

## **Collaborative Approach for Water & Energy Conservation: Clothing Industry of Bangladesh**

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### **ABSTRACT**

*The Bangladesh economy has largely benefited from the growth of the clothing and textile manufacturing sector, yet it faces considerable challenges in efficiently managing the natural resources required for textile wet processing, particularly water and energy. The complicated and heterogeneous structure of Small-Medium Enterprises (SME) textile processing factories are a barrier to the diffusion of industry-wide standards. This study demonstrates how an innovative and collaborative approach involving many stakeholders between the Responsible Sourcing Initiative (RSI) and Partnership for Cleaner Textile, (PaCT) has been developed to identify and address resource management challenges in the Bangladeshi clothing industry. Stakeholders included in this collaborative initiative are the Bangladeshi government, the World Bank, International Finance Corporation (IFC) and the private sector including global clothing brands and textile manufacturing facilities. The study also highlights the success of the PaCT program in ten different textile processing factories around Dhaka, Bangladesh in reduction of cost, natural resource use, and pollution generation (GHG, wastewater effluent). The initiative is well recognized and highly valued throughout the industry and has shown potential in water and energy conservation in industry processing. If the low-cost resource savings recommendations are implemented in 50 percent of the textile processing units in Bangladesh, the estimated annual savings would be 75 million USD; 63 billion liters of water; 650 million cubic meters of gas and 300 gigawatt-hours of electricity. Additionally, a significant reduction in wastewater and greenhouse gas (GHG) generation would be observed in textile and apparel wet processing facilities.*

*Keywords: Clothing Industry, Water, Energy, Collaboration, Conservation, Investment, Return*

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### **1. Introduction:**

#### **1.1 Clothing Industry of Bangladesh:**

Bangladesh is the second largest clothing exporter in the world, after China, with a market share of 6.4 percent of the \$445 billion global clothing export market (WTO

2017). Of Bangladesh's total export earnings, 82% is from clothing, which contributes to 10% of the country's GDP. The country has approximately 5000 cutting and sewing factories and around 1700 wet processing units (washing, dyeing and finishing: WDF),

which directly employ four million workers. Approximately 80% of these employees are women (BGMEA 2017, ARUP 2015). Additional growth is expected in the industry. The Bangladesh Garment Manufacturers and Exporters Association (BGMEA) recently set a goal of 50 billion USD in exports by 2021 (Leahey 2015). Bangladeshi exports are estimated to grow and reach 82.5 billion USD by 2030.

A study of major sourcing executives showed that Bangladesh is rated as one of the most desired clothing sourcing destination (Kurt Salmon 2015). However, the lack of regulations and the lack for regulation enforcement for this industry throughout the county have resulted in negative environmental impacts. Research shows that the textile industry is not only critical to the economic growth of the country, but it also had an impact on the environmental quality of life in many communities (Shukla 2007).

This situation is not unique to Bangladesh, but it is seen in many developing countries where textile and apparel manufacturing factories are locating. Many industry stakeholders' attention is focused on the natural resources that are the industry's lifeline, water and energy. Inadequate supplies and/or quality of these resources can bring the industry to a standstill. For industry to be sustainable, both in Bangladesh and globally, it is critical for local manufacturing firms, retailers and brand manufacturing in the region, and the government to collaborate in identifying areas of concern and work towards solutions that will be beneficial to the industry and communities.

### ***1.2 Water & Energy Footprint of Clothing Industry of Bangladesh:***

In Bangladesh, clothing manufacturing involves a variety of steps including yarn production, fabric production, wet processing and garment production. The wet processing (washing, dyeing and finishing) factories have the greatest environmental footprint, due to intensive use of freshwater, energy and chemicals needed to wash, dye and finish textiles. According to IFC (International Financial Corporation), the Bangladesh

factory consumes 250-300 liters of water while producing one kilogram of fabric compared to the international benchmark of using 100 liters of water per kilogram (ARUP 2015). Wet processing consumes large amounts of energy to produce steam and hot water and to dry the product. In addition, there is the release of a large quantities of wastewater containing a variety of chemicals, some of which are harmful to humans and the environment. (NRDC 2012).

Raihana (2015) reported that the wet processing industry in Bangladesh used almost 1,500 billion liters of ground water annually. The availability and ease of access to clean water is critical to the industry. In Dhaka, the groundwater level is critically low because of over-extraction of water by the wet processing units in and around the city (Akther, Ahmed, and Rasheed 2010). The ground water level in different locations has dropped 70 meters from the surface and this level is decreasing at the rate of 2.5 m/year (Raihana, 2015). The lower the water level, the higher the water pumping cost will be; this will directly affect the profitability of the processing plant. In the worst case, the wet processing unit may have to remain idle due to the lack of an alternative source of clean water (World Bank 2014). To achieve the projected growth to 82.5 billion USD in exports by 2030, the industry will require 6,750 megaliters of water in a "business as usual" model. This is equivalent to the annual water needs of a population of approximately 60 million people (ARUP 2015).

The wet processing industry is inherently energy intensive. Dyeing and finishing processes require extensive generation of hot water and steam (Kocabas, Yukseler, Dilek, and Yetis 2009). Similarly, washing and denim processing factories also require a significant amount of energy to continually maintain a high temperature of the processing baths. As a result, energy consumption is largely dependent on the quantity of water used. In addition, reduced water consumption results in reduced energy use (Kocabas, Yukseler, Dilek, and Yetis 2009). The wet processing factories in Bangladesh primarily use gas generators and

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depend on a natural gas to produce energy. The demand for electricity in Bangladesh is anticipated to increase to 22,500 megawatts (MW) by 2021, 40 percent of which will be consumed by the industrial sector (Kocabas, Yukseler, Dilek, and Yetis 2009). A recent study shows that textile production facilities are losing up to 30 percent of their production capacity due to power outages (Islam, Khan, and Islam 2013).

There are several studies highlighting the use of simple and less expensive techniques in textile processing to achieve a high level of water and energy conservation. Dulkadiroglu et al. (2002) reinforces the importance of taking simple measures in textile processing plants can result in significant savings (Dulkadiroglu, Eremektar, Dogruel, Uner, Germirli-Babuna, Orhon 2002). Smith (1989) mentioned that appropriate water use, and an effective water recovery system can reduce water usage as much as 10-30 percent in a processing plant (Smith 1989). Another study shows a 20-50 percent reduction in water during continuous dyeing by using simple counter-current washing techniques (Gleick, Wolff, and Cushing 2003). There are several other studies that highlight how water use can be reduced 10-20 percent through the reuse of cooling water, a minor process modification (Fresner 1998; Tanapongpipat, Khamman, Pruksathorn, and Hunsom 2008).

NRDC stated in their Clean by Design report (December 2012) that the Clothing Manufacturing industry can be a large part of the water solution in Bangladesh and can save money in processing (NRDC 2012). Hence it has become essential to take action to measure and benchmark the water and energy use of the local clothing industry in Bangladesh and to suggest potential improvements.

### ***1.3 Limitations of Current Water & Energy Conservation Approach:***

Most of the water and energy conservation methods for the wet processing industry are quite simple and readily available, however they are not easy to implement. There are several factors that

limit water and energy conservation historically. Some of the major factors include the lack of investment capacity of the SME clothing manufacturers, and the lack of large multi-stakeholder collaborations.

Clothing manufacturing is known as one of the oldest and most varied manufacturing industries as it is considered heterogeneous in nature (Kocabas, Yukseler, Dilek, and Yetis 2009). A wide range of fibers (cotton, wool, synthetics, man-made, etc.), and production processes are used in clothing manufacturing supply chain. These processes range from spinning, fabrication, wet processing, to apparel production (garmenting). The industry is typically dominated by SMEs specializing in specific processes (Hasanbeigi 2012). This is one of the reasons why even an effective improvement plan is not relevant for all manufacturers throughout the industry.

There are several studies reported from Turkey, German, Columbia, Taiwan, and India on how to reduce energy consumption in the clothing industry (Hasanbeigi 2012). From these studies, several ways have been identified in which the industry can improve efficiency two of these are 1) improve process, and 2) replace existing machinery with more efficient machinery. Historically, process improvement is preferred over the replacement of machinery. New machinery requires a higher capital and the savings from the new machinery compared to process optimization may not always be justifiable (Hasanbeigi 2012).

Although studies show that, the type of machinery used directly affects the water and energy consumption of a processing plant and that 20-32% of energy waste in a textile processing plant are a result of old energy management systems and machinery (Kocabas, Yukseler, Dilek, and Yetis 2009; Habib, Hasanuzzaman, Hosenuzzaman, Salman, and Mehadi 2016). In process improvement, the monitoring of water and energy consumption over a period of time is required, followed by the identification of the potential scope of improvement. The high level of seasonality of the fashion business and the heterogenous nature of the industry

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result in variation in production programs even within a single day; this variation inhibits standardization of improvement initiatives. In addition, the lack of processing level data makes the process improvement more challenging (Kocabas, Yukseker, Dilek, and Yetis 2009).

Another constraint in efficiency improvement in the clothing industry is its lack of the information on the implementation of different cost-effective and efficiency improvement techniques and opportunities that are readily available. This lack of information reduces the adoption rate throughout the industry. One of the primary reasons for this, is the SME nature of the industry. SME's typically lack the capacity to acquire knowledge when compared to large, international enterprises. That is why it is critical for the SME dominated industry to receive improvement knowledge. The dissemination of information needs to easily accessible throughout the industry and specifically to SMEs (Hasanbeigi 2012). Hence, there is a need to define a practical approach to study this issue and to determine if these cost-effective actions are really viable and possible to scale up.

In developing countries like Bangladesh, there usually exists an acceptable legislative and regulatory environmental management framework. However, institutional inefficiencies limit the enforcement capacity to address growing environmental concerns caused by the industry. The World Bank suggests that, a collaborative engagement with industry is an effective approach to address the situation of inadequate monitoring and weak enforcement. This positive and collaborative approach will support to build a roadmap for sustainable environmental practices (World Bank 2014).

## **2. Collaborative Approach towards Water & Energy Conservation:**

### **2.1 Responsible Sourcing Initiative (RSI):**

Global brands and retailers have been outsourcing apparel and textile products from a variety of developing countries for many years. The overall lower cost of doing business in these countries, including lower labor costs for this labor-intensive industry, have allowed them to remain competitive in a global market (WTO 2017). This has pushed the clothing manufacturing in low-cost country especially in Asia where a lack of environmental regulations and weak enforcement exists. Thus, it requires an effort from the private sector to address the environmental impact of this industry. NRDC (Natural Resources Defense Council) has put forward Responsible Sourcing Initiative (RSI) to leverage the influence of collaborative efforts of the private sector in addressing the environmental impact of wet processing industry (washing, dyeing, and finishing) (World Bank 2014).

The Bangladesh Responsible Sourcing Initiative (RSI) is a collaboration among the World Bank, IFC, Bangladeshi government, civil society and private sector. The Bangladesh RSI targets to test a new, innovative, and collaborative approach in greening the apparel supply chain by reducing the environmental impact of wet processing industry. The initiative was focused on two pillars: 1) identification of a range of cleaner production best practices, which is acceptable for most of the stakeholders, and 2) promoting the multi-stakeholder partnership to work together in identification and implementation of this cleaner production best practice (World Bank 2014).

Bangladesh RSI was one of the first collaborative and scaled initiatives to address water and energy efficiency issues in the Bangladesh clothing industry. A pilot project was completed with four different textiles wet processing factories in Bangladesh and as a result of this seven energy and water saving best practices for Bangladeshi factories were identified (Table 1).

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Bangladesh RSI stated that, together these seven best practices could save 27 percent of water usage and a significant amount of energy usage in a textile wet processing factory (NRDC 2012). These best practices were identified and validated based on initial investment costs, ongoing operational costs, payback period of the investment, and

resource saving with regard to water, materials, and energy (NRDC 2012). None of the seven best practices has greater than a 15-month payback period; two of the practices can be implemented at a low cost; three cost less than 5,000 USD each; and two others can be implemented for less than 5,000 USD (NRDC 2012).

**Table 1: Seven energy and water saving best practices for Bangladeshi Wet Processing factories<sup>1</sup> (NRDC 2012).**

Practice	% Resource Savings		Savings (Tk/ ton fabric)		Cost (Tk/ ton fabric)		Investment Cost (Tk-USD) NRDC's Ten Best Practices		Payback Period (months)	
	Low	High	Low	High	Low	High	Low	High	Low	High
	N/A	N/A	N/A	N/A	N/A	N/A	20,000 each	500000 each	N/A	N/A
<b>Water Saving Practices</b>										
Eliminate water leaks and reduce hose pipe use	0.3	0.7	6.8	31.3	0.7	1.1	3000 (\$36.6)	3000 (\$36.6)	0.4	1.4
Reuse cooling water from dyeing machine	8.2	14.8	392	714	75	204	280000 (3,414.63)	800000 (\$9,756)	2.1	3.3
Reuse process water from rinsing	9	11.9	91	426	134	196	380000 (4,634.15)	1000000 (\$12,195.12)	3.9	25.9
<b>Energy Saving Practices</b>										
Steam management	1.1	5.3	81	349					Immediate	Immediate
Insulate pipes, valves, flanges	0.4		23		22		60000 (\$731.7)		11.2	
Recover heat from drying operations	20	20	527	1769	267	368	1000000 (\$12,195.12)	1500000 (\$18,292.68)	2.5	8.4

## 2.2 Partnership for Cleaner Textile (PaCT):

In 2010, IFC partnered with Solidaridad, (a Dutch organization) and a variety of brands and retailers (i.e. H&M, Kappahl, Lindex, Mothercare, Levi's, WE Fashions, New Look, Bestseller, Primark and Tesco) in the implementation of a technical assistance pilot project. The purpose of this project was to identify and implement potential resource efficiency and cost saving measures related to energy and water usage in Bangladeshi wet processing factories. The partnership became known as Partnership for Cleaner Textile, or more commonly referred to as PaCT. PaCT demonstrated the potential for significant environmental benefits including improvements in water conservation, energy conservation, effluent release, and greenhouse gas (GHG) emission with a good return on investment (ROI) (World Bank 2014).

This paper reviews the water conservation, energy conservation, greenhouse gas (GHG) emission, and effluent water release performance of the 10 factories who participated in the PaCT program. An international consulting firm assigned by IFC conducted the baseline study for each factory and suggested a set of recommendations be implemented to improve the water conservation, energy conservation, (GHG) emission, and effluent water release performance. The set of recommendations are customized for each factory based on the baseline study of that specific factory, specificity of the problem, types of processing, locations and investment capability and willingness of the factory.

IFC identified a local consulting firm then supported and monitored the implementation of the recommendations through monthly visits over a period of six

<sup>1</sup> Values are in Bangladeshi Tk, 1 USD = 82 Tk (NRDC 2012).

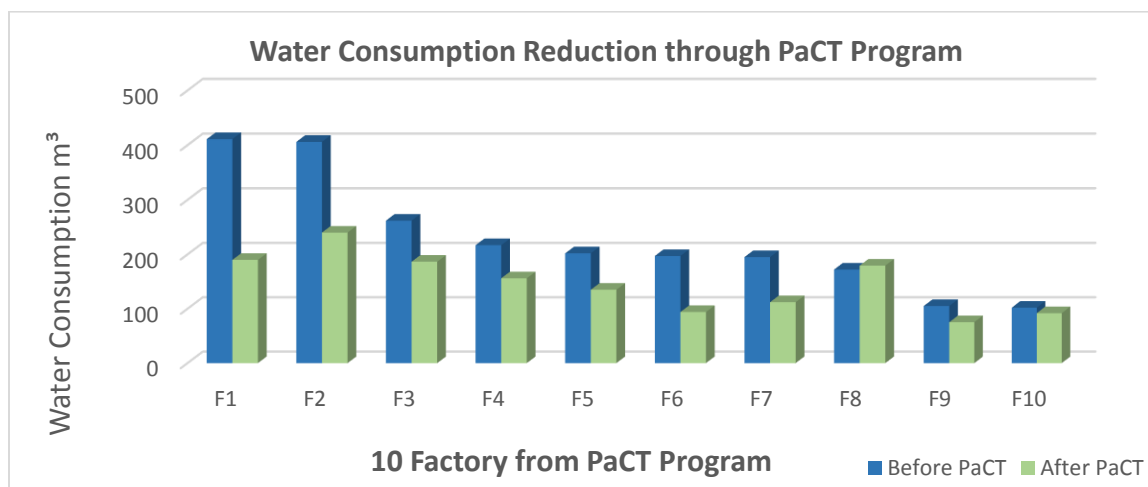
months to one year. The water conservation, energy conservation, GHG emission, effluent water release performance of each factory was measured at the beginning and end of the project and reported. The level of investment by each factory and the level of expected ROI was calculated. The data of these 10 factories can be found in Figures 1-4 with each factory identified as F1-F10. These 10 factories are different with regard to types of processing, size, capacity, technological capability etc. For example, the set of 10 factories include dyeing of knits fabrics, dyeing of woven fabrics, denim processing, washing, and other production processes. The factories were selected from areas of Dhaka, where the water levels and energy situations varied. Thus, there is no communality among the factories except that they are all textile wet processing factories, were in the Dhaka area, and they participated in the similar categories of recommendations. All factories were monitored by the same consulting firm during the PaCT program which took place in these factories over a two-year period from mid- 2013 to mid-2015.

This paper does not intend to show any normality among the observations. The objective is to show that a variety textile wet processing factories and the PaCT program have showed success in reducing overall water and energy consumption with a small investment and/or a good return on these investments.

The reduction in water consumption after the implementation of the recommendations by the consulting firm was observed in nine of the ten factories (Figure 1). Water consumption was reduced from as low as 10% (F10) to a high of 54% (F1). In general, the recommendations include reducing the number of baths in the wet processes, using low liquor ratio dyeing machines, using high fixation dyes in the processes, improving the bulk to bulk processing 'right first time' rate (RFT), increasing condensate recovery, cooling water reuse, and implementing initiatives to improve awareness of water saving. The great improvement seen by factory F1 was achieved through dyeing process engineering and adjustment. The water consumption increased for factory F8 and this is attributed to two new buildings constructed during PaCT monitoring program which resulted in an overall increase in water consumption.

The wastewater generation of a wet processing factory is directly linked to the overall water consumption. Understanding this relationship is key to explaining the reduction in wastewater generation by all factories (F1-F10) after the implementation of the PaCT recommendations (Figure 2). Factory F1 achieved the greatest reduction of wastewater generation (approximately 59%) whereas factory F8 achieved the least reduction (approximately 7%).

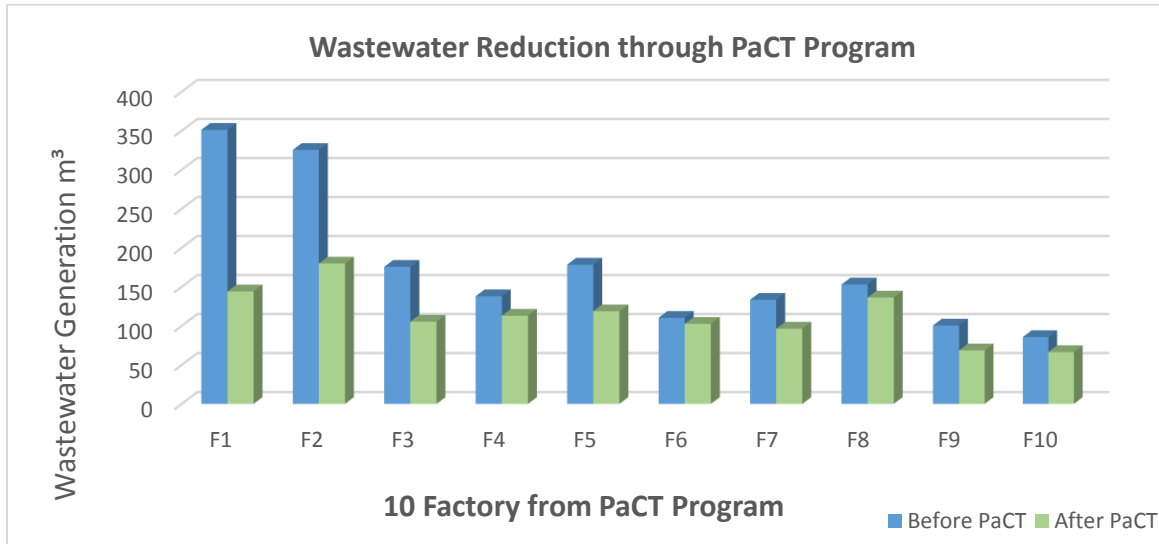
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**Figure 1: Water Consumption Reduction through PaCT Program**

The increased water consumption of factory F8 did not contribute to wastewater generation since the increased water

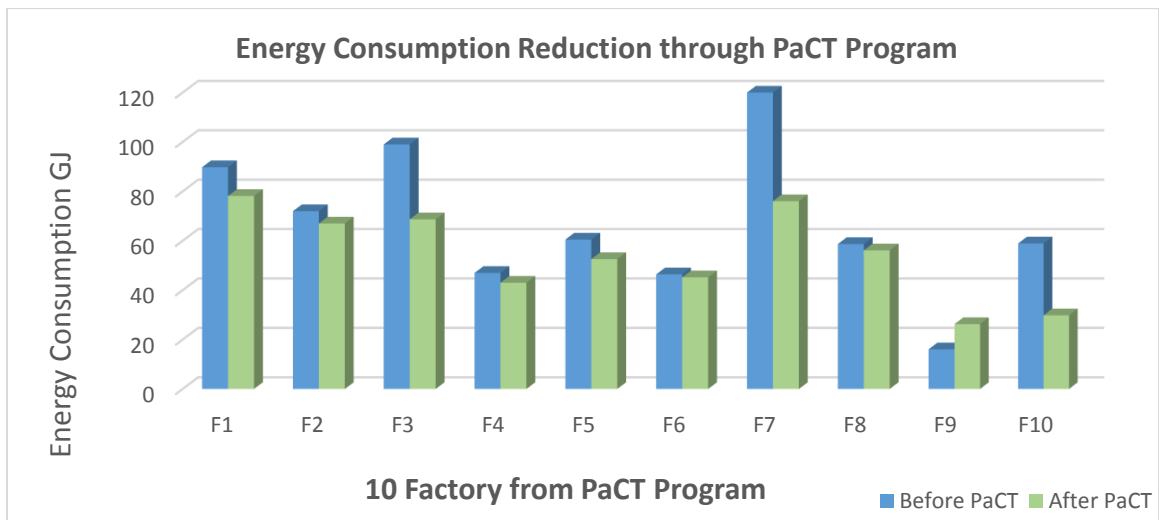
consumption was a result of new building construction rather than textile wet processing.



**Figure 2: Wastewater Reduction through PaCT Program**

Several recommendations to improve energy efficiency were suggested and implemented in the 10 factories. These included the installation of energy meters with increased monitoring, condensate recovery systems, overhauling of gas generators, and installation of low liquor ratio dyeing machines. These changes resulted in a decrease in energy consumption in nine (F1-F8 and F10) of the 10 factories (Figure 3). For

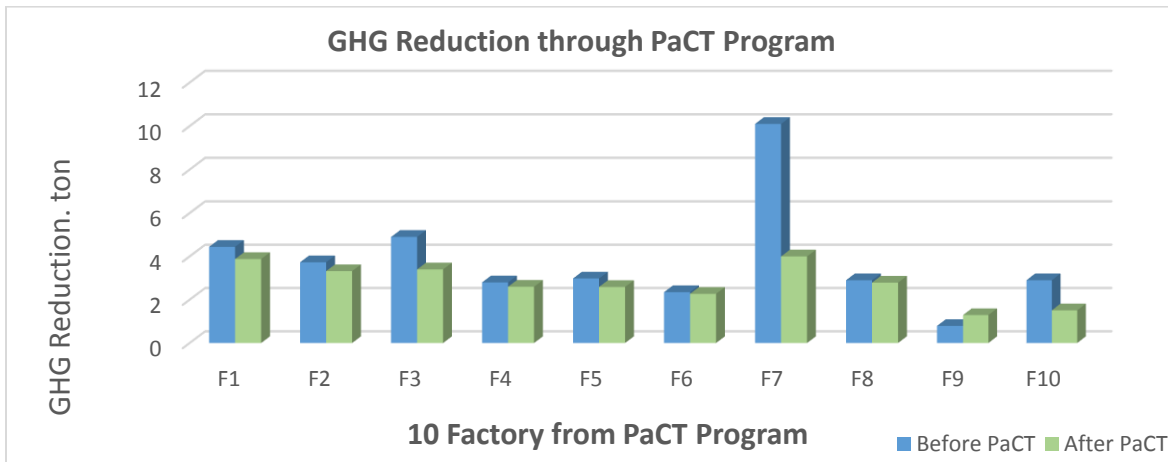
factory F9, the total energy consumption of the factory increased, and this is attributed to the installation of a new wastewater treatment plant during the PaCT monitoring program. For factory F7, an increased steam condensate returns (3.5% to approximately 80%) and an automatic hot water collection resulted in greatly reducing energy consumption.



**Figure 3: Energy Consumption Reduction through PaCT Program**

There is also an inherent relationship between energy consumption and the GHG; as energy consumption increases so does GHG emissions. This was seen here as the reduced energy consumption contributed to reduced generation of GHG emissions for the factories in the study (Figure 4). Note that Factory F7 achieved the greatest reduction of

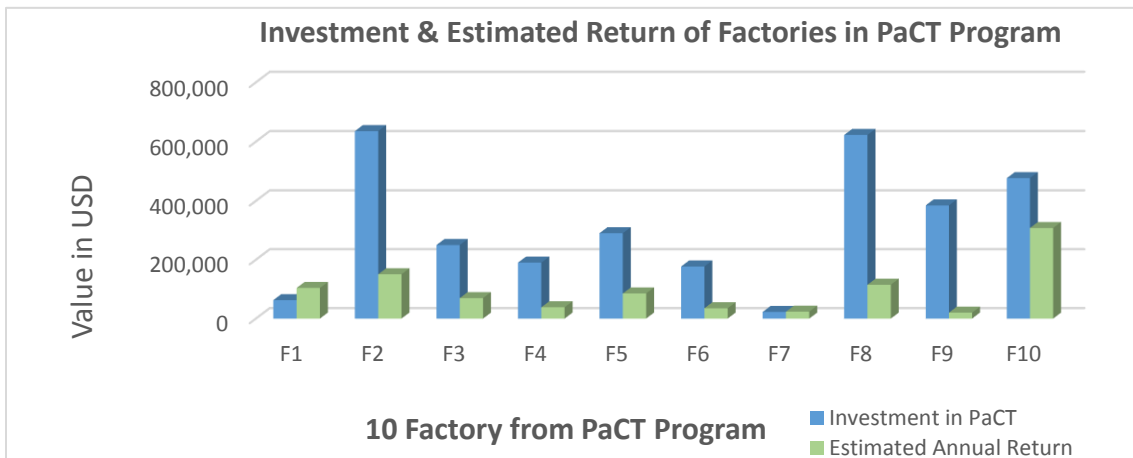
GHG generation (approximately 60%) because of their increased steam condensate returns and automatic hot water collection system. On the other hand, factory F9 observed an increase in GHG generation as a new ETP was installed during the PaCT program which increased energy consumption.



**Figure 4: GHG Reduction through PaCT Program**

All ten factories (F1-F10) made investments to implement the consulting firm's recommendations (Figure 5). Most of the investments were in new water and energy efficient equipment, training of operators in water and energy conservation measures, installing water, energy, gas, and steam metering systems; wastewater treatment plant installation, expansion and

modification; and laboratory equipment was installed to improve the right first time (RFT) processing rate. The payback period was calculated to be between six months and five years for most of the factories. Factory F1 and F7 had the quickest return on their investment through various processing adjustments and re-engineering.



**Fig 5: Total Investment & Expected Return of Factories in PaCT Program**



These practices do not require any investment but did result a noticeable return. Results also show that Factories F2, F8, and F9 had the slowest return on investment as they made large investments in specific equipment including an energy efficient boiler and gas generator in F2, energy efficient dyeing and finishing machines in F8, and a new wastewater treatment plant in F9.

In 2014, PaCT and World Bank have estimated that if 50 percent of the factories in the wet processing industry adopted similar measures, the savings would include 75 million USD; 63 billion liters of water; 650 million cubic meters of gas and 300 gigawatt-hours of electricity per year (World Bank 2014). Addressing this significant potential, IFC has scaled up this technical assistance in an additional 200 wet processing factories to ensure the continued competitiveness of this sector through reduction of the environmental footprint (World Bank 2014). Raihana has reported (2015) that PaCT has succeeded to save 7.8 million liters of fresh water, 64000 tons of GHG avoided, 19 million USD investment facilitated, and 1.3 years average paybacks period is achieved (Raihana 2015).

### 3. Conclusion:

The IFC's Bangladesh Partnership for Cleaner Textiles (PaCT) and the World Bank Bangladesh Responsible Sourcing Initiative (RSI) is being recognized as key initiatives for water and energy conservation in the clothing industry of Bangladesh. The implementation of simple actions with low investment resulted in the approach gaining popularity industrywide. The recommendations and initiatives are valued by the local manufacturing firms. They are expected to play a vital role in the reduction of water and energy use by the industry. If the industry lose access to adequate clean water and energy it might directly impact the livelihood of 4 million workers (PaCT 2017). The success of PaCT program in Bangladesh has been reported through international media and it is has been proposed that the RSI and PaCT collaboration has the potential to

make a difference to textile industries in other countries given the replicability of the model (YEE, 2013). Recently VF Corporation and Target have collaborated to implement similar water and energy conservation efforts in Vietnam (McGregor 2016). Solidaridad is capitalizing the experience of the PaCT program in developing Ethiopian clothing industry through collaboration with H&M (Solidaridad 2014). The PaCT program demonstrates that collaboration among brands, retailers, manufacturers throughout the supply chain, NGO's, and government agencies is a way forward in successfully identifying and addressing critical industrywide issues. This approach will lead to manufacturers throughout the textile, apparel and fashion supply chain, throughout the world, having access to information on best practices, innovative technology and processes, and implementation strategies in reducing the use and protection of scarce natural resources. The application of this information will result in a more sustainable industry financially and environmentally.

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