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可持續發展委員會
Council for Sustainable Development

Enhancing the Low Carbon Competitive Advantage across the Manufacturing Sector of the Hong Kong Apparel Supply Chain through Effective Carbon Disclosure & Carbon Emission Reduction (SDF425)

Apparel Supply Chain –Carbon Assessment about Jeans Producing

[Completed By]

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Introduction

Fashionable and comfortable textiles and apparel products is playing important role in our daily life. The textile and apparel industry contributes a large share of raw materials and energy consumption in their manufacturing locations. To launch this pilot study is a prerequisite for seeking the low carbon manufacturing opportunities for the whole industry and answering the voice of sustainable fashion from brands, consumers, NGOs and even the whole public.

Pilot factories from the manufacturing sector of major cotton products have been invited to this case study, that aim to help them build their low carbon competitive advantages by identifying carbon emission reduction opportunities.

Jeans is a typical cotton product produced by the local industry. This chapter will demonstrate 5 pilot reports in jeans manufacturing supply chain, including spinning, dyeing, weaving, finishing, garment manufacturing and washing.

Four internal carbon assessment tools were adopted to quantitatively monitor the pilot factories’ GHG emissions levels and qualitatively position the potential carbon reduction opportunities.

Tool 1 — Average GHG emissions per unit product per month

- To monitor the monthly fluctuation of the GHG emissions by unit products
- Key parameters: monthly GHG emissions, monthly total production

Tool 2 — GHG emissions distribution by space

- To compare the distribution of the GHG emissions by space.
- Key parameters: administrative facilities, production facilities (including auxiliary production facilities)

Tool 3 — GHG emissions distribution by sub-process

- To clarify the distribution of the GHG emissions by sub-process.
- Key parameters: manufacturing sub-process

Tool 4 — GHG emissions distribution by emission source

- To trace the distribution of the GHG emissions by emission source.
- Key parameters: emission source

Figure 1 Internal carbon assessment tools for manufacturing sector

of Hong Kong Apparel Supply Chain.

NOTE Auxiliary production facilities are assisting equipment in production area such as air compressors, lightings, electric fans and air-conditioners.

Pilot report 1: Cotton Spinning

About Cotton Spinning

Spinning is the process to turn the fibers to yarns by means of series of sub-processes, e.g. blowing, carding, drawing, roving, spinning, etc. This is a very traditional textile manufacturing process, being greatly developed based on the innovations of machine and technology. Different properties of fiber require their special spinning systems. And even the same fiber, with various requirements of yarn, manufacturers' experience and machine, their sub spinning processes would differ from one another.

Pilot factory introduction

This medium size spinning factory with about 30,000 spindles had been invited to this pilot study. This factory mainly provides high-grade cotton yarns for denim products. It works with its sister companies of yarn dyeing and fabric weaving to constitute a vertical chain from fiber to fabric.

Process map

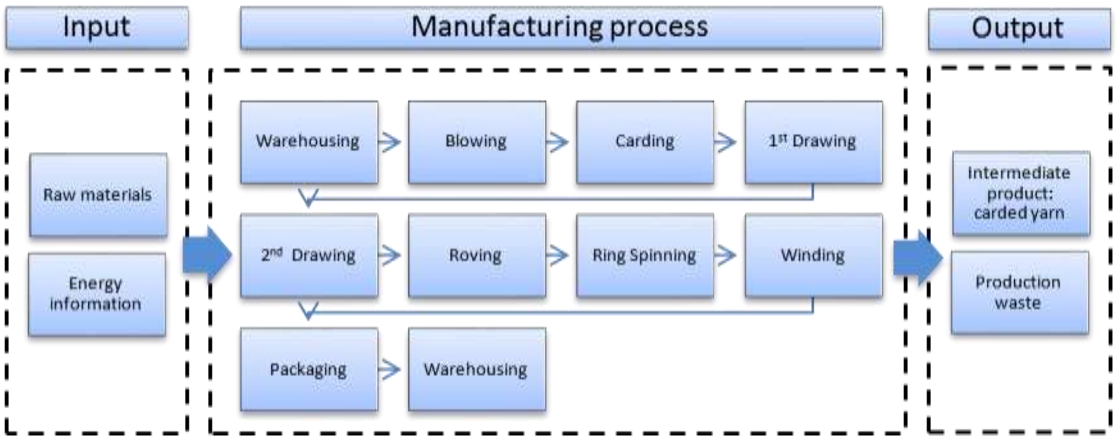

Figure 2 Process map of carded yarn spinning

Data collecting and analysis results

A set of data had been collected from the pilot factory. The important results focused on time, space, sub-process and energy consumption source are featured in Figure 3, 4, 5 and 6.

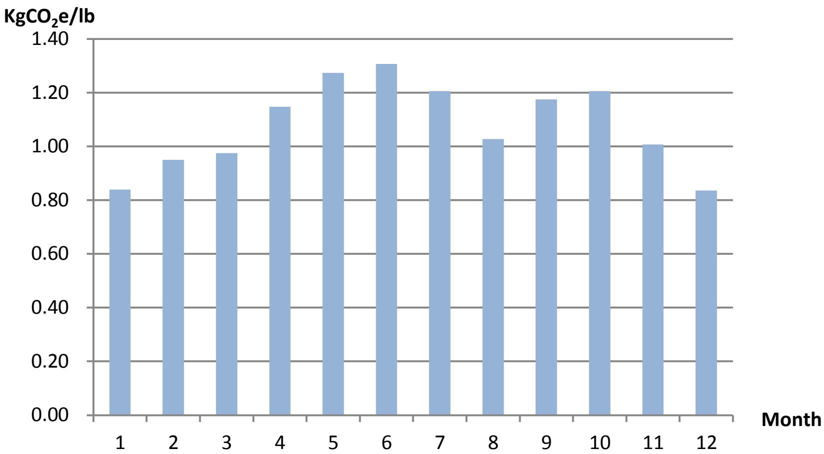

Figure 3 Average GHG emissions per pound per month (2011)

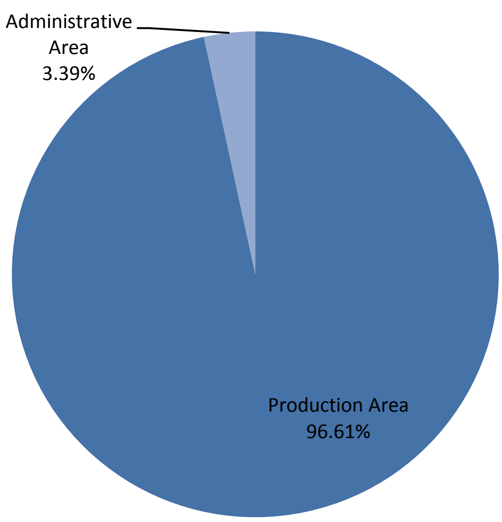

Figure 4 GHG emissions distribution by space (2011)

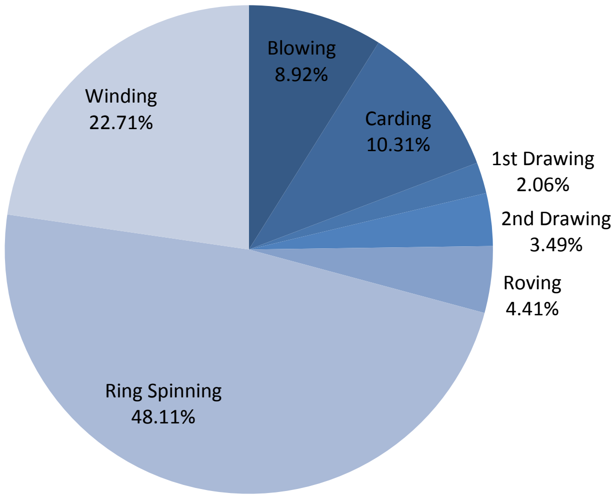

Figure 5 GHG emissions distribution by sub-process (2011)

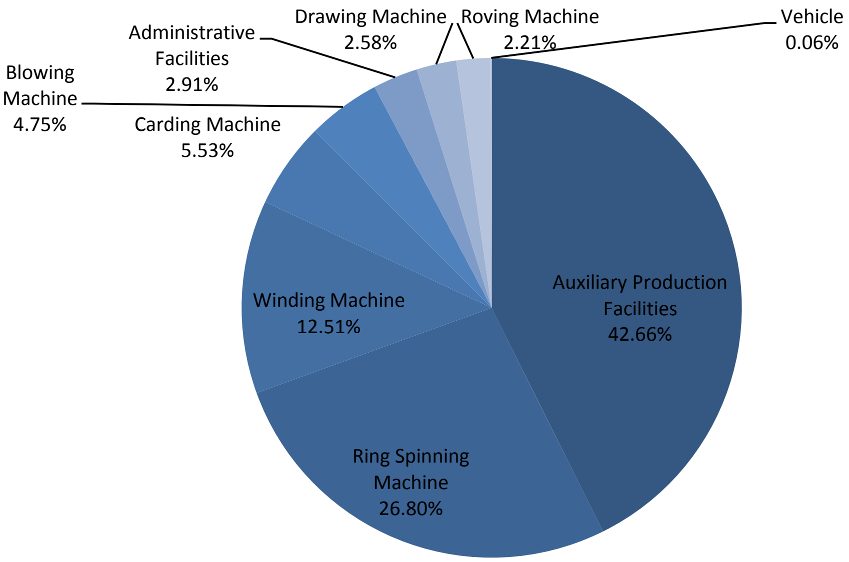

Figure 6 GHG emissions distribution by emission source (2011)

NOTE Auxiliary production facilities are assisting equipment in production area such as air compressors, lightings, electric fans and air-conditioners.

NOTE Administration facilities are general office equipment in administrative area, such as lightings, computers, electric fans and air-conditioners.

Discussion and carbon reduction opportunities

On the basis of results in Figure 3, 4, 5 and 6, further discussions have been made to find out the opportunity for carbon reduction.

1. In Figure 3, the average GHG emission per pound of yarn per month of this pilot factory in 2011 is showed. This emission figure calculated based on two major factors, monthly GHG emission and monthly total production. It indicates the overall stability of the GHG emissions per unit product of the factory. The fluctuation in Figure 17 is considered acceptable due to the good balance between monthly GHG emission and monthly total production. The former comes from all the emission source of a factory, such as administrative facilities and production facilities. The latter would be affected by production order, production plan and production efficiency. Each of the parameters indicates the carbon reduction opportunities.

2. In Figure 4, the GHG emissions from production area and administrative area respectively cover about 97% and 3% of the total GHG emissions. The majority energy consumptions are contributed to direct manufacturing processes, and this indicates the use of the energy is efficient in this pilot factory.

3. In Figure 5, ring spinning that consumed the most energy is the sub-process occupies almost half of the total GHG emissions. Winding, carding and blowing covers 40% in total. As electricity is the major source

of energy of the spinning process, the figure indicates that about 90% of the energy was consumed by ring spinning, winding, carding and blowing sub-process. The energy efficiency in these sub-processes will provide the potential carbon reduction opportunity.

4. In Figure 6, important emission source can be highlighted. The two machines that consumed the most energy are ring spinning machine and winding machine, which reconfirms the results of Figure 19. The total auxiliary production facilities, such as air compressor, lighting, electric fan and air-conditioner, plays a very important role of energy consumption. These auxiliary facilities are essential supporting equipment to ensure the product quality and manufacture environment, and this indicate the potential carbon reduction opportunity.

NOTE The above results and discussions are based on the data collected from the pilot factory in the reporting year of 2011, which can only indicate the possibility in the given period and location.

Pilot report 2: Cotton Yarn Dyeing

About Cotton Yarn Dyeing

The denim yarn dyeing process is one that applies indigo dyes and sizing chemicals to the warp with series of sub-processes.

Pilot factory introduction

This is a small and medium enterprise, with single intermediate products of dyed warp for denim fabric in a three-story building. Although it is a dyeing department of a textile company, this factory has independent manufacturing space, entire manufacturing processes, raw materials and energy consumption. In this pilot study, it is regarded as a factory conveying the assessment of carbon footprint of yarn dyeing process.

Process map

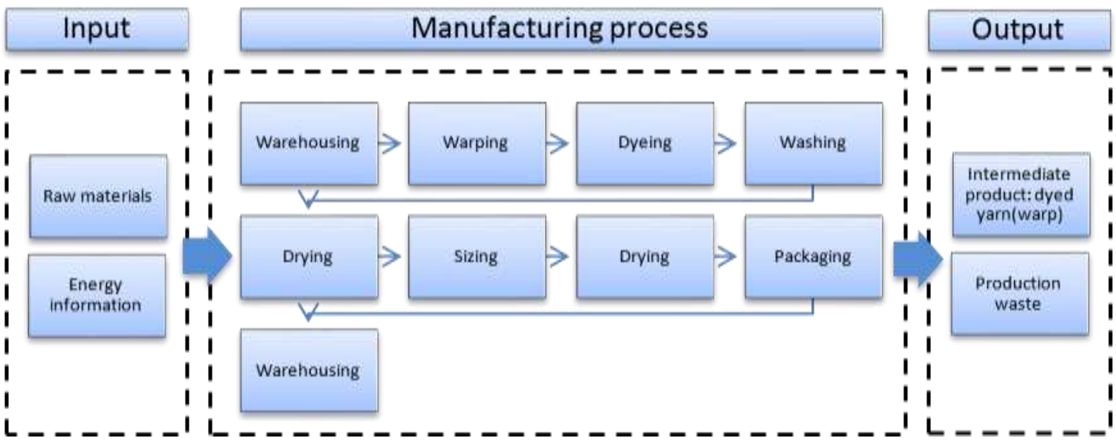

Figure 7 Process map of yarn dyeing

Data collecting and analysis results

A set of data had been collected from the pilot factory. The important results focused on time, space, sub-process and energy consumption source are featured in Figure 8, 9, 10 and 11.

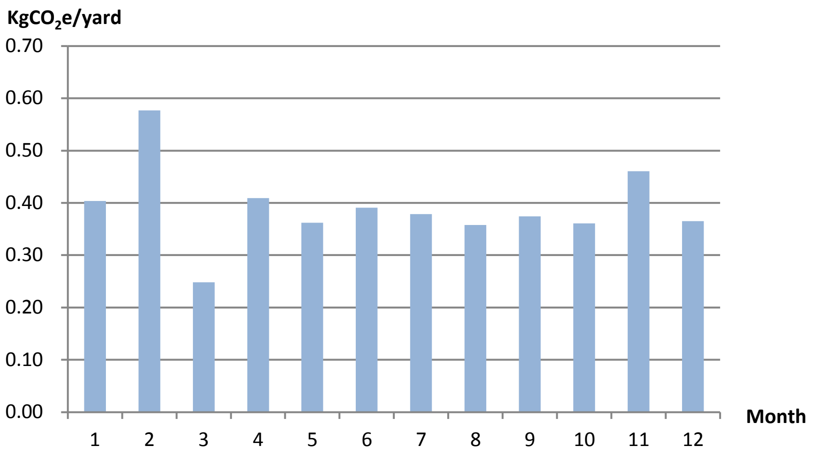

Figure 8 Average GHG emissions per yard per month (2011)

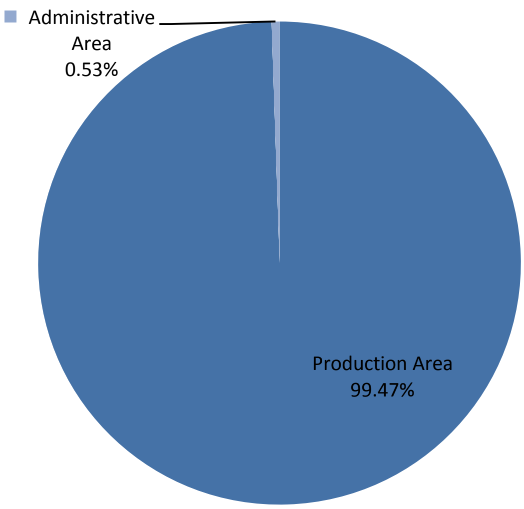

Figure 9 GHG emissions distribution by space (2011)

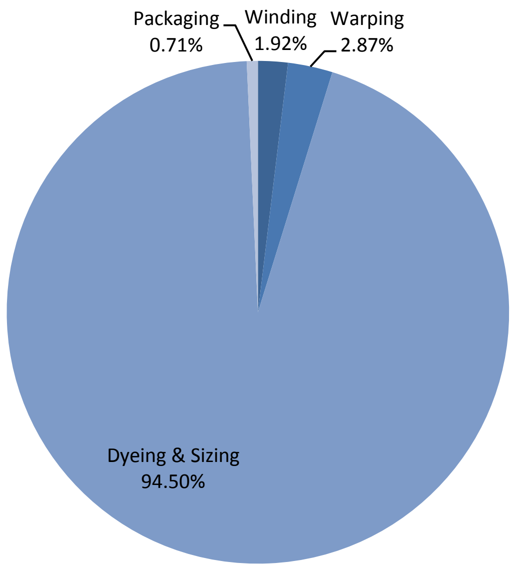

Figure 10 GHG emissions distribution by sub-process (2011)

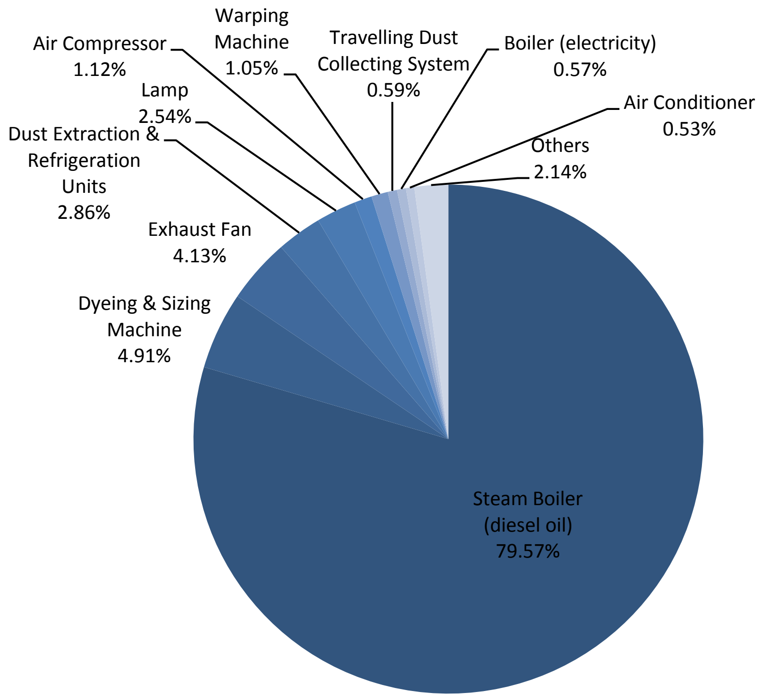

Figure 11 GHG emissions distribution by emission source (2011)

NOTE Others include 11 kinds of emission source, the percentage of each items is less than 0.53%.

Discussion and carbon reduction opportunities

On the basis of results in Figure 8, 9, 10 and 11, further discussions have been made to find out the opportunity for carbon reduction.

1. In Figure 8, the average GHG emission per pound dyed yarn per month fluctuated slightly, which means that this pilot factory was in stable operation in 2011. In February, the factory has the highest GHG emission of the year. In contrast, the collective primary data shows that this month had the lowest total production.

   The order's fluctuation is mainly due to fashion season and sourcing's cycle, and the change of factory's operating rate due to the workers' holiday. These factors will affect the monthly output which has relevance with the average GHG emission per unit product during a same period. It is not a conclusion but it may be supposed that the external environment, such as fashion seasons, holidays and even outer economic environment, would have impacts on the carbon performance of an organization.

2. In Figure 9, it was shown that almost 99% GHG emissions occurred in the production area. The energy efficiency in the factory is very high.

3. In Figure 10, the dyeing and sizing sub-process consumed about 95% of the total energy, and it indicates this sub-process have the most energy consumption. Fully understand the energy source used and the behavior of

the machines in this sub-process could provide important probability to reduce the carbon level.

4. In Figure 11, the diesel steam boiler contributed about 80% GHG emissions of the total. Dyeing machine and sizing machine is the second energy consumer. These results reconfirm the findings from Figure 24 and ascertain the biggest GHG emission source.

NOTE The above results and discussions are based on the data collected from the pilot factory in the reporting year of 2011, which can only indicate the possibility in the given period and location.

Pilot report 3: Fabric Weaving and Finishing

About fabric weaving

This is a process of interlacing two or more yarns at right angles to each other to produce woven fabric. There are three kinds of basic weaves, commonly used for the majority of fabrics, named plain weave, twill weave and satin weave. Other weaves are a variation or a combination of these weaves. Fabric finishing is the final process carried out after coloration and before the materials are made up into garments, which furnish the textiles materials suitable for their end uses (e.g. water repellent) and to meet certain customers' expectation (e.g. shrinkage control).

Pilot factory introduction

The pilot factory undertakes the manufacturing functions of denim fabric weaving and finishing. The yarns come from its sister spinning company Pilot factory 1. This vertical manufacturing group is a very good case to simulate carbon footprint assessment in a real fiber to fabric supply chain of denim.

Process map

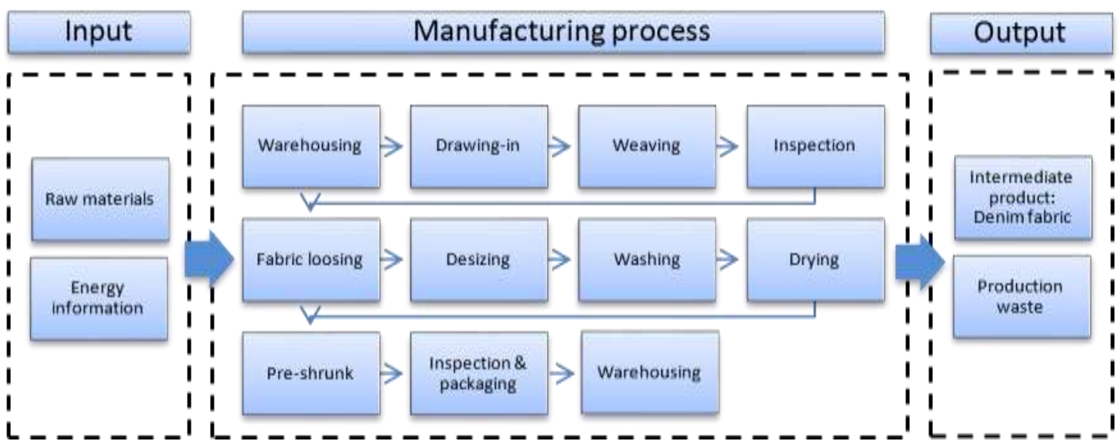

Figure 12 Process map of fabric weaving and finishing—denim fabric

Data collecting and analysis results

A set of data had been collected from the pilot factory. The important results focused on time, space, sub-process and energy consumption source are featured in Figure 13, 14, 15 and 16.

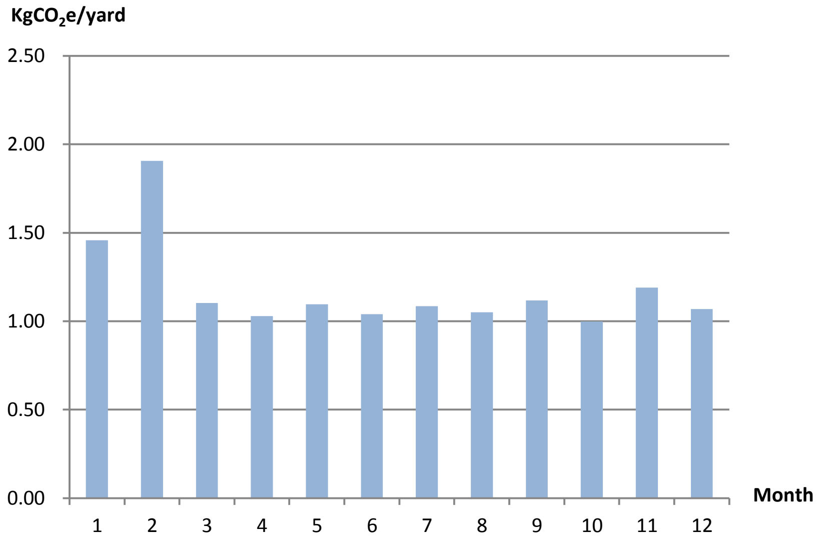

Figure13 Average GHG emissions per yard per month (2011)

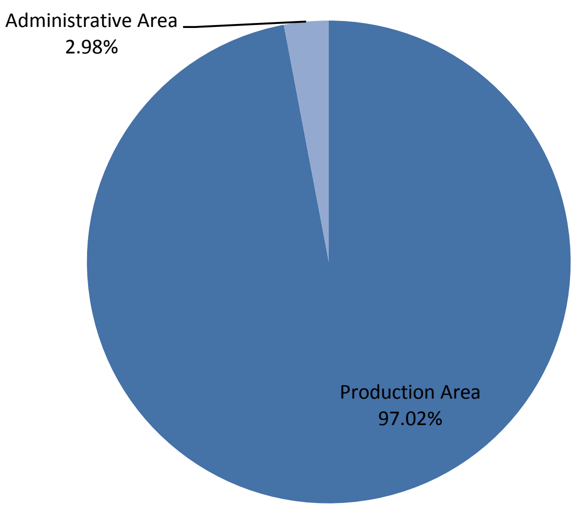

Figure 14 GHG emissions distribution by space (2011)

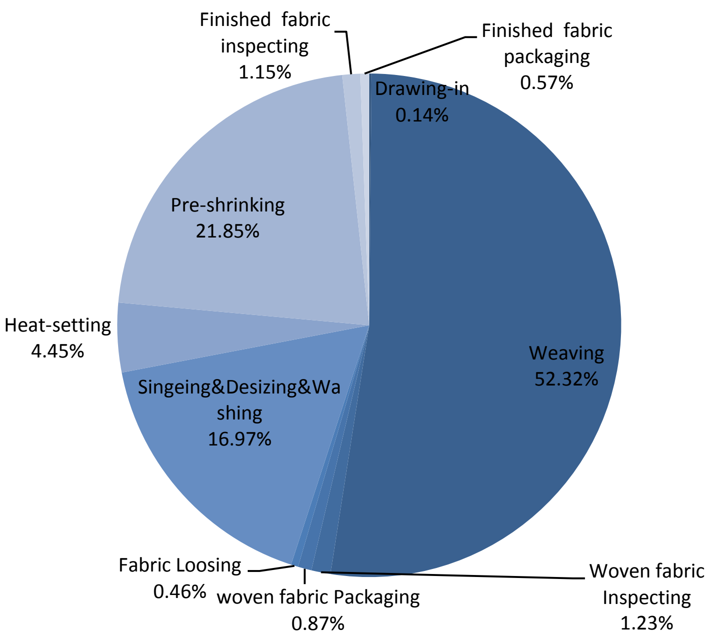

Figure 15 GHG emissions distribution by sub-process (2011)

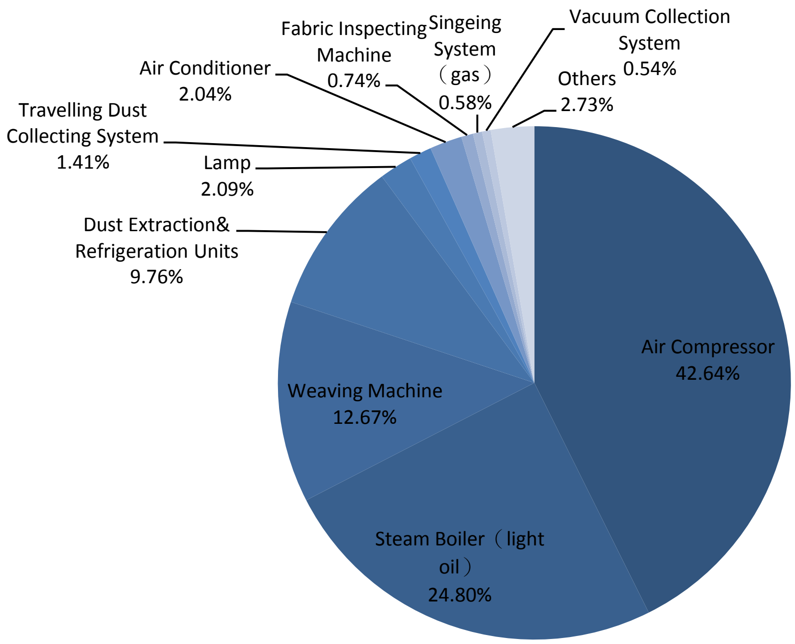

Figure 16 GHG emissions distribution by emission source (2011)

NOTE Others include 19 kinds of emission source, the percentage of each items is less than 0.58%.

Discussion and carbon reduction opportunities

On the basis of results in Figure 13, 14, 15 and 16, further discussions have been made to find out the opportunity for carbon reduction.

1. In Figure 13, average GHG emission per yard per month of denim fabric weaving and finishing progress is almost evenly distributed. The data in January and February is a little bit higher than other months. This period is the traditional holiday. The possible reasons of this fluctuation may refer to the analysis for Figure 8.

2. In Figure 14, it was shown that the factory had very good energy efficiency as most of the GHG emissions were emitted by the production area. The GHG emissions in administrative area has only very small portion.

3. In Figure 15, weaving sub-process offered more than half GHG emissions of the whole production part. Preshrinking, singeing, desizing, washing and heat-setting, which make up the major denim fabric finishing process, contributed about 40% GHG emissions of total. To investigate all the manufacturing machines, including auxiliary production facilities, is an important step to focus the key carbon reduction opportunity.

4. In Figure16, air compressor, steam boiler (light oil) and weaving machine are the top three machines contributed about 80% GHG emissions of the total emissions of the factory. Compressed air is essential motive power in

many processes of textile manufacturing. In weaving process, the air jet loom needs a great deal of compressed air. Owing to the 40% GHG emissions of the whole factory, the air compressor may be defined as an important source for carbon reduction. The steam boiler providing steaming for finishing sub-process, such as desizing, drying and preshrinking, are the second GHG emission source which should be emphasized with about 20% of the total GHG emissions. Weaving machine is another big energy consumer. A combination of the weaving process and the necessary compressed air make the weaving sub-process the biggest GHG emission source.

NOTE The above results and discussions are based on the data collected from the pilot factory in the reporting year of 2011, which can only indicate the possibility in the given period and location.

Pilot report4: Garment Manufacturing

About Garment Manufacturing

Garment manufacturing is the process the garments are made. Cut and Sewn is a simplified description. In brief, it is to cut the fabrics according to the pattern construction and then sew the pieces to a complete garment. Besides, the accessories and trimmings will be assembled to the garments during this manufacturing process. Not all the garments are made by cut and sewn method but the woven fabrics and some knitted fabrics are usually be made to garments by means of this method. Generally speaking, the output from this process is the final product of manufacturing sector, excluding some special effects conveyed on it due to the requirements of functions or design concepts.

Pilot factory introduction

This pilot factory is located in Guangdong province focused on jeans garments manufacturing. This process turns the denim fabrics in bundles to denim jeans in wearable pieces. After sewing, the intermediate product will be sent to washing factory for special washing effects.

Process map

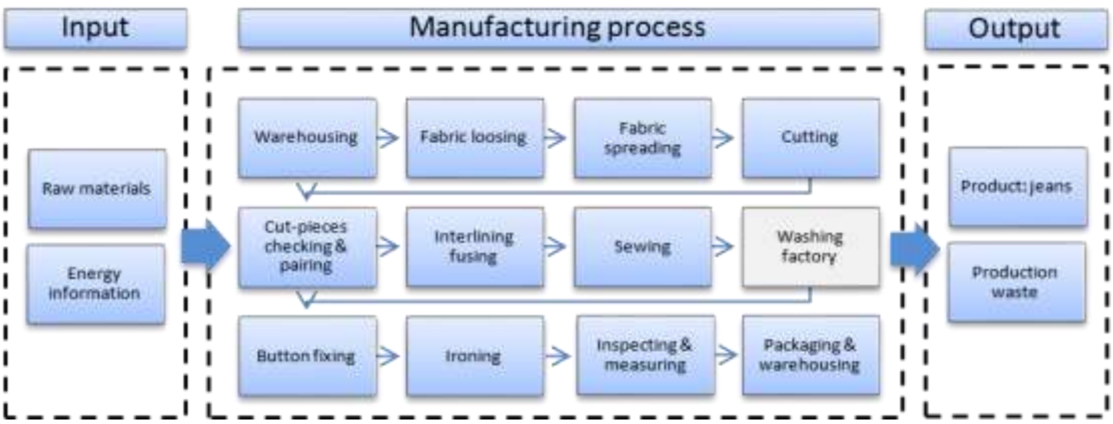

Figure17 Process map of jeans manufacturing

Data collecting and analysis results

A set of data had been collected from the pilot factory. The important results focused on time, space, sub-process and energy consumption source are featured in Figure 18, 19, 20 and 21.

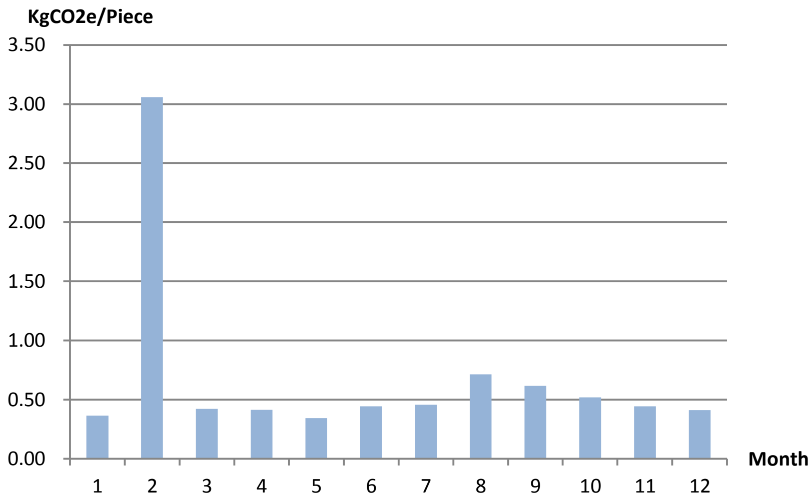

Figure 18 Average GHG emissions per piece per month (2011)

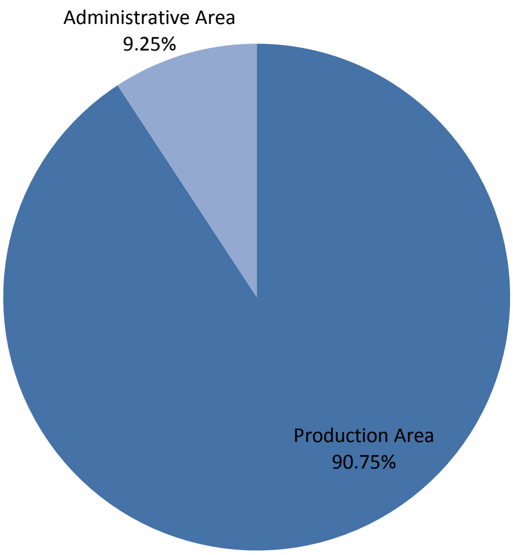

Figure 19 GHG emissions distribution by space (2011)

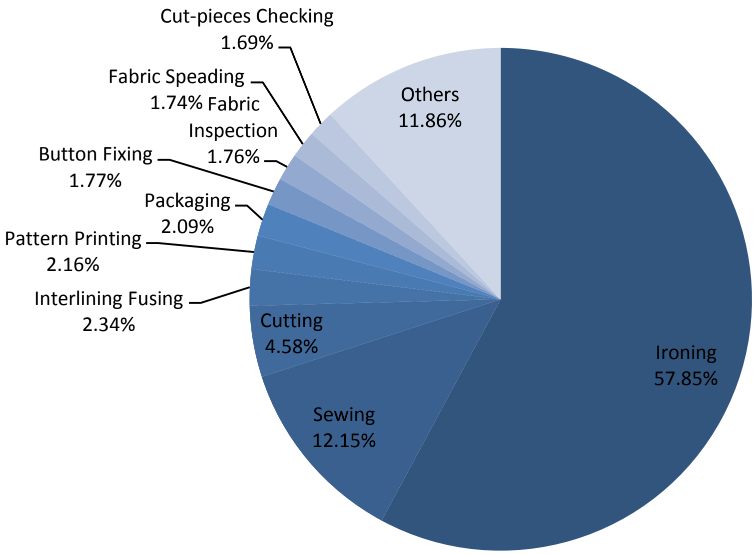

Figure 20 GHG emissions distribution by sub-process (2011)

NOTE Others include 11 processes, and PCF of each process is less than cut-pieces checking process: 1.69%.

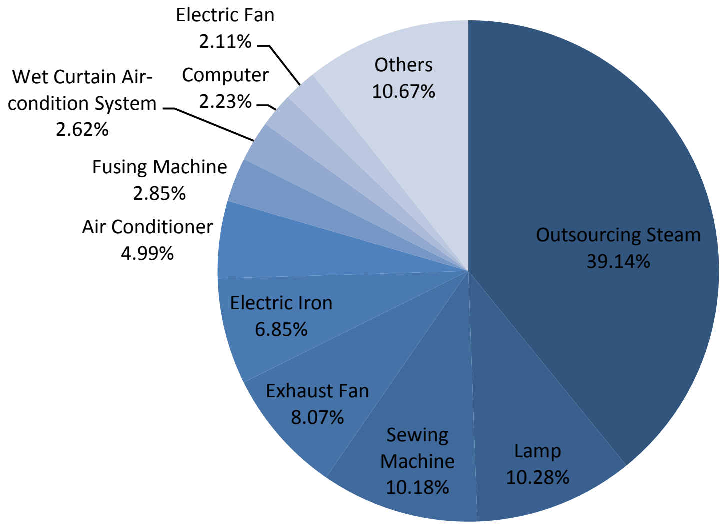

Figure 21 GHG emissions distribution by emission source (2011)

NOTE Others include 28 kinds of emission source, the percentage of each items is less than 2.11%.

Discussion and carbon reduction opportunities

On the basis of results in Figure 18, 19, 20 and 21, further discussions have been made to find out the opportunity for carbon reduction.

1. In Figure 18, the monthly average GHG emission per piece denim jeans are nearly even except the special case in February. The possible reasons of this fluctuation may refer to the analysis for Figure 8. Garment manufacturing is a labor intensive process. If the workers go back hometown for Lunar Chinese New Year, the operating rate of the factory will be greatly declined in February, This month has the lowest output of the year which almost no more than the 10% or the monthly average. This would be the potential reason for this special case.

2. In Figure 19, the ratio of GHG emission from production area to those from administrative area is close to 91 to 9. The energy efficiency in the factory is very high.

3. In Figure 20, ironing, sewing and cutting are the top three energy consuming sub-processes, which totally contributed about 75% GHG emissions of the total GHG emissions. Ironing is a sub-process using immense energy to smooth the fabric wrinkle. Sewing is one the major sub-process which turns the fabrics to garments. Cutting process has a low production and cost a lot of working hours, so it has a big GHG emission.

4. In Figure 21, out sourcing steam, lighting, sewing machine, exhaust fan, electric Iron, air conditioner and fusing machine are the major GHG emission source.

NOTE The above results and discussions are based on the data collected from the pilot factory in the reporting year of 2011, which can only indicate the possibility in the given period and location.

NOTE The steam used in this factory is outsourcing, so we use the ‘outsourcing steam’ instead of the ‘steam boiler’ in figure 21.

Pilot report 5: Jeans Washing

About jeans washing

In order to make the jeans show distinctive visual effects, a unique washing process will be done after the garment or fabric stage, such as standard wash, stone wash, enzyme wash, chemical wash, bleach wash and destroy wash. The jeans washing effect design is an important step of jeans development, which attracts the consumers.

Pilot factory introduction

This pilot factory is a sister company of pilot factory 4 and in close collaboration with each other. This factory has mature and trendy washing techniques. The washed products will be sent back to garment manufacturing factory for final inspection and packaging steps. This is the end of the assessment of jeans carbon footprint in manufacturing sector.

Process map

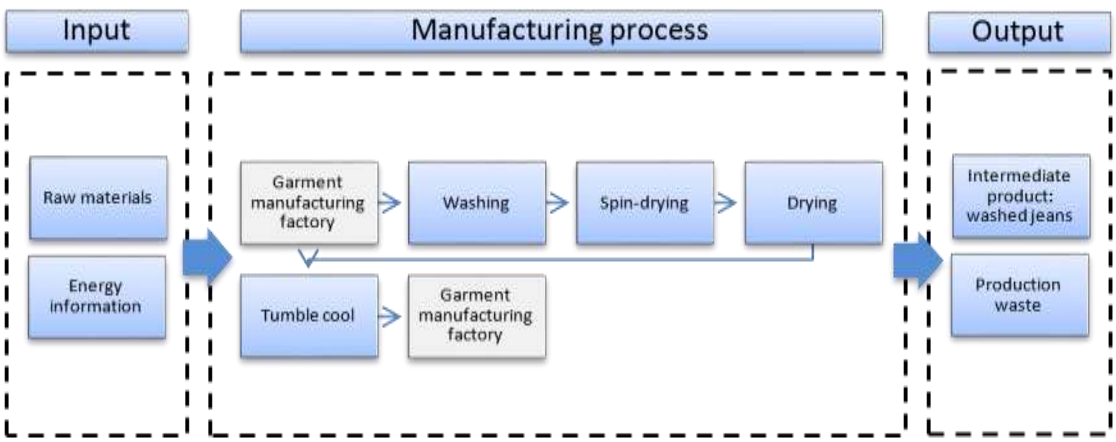

Figure 22 Process map of jeans washing

Data collecting and analysis results

A set of data had been collected from the pilot factory. The important results focused on time, space, sub-process and energy consumption source are featured in Figure 23, 24, 25 and 26.

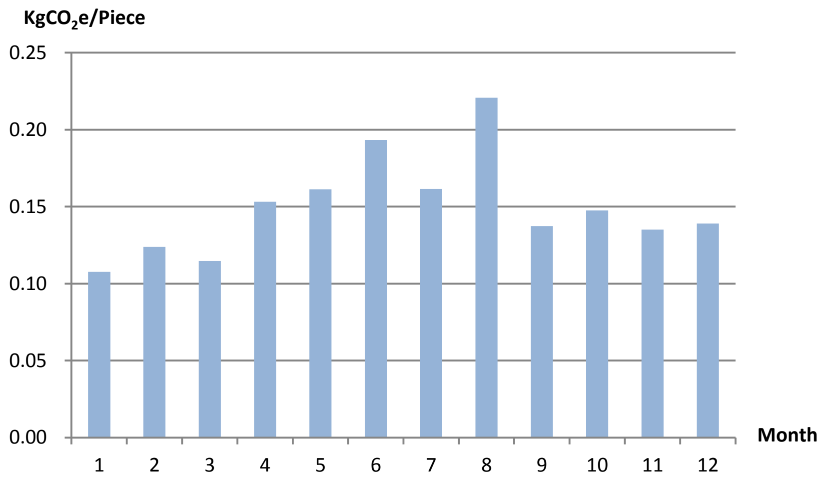

Figure 23 Average GHG emissions per piece per month (2011)

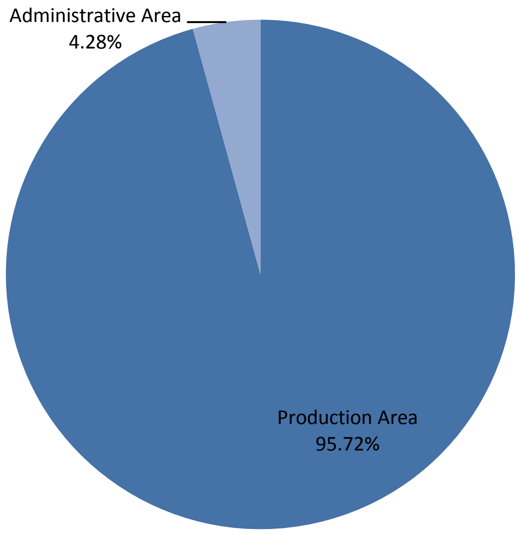

Figure 24 GHG emissions distribution by space (2011)

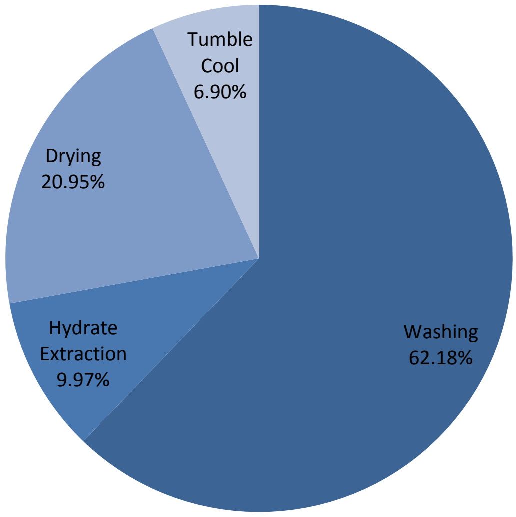

Figure 25 GHG emissions distribution by sub-process (2011)

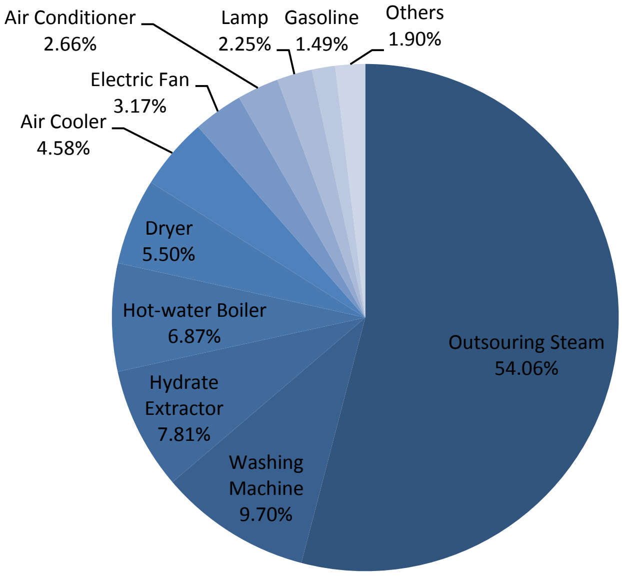

Figure 26 GHG emissions distribution by emission source (2011)

NOTE Others include 13 kinds of emission source, the percentage of each items is less than 1.49%.

Discussion and carbon reduction opportunities

On the basis of results in Figure 23, 24, 25 and 26, further discussions have been made to find out the opportunity for carbon reduction.

1. In Figure 23, the monthly GHG emission per piece per month of denim jeans washing is not fluctuated significantly. According to the collective primary data, the production in this factory is nearly stable. Comparing to garment manufacturing process, the washing process is less labor intensive as this sub-process relies mostly on machines. Even in the traditional holidays, the carbon performance is not obviously decreased.

2. In Figure 24, the ratio of GHG emissions from production area to those from administrative area is close to 96 to 4. The energy efficiency in the factory is very high.

3. In Figure 25, the GHG emissions distribution by sub-process of denim jeans washing are very simple, as only four major sub-processes are involved. The highest one is washing which contributes more than 60% of the total GHG emissions of the factory. The second one is drying. These two sub-processes are majority of the whole GHG emissions with a total share of about 80%, which should be considered as the possibility of carbon reduction opportunities.

4. In Figure 26, out sourcing steam holds the biggest share of the total emissions which are the essential elements for washing sub-processes which providing steaming to enhance the washing effects. The electricity used to run the washing machines contributes about 10% of GHG emissions. These two parts are the major energy consumption source of

washing sub-process, with a share of 60% of the total. This process is the biggest carbon reduction opportunities.

NOTE The above results and discussions are based on the data collected from the pilot factory in the reporting year of 2011, which can only indicate the possibility in the given period and location.