BETTER WORK

ENERGY PERFORMANCE IN THE CAMBODIA GARMENT SECTOR

A BENCHMARKING SURVEY

International Labour Office

International Finance Corporation
World Bank Group

In Collaboration with GMAC

November 2009

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This report was prepared by the BDLink Cambodia team led by Ms. Sandra D'Amico (Managing Director), Ms Oum Sokuntheary (Analyst), Ms. Isabelle Duzer (Consultant) in collaboration with energy experts from Comin Khmer Renewable Energy Division: Richard Vaillant (Division Manager) Steve Gosselin (Project Manager), Huon Phalla (Project Manager).

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Note: *This report is based on a survey of 31 participating factories' qualitative information and should not be taken as a detailed scientific exercise. The results provide indicative data on energy usage, and provide a useful comparative assessment of energy efficiency performance in the garment sector.*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND DEFINITIONS

ACRONYMS

Acronyms	Definition
BFC	Better Factories Cambodia
BW	Better Work
CCCO	Cambodian Climate Change Office
EDC	Eléctricité Du Cambodge
GHG	Greenhouse Gases
GJ	Gigajoule
GMAC	Garment Factories Association of Cambodia
HFO	Heavy Fuel Oil
IGES	Institute for Global Environmental Strategies
IFC	International Finance Corporation
ILO	International Labour Organization
IPPC	International Panel for Climate Change
KPI	Key Performance Indicator
LPG	Liquid Petroleum Gas
REE	Rural Electricity Enterprise

MAIN DEFINITIONS

Terms	
Carbon dioxide (CO2)	Carbon dioxide is most important greenhouse gas. CO2 emissions result from the combustion of fuel, from land use changes and from some industrial processes. (Carbon Trust definition)
Emission Factor	Measure of the average amount of a specific pollutant or material discharged into the atmosphere by a specific process, fuel, equipment, or source. It is expressed as number of pounds (or kilograms) of particulate per ton of the material or fuel. (See 1.1.3. Conversion and Emission Factors)
Energy Efficiency	EE means using less energy to achieve same or better output compared to pre-implementation of the energy efficiency project
Energy Intensity	The amount of energy used per unit of activity (e.g., production volume, number of employees etc.)
Gigajoule (GJ)	Joule (J) is a metric term used for measuring energy use. A gigajoule is one thousand million (10^9) joules
Greenhouse Gases (GHG)	Greenhouse gases are those which contribute to the greenhouse effect when present in the atmosphere. Six greenhouse gases are regulated by the Kyoto Protocol, as they are emitted in significant quantities by human activities and contribute to climate change. The six regulated gases are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF6). Emissions of greenhouse gases are commonly converted into carbon dioxide equivalent (CO2e) based on their 100 year global warming potential. This allows a single figure for the total impact of all emission sources to be produced in one standard unit. (Carbon Trust definition)
tCO2e	Ton of carbon dioxide equivalent. The mass of each greenhouse gas emitted is commonly translated into a carbon dioxide equivalent (CO2e) amount so that the total impact from all sources can be summed into one figure

MAIN FINDINGS

Cambodia has shown impressive growth and economic change over the last decade. The garment sector in particular is a crucial industry for the country and has created approximately 350,000 jobs at its peak. As one of the key pillars of the economy that was severely affected by the global financial crisis in 2008 and 2009, the sector faces several obstacles to ensure its survival and sustainable contribution to the economy.

All exporting factories in Cambodia are required to be members of the Garment Manufacturers Association of Cambodia (GMAC). This survey represents the findings of over 30 GMAC-member garment factories, or approximately 12% of the exporting industry. This is the first time that the industry, in collaboration with partners has embarked on an energy performance benchmarking exercise. Benchmarking is a proven technique that has been used in many countries to assist industries in better understanding their cost structure and performance against competitors and industry best practice. The technique provides managers with the necessary tools to quickly focus on best housekeeping options that will minimize costs, and evaluate new technology options. For many companies, energy efficiency improvement is the first step towards overall cleaner and more efficient production. The results of the survey represent a variety of indicators presented in detail and provide a first step towards addressing energy efficiency and better management practices in the sector. The survey is detailed in its output and brings to the attention of interested stakeholders in the garment sector the need for a variety of interventions, support and assistance, additional specific studies and the need for regular benchmarking studies.

All data in the study relates to 2008 – a particularly interesting year as the latter half of the year saw the impact of the financial crisis on the sector. The table below highlights the correlations that exist between the main indicators and a variety of variables. The most correlations are found when reviewing energy cost and production size which represents tons of garments produced per year.

Table 1: Summary table: Existing correlations by Main Indicators and Variables

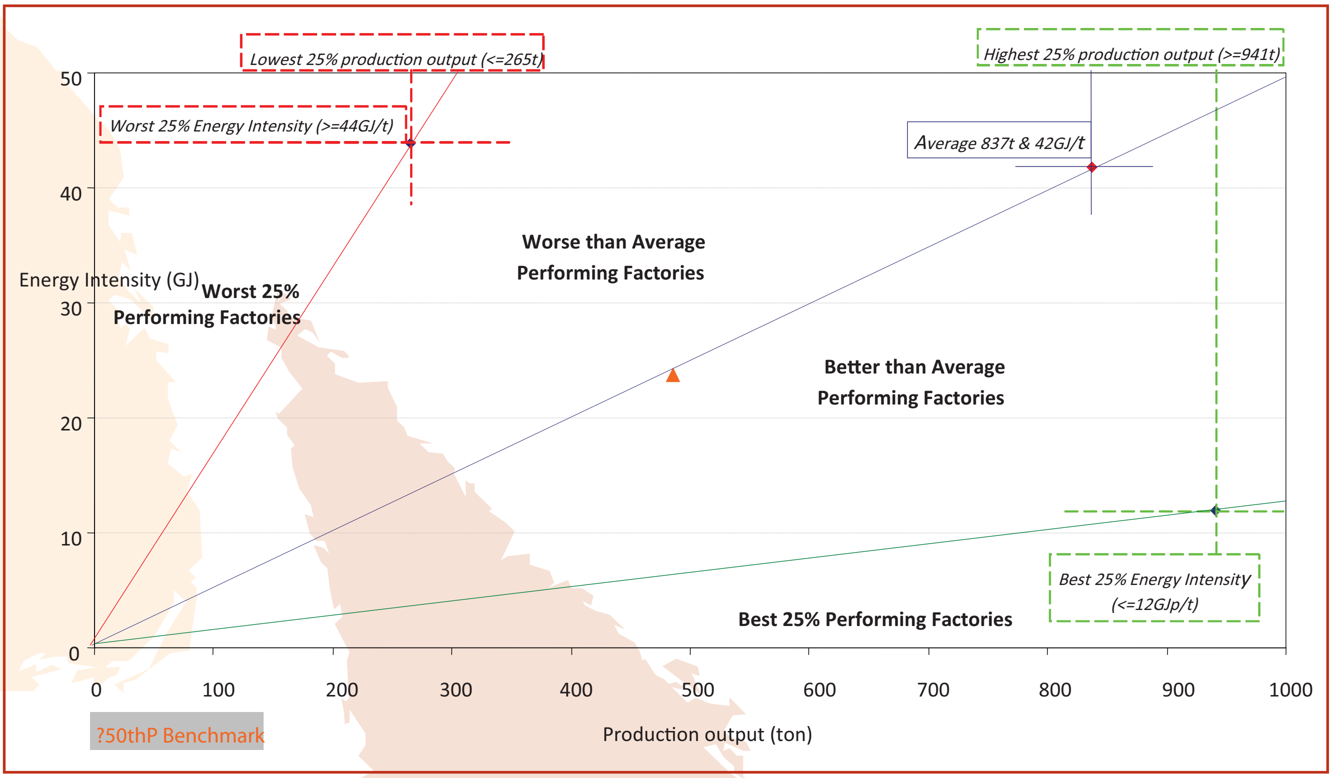
	Type of Garment	Production Size	Factory Size (employees)	Production Floor Size	Age of Machinery	Age of Factory
Energy Cost	Yes	Yes	No	Yes	No	No
Energy Intensity (per ton of product)	No	No	No	No	No	No
GHG Emission	No	Yes	No	No	No	No
Ratio Energy Cost/Production Cost	No	Yes	No	No	No	No
Ratio Energy Cost/Production Cost	No	Yes	No	No	No	No

The different indicators highlight the following specific findings

Energy Intensity:

- The average energy intensity for all factories is 42GJ per ton of garment produced. There is a wide variance of energy intensity amongst factories ranging from approximately 2GJ to 237GJ per ton of product with 50% of the factories having an energy intensity below 25.2 GJ/t. Electricity represents a small contribution to overall energy intensity which is dominated by all other fuels.
- The most energy intensive production facilities per ton of product are factories producing bottoms (56GJ per ton of products) and shirts (55GJ/t) and factories with more than 3000 employees (74GJ/t).
- Machinery less than 3 years old has the lowest energy intensity per ton of product (25.6GJ/t), per employee (10.3GJ/t) and per production area (1.7GJ/t).

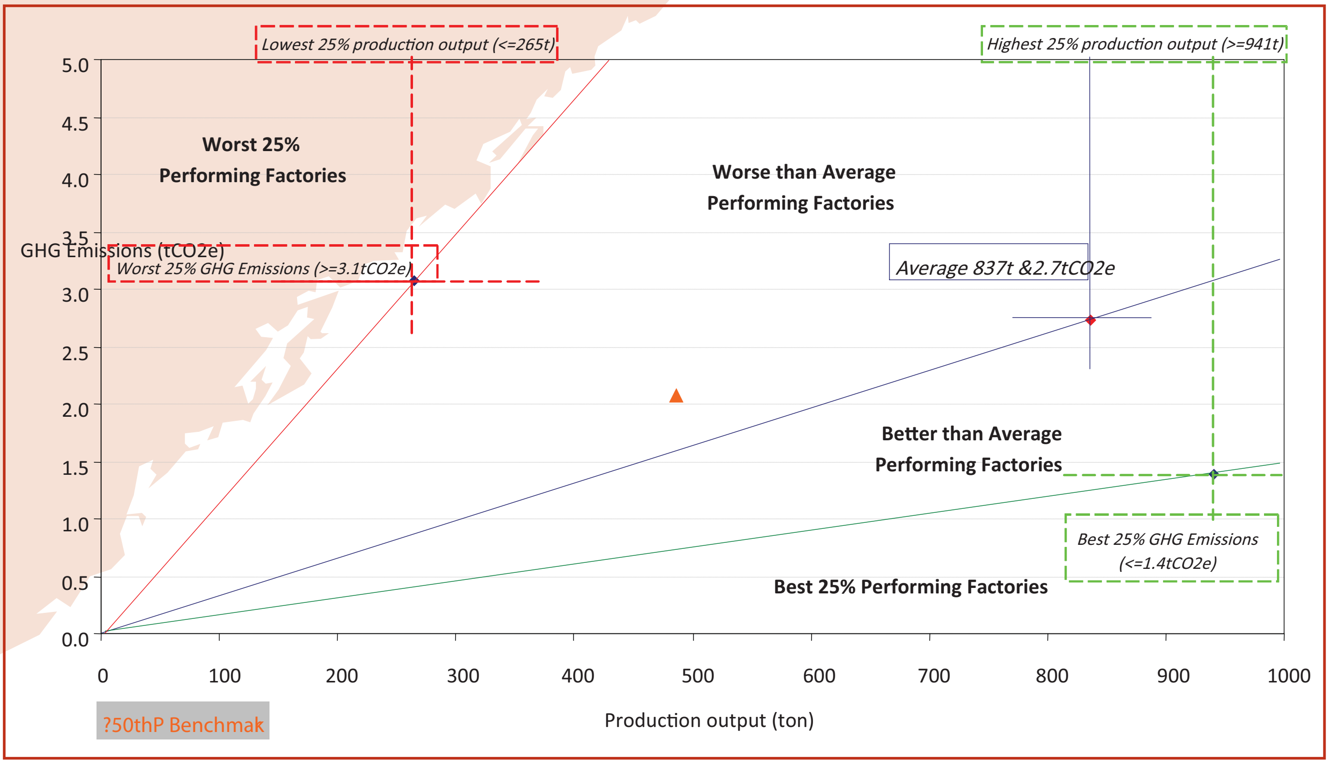
Figure 1: Energy Intensity Benchmark



Greenhouse Gas Emissions:

- The mean emission level from the surveyed factories is 2.74tCO2e per ton of garment production. The best 25% of the factories emit less than 1.39tCO2e.
- Electricity represents 60% of the greenhouse gas emissions, followed by diesel at 24%.
- There is a reverse correlation between production output and GHG emissions.
- The highest GHG emissions are seen in factories with relatively low energy intensity.

Figure 2: GHG Emission Performance Benchmark



Energy Usage and Cost:

- Average energy cost to produce a ton of garment is US$560. There is a wide variance amongst factories ranging from $30 to $1737 in energy costs per ton of garment produced.
- Energy accounts for 16.7% of total production costs. There is a wide variance amongst factories ranging from as little as 6% to as high as 60%. 31% of responding factories have a percentage energy cost higher than the average.
- Electricity is used by all factories. However; electricity accounts for only 24.5% of total energy usage and its cost represents 53% of total energy cost per ton of production.
- Wood is used to produce 43.3% of total energy used in factories and is used by a majority (71%) of factories. Wood is the cheapest source of energy and it accounts for only 10% of total energy cost per ton of product.

Figure 3: Energy Cost Benchmark

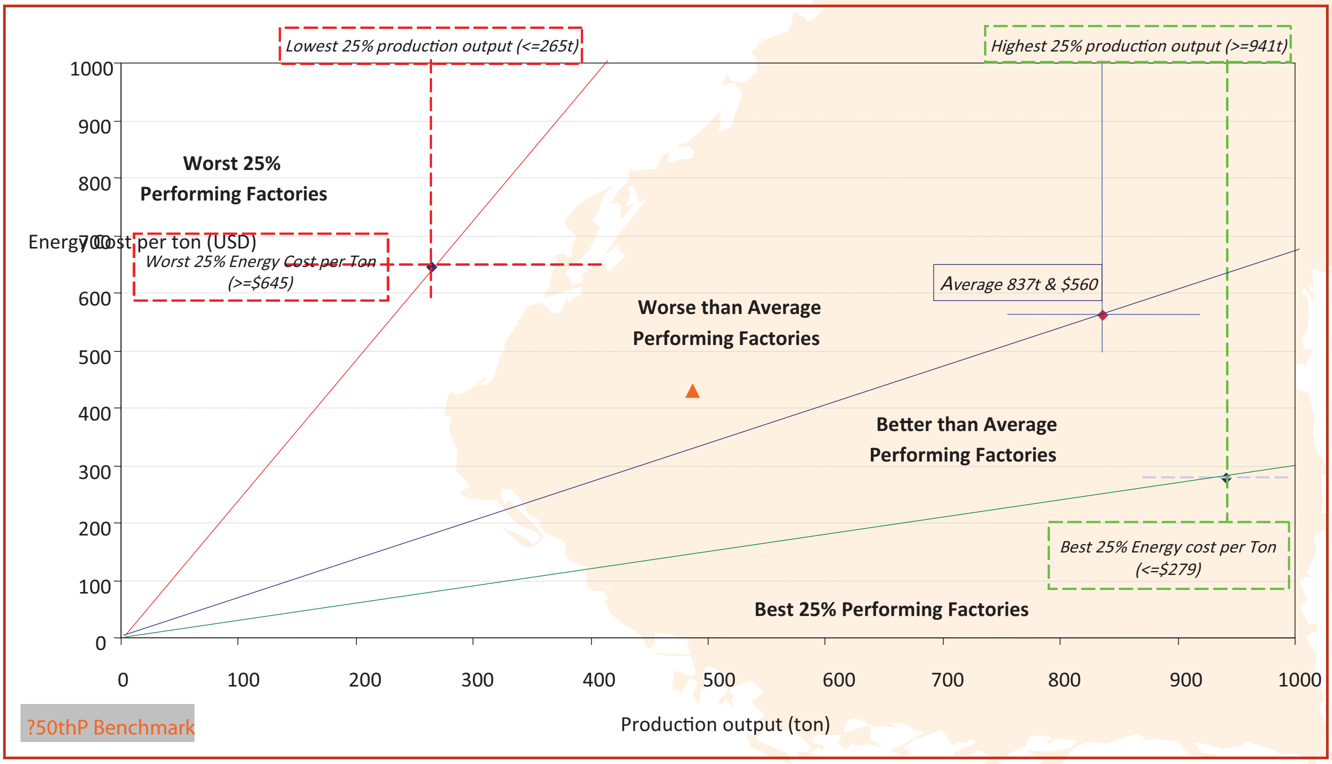


Figure 4: % Energy Cost of Production Benchmark

Electricity Consumption:

- Sewing and other production machines (38.9%) and lighting (23.9%) consume the most electricity in factory operations. Of total lighting usage, the production area accounts for 22%.
- Newer factories consume more lighting energy in their production area (55kWh/t) than factories that are more established (older) (26kWh/t)
- Production area lighting consumption decreases with higher production outputs and bigger production floor sizes

Energy Management Practices:

- Overall energy management scores are low: The sample average is 20%.
- Energy audits received the lowest score amongst sampled factories with an average of 4.2%.
- Factories with the smallest number of employees have the lowest energy management scores.

I INTRODUCTION TO THE STUDY

1.1. BACKGROUND:

With the growing global interest to address climate change issues coupled with the current global financial crisis, international brands and manufacturers are looking at initiatives that would protect the environment, increase competitiveness and generate profits. Interest in initiatives that enhance collaboration among buyers, supplier networks and other relevant stakeholders has been increasing. A recent example of this kind of collaboration is the Better Work (BW) program, a joint initiative of the International Finance Corporation (IFC) and the International Labour Organisation (ILO) that builds cooperation between government, employers' and employee's organizations and international buyers to improve labor standards and strengthen competitiveness in global supply chains.

Recent consultations with international buyers participating in the global Better Work program indicate a strong demand for expanding Better Work products and services beyond labor competitiveness to include environmental issues. The overall objective is to enhance environmental sustainability in supply chains in a collaborative and cost efficient method. To achieve this, Better Work is evaluating the feasibility of delivering an energy efficiency advisory product for factories participating in the program. Partnerships with different stakeholders are essential to make the pilot successful. The proposed pilot consists of two components: (1) Benchmarking survey of 31 garment factories as described further in this report; and (2) Development of Best Practice Notes to help factories improve their energy performance.

As the first step in this process, this survey aims to provide a picture of current practices in energy consumption in the Cambodian garment sector and to establish a baseline for energy performance benchmarking. Benchmarking is a useful tool because it allows companies to compare themselves with others in the same sector and country. It also provides information on current performance and can be used as a guide for further action. Most importantly it motivates the company to improve particularly if the company knows they are lagging compared to their peers and therefore losing their competitiveness.

Energy costs and the cost of infrastructure are a key concern for the industry to remain competitive. In the context of the current crisis, this benchmarking will serve the needs of the industry and stakeholders by:

1. Providing individual factories with information on current performance compared to their peers
2. Providing interested stakeholders with baseline data that can be used as a guide for further action and interventions regarding energy, energy performance and efficiency.
3. Specifically providing Better Work data off which to fine tune its future energy and environment programs in Cambodia and in other countries.

1.2. METHODOLOGY

This rapid assessment was conducted amongst 31 garment factories in Cambodia during July and August 2009, representing approximately 12% of exporting factories in operation in Cambodia. Overall, approximately 155 factories were contacted to participate in the study.

The Survey Team and Questionnaires

Survey team members underwent a one-day training program to become familiar with IFC-designed questionnaires. Each survey team member was assigned specific responsibilities due to the technical nature of the survey. Team members included engineers who are experienced in working with mechanical and electrical equipment and other specialists with extensive experience in surveying and working with the garment industry. English, Chinese and Khmer were used during interviews as required by factories.

Participating factories were visited by a team of 2 to 4 surveyors who conducted interviews with a range of factory managers. Following the interviews, a tour of the factory's energy consuming machinery and equipment was conducted. Each factory visit lasted several hours and required extensive follow up to complete and consolidate the data. The questionnaire was provided in English and Chinese prior to factory visits and focused on four specific areas relating to energy including (i) production outputs (ii) material inputs, (iii) energy consumption and (iv) energy consuming equipment. Seven areas of energy management practices were also reviewed as part of the survey to identify current practices regarding energy management.

Factory Selection

Factories were chosen based on several factors including number of employees, type of production and location. Selecting a wide range of factory sizes was important to see if larger factories used energy more efficiently than smaller ones. Selected factories are also geographically independent rather than grouped together in a complex as factories in a complex often do not have detailed information about their energy use because electricity, backup generation, or steam generation may be shared among several factories.

Results and Confidentiality

The results of the interviews and factories were compiled in a database, cleaned, verified and audited before analysis. Results of the survey calculate the main key performance indicators (KPIs) on the energy consumption and the greenhouse gas (GHG) emissions for individual factories as well as the industry as a whole. Each factory is provided with individual KPIs.

Key performance indicators allow factories to compare their performance with others Benchmark values are presented in ratios and percentages which hide the actual confidential data for each factory. To respect the confidentiality of individual factories, results are aggregated and presented without providing factory names.

1.3. CONVERSIONS AND CALCULATIONS EXPLANATIONS

1.3.1. CONVERSION AND EMISSION FACTORS

The table below presents the conversions used in the study and agreed with all stakeholders.

Table 2: Conversion and Emissions Factors

Factor	Value	Unit	Source
Heavy Fuel Oil	42.84	GJ / m3	Carbon Trust 2008
Diesel	39.24	GJ / m3	Carbon Trust 2008
Wood	8.48172	GJ / m3	IPCC Reports 2006
Heavy Fuel Oil	3.1785	tCO2e / m3	Carbon Trust 2008
Diesel	2.63	tCO2e / m3	Carbon Trust 2008
Wood	0.112	tCO2e / m3	IPCC Reports 2006
Electricity	0.001205	tCO2e / kWh	Carbon Emissions Estimator Tool (CEET)
Volume conversion	543.7*	kg/m3	International Rubber Research and Development Board (IRRDB)
Volume conversion	1000	L / m3	www.onlineconversion.com
Energy Conversion	0.0036	GJ / kWh	www.onlineconversion.com

** The majority of wood burned in garment factories is rubber wood.*

1.3.2. CALCULATION AND AGGREGATION EXPLANATIONS

All data presented in the study reflects data collected for the Financial Year 2008. A variety of classifications were required to be made based on the final data sample and these are described below.

Type of garments produced

Factories have been aggregated according to the type of garments they produce. A factory producing more than 50% of a certain type of one garment is classified in that category. For example, if a factory produces 20% shirts, 15% jackets, and 65% trousers, it is classified as a 'bottoms' producing garment factory. The resulting classification took into account the comments from GMAC and the IFC. Garment types have been classified into the following four categories:

1) Shirts
2) Bottoms (trousers, jeans, shorts)
3) Small garments (baby wear, swim wear, night wear)
4) Other (sweaters, coats, jackets, sportswear, aggregate*)

*Aggregate refers to garment factories that make a variety of different types of garments, with no one type having a high enough proportion to classify that garment factory as producing a certain type of garment. This also includes factories that were unable to provide an accurate breakdown of the type of garments they produced overall in 2008 since data is all in paper format.

Production Output or tonnage per year

All production data by length, piece, or mass is converted into metric tons for comparison purposes. This is done by using a conversion factor given by the factory or by analyzing boxed finished product in shipping areas.

Equipment Running Hours Calculation

To calculate the most accurate data of running hours of the garment machines, the survey team measured the real use time of each garment machine. Using a chronometer, they observed how long a manual machine was operating during a 10 minutes span and multiplied these numbers to get the real hours of use. Average working hours for factories is about 10 hours per day and 6 days per week. Machinery is typically on during these working hours. Security and other lighting or security devices are used 24 hours or in the evening only.

1.3.3. DATA QUALITY AND RESULT VARIANCE

Production cost or production output data can be sensitive and confidential issues for factory managers. Rigorous follow-up was conducted on apparent erroneous data, however, the survey relies on the data provided by each factory.

Other data anomalies may result from the sampled year. 2008 was a difficult year for the industry due to the global economic downturn which affected sales.. Consequently, larger factories may have had reduced production for a time. Survey questions did not specifically take this into account.

There were some factories in particular that had unique data. These data are not necessarily erroneous and could be the result of a variety of factors specific to the individual factory.

Factories 19 and 31 reported very low production compared to their size and apparent potential. This has an effect on, for example, the energy use per ton of production – these factories appear energy intensive when in fact it is a result of the reported low production. Factory 22 reported a very high lighting consumption which results in more lighting per area of production. Factories 14 and 29 reported very high energy consumption (60% and 40% respectively) as a portion of their entire production output. These two factories sway the average from 14.5% to 16.7% which is significant for this indicator.

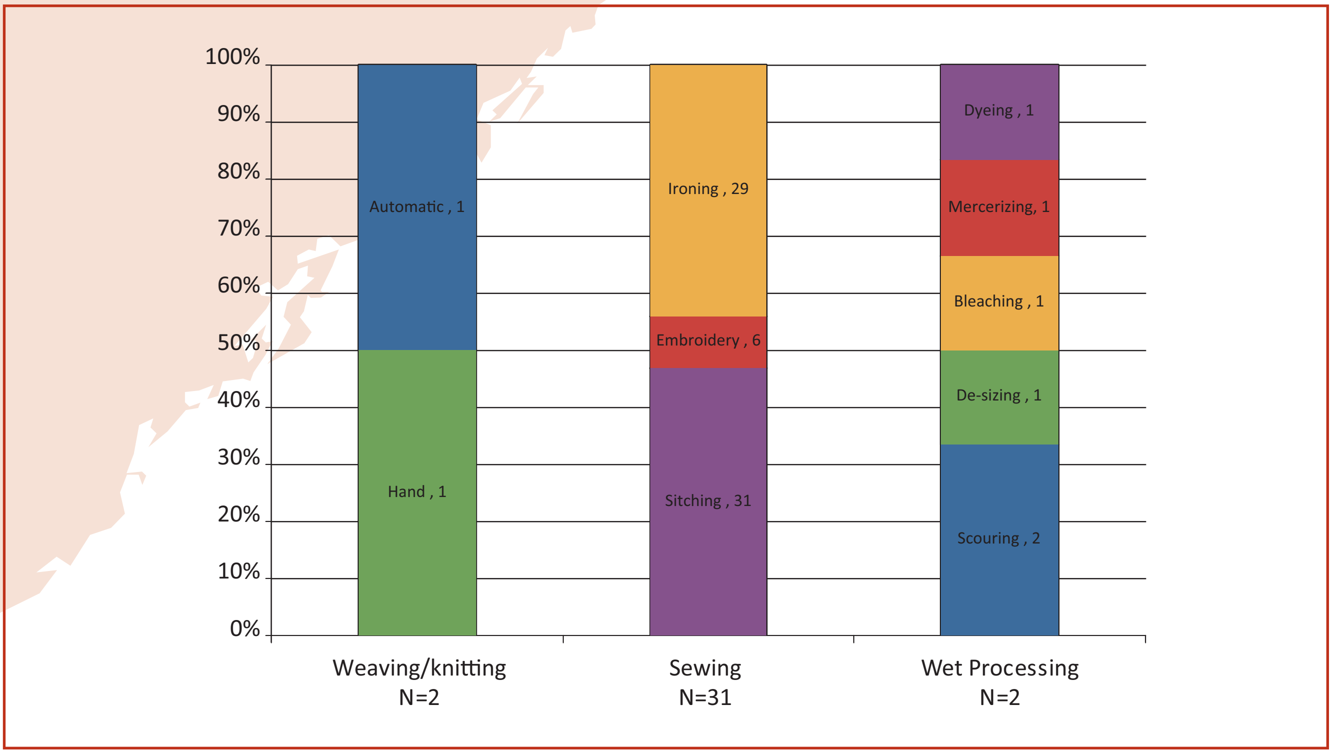
II SURVEY RESULTS

This section displays results from the surveyed factories by a variety of indicators. All data collected from factories is presented in the form of benchmarking charts which display overall industry performance. Where applicable and feasible, individual factory data is displayed to review factory performance against the industry. All data collected represents 2008 figures. A total of 31 factories participated in the survey representing around 12% of the total industry as of July 2009.

2.1. PROFILE OF FACTORY PARTICIPANTS

1. **Years of operation:** Overall, the sample shows that factories are relatively new. 58% of the total factories surveyed have been in operation for less than 5 years. Of the remaining factories, 23% have been in operation for 5 to 10 years and 19% more than 10 years.
2. **Type of garment produced:** Shirts represent the largest part of the production (29%), followed by bottoms (trousers, shorts and jeans) (26%).
3. **Production:** The majority of factories (54%) produced less than 500 tons of garments in 2008
4. **Number of Employees:** The total number of employees in this survey is 38,432 including production floor workers, managers, and administration and support staff. Operators represent between 82% and 99% of the total number of employees working in the factories. The majority (48%) of factories surveyed employ between 500 – 1000 employees.
5. **Type of production:** All 31 factories have CMT (cut, make, trim) operations. Two factories have weaving/knitting and 2 have a wet processing operation. Factories may have several processes indicating why the total number of activities represented is greater than the total number of factories participating in the survey.

Figure 5: Type of Production Breakdown



6. **Age of Production Machinery:** Production machinery refers to garment producing equipment including sewing and stitching machines. The results show that the average age of the machinery for all the factories is 5 years. The survey did not highlight any direct or significant correlation between the average age of production machinery and the different characteristics of factories except for the age of the factories.

    a. Factories that have been in operation for less than 5 years have relatively newer equipment (4 years on average) while factories that have been in operation for more than 10 years, have equipment with an average age of 6.8 years. As machinery ages, it also becomes less efficient and requires more maintenance. During the interviews, factories explained that they have to upgrade some of their equipment every year or replace equipment when it stops functioning so the values below refer to the average age of the majority of garment production equipment.

Results are presented in the figures below:

Figure 6: Factory Years of Operation

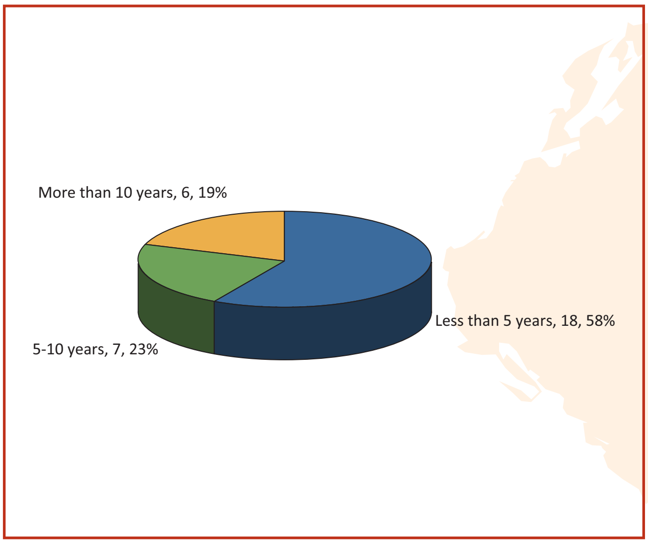


Figure 7: Types of Garments Produced

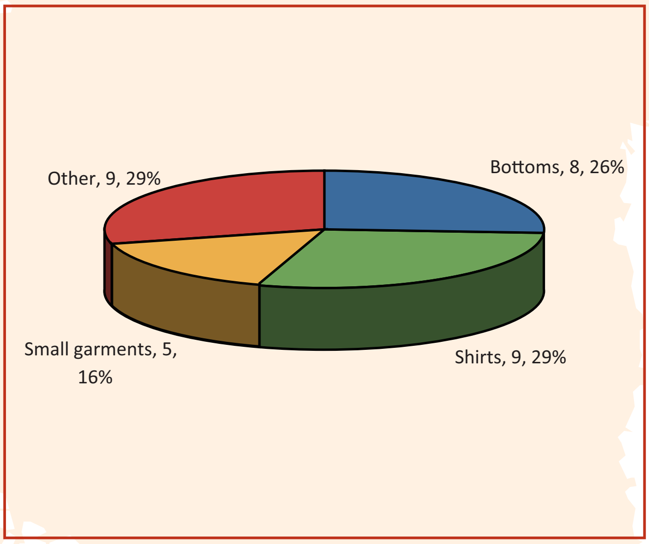


Figure 8: Production Output

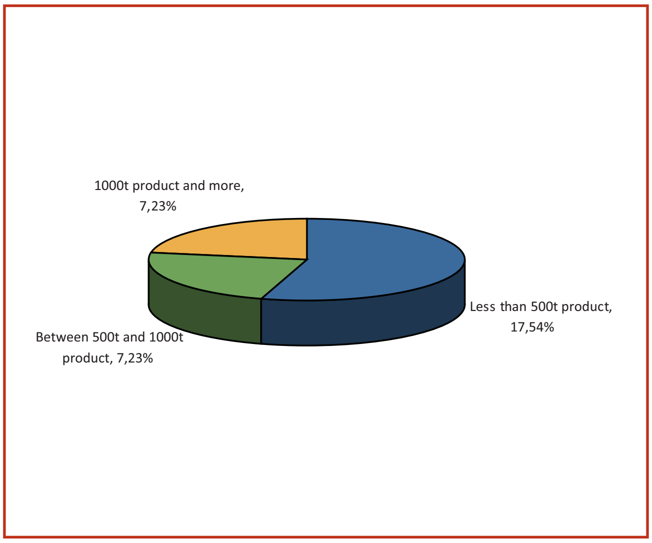


Figure 9: Factory Size (# of Employees)

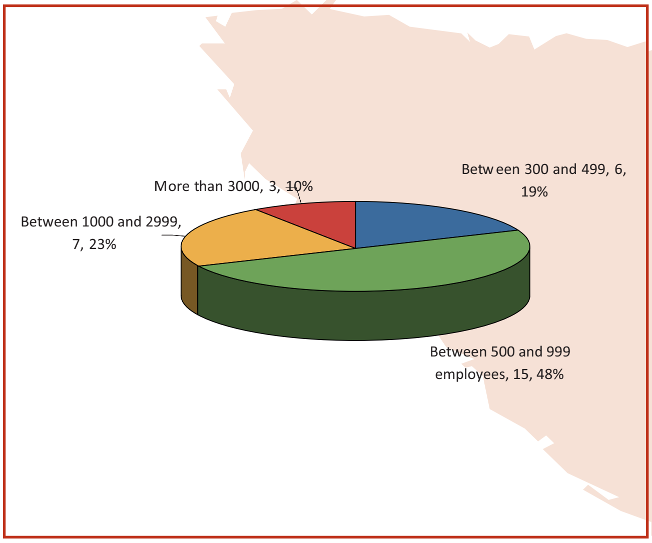


Table 3: Average Age of Production Machinery

Product	Number of Respondent Factories	Average Age of Production Machinery (years)
Type of Garment		
Bottoms	8	5.3
Shirts	9	3.4
Small Garments	5	4.9
Other	8	6.6
Production Output		
Less Than 500t	16	5.6
500t to 1000t	7	4.3
More Than 1000t	7	4.4
Factory Size (employees)		
300 to 499	5	7.0
500 to 999	15	4.1
1000 to 2999	7	5.2
More Than 3000	3	5.8
Production Floor Size		
$1500m^2$ to $4999m^2$	5	4.9
$5000m^2$ to $9999m^2$	12	5.2
More Than $10000m^2$	13	4.9
Age of Production Machinery		
Less Than 3 years	8	1.5
3 to 5 years	13	4.7
6 years and more	9	8.7
Factory Age		
Less than 5 years	17	4.0
5 to 10 years	7	6.0
More than 10 years	6	6.8
All Factories	30	5.0

2.2. ENERGY USAGE, COST AND INTENSITY

2.2.1. ENERGY USAGE AND COST

Garment factories have several energy intensive operations that require a variety of different energy sources. Energy is used constantly during working hours by most devices. Working hours vary per factory but in general are 10 hours per day, 6 days per week. Electricity and wood are the most commonly used types of fuel.

Electricity, for the most part, is supplied from a number of different sources including Cambodia's electricity grid (EdC), a garment factory complex owner, or a private electricity enterprise. A typical factory uses power from EdC and has a backup diesel or HFO generator. Where there is no access to the EdC grid either a diesel or HFO generator is used for all electricity production. Sometimes garment factories are grouped into a complex with the owner supplying energy (electricity, steam from boiler, backup electricity) to a number of factories. In these cases, the factory may have less knowledge about the energy generation as a monthly fee is paid and no data exists on the amounts used.

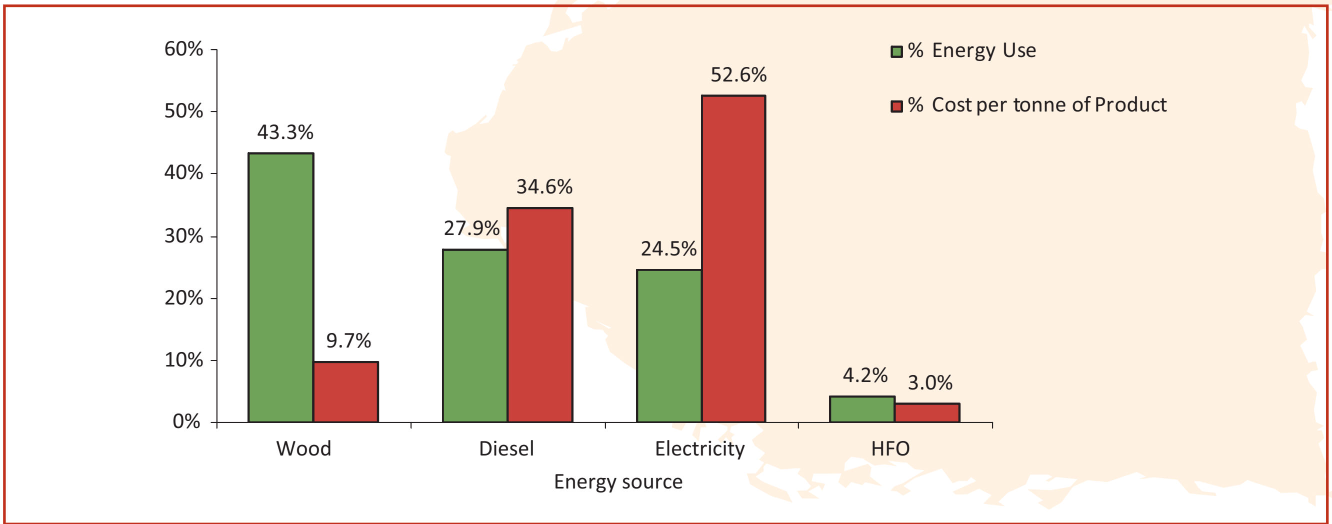
The most common wood found in the garment industry is rubber wood. The wood is burned in boilers to convert water into steam which is an energy intensive process. Wood burning boilers are commonly used due to the low price of wood compared to other energy sources (coal, oil, electric, gas). An IGES-CCCO wood energy baseline study for CDM in 2006 and a wood energy study by GERES in 2007 both suggest that the supply of wood for production in various industries is not sustainable. Boilers fuelled by diesel or HFO can be found in some older factories or used only for backup purposes.

Figure 6 shows that, excluding HFO, energy usage and cost are inversely proportional. Nearly all equipment in a garment factory is electrical and electricity is therefore the most widely used energy source. Electricity accounts for 24.5% of total energy used by all factories and the highest proportion of energy cost (52%) for producing a ton of product.

Wood accounts for the largest percentage of energy used in the factories (43.3%) and is used by 71% of participating factories. While wood burning is an energy intensive process, it only represents 10% of total energy cost per ton of garments produced.

Diesel accounts for 27.90% of total usage and 35% of the total cost per ton of product.

Figure 10: Energy usage vs. percentage cost per ton of product



The average energy cost to produce a ton of garments is $560. Energy costs per ton of garments show the following characteristics:

- Factories producing shirts have the highest cost of energy per ton of garment and those producing small garments (underwear, swimwear, nightwear) have the lowest cost per ton of garment.
- There is no correlation between energy cost and type of energy used. It might be expected that factories not connected to the grid would pay more for electricity (clearly seen in figure 7 as F9, F18, F23, F28) but this is not the case. However,, grid electricity is expensive so there may be little difference in using the electricity grid or relying solely on self-generated power. None of the factories surveyed used only one source of energy. This makes it difficult to compare a factory using electricity to a factory using diesel only, to see which one performs more efficiently.
- There is a clear reverse correlation between production output and energy costs. Factories producing smaller tonnage per year have higher energy costs per ton of garment produced while those with higher production outputs are paying less per ton produced.
- There is no correlation between employee size and cost of energy per ton of garments produced. Although factories with more than 3,000 employees have the highest cost per ton of garments produced, results should be interpreted with caution due to the limited number of factories represented.

- Similarly to production size, there is a reverse correlation between the production floor size and the energy cost per ton of garments produced. Factories with larger production areas are paying less for energy per ton of garments while factories with smaller production areas are paying more.
- Factories that have been in operation for less than 5 years have the lowest energy cost per ton of product ($528)

Detailed results of energy costs are presented in the tables and figures below.

Table 4: Data Table: Energy Cost per Ton of Garment Production

Product	Number of Factories	HFO	Diesel	Wood	Electricity	Total
		USD / garments (t)				
Type of Garment						
Bottoms	8	$45	$102	$97	$324	**$568**
Shirts	9	$13	$398	$54	$199	**$665**
Small Garments	5	$6	$42	$30	$244	**$321**
Other	8	$0	$152	$27	$405	**$584**
Production Size						
Less Than 500t	16	$0	$185	$54	$381	**$620**
500t to 1000t	7	$25	$212	$80	$260	**$577**
More Than 1000t	7	$48	$196	$29	$131	**$404**
Factory Size (employees)						
300 to 499	5	$6	$74	$43	$356	**$479**
500 to 999	15	$2	$209	$75	$320	**$606**
1000 to 2999	7	$33	$210	$15	$212	**$470**
More Than 3000	3	$73	$279	$64	$260	**$676**
Production Floor Size						
1500m^2 to 4999m^2	5	$0	$320	$32	$317	**$669**
5000m^2 to 9999m^2	12	$5	$133	$92	$358	**$588**
More Than 10000m^2	13	$35	$202	$28	$227	**$492**
Age of Machinery						
Less Than 3 years	8	$3	$161	$36	$178	**$378**
3 to 5 years	13	$11	$237	$69	$324	**$642**
6 years and more	9	$37.01	$161.03	$50.18	$355.79	**$604.01**
Age of Factory						
Less than 5 years	17	$2	$200	$43	$284	**$529**
5 to 10 years	7	$4	$137	$105	$378	**$624**
More than 10 years	6	$75	$242	$28	$228	**$574**
All Factories	30	$17	$194	$54	$295	**$560**
# Factories using the energy source	30	5	24	22	30	**30**

Figure 11: Energy Cost per Type of Product

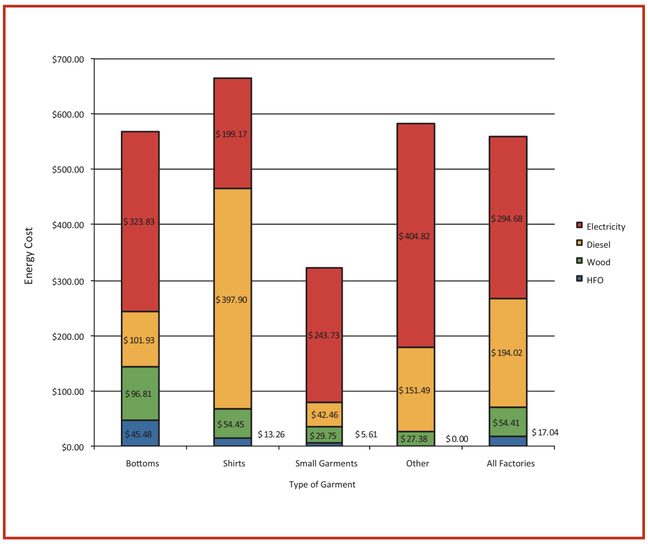


Figure 12: Energy Cost per Production Output

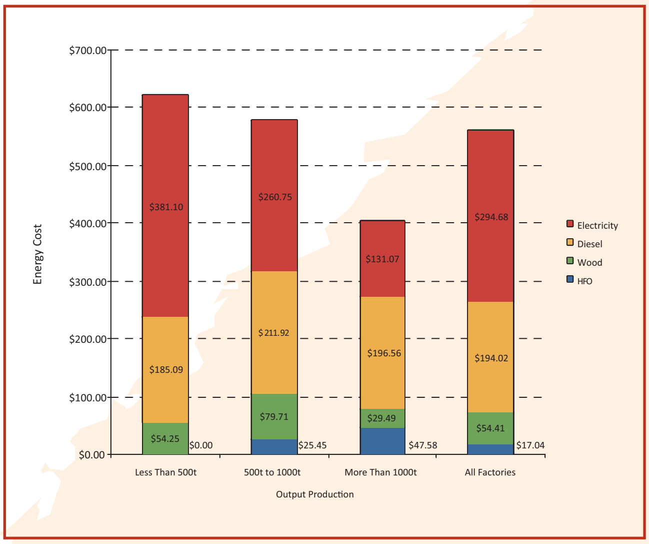


Figure 13: Energy Cost per Factory Size

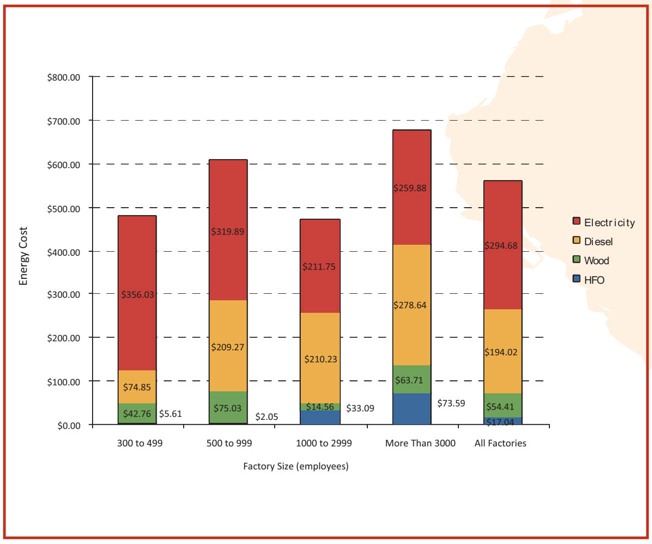


Figure 14: Energy Cost per Production Area

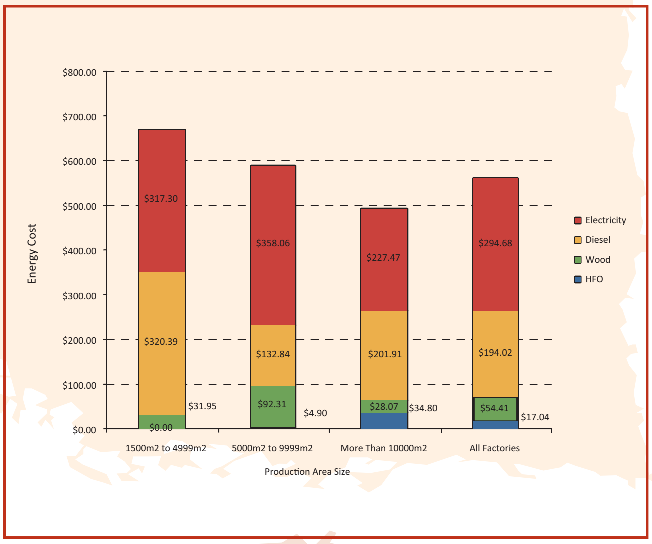


Figure 15: Energy Cost per Age of Machinery

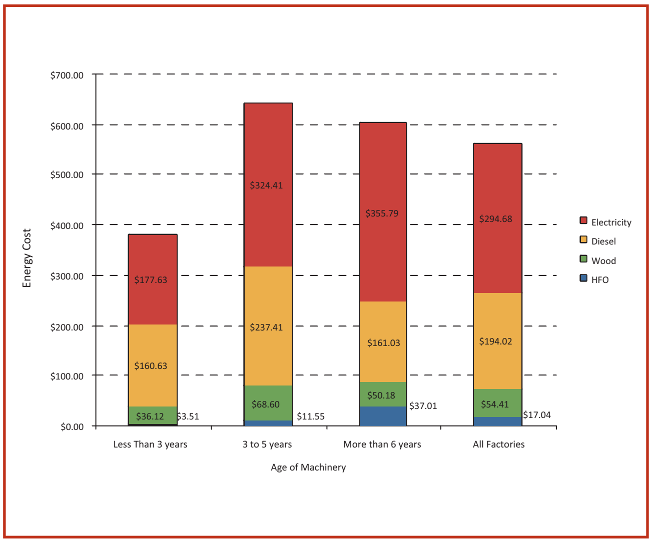
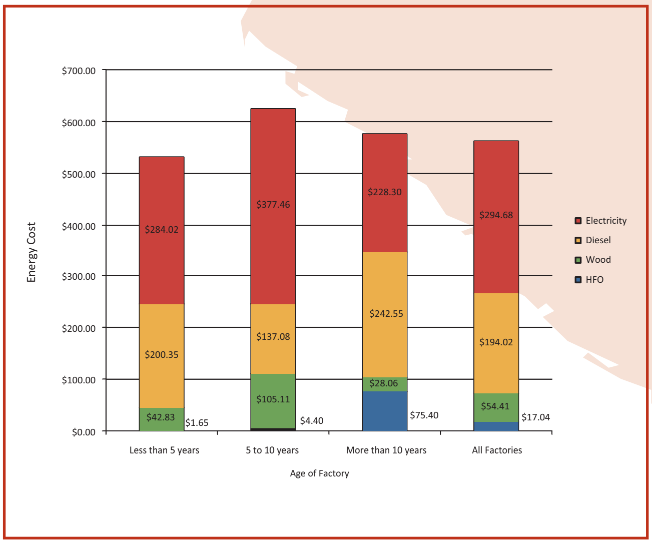


Figure 16: Energy Cost per Age of Factory

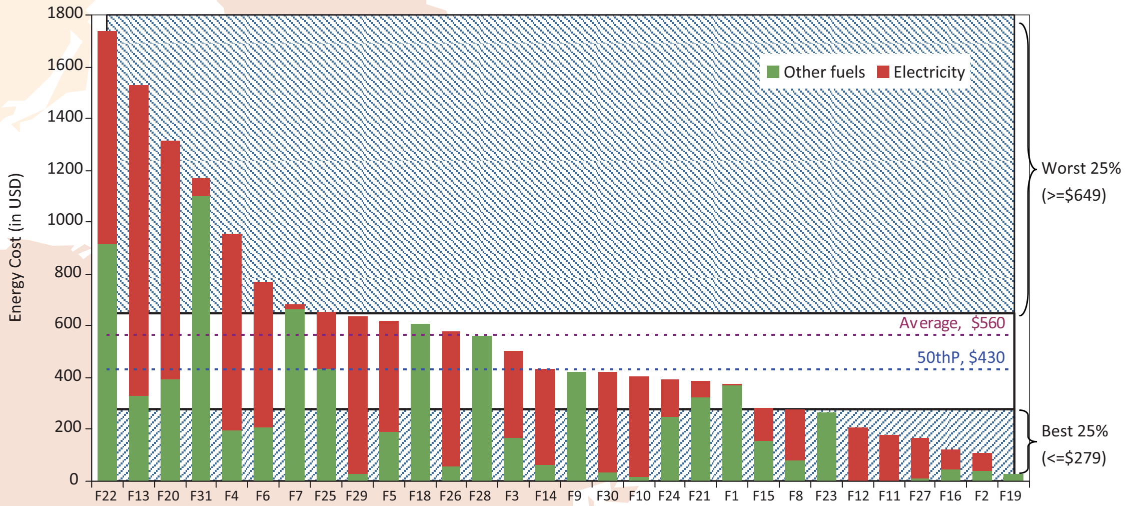


The figure below shows a wide variance amongst factories of the cost of energy to produce a ton of garments. Costs can range from as little as $30 to as much as $1,737. Energy cost per ton of garments produced is presented for each participating factory and distinguishes the cost of electricity and other fuels (wood, HFO and diesel).

12 factories are producing each ton of garments at more than the average amount ($560). F19, which represents the lowest cost, uses 100% of other fuels and no electricity. The majority of factories show that the biggest proportion of cost is electricity. In general, the more electricity used the higher the cost.

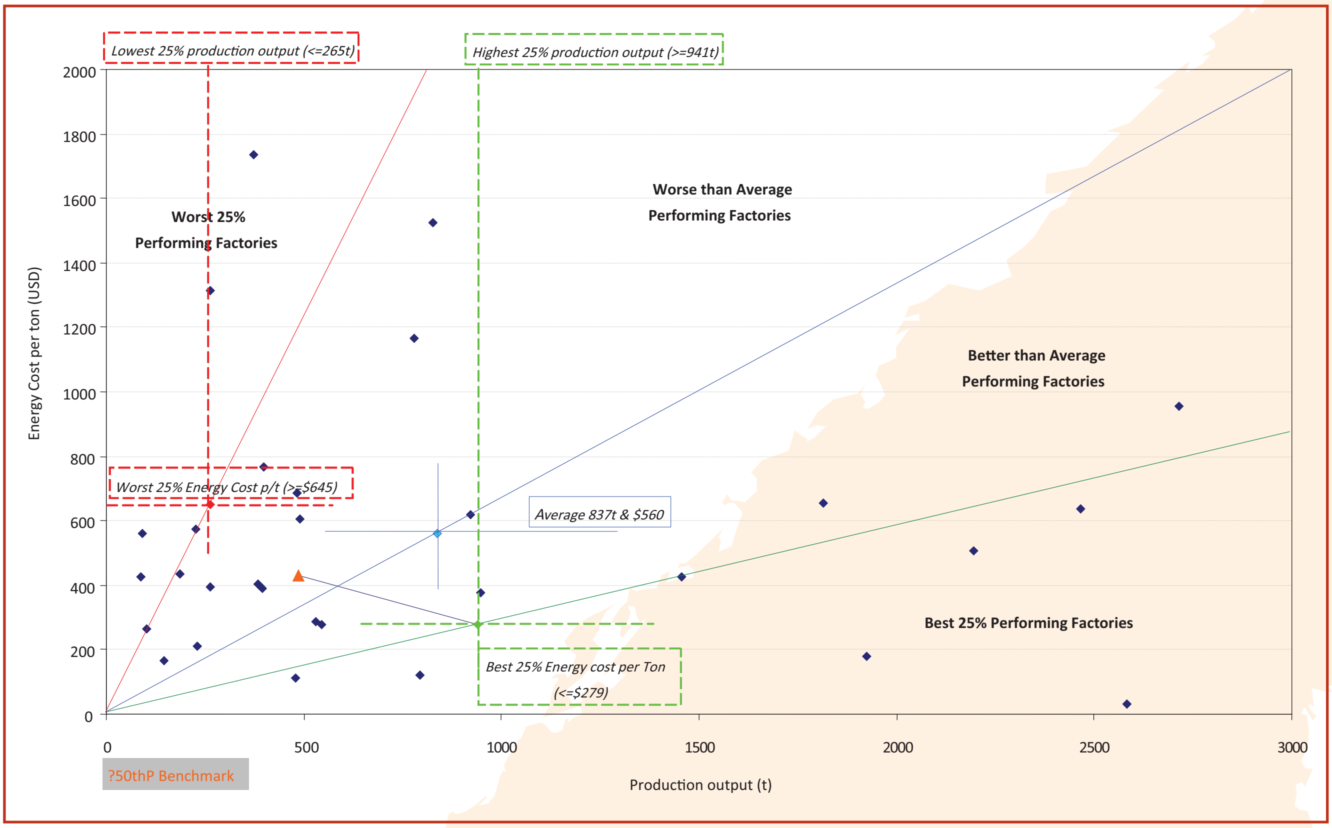
Various other Benchmark are presented in the chart below. There is clearly a wide range of energy costs paid per ton of product produced in a factory as well as varying proportion of type of energy used per factory. High performing factories represented by the best 25% are paying less than $279 per ton of product and the worst performing factories >=$649 per ton of product.

Figure 17: Energy Cost per Ton of Product by Factory



The figure below demonstrates the energy cost per factory by production output of the factory. It shows that most of the factories produce less than 1,000 tons a year and have an energy cost below $700 per ton of products. On the basis of the limited survey size, there appears to be no direct correlation between production volume and energy cost.

Figure 18: Energy Cost per Factory by Production Output



2.2.2. ENERGY INTENSITY

Energy intensity represents how efficiently a garment factory is using energy. Energy efficient factories should use less energy per ton of product produced. This indicator analyzes how efficiently employees use energy and how much energy is used in a square meter of production area and per ton of product.

The results show that factories with the highest energy intensity per ton of product are those producing bottoms (56GJ/t per product) and shirts (55.25GJ/t) and factories with more than 3,000 employees (74GJ/t).

Machinery less than 3 years old has the lowest energy intensity per ton of product (25.6GJ/t), per employee (10.3GJ/t) and per production area (1.7GJ/t).

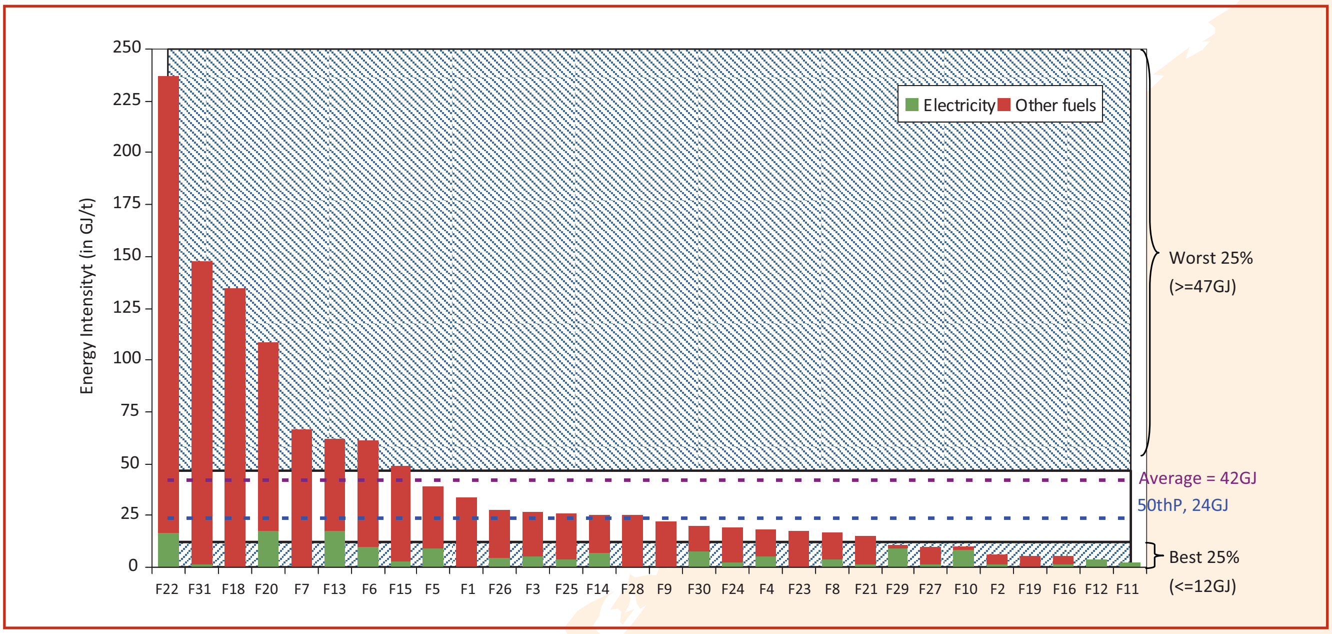
Detailed results are present in the table below.

Table 5: Energy Intensity

Category	Number of Respondent Factories	Energy (GJ)		
		per Product (t)	per Employee	per Area Production (m^2)
Type of Garment				
Bottoms	8	56.78	44.92	5.96
Shirts	9	55.25	15.06	2.53
Small Garments	5	19.49	10.75	1.83
Other	8	25.37	12.27	1.82
Production Size				
Less Than 500t	16	41.50	12.84	1.98
500t to 1000t	7	46.06	36.23	4.94
More Than 1000t	7	37.92	26.81	4.00
Factory Size (employees)				
300 to 499	5	26.39	15.22	1.87
500 to 999	15	49.89	22.82	3.28
1000 to 2999	7	21.35	10.77	2.41
More Than 3000	3	74.02	50.99	6.27
Production Floor Size				
1500m^2 to 4999m^2	5	41.88	11.36	2.58
5000m^2 to 9999m^2	12	50.97	28.27	3.71
More Than 10000m^2	13	33.14	19.29	2.83
Age of Production Machinery				
Less Than 3 years	8	25.61	10.27	1.70
3 to 5 years	13	51.12	26.50	3.65
6 years and more	9	42.49	24.45	3.68
Age of Factory				
Less than 5 years	17	37.25	12.58	2.05
5 to 10 years	7	55.36	37.90	5.06
More than 10 years	6	38.53	27.93	3.99
All Factories	30	41.73	21.56	3.14

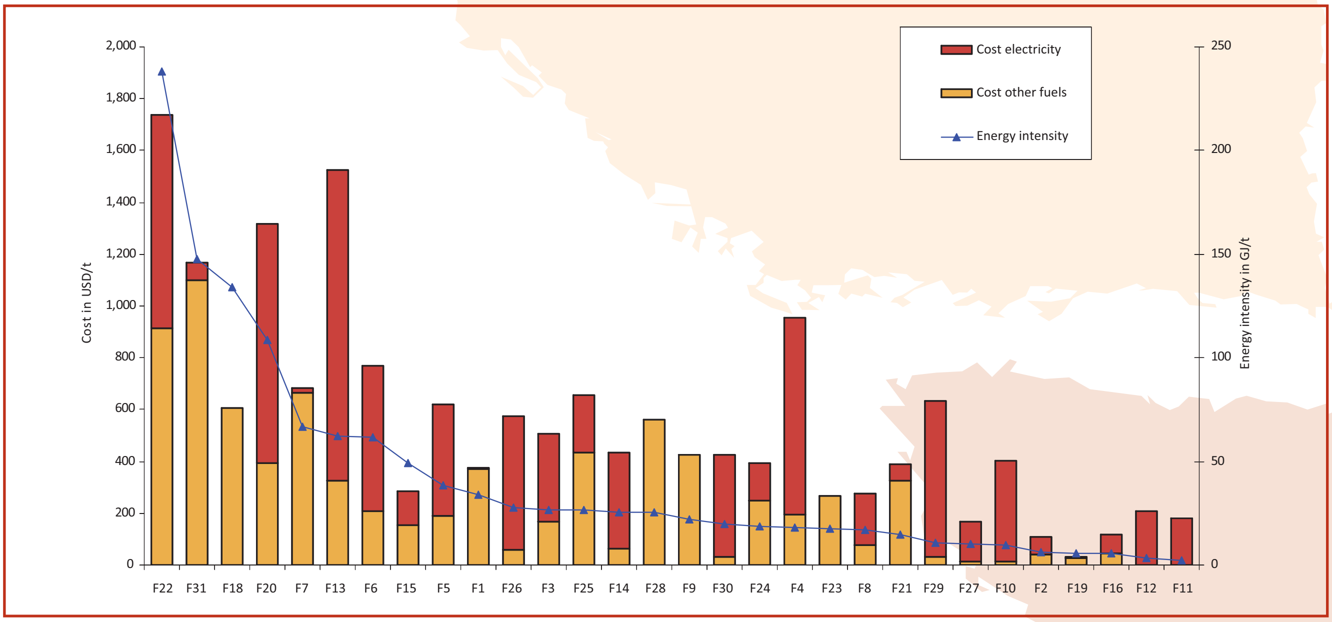
The figure below shows the energy intensity per ton of product for each factory. There is a very broad variance in energy intensity amongst factories ranging from less than 10GJ/t to just below 250GJ/ t. The average energy intensity across factories is 42GJ/t. The best 25% factories have energy intensity below 12GJ/t, while the worst 25% have an energy intensity higher than 47GJ/t.

Figure 19: Energy Intensity per Factory



The figure below shows the total cost of energy types in the bars with the energy intensity mapped on top of each factory. There is no correlation between energy intensity and cost.

Figure 20: Comparison Energy Intensity and Type of Energy Cost per ton of product per Factory

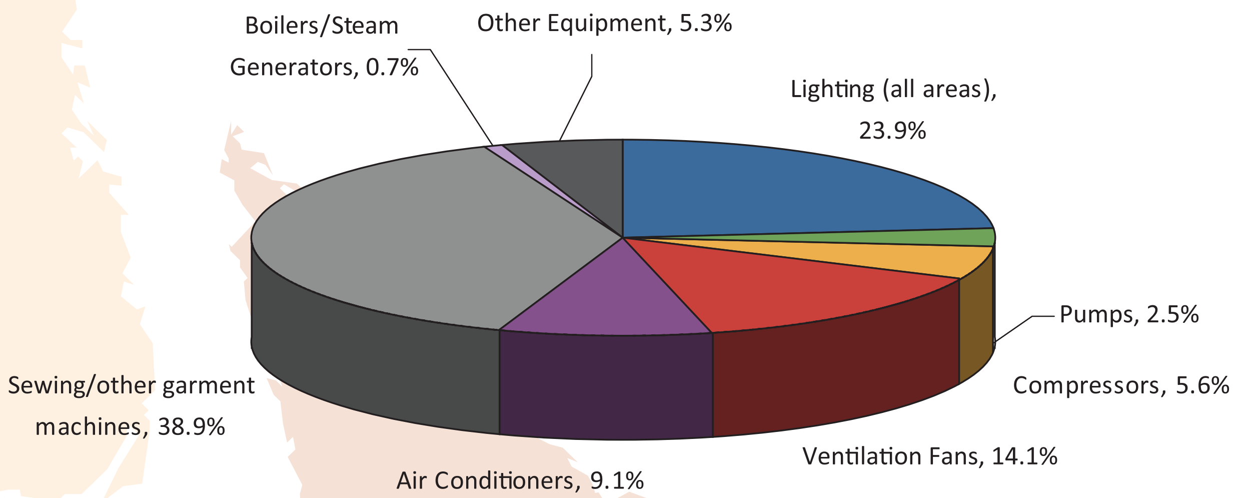


2.3. EQUIPMENT ELECTRICITY CONSUMPTION

This indicator provides a useful representation of how electricity is distributed and used by various devices. A factory may find that it uses a larger proportion of energy for lighting than the benchmark value. This may identify inefficiency and lead to further analysis of the lighting system. This is one area where there is clear consistency between factories. Where each factory may use a different mix of energy generating methods, they are all using similar electrical equipment. This analysis looks at electrical devices only. The common groupings for these devices are production machinery, air conditioning, pumps, compressors, ventilation fans, lighting, boilers, and other equipment.

Note that electricity for these devices comes not only from the electrical grid but also other means like backup diesel or fuel oil generation.

Figure 21: Electricity Consumption by Equipment Type- All Factories



Production Machinery (38.9%): The most energy consuming equipment in any garment factory are the garment production machines. Among these, sewing, cutting, stitching, and embroidery machines are the most obvious. Some factories also make use of automatic knitting machines, fabric inspectors, and fusion machines. It should be noted that with these devices, it is usually the motor of the device that consumes electricity.

Air Conditioning and Ventilation (9.1% + 14.1% = 23.2%): Cooling and air flow help to alleviate the adverse high temperature and humidity conditions. Air-conditioning an entire factory is not cost effective but cooling is usually found in areas outside the production floor, for example in the offices. It is common to see ventilation fans and blowers on the production floors which together consume 23.2% of the total electricity used..

Total lighting (23.9%) = Production lighting (22.0%) + Other Lighting (1.9%): Rows of fluorescent tubes are located in the production areas and can total a thousand or more per production floor. Each light has a low consumption but collectively are numerous and remain powered up continuously throughout the entire workday or longer. Collectively they consume 23.9% of the total electricity used. Production lighting consumes the majority (22.0%) of total lighting (23.9%). After hours when machinery is turned off, security lights are used throughout the night.

Boilers (0.7%): Garment factories participating in the survey use boilers to create steam for irons and washing machines. Boilers are big consumers of energy. The factories surveyed did not use electrical boilers (some are installed for backup or future use) and therefore, only the motor of the boiler consumes electricity. There is an overwhelming presence of wood boilers. Electrical boilers are not being used because there is currently a lack of qualified technicians able to service them (GMAC interview 2009).

Other Equipment (13.4%): Other items which are set apart for analysis in the survey included pumps and air compressors. Pumps are used mainly to move water for washing, feeding the boiler and for water treatment plants if required. Air compressors are used for activities like power washing and maintenance.

Table 6: Data Table: Electricity Consumption (kWh) ratio by Equipment Type (part 1)

Category	Number of Factories	Lighting (total) (1)=(2)+(3)	Lighting in production area (2)	Lighting in other areas(3)	Pumps	Compres-sors	Ventilation Fans	Air Conditioners (total) (4)=(5)+(6)	A/C in production area (5)	A/C in other areas(6)	Sewing/ other garment machines	Boilers* (Steam Generators)	Other Equipment	Total
Average Use of Device														
Hours Per Month	30	242	237	247	211	176	220	211	201	222	90**	235	167	**194**
Type of Garment														
Bottoms	7	23.7%	21.3%	2.3%	3.5%	9.3%	12.8%	8.2%	0.8%	7.4%	38.1%	0.3%	4.1%	**100.0%**
Shirts	9	25.8%	23.8%	2.0%	2.4%	4.9%	14.0%	12.0%	0.7%	11.3%	33.6%	0.7%	6.6%	**100.0%**
Small Garments	5	22.3%	20.9%	1.4%	1.4%	7.2%	13.6%	7.0%	0.0%	7.0%	39.4%	0.4%	8.7%	**100.0%**
Other	8	23.8%	22.3%	1.5%	2.5%	3.0%	16.5%	8.3%	1.0%	7.3%	41.5%	1.2%	3.3%	**100.0%**
Production Output														
Less Than 500t	17	20.7%	19.3%	1.4%	2.3%	4.6%	14.0%	8.4%	0.4%	8.0%	43.0%	0.6%	6.3%	**100.0%**
500t to 1000t	7	29.1%	25.7%	3.4%	2.7%	7.1%	12.1%	8.7%	0.8%	7.8%	36.8%	0.8%	2.8%	**100.0%**
More Than 1000t	6	26.7%	25.4%	1.3%	2.8%	6.8%	16.8%	11.3%	1.1%	10.2%	29.6%	0.7%	5.3%	**100.0%**
Factory Size (employees)														
300 to 499	6	21.4%	19.5%	1.9%	1.6%	1.3%	14.0%	6.3%	0.2%	6.1%	48.7%	0.9%	5.9%	**100.0%**
500 to 999	15	24.4%	22.5%	1.9%	2.9%	7.0%	13.1%	9.1%	0.7%	8.4%	38.0%	0.5%	5.0%	**100.0%**
1000 to 2999	6	24.6%	22.5%	2.1%	2.0%	3.5%	15.2%	10.1%	0.3%	9.8%	39.8%	1.1%	3.6%	**100.0%**
More Than 3000	3	24.7%	23.6%	1.0%	3.3%	11.6%	17.3%	12.1%	1.9%	10.1%	21.9%	0.3%	8.7%	**100.0%**
Production Floor Size														
1500m2 to 4999m2	6	23.3%	21.2%	2.1%	1.4%	5.5%	11.9%	5.5%	1.0%	4.4%	45.5%	0.5%	6.4%	**100.0%**
5000m2 to 9999m2	12	25.0%	23.8%	1.2%	2.9%	4.6%	13.4%	10.3%	0.5%	9.8%	38.9%	0.8%	4.1%	**100.0%**
More Than 10000m2	12	23.0%	20.6%	2.4%	2.6%	6.7%	15.9%	9.6%	0.6%	9.0%	35.6%	0.7%	5.8%	**100.0%**
Age of Machinery														
Less Than 3 years	9	26.0%	24.2%	1.8%	3.0%	4.8%	14.1%	6.8%	0.1%	6.7%	42.4%	0.6%	2.3%	**100.0%**
3 to 5 years	13	23.1%	20.9%	2.2%	2.9%	7.4%	15.3%	12.0%	0.8%	11.2%	33.7%	0.6%	5.1%	**100.0%**
6 years and more	8	22.8%	21.3%	1.4%	1.4%	3.7%	12.2%	6.9%	1.1%	5.8%	43.3%	0.9%	8.9%	**100.0%**
Age of Factory														
Less than 5 years	18	25.7%	23.3%	2.4%	2.7%	4.9%	14.1%	9.0%	0.7%	8.3%	39.3%	0.4%	3.8%	**100.0%**
5 to 10 years	7	21.1%	20.2%	0.8%	2.5%	5.3%	13.4%	9.7%	0.7%	9.0%	40.6%	1.1%	6.4%	**100.0%**
More than 10 years	5	21.3%	19.8%	1.5%	1.8%	8.6%	15.2%	8.3%	0.3%	7.9%	34.9%	1.0%	8.9%	**100.0%**
All Factories	30	23.9%	22.0%	1.9%	2.5%	5.6%	14.1%	9.1%	0.7%	8.4%	38.9%	0.7%	5.3%	**100.0%**

**Only electricity is examined here so in the case of the boiler, only the boiler's motor uses electricity.*

***Many garment producing machines are manual (human operated). In this case they are used intermittently throughout the day and not constantly electrified as production floor lighting would be.*

Figure 22: Electricity Consumption per Type of Product

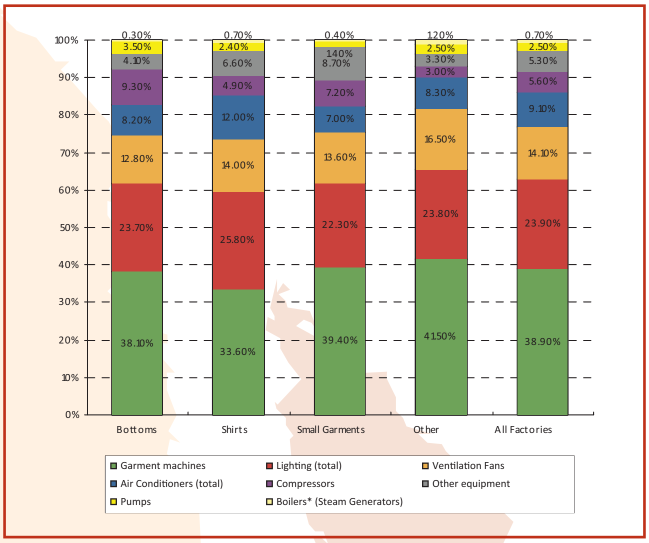


Figure 23: Electricity Consumption per Production Volume

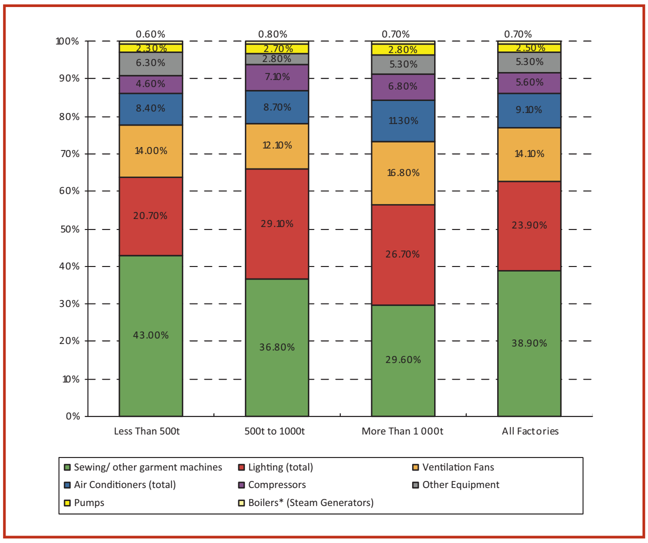


Figure 24: Electricity Consumption per Factory Size

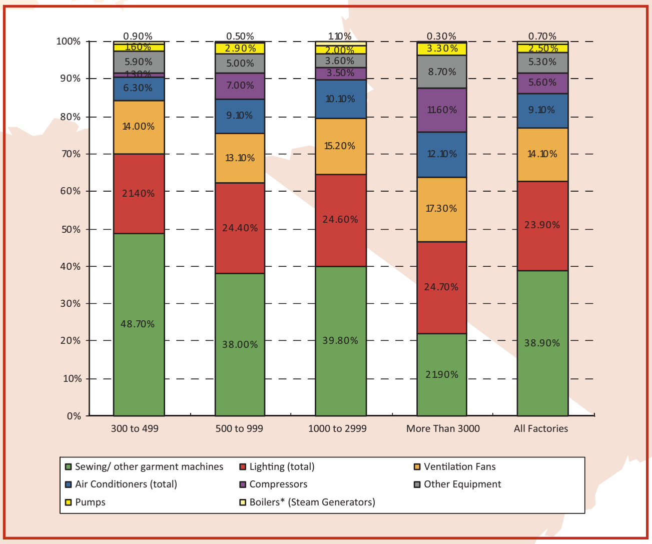


Figure 25: Electricity Consumption per Production Area

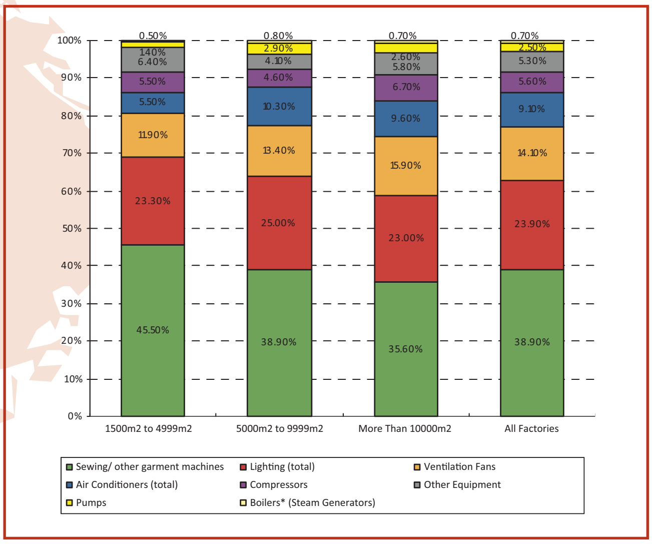


Figure 26: Electricity Consumption per Age of Machinery

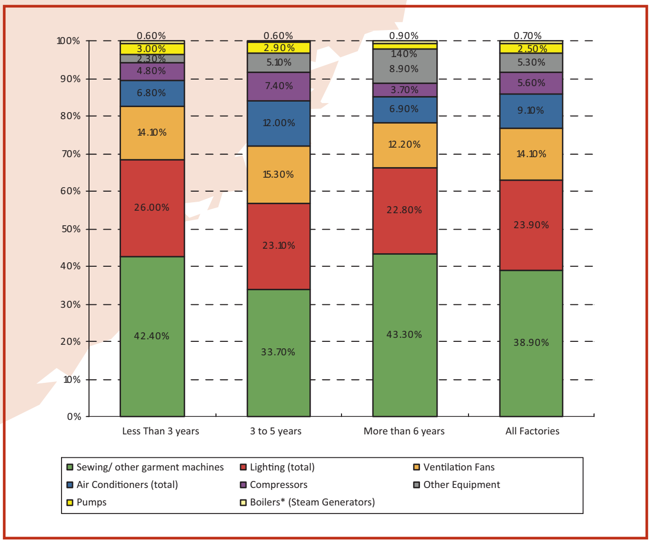
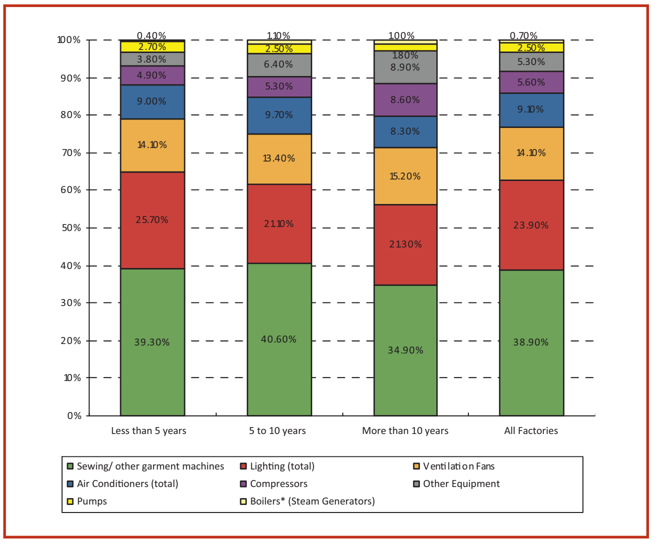


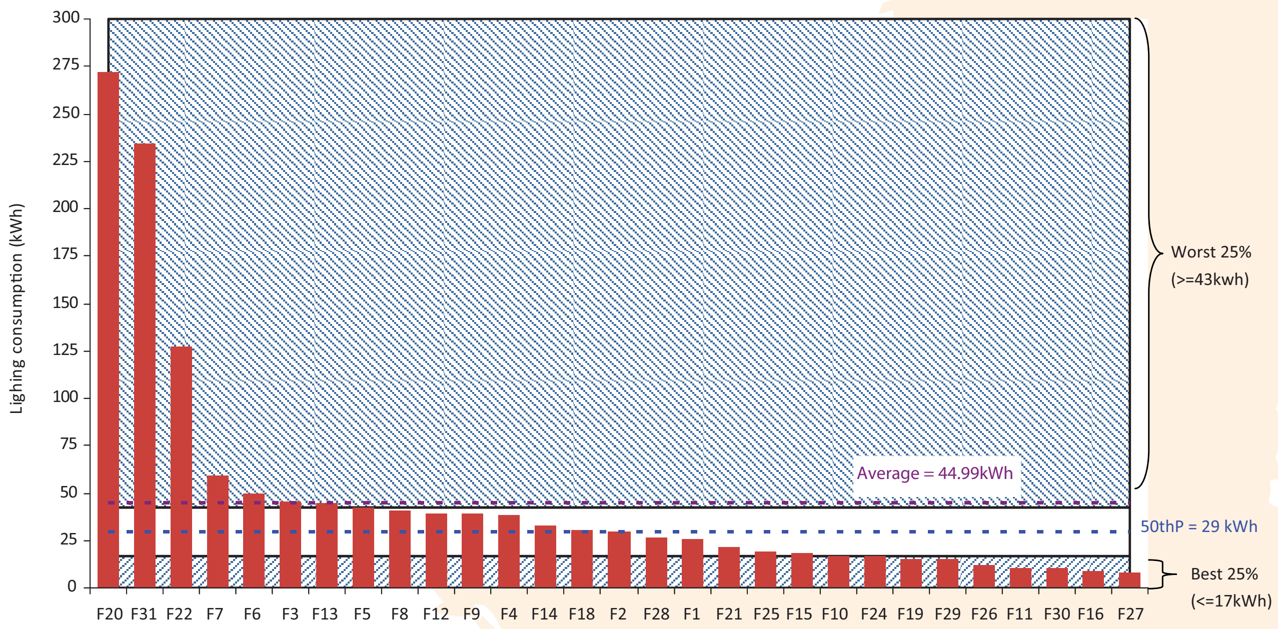
Figure 27: Electricity Consumption per Age of Factory



2.3.1. PRODUCTION AREA LIGHTING CONSUMPTION PER TON OF GARMENT PRODUCTION

Lighting consumption in the production area represents an average of 22% of the total electricity consumption. In 2008, lighting consumption ranged from 8kWh to 272kWh per ton of product, with an average of 45kWh per ton of product. The figure below presents lighting consumption by factory and shows again a wide variance. Noticeably, the average (44.99kWh) is positioned within the worst 25% performing factories. The best 25% performing factories use <=17kWh in lighting.

Figure 28: Production Area Lighting Consumption (kWh) per Factory



When reviewing the data by categories some interesting correlations and findings emerge:

- Lighting consumption per square meter of production area and per ton of product is lower for the biggest production floors. The consumption is 3.73kWh/m2 for the smallest production areas (1,500m2 to 4,999m2) and falls to 2.31kWh/m2 for the largest areas (more than 10,000m2).
- Age of machinery: lighting consumption per square meter of production area and per ton of product decreases with the age of the machinery. Consumption is 3.43kWh/m2 for factories with the youngest machinery and decreases to 2.44kWh/m^2 for factories with the oldest machinery (6 years and more).
- Production output: lighting consumption per ton of product decreases with the rise in production volume. Consumption is 59kWh/t of products for the production output below 500t and falls to 24kWh/t for the production outputs over 3000t.
- Age of factory: lighting consumption per ton of product also decreases for the oldest factories. Factories that have been operating for less than 5 years consume 55kWh/t of product though factories more than 10 years old consume 26kWh/t.

Table 7: Data Table: Production Area Lighting Consumption

Product	Number of Respondent Factories	Production Area Lighting (kWh)*	
		per Area Production (m^2)	per Product (t)
Type of Garment			
Bottoms	7	3.43	30.50
Shirts	9	3.58	82.25
Small Garments	5	2.88	30.82
Other	8	2.15	30.23
Production Output			
Less Than 500t	16	2.49	58.79
500t to 1000t	7	4.40	37.78
More Than 1000t	6	2.86	24.10
Factory Size (employees)			
300 to 499	5	2.17	27.77
500 to 999	15	3.51	65.20
1000 to 2999	6	2.93	22.30
More Than 3000	3	2.25	33.01
Production Floor Size			
1500m² to 4999m²	5	3.73	67.00
5000m² to 9999m²	12	3.45	56.85
More Than 10000m²	12	2.31	27.71
Age of Machinery			
Less Than 3 years	8	3.43	56.32
3 to 5 years	13	3.14	47.79
6 years and more	8	2.44	34.73
Age of Factory			
Less than 5 years	17	3.03	55.41
5 to 10 years	7	3.64	39.46
More than 10 years	5	2.16	26.31
All Factories	29	3.03	46.54

**Lighting only in the production floor area*

The figures on the next page give a visual representation of the production area lighting consumption related to various factors compared to the consumption average.

Figure 29: Light Consumption in kWh per Type of Product

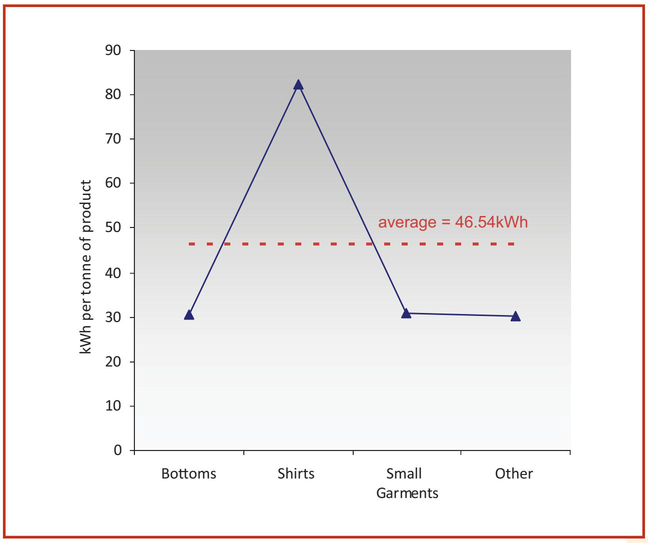


Figure 30: Light Consumption in kWh per Prod. Volume

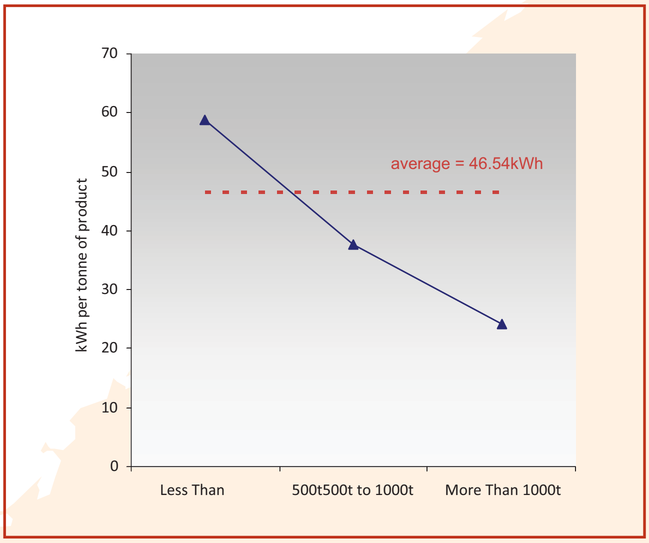


Figure 31: Light Consumption in kWh per Factory Size

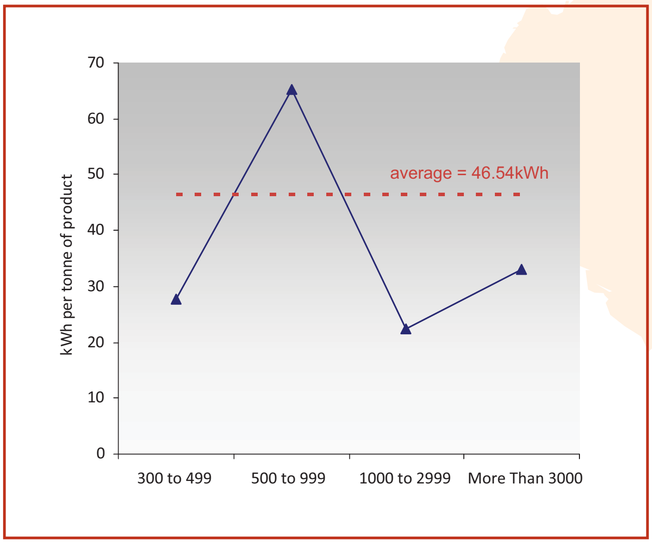


Figure 32: Light Consumption in kWh per Production Area

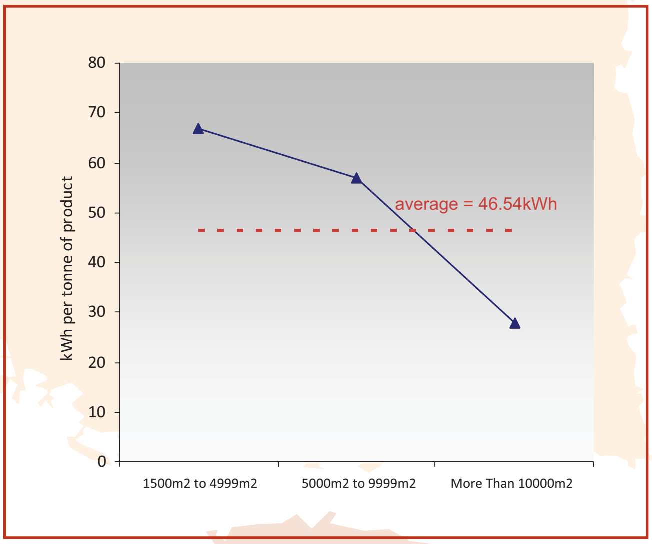


Figure 33: Light Consumption in kWh per Age of Machinery

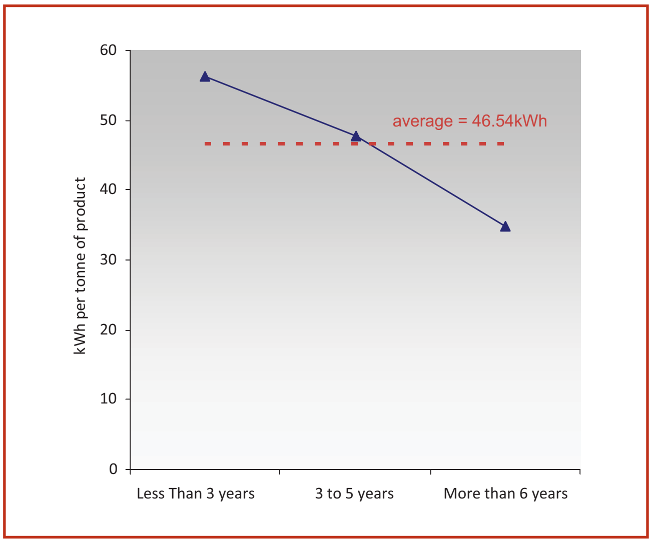
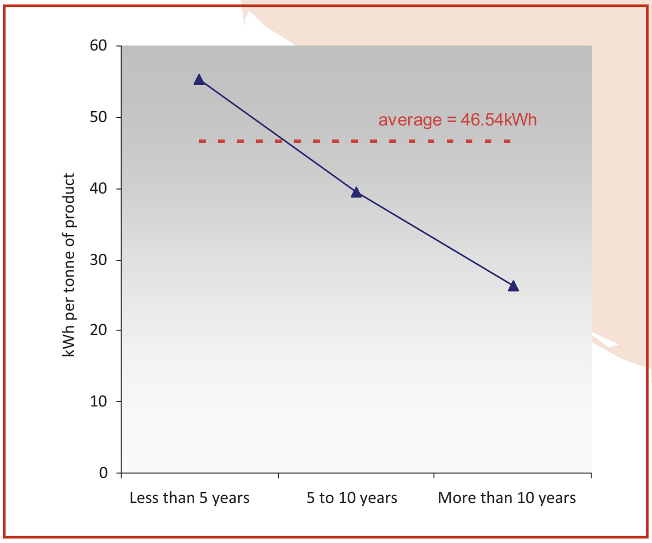


Figure 34: Light Consumption in kWh per Age of Factory



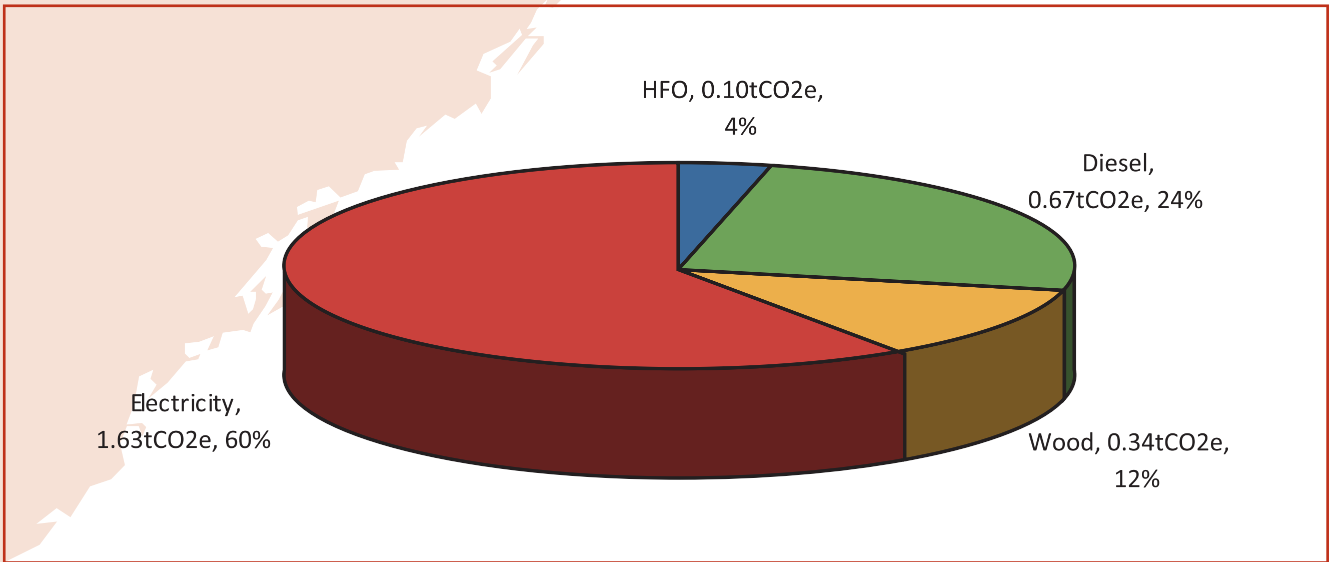
2.4. GHG EMISSIONS

For comparison purposes, all Greenhouse Gas (GHG) emissions are converted to tCO2e (tons of carbon dioxide equivalents)[1]. The mean level from the sample size is 2.74tCO2e per ton of garment. The tables and figures below provide a detailed breakdown of GHG Emissions per ton of garment production by various indicators as well as fuel type. Key points are summarized as follows:

- Of all fuel types, electricity produces the highest GHG emissions per ton of product followed by diesel and then wood. A reminder that electricity accounts for 24.5% of total energy use, and diesel 27.9%. Also to be noted is that the electricity conversion rate is based on the Cambodian electrical grid, which takes into account that the electricity production comes primarily through diesel generators. Wood accounts for 43.3% of total energy use and emits the lowest GHG emissions.
- Shirts have the highest GHG emissions per ton of production although bottoms and other types of products are not far behind. Small garment produce the least GHG emissions per ton of production.
- There is a reverse correlation between production outputs and GHG emissions. Factories producing less than 500t per year emit approximately 36% more GHG emissions than the factories producing the highest volumes.
- There is no correlation between the number of employees in a factory and GHG emissions. Factories with 1,000 to 2,999 employees have the lowest emissions followed by factories with 300 – 500 employees. Other employee sizes have a GHG emission larger than 3.
- There is no correlation between GHG emissions and type of energy used. It may seem that factories running 100% on fuel generators and wood or fuel burning boilers (F9, F18, F23, F28) would emit the most GHG but this is not the case. As mentioned before, nearly all electricity grid generation comes from fuel burning anyway and the GHG emission factor for Cambodian specific electricity grid accounts for this.
- There is no obvious correlation between production floor size, age of production machinery, age of factory and GHG emissions. Further detailed energy audits will be required to comment on this KPI.

The figure below shows the distribution of Greenhouse emissions by type of fuel. Electricity represents the highest portion with 60% of the total emissions, followed by diesel (24%). Electricity generation in Cambodia comes almost entirely from diesel or fuel burning generators.

Figure 35: Greenhouse Gas Emissions by Type of Fuel for All Factories



4 See 1.1.3. Conversion and Emission Factors

Table 8: GHG Emissions per Ton of Garment Production

Product	Number of Respondent Factories	HFO	Diesel	Wood	Electricity	Total
		tCO2e per ton of product				
Type of Garment						
Bottoms	8	0.28	0.32	0.57	1.75	2.93
Shirts	9	0.07	1.45	0.38	1.25	3.14
Small Garments	5	0.03	0.16	0.16	1.57	1.91
Other	8	0.00	0.46	0.17	1.98	2.61
Production Output						
Less Than 500t	16	0.00	0.69	0.33	2.04	3.07
500t to 1000t	7	0.17	0.67	0.39	1.52	2.75
More Than 1000t	7	0.25	0.61	0.30	0.80	1.97
Factory Size (employees)						
300 to 499	5	0.03	0.21	0.23	1.74	2.21
500 to 999	15	0.03	0.80	0.42	1.86	3.12
1000 to 2999	7	0.19	0.63	0.08	1.10	1.99
More Than 3000	3	0.35	0.88	0.68	1.55	3.46
Production Floor Size						
1500m^2 to 4999m^2	5	0.00	1.26	0.26	1.17	2.69
5000m^2 to 9999m^2	12	0.05	0.47	0.48	2.24	3.25
More Than 10000m^2	13	0.18	0.63	0.23	1.25	2.28
Age of Production Machinery						
Less Than 3 years	8	0.02	0.54	0.19	1.08	1.83
3 to 5 years	13	0.08	0.86	0.42	1.89	3.25
6 years and more	9	0.20	0.50	0.36	1.74	2.80
Age of Factory						
Less than 5 years	17	0.01	0.75	0.28	1.53	2.56
5 to 10 years	7	0.07	0.44	0.54	2.44	3.49
More than 10 years	6	0.39	0.71	0.26	0.98	2.34
All Factories	30	0.10	0.67	0.34	1.63	2.74
# Factories using the energy source	30	5	24	22	30	30

GHG EMISSIONS PER TON OF PRODUCTION

Figure 36: GHG Emissions and Type of Product

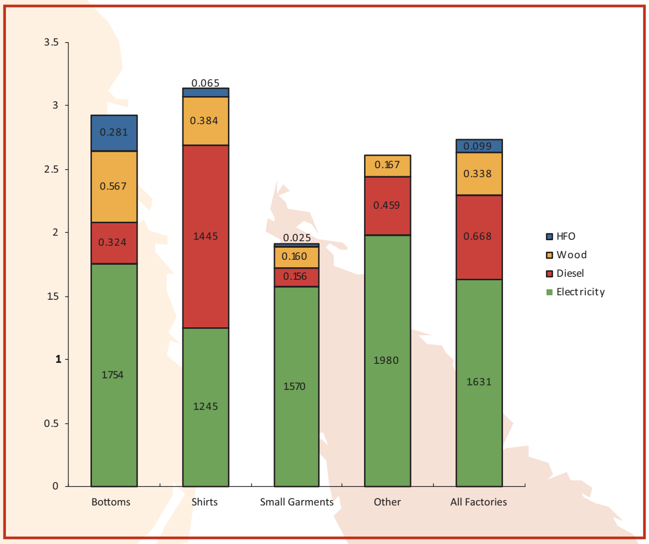


Figure 37: GHG Emissions by Production Volumes

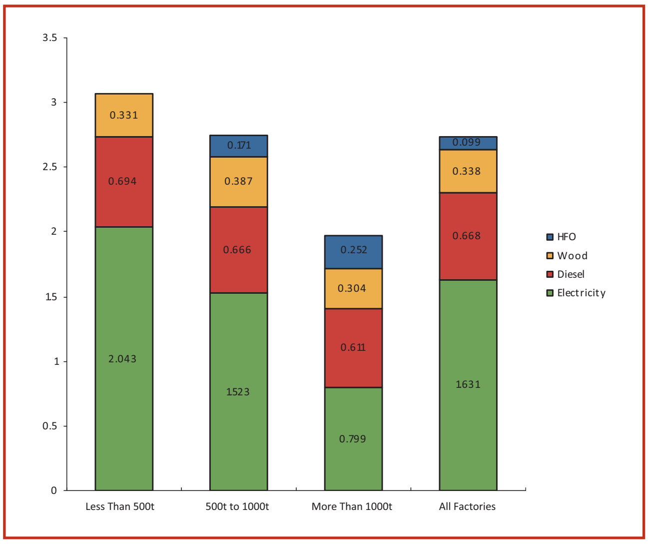


Figure 38: GHG Emissions by Factory Size

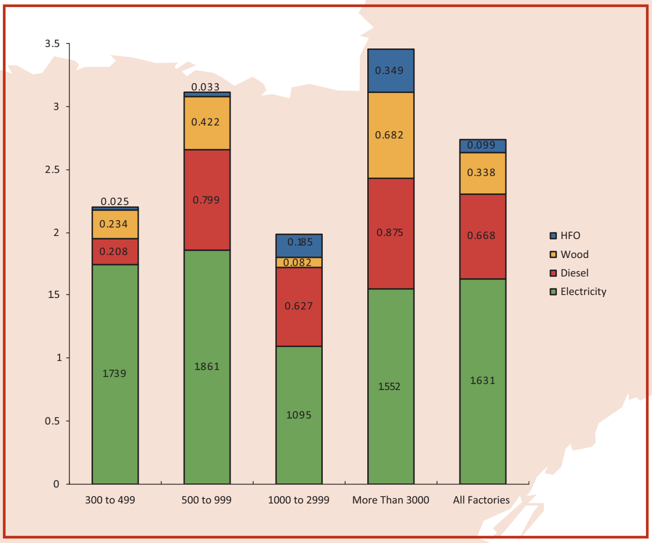


Figure 39: GHG Emissions by Production Area

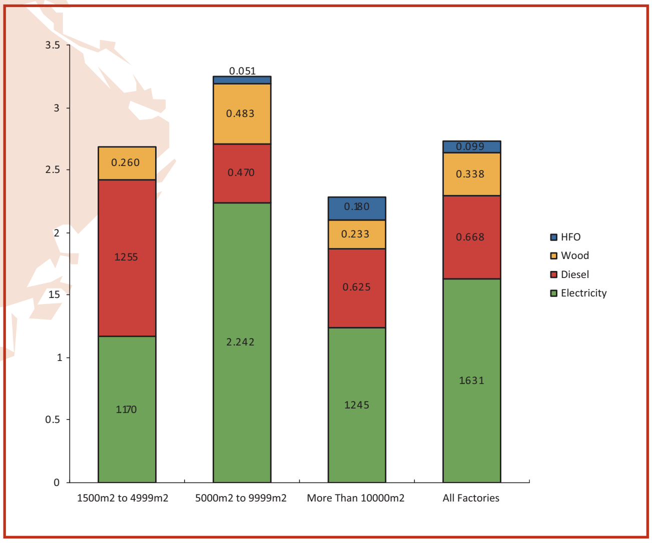


Figure 40: GHG Emissions by Age of Machinery

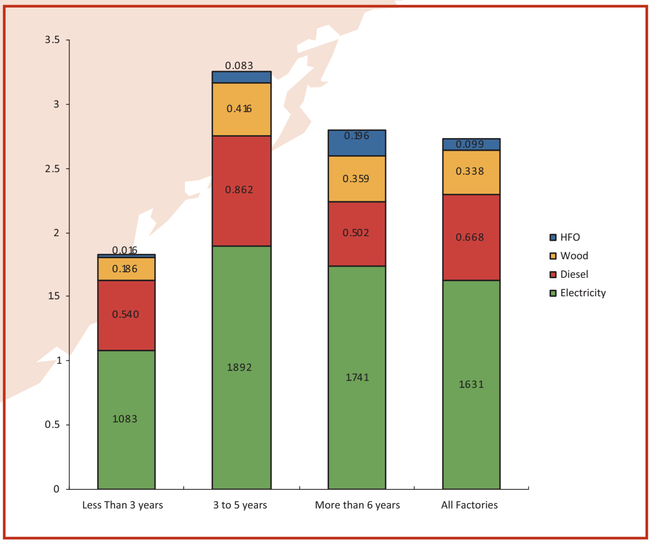
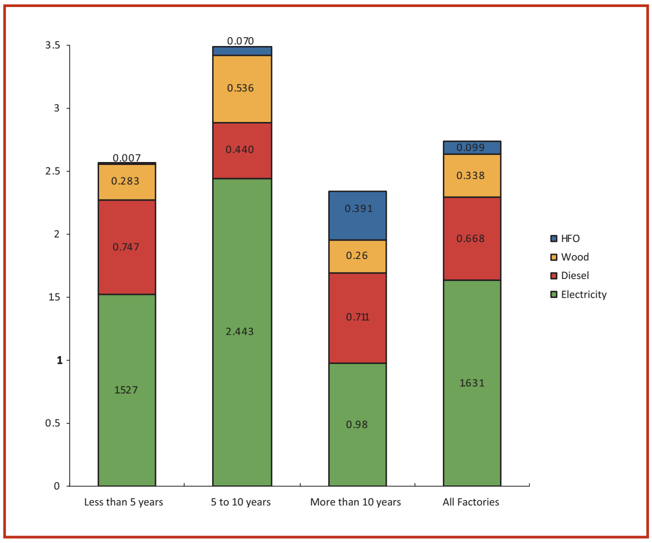
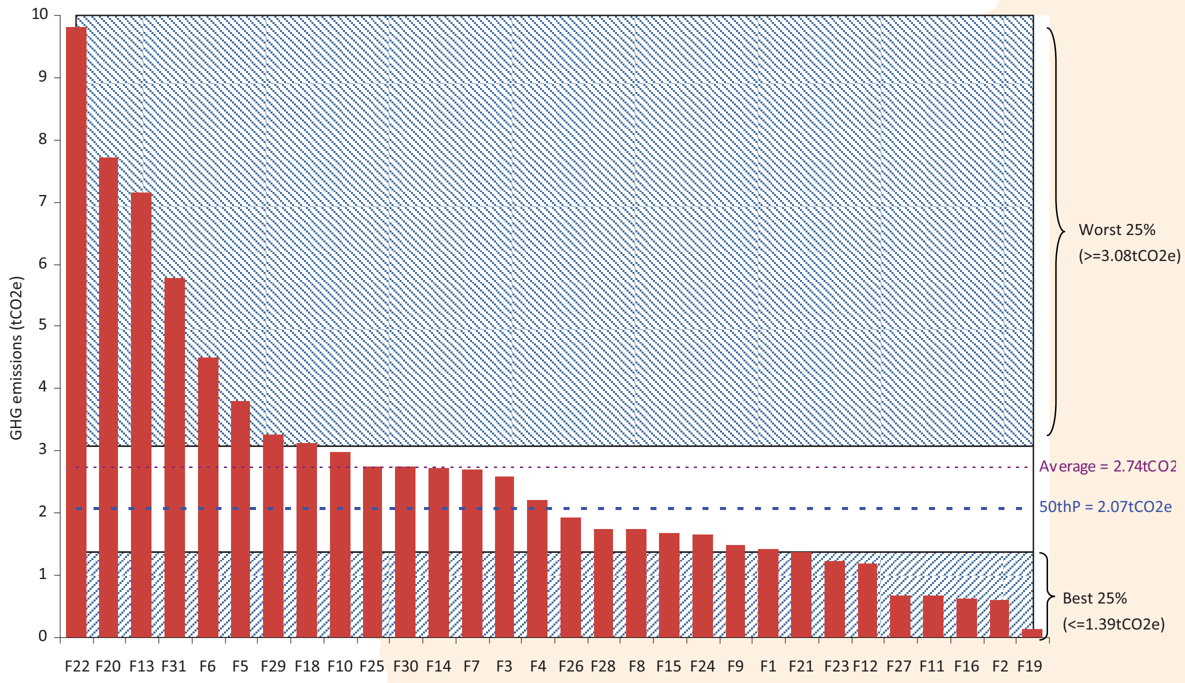


Figure 41: GHG Emissions by Age of Factory



The figure below shows GHG emissions per factory. Again a wide variance is observed amongst factories, ranging from approximately 0.13tCO2e to just under 9.81tCO2e. The best 25% factories have GHG emissions below 1.39 tCO2e while the worst 25% have GHG emissions higher than 3.08 tCO2e.

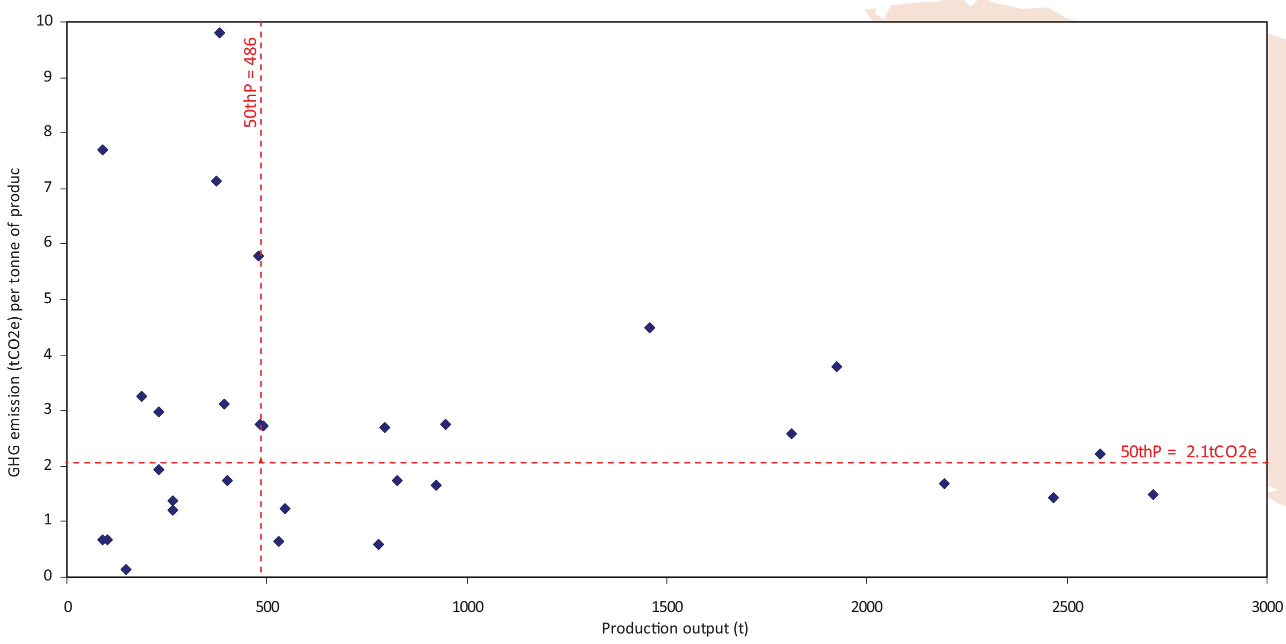
Figure 42: GHG Emissions per Factory



GHG EMISSIONS AND ENERGY INTENSITY

The figure below shows that the majority of factories emitting the highest GHG emissions are those with relatively low energy intensity.

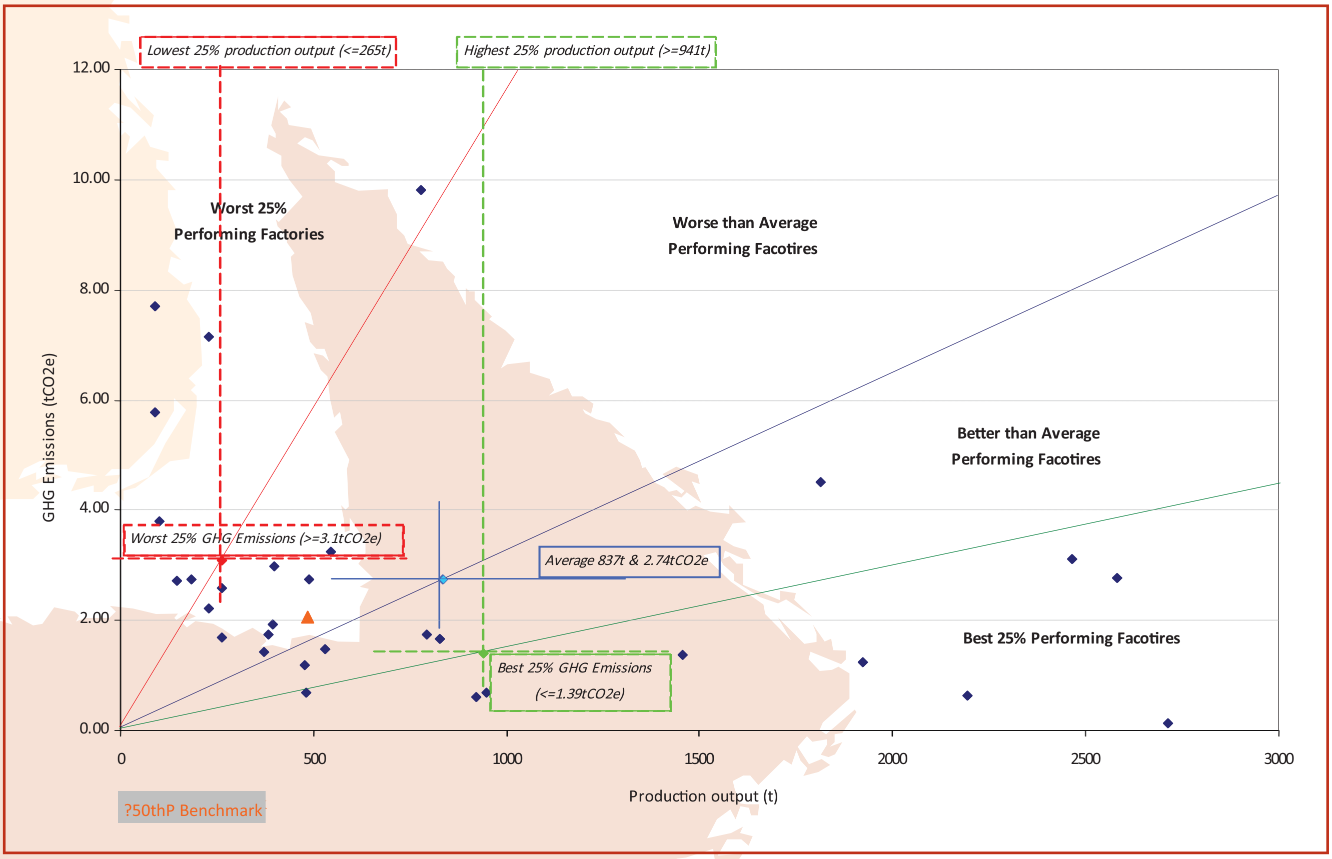
Figure 43: GHG Emissions per Factory by Energy Intensity



GHG EMISSIONS AND PRODUCTION OUTPUTS

Factories with smaller production outputs (<500 tons per year) have the highest GHG emissions per ton of products.

Figure 44: GHG Emissions per Factory by Production Output



2.5. ENERGY COST COMPARED TO TOTAL PRODUCTION COST

This performance indicator may be the most relevant in deciding how efficiently a factory uses energy.. Raw materials are excluded from the calculations since factories can obtain them by a variety of means. One factory may purchase their own fabric as part of their production activities while another has these materials supplied directly by the client.

On average, energy accounts for 16.7% of total production costs. Summary results show:

- For factories producing small garments, 23.4% of their total production costs are spent on energy. The data point is significant given one factory recorded an energy cost of 60% of production cost. Shirt production has the lowest energy cost of total production.
- Factories producing more than 1,000 tons per year have a significantly lower energy cost ratio to total production costs.
- Factories with 1,000 or more employees have a lower percentage of energy to production cost than factories with less than 1,000 employees.
- Factories with a relatively smaller production floor size (1,500m2 to 4,999m2) have a higher percentage of energy cost (24.4%).
- There is no correlation between age of machinery, age of factory and the average proportion of energy to total production cost.

The table below summarizes the detailed findings from each factory surveyed

Table 9: Proportion of Energy Cost in Total Production Cost

Product	Number of Factories	Average proportion of Energy Cost in Total Production Cost*	Max	Min
Type of Garment				
Bottoms	8	17.3%	40.0%	8.0%
Shirts	9	12.9%	26.0%	6.0%
Small Garments	5	23.4%	60.0%	10.0%
Other	7	16.1%	25.9%	10.0%
Production Output				
Less Than 500t	15	18.3%	60.0%	10.0%
500t to 1000t	7	19.6%	40.0%	10.0%
More Than 1000t	7	10.2%	15.0%	6.0%
Factory Size (employees)				
300 to 499	5	16.2%	25.9%	10.0%
500 to 999	14	20.4%	60.0%	10.0%
1000 to 2999	7	11.5%	20.0%	6.0%
More Than 3000	3	12.5%	15.0%	11.0%
Production Floor Size				
1500m2 to 4999m2	5	24.4%	40.0%	15.0%
5000m2 to 9999m2	12	14.5%	25.0%	10.0%
More Than 10000m2	12	15.7%	60.0%	6.0%
Age of Machinery				
Less Than 3 years	7	13.1%	26.0%	6.0%
3 to 5 years	13	18.8%	60.0%	10.0%
6 years and more	9	16.4%	25.9%	8.0%
Age of Factory				
Less than 5 years	16	16.4%	60.0%	6.0%
5 to 10 years	7	20.0%	40.0%	10.0%
More than 10 years	6	13.7%	25.9%	8.0%
All Factories	29	16.7%	60.0%	6.0%

**Raw material costs are omitted from the total production cost as some factories are supplied with raw materials*

The figure below shows the energy cost ratio to total production costs per factory. There is a wide variance amongst percentage energy costs ranging from as little as 6% to as high as 60%. The worst performing factories have an energy cost of >=20%. The best 25% performing factories have an average energy cost of <=10% of total production cost.

Figure 45: % Energy Cost of Total Production Cost per Factory

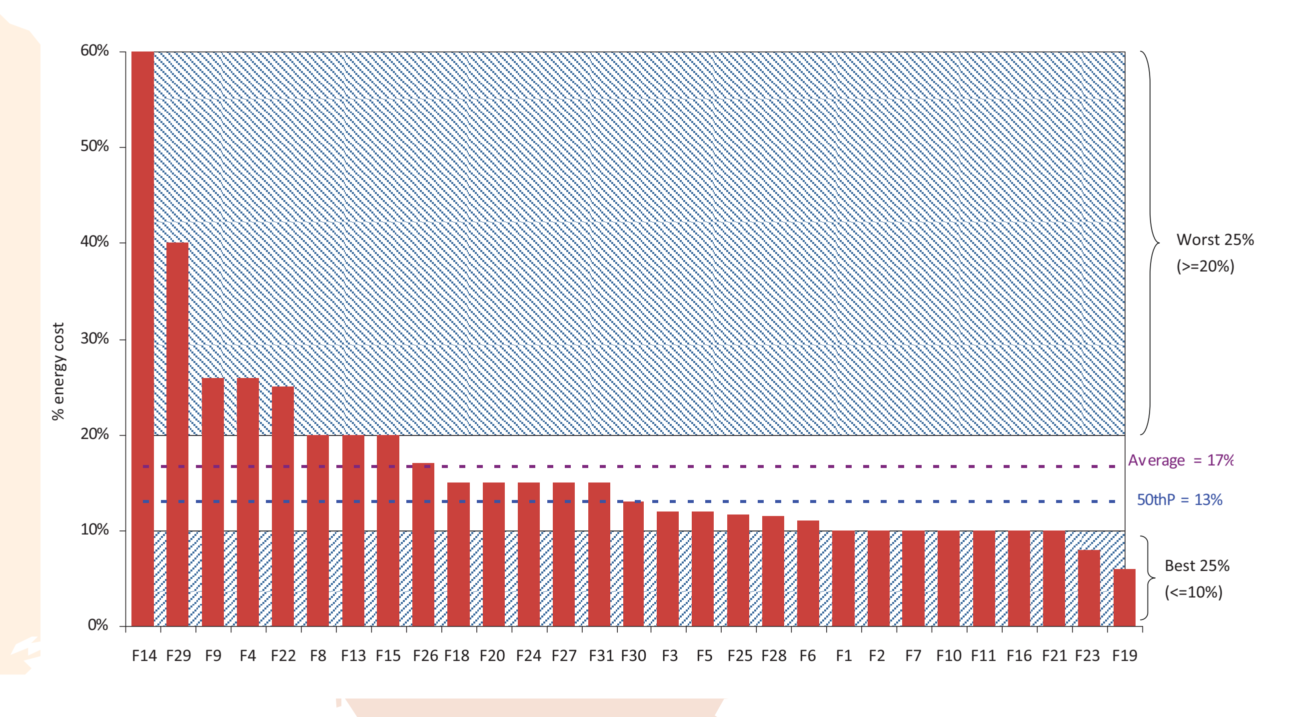


Figure 46: % Energy Cost of Total production by production output

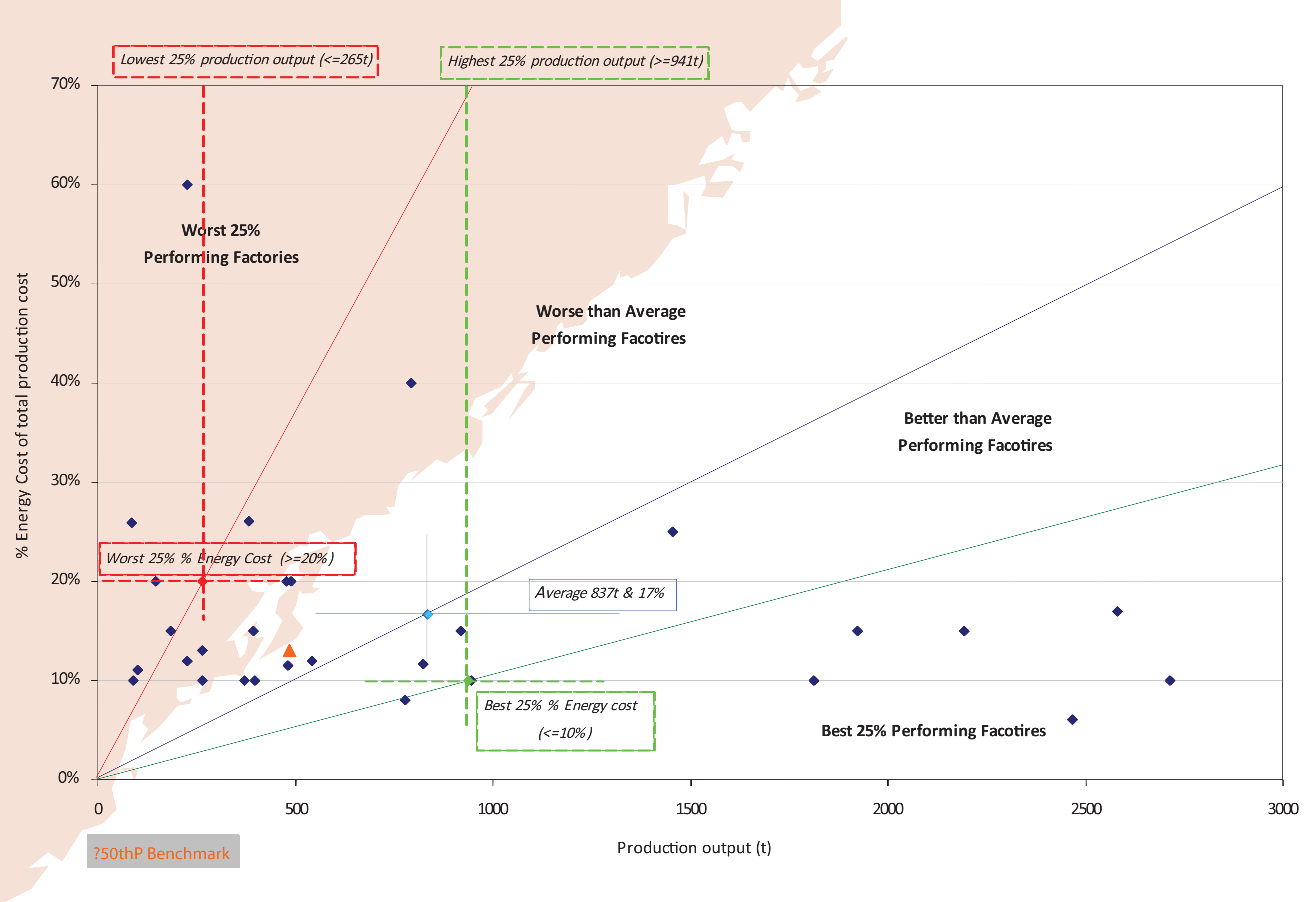


Table 10: Energy Performance Benchmark

Measure	Units	Average	Min.	Max	Variance	Best 25% are under...	Worst 25% are over...
Energy Intensity	GJ / t	41.73	2.02	236.92	2,718	11.99	43.90
Energy Cost	USD / t	$560	$30	$1,73	172,47	$279.00	$649.30
GHG intensity	tCO2e / t	2.74	0.13	9.81	5.08	1.39	3.08

2.6. ENERGY MANAGEMENT PRACTICES

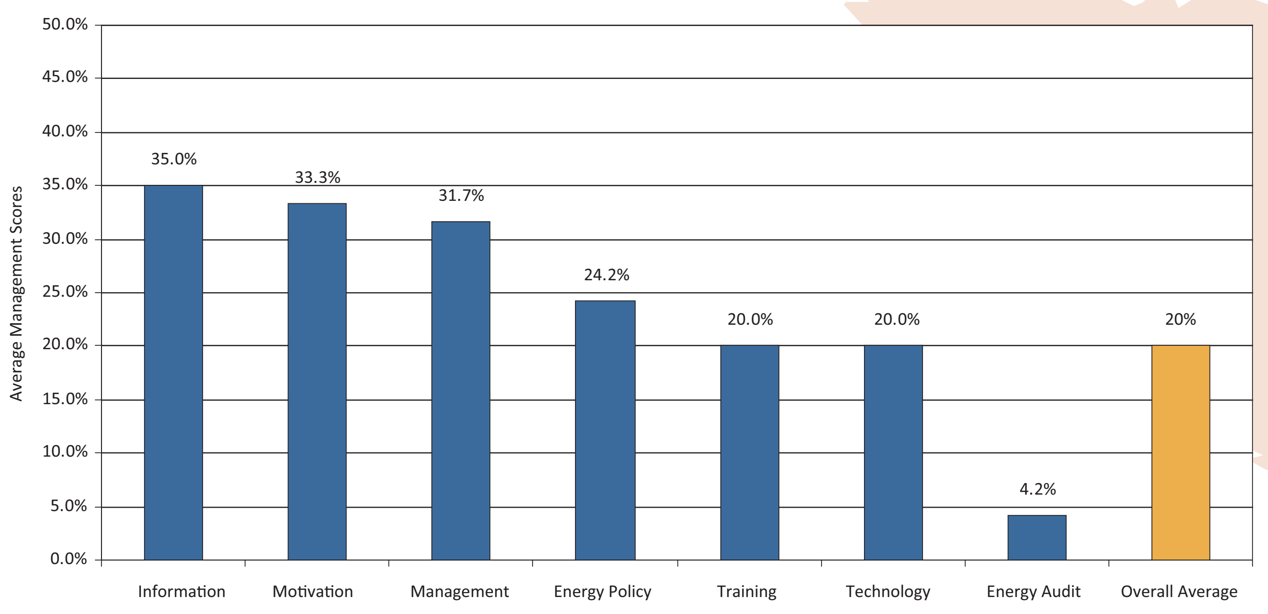
Energy audits have generally not been performed in most of the garment factories surveyed. Where they have been performed, there has been little follow-up and recommendations have not been implemented. The depth of analysis of the energy audits performed is uncertain and was not obtainable during the survey.

Most factories claim that energy efficiency is important to them and that these values are passed on throughout the organization. Informal encouragement to take energy efficient steps where possible occurs on a regular basis but little action is taken towards implementation of formal training or company policy. Energy efficiency consultants and energy auditors are still few in Cambodia. There is clearly a need for the development of energy efficiency and energy auditing services. Several factories have invested in efficient technology where the returns prove to be reasonable. This section of the survey reviews whether the management of the garment factory considers that energy efficiency is an important business issue.

Surveyors determined the overall energy management rating based on observations in each factory along with answers to key questions to management and staff involved in the survey. A management score out of 5 is given in each of the 8 areas for a total of 40.

Overall, the factories had low scores relating to energy management practices. Information, motivation and management overall scored between 30% - 35%. Few factories had comprehensive energy policies and this is reflected in the score of 24%. Training in energy management and knowledge of technology both scored 20%. Energy audits received the lowest score at 4.2%.

Figure 47: Energy Management Areas



Overall energy management performance averages less than 30%. The results are presented in the table below and can be summarized as follows:

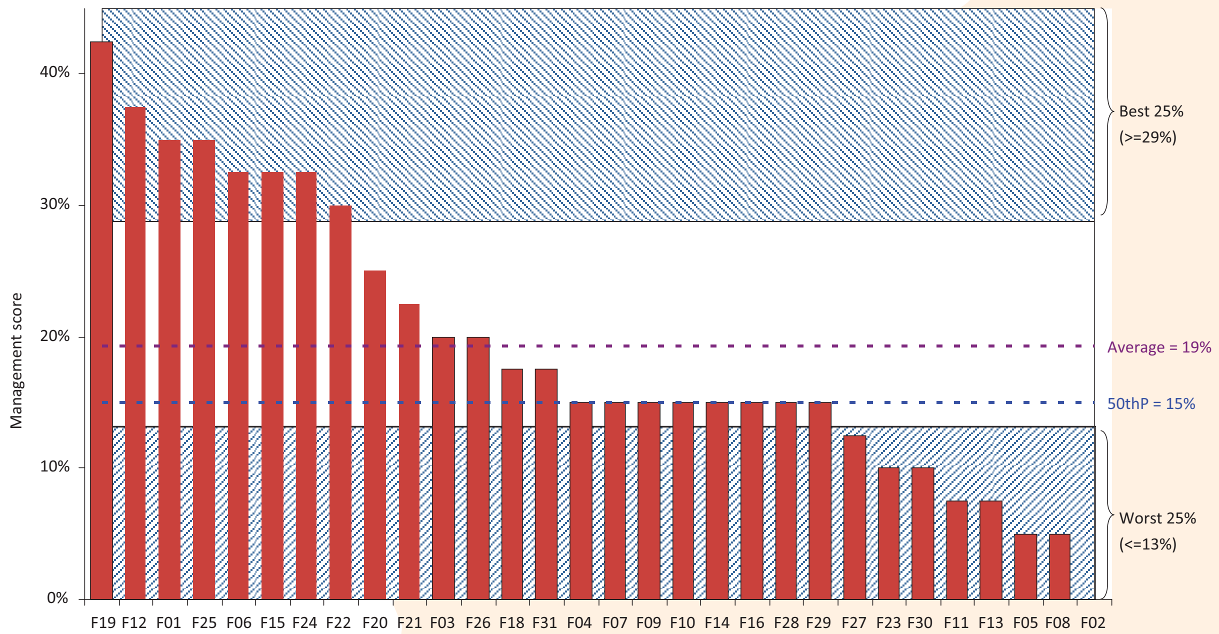
- Factories producing shirts and other garments have the highest overall management score, 25.8% and 22.8% respectively
- Factories producing the highest volumes per year have the highest management score (25.0%)
- There is a direct correlation between the employee size and energy management practices. Smaller factories have lower management scores (<20%) while bigger factories have better management scores (>20%)
- There is no direct correlation when reviewing production floor size even though the factories with the biggest production floor sizes (>10,000m2) have the highest score
- Factories with the youngest machinery have the highest management score overall but there is no specific correlation relating to age of machinery.
- Younger factories tend to have better management scores than factories that have been in operation for more than 5 years.

Table 11: Overall Energy Management scores by main factory drivers

Product	Number of Respondent Factories	Management Benchmark Score
Type of Garment		
Bottoms	8	15.6%
Shirts	9	25.8%
Small Garments	5	8.0%
Other	8	22.8%
Production Output		
Less Than 500t	17	18.5%
500t to 1000t	7	16.8%
More Than 1000t	7	25.0%
Factory Size (employees)		
300 to 499	6	15.4%
500 to 999	15	19.0%
1000 to 2999	7	20.7%
More Than 3000	3	28.3%
Production Floor Size		
1500m^2 to 4999m^2	6	17.1%
5000m^2 to 9999m^2	12	16.3%
More Than 10000m^2	13	23.8%
Age of Production Machinery		
Less Than 3 years	9	24.4%
3 to 5 years	13	18.7%
6 years and more	9	16.1%
Factory Age		
Less than 5 years	18	21.1%
5 to 10 years	7	17.1%
More than 10 years	6	17.9%
All Factories	31	19.6%

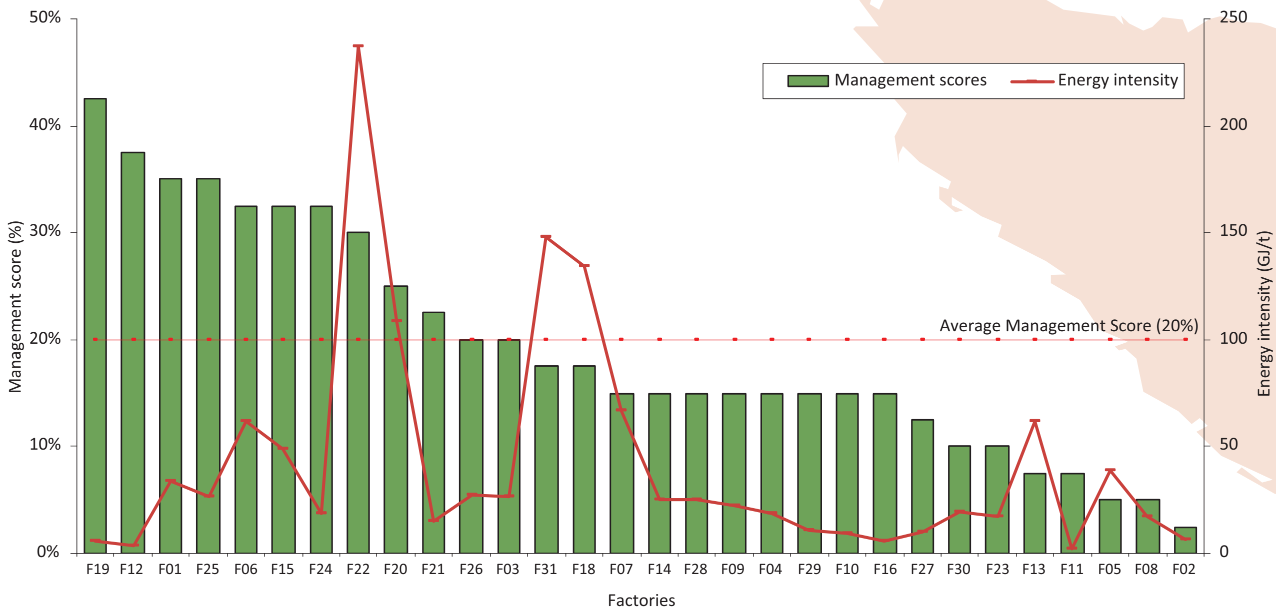
The chart below shows the overall energy management scores. The 25% best performing factories have management scores >=29% and the 25% poorest performers have management scores <=13%. Overall, the highest score is less than 45% and indicate there is large scope for overall industry improvements in energy management.

Figure 48: Overall Energy Management Scores by Factory



There is no correlation between energy intensity and energy management scores. Although one would assume that factories with better management practices would have better energy intensity, the figure below demonstrates that this is not the case in the garment sector.

Figure 49: Comparison Energy Management Scores and Energy Intensity (GJ/t) by Factory



III SUMMARY REMARKS AND POSSIBLE NEXT STEPS

An improvement in energy efficiency can be achieved by a process, technique or equipment change that reduces energy consumption while maintaining the same or better production output level and maintaining or improving process time, quality, performance or safety with minimal impact to the environment.

The results of this study show a variety of opportunities for intervention at a factory level and industry level. There are a number of practical measures that factories can take to reduce their overall energy consumption. Some proven energy saving devices are; (i) intelligent motor controllers, (ii) compact fluorescent lamps, (iii) electronic ballasts, (iv) installation of energy efficient devices in power plants, (v) co-generation. First target action items are efficiency improvements and lower cost investments ranging up to high cost major refurbishment of equipment and upgrading of factory premises

The survey results suggest that key areas to consider are:

- Lighting systems
- Sewing machine controllers
- Air ventilation
- Boilers

ENERGY AUDITS

Energy audits are important so that each factory is able to determine what specific actions can be taken. These are prioritized and costed out. The benchmarking survey has produced some *indicative* data, but the only way to determine what specific energy saving measures are appropriate for a specific factory is to measure actual energy use. The audit is usually performed by an experienced contractor who has the necessary measuring equipment to assess individual equipment consumption. Often, the collection and analysis of energy use data during an energy audit will uncover energy inefficiencies and make clear what steps can be taken. An experienced energy auditor will be able to interpret the data and provide an action plan.

BEST PRACTICE

BW intends to produce best practice guidelines on energy performance in the garment sector. These guidelines will feature case studies indicating the various practical measures that can be taken together with the associated costs and payback period

CONCLUSION

There are a number of steps that garment factories can take in order to operate in a way that uses energy more efficiently, thereby reducing a substantial cost component of operations in a highly competitive market environment. Many of the measures listed above can be started immediately, while some will need to wait until an energy audit has been completed for the factory in question. Not all measures to save energy need high capital requirements. In fact, many of the suggestions are at no cost, or relatively low cost

About Better Work

Better Work, a unique partnership between the International Labour Organisation (ILO) and the International Finance Corporation (IFC), aims to improve labour standards and competitiveness in global supply chains. The focus is on scalable and sustainable solutions that build cooperation between government, employers' and workers' organisations, and international buyers. The Better Work global programme is supported by the governments of the Netherlands, Germany, Switzerland, Ireland, Japan, Norway, Luxembourg, Italy, and New Zealand. In Cambodia, Better Work programme is supported by Finland, Ireland, the Netherlands, New Zealand, and Switzerland

For more information, visit www.betterwork.org

About GMAC

In mid 1996, most of the garment investors, coming from such a diverse background as China, Hong Kong, Macau, Malaysia & Singapore, decided to form an ad hoc unit (GMAC) to represent them as a group instead of being singled out individually when dealing with officials from the Ministry of Commerce (MoC), which has been charged by the Royal Government of Cambodia (RGC) to oversee the export of garments and the issuance of Certificates of Origin. In that same year, the RGC (MoC) working together with GMAC, were instrumental in the successful lobbying effort to persuade the US to grant Cambodia its Most Favoured Nation (MFN) status, in order that normal tariff applies to Cambodian garments imported into the USA. Thus began a journey of symbiotic cooperation between the garment manufacturers and the RGC that has stood the test of time until today.

In 1999, GMAC was officially registered with the Ministry of Social Affairs, Labor, Veteran & Youth Affairs as a employers' organisation in compliance with the Cambodian Labor Law 1997. Later on, it was incorporated as an association with the Ministry of Commerce.

GMAC performs many roles. At the outset, it was a pressure group, making representations to MOC on issues that affect the general interests of its members. When external developments posed a threat to the well-being and survival of the Cambodian garment industry, GMAC was at the forefront lobbying the RGC to improve its trade facilitation efficiency and reduce fees and levies to keep the industry competitive in the world market.

About the ILO

The International Labour Organisation was established in 1919 by the Treaty of Versailles and became the first specialised agency of the United Nations system in 1946. Its work in setting and monitoring international labour standards has provided the framework for national labour law and practice in virtually all countries. The ILO's total budget for 2006-2007 is just over US$900 million, including a regular budget of US$594 million plus US$306 million in extra-budgetary funds associated with special technical cooperation projects.

For more information, visit www.ilo.org

About IFC

IFC, a member of the World Bank Group, creates opportunity for people to escape poverty and improve their lives. We foster sustainable economic growth in developing countries by supporting private sector development, mobilizing private capital, and providing advisory and risk mitigation services to businesses and governments.

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