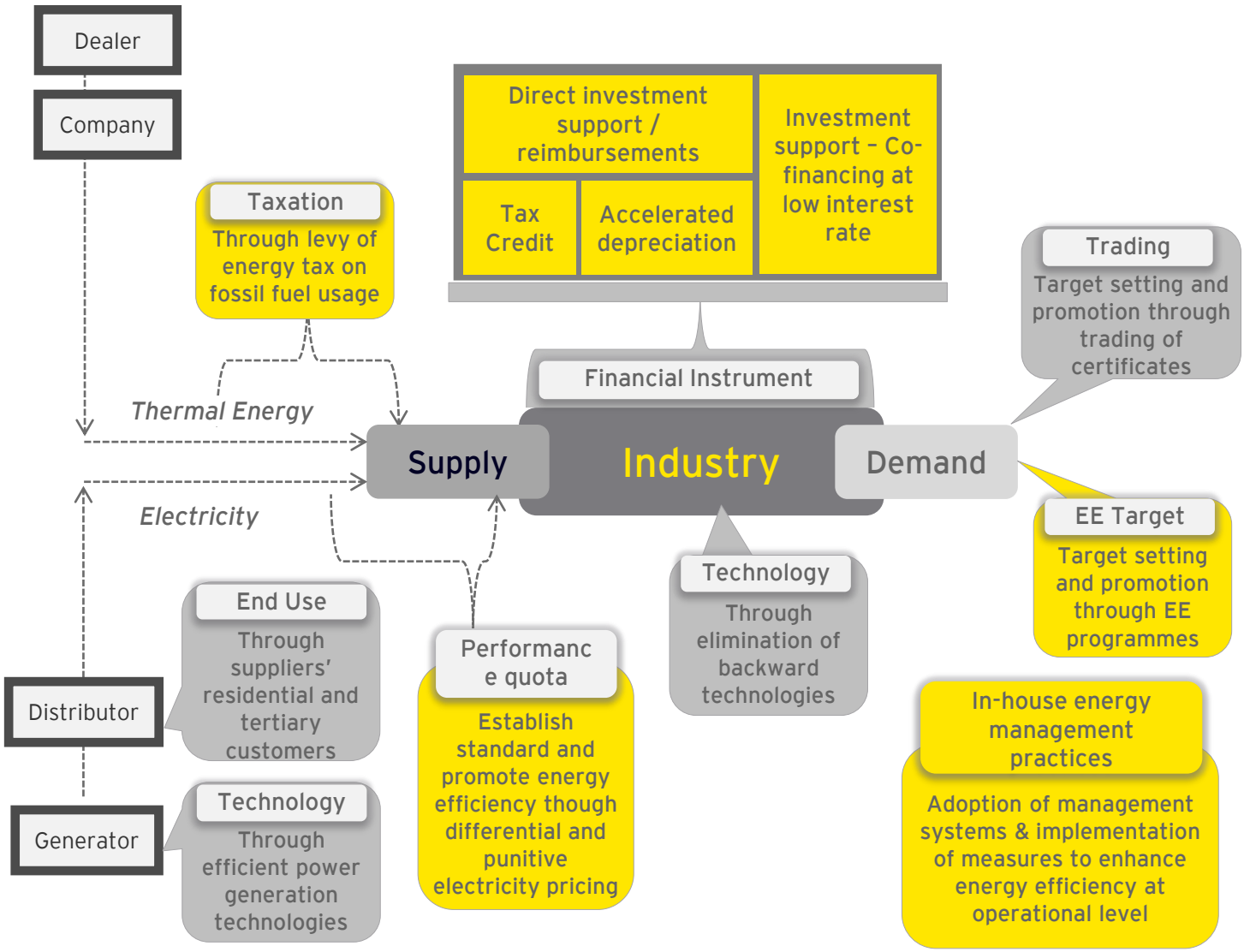
Japan	
EE Targets	Sectoral EE targets
Mandatory	Electricity & identified EI sector

Salient features

1) Benchmarks established for energy-intensive sectors – iron and steel, cement, and electricity suppliers.
2) Coverage is expected to be expanded to other sectors in the future. These must be met in the medium and long-term (so 2015 and 2020).
3) Targets have initially been set and are based on the energy efficiency level of the best performing companies (top 10 to 20%) in each sub-sector.

Annexure III – International Policy Overview - Industry

Key policy areas for Bhutan



Annexure IV – International Policy Overview - Buildings

Policy overviews - Buildings

1 Building Energy Codes

- Prescriptive
- Trade-off
- Model Building
- Energy Frame
- Overall Performance

2 Labelling schemes

- Comparative Labels
- Endorsement Labels

3 Incentive schemes

- Preferential Loans
- Direct Grants or Subsidies
- Taxes, Tax incentives or rebates
- Rebates

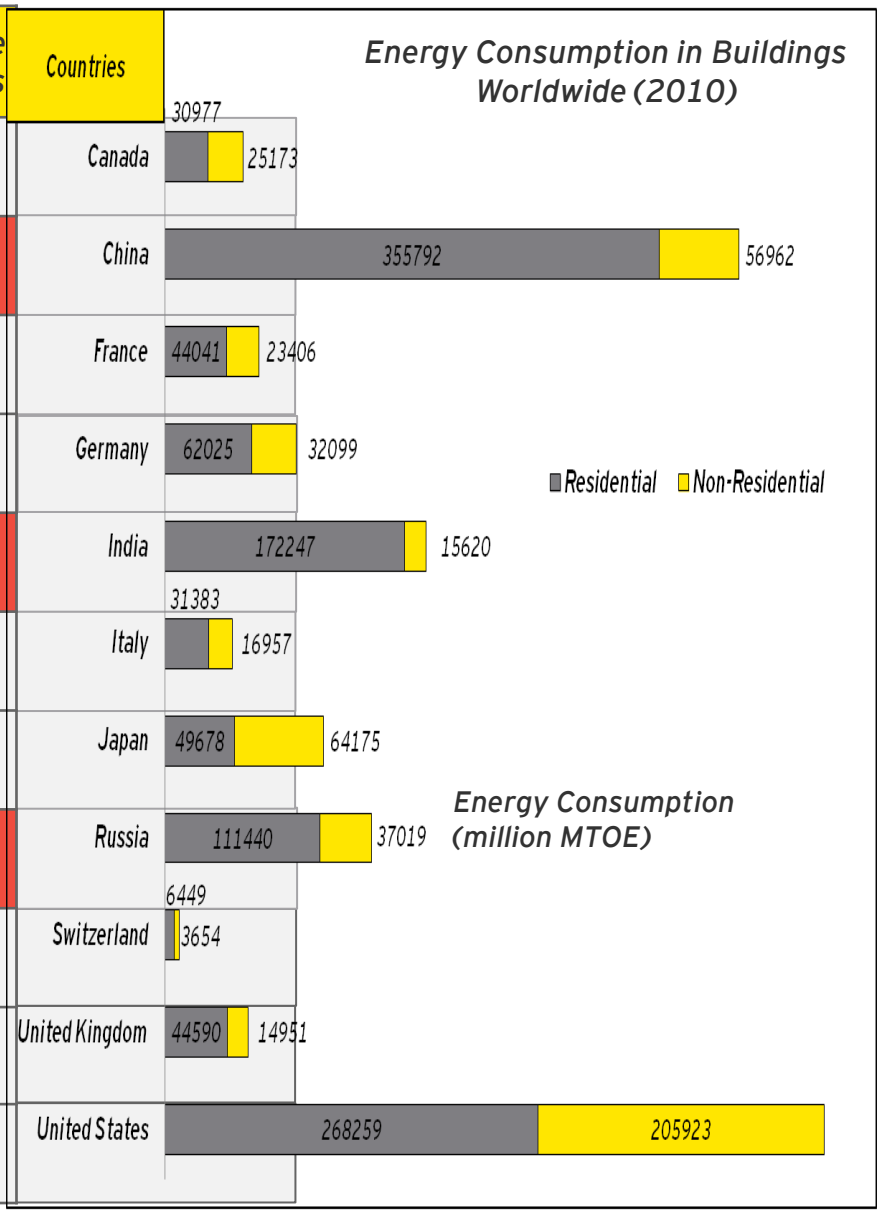
Quick glance

- Analysis on understanding of the policy framework related to "energy" and "climate change" in key countries.
- Broadly the policies are focused on three major segments which include (1) Building Energy Codes, (2) Labelling schemes, (3) Incentive schemes
- The overarching framework policies, plans, strategies and goals have had been translated into specific policies, targets and implementation plans.

Annexure IV – International Policy Overview - Buildings

Policy overviews - Buildings

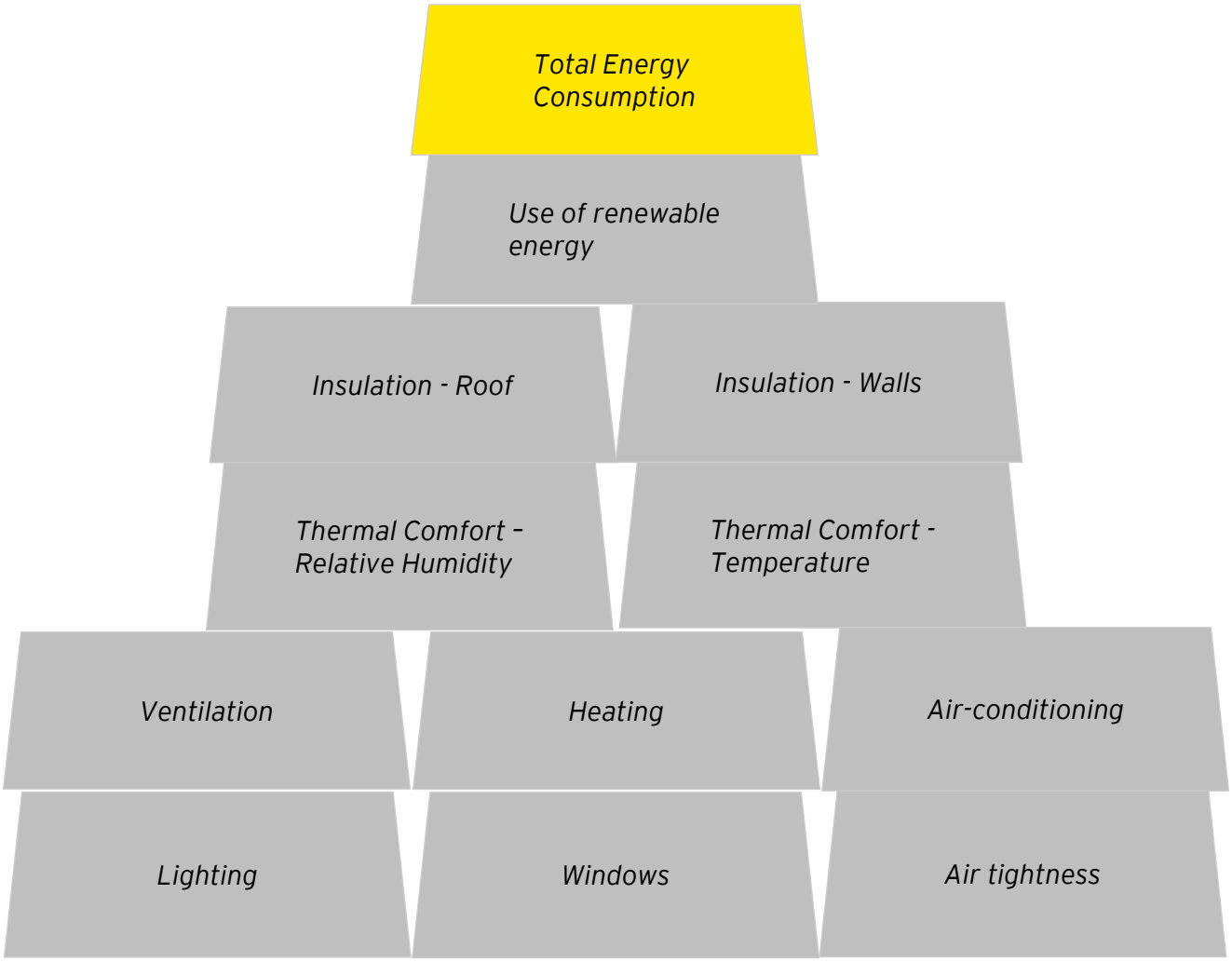
Building Energy Code	Labeling Schemes	Incentive Schemes	Countries
★	★	★	Canada
★	★		China
★	★	★	France
★	★	★	Germany
★	★		India
★	★	★	Italy
★	★	★	Japan
★	★		Russia
★	★	★	Switzerland
★	★	★	United Kingdom
★	★	★	United States



Annexure IV – International Policy Overview - Buildings

Building energy codes

Standard features considered under Building Energy Codes worldwide



Annexure IV – International Policy Overview - Buildings

Building energy codes

China	
Design Standard for Energy Efficiency	
Applicability	Residential Buildings
Salient Features	Codes segregated into three climatic zones: a) Severe Cold and Cold zone b) Hot Summer and Cold Winter zone c) Hot Summer and Warm Winter zone

England and Wales	
Building Regulations	
Applicability	Statutory requirement. Required for most building work.
Salient Features	Latest regulations released in 2010. Areas covered include structure, fire safety, resistance to moisture & sound, ventilation, combustion appliance & fuel storage systems, glazing, conservation of fuel and power

India	
Energy Conservation Building Code	
Applicability	All buildings that have connected load of 100 kW or greater or contract demand of 120 kVa or greater
Nature	Majorly voluntary. Recently codes have been made mandatory for commercial buildings across eight states
Salient Features	Provisions of the code apply to: a) Building Envelopes b) Mechanical systems and equipment c) Service hot water heating d) Interior and exterior lighting e) Electrical power and motors Residential facilities with centralized system shall have solar water heating for at least 1/5th of the design capacity

Annexure IV – International Policy Overview - Buildings

Labelling schemes

United Kingdom	
BREEAM standards	
Availability	Covers all buildings. Minimum standard level 3 prescribed for domestic buildings.
Salient Features	Scheme provides methodology, software tool and certification for projects. Includes refurbishment projects as well with project scopes such as variety of alteration made to existing dwelling, change of use projects etc.

Switzerland	
Minergie Standards	
Availability	All Buildings - New and refurbishment. Voluntary standards
Salient Features	Simplified standard solutions available for single family-homes for heating and hot water preparation Insulation requirements to be met: For walls 0.2 W/M^{2}k, for windows 1.3 W/M^{2}k

India	
Indian Green Building Council (IGBC) and LEED India	
Availability	IGBC available for Homes, Townships, Special Economic Zones and Factory buildings LEED India available for new constructions, and core & shell projects (typically commercial buildings)
Salient Features	Projects can apply for IGBC rating if it meets all mandatory requirements and achieve minimum required points. Energy savings anticipated at 20 – 30% Existing buildings which retrofit accordingly to criteria mentioned can also apply

Annexure IV – International Policy Overview - Buildings

Incentive schemes

United States			
Comprehensive Incentive schemes covering all instruments			
Salient Scheme	Incentive instrument	Type of Coverage	Scheme Features
Energy Efficient Mortgage Program	Loan	Residential Existing	Financing cost of energy efficient features
Low Income Home Energy Assistance Program	Grant	Residential Existing	Helps low-income households in fueling funds for paying energy bills. Disseminates information on low-income energy issues
Tax deductions for energy efficient commercial buildings	Tax rebate	Commercial Existing	25% Interior lighting, 15% HVAC, 10% building envelope relative to reference Building Financed by issuance of qualified energy conservation bonds
Personal tax credits for residential energy efficiency measures	Tax rebate	Residential New	30% of costs of certain qualified residential alternate energy equipment such as solar water heaters are claimable

Annexure IV – International Policy Overview - Buildings

Energy efficient equipments

Worldwide, policies covering Energy Efficient Equipment standards and labelling have been introduced to drive the energy efficiency agenda. Typical equipments covered under standards and labelling include:

LPG Stoves	Motors	Television sets
Ceiling Fans	Air-Conditioners	Pump sets
Tubular Fluorescent Lamps	Water geysers	Refrigerators
Washing machines	Boilers	Distribution Transformers
Battery Chargers	Heat Pumps	Commercial Freezers
Computer Monitors	Compressors	Kerosene stoves

Annexure IV – International Policy Overview - Buildings

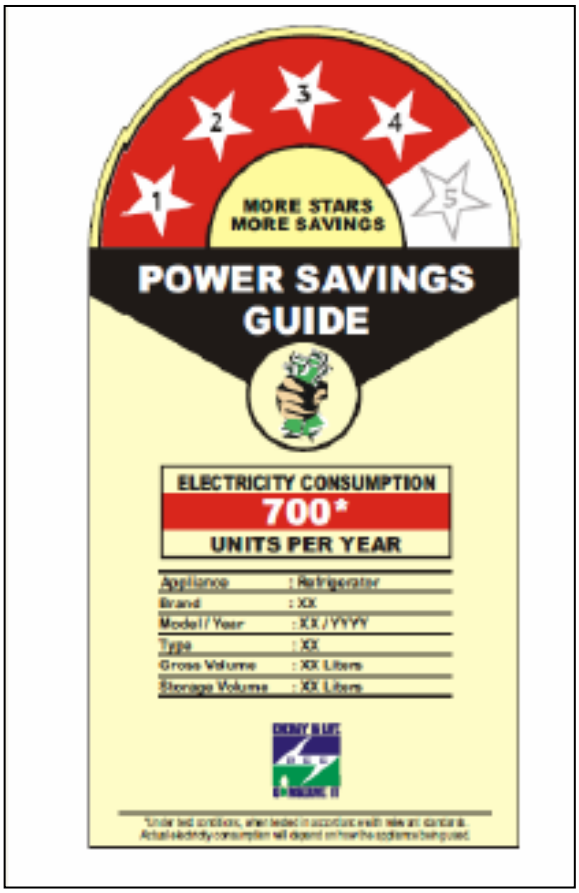
Energy efficient equipments – India policy overview

Equipment standards and labelling in India is managed by the Bureau of Energy Efficiency. Immediate mission is to reduce energy consumption by 3000 MW through use of Energy Efficiency equipments.

Overview of the standards and labelling methodology

1	*Determine equipments that are highest priority based on the quantified benefits*
2	*Develop a testing capability*
3	*Design and implement a Labeling program and set standards for implementation*
4	*Design and implement a communication campaign*
5	*Ensure program integrity*
6	*Continuous monitoring and evaluation of the program*

BEE star label - Illustrative



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