Sri Lanka
Sustainable Energy
Authority

Energy Consumption Benchmark Analysis

PREFACE

Sri Lanka Sustainable Energy Authority is in the process of implementing its recently formulated and ambitious National Energy Management Plan (EnMAP) covering a period of five years from 2012-2016. EnMAP forecasts an overall energy saving of around 20% of the total energy consumption of year 2010, by 2020.

Industrial and commercial sectors, which contribute for around 60% of the electricity consumption of the country, are some of the key areas to implement energy conservation measures in order to achieve these targets. So Sri Lanka Sustainable Energy Authority (SLSEA) has initiated a process in setting up energy benchmarks by identifying baseline energy consumption levels to assess the energy saving potential in number of industry sectors.

Accordingly SLSEA has published "Energy Consumption Baseline Analysis" for six different industrial sectors as a first attempt in setting benchmarks. Since benchmarking is a continuous process and industries are growing in large scales, those baseline values should be revised time to time. In this context, SLSEA is publishing this document as a revision of energy consumption benchmarks. All the accredited energy managers who provided their energy consumption information and the members of Greening Sri Lanka Hotels Project -Switch Asia are greatly acknowledged.

Energy Consumption Benchmark Analysis

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1. Introduction to Benchmarking

Benchmarks are reference or measurement standards used for the purpose of comparing performances of industries, businesses within industries, processes, systems or equipment. Benchmarking has been recognized to be an effective analysis methodology and management tool that helps to improve efficiency and performance in many areas for different objectives. Industrial energy benchmarking is a process of evaluating energy performance of an individual industrial plant or sector against a reference plant or sector. Energy benchmarking based on the performance of industry leaders or best practices is particularly useful for identifying energy inefficiencies in the production processes to keep performances within established norms, match rival performances in peer benchmarking and estimate the saving potential through cost/benefit analyses.

1.1 Benchmarking Indicators

"Specific Energy Consumption" value was used to present the benchmark standards for each sector which implies the amount of energy used per unit output of a product. All sources of energy utilized are captured, such as electricity, LPG, diesel, furnace oil, biomass etc. All sources of energy are converted into one common unit, MJ to present the total energy consumption.

This document provides the revised benchmarks for four selected sectors and a general overview of other industrial sectors.

- Tea Sector
- Apparel Sector
- Hotel Sector
- Commercial Buildings
- Other industries

In establishing benchmarks it is vital that realistic and achievable targets are set. In addressing this requirement, all benchmark values were derived from data gathered from a set of industrial units that have been in operation in the year 2012 and 2013, mostly through Energy Data Reporting Scheme of Energy Managers appointed by SLSEA.

General norm of comparing the specific indicators of a particular industrial sector to the reported benchmarks is, if the industry's indicator is less than the benchmark value, then it is operating with good practices and if the industry's indicator is greater than the benchmark value, then the industry can further improve its energy efficient practices.

02. Tea Industry

Sri Lanka has a strong & vibrant tea industry with a prominent brand name and having the number one position for agriculture based foreign exchange earner to the country. Sri Lanka produces about 300 million kg of tea annually and there are about 700 factories in operation in the country. Tea is grown in three different elevations (Up/Mid/Low) and possesses unique and specific characteristics of quality & taste attribute to its geographical origin & unique manufacturing practices. So the industry can be categorized either production methodology wise or geographical variation wise. But the overall quality of tea and the respective production methods have a fair dependence on the location. So the data was analysed considering two sub category levels as Up/Mid country and Low country.

Tea industries utilize energy in the form of electrical energy and thermal energy. Mostly electrical energy is supplied through grid or diesel generators. Thermal energy is used to generate hot air for the drying and withering processes and the fuel source widely used is firewood. Tea sector consume about 5 % of the total energy consumed by all industrial sectors.

Data from 26 tea factories from Up/Mid country were statistically analyzed to produce the following levels in energy consumption.

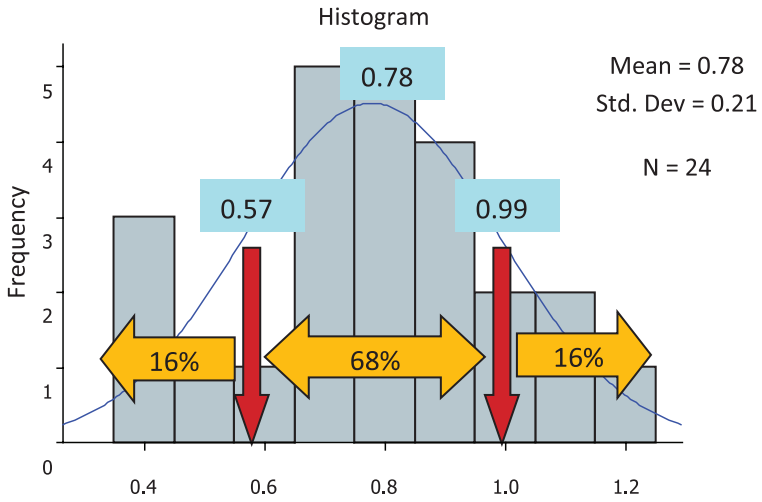
Table 01: Specific energy consumption levels for different energy sources in tea industry – Up/Mid Country

Description	Sample Size	Minimum	Maximum	Mean	Std. Deviation
Electricity consumption (kWh/ kg of Made Tea)	24	0.38	1.19	0.78	0.21
Diesel consumption (l / kg of Made Tea)	14	0.002	0.01	0.006	0.003
Biomass consumption (kg / kg of Made Tea)	20	1.26	2.92	2.02	0.49
Total Energy Consumption (MJ/kg of Made tea)	20	24	49.7	35.2	7.87

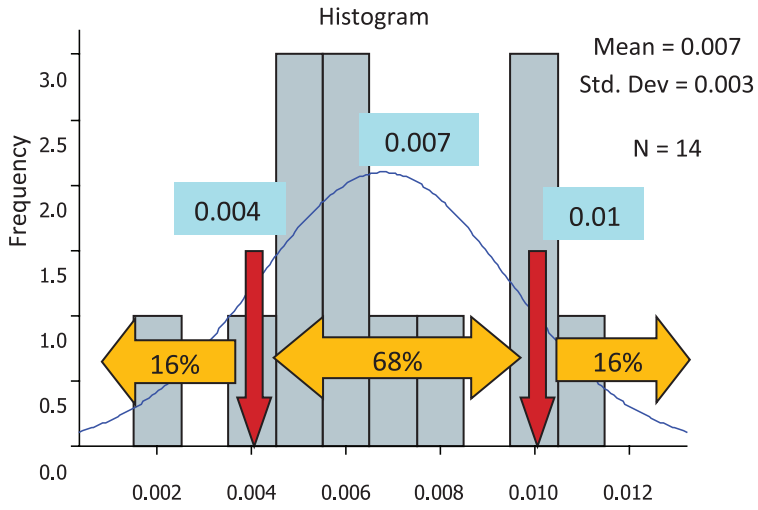
Table 02: Energy consumption benchmarks for tea industry – Up/Mid Country

Energy Source	Benchmark	Best Achievement
Electricity	0.78 kWh/ kg of Made Tea	0.57 kWh/ kg of Made Tea
Diesel	0.007 l / kg of Made Tea	0.004 l / kg of Made Tea
Biomass	2.02 kg / kg of Made Tea	1.53 kg / kg of Made Tea
Total Energy	35.2 MJ/kg of made tea	27.33 MJ/kg of Made tea

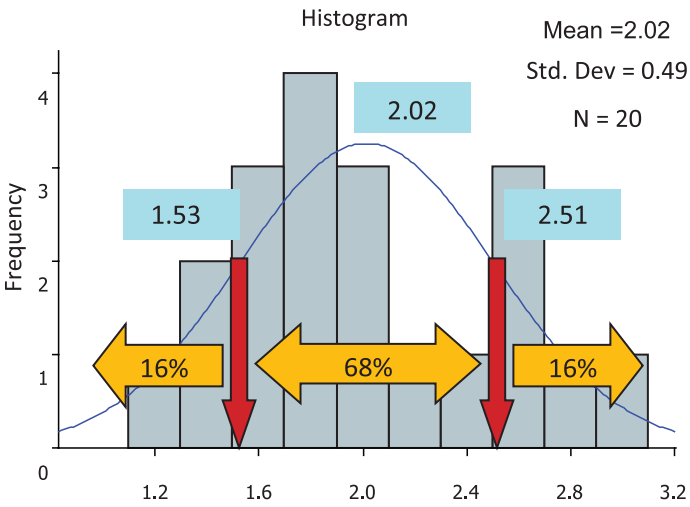
The graphical representation showing the Up/Mid country tea Industry Average, Best Achievement and the Worst Case Scenario levels are given below.



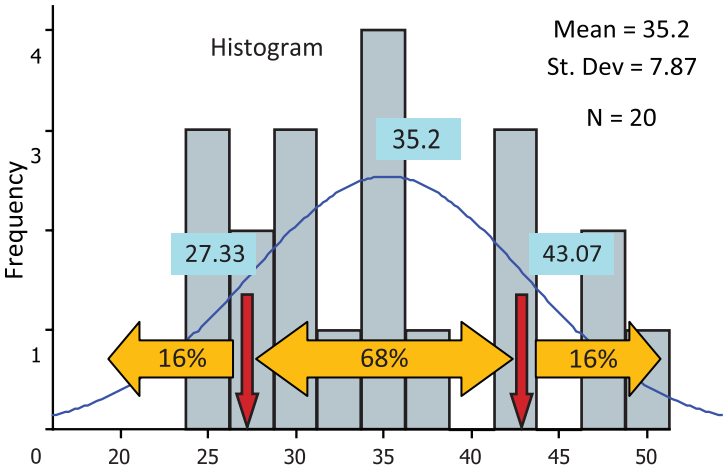
Specific electricity consumption – kWh/kg of Made Tea



Specific diesel consumption – l/kg of Made Tea



Specific biomass consumption – kg/ kg of Made Tea



Specific total energy consumption – MJ/kg of Made tea

Data from 26 factories from Low country were statistically analyzed to produce the following levels in energy consumption.

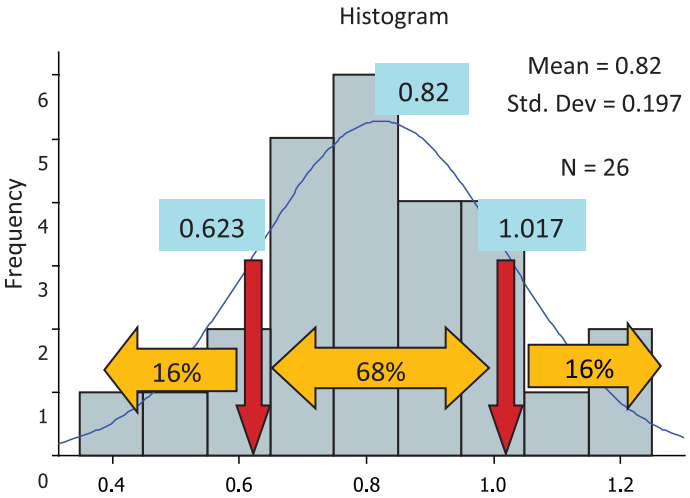
Table 03: Specific energy consumption levels for different energy sources in tea industry – Low Country

Description	Sample Size	Minimum	Maximum	Mean	Std. Deviation
Electricity consumption (kWh/ kg of Made Tea)	26	0.38	1.22	0.82	0.197
Diesel consumption (l / kg of Made Tea)	18	0.001	0.015	0.006	0.004
Biomass consumption (kg / kg of Made Tea)	24	1.28	2.84	2.01	0.48
Total Energy Consumption (MJ/kg of made tea)	24	23	48.2	34.94	7.73

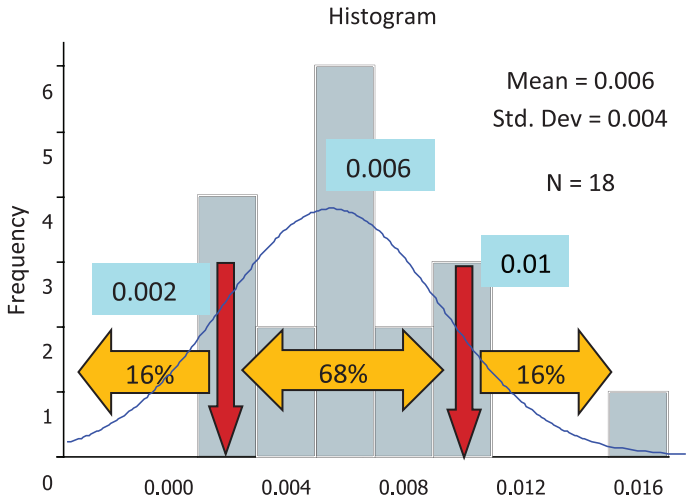
Table 04: Energy consumption benchmarks for tea industry – Low Country

Energy Source	Benchmark	Best Achievement
Electricity	0.82 kWh/ kg of Made Tea	0.623 kWh/ kg of Made Tea
Diesel	0.006 l / kg of Made Tea	0.002 l / kg of Made Tea
Biomass	2.01 kg / kg of Made Tea	1.53 kg / kg of Made Tea
Total Energy	34.94 MJ/kg of made tea	27.21 MJ/kg of made tea

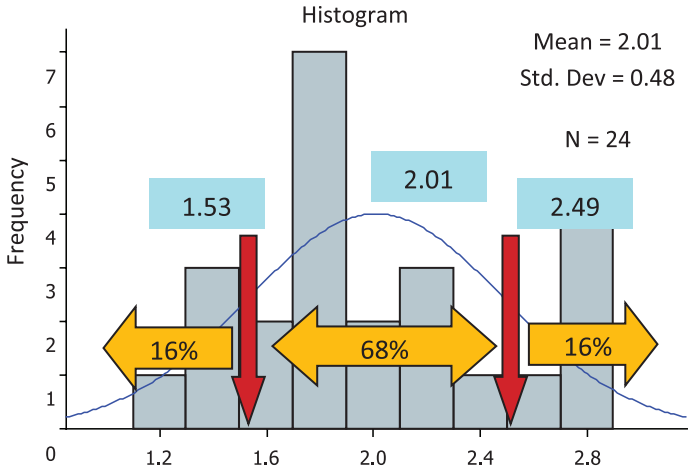
The graphical representation showing the low country tea Industry Average, Best Achievement and the Worst Case Scenario levels are given below.



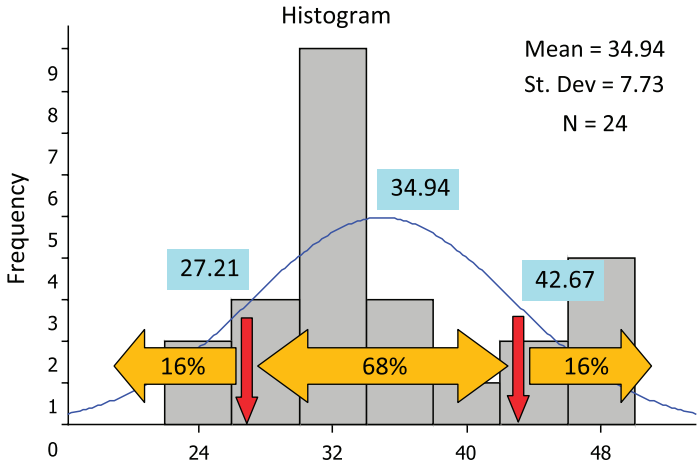
Specific electricity consumption – kWh/ kg of Made Tea



Specific diesel consumption – l / kg of Made Tea



Specific biomass consumption – kg/ kg of Made Tea



Specific total energy consumption – MJ/kg of made tea

3. Apparel Industry

The Textile and Apparel Industry occupies the most significant and dynamic position in industrial sector. This industry has grown over the last three decades and has become the top foreign exchange earner and the largest single employer in the manufacturing industry. It consumes about 14% of the total energy consumed by all industrial sectors.

Apparel industries utilize energy in the form of electrical energy and thermal energy. Mostly electrical energy is supplied through grid or diesel generators and thermal energy is supplied through various solid, liquid and gaseous fuels such as diesel, furnace oil, kerosene, LPG, biomass etc. Data from 36 apparel factories were statistically analyzed to produce the following levels in energy consumption.

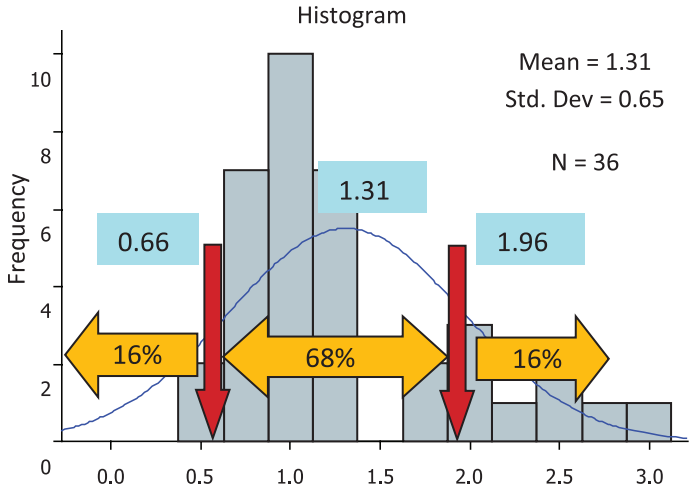
Table 05: Specific energy consumption levels for different energy sources in garment industry

Description	Sample Size	Minimum	Maximum	Mean	Std. Deviation
Electricity consumption (kWh/ Clock Hour)	36	0.55	3.05	1.31	0.65
Diesel (electrical) consumption (l / Clock Hour)	29	0.001	0.019	0.008	0.003
Diesel (thermal) consumption (l / Clock Hour)	5	0.007	0.044	0.031	0.014
Biomass consumption (kg / Clock Hour)	4	0.03	0.399	0.17	0.13
Furnace Oil Consumption (l/Clock Hour)	10	0.011	0.205	0.096	0.059
LPG Consumption (kg/Clock Hour)	9	0.003	0.024	0.01	0.007
Kerosene Consumption (l/Clock Hour)	7	0.013	0.028	0.018	0.006
Total energy consumption (MJ/Clock hour)	36	2.33	15.03	6.46	3.53

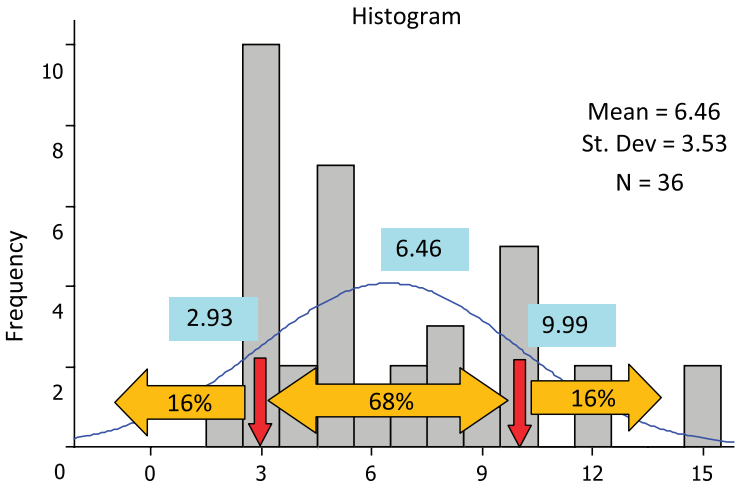
Table 06: Energy consumption benchmarks for Apparel industry

Energy Source	Benchmark	Best Achievement
Electricity	1.31 kWh/ Clock Hour	0.66 kWh/ Clock Hour
Diesel(Electrical)	0.008 l / Clock Hour	0.003 l / Clock Hour
Diesel(Thermal)	0.031 l/Clock Hour	0.017 l/Clock Hour
Biomass	0.17 kg / Clock Hour	0.04 kg / Clock Hour
Furnace Oil	0.096 l/Clock Hour	0.037 l/Clock Hour
LPG	0.01 kg/Clock Hour	0.003 kg/Clock Hour
Kerosene	0.018 l/Clock Hour	0.012 l/Clock Hour
Total Energy	6.46 MJ/Clock hour	2.93 MJ/Clock hour

The graphical representation showing the Industry Average, Best Achievement and the Worst Case Scenario levels are given below.



Specific electricity consumption – kWh/ Clock hour



Specific total energy consumption – MJ/Clock hour

4. Commercial Buildings

Commercial establishments are expanding rapidly in recent years and they consume about 8% of the total energy consumed by the industrial sector. Most of the buildings use energy in the form of electrical energy only and higher percentage of that is consumed for air conditioning and lighting. Data from 27 commercial buildings were statistically analyzed to produce the following levels in energy consumption.

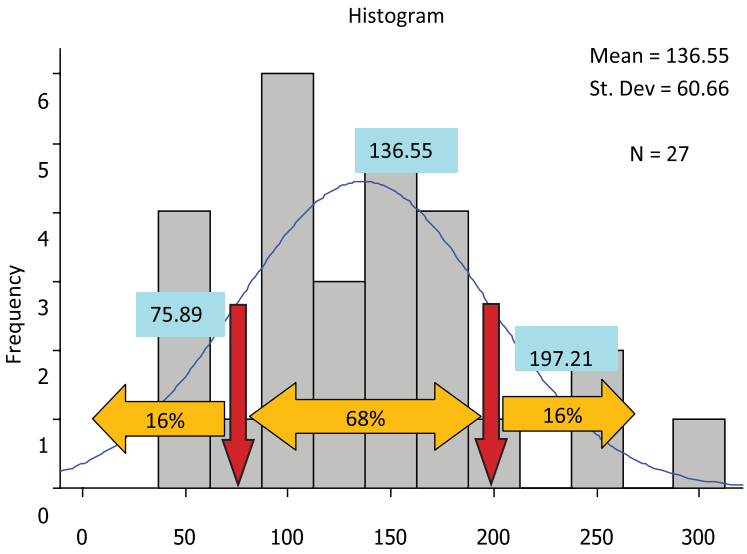
Table 07: Specific energy consumption levels for commercial buildings

Description	Sample Size	Minimum	Maximum	Mean	Std. Deviation
Annual Electricity Consumption (kWh/m^2)	27	43.76	293.26	136.55	60.66

Table 08: Energy consumption benchmarks for Commercial Buildings

Energy Source	Benchmark	Best Achievement
Electricity	136.55 kWh/m^2.year	75.89 kWh/m^2.year

The graphical representation showing the Building Average, Best Achievement and the Worst Case Scenario levels are given below.



Specific electricity consumption – kWh/m2.year

5. Hotel Industry

Hotel industry has also grown with the increasing tourist attraction to the country and it consumes about 5% of the total energy consumed by all industrial sectors. It is obvious that the energy performance of hotel industry will depend on the level of service provided to a guest. Considering this matter, it is essential to set benchmarks for each category of hotels according to the level of service provided. In this case, the most commonly used categorization defined by Sri Lanka Tourism Development Authority (SLTDA) accommodation guide is used as following.

- Five Star
- Four Star
- Three Star
- Two Star
- One Star
- Boutique
- Unclassified
- Supplementary

Also another important parameter that has to be considered when establishing benchmarks for this industry is the effect of occupancy. The specific consumptions would not be constant even if the hotel operates with the same sustainable practices, since higher occupancies have an effect of lowering the specific indicators and lower occupancies increases the specific indicators. Taking this fact into account, in this study, benchmarks are calculated for three occupancy levels, at the countrywide annual average occupancy, and two other occupancies above and below this value, as follows:

- Country-wide annual average occupancy for 2012 from SLTDA statistics – 72%
- 66% occupancy
- 92% occupancy

A further complication that was addressed was the functions such as weddings, receptions and conferences that are catered by some hotels. Functions also consume resources and if not corrected for, would distort consumption figures. These were corrected by converting the number of function guests to equivalent room nights. For energy consumption, 20 function guests were taken as equivalent to one room night.

Thus, when comparing the specific indicators of a particular accommodation facility to the reported benchmarks, it is vital that the hotel's indicators are adjusted to one of the occupancies given above.

The sample sets of the all eight hotel categories were statistically analysed to produce the following for the three different occupancies.

Table 09: Specific primary energy consumption levels for hotel industry

Category	Description	Sample Size	Occupancy	Minimum	Maximum	Mean	Std. Deviation
Five Star	Primary Energy Consumption (kWh/ Room Night)	11	62 %	85.3	241.6	162.6	151
			77 %	70.3	203.4	137.4	42.4
			92 %	60.0	177.4	120.1	37.8
Four Star	Primary Energy Consumption (kWh/ Room Night)	8	62 %	47.5	211.4	107.4	46.9
			77 %	41.4	169.7	90.7	40.1
			92 %	41.4	142.1	79.9	35.5
Three Star	Primary Energy Consumption (kWh/ Room Night)	8	62 %	43.7	195.2	96.5	44.9
			77 %	35.1	154.7	79.3	37
			92 %	29.3	127.8	68.6	32.3
Two Star	Primary Energy Consumption (kWh/ Room Night)	8	62 %	38.0	102.1	65.2	26.1
			77 %	32.1	85.9	54.5	20.7
			92 %	27.4	80.4	47.3	17.6
One Star	Primary Energy Consumption (kWh/ Room Night)	4	62 %	13.9	104.9	69.1	50
			77 %	11.6	89.0	58.4	42.5
			92 %	10.1	77.7	50.9	37.2
Boutique	Primary Energy Consumption (kWh/ Room Night)	5	62 %	56.3	229.0	160.4	80
			77 %	49.0	200.7	137.6	68.2
			92 %	43.8	180.0	121.4	59.8
Unclassified	Primary Energy Consumption (kWh/ Room Night)	25	62 %	13.7	316.1	71.1	45.5
			77 %	11.9	251.9	59.8	37.6
			92 %	10.7	209.1	52.2	32.1
Supplementary	Primary Energy Consumption (kWh/ Room Night)	5	62 %	13.7	316.1	71.1	45.5
			77 %	2.1	65.7	38.6	34.6
			92 %	2.1	70.0	34.6	31.2

Table 10: Energy consumption benchmarks for Hotel Industry

Category	Occupancy	Energy Source	Benchmark	Best Achievement
Five Star	77%	Primary Energy	137.4 kWh/ Room Night	95 kWh/ Room Night
Four Star	77%	Primary Energy	90.7 kWh/ Room Night	50.6 kWh/ Room Night
Three Star	77%	Primary Energy	79.3 kWh/ Room Night	42.3 kWh/ Room Night
Two Star	77%	Primary Energy	54.5 kWh/ Room Night	33.8 kWh/ Room Night
One Star	77%	Primary Energy	58.4 kWh/ Room Night	15.9 kWh/ Room Night
Boutique	77%	Primary Energy	137.6 kWh/ Room Night	69.4 kWh/ Room Night
Unclassified	77%	Primary Energy	59.8 kWh/ Room Night	22.2 kWh/ Room Night
Supplementary	77%	Primary Energy	38.6 kWh/ Room Night	4 kWh/ Room Night

6. Other Industries

General Overview of the level of energy consumption of few different industrial sectors is given below. Since the sample set for each category is very small, a comprehensive statistical analysis could not be done and following values are given as reported.

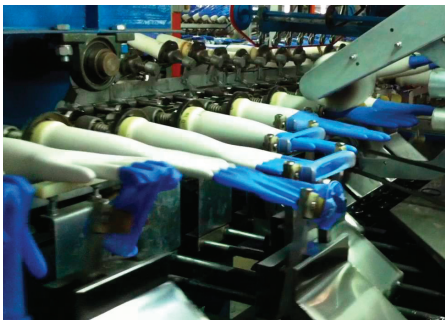



Table 11: Specific energy consumption levels for other industrial sectors

Industry Category	Energy Source	Baseline
Porcelain	Electricity consumption (kWh/ kg)	1.06
	Thermal Energy consumption (kWh/ kg)	3.8
	Total Energy consumption (MJ/ kg)	17.5
Tyre	Electricity consumption (kWh/ kg)	0.54
	Thermal Energy consumption (kWh/ kg)	0.69
	Total Energy consumption (MJ/ kg)	3.5
Food	Electricity consumption (kWh/ kg)	0.33
	Thermal Energy consumption (kWh/ kg)	0.4
	Total Energy consumption (MJ/ kg)	2.6
Beverages	Electricity consumption (kWh/ litre)	0.15
	Thermal Energy consumption (kWh/ litre)	0.2
	Total Energy consumption (MJ/ litre)	1.3
Glass	Electricity consumption (kWh/ kg)	0.24
	Thermal Energy consumption (kWh/ kg)	1.02
	Total Energy consumption (MJ/ kg)	4.5
Corrugated packaging	Electricity consumption (kWh/ kg)	0.7
	Thermal Energy consumption (kWh/ kg)	0.3
	Total Energy consumption (MJ/ kg)	3.6
Gloves	Electricity consumption (kWh/ pair)	0.15
	Thermal Energy consumption (kWh/ pair)	0.58
	Total Energy consumption (MJ/ pair)	1.9
Cement and concrete	Electricity consumption (kWh/ kg)	0.05
	Thermal Energy consumption (kWh/ kg)	0.02
	Total Energy consumption (MJ/ kg)	0.3

7. Summarized details of energy consumption benchmarks and potential for energy saving

Industry Sector	Energy Source	Benchmark	Best Achievement	Saving Potential (per annum)
Tea – Up Country	Electricity	0.78 kWh/ kg of Made Tea	0.57 kWh/ kg of Made Tea	3.5 GWh
	Diesel	0.007 l / kg of Made Tea	0.004 l / kg of Made Tea	28000 l
	Biomass	2.02 kg / kg of Made Tea	1.529 kg / kg of Made Tea	6300 tons
	Total Energy	35.2 MJ/kg of made tea	27.33 MJ/kg of made tea	100.8 TJ
Tea – Low Country	Electricity	0.82 kWh/ kg of Made Tea	0.623 kWh/ kg of Made Tea	3.3 GWh
	Diesel	0.006 l / kg of Made Tea	0.002 l / kg of Made Tea	107000 l
	Biomass	2.01 kg / kg of Made Tea	1.53 kg / kg of Made Tea	7300 tons
	Total Energy	34.94 MJ/kg of made tea	27.21 MJ/kg of made tea	1152 TJ
Garment	Electricity	1.31 kWh/ Clock Hour	0.66 kWh/ Clock Hour	34 GWh
	Diesel (Electrical)	0.008 l / Clock Hour	0.003 l / Clock Hour	211000 l
	Diesel (Thermal)	0.031 l/Clock Hour	0.017 l/Clock Hour	91000 l
	Biomass	0.17 kg / Clock Hour	0.04 kg / Clock Hour	700 tons
	Furnace Oil	0.096 l/Clock Hour	0.037 l/Clock Hour	750000 l
	LPG	0.01 kg/Clock Hour	0.003 kg/Clock Hour	108000 l
	Kerosene	0.018 l/Clock Hour	0.0123 l/Clock Hour	70000 l
	Total Energy	6.46 MJ/Clock Hour	2.93 MJ/Clock Hour	183.6 TJ
Commercial Buildings	Electricity	136.55 kWh/m^2.year	75.89 kWh/m^2.year	14 GWh

Hotel sector				
Five Star	Primary Energy	137.4 kWh/ Room Night	95 kWh/ Room Night	38. 5 GWh
Four Star	Primary Energy	90.7 kWh/ Room Night	50.6 kWh/ Room Night	5.7 GWh
Three Star	Primary Energy	79.3 kWh/ Room Night	42.3 kWh/ Room Night	12.2 GWh
Two Star	Primary Energy	54.5 kWh/ Room Night	33.8 kWh/ Room Night	11.8 GWh
One Star	Primary Energy	58.4 kWh/ Room Night	15.9 kWh/ Room Night	14 GWh
Boutique	Primary Energy	137.6 kWh/ Room Night	69.4 kWh/ Room Night	55.7 GWh
Unclassified	Primary Energy	59.8 kWh/ Room Night	22.2 kWh/ Room Night	59.7 GWh
Supplementary	Primary Energy	38.6 kWh/ Room Night	4 kWh/ Room Night	38.5 GWh

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