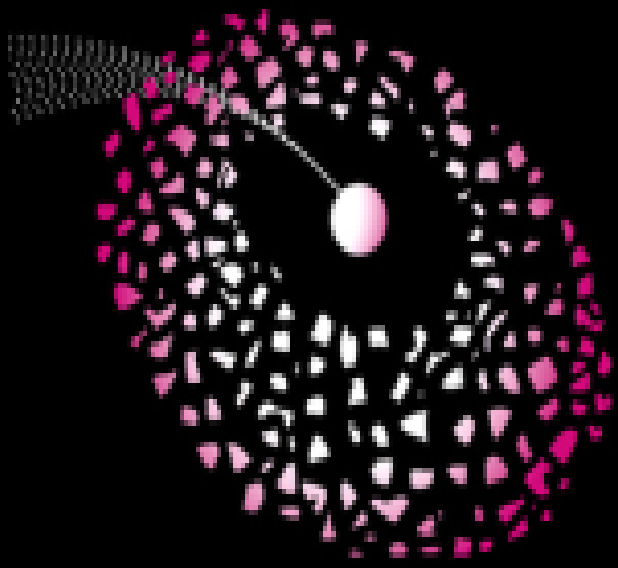
*August 2016*

# *Promoting Cleaner Production and Energy Efficiency in the Industry of Pakistan: A Case Study of Textile Manufacturing Sector*




***Author:***
***Owais Ur Rehman Khan***

***Supervisor:***
***Prof. Dr. Joy Clancy***


UNIVERSITY OF TWENTE.

# Promoting Cleaner Production and Energy Efficiency in the Industry of Pakistan:
## *A Case Study of Textile Manufacturing Sector*

[*In partial fulfillment of the requirements for the Degree of Master of Environmental and Energy Management*]

August 2016


Submitted By:
**OWAIS UR REHMAN KHAN**
ID: s1698788

Supervised By:
**PROF. DR. JOY CLANCY**
**JOOP NEINDERS**



Academic Year 2015 / 2016
Master of Environmental and Energy Management (MEEM)
Department of Governance and Technology for Sustainability (CSTM)
Faculty of Behavioural, Management and Social Sciences (BMS)
**UNIVERSITY OF TWENTE**

# ABSTRACT

Industrial production has been putting such a strain on natural resources of the earth that it would no longer be able to sustain future generations. The human life has been already living beyond its means as the two-third resources of the earth have already been used up. However, the world would need 45% more energy and 30% more water by 2030 due to the population growth. Also, Pakistan being the sixth most populated and as a developing country must have to address the challenges of resources constraints, energy crisis, and climate change. The industrial sector being the largest energy consumer i.e. 37.6% of the total energy consumption is also linked to the climate change in Pakistan.

The background of this research is an inefficient use of energy by the industrial sector particularly the textile sector of Pakistan and its environmental impacts. This research aims to promote cleaner production and energy efficiency in the industrial sector particularly in the textile sector of Pakistan. Cleaner production aims to increase production efficiency as well as minimizing wastes and emissions. However, cleaner production requires resources and energy efficiency vice versa. The concept of cleaner production is very important especially for developing countries where some resources are scarce and the environmental degradation is continuously increasing. This research followed three research strategies: (i) review of relevant policies and initiatives of Pakistan, (ii) review of relevant policies and initiatives of regional countries (China, India, and Bangladesh), and (iii) case study of the textile sector of Pakistan.

Pakistan has formulated environmental policy, energy policy, industrial policy, and textiles policy long ago. Pakistan also has established a National Cleaner Production Centre (NCPC), National Energy Conservation Centre (ENERCON), and the Cleaner Production Institute (CPI) that introduced various initiatives to promote cleaner production and energy efficiency. However, the majority of textile factories merely have been following environmental compliance due to the weak enforcement system. In contrast, factories or enterprises in China have already following cleaner production and energy efficiency due to the mandatory Cleaner Production Audits and strict penalties for violation of Cleaner Production Promotion Law. Similarly, India has been progressing in promoting cleaner production and energy efficiency. China and India have formulated various policies and strategies with specific targets to be achieved by applying mix policy instruments. They have strengthened cooperation with international organizations for financing, capacity building, and technology transfer. Bangladesh is also making efforts for promoting cleaner production and energy efficiency in its industrial sector.

The case study collected data using questionnaires and semi-structured interviews. The results shows that the major barriers to cleaner production and energy efficiency in the textile sector of Pakistan includes lack of budget, limited access to capital, lack of grants, higher production priority, weak environmental regulations, lack of cleaner production expertise or technical staff, absence of incentives for cleaner production, and low priority to energy management. The recommendations for promoting cleaner production and energy efficiency in the textile sector of Pakistan includes raising awareness, building capacity, strengthening regulatory framework and institutional structure, facilitating finance, establishing collaboration and networking among stakeholders.



**Keywords**: Barriers, Cleaner Production (CP), Energy Efficiency, Pakistan, Policies and Initiatives, Recommendations, Textile Industry

# ACKNOWLEDGEMENT

First of all, thanks to Almighty Allah for His countless blessings that enabled me to complete this research successfully. Subsequently, my sincere gratitude and thanks to my supervisor Prof. Dr. Joy Clancy for her immense guidance, knowledge, motivation, patience, and never-ending support. Her mentorship skills accorded to me in executing my research is priceless and will forever be cherished. In parallel view my profound gratitude to my co-supervisor Mr. Joop Neinders for his valuable counsels and insightful remarks. It has been a great learning experience for me working with both of you and I will hold this experience in high esteem forever.

Besides, I want to appreciate the committee of Master of Environmental and Energy Management (MEEM) program for the opportunity bestowed upon me to pursue my master's degree which led to the undertaken and completion of this research. Specifically, many thanks to the Prof. Dr. Hans Bressers and the program coordinators Mrs. Hilde Van Meerendonk-Obinna and Ms. Rinske Koster for their immense assistance and indefatigable qualities in all ramifications since inception. Similarly, special thanks to MEEM lecturers who have imparted various skills in me those were vastly beneficial towards my research's success. Moreover, I highly appreciate and acknowledge the University of Twente for funding my studies through UTS scholarship. This will always be cherished as a major stepping stone that enabled me to further my career.

Furthermore, I want to acknowledge all of those that devoted time to my questionnaire, shared their observations, knowledge, and experiences. I am also grateful to my MEEM colleagues who were encouraging and supportive all through both in academic learning and their true hearts of friendship. Finally, I want to express my very profound gratitude to my wife, my parents, my family members, and my friends for providing me unfailing support and continuous encouragement throughout my stay in the Netherlands and during this research.

I wish a very happy, healthy, and long successful life to everyone mentioned above.

Owais Ur Rehman Khan

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES



# LIST OF APPENDIXES

# LIST OF ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| ADB | : | Asian Development Bank |
| APTMA | : | All Pakistan Textile Mills Association |
| BEE | : | Bureau of Energy Efficiency (India) |
| CDM | : | Clean Development Mechanism |
| CETP | : | Common Effluent Treatment Plant |
| CHWTSFs | : | Common Hazardous Waste Treatment and Storage Facilities |
| CP | : | Cleaner Production |
| CPI | : | Cleaner Production Institute (Pakistan) |
| EE | : | Energy Efficiency |
| EJ | : | Exajoule ($10^{18}$ joules) |
| EKN | : | Embassy of Kingdom of the Netherlands (in Pakistan) |
| EMS | : | Environmental Management System |
| ENERCON | : | National Energy Conservation Centre (Pakistan) |
| EnMS | : | Energy Management System |
| EPAs | : | Environmental Protection Agencies (Pakistan) |
| GDP | : | Gross Domestic Product |
| GHG | : | Greenhouse Gas |
| GWh | : | Gigawatt Hours ($10^6$ kWh) |
| IEA | : | International Energy Agency |
| ktoe | : | Kilo Tonnes of Oil Equivalent |
| MEP | : | Ministry of Environmental Protection (China) |
| Mtoe | : | Million Tonnes of Oil Equivalent (Mega Tonnes of Oil Equivalent) |
| MW | : | Megawatt ($10^6$ Watt) |
| NCPC | : | National Cleaner Production Center |
| NDRC | : | National Development and Reform Commission (China) |
| NEQS | : | National Environmental Quality Standards (Pakistan) |
| NPCSC | : | Standing Committee of the National People's Congress (China) |
| Pak-EPA | : | Pakistan Environmental Protection Agency |
| SAARC | : | South Asian Association for Regional Cooperation |
| SEPA | : | State Environmental Protection Administration (China) |
| SMEDA | : | Small and Medium Enterprises Development Authority (Pakistan) |
| SMEs | : | Small and Medium-Sized Enterprises |
| SPRU | : | Science Policy Research Unit (University of Sussex, UK) |
| sq. km | : | Square Kilometre |
| sq. mi | : | Square Mile |
| SREDA | : | Sustainable and Renewable Energy Development Authority (Bangladesh) |
| tCO2eq | : | Tonnes of Carbon Dioxide Equivalent |
| toe | : | Tonne of Oil Equivalent |
| UNDP | : | United Nations Development Programme |
| UNEP | : | United Nations Environment Programme |
| UNIDO | : | United Nations Industrial Development Organization |

# CHAPTER ONE: INTRODUCTION

This chapter introduces the research context and highlights the challenges faced by the textile industry of Pakistan. It also defines key concepts and states the primary objectives of this research. In last, it provides the justification and significance of this research.

## 1.1. Background

Manufacturing industries are vital for the existence of the modern world, as they provide the commodities for life and support the economy. Manufacturing industries have become the core of a growing US$ 77.9 trillion global economy (World Bank, 2016). Furthermore, it is evident that industrial development is a key element to reducing poverty. For example, manufacturing industries and their related services sectors can absorb a large number of workers, provide them stable jobs and benefits, and increase the prosperity of their families and communities. UNIDO (2014a) reported that manufacturing industries provide almost 500 million jobs worldwide, whereas 22.3% out of 3.39 billion world labor force is associated with the industrial sector (CIA, 2016). The above figure illustrates that the economic growth is also somehow linked to the industrial growth.

Many countries have been competing for the higher industrial productivity in order to gain economic power. In 2008, industrial sector globally used approximately 98 EJ of energy. However, IEA (2010) projections predict industrial energy use to increase by 44% between 2006 and 2030. Moreover, industries account for about 78% of the global annual coal consumption, 41% of the global electricity use, 35% of the global natural gas consumption, and 9% of the global oil consumption (IEA, 2007). Hence, it has become a major challenge to boost economic or industrial growth with limited natural resources of the earth. Furthermore, the increasing energy demand has been producing unwanted effects such as higher energy prices, increasing air pollution and higher greenhouse gas (GHG) emissions linked to the climate change (UNEP, 2007). In other words, the growing industrial activities have been greatly influencing on GHG emissions since fossil fuels are still the dominant source of energy in industries. Manufacturing industries utilize energy and resources of one kind or another to produce any product. However, in the production process, some resources remain unspent, or unwanted products are produced as waste because 100% conversion or transfer of resources is rarely possible. Hence, this waste causes pollution when discharged to the environment (UNEP, 2004).

There are various pros and cons of the global industrialization. However, one of them, notably the global climate change has become one of the major challenges of the 21st century. Steinfeld (2001) reported that the average surface temperature of the earth has risen by approximately 0.7 $^{0}$C in the last 100 years. There is a strong scientific evidence that the global warming occurred due to the greenhouse effect intensification i.e. atmospheric concentration of greenhouse gases (GHGs) namely as carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs) and sulfur hexafluoride ($SF_6$). Furthermore, EPA (2014) estimated that the industrial sector globally accounts for 21% of total GHG emissions, excluding electricity and heat production which accounts for 25% (largest single source) of GHG emissions. In order to protect both environmental values and economic growth, it has become necessary to deploy less carbon-intensive energy sources and to increase energy efficiency. However, to achieve these goals, the industrial sector has a key role due to its size and importance.

Historically, the industrial sector responded to the pollution in four ways. Firstly, by ignoring the problem, this always causes maximum damage to the environment. Secondly, by diluting or dispersing pollution so that its effects are apparent or less harmful. Thirdly, pollution treated by the end-of-pipe approach. Fourthly and most recently, industrial sector adopted an approach of prevention of pollution and waste generation at the source itself which is referred to as cleaner production (CP) (UNEP, 2004). The adoption of CP ensures the conservation of raw materials and energy. It also ensures the reduction or elimination of toxic materials. Moreover, it helps to reduce the quantity of wastes and toxicity of emissions during the production process. However, CP requires resource (energy and materials) efficiency and vice versa. In conclusion, CP is a vital solution to prevent pollution and reduce GHG emissions from the industrial production. It is an approach to sustainable manufacturing and one of the key climate change abatement strategies that offer tangible benefits to both industries and the environment.

The United Nations (2015) reported the projection of the world population growth from 7.3 billion today to 8.5 billion by 2030 and 9.7 billion by 2050. Hence, under a business as usual scenario, the demand for energy must increase substantially over that period. In other words, the population growth might strongly influence the energy demand globally and substantially affect developing countries like Pakistan. For instance, United Nations (2015) also predicted the population growth of Pakistan from 188.9 million (ranked sixth) today to 244.9 million by 2030 and 309.6 million by 2050. However, 56 million people of Pakistan are already living without electricity, whereas the industrial sector consumes 37.6% (biggest consumer) of energy supplies in Pakistan (Christian Aid, 2014). Pakistan has been facing a severe energy crisis, frequent load shedding or power outages imposing a large cost on the economy. Hence, formulating the appropriate policies and adoption of CP and energy efficiency in the industrial sector has become essential for Pakistan. Moreover, adoption of CP and energy efficiency would serve the climate agenda by reducing energy intensity and GHG emissions. However, there is no specific legislation on GHG reduction or cleaner production in Pakistan (Jeswani et al, 2008). Moreover, the growth of Clean Development Mechanism (CDM) in the industrial sector has not been promising i.e. until now only 9 CDM projects registered in Pakistan (SCI-Pak, 2010). Therefore, it is essential to identify the factors affecting the implementation of CP practices and energy efficiency measures in the industrial sector of Pakistan.

### 1.2. Problem Statement

Industrial production has been putting such a strain on natural resources of the earth that it would no longer be able to sustain future generations. In other words, certain resources on the earth are in limited supply and have been depleted quickly such as oil which is being extracted from the earth faster than it can be replenished by the earth. Moreover, Radford (2005) reported that 1360 scientists from 95 countries endorsed that two-thirds resources of the earth have already been used up. Hence, the human life has been already living beyond its means. However, globally there would be an inevitable increase in the demand for natural resources with population growth from 7.3 billion today to 9.7 billion by 2050. For instance, United Nations predicted that the world would need 45% more energy and 30% more water by 2030. Also, the water demand in the manufacturing industries would increase by 400% from 2000 to 2050, wherein the majority of this increase would occur in emerging economies and developing countries (UNESCO, 2015). In such a situation of worldwide resources constraints, manufacturing industries specifically in the developing countries like Pakistan has to address these issues to sustain its economic growth.

Pakistan is the second largest economy in South Asia with GDP US$ 270 billion (World Bank, 2016). The industrial sector is the second largest contributor to the economic growth of Pakistan, wherein, the manufacturing industries contribute about 25% to the GDP of Pakistan (UNIDO, 2014b). Pakistan has been planning to gain economic power through industrial development thus set a target of 8-10% annual industrial growth rate until 2030 (PISD, 2013a). However, industrial growth depends on the uninterrupted supply of power and energy. In contrast, Pakistan has been facing an energy crisis[1], frequent load shedding[2] or power blackouts strongly influencing the domestic sector as well as the industrial sector. Furthermore, IEP (2013) reported that the recoverable reserves[3] of the crude oil and natural gas in Pakistan have a reserves-to-production ratio[4] of 11 years and 18 years respectively. If more energy reserves are not found and the rate of energy consumption is not controlled then Pakistan would be facing much more severe energy crisis than today.

The total energy consumption of Pakistan is 40.0 Mtoe (HDIP, 2013). However, the energy demand would increase substantially with the population growth of Pakistan from 188.9 million today to 244.9 million by 2030 and 309.6 million by 2050. On the other hand, the industrial sector has been the largest energy consumer and accounts to 37.6% of the total energy consumption of Pakistan (HDIP, 2013). Moreover, the energy sector (including industries) accounts for 51% of total GHG emissions in Pakistan i.e. it is the largest contributor to the GHG emissions linked to the climate change in Pakistan (MOCC, 2013). Pakistan is not only an energy deficient country but it is also facing serious threats caused by the global warming. Recently, a heat wave killed more than 1300 people in Karachi shows that the climate change has been taking its toll in Pakistan (Maheshwari, 2015). In conclusion, Pakistan has been facing resources constraint situation and needs to adopt resource efficiency.

The textile sector of Pakistan consists of more than 670 factories. It contributes to 58% of the total exports, accounts for 46% of the total manufacturing, and provides employment to 40% of the total labor force in Pakistan (MINTEX, 2013). However, the textile sector accounts for 17% share in the total industrial energy consumption of Pakistan and utilize 16% electricity and 82% natural gas as its main sources of energy. The textile sector of Pakistan has been facing significant competitiveness challenges due to escalating power outages and rising energy costs. Moreover, the textile sector also needs to comply with environmental standards to sustain its business in international markets. Hence, it is essential for the textile sector to adopt CP. The concepts of CP and energy efficiency have been already introduced in Pakistan through several initiatives but yet the adoption of CP and energy efficiency in the factories remained very slow. Therefore, the factors that affect the implementation of CP practices and energy efficiency measures in the textile sector of Pakistan need to be identified so that appropriate measures to overcome the negative factors and promote the positive can be introduced.

[1] The average shortfall in the power sector is 4,000 MW and nearly 2 billion cubic feet per day in the natural gas sector. Retrieved 12 August 2016, from http://www.dawn.com/news/1275116

[2] Rotational load shedding also referred to as power blackout. It is an intentionally engineered electrical power shutdown where electricity delivery is stopped for non-overlapping periods of time over different parts of the distribution region. It is a normal daily event in developing countries where electricity generation capacity is underfunded or infrastructure is poorly managed.

[3] A term used to describe the amount of resources identified in a reserve that is technologically or economically feasible to extract. A new reserve can be discovered, but if the resource cannot be extracted by any known technological methods, then it would not be considered as recoverable or proved reserves.

[4] A ratio indicating the remaining lifespan of a natural resource. This ratio is expressed in terms of years, and is used in forecasting the future availability of a resource.

### 1.3. Definition of Key Concepts

The key concepts help to delineate a research project. The following key concepts are defined specifically in the context of this research. These concepts are discussed in details in chapter two.

- **Cleaner Production (CP)**: Company-specific environmental protection initiative to minimize emissions, prevent waste and maximize product output.

- **Energy Efficiency**:

  It is the ratio of the useful work performed by a machine or in a process to the total energy input. The goal of energy efficiency is to use less energy to produce the same products or services. In other words, it is the way of managing effective energy usage and restraining the energy consumption to avoid energy wastage in a factory.

- **Barriers**: Those conditions and factors which restrict and / or negatively influence the adoption of CP practices and energy efficiency measures in a factory.

- **Drivers**: Those conditions and factors that lead and accelerate the adoption of CP practices and energy efficiency measures in a factory.

- **Policies**: Those systematic plans of action and directions which are formed by any legal entity to promote CP and energy efficiency in the industrial sector.

- **Initiatives**: A program or strategy that guides, supports, and promote CP and energy efficiency in the industrial sector.

- **Textile Manufacturing**: A major industry covers everything from fiber to apparel. The manufacturing process covers yarn, fabric, treatment, dyeing, printing and finishing.

### 1.4. Research Objective

Climate change, economic crises, energy and resource constraints have emerged as global issues of the 21st century. Moreover, these issues have been affecting several countries of the world. Similarly, Pakistan being a developing country has been facing the challenges such as energy crisis, climate change, and socioeconomic issues. However, the sustainable industrial growth is one the vital solutions to overcome these challenges. Globally, the importance of CP has been realized due to its tangible benefits to both companies and the environment. Since CP is an approach to reduce pollution, conserve materials and energy and to gain competitiveness in the international market. Hence, international efforts have been made to promote CP and energy efficiency. Also, several initiatives have been introduced in Pakistan, however, the adoption of CP and energy efficiency in the industrial sector of Pakistan remained very slow. Therefore, the objective of this research was to identify the factors affecting the implementation of CP and energy efficiency in the textile sector of Pakistan and to provide recommendations in order to promote CP and energy efficiency in the industrial sector and particularly the textile sector of Pakistan.

### 1.5. Research Question

In order to achieve the above-stated research objective one main research question and four sub-research questions have been made which are as follows:

Main Question:

- How can cleaner production (CP) and energy efficiency be promoted in the textile sector of Pakistan?

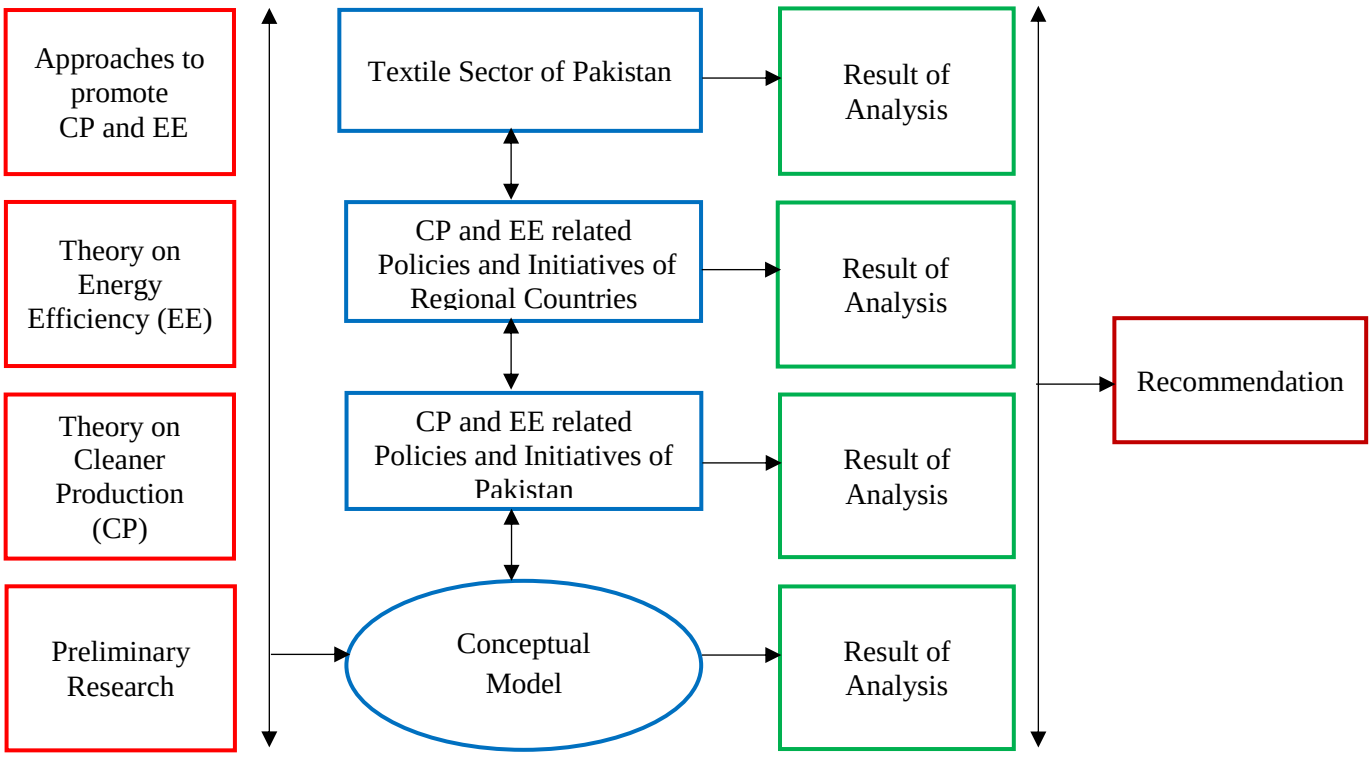
Sub Questions:

- What policies and initiatives have been introduced to promote CP and energy efficiency in the industrial sector of Pakistan and particularly in the textile sector? And how effective are these policies and initiatives?
- How have other regional countries promoted CP and energy efficiency in their industrial sector and particularly in the textile sector?
- What is the present level of CP practices and energy efficiency measures adopted by the textile factories in Pakistan?
- What are the barriers and drivers to the implementation of CP and energy efficiency in the textile factories of Pakistan?

### 1.6. Research Framework

Research framework ensures the logical follow-up to realize the research objective. It includes step by step activities to achieve the research objective. Figure 1.1 shows the systematic representation of the research framework which is further developed into an analytical framework (see section 3.4).

Figure 1.1: Systematic Representation of Research Framework.



## 1.7. Justification and Significance of Research

Undoubtedly, the adoption of CP and energy efficiency in the industrial sector of Pakistan would not only serve the climate agenda by reducing energy intensity and GHG emissions, but it would also financially benefit to the factories by saving their production costs. However, Pakistan does not have any specific legislation on GHG reduction or cleaner production and the growth of CDM in the industrial sector of Pakistan has not been promising so far. Although several initiatives have been introduced in Pakistan to promote CP and energy efficiency, however, their adoption remained very slow in the industrial sector. Therefore, it was really essential to identify the factors affecting the implementation of CP and energy efficiency from the perspective of factories. This research work will add some literature about promoting CP and energy efficiency in the industrial sector of Pakistan. It provides statistics and insights from the perspective of textile factories in Pakistan. It also provides information about various initiatives adopted by regional countries. As a result, this research will provide information to the policy makers and relevant authorities to promote CP and energy efficiency in the industrial sector of Pakistan.

## 1.8. Delimitation

Pakistan has been facing the challenges of resources constraint, energy crisis, and climate change. To cope with these challenges implementing CP and energy efficiency is one of the vital solutions. Hence, it has become essential to promote CP and energy efficiency in the industrial sector of Pakistan. However, considering the time constraints, the objective of this research was kept limited to the textile sector as it contributes 58% of the total exports of Pakistan and provides employment to 40% of the total labor force. Moreover, the textile sector of Pakistan is the most polluting industry and facing the significant competitiveness and environmental challenges. Hence, to serve the research objective, the textile manufacturing sector was chosen and focused in this research.

## 1.9. Structure of the Thesis

There are seven chapters in this research thesis. Chapter one and two respectively describes the introduction and literature review of the research. Chapter three represents the methodology applied in this research. Chapters four, five and six answer the four sub-research questions. Chapter seven represents recommendations as an answer to the main research question.

**Chapter One**: This chapter describes the background, problem statement, research objective, research questions, research framework, and significance of the research.

**Chapter Two**: This chapter describes the background information of the country as well as theoretical knowledge about the concepts of cleaner production (CP) and energy efficiency. This chapter particularly elaborates industrial energy consumption and the textile sector of Pakistan. Furthermore, it explains the benefits, barriers, and drivers for CP and energy efficiency.

**Chapter Three**: This chapter describes research methodology. It explains how the data was collected and analyzed. Moreover, it shows the analytical framework of the research. In last, it states the limitation of data collection.

**Chapter Four**: This chapter answers the first sub-research question. This chapter provides a review of various policies and initiatives of Pakistan relevant to CP and energy efficiency. Also, it states the summary of relevant policies and initiatives. In last, it shows the analysis of the effectiveness including strengths and weaknesses of the relevant policies and initiatives of Pakistan.

**Chapter Five**: This chapter answers the second sub-research question. This chapter provides a review of policies and initiatives of other regional countries (China, India, and Bangladesh) relevant to CP and energy efficiency. Also, it states the summary of relevant measures adopted by the other regional countries. In last, it shows the analysis why and what measures Pakistan should adopt from the lessons of other regional countries.

**Chapter Six**: This chapter answers the third and fourth sub-research questions. This chapter consists of a case study of the textile sector of Pakistan. It illustrates the present status of CP and energy efficiency implementation in the textile sector of Pakistan. Furthermore, it shows the significant barriers and drivers to CP and energy efficiency implementation in the textile sector of Pakistan. In last, it indicates options or tools to promote CP and energy efficiency in the textile sector of Pakistan.

**Chapter Seven**: This chapter answers the main research question. This chapter provides recommendations in order to promote CP and energy efficiency in the industrial sector and particularly in the textile sector of Pakistan.

# CHAPTER TWO: THEORETICAL CONCEPTS AND LITERATURE REVIEW

This chapter provides a theoretical understanding of various concepts related to this research. The first section elaborates about background information such as country profile, energy consumption, GHG emissions, and textile sector. The second and third sections explain the benefits, barriers, and drivers to CP and energy efficiency respectively. In last, it provides information about various approaches to promote CP and energy efficiency.

## 2.1. Background Information

### 2.1.1. Country Profile

Pakistan is a developing country located in South Asia. Pakistan is the 6th most populous country with a population exceeding 188.9 million people and 35th largest country with an area of 881913 sq.km (340509 sq. mi)[5]. Pakistan is considered as a lower middle-income[6] country, however, is one of the Next Eleven (N-11)[7] countries, along with BRIC[8], having high potential to become world largest economies in the 21st century (Grant, 2011). For example, Pakistan has the 9th largest labor force in the world i.e. 59.6 million workers (Ministry of Finance, 2013). Moreover, the manufacturing industries in Pakistan are one of the largest sectors of the economy. However, Pakistan needs to adopt sustainable industrial development to fully utilize its significant potential.

Pakistan is the 41st largest economy in the world and the 2nd largest economy in South Asia. The GDP of Pakistan remained US$ 270 billion although it could be further increased (World Bank, 2016). However, Pakistan has been facing varying economic, political and social challenges, hence, overall GDP growth rate reduced to 2% in 2007-2008 and only increased up to 4.14% in 2014-2015 (EC, 2015). In fact, the slow economic growth was significantly hampered by the energy crisis and the fragile law and order situation in Pakistan (EC, 2015). Furthermore, the economic growth demands higher energy inputs, whereas Pakistan imports crude oil and petroleum products, which consequently burdens on the economy of Pakistan. Hence, Pakistan needs to address above-mentioned challenges in order to become one of the largest economies in the world.

### 2.1.2. Industrial Energy Consumption and GHG Emissions of Pakistan

Pakistan has been exposed to a deep multi-dimensional energy crisis consisting of energy shortages and increasing energy prices. This situation adversely impacted all sectors of the economy. However, domestic and industrial sectors have been the most affected one. Most importantly, Pakistan would remain vulnerable to face such energy crisis in the future too, if the depth of the energy crisis is not fully understood and appropriate actions are not taken. However, high dependence on imported energy is one of the main reasons for Pakistan's vulnerability to the energy crisis.

---

[5] Including data for Pakistani territories of Azad Kashmir (13297 sq. km or 5134 sq. mi) and Gilgit-Baltistan (72520 sq. km or 28000 sq. mi) makes Pakistan total area of 881913 sq. km or 340509 sq. mi. Retrieved 10 May 2016, from http://www.geohive.com/cntry/pakistan.aspx, and http://www.geohive.com/earth/area_top50.aspx

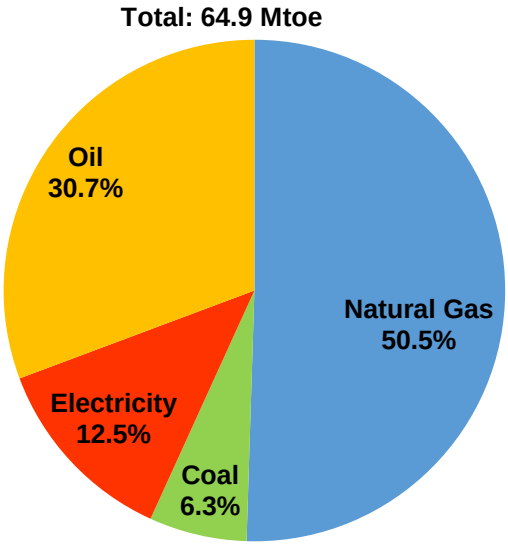
[6] The country with per capita income US$1046 - US$4125 falls under the lower middle-income country category.

[7] The Next Eleven (N-11) are the eleven countries - Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, Turkey, South Korea and Vietnam - identified by Goldman Sachs investment bank and economist Jim O'Neill in a research paper as having potential to be world's largest economies in the 21st century.

[8] BRIC is a grouping acronym refers to countries Brazil, Russia, India, and China.

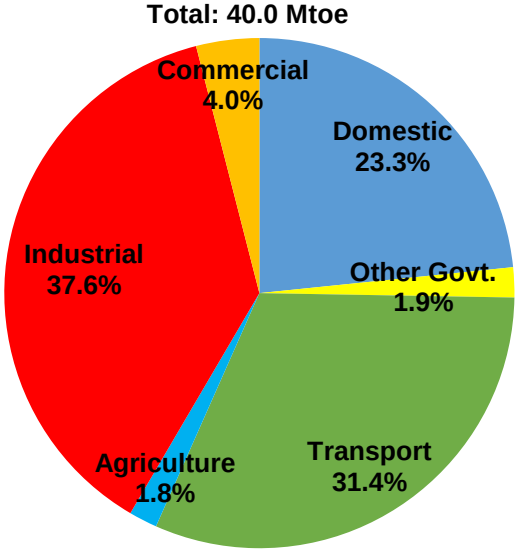
The total indigenous energy available in Pakistan is 66,015 ktoe as of 2014, wherein, 45,251 ktoe (68.5%) indigenously produced and 20,764 ktoe (31.5%) imported (Christian Aid, 2014). In contrast, the total indigenous energy available in Pakistan was 64,910 ktoe in 2012. Figure 2.1 shows the share of primary energy supplies of Pakistan in 2011-2012.

Figure 2.1: Primary Energy Supplies of Pakistan (Source: HDIP, 2013)



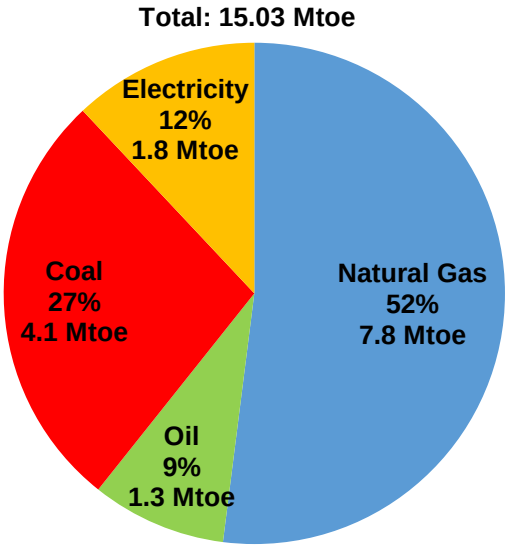

Pakistan has been planning to set up more industrial estates along the intercity corridors in order to achieve 8-10% annual industrial growth rate until 2030 (PISD, 2013a). However, Pakistan has already 74 industrial estates, whereas setting up more industrial estates would require additional energy. Hence, the increasing energy demand and alarming depletion of resources have become as one of the major challenges for the industrial growth in Pakistan. The industrial sector being the largest energy consumer accounts for 37.6% of total energy consumption in Pakistan. Figure 2.2 shows the total energy consumption (excluding fuels consumed in thermal power generation) by different economic sectors of Pakistan. It is also a fact that the industrial sector of Pakistan utilizes energy inefficiently due to their orthodox practices and equipment. However, energy efficiency is most the most cost-effective way for reducing the energy gap. Moreover, the marginal cost of additional energy supply is much higher than the cost of investing in energy efficiency. Hence, energy efficiency has become an absolute priority for Pakistan in the context of increasing energy prices and increasing energy demand.

Figure 2.2: Energy Consumption of Pakistan by Sector (Source: HDIP, 2013)



The industrial energy consumption in Pakistan accounted to 15.03 Mtoe in 2011-2012 which was a bit decrease from 16.8 Mtoe in 2008-2009 (Ministry of Petroleum, 2013). Figure 2.3 shows the total industrial energy consumption of natural gas (7.8 Mtoe), coal (4.1 Mtoe), oil (1.3 Mtoe) and electricity (1.8 Mtoe). However, according to MOCC (2013) and UNFCCC (2011), the GHG emissions in Pakistan have been low compared to the international standards. In 2008, total GHG emissions in Pakistan accounted to 310 million tCO2eq, which comprised 54% Carbon Dioxide ($CO_2$), 36% Methane ($CH_4$), 9% Nitrous Oxide ($N_2O$), 0.7% Carbon Monoxide (CO) and 0.3% Non-Methane Volatile Organic Compounds.

Figure 2.3: Industrial Energy Consumption Breakdown (Source: HDIP, 2013)




The energy sector has been the largest contributor (51%) of GHG emissions in Pakistan followed by agriculture sector (39%). These two sectors have been the source of 90% GHG emissions in Pakistan (MOCC, 2013). Figure 2.4 shows the Carbon Dioxide ($CO_2$) emissions of energy sector where power and industries accounted for 32% and 30% respectively.

Figure 2.4: $CO_2$ Emissions of Energy Sector in Pakistan (Source: MOCC, 2013)

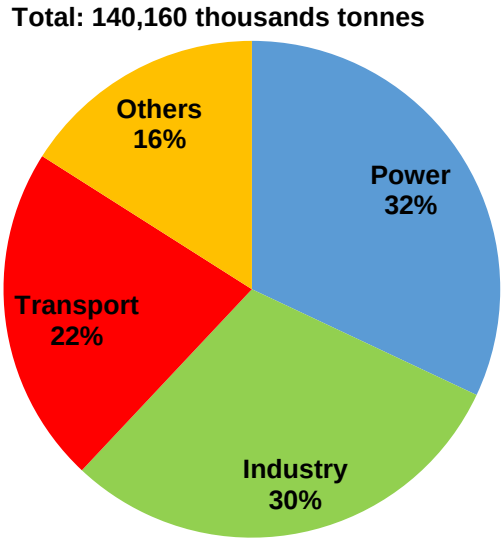


Table 2.1 shows the primary energy reserves of Pakistan. According to IEP (2013), the recoverable reserves[9] of the crude oil and natural gas in Pakistan have a reserves-to-production ratio[10] of 11 years and 18 years respectively. If more energy (crude oil and natural gas) reserves are not found and the rate of energy consumption is not controlled then Pakistan would be facing much more severe crisis than today. However, IEP (2013) also reported that 175 billion tonnes of coal reserves have been discovered in the Thar region of Pakistan, which can be used to generate 100,000 MW of electricity for over 200 years.

Table 2.1: Primary Energy Reserves of Pakistan (Source: HDIP, 2013)

| | **Original Recoverable Reserves** | (As of June 30, 2013) **Cumulative Production** | |
|---|---|---|---|
| | | **Units** | **% Used** |
| Crude Oil (Million Barrels) | 1,103 | 732 | 66.4 |
| Natural Gas (Billion Cubic Feet) | 56,636 | 30,895 | 55.5 |
| Coal* (Million Tonnes) | 3,450 | - | - |
| *Coal reserves are the measured reserved. If the indicated, inferred, hypothetical reverses included, the total reserves become 186,007 million tonnes. | | | |

### 2.1.3. Textile Sector of Pakistan

The textile sector is an important part of the economy of Pakistan. It contributes to 58% of the total exports of the country and provides employment to 40% of the total labor force in Pakistan (MINTEX, 2013). Moreover, it accounts for 46% of the total manufacturing output in Pakistan[11]. Hence, the textile industry enjoys a pivotal position in the industrial sector of Pakistan. There are more than 670 textile factories operating in Pakistan and around 400 textile factories are the members of All Pakistan Textile Mills Association (APTMA)[12]. Around 300 factories are located in Karachi and the others mostly located in Punjab

Pakistan is the 4th largest cotton grower in the world thus the availability of cotton has been playing a vital role in the growth of the textile industry in Pakistan (Muneer et al, 2006). Moreover, Pakistan is the 8th largest exporter of textile products in Asia. Notably, Pakistan exports a large proportion of its textile products to USA, EU and the Middle East. Hence, being a successful candidate in the international market, Pakistan has been seeking modern and high-tech facilities to improve the quality of its textile products (Muneer et al, 2006). However, the textile sector of Pakistan has been facing challenges of the energy crisis and environmental impacts. The textile sector needs to comply with environmental standards to sustain its business in international market. The textile sector accounts for 17% of the total industrial energy consumption in Pakistan. Furthermore, the textile sector of Pakistan approximately consumes 7 billion cubic metre ($m^3$) of natural gas, 4000 gigawatt hours (GWh) electricity, and 800 million cubic metre ($m^3$) of water per year (SCI-Pak, 2007). Figure 2.5 shows the total energy consumption in the textile sector of Pakistan wherein natural gas is the dominant source of energy.

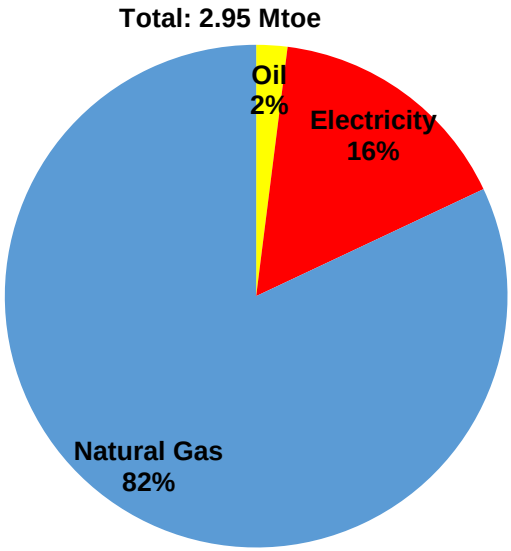
[9] A term used to describe the amount of resources identified in a reserve that is technologically or economically feasible to extract. A new reserve can be discovered, but if the resource cannot be extracted by any known technological methods, then it would not be considered as recoverable or proved reserves.

[10] A ratio indicating the remaining lifespan of a natural resource. This ratio is expressed in terms of years and is used in forecasting the future availability of a resource.

[11] Pakistan's total manufacturing output accounts to 35.26 billion USD as of 2012. In addition, the share of manufacturing in Pakistan as a percentage of GDP, employment, and fixed investment is 18.5, 13.0, and 16.2 respectively. Retrieved 12 August 2016, from https://www.quandl.com/collections/economics/industrial-production-by-country and http://www.finance.gov.pk/survey/chapter_10/03_Manufacturing.pdf

[12] APTMA is the premier national trade association of the textile spinning, weaving, and composite mills. APTMA represents its members (textile mills) in dealings with the government. (see Appendix-D)

Figure 2.5: Energy Consumption in Textile Sector of Pakistan (Source: HDIP, 2013)




The textile sector of Pakistan consumes 82% natural gas, 16% electricity and 2% oil as a backup source of energy. In contrast, Pakistan is not only an energy deficient country[13] but it also has been facing serious threats caused by the global warming. UNEP through its OCA/PAC regional seas program alarmed Pakistan for being vulnerable to the effects of sea level rise (UNFCCC, 2003). For instance, the largest city of Pakistan i.e. Karachi being situated on the coast, with population 24.3 million and 40% of all manufacturing industries, is most vulnerable to the climate change. Recently, a heat wave killed more than 1300 people in Karachi which illustrated that climate change has been taking its toll in Pakistan (Maheshwari, 2015). In addition, the textile industry is the most polluting industry in Pakistan. However, the textile industry does not only damage to the environment but it also adversely impacts on the human health. Table 2.2 shows the various impacts of the textile industry on the environment and human health.

Table 2.2: Impacts of Textile Industry on Environment and Human Health (Source: HSE, 2015)

| Source | Impact |
|---|---|
| Contaminated waste water | Causes serious impacts on the environment and human health |
| Solid Waste | |
| Flue gasses or emissions to air | |
| Oil and acid mists | |
| Dust and solvent vapors | |
| Excessive Noise | Causes permanent hearing loss |
| Mishandling of chemicals, dyes, and pigments | Causes carcinogenic or mutagenic impacts on health |
| Hot working environment | Causes heat stroke or fainting among workers |

PISD (2013b) evaluated that the inefficient use of energy and high production costs causing major issues in the textile industry of Pakistan. However, the textile industry of Pakistan can save PKR 400 million annually through energy efficiency (Dawn, 2012a). According to IEA (2007), industrial energy efficiency can be improved from 18-26% which can ensure reduction of industrial $CO_2$ emissions by 19-32%. Similarly, SMEDA (2008) reported 10-30% energy saving potential in the textile sector of Pakistan. Hence, it can be concluded that the textile sector of Pakistan needs to focus on CP and energy efficiency in order to manage its environmental impacts and energy crisis.

[13] There is a supply-demand gap which has to be met by imports. In fact, Pakistan has sufficient natural resources however these resources are not being exploited due to the barriers such as lack of political will, technical feasibility, and financial constraints.

## 2.2. Cleaner Production (CP)

According to Terefe et al (2015), environmental attitudes can be summarized into three categories such as foul and flee, concentrate and contain, and dilute and disperse. However, all of these environmental attitudes proved to be wrong in the long-term and caused many environmental problems and even disasters e.g. Bhopal disaster[14]. Finally, in order to reduce the environmental impacts of the industrial sector, UNEP developed the concept of cleaner production (CP) in 1989 which is defined as following. "CP is the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment" (UNIDO, 2015). For production processes, CP includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity as well as the toxicity of all emissions and wastes. For products, the focus is on reducing negative impacts along the life cycle of a product i.e. from raw materials extraction to its ultimate disposal. For services, it incorporates environmental concerns into the design and delivery services (Nilsson et al, 2007).

CP is neither a one-time activity nor limited to any certain type or size of a factory. In fact, CP is a continuous improvement process with long-term benefits. Moreover, CP is a very vast concept and it includes the concepts of pollution prevention, waste minimization, eco-efficiency, and cleaner technology. It also considers the impact of resource extraction, production stages, distribution, use, and disposal. In addition to the life cycle impacts, it also addresses health and safety concerns and emphasizes on risk reduction. CP has much in common with the environmental management system, industrial ecology and general concepts of sustainable development. However, CP is not only an environmental strategy but indeed it is a win-win strategy that protects the environment, community and the business (Pimenta and Gouvinhas, 2011).

### 2.2.1. Benefits of Cleaner Production (CP)

CP brings tangible economic savings or financial benefits by improving the overall efficiency of production, health benefits for laborers and creating new markets. Table 2.3 shows the summary of CP benefits as reported by many factories from different industrial sectors.

Table 2.3: Summary of CP Benefits (Source: UNEP, 2015a)

| Category | Benefits Description |
|---|---|
| **Cost Savings** | • Waste disposal costs reduction<br>• Raw material costs reduction<br>• Health and safety i.e. EHS costs reduction |
| **Performance** | • Increasing productivity<br>• Gaining competitiveness advantage in local and international market<br>• Gaining continuous improvement in environment performance<br>• Improvement in overall performance of a factory |
| **Image** | • Improvement in factory and public relations<br>• Gaining market recognition and customers trust |
| **Legal** | • Achieving regulatory environmental compliances |
| **Risks Minimization** | • Minimizing risks to environment and employees health |

[14] Industrial pollution has been the cause of so many environmental disasters. One of the most serious was the Bhopal disaster in December 1984 when a leak of methyl isocyanate resulted in at least 22,000 deaths. Retrieved 18 July 2016, from http://www.earthtimes.org/encyclopaedia/environmental-issues/environmental-disasters

### 2.2.2. Cleaner Production (CP) Practices

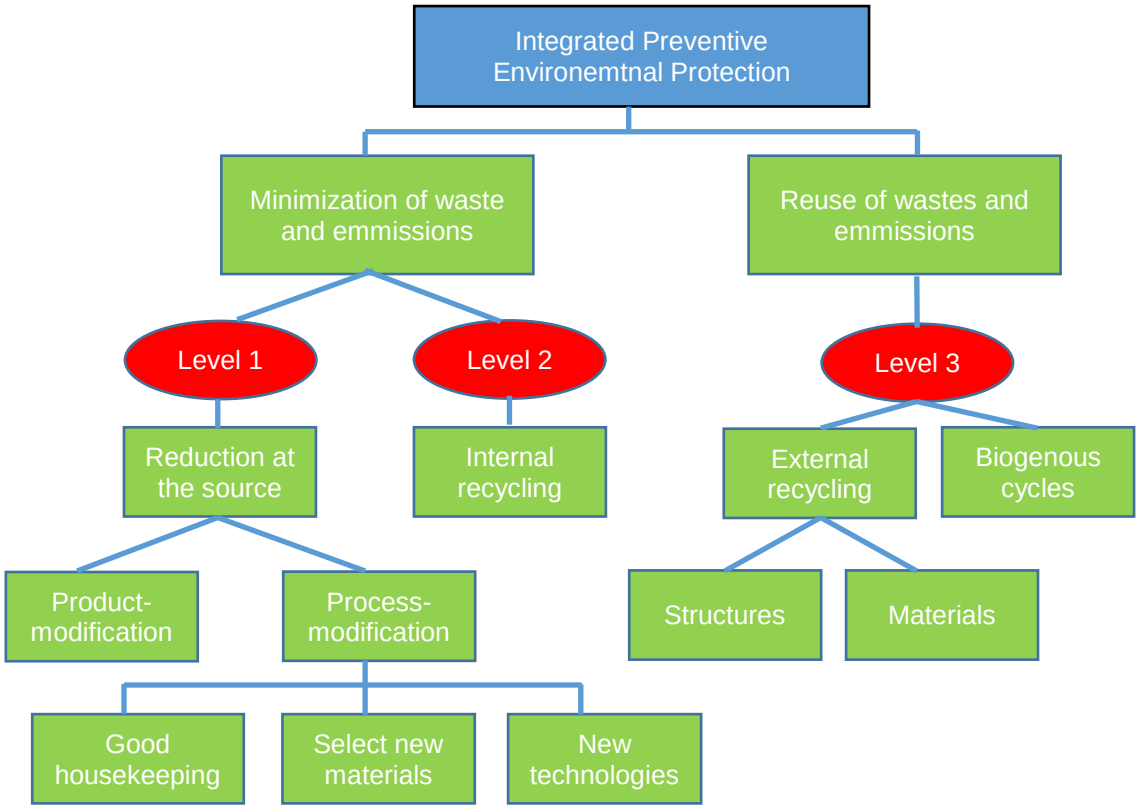
According to Hilson (2000), CP enables factories to achieve a win-win scenario for both business and the environment. Moreover, cleaner technologies i.e. highly efficient equipment and improved control systems actually facilitate CP. Similarly, CP practices are just the management and organizational measures that provide factories a better position to handle, minimize and anticipate problems with waste. Table 2.4 shows the summary of some common CP practices.

Table 2.4: Summary of CP Practices (Source: UNEP, 2015a)

| CP Practice | Description of Action |
|---|---|
| **Good housekeeping**: | Taking appropriate managerial and operational actions<br>• To prevent leaks<br>• To prevent spills<br>• To enforce existing operational instructions. |
| **Input substitution**: | Substituting input or raw materials<br>• By less toxic materials<br>• Or by renewable materials<br>• Or by adjunct materials which have longer service lifetime in production |
| **Better process control**: | Making appropriate actions or modifications to gain control<br>• By modifying operational procedures<br>• By modifying equipment instructions<br>• By keeping process record in order to run the processes more efficiently and at the lower waste and emission generation rates. |
| **Equipment modification**: | Modifying the existing production equipment and utilities<br>• In order to run the processes at higher efficiency<br>• In order to reduce waste and lower the emission generation rate |
| **Technology change**: | Applying latest tools to minimize waste and emission during production<br>• By replacing the technology<br>• By replacing the processing sequence<br>• By replacing synthesis pathway |
| **On-site recovery or reuse**: | Minimizing waste materials<br>• By reusing the wasted material in the same process<br>• Or by reusing the wasted material in another useful application within a factory |
| **Production of a by-product** | Transforming waste into a useful by-product<br>• To sold as an input material for companies in other business sectors |
| **Product modification**: | Modifying the product characteristics<br>• To minimize the environmental impacts of the product during its use or after disposal<br>• To minimize the environmental impacts of its production |
| **Using energy efficiency**: | Reducing the environmental impacts from energy usage<br>• By improving energy efficiency<br>• By using energy from renewable sources |

There are three levels for CP implementation in a factory. The least level is the reuse of wastes generated by a factory, whereas the actual target of CP is the reduction of waste and emissions at the source. Figure 2.6 shows three levels of CP strategies that any factory can opt as per its capacity.

Figure 2.6: Levels of CP Strategies (Sources: Nilsson et al, 2007; Willers et al, 2014)




### 2.2.3. Barriers to CP

There are many benefits of CP such as waste reduction, cost savings, improved compliance, and increased efficiency. However, these benefit often not enough to trigger adoption of CP in a factory, as there are also various barriers to CP implementation which can be divided as internal barriers and external barriers. In addition, these barriers can also be classified as organizational, technical, financial and policy barriers. Notably, Hilson (2000) emphasized that despite above-mentioned CP benefits, in order to adopt CP, factories often need some form of external pressure such as customer pressure, market pressure or regulations. UNEP (2004) explained following internal and external factors that usually influence or hinders the CP implementation in a factory.

#### 2.2.3.1. CP Barriers Internal to Factories:

Those factors which internally influence on CP implementation in a factory are as follows.

- **Resistance to change**: Many factories have an attitude to follow their business as usual i.e. do not adopt any change. Moreover, they consider any change as unwanted, risky and not necessarily profitable thus this attitude, especially from the top management, hinders CP implementation.

- **Lack of information and adequate expertise**: Many factories often become interested in the CP concept due to its potential benefits. However, they are usually unable to put CP in practice due to information gaps, lack of technical assistance and experts.

- **Lack of communications**: In many factories, it also happens that employees or middle management become interested in CP, and they also possesses necessary skills or expertise. However, they either fail to communicate or often reluctant to communicate the CP concept and its benefits with the top management (UNEP, 2004). Hence, this communication gap also hinders CP implementation.

- **Competing for business priorities**: A significant barrier to CP implementation is business priorities i.e. many factories emphasize on short-profitably. For instance, the investors principally focus on short-term performance rather than long-term financial returns. Therefore, factories reluctant to invest in CP, even though the project possesses demonstrably attractive long-term financial benefits.

- **Perception of risk**: CP involves the possibilities of process modification, equipment replacement or product redesign. However, the top management often considers it as risky, especially in a case, if the technology is not proven or the product is not yet tested in the market. Hence, this perception also becomes a barrier to CP implementation.

- **Low environmental awareness**: Low environmental awareness among factory workers or at the public level also hinders the adoption of CP. For instance, developing countries particularly lack environmental awareness in their cultural perspective or at the public level.

- **Financial obstacles**: Factories often do not have the finance to invest in CP technologies. Hence, it is also a major barrier to CP implementation.

- **Middle management inertia**: The role of middle management is important in a factory i.e. they can either slow down or accelerate the implementation of CP. For instance, they have the power to motivate the factory laborers or workers thus they can promote the culture of pollution prevention within their factory.

- **Labor force obstacles**: Majority of the laborers are illiterate in many developing countries. Moreover, they are unfamiliar with CP practices and environmental concerns. Hence, it also creates a significant barrier to CP implementation in a factory.

- **Lack of accounting system to measure environmental costs and benefits**: Factories usually do not have any accounting system which can measure environmental impacts, risks, liabilities and associated costs. Therefore, factories are unable to judge environmental performance in a business perspective (UNEP, 2004). Hence, it also creates a significant barrier to CP implementation.

#### 2.2.3.2. CP Barriers External to Factories:

Those factors which externally influence on CP implementation in a factory are as follows.

- **The failure of existing regulatory approaches**: One of the major impediments to CP implementation is a lack of orientation in the existing national policies and regulatory framework. Moreover, in many cases, the conventional regulatory approaches are proved to be counterproductive (UNEP, 2004).

- **Perverse economic incentives**: Economic subsidies for resources used as input in a factory may also become a significant disincentive to CP. For instance, if the government subsidizes the prices of relatively polluting fuels then it will diminish the financial benefits of CP (UNEP, 2004). Similarly, if the government subsidizes water and energy then factories will no longer be motivated for resource efficiency. Hence, perverse economic incentives also a barrier to CP implementation.

- **Difficulty in accessing external finance**: CP technologies often require huge financial investments. However, the government agencies, banks, corporate financial departments and venture capitalists either discriminate or do not have the competencies to evaluate applications concerning to CP. Therefore, factories face difficulty in accessing external finance. Hence, it also creates a major significant barrier to CP implementation.

- **Difficulty in accessing cleaner technology**: There are several potential external barriers in addition to the substantial costs of cleaner technology which may discourage factories to update their existing plant or replace equipment. For instance, investment in new technology is always a major decision. Moreover, it is hard to transfer cleaner technologies from one user to another user due to the complexity and specificity of a new technology thus factories cannot make an investment decision (UNEP, 2004). Hence, difficulty in assessing cleaner technology is also a major barrier to CP implementation.

Shi et al (2008) also classified above-mentioned barriers to CP implementation into four categories namely as managerial and organizational barriers, technical and information barriers, policy and market barriers, and financial and economic barriers. Table 2.5 shows the summary of above-mentioned barriers with respect to their classification.

Table 2.5: Summary of Barriers to CP Implementation (Source: Shi et al, 2008)

| Category | Barrier | Description |
|---|---|---|
| **Policy and Market Barriers** | Lax environmental enforcement | Weak enforcement of environmental regulations does not force factories hence CP adoption becomes an unimportant task. |
| | Absence of economic incentives | The absence of economic incentives such as tax exemptions and grants hinder CP adoption. |
| | Lack of market preference / demands | Customers do not demand or prefer environment-friendly products. |
| | Inadequate industrial self-regulation | Government assistance or initiatives fail to result in self-regulation in factories. |
| | Weak public awareness and pressure | Weak public awareness & insufficient community pressure on factories to improve environmental performance & to adopt CP. |
| **Financial and Economic Barriers** | High initial capital cost | Higher initial capital costs of cleaner technology as compared to conventional technologies hinder CP adoption. |
| | Difficulty in accessing financial capital | Limited funding opportunities especially for CP projects in factories |
| | Poor financial performance of CP | Low returns and longer gestation periods make factories reluctant to invest in CP. |
| | Lack of effective measures for CP evaluation | Difficulty to quantify the financial performance of CP projects. |
| | Lack of financing service for factories | Financial institutes not willing to serve factories thus hinder CP adoption. |
| **Technical and Information Barriers** | Limited expertise / capability | Factories possess limited technical staffs who are fully occupied on daily production thus no one there to implement CP. |
| | Lack of access to external technical support | Factories are incompetent at accessing external technical support. |
| | Difficulty to access information on CP | Factories face difficulty in accessing CP related information and to act on them. |
| | Additional infrastructure requirements | Integrating CP into existing production systems often encounters problems with space, infrastructure or other reasons. |
| | Lack of technical training | Factories lack training programs for the employees to operate and maintain CP. |
| **Managerial and Organizational Barriers** | Higher priorities to production expansion / market share | Managers consider that expansion of production capacity and market share is more important than implementing CP. |
| | Concern about competitiveness | Adoption of CP often incurs additional costs and undermines companies' competitiveness in the market. |
| | Management resistance to change | Managers consider risks in changing the current production processes and technologies. |
| | Lack of awareness of CP | Managers and staffs are unaware of CP's economic and environmental benefits. |
| | Inadequate management capacity | Managers lack the basic managerial and technical capacity to implement CP. |

### 2.2.4. Drivers for CP

Despite the above-mentioned barriers to CP implementation, there are also various internal and external factors that motivate factories to adopt CP. Table 2.6 show the different motivators and drivers for CP implementation in a factory.

Table 2.6: Motivators and Drivers for CP Implementation (Source: UNEP, 2015a)

| Drivers Internal to the Factories | Drivers External to the Factories |
|---|---|
| • Environmental management systems and continuous improvement<br>• Corporate environmental reports<br>• Environmental leadership<br>• Environmental accounting<br>• Requirement of owners and investors<br>• Higher cost of production inputs<br>• Recognition and factory image<br>• Voluntary initiatives | • Environmental regulations and pollution prevention<br>• Environmental auditors<br>• International trade incentives<br>• Financial incentives<br>• Loans from financial institutions<br>• Rising energy prices<br>• Product specifications in foreign market<br>• Green consumers<br>• Industry networking<br>• Buyer-supplier relations<br>• Supply chain demands<br>• Negotiated self-regulation<br>• Codes of practice<br>• Education and training<br>• Public pressure<br>• Community perceptions & involvement |

## 2.3. Energy Efficiency

It is not a problem that energy is the subsistence of this world. However, the problem is carbon or GHG emissions i.e. how energy is produced and consumed globally. For instance, the use of fossil fuels to generate energy and its substantial consumption in the industries poses a major threat to the environment and causes global warming. According to IPCC (2007), industries consume around 40% of the global energy consumption and contribute to 37% of the global GHG emissions. However, the developing countries' share of industrial $CO_2$ emissions from energy usage increased from 18% in 1971 to 55% in 2005 (Worrell et al, 2009). Also, IEA (2007) pointed out that industries account for about 78% of the global annual coal consumption, 41% of global electricity use, 35% of global natural gas consumption and 9% of global oil consumption. Hence, as a result of this significant energy consumption, the earth has been facing global warming and depletion of fossil fuel reserves. Undoubtedly, the climate change and increasing energy demand are the most critical challenges of the 21st century. However, energy efficiency is one of the key climate change abatement strategies that offer tangible solutions to both above-mentioned challenges (World Bank, 2009).

In simple words, energy efficiency means using less energy to provide the same service. However, the term energy efficiency is widely used but not always well understood. Energy efficiency is defined as the ratio of useful outputs to energy inputs for a system, where a system may be an energy

conversion device (e.g. a boiler), an industrial process, a building, a factory and a sector of the economy. However, in all cases, the measure of energy efficiency will depend on how the term "useful" is defined and how input and output are measured (Patterson, 1996). In thermodynamic measures, the output is defined in terms of heat content or as the capacity to perform useful work. In physical measures, the output is defined in physical terms such as tonnes of steel or vehicle kilometres (km). And in economic measures, output or input is defined in economic terms such as GDP or value-added. The concept of energy efficiency has a vital application in the industrial sector as it is one of the most significant and cost-effective options for mitigating GHG emissions.

### 2.3.1. Benefits of Energy Efficiency

There are various benefits for implementing energy efficiency in a factory. For example, it includes economic growth, competitiveness, energy security, financial savings and reduction in GHG emissions. Table 2.7 shows the category wise benefits of energy efficiency.

Table 2.7: Summary of Energy Efficiency Benefits (Source: UNEP, 2015b)

| Category | Benefits Description |
|---|---|
| **Environmental** | • Improved capacity for compliance with environmental demands.<br>• Reduction in GHG emissions. |
| **Economic** | • Reduced operational or production costs.<br>• Reduced risks through decreased dependence on volatile and rising energy prices.<br>• Increased energy security.<br>• Improved reliability of equipment and production processes.<br>• Better positioning in production chains.<br>• Better sells and marketing opportunities due to improved energy efficiency.<br>• Gaining competitiveness in the market.<br>• Improved image of the factory. |
| **Social** | • Improved working environment for employees.<br>• Improved personnel attitudes of employees.<br>• Minimized personnel fluctuations. |

### 2.3.2. Barriers to Improve Energy Efficiency

According to IEA (2008), the industrial sector represents the biggest opportunity for saving 33% energy consumption and 38% reduction of GHG emissions. Moreover, it is an established fact that the energy efficiency undertakings are the fastest, cleanest and most cost-effective way to deal with energy demand and GHG emissions. Factories also have been realizing to adopt energy efficiency due to increasing energy prices and tough market competitions. However, the prospects of energy efficiency are usually overlooked due to some critical limiting factors which are known as barriers. SPRU (2000a) identified following barriers to energy efficiency and also classified them into three main categories such as economic barriers, organizational barriers, and behavioral barriers. Moreover, table 8 shows the summary of barriers to the energy efficiency.

#### 2.3.2.1. Economic Barriers

The concept of barriers to energy efficiency originated from the mainstream economics theory. Hence, the economic barriers can be subdivided into two categories namely as economic barriers related to market failures and economic barriers related to non-market failures.

##### 2.3.2.1.1. Economic Barriers related to Market Failure

- **Imperfect information:** Information is a vital instrument for making a cost-effective decision related to energy efficiency. However, imperfect information about the energy performance of technologies leads to sub-optimal decisions which consequently inhibit investment or lead to underinvestment of inefficient technologies (SPRU, 2000a). Hence, imperfect information is a significant barrier to energy efficiency implementation.

- **Split incentives**: It is a form of market failure resulting from asymmetric information. However, it appears when there is a disparity of benefits i.e. someone gains more benefit than others, therefore, it leads to low interest on energy efficiency investment. Hence, the split incentive is also a significant barrier to energy efficiency implementation.

- **Adverse selection**: It is a form of asymmetric information resulting from a disparity in the available level of information. For instance, if one party is well informed about the technology before entering into a buying and selling contract then the transaction cost may affect the efficiency benefits being signaled. Hence, it leads to the buyer not buying the technology because the information available is inadequate to make a cost effective decision.

- **Principal-agent relationship**: The principal-agent relationship is a consequence of imperfect information on the part of the principal. This may lead principal to impose strict investment criteria and thereby discourage agent to buy energy efficient technologies (SPRU, 2000a).

##### 2.3.2.1.2. Economic Barriers related to Non-Market Failure

- **Heterogeneity**: The variation in the cost-effectiveness experienced by a technology adapter is referred to as heterogeneity of the technology. It may discourage a potential adapter not to adopt energy efficiency technologies because the cost-effectiveness is not 100% assured (SPRU, 2000a). Hence, heterogeneity also creates a barrier to energy efficiency.

- **Hidden costs**: Engineering-economics analyses may fail to account for either the reduction in utility costs or additional costs associated with energy efficient technologies. As a result, it may overestimate energy efficiency potential. Other examples of hidden costs include overhead costs for management, disruptions to production, staff replacement, training, and the costs associated with gathering, analyzing and applying information (UNIDO, 2011). Hence, a hidden cost is one of the most significant barriers to energy efficiency.

- **Access to capital**: If a factory has insufficient capital and facing difficulty in raising additional funds through loans then a factory might prevent energy efficient investment. Moreover, investments can also be inhibited due to internal budgeting procedures, investment appraisal rules and short-term incentives of energy management staff (UNIDO, 2011). Hence, it is a major barrier to energy efficiency implementation.

- **Risk**: Energy efficiency investment may represent a rational response to risk because such investments represent a higher technical or financial risk than other types of investment (UNIDO, 2011). Hence, it is a major barrier to energy efficiency implementation.

#### 2.3.2.2. Organizational Barriers

The organizational theory states that organizational factors like power and culture of an organization can restrain energy efficiency investments. However, these two factors are usually related to structure, size, and infrastructure of an organization.

- **Power**: Engineering, utilities, and energy related matters are usually assigned to engineering or maintenance department that belongs to a lower part of an organogram[15] in a factory. However, they lack sufficient power to initiate a project as power is constrained by the hierarchy in a factory. In contrast, the top management who has the power to initiate energy efficiency projects usually overlook such projects because improving energy efficiency is not a core business activity thus fail to see the significance of energy efficiency projects.

- **Culture**: the culture of an organization is not considered as a major barrier to energy efficiency but rather it is an important variable to explain why energy efficiency measures are not implemented by an organization (SPRU, 2000a). In other words, culture can be seen as organizational values, norms, and routines that may shroud important investments for energy efficiency. For example, those organizations having the culture of environmental awareness are more aware of the environmental implications of energy use. Therefore, they are more likely to adopt energy efficiency than those organizations having no culture of environmental awareness. Hence, the culture of an organization affects the attitude and actions of both top management and staff towards the energy efficiency.

#### 2.3.2.3. Behavioral Barriers

According to Sardianou (2008), decision-making process to invest in energy efficiency like other investments decisions is a function of the behavior of individuals within a factory or an organization. Moreover, some behavioral parameters such as forms of information, credibility and trust, values, inertia, and bounded rationality can also act as impediments to energy efficiency implementation.

- **Forms of information**: The information available to factory or an organization is an important parameter for decision-making. It aids in the cost-effective implementation of energy efficiency projects. Moreover, the form in which information is disseminated can impede the improvement of energy efficiency in an organization. Hence, the information should be specific, vivid, clear and simple to understand.

[15] A chart showing the lines of responsibility between departments of a large organization

- **Credibility and trust**: The credibility of the source of information is also an important dimension. For instance, if the credibility is questionable and not trustworthy then a factory or an organization may be reluctant to invest in energy efficiency projects based on that particular information. Hence, credibility and trust create a barrier to energy efficiency.

- **Values**: The values of an organization like culture are also not considered as a barrier. However, it is a descriptive variable that justifies why organizations adopt or not adopt energy efficiency. For instance, if an organization is well entrenched in environmental awareness and energy efficiency values, then they are more likely to invest in energy efficiency than those organizations lacking with such values. Hence, the values of an organization can explain why some organizations adopt energy efficiency and why some organizations do not adopt energy efficiency.

- **Inertia**: The inertia refers to the tendency of a factory or an organization to adopt any change contrary to their established normal routines. Moreover, the existence of inertia in a factory or an organization can explain why energy efficiency investments are not taken.

- **Bounded rationality**: Individuals do not make decisions in manners as assumed in the economic models due to time constraints, attention, and their ability to process information. As a result, even though when good information and appropriate incentives are available they may neglect energy efficiency opportunities (UNIDO, 2011).

Table 2.8 shows the summary of above-mentioned barriers related to the energy efficiency with respect to their classification.

Table 2.8: Summary of Barriers to Energy Efficiency Implementation (Source: SPRU, 2000b)

| Category | Sub-division | Barrier | Description |
|---|---|---|---|
| **Economic** | Market or organizational failure | Imperfect information | Agent lacks sufficient information to make economically efficient decisions. |
| | | Split incentives | Agent cannot make appropriate benefit of investment, landlord-tenant type relationships. |
| | | Adverse selection | Agent cannot transmit or discover energy properties of equipment. |
| | | Principal-agent relationships | The principal may impose strict investment criteria to compensate for imperfect information. |
| | Non-market or rational behavior | Heterogeneity | Technology may not be cost-effective in a particular case. |
| | | Hidden cost | Technology investment entails additional costs or benefits loss not usually reflected in models. |
| | | Access to capital | Some agents cannot obtain capital to invest. |
| | | Risk | Stringent investment criteria may represent a rational response to risk. |
| **Organizational** | - | Power | Agent lacks sufficient power within an organization to initiate action. |
| | | Culture | Environmental awareness and energy efficiency play no part in a factory culture. |
| **Behavioral** | Human dimension | Forms of information | Forms of information may be inadequate to stimulate an action. |
| | | Credibility and trust | Agent may not trust the source of information. |
| | | Values | Lack of environmental awareness leads to neglect of energy efficiency opportunities. |
| | | Inertia | Agents resist change because they are committed to what they are doing and justify inertia by downgrading contrary information. |
| | Bounded rationality | Bounded rationality | Cognitive limitations lead to agents satisficing rather than optimizing and relying on routines & rules of thumb. Organizational routines may systematically neglect energy efficiency. |

### 2.3.3. Drivers for Energy Efficiency

Despite the above-mentioned barriers to energy efficiency implementation, there are also various factors that motivate factories to adopt energy efficiency. However, the motivation to implement energy efficiency may originate either within a factory or may arise due to any external pressures on a factory. Table 2.9 shows the different motivators and drivers for energy efficiency implementation.

Table 2.9: Motivators and Drivers for Energy Efficiency Implementation (Source: Reddy, 2013)

| Drivers Internal to the Factories | Drivers External to the Factories |
|---|---|
| • Financial motives of the factory.<br>• Energy consumption or energy bills.<br>• Cost savings.<br>• Departmental performance motives.<br>• Factory commitment to achieve energy efficiency and environmental standards.<br>• Technology advancement motive.<br>• Government supports seeking motive.<br>• Factory image promotion motive.<br>• Avoiding development risk motive. | • Government policy regulations to achieve current and future environmental compliances.<br>• Environmental regulations for GHG emissions.<br>• Rising energy costs.<br>• Energy security.<br>• Market competition.<br>• Public and market demand.<br>• Social pressure or social values. |

## 2.4. Approaches to Promote Cleaner Production (CP) and Energy Efficiency

CP requires resource (energy and materials) efficiency and vice versa. In other words, the concepts of CP and energy efficiency are interlinked thus same approaches can be applied to promote both CP and energy efficiency. In order to overcome above-mentioned barriers to CP and energy efficiency many approaches have been identified. For instance, UNEP (2002) reported that many countries have made progress in promoting CP by applying mixed policy instruments. Furthermore, UNEP (2003) emphasized that the development of a national strategy as well as selecting the right mix of policy instruments is essential to promote CP and resource efficiency. However, CP strategies can also be integrated into various policies such as:

- Environmental policies
- Industrial policies
- Resource pricing policies
- Trade policies
- Fiscal policies
- Educational policies
- Technology development policies

There are various possible strategies for promoting CP and energy efficiency through the use of different policy tools such as regulatory, economic, information based and voluntary program instruments. However, short explanations of these instruments are as follows.

- **Regulatory-based instruments**: Regulatory instrument has been a dominant strategy for pollution reduction, wherein, a legal authority sets standards, monitors and enforces the compliance, and punish violations of formal legal sanctions. According to Stevenson (2002), there are certain situations in which regulatory instrument is regarded as the most appropriate and effective means to achieve desired environmental outcome. A pertinent example is the control of hazardous materials through specified restrictions and banning. However, Francisco (2002) stated that command and control policies would not work so well, in the case of weak public administration and various polluters since the community tends to become united to oppose the rule makers.

- **Economic instruments or MBIs**: Economic instruments are usually better at stimulating reduction processes rather than achieving specific emission targets. For instance, the economic instruments have put an important focus on the costs of reductions thus allow factories to meet general or specific goals with more flexibility. However, market-based instruments allow each polluter to decide whether to pay a tax or assume an additional abatement. In addition, the government may stimulate CP and energy efficiency by providing grants, subsidies, and favorable tax regimes to factories. For example, taxes can be used to promote CP such as raising the costs of undesired outputs or by providing incentives to promote more efficient use of natural resources (Stevenson, 2002). Moreover, subsidies can also be provided to the factories facing problems in complying with imposed environmental standards. Similarly, grants and soft loans can also be provided to undertake CP and energy efficiency measures in the factories.

- **Information-based instruments**: The government can also stimulate the adoption of CP through the informational measures such as product labeling, information dissemination, and training facilities. The product labeling includes eco-labeling schemes and environmental declarations. However, the information dissemination can provide factories very useful information regarding CP implementation. Moreover, arranging training facilities is also very important since it develops skilled human resource required to implement CP and energy efficiency in their respective factories.

- **Other instruments**: The government can also adopt various other instruments such as environmental planning and assessment, voluntary programs, information disclosure schemes and environmental management audit schemes. Furthermore, these instruments involve in improving the environmental performance by enlisting the voluntary support of the concerned parties and supplying them better information, guidance and training.

In conclusion, there are many approaches to promote CP and energy efficiency. However, appropriate policy instruments or a mix of instruments should be used to develop a concentrate national strategy. Most importantly, the national strategy or policy should be implemented properly in the industrial sector. Moreover, it should also integrate local perspective to safeguard both economic and environmental benefits.

# CHAPTER THREE: RESEARCH METHODOLOGY

Research methodology is a strategy to answer the research questions in order to achieve research objective. This chapter describes the research methods used to carry out this research. It illustrates how the data was collected and analyzed. Moreover, it states the limitations of the data collection.

## 3.1. Research Strategy

This research is practice-oriented and based on both qualitative and quantitative information. Hansen et al (1998) suggested that researchers should not only consider the most appropriate method for their research topic but also what combination of research methods will produce a better understanding of it. Hence, a combination of methods to collect data i.e. desk research and case study methodology was adopted in this research. In addition, three research objects have been studied to achieve the research objective. The three research objects are as follows:

1. Policies and initiatives related to CP and energy efficiency adopted by Pakistan
2. Policies and initiatives related to CP and energy efficiency adopted by other regional countries (China, India, and Bangladesh)
3. Textile sector of Pakistan

This research adopted following main steps as a research strategy. Firstly, a literature review was performed to understand the concepts relevant to this research. Notably, this step provided significant information to develop a questionnaire. Secondly, desk research strategy was applied to conduct the review of policies and initiatives adopted by Pakistan and three regional countries (China, India, and Bangladesh). This step provided significant information in order to answer the first and second sub-research questions. In short, this step particularly provided an insight into why and what policies and measures Pakistan should adopt from the experiences of the other regional countries. Thirdly, case study as a research strategy was followed in order to answer the third and fourth sub-research questions. In short, case study evaluated the current status of CP and energy efficiency implementation through the interview and questionnaires with the textile factories of Pakistan. Notably, the most impacting factors that hinder CP and energy efficiency implementation were assessed. Also, the effectiveness of policies and initiatives of Pakistan were evaluated through the interview and questionnaires. However, in order to obtain access to the required data, the anonymity of textile factories and confidentiality of the responses were ensured. Finally, the data and information obtained through above-mentioned steps were analyzed to develop recommendations in order to promote CP and energy efficiency in the industrial sector and particularly in the textile sector of Pakistan i.e. to answer the main research question.

## 3.2. Data Collection

Research data was collected through desk research and case study. The review of policies and initiatives (see sections 3.2.1 and 3.2.2) was performed and required data was collected through the desk research strategy. Moreover, the current status and the barriers and drivers to CP and energy efficiency implementation in the textile factories of Pakistan were evaluated (see section 3.2.3), and the required data was collected through the case study. The details of data collection methods are as follows:

### 3.2.1. Review of Policies and Initiatives of Pakistan

The policies and initiatives of Pakistan relevant to CP and energy efficiency were reviewed in order to answer the first sub-research question. In particular, National Environmental Policy (2005), National Climate Change Policy (2012), National Power Policy (2013), National Energy Conservation Policy (2006), National Industrial Policy (2011), and Textile Policies (2009 and 2014) were reviewed (see section 4.2). The above-mentioned policies are directly or indirectly relevant to promote CP and energy efficiency in the industrial sector of Pakistan. Also, many relevant initiatives such as PISD, SCI-Pak, CTP-Textile, and REEE-Pakistan were reviewed (see section 4.3). The effectiveness of above-mentioned policies was assessed through the interviews with the textile factories. Similarly, the effectiveness of above-motioned initiatives was evaluated on a scale of 0-4 through the questionnaires (see section 3.3). In addition, the strengths and weaknesses of above-mentioned policies and initiatives were revealed through the analysis.

### 3.2.2. Review of Policies and Initiatives of Regional Countries

The policies and initiatives of other regional countries (China, India, and Bangladesh) relevant to CP and energy efficiency were reviewed in order to answer the second sub-research question. This review includes policies and initiatives of China including CP promotion law and CP audits (see section 5.1), policies and initiatives of India (see section 5.2), and policies and initiatives of Bangladesh (see section 5.3). Notably, the key lessons and successful measures were revealed through the analysis of policies and initiatives of other regional countries.

The reasons for selecting China, India, and Bangladesh for the review of other countries' policies and initiatives are as follows:

- China, India, and Pakistan are neighboring countries and the members of RECPnet[16]. Moreover, China and India established their National Cleaner Production Centre (NCPC) in 1995 and they have the highest number of CDM projects[17].
- Bangladesh, India, and Pakistan are the members of SAARC[18]. Moreover, they are considered as developing economies in South Asia. The economic growth of these countries is mostly based on industry. However, the industries of these countries are highly dependent on fossil fuels. Therefore, these countries need to promote cleaner production (CP) and energy efficiency in their industrial sector.
- China and India represent BRIC[19] whereas Bangladesh and Pakistan represent the Next Eleven (N-11)[20] countries. As aforementioned, these countries have high potential to become world largest economies[21] in the 21st century.

[16] RECPnet is the global network for promoting the widespread adaptation and adoption of Resource Efficient and Cleaner Production in developing and transition economies. As patron agencies, UNIDO and UNEP, provide support for RECPnet through their joint RECP Programme. Retrieved 18 July 2016, from http://www.recpnet.org/members

[17] China and India have respectively 56.0% and 29.4% of the total CDM projects in Asia. Retrieved 18 July 2016, from http://www.cdmpipeline.org/cdm-projects-region.htm

[18] The South Asian Association for Regional Cooperation (SAARC) is regional intergovernmental organization and geopolitical union in South Asia. Its member states include Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan, and Sri Lanka. SAARC comprises 3% of the world's area, 21% world's population, and 9.12% of the global economy as of 2015. Retrieved 18 July 2016, from http://www.saarc-sec.org/

[19] BRIC is a grouping acronym refers to countries Brazil, Russia, India, and China.

### 3.2.3. Case Study of Textile Sector of Pakistan

In order to answer the third and fourth sub-research questions, a case study approach was chosen as a research strategy. The specific goal of the case study was to evaluate the current status and to find out the barriers and drivers to the implementation of CP and energy efficiency in the textile factories of Pakistan. The data was collected through structured questionnaire (see Appendix-A) and semi-structured interview (see Appendix-B). In total, 39 textile factories responded to the structured questionnaire and 2 textile factories responded through the semi-structured interview. In conclusion, the most significant barriers and drivers to CP and energy efficiency were identified. Also, the statistics and the options or tools to promote CP and energy efficiency were identified through this case study.

Table 3.1: Research Strategy, Data Collection Tools, and Expected Outcomes of the Research

| Research Question | Research Strategy | Data Collection Tools | Expected Outcomes |
|---|---|---|---|
| 1. What policies and initiatives have been introduced to promote CP and energy efficiency (EE) in the industrial sector of Pakistan and particularly in the textile sector? And how effective are these policies and initiatives? | Review of national policies and initiatives:<br>• Environmental Policies<br>• Climate Change Policies<br>• Energy Policies<br>• Industrial Policies<br>• Textile Policies<br>• CP and energy efficiency initiatives. | • Desk Research<br>• Questionnaire<br>• Semi-structured interview | • Policy instruments applied<br>• Effectiveness of relevant policies and initiatives<br>• Strengths and weaknesses of relevant policies<br>• Weaknesses or flaws of CP and energy efficiency initiatives |
| 2. How have regional countries promoted CP and energy efficiency (EE) in their industrial sector and particularly in the textile sector? | Review of regional countries' policies and initiatives related to CP and energy efficiency. | • Desk Research | • Policy instruments applied<br>• Successful measures and initiatives<br>• Lessons for Pakistan |
| 3. What is the present level of CP practices and energy efficiency (EE) measures adopted by the textile factories in Pakistan? | Analysis of CP and energy efficiency (EE) adoption in the textile factories of Pakistan. | • Questionnaire<br>• Semi-structured interview | • Present status (statistics) of CP and EE adoption in textile factories<br>• Options or tools to promote CP and EE |
| 4. What are the barriers and drivers to the implementation of CP and energy efficiency (EE) in the textile factories of Pakistan? | Analysis of the barriers and drivers to CP and energy efficiency (EE) implementation in textile factories of Pakistan. | • Questionnaire<br>• Semi-structured interview | • Identification of most significant barriers and drivers to CP and energy efficiency in textile factories<br>• Recommendations |

[20] The Next Eleven (N-11) are the eleven countries - Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, Turkey, South Korea and Vietnam - identified by Goldman Sachs investment bank and economist Jim O'Neill in a research paper as having potential to be world's largest economies in the 21st century.

[21] The potential to become world largest economies is measured on the assumption that GDP is the measure of the size of the economy. Retrieved 18 July 2016, from http://www.theglobeandmail.com/report-on-business/economy/economy-lab/daily-mix/on-10th-birthday-brics-poised-for-more-growth/article2264208/

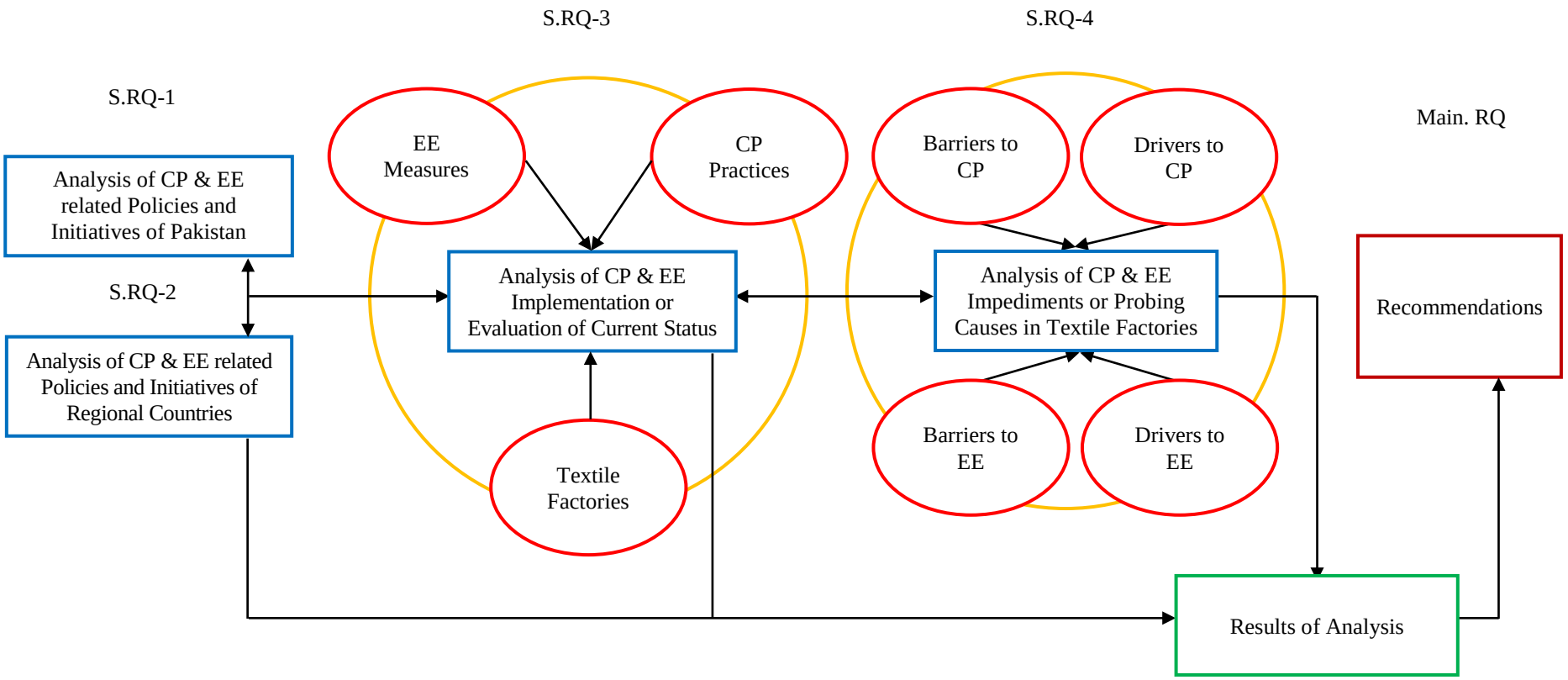
### 3.3. Data Analysis

This research accessed data from both primary and secondary sources of information. Moreover, this research data possessed both qualitative and quantitate information which was analyzed accordingly. The data obtained from the questionnaires were analyzed using simple statistical techniques and their results were represented by charts. For instance, the effectiveness of the relevant initiatives was evaluated on a scale a scale of 0-4 with an assigned weighted value for each term i.e. none (0), low (1), average (2), above average (3), and high (4). In short, the effectiveness of policies was evaluated using a weighted average of the responses i.e. data collected from the textile factories. However, the most significant barriers and drivers were evaluated on a scale of 0-1 with an assigned weighted value for each term i.e. rarely important (0), sometimes important (0.5), and often important (1). Similarly, all questions of the questionnaire were accordingly analyzed either using weighted average or percentage (see Appendix-A). In addition, the qualitative analysis was performed to analyze the data obtained from desk research as well as the contents of the interviews. In short, firstly, the interview transcript was summarized and then the key information was extracted in order to answer the sub-research questions.

### 3.4. Analytical Framework

An analytical framework was developed in order to answer the main research question. Figure 3.1 shows the analytical framework for this research.

Figure 3.1: A Schematic Representation of Analytical Framework



### 3.5. Data Limitations

This research encountered some limitations, particularly in data collection. However, these limitations do not defeat the objective of this research.

- CP has been under development phase in Pakistan. Also, it is rarely studied in Pakistan. Therefore, the literature related to CP in Pakistan is extremely scarce.
- There are very few experts of CP in Pakistan who are directly working in this field.
- The questionnaire developed for this research is very specific to CP and energy efficiency. It could only be filled up by very selective personnel from the textile factories i.e. someone who has knowledge on the subject e.g. top management, EHS Manager, and Energy Manager. Hence, identifying and contacting the right person was a very difficult task.
- In total, 70 textile factories were sent questionnaires and 4 textile factories were requested for an interview. However, 31 textile factories did not respond due to hierarchy and poor communication issues. In total, 39 textile factories responded to the questionnaire and 2 textile factories responded through the interview. Moreover, there was a very limited time to collect data. In short, this research could provide a better picture if a large number of textile factories had participated.
- The participants were also reluctant to provide vital information even though the confidentially of the information was assured.

# CHAPTER FOUR: POLICIES AND INITIATIVES OF PAKISTAN

This chapter answers the first sub-research question: what policies and initiatives have been introduced to promote CP and energy efficiency in the industrial sector of Pakistan and particularly in the textile sector? And how effective are these policies and initiatives?

## 4.1. Background

Pakistan realizes the significance of industrialization as a means of poverty alleviation and economic development. Hence, industrialization has always been one of the major objectives of the development planning in Pakistan. There was no question of environmental protection or sustainable development in Pakistan before the 1980s. However, Pakistan decided to get onto the international environmental bandwagon thus promulgated the Pakistan Environmental Protection Ordinance (PEPO) in 1983. Furthermore, Pakistan also took serious actions as the environmental movement gripped the world attention after Rio Conference in 1992. For instance, National Conservation Strategy (NCS) was developed in 1993, Pakistan Environmental Protection Act (PEPA) was promulgated in 1997, and during the same period Environmental Protection Agencies (EPAs) were established, and National Environmental Quality Standards (NEQS) were approved and implemented.

Environmental problems caused by the industrial pollution have increased global demand for environmentally-friendly products and services. Hence, the international trade organizations have been incorporating environmental problems into their policy framework. However, the industrial sector of Pakistan has been facing challenges in mobilizing the investments and the human resources needed to meet these demands. To cope with this situation, the Government of Pakistan developed new policies and established National Cleaner Production Center (NCPC). The policy measures and initiatives adopted by Pakistan to promote CP and energy efficiency are as follows.

## 4.2. Policies of Pakistan

The Government of Pakistan has been formulating various policies to address issues related to environment, energy, and industries. However, this section focuses only those policy objectives and measures which are directly or indirectly relevant to promote CP and energy efficiency.

### 4.2.1. Environmental Policy

Pakistan has been facing environmental problems both of a green and a brown nature. The green issues mainly include environmental problems of irrigated agriculture, rainfed agriculture, forests, and rangelands. The brown environmental problems include industrial wastewater pollution, domestic wastewater pollution, motor vehicle emissions, urban and industrial air pollution, and marine and coastal zone pollution. UNIDO (2000) alarmed that the industrial pollution in Pakistan has been increasing and its impacts are significant and worsening. It has been observed that effective environmental policies and regulations always have a greater impact on industries than the industrial policies itself because they directly address the environmental problems at the source and force industries to internalize environmental costs. However, the environmental legislation in Pakistan goes a long way back but there have been no effective policies until recently to ensure both industrial growth and environmental sustainability.

The Ministry of Environment developed the National Environmental Policy (2005-2015) which aims to protect, conserve and restore the environment of Pakistan in order to improve the quality of life for its citizen through sustainable development. It addresses the sectoral issues such as water management, energy efficiency, agriculture, forestry, biodiversity, climate change, pollution, health, trade and waste management etc. Two relevant goals of this environmental policy are as follows:

- Conservation, restoration and efficient management of environmental resources.
- Meeting international obligations effectively in line with the national aspirations.

The National Environmental Policy (2005-2015) suggested the following measures, which are directly or indirectly relevant to promote CP and energy efficiency in the industrial sector of Pakistan.

- Establish cleaner production centers to promote cleaner production technologies and practices.
- Devise and implement master plans for treatment of municipal and industrial wastewater.
- Devise and implement National Energy Conservation Policy.
- Institute the National Energy Conservation Award.
- Give preferential status and tax incentives to energy efficient domestic products and imports.
- Promote renewable energy (wind, solar, biogas etc.) at all levels.
- Encourage use of waste resources for energy production.
- Encourage reduction, recycling and reuse of municipal and industrial solid and liquid waste.
- Ensure effective implementation of NEQS and self-monitoring rules.
- Promote ISO 14000 certification.
- Ensure reduction and control of harmful emissions through regulatory programs.

In order to enforce environmental regulations relevant authorities also took some actions. For instance, Pakistan Environmental Protection Council (PEPC) developed a software i.e. Self-Monitoring and Reporting Tool (SMART) to be used by the industrial units in the country to generate systematic reports of their environmental data and send it to Pakistan Environmental Protection Agency (Pak-EPA) for compilation and analysis. Moreover, Pak-EPA has recently incorporated a parastatal company named Clean Environment Fund. The objective of the company is to create funding and mobilize resources for environmental protection activities.

### 4.2.2. Climate Change Policy

Pakistan is among the countries whose contribution to the total global GHG emissions is very low. However, Pakistan is among top 10 countries which are most vulnerable to the climate change (Germanwatch, 2015). Hence, Pakistan has been working on a strategy that seeks to conserve energy, improve energy efficiency, and optimize fuel mix to support global efforts for the reduction in GHG emissions. The Ministry of Climate Change promulgated the National Climate Change Policy in 2012 in order to ensure climate resilient development. Three relevant goals of this climate change policy are as follows:

- To pursue sustainable economic growth by appropriately addressing the challenges of climate change.
- To ensure water security, food security and energy security of the country in the face of the challenges posed by climate change.
- To promote conservation of natural resources and long-term sustainability.

The major industries in Pakistan include textiles, fertilizers, cement, sugar, steel, and large petrochemical plants. These industries significantly contribute to the total GHG emissions of the country. However, energy efficiency, energy conversation, and demand reductions provide an excellent and cost-effective ways to ensure sufficient energy supply in order to achieve economic development without compromising GHG emissions or climate change. Therefore, the National Climate Change Policy-2012 also suggested various measures not limited to the following:

- Incorporate economic incentives to promote emission-reduction by upgrading industrial processes and technologies.
- Prepare voluntary Corporate Social Responsibility (CSR) guidelines and encourage the corporate sector to create a CSR fund to cover carbon emission reduction efforts in the industrial sector.
- Promote integration of the Cleaner Production (CP) strategy in the industrial sector by making more efficient use of inputs such as energy, water, and raw materials.
- Promote the use of energy efficient motors in the industrial sector.
- Encourage the industrial sector to have periodic Energy Efficiency Audits.
- Develop the capacity to monitor and estimate emissions locally for each industry.
- Ensure that technology transfer is accelerated for industries like cement manufacturing, to control emissions without hampering the production process.
- Install plants to generated power from municipal waste.
- Strive to conserve energy and improve energy efficiency in all energy using devices and processes.
- Incentivize CDM projects in the field of energy efficiency and energy conservation.
- Improve energy efficiency in building by standardizing building and construction codes and legislating / creating incentives for retrofitting, maximum use of natural light, better insulation and use of energy efficient lights, boilers, appliances and groundwater pumping units.
- Promote and gradually make it mandatory to specify the energy efficiency/fuel consumption rates of energy using equipment and devices of common use.
- Promote and provide incentives for activities required for increasing the energy mix and switching to low-carbon fossil fuels, and develop indigenous technology for carbon capture & storage (CCS) waste heat recovery, cogeneration, and combined cycle power generation.

Recently, the government of Pakistan has announced to establish a Climate Change Council under the Climate Change Act-2016. It has been expected that the proper implementation of above-mentioned measures will promote CP and energy efficiency in the industrial sector of Pakistan.

### 4.2.3. Energy Policy

Energy is the lifeline of an economy and is a vital input to sustain industrial, commercial and domestic activities. The energy crisis in Pakistan had been brewing since 2007 and deepened in 2012 which negatively affected the economic growth, employment and social cohesion in the society. The Ministry of Water & Power promulgated National Power Policies in 1994, 1998, and 2002. However, these policies were failed to meet the future energy needs of the country. The absence of effective planning, an economically and financially viable strategy, and incapacitated regulator resulted in the supply-demand gap. The situation has been further compounded due to high transmission and distribution losses (23-25%), the development of black-market for power, and declining revenue collection (Ministry of Finance, 2014).

The Ministry of Water & Power announced an ambitious Power Policy in 2013 to resolve the energy issues on the permanent basis. The National Power Policy-2013 aimed to provide affordable energy through efficient generation, transmission, and distribution system. According to Shahid (2014), this power policy can be reduced to two major goals i.e. reducing the power shortfall from 5500 MW to zero by 2017 and enhancing the energy mix by incorporating renewable energy sources. Pakistan is blessed with an abundance of renewable energy potential but this potential has not been harnessed except for large hydroelectric projects. The Renewable Energy Policy of Pakistan was developed in 2006 which envisages mainstreaming of renewable energy in the development plans of the country. Also, Alternate Energy Development Board (AEDB) has been mandated to act as a central agency for development and promotion of Alternative & Renewable Energies (AREs) in the country and to facilitate the private sector investment in this sector.

The National Energy Conservation Policy was developed and approved by the Government of Pakistan in 2006. Four main goals of this policy are as follows:

- To foster energy conservation through stimulation of resources and regularizing total energy management programs in all sectors of the economy.
- To develop energy conservation market and facilitate commercialization by creating awareness and launching nation-wide demonstration projects.
- To maximize the demand for energy from indigenous resources.
- To create an enabling environment to reduce the energy intensity of different energy consuming sectors through appropriate technological and policy measures, so as to promote sustainable growth.

Recently, the Government of Pakistan has assigned a wide range of functioning powers to the National Energy Conservation Centre (ENERCON) through the National Energy Efficiency and Conservation Act-2015. Hence, it has been expected that the National Energy Conservation Policy will directly or indirectly promote CP and energy efficiency in the industrial sector of Pakistan.

### 4.2.4. Industrial Policy

The Government of Pakistan established the Ministry of Industries & Production in the early 1950s with a mission to formulate and implement a comprehensive strategy for industrialization in Pakistan. According to SDPI (2000), the Government of Pakistan formulated industrial policies

either in response to a crisis or as part of the medium-term development plans but most of them were never actualized. Moreover, these industrial policies were formulated irrespective of environmental considerations until recently. Dawn (2012b) reported that the Government of Pakistan introduced Industrial Policy-2011 with an unrealistic vision to turn Pakistan into "a factory for the world rather than a shop". Two relevant goals of the Industrial Policy-2011 are as follows:

- Diversification from traditional resource-based / low technology enterprise to medium and high technology enterprise.
- Rapid growth of industrial competitiveness and value addition.

The Industrial Policy-2011 suggested the following measures, which are directly or indirectly relevant to promote CP and energy efficiency in the industrial sector of Pakistan.

- A pilot project to encourage the adoption of cleaner production technologies will be launched. Tax incentives and tax rebates will be afforded to companies which establish effluent treatment plants and testing and certification laboratories. The government will allocate sufficient funds for the establishment of landfill sites of hazardous and nonhazardous waste. Finally, the government will revise the NEQS to ensure they are industry specific.
- The government will encourage investments in improvement business processes and technologies by fostering strategic alliances with foreign entities. A sustained effort will be made for internal technology transfer from innovative and productive organizations to those who are lagging behind.
- The government will prioritize the provision of energy to manufacturing industry over other users. Current energy tariffs will be replaced with a cascading structure with industry paying the lowest tariff and domestic consumers paying the highest.

### 4.2.5. Textiles Policy

The Government of Pakistan established the Ministry of Textile Industry in 2004 with a mission to sustain the growth of the textile sector in an increasingly competitive environment while effectively responding to the challenges and opportunities provided by the globalization of trade and providing a forum to the textile industry for a mutually beneficial interface. The Ministry of Textile Industry promulgated two policies namely as Textiles Policy (2009-2014) and Textiles Policy (2014-2019).

The Textiles Policy (2009-2014) was introduced with a vision of an integrated textiles value chain that adds fullest value to the country's potential by serving domestic needs and high-value exports demand through a well-planned industrial structure, product diversification, and institutional framework. Two relevant goals of this textiles policy are as follows:

- Facilitate the textile sector to develop international and domestic demand demand-driven capabilities.
- Evolve a legislative framework that sets standards for each stage of processing with a view to increasing productivity, improving quality, ensuring optimum utilization of resources and promoting compliance.

The Textiles Policy (2014-2019) was introduced with a vision to become a leading country in the field of export of value-added textile products. Three relevant goals of this policy are as follows:

- Make textiles sector domestically and internationally compliant especially with respect to labor and environment rules and conventions.
- Encourage textiles units to use modern management practices for improving efficiency and reducing wastages.
- Adopt measures to increase ease of doing business and reducing the cost of doing business.

The Textiles Policy (2014-2019) suggested the following measures, which are directly or indirectly relevant to promote CP and energy efficiency in the textile sector.

- To achieve compliance with international standards, the textile units in the value added sector would be provided Long Term Financing Facility (LTFF) for technology up-gradation from State Bank of Pakistan (SBP) at the rate of 9% for 3-10 years duration.
- The duty-free import of machinery under Textiles Policy (2009-2014) i.e. the facility (SRO 809) would be extended for another two years.
- Textiles associations would be facilitated to carry out energy audits and productivity analysis within their member units.
- To attain international compliance in Occupational Health & Safety (OHS), training would be provided to the SMEs in partnership with provincial governments, ILO, and other agencies.
- The government would identify areas where Effluent Treatment Plants (ETP) can be established through public-private partnerships.
- To establish Combined Effluent Treatment Plant (CETP) in Faisalabad, the government would seek funding from international donors and operational costs would be provided by the processing industry.
- To fully utilize the GSP+ status, energy provision would be prioritized for the textile sector.

### 4.2.6. Summary of Relevant Policies of Pakistan

Table 4.1 shows the summary of above-mentioned policies of Pakistan. It also indicates the policy instruments applied and the measures taken to promote CP and energy efficiency.

Table 4.1: Summary of Relevant Policies of Pakistan

| Name of Policy | Type of Policy Instrument | Measures to promote CP and Energy Efficiency |
|---|---|---|
| National Environmental Policy (2005-2015) | Regulatory Instrument | ➢ Ensuring reduction of harmful emissions by enforcing a penalty or punishment for violating regulations.<br>➢ Ensuring effective implementation of NEQS through self-monitoring and reporting i.e. SMART software. |
| | Economic Instrument or MBI | ➢ Encouraging technology up gradation to safeguard the environment by giving financial incentives e.g. low-interest loans and tariffs reduction.<br>➢ Encouraging energy efficient products by giving tax incentives and preferential status. |
| | Information and Other Instruments | ➢ Promoting CP technologies and practices by establishing CP centers.<br>➢ Promoting energy efficiency and waste-to-energy by establishing the National Energy Conservation Award. |
| National Climate Change Policy (2012) | Regulatory Instrument | ➢ Improving energy efficiency by enforcing building codes and regulations. |
| | Economic Instrument or MBI | ➢ Promoting energy mix and switching to low-carbon fuels by providing financial incentives.<br>➢ Encouraging technology up gradation for emissions reduction by providing incentives.<br>➢ Encouraging CDM projects for energy efficiency and conservation through economic or fiscal incentives<br>➢ Promoting the use of energy efficient lights, boilers, motors, and appliances by creating incentives. |
| | Information and Other Instruments | ➢ Monitoring emissions through the capacity development in all industry.<br>➢ Promoting energy efficiency by encouraging periodic energy efficiency audits.<br>➢ Promoting energy efficiency through mandatory labeling of fuel consumption rates on all equipment and devices in the factories. |
| National Energy Conservation Policy (2006) | Regulatory Instrument | ➢ Promoting energy efficiency by enforcing regulations and banning inefficient equipment and appliances. |
| | Economic Instrument or MBI | ➢ Promoting regular energy audits through subsidies.<br>➢ Encouraging installation of fast-payback energy conservation measures by providing incentives. |
| | Information Instruments | ➢ Promoting energy conservation by creating awareness and launching nation-wide demonstration projects. |
| National Industrial Policy (2012) | Economic Instrument or MBI | ➢ Encouraging factories to establish effluent treatment plants by providing tax incentives and tax rebates.<br>➢ Encouraging CP adoption by facilitating technology transfer from foreign countries. |
| | Information Instrument | ➢ Promoting CP adoption by creating awareness and launching pilot projects. |
| National Textiles Policy (2014-2019) | Economic Instrument or MBI | ➢ Encouraging technology up gradation for CP implementation by providing Long Term Financing Facility-LTFF (loan at 9%). |
| | Information and other instruments | ➢ Promoting energy efficiency by facilitating energy audits and productivity analysis.<br>➢ Encouraging factories to achieve environmental compliance by providing training<br>➢ Establishing effluent treatment plants (ETP) by encouraging public-private partnerships. |

### 4.3. Initiatives of Pakistan to Promote CP and Energy Efficiency

The idea of CP and energy efficiency brought the focus of donor agencies, environmental protection agencies and other stakeholders for the improvement of environmental conditions in the industrial sector of Pakistan. Notably, Embassy of Kingdom of The Netherlands (EKN) has been involved in promoting CP and energy efficiency in Pakistan under public-private partnership since 1994. The various initiatives introduced in Pakistan are as follows:

#### 4.3.1. Cleaner Production Institute (CPI)

CPI is an independent, non-profit, network-based organization with a mission to enhance industrial productivity through the transfer of environmental knowledge and technology. It executes environmental and energy-related development projects in different industrial sectors of Pakistan. Currently, it has been providing services to leather, textile, sugar, and paper sectors which are extendable to other industrial sectors. CPI offices are located in Lahore, Karachi, and Faisalabad. It operates under the managing committee comprising of industry representatives and technical professionals. CPI has following four major divisions.

- Research Division
- Development Projects Division
- Publication & Training Division
- Finance Division

The main partners of CPI include EKN, multilateral organizations (World Bank, UNDP, and UNICEF), NGOs (WWF, IUCN, and local organizations) and the private sector. CPI has introduced following initiatives in Pakistan during last 15 years (CPI, 2015a).

- Cleaner Technology Program for Korangi Tanneries (CTP-KT, 2003-2008)
- Introduction of Cleaner Technologies in Punjab Tanneries (ICTP, 1998-2006)
- Introduction to Cleaner Production in Textile Sector
- Environmental Technology Program for Industry (ETPI, 1996-2001)
- Cleaner Production Program (CPP, 2002-2003)
- Cleaner Technology Program for Textile Sector (CTP, 2000-2002 & 2004-2007)
- Energy Conservation Program for Tanneries (ECPT, 2005-2008)
- Program for Industrial Sustainable Development (PISD, 2007-2010)
- Combined Effluent Treatment Plant for Korangi Tanneries (CETP, 1998-2006)
- Sustainable and Cleaner Production in Manufacturing Industries (SCI-Pak, 2009-2013)
- More than 100 Environmental Impact Assessments for New Projects
- More than 200 Environmental Audits of Different Industrial Units
- Establishment of Cleaner Production Centers

The major stakeholders which participated and contributed to the above-mentioned initiatives include industry associations, partner industrial units, Pakistan Chamber of Commerce and Industry, Environmental Protection Agencies (EPAs), technology vendors, R&D institutions and international agencies whereas CPI served as a focal organization. According to Rafiq (2015), CP initiatives

resulted in the implementation of Cleaner Production Technologies at process level in 250 factories including 120 tanneries, 60 textile mills, and about 70 other factories. Also, CPI (2015b) reported following achievements.

- Institutional capacity of industrial associations was developed with the establishment of environmental committees.
- Laboratory of Environmental Sciences was established to provide comprehensive testing facilities.
- International collaborations led to research, customization, and transfer of technology.
- Industries got an investment of more than PKR 1.5 billion.
- Future investments expected by industries are about PKR 1.0 billion.
- 13000 people were trained from industry and other stakeholder institutions.
- Combined effluent treatment plant was installed to serve 170 tanneries and more than 20 individual treatment plants were installed by industrial units.

It was never easy for CPI to accomplish above-mentioned achievements as CP implementation process passed through many active and passive periods in Pakistan. CPI has been confronting many challenges such as inconsistent economic growth rate of the country, changes in political make-up of the government which leads to policy and institutional changes, the fluctuating behavior of industrial associations due to their political setup, changes in international trade climate, the energy crisis of the country, behavior and policies of enforcement agencies and shifting priorities of the donor and bilateral development agencies.

### 4.3.2. Cleaner Technology Program for Textile (CTP-Textile)

CPI introduced Cleaner Technology Program for Textile Sector (CTP-Textile)[22] with a mission to make textile factories environmental friendly. CTP-Textile mainly focused on the capacity building of the textile processing sector for compliance with the international environmental standards. The goals of CTP-Textile were as following.

- To create awareness about the key environmental issues, health and safety concerns and environmental legislation.
- To improve process efficiency and resource conservation.
- To help in enhancing workforce productivity due to healthier and efficient work environment.
- To conduct environmental audits and preparation of environmental action plans to implement cleaner technology for source pollution abatement.
- To prepare a detailed design for implementation of wastewater treatment plants.
- To assist textile processing mills to implement environmental management system (ISO 140001) and to get eco-label certifications.

[22] The stakeholders involved in CTP-Textile includes Cleaner Production Institute (as a project executor), Embassy of Kingdom of the Netherlands (as a financial supporter), Royal Heskoning and NEC-Consultants (as technical assistance providers), All Pakistan Textile Processing Mills Association (as a textile processing mills representative association), and textile processing mills (as participants). In addition, CPI coordinated with Ministry of Environment, Pakistan Environmental Protection Agency (PEPA), and Provincial Environmental Protection Agencies (EPAs).
Initially, the number of textile mills involved in CP activities was less. However, the number of textile mills joining similar initiative Programme for Industrial Sustainable Development (PISD) is increasing.

The key activities of CTP-Textile were as following.

- Environmental Audits
- Environmental Action Plans (EAP)
- Environmental Management System (ISO-14001 Certification)
- Waste Water Treatment Plans (WWTP)
- Eco-Label Certification
- Training and Human Resource Development
- Dissemination and Communication

CPI conducted environmental audits in textile factories to observe the practices and consumption patterns for dyes, chemicals, and utilities. CPI followed UNIDO and UNEP standards to conduct the environmental audits. According to CPI (2015c), environmental audits were conducted in total 100 selected (29 Karachi, 29 Lahore, and 42 Faisalabad) textile processing units and the findings were solved through implementation of cleaner technologies. CPI also proposed appropriate action plans to the textile factories along with cost and benefit analysis. CTP-Textile assisted the implementation of environmental management system in the textile factories. It also offered design of wastewater treatment plants along with construction supervision and commissioning of the plant. It disseminated the information and knowledge through different events, publications, and website. Moreover, CTP-Textile invited highly skilled foreign trainers from CREM, TNO, and Royal Heskoning to build the capacity of textile industry personnel.

### 4.3.3. Cleaner Technology Program for Korangi Tanneries (CTP-KT)

CPI introduced Cleaner Technology Program for Korangi Tanneries (CTP-KT) in order to implement cleaner technologies and to adopt better working practices for better environmental performance. The approach of the program was to implement proposed environmental solutions in a logical sequence under a cost-effective framework with direct and indirect financial solutions. The goals of CTP-KT were as following.

- To introduce and implement cleaner technology options and occupational health and safety program in the Korangi Tannery cluster.
- To implement an Environmental Management System (EMS) to achieve ISO-14000 certification.
- To provide assistance in self-monitoring program.
- To develop and initiate solid waste management program at the cluster level.
- To utilize CETP as a demonstration project for introducing UASB technology (cost effective and technologically simple waste water technology), to enable a large number of industries and municipalities to implement wastewater treatment plant projects.

### 4.3.4. Programme for Industrial Sustainable Development (PISD)

CPI in collaboration with EKN initiated Programme for Industrial Sustainable Development (PISD) in 2007. The objective of PISD was to enable major industrial sectors of Pakistan to comply with international environmental requirements and to adopt best energy efficiency practices. In addition,

many multi-faced benefits were also expected from PISD such as implementation cleaner production, energy efficient technologies, and environmental management systems in 256 industrial units (NEC, 2010). Under PISD, CPI teams in Lahore, Karachi and Faisalabad provided technical services to the industry on energy efficiency, cleaner production technology, wastewater treatment, environmental management system and CSR. The goals of PISD were as following.

- To increase awareness about environmental and energy issues amongst at least 1500 industrial personnel.
- To increase competitiveness and market image of 4 major industrial sectors of Pakistan through resource conservation, environmental compliance, and pollution control etc.
- To establish institutional coordination between industrial associations and ministries for dovetailing environmental issues into national industrial policies.
- To improve workforce productivity through better occupational health and safety conditions.
- To improve industrial relations with R&D institutions, certification, and legal bodies, vendors, and other stakeholders.

The key activities of PISD were as following

- Institutional Development
- Training and Human Resource Development
- Cleaner Technologies and Energy Efficiency
- Corporate Social Responsibility (CSR)
- Environmental Management System and Certification
- Waste Water Treatment Plants
- Cleaner Production and Energy Efficient Technologies and WWTP Performance Reports
- Dissemination and Communication

### 4.3.5. Sustainable and Cleaner Production in the Manufacturing Industries of Pakistan (SCI-Pak)

CPI introduced several CP initiatives which primarily focused on assessment of needs, energy audits, provision of technical assistance to the industry in adopting energy efficiency and wastewater recycling techniques and raising awareness of cleaner production packages. Despite these CP initiatives, the target sectors were lacking the capacity for the application of sustainable production technologies and awareness of the environmental impacts and potential financial benefits associated with them. Hence, SCI-Pak project was introduced to develop a model for sustainable production through the implementation of energy and resource recovery initiatives in the textile and tannery sectors of Pakistan, with the potential to adapt these initiatives to other manufacturing industries. SCI-Pak project was funded by the European Commission whereas ttz Bremerhaven-Germany, CSCP-Germany, and IHT-Pakistan were the project partners.

The overall objectives of SCI-Pak project were as following.

- To improve the energy and resource efficiency of textile and tannery industries of Pakistan along the complete process chain.
- To increase the technological capacity of textile and tannery industries of Pakistan and to induce the technical innovations for promoting the indigenization of technologies.

- To minimize GHG emissions and to enhance the share of renewable energy technologies.
- To widen the scope of sustainable production at the local, national and international levels.
- To create an enabling environment for promoting sustainable production amongst the targeted industrial sectors.
- To strengthen the links between EU and Pakistan for research and industry from the technology to the policy level.

The key activities of SCI-Pak project were as following.

- Life Cycle Analysis (LCA) of textile and leather processing industries.
- Capacity assessment of local industrial equipment manufacturers for technology transfer.
- Transfer of technology of energy and resource efficiency equipment manufacturing to local IEMs and universities.
- Implementation of energy efficient pilot initiatives along the entire production chain.
- Development of business cases for energy and resource efficiency initiatives.
- Creation of a sustainable production network.
- Creation of an enabling environment.
- Policy dialogue and dissemination.

### 4.3.6. Program for Environmental Research and Training

CPI also introduced Program for Environmental Research and Training. CPI in collaboration with WWF-Pakistan[23] and LEAD-Pakistan successfully organized following training workshops.

- Cleaner Production in Textile Sector
- Cleaner Production in Pharmaceutical Sector
- Best Water Management Practices in Textile Sector and Sugar Sector
- National and International Business Scene

### 4.3.7. Energy Conservation in Punjab Tanneries (ECPT)

Keeping in view of the inefficient use of energy in tanneries, Pakistan Tanners Association-Northern Zone (PTA-NZ) with the financial assistance of EKN initiated Energy Conservation in Punjab Tanneries. ECPT provided free services for three years[24] (August 2005 to July 2008). The goals of ECPT were as following.

[23] World Wide Fund for Nature - Pakistan (WWF-Pakistan) through its project Promoting Better Environmental Practices in the Textile Processing Industry of Pakistan plans to (i) generate knowledge on better environmental management practices in the textile processing sector through research and information sharing with EU. (ii) Do capacity building of textile sector personnel through international consultants. (iii) And promote environmental reporting in the sector through organizing awareness session and rewarding industries for their transparency. The project has been funded by EU-Small Grants Facility.
Recently, WWF-Pakistan in collaboration with CPI also organized a workshop to train industrialists on efficient use of water and energy. Retrieved 18 July 2016, from http://www.wwfpak.org/newsroom/8514_watermanagement.php, and http://www.wwfpak.org/newsroom/170415_leathersector.php

[24] CPI team evaluated ECPT and reported that all the economic benefits were successfully achieved. . Retrieved 18 July 2016, from
http://www.cpi.org.pk/ECPTPFirstPagePDF/Case%20Study%20of%20an%20energy%20efficient%20tannery.pdf

- To make tanneries, energy efficient in their operations.
- To reduce air emissions in line with the deliberations of Kyoto Protocol.
- To reduce the production costs.
- To provide free of cost consultancy services to selected tanneries in Punjab.
- To control environmental pollution and conserve natural resources.

### 4.3.8. The National Energy Conservation Centre (ENERCON)

The National Energy Conservation Centre (ENERCON) was established in 1987. ENERCON serves as the national focal agency mandated for initiating, catalyzing and coordinating all energy conservation and energy efficiency activities in all sectors of the economy. The responsibilities of ENERCON are as following.

- Formulating energy conservation programs in all main energy consuming sectors.
- Planning and initiating energy conservation actions nationwide.
- Outlining policy guidelines to support energy conservation initiatives.
- Developing a comprehensive database of opportunities for energy conservation.
- Supporting training activities on energy conservation application.
- Undertaking field research and pilot demonstration activities on specific energy conservation options and technologies; and
- Monitoring the implementation of conservation programs by other public and/or private sector entities.

The key projects and services of ENERCON are as following.

- Energy Standards & Labeling Scheme
- Energy Audit Firm Registration
- Free Energy Assessment Audit (Energy Audit on Cost Sharing)
- Energy Efficiency School Campaigns
- Efficient Lighting (en.lighten) Project
- Certified Energy Managers
- Energy Conservation Fund
- National Energy Efficiency and Conservation Awards

### 4.3.9. Renewable Energy and Energy Efficiency-Pakistan (REEE-Pakistan)

GIZ-Germany launched REEE-Pakistan in 2005 along with AEDB and ENERCON as program partner institutions. The overall objective of the program was to improve the capacities of the public and private sector for both the promotion of renewable energy (RE) as part of rural electrification and the implementation of energy efficiency (EE) in small and medium-sized enterprises (SME). It supported the relevant industrial associations in the implementation of Energy Management System (EnMS) in the industrial sectors of Pakistan.

### 4.3.10. Summary of Relevant Initiatives of Pakistan

Table 4.2 shows the summary of above-mentioned initiatives introduced in Pakistan to promote CP and energy efficiency.

Table 4.2: Summary of Relevant Initiatives of Pakistan

| Name of Initiative | Years | Focused Industry | Key Activities |
|---|---|---|---|
| CTP-Textile | 2000-2002 and 2004-2007 | Textiles | ➢ Assisting in EMS certifications and eco-labeling<br>➢ Conducting Environmental Audits (EA)<br>➢ Conducting training and human resource development<br>➢ Creating awareness<br>➢ Designing Waste Water Treatment Plans (WWTP)<br>➢ Dissemination and communication<br>➢ Preparing Environmental Action Plans (EAP) |
| CTP-KT | 2003-2008 | Tanneries | ➢ Demonstrating CETP<br>➢ Developing waste management systems<br>➢ Identifying CP technology options<br>➢ Implementing EMS and ISO-14000 certification |
| REEE-Pakistan | 2005 | Textiles, Foundries, Steel Re-rolling, Edible Oil, and Dairy | ➢ Capacity building<br>➢ Implementing EnMS in SMEs<br>➢ Implementing Renewable Energy |
| ECPT | 2005-2008 | Tanneries | ➢ Creating awareness<br>➢ Dissemination and communication<br>➢ Identifying energy efficiency options |
| PISD-I and II | 2007-2010 And 2010-2013 | Textile, Tanneries, Sugar, and Paper | ➢ Capacity building<br>➢ Conducting training and human resource development<br>➢ Designing waste water treatment plans<br>➢ Dissemination and communication<br>➢ Establishing network between ministries and industrial associations.<br>➢ Implementing EMS and CSR<br>➢ Preparing WWTP performance reports<br>➢ Promoting technologies related to CP and energy efficiency<br>➢ Raising awareness at large scale |
| SCI-Pak | 2009-2013 | Textile and Tanneries | ➢ Conducting Life-Cycle Analysis (LCA)<br>➢ Capacity assessment and capacity building<br>➢ Creating network<br>➢ Transferring technology<br>➢ Developing business cases for energy and resource efficiency initiatives<br>➢ Policy dialogue and dissemination<br>➢ Demonstrating pilot initiatives |

### 4.4. Analysis of the Effectiveness of Policies and Initiatives of Pakistan

Effectiveness means the power to be effective i.e. the quality of being able to bring about an effect. Hence, the effectiveness of something can be judged by its effects[25] or the results achieved. Similarly, the effectiveness of aforementioned policies and initiatives can be judged through its effects on the industrial sector or by the results achieved. In addition, the strengths and weaknesses of the policies are also an important parameter to determine the effectiveness. This research particularly considered the perspective of textile factories in order to evaluate the effectiveness of aforementioned policies and initiatives. Therefore, textile factories were questioned about the effectiveness of aforementioned policies and initiatives through interview and questionnaire.

A textile factory concisely stated that textile factories realize the significance of CP and energy efficiency. However, most of the policies related to the textile sector are worth nothing more than just a piece of a paper. It indicates that though some good policies exist, but such policies are useless unless they are not properly implemented. In fact, there is weak enforcement system that spoils the worth of a policy. In addition, bureaucracy further complicates the implementation process of a policy. Similarly, another textile factory pointed out that policies lack consistency and practically they rarely get whatever the incentives or benefits are announced in the policies. It indicates that proclaimed incentives or benefits are not granted to the textile factories due to difficult bureaucratic procedures. In addition, political instability or changes in the political make-up of the government often lead to frequent changes in policies thus diminish the benefits. In short, the relevant legislations or policies seem okay but their effectiveness is questionable due to the above-mentioned reasons. Previously, SCI-Pak (2009) also evaluated the effectiveness of policies relevant to CP and energy efficiency. Table 4.3 shows whether legislation and policy exist in the particular area, whether it is appropriate and how well it is enforced.

Table 4.3: Effectiveness of Relevant Policies of Pakistan (Source: SCI-Pak, 2009)

| | | **Existence of Legislation** | **Appropriateness** | **Enforcement** |
|---|---|---|---|---|
| Relevant CP Aspects | Resource Efficiency (Raw Materials / Water) |  |  |  |
| | Energy Efficiency |  |  |  |
| | Solid Waste / Wastewater Treatment |  |  |  |
| | Laborers' Health & Safety |  |  |  |
| Factories' Specific Aspects | Factories' Capacities |  |  |  |
| | Technology Innovation |  |  |  |
| | Access to Finance |  |  |  |

 **Good**  **Medium**  **Challenging**

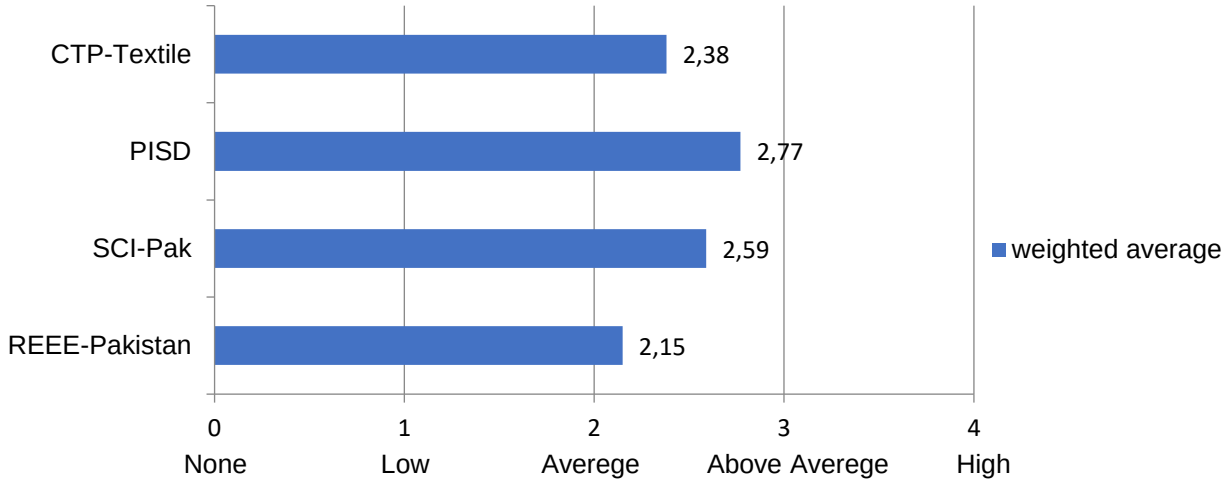
**Explanation**: The green dots stand for a good meeting of the criteria, yellow for medium and red for challenging. At the same time, the red dots indicate the biggest potentials for improvement. As can be seen, the opportunities lie mainly in the enforcement of the policy intervention as well as in the area of access to finance. But the yellow colored dots also show where opportunities lie in improving or extending legislation which is already in place.

[25] Effects referred here as a general term however effects may differ in scale, type, and duration.

It is clearly evident that appropriate legislation and policies exist in each particular area. However, these legislations and policies need further improvement. In particular, the policies for facilitating access to finance facing a challenging situation thus need much attention. Furthermore, the legislations and policies which already exist can further be extended in order to meet specific goals. Also, it is clearly evident that the enforcement of policies facing a challenging situation.

Textile factories were also questioned about their satisfaction with the initiatives of CPI and ENERCON. In particular, textile factories were asked to evaluate four relevant initiatives namely CTP-Textile, PISD, SCI-Pak, and REEE-Pakistan on a scale of 0 to 4. Figure 4.1 shows the effectiveness of above-mentioned initiatives in terms of weighted average. It indicates that the ongoing initiative of CPI i.e. PISD is a bit more effective and popular than the previous initiatives.

Figure 4.1: Effectiveness of Relevant Initiatives of Pakistan




The above-mentioned results (table 4.3 and figure 4.1) respectively represent the effectiveness of relevant policies and initiatives of Pakistan. In addition, table 4.4 shows the analysis of the strengths and weaknesses of the relevant policies and initiatives of Pakistan.

Table 4.4: Analysis of the Strengths and Weaknesses of the Relevant Policies and Initiatives of Pakistan

| Strengths | Weaknesses |
|---|---|
| ➢ Formulation of sector wise policies (e.g. environmental, climate change, energy, industrial, and textile policies).<br>➢ Mandating powers to respective institutions for policies implementation.<br>➢ Applying mix of policy instruments to achieve policy objectives.<br>➢ Revising rules and regulations (wherever required) of the policy.<br>➢ CP initiatives introduced specific to industry (e.g. CTP-Textile) | ➢ There is a lack of consistency among policies (e.g. power policies).<br>➢ There is a lack of a mechanism for coordination among different stakeholders.<br>➢ Policies lacking with clear long-term targets.<br>➢ CP initiatives do not offer financial support to factories<br>➢ Short tenure CP initiatives (e.g. CTP-Textile, 2002-2004, and SCI-Pak, 2009-2013) |

## 4.5. Conclusion

The above-mentioned discussion (see sections 4.2 and 4.3) thoroughly answers the first part of the first sub-research question i.e. what policies and initiatives have been introduced to promote CP and energy efficiency in the industrial sector of Pakistan and particularly in the textile sector. Notably, the summary of relevant policies and initiatives (see sections 4.2.6 and 4.3.10) concisely answers the same question. In addition, the analysis of the effectiveness of policies and initiatives of Pakistan (see section 4.4) answers the second part the sub-research question i.e. how effective are these policies and initiatives.

Pakistan has already introduced various policies and initiatives relevant to CP and energy efficiency. However, the overall effectiveness of these policies and initiatives is questionable due to various factors as mentioned above. In particular, the weak enforcement of policies usually diminishes the effectiveness of the policies. Similarly, the above-mentioned results show that the textile factories are averagely or partially satisfied with the relevant initiatives. In addition, chapter six analyze the barriers i.e. what factors hinders CP and energy efficiency implementation in the textile sector despite having specific policies and initiatives. This chapter concludes that Pakistan needs more efforts in order to promote CP and energy efficiency. Chapter seven provides recommendations on how to promote CP and energy efficiency in the industrial sector and particularly in the textile sector of Pakistan.

# CHAPTER FIVE: POLICIES AND INITIATIVES OF OTHER COUNTRIES

This chapter answers the second sub-research question: how have other regional countries promoted CP and energy efficiency in their industrial sector and particularly in the textile sector? This chapter elaborates relevant policies and initiatives of China, India, and Bangladesh.

## 5.1. Policies and Initiatives of China

### 5.1.1. Background

China being the largest developing country has lifted millions of people from poverty to a reasonable level of living standard. China has gained exceptional economic growth by providing low-cost and good-quality consumer products to all over the world. Consequently, this rapid economic growth i.e. industrialization also caused severe environmental deterioration. However, China has been aiming to maintain economic growth simultaneous to ensuring environmental protection. Hence, China has been integrating preventive approaches into the development plans. Particularly, CP has been playing an increasingly prominent role in the industrial and environmental protection policies of China.

China introduced CP as a prime tool to fight against the industrial pollution during the 1990s via development aid projects (Zhang et al, 2013). From 1992 to 1997, China strongly focused on the introduction of CP methodology, training of personnel, and the implementation of demonstrative projects at the factory level. After 1997, China emphasized on CP policy-making thus promulgated Cleaner Production Promotion Law in 2002 (Mol and Liu, 2005). Notably, China is the first country which issued a Cleaner Production Promotion Law and enforced CP implementation as mandatory for certain factories and organizations (Peng and Liu, 2016). In short, China considers CP as an integral part of its national strategy to establish a circular economy.

### 5.1.2. Cleaner Production Policies of China

Generally, the policies related to CP can be divided into three categories such as regulating policies, incentive policies, and guiding policies. These policies serve different functions i.e. regulating policies adjust factory production behaviors with mandatory measures, incentive policies actively engage factories in CP implementation, and guiding policies guide the models, methods, and directions of CP (Peng and Liu, 2016). The Government of China formulated various incentive policies for CP especially economic incentive policies. For instance, policies such as deducting training costs and CP audit tax, awarding CP achievements, reducing or exempting value-added tax for the factories that produce products from the waste, and setting up a special fund for SMEs in order to integrate CP into practice (Hicks and Dietmar, 2007).

CP policies of China usually motivate factories to carry out CP voluntary. However, the Cleaner Production Promotion Law brought great importance to the motivation measures for CP. For example, it provides specific CP funds as well as reduces or exempts the value-added tax for SMEs (Hicks and Dietmar, 2007). Similarly, the CP guiding policies played an important role in CP implementation. The Government of China introduced various policies that guided factories about advanced environmental protection technologies, advanced energy technologies, and advanced operation technologies (Kong and White, 2010).

In addition, China has been implementing various kinds of policies to promote CP. For instance, the fiscal and taxation policies (like setting exclusive funds for CP and guiding social capital to support key CP projects), education policies (like incorporating the curriculums of CP technologies and management into higher education, vocational education and technical training), rewarding and punishing policies (like establishing the system of commendation and reward of CP), and procurement policies (like giving priority to the products of CP). The Government of China issued its first major file about CP on April 1997 since then many other policies, regulations, and files have been issued. Table 5.1 shows the summary of CP policies, regulations, and governing documents.

Table 5.1: Summary of CP Policies, Regulations, & Governing Documents of China (Source: Peng and Liu, 2016)

| File Name (Reference No.) | Issuing Organization | Issue Date | Policy Classification |
|---|---|---|---|
| Notice of Opinions for Promoting CP (No. 232) | SEPA | April 1997 | Comprehensive Policies |
| CP Promotion Law of China (No. 72) | NPCSC | June 2002 | Guiding Policies |
| Opinions for Implementing Laws for Promoting CP (No. 60) | SEPA | April 2003 | Comprehensive Policies |
| Opinions for Accelerating CP (No. 100) | NDRC, MEP and other Ministries | December 2003 | Guiding Policies |
| Interim Procedures for Auditing CP (No. 16) | NDRC and SEPA | August 2004 | Guiding Policies |
| Methods for Utilizing the Exclusive Funds for CP Subsidized by Central Government (No. 343) | Ministry of Finance | October 2004 | Incentive Policies |
| Notice of Regulating the Audit Process of CP for Key Firms (No. 151) | SEPA | December 2005 | Regulating Policies |
| Notice of Further Enhancing the CP Audit of Key Firms (No. 60) | SEPA | July 2008 | Comprehensive Policies |
| Notice for Further Advancing CP of Key Firms (No. 54) | SEPA | April 2010 | Comprehensive Policies |
| Decision for Modifying the Laws for Promoting CP of China (No. 54) | NPCSC | February 2012 | Guiding Policies |

### 5.1.3. Cleaner Production Promotion Law of China

The CP strategy in China was proposed by the State Environmental Protection Administration (SEPA) and National Economic and Trade Commission (NETC) in 1993. However, the Cleaner Production Promotion Law of China was approved by the National People's Congress in 2002. The objectives of this law include: promote cleaner production, increase resource efficiency, reduce and avoid the generation of pollutants, protect and improve environments, ensure the health of human beings and promote the sustainable development of the economy and society. According to this law, any units or individuals engaged in activities relating to production or provision of services and their corresponding management agencies must organize and implement systems for cleaner production.

The CP Promotion Law was designed largely on a positive and voluntary basis as reflected in its title. However, on the basis of experiences in the US, EU, and in other countries, and taking into consideration specific industry characteristics and new environmental management requirements in China, a number of mandatory items and requirements have been included in the Law as negative incentives. One of the most important and practical regulations proposed in the law is the concept of a mandatory CP audit (Bai et al, 2015). Since 2003, the implementation of CP in China is mainly conducted through the promotion of Cleaner Production Audit (CPA) which is mandatory for key polluting enterprises. The Cleaner Production Promotion Law of China clearly defines three categories of enterprises required to carry out mandatory CP audits.

- Category 1 includes those factories exceeding national or local discharge standards or total load control targets for pollutants set by the relevant local governments.
- Category 2 covers factories whose energy consumption per unit of the product exceeds sectoral limits of energy consumption.
- Category 3 includes all factories using toxic and hazardous materials in production or that discharge toxic and hazardous substances

The promulgation and implementation of CP Promotion Law of China and Clean Production Interim measures have marked that the state, from a strategic perspective, has established a policy to prevent and control contamination produced from the source and entire process of production in order to realize the win-win goal of promoting environmental protection and economic development.

### 5.1.4. Cleaner Production Audits in China

The CP Promotion Law of China proposes the use of mandatory CP audits as innovative measures for advancing CP. This mandatory CP audit system aims to improve resources efficiency, minimizing the production of pollutants, and decreasing the usage of harmful substances. In fact, CP audit system quantifies the total waste generation and resources consumption in the production process in order to provide recommendations and guidelines for CP implementation. In practice, CP audit has been proved to be an efficient and unique method to advance CP. NDRC and SEPA formulated the Interim Procedures for Auditing CP (No. 16) in 2004. However, to regulate and improve the CP audit system, SEPA also issued other files such as No. 151 in 2005 and No. 60 in 2008. All of these three files focus on the scope, implementation, organization, management, and rewarding and punishment of CP audit.

The Government of China and factories are two major players in the mandatory CP audit system. Factories carry out CP audits to contribute towards the safeguarding of the environment. The role of government is to provide guidance, supervision, and incentives. The mandatory CP audit has effectively combined with key environmental protection tasks to improve overall pollution prevention in key industries. Since 2013, Ministry of Environmental Protection (MEP) is responsible for promoting and implementing the mandatory CP audit system. The relevant departments at each level of governments supervise the implementation of mandatory CP audits. Punishments and penalties of up to half a million RMB (equivalent to about USD 81,000) will be imposed on factories that fail to disclose environmental information, that fails to conduct a CP audit, or that report false results, as per the Cleaner Production Promotion Law (Bai et al, 2015).

### 5.1.5. Industrial Energy Efficiency Policies of China

China was able to limit energy demand growth from 1980 to 2001. This was achieved through very aggressive energy-efficiency programs organized by the Government of China working closely with provincial and municipal authorities. According to Zhou et al (2010), the main features of the governmental policy and implementation approaches during this period included:

- Tight oversight of industrial energy use, including monitoring requirements for large industrial energy users in support of energy quotas as well as the closing of inefficient facilities and promotion of efficient technologies.
- Financial incentives, initially grants and later low-interest loans for energy-efficiency investments and cogeneration.
- Information services at the national, provincial, and local levels, including the creation of over two hundred energy conservation service centers.
- Education, training, and propaganda, including an annual energy conservation week in November and training promoted by the Government of China.
- R&D at modest funding levels and demonstration projects at more significant levels.

The energy intensity in China fell by 60% from 1980 to 2001. However, from 2002 to 2005 there was no further improvement (UNIDO, 2014b). In response, the Chinese energy efficiency policy has again become very aggressive by including an efficiency component in its industrial structural adjustment program and launching two energy conservation and efficiency programs.

### 5.1.6. Evaluation of Relevant Policies and Initiatives of China

Table 5.2 shows the outcome of relevant policies and initiatives of China.

Table 5.2: Outcome of Relevant Policies and Initiatives of China (Source: Jie. Y, 2013)

| Name | Results Achieved |
|---|---|
| CP Promotion Law of China and Various CP Initiatives by NCPC | Regulatory Framework:<br>➢ Established regulatory framework and successfully mobilized special CP funds given by the government.<br>Technical Supporting System:<br>➢ Developed CP Standards for 58 sectors, CP Evaluation Indicator System for 45 sectors, and 3 Batches of CP technologies.<br>➢ Popularized CP technologies in 34 key industrial sectors.<br>Capacity Building:<br>➢ Established National Database of CP Experts.<br>➢ Increased capacity i.e. more than 700 CP services providers.<br>➢ Trained nearly 30,000 people through professional training courses. Over 100,000 people participated in CP awareness raising workshops & activities.<br>Economic and Environmental Benefits:<br>➢ Achieved an accumulated reduction in COD by 2.27 million tonnes, in $SO_2$ by 712,000 tonnes, and in Ammonia Nitrogen by 51,000 tonnes.<br>➢ Achieved water savings by 11.8 billion tonnes.<br>➢ Achieved energy savings by 49.32 million tonnes of standard coal equivalent. |
| Mandatory CP Audits of China | ➢ Strengthened infrastructure and monitoring system for CP audits.<br>➢ Over 20,000 enterprises carried out CP audits. More than half were compulsory CP audits. |
| Energy Efficiency Policies of China | ➢ Reduced overall energy intensity by 60%. |

## 5.2. Policies and Initiatives of India

### 5.2.1. Background

The industrial development is considered to be a major tool for achieving economic growth. SMEs are the backbone of the Indian economy. There are more than three million SMEs in India which contributes 40% to the national income and provides employment to more than 16 million people. SMEs accounts for about 70% of industrial pollution in India. However, in order to compete globally, India has been adopting many technological contributions generated worldwide. India has been initiating many regulations and acts to ensure sustainable development and to mitigate environmental problems. The National Cleaner Production Centre (NCPC) was established in 1994 with the motto of developing and introducing clean production practices in SMEs. The DESIRE project was also initiated by NCPC in 1994 to demonstrate reducing waste in small industries.

### 5.2.2. Cleaner Production Initiatives of India

CP has been implemented in various industrial sectors of India. The DESIRE project was one of the first systematic investigations for the feasibility of waste minimization for developing countries. India implemented demonstrations in small industries for reducing waste through the DESIRE project between 1993 and 1995 (Unnikrishnan and Hegde, 2007). The Ministry of Environment & Forest (MoEF) took several initiatives to promote CP and to mitigate environmental pollution in India. In addition, National Productivity Council (NPC) also prepared an action plan to promote CP under a project funded by the Asian Development Bank (ADB). The National Cleaner Production Centre (NCPC) was set up in New Delhi by NPC and UNIDO whereas NCPC helped to set up four regional centers in Karnataka, Gujarat, Punjab and West Bengal (Rathi, 2003).

The various activities of CP centers in India include following:

- Creating awareness on cleaner production.
- Orientation, dissemination and training programs on CP.
- Providing cost-effective training to industrial personnel on CP assessment and implementation.
- Conducting CP projects assessment in different clusters.
- Awareness programs on Energy Efficiency.
- Advising industries in developing Project Design Document (PDD) and getting approval from Designated National Authorities (DNA) for CDM projects.
- Providing guidance for inculcating the culture of CP in industrial units.
- Providing consultancy for CETP management at the industrial estate levels.
- Providing assistance to the government in framing the policy for CP/CT promotion.

In a developing country, it is observed that handling the polluter pay task is difficult because pollution is calculated in volumes. Moreover, expecting a polluter to invest huge capital in reducing emission level is also challenging. However, the Government of India gave 100% depreciation allowance for installing pollution control equipment and assisted to SMEs using cleaner technology (Agnello et al, 2015). MoEF established Common Effluent Treatment Plants (CETPs) and Common

Hazardous Waste Treatment and Storage Facilities (CHWTSFs) in the areas where clusters of SMEs are located. The Central Pollution Control Board (CPCB) is also focusing on older industries in ensuring pollution control. The Integrated Technology Up-gradation and Management Programme (UPTECH) also significantly contributed to pollution control and adoption of clean technologies in India. Moreover, the EU also introduced an initiative namely European Business and Technology Centre (EBTC) for India in 2013. There is some evidence that shows CP technology is effectively used in the Indian states such as Gujarat and Maharashtra. India has been slowly transforming towards clean technology implementation and eco-friendly production. (Agnello et al, 2015)

In India, there are various funding tools available for CP but SMEs are not aware of these investment options. However, the financial institutions are steadily raising the awareness of SMEs through advertising campaigns and various discussion forums. In India, the World Bank and Asian Development Bank (ADB) also provides loans under various programs but initially these loans were only available to medium and large-scale industries since SMEs were not in a position to prepare viable proposals (UNIDO, 2009). Furthermore, it is usually difficult for SMEs to get access to loans since the risk to return loan is high in the case of SMEs as compared to large-scale industries. Commercial banks also offer conditional loans at commercial rates, and in many cases, they also render loan assistance under various schemes of the government. However, they do not offer any specific program for the adoption of cleaner technology. Moreover, some public sector banks such as the State Bank of India and the Bank of Baroda are promoting programs in the area of environmental management. The Industrial Credit and Investment Corporation of India (ICICI) allocated $25 million under the Trade in Environmental Services and Technologies (TEST) scheme, to facilitate loans at 12.5% rate for environmentally friendly technologies and practices. Despite the above-mentioned funding options, the major hindrance is the high-interest rate. (Agnello et al, 2015).

### 5.2.3. Industrial Energy Efficiency Initiatives of India

Industrial energy efficiency has emerged as one of the key issues in India. India accounts for 4.5% of industrial energy use worldwide but it is projected to increase as the economy expands rapidly (Gielen and Taylor, 2009). In the 1980s, the energy sector was considered critical to economic growth as it accounted for over 30% of public investments, utilized 25% of export earnings for energy imports and generated about 15% of government revenues. The industrial sector used about 40% of total energy in the country (Yang, 2006). The expenditure on energy as a percentage of the total production costs in the industrial sector of India is generally very high, accounting for 15% in textiles, 25% in pulp and paper, and 40% in glass, ceramics and cement (Rao, 2004). Therefore, the Government of India is interested in developing better policies for energy efficiency in the industrial sector. According to Yang (2006), a number of energy efficiency policies and measures have been developed over the past 25 years which includes:

- Disclosing companies' particulars on energy efficiency.
- Accelerated depreciation for energy efficiency and pollution control equipment.
- Setting up the Energy Management Centre under the Ministry of Energy.
- Deregulation to promote industrial competitiveness.
- Energy price reforms to guide energy efficiency initiatives and to encourage international competitiveness.
- Enforcement of the Energy Conservation Act and the Electricity Act.

The level of industrial energy efficiency in India varies widely i.e. certain sectors such as cement is relatively efficient whereas others such as pulp and paper are relatively inefficient[26]. In fact, energy costs account for 40% of total production costs in Indian cement industry (Gielen and Taylor, 2009). It indicates that when energy costs are a significant part of the total costs then there is a driver for energy efficiency. India's energy efficiency is the fifth lowest in the world. However, there is a huge potential for substantial energy savings in India (Sahoo et al, 2016). The Energy Conservation Act was enacted in 2001 whereas the Bureau of Energy Efficiency (BEE) was set up in 2002 to facilitate its implementation. The Ministry of Power through BEE has also initiated various energy efficiency initiatives in SMEs and large industries including the development of energy consumption norms for industrial subsectors and capacity building. Moreover, USAID through its Program for Accelerated Energy Research (PACER) tailored an energy and environment campaign for India. The PACER project promoted awareness through seminars, conferences, and training. It also conducted projects in five Indian plants to demonstrate the energy efficiency benefits.

The Government of India developed a new certificate scheme (trading of energy savings) following an amendment to the Energy Conservation Act in 2010. This scheme namely Perform Achieve and Trade (PAT) is a comprehensive policy, which aims to achieve energy savings of over 10 million tonnes of oil equivalent (Mtoe) over three years (ADB, 2014). Moreover, in 2011, the Government of India also introduced financing mechanisms such as preferential loans and venture capitals under the Framework for Energy Efficiency Economic Development (FEEED) which is administered by the India Renewable Energy Development Agency (IREDA).

### 5.2.4. Evaluation of Relevant Policies and Initiatives of India

Table 5.3 shows the outcome of relevant policies and initiatives of India.

Table 5.3: Outcome of Relevant Policies and Initiatives of India (Sources: ENVIS, 2014; GCPC, 2016; IIP, 2015)

| Name | Results Achieved |
|---|---|
| Environmental Polices of India and CP Initiatives by NCPC | ➢ Constructed 34 CETPs in Gujrat to treat effluent from various industries.<br>➢ Established ENVIS, which is the largest network of environmental information in the world.<br>➢ Distributed Cleaner Production Award each year.<br>➢ Included CP subject in the curriculum of various university programs.<br>➢ Reduced water consumption by 45.45% in the textile sector.<br>➢ Reduced chemical consumption by 8.65% in the textile sector.<br>➢ Reduced electrical power consumption by 37.04% in the textile sector.<br>➢ Reduced fuel (coal) consumption by 24.55% in the textile sector.<br>➢ Reduced caustic consumption by 15,000 kg per year in the textile sector.<br>➢ Identified various CP options and BAT for industries including textile sector. |
| Energy Efficiency Initiatives (National Mission) of India | ➢ Achieved annual fuel savings of 23 million tonnes of oil equivalent (Mtoe).<br>➢ Avoided cumulative electricity capacity addition of 19,000 MW.<br>➢ Achieved $CO_2$ emission mitigation by 98 million tonnes per year. |
| Perform Achieve and Trade Scheme (PAT) | ➢ Achieved fuel savings of 9.78 million tonnes of oil equivalent (Mtoe).<br>➢ Achieved GHG emissions savings of 26.21 million tonnes. |

[26] According to Gielen and Taylor (2009), the majority of large kilns in India are among the most energy efficient in the world with an average thermal energy use of 3 GJ/t. This can be explained by the fact that India had a clinker to cement ratio of 0.87. This means that 0.87 tons of clinker is used per ton of cement produced. A low clinker-cement ratio contributes significantly to lower energy use per tonne of cement. In contrast, Indian pulp and paper industry comprised of mostly SMEs. Moreover, it is not economic to install the same energy efficient equipment in a small or medium-sized plant as in a large plant. Therefore, the cement industry is relatively energy efficient than pulp and paper industry in India.

## 5.3. Policies and Initiatives of Bangladesh

### 5.3.1. Background

Bangladesh being a least developed and highly densely populated country with limited natural resources is facing enormous problems including national disasters, climate change, environmental degradation and energy security etc. However, to cope with these challenges, the Government of Bangladesh has been taking initiatives for sustainable development. The Government of Bangladesh established the Ministry of Environment and Forest (MoEF) to coordinate and supervise the activities related to environmental protection. Notably, Bangladesh promulgated National Environmental Policy in 1992. In addition, Bangladesh introduced Environmental Conversation Act (1995), National Environmental Management and Action Plans (1995), and Environmental Conservation Rules (1997) along with different environmental strategies and guidelines.

In Bangladesh, the textile and garment industry accounts for 79% of the exports (ADB, 2011). Industry accounts for about 50% of the global final energy consumption whereas the situation is also same in Bangladesh. However, substantial energy efficiency improvement potential exists in Bangladesh (ADB, 2014). In order to ensure energy security and sustainable energy access, the Government of Bangladesh formulated National Energy Policy in 1995 and Renewable Energy Policy in 2008 under the Ministry of Power, Energy and Mineral Resources. In addition, to promote renewable energy technologies and to facilitate energy efficiency and conservation, the government of Bangladesh introduced Sustainable and Renewable Energy Development Authority (SREDA) Act in 2012 and Energy Efficiency and Conversation Rules in 2013.

### 5.3.2. Cleaner Production Policies of Bangladesh

Bangladesh does not have any direct legislation like the CP promotion law in China. However, the Government of Bangladesh has introduced various policies related to the environment, energy, and industries. The objectives of these policies are somehow relevant to promote CP in Bangladesh. For example, the objectives of the National Environmental Policy (1992) include, ensuring environmentally sound development in all sectors and ensuring sustainable, long term and environmentally sound use of all natural resources. According to Hossain (2015), to attain CP objectives, the National Environmental Policy (2013) suggests some measures: (i) Implementing 3R (Reduce, Reuse, and Recycle) strategy to ensure prevention of wastes of raw materials and to ensure efficient use of raw materials. (ii) Setting up energy efficient technologies in the industry. (iii) Providing fiscal incentives to the industries for implementing zero discharge or zero emission systems.

The National Industrial Policy (2005) of Bangladesh along with other goals also focused on CP strategy such as it aims to provide all necessary assistance for producing an environment-friendly product with the objective of creating a pollution-free environment in the industrial sector. To attain this objective, the Government of Bangladesh suggested some measures in the revised National Industrial Policy (2010). For instance, the Government of Bangladesh will provide proactive incentives such as tax and duty concession in order to encourage SMEs and other large scale industries to adopt environmentally sound manufacturing processes and practices. Moreover, the Government of Bangladesh will facilitate the transfer of climate-friendly technology from the developed countries (Hossain, 2015).

Bangladesh also introduced National Renewable Energy Policy (2008) with the overall objective to accelerate the use of renewable energy resources. The Government of Bangladesh has been providing different fiscal incentives, such as, the import of renewable energy technologies is free from 15% VAT and the corporate income tax is freed up to five years for the investors of renewable energy project. In addition, electricity generated from the renewable energy technologies is getting 10% higher incentive tariff than others (Hossain, 2015). The most relevant strategy and action plan to promote CP in Bangladesh is National 3R (Reduce, Reuse, Recycle) Strategy (2010), wherein the industrial sector is prioritized for 3R implementation. However, the strategy is facing challenges such as lack of institutional capacity, public cooperation, financing and cost recovery etc.

### 5.3.3. Industrial Energy Efficiency Initiatives of Bangladesh

The industrial sector is the largest energy consumer i.e. 44.0% of the total energy consumption in Bangladesh. The energy demand in Bangladesh has been increasing very rapidly whereas the industrial sector consumed 12% more energy in 2012 than in 2011 (ADB, 2014). Bangladesh is in the top 10 countries of the world in the production of textiles, leather, and ceramics etc. Hence, the industrial growth of Bangladesh is also inducing additional energy demand. Furthermore, the manufacturing industries in Bangladesh are not efficient in energy use. However, Bangladesh can promote low-carbon industrial development through its 25-30% energy efficiency potential by overcoming barriers such as such as financing, information, and skilled manpower etc. (IFC, 2012).

Bangladesh emphasized the importance of energy efficiency to develop a low carbon economy through the formulation of SREDA Act (2012) and Energy Efficiency and Conservation Rules (2013). The responsible authority i.e. SREDA taking necessary measures such as energy auditing, energy standard labeling, technology transfer, institutional capacity building, financing, raising awareness, and energy research & development etc. (ADB, 2014). Notably, the financing of energy efficiency projects is gaining momentum in Bangladesh. The Asian Development Bank (ADB) introduced the Bangladesh Industrial Energy Efficiency Finance Program (BIEEFP), which extended a non-sovereign loan facility and technical assistance to the Industrial and Infrastructure Development Finance Company (IIDFC) and other financial institutions for eligible energy efficiency projects. The BIEEFP focuses on six target industrial sectors namely textiles, iron and steel, cement and clinker, chemicals, ceramics and glass, and agro-industries to deploy globally best energy efficiency technologies and practices relevant to these sectors (ADB, 2014).

### 5.3.4. Evaluation of Relevant Policies and Initiatives of Bangladesh

Table 5.4 shows the outcome of relevant policies and initiatives of Bangladesh.

Table 5.4: Outcome of Relevant Policies and Initiatives of Bangladesh (Source: UNCRD, 2013)

| Name | Results Achieved |
|---|---|
| Environmental Policies and 3R (Reduce, Reuse, Recycle) Strategy of Bangladesh | ➢ Increased environmental awareness.<br>➢ Improved infrastructure and empowered institutions.<br>➢ Achieved savings of USD 4.73 million through the recovery various materials from the waste.<br>➢ Recycled 51% of the total plastic waste in Dhaka city.<br>➢ Reduced waste disposal by 20%. |
| Energy Efficiency Policies of Bangladesh | ➢ Improved industrial energy efficiency by 16%. |

## 5.4. Summary of Regional Countries' Measures

Table 5.5 and Table 5.6 show the summary of regional countries' measures to promote CP and energy efficiency but not limited to the following.

Table 5.5: Summary of Relevant Measures Adopted by China

| Name of Country | Type of Instrument | Measures to promote CP and Energy Efficiency |
|---|---|---|
| China | Regulatory Instrument | ➢ Implementing CP by enforcing CP Promotion Law i.e. punishments and penalties up to half a million RMB (equivalent to about USD 81,000) to the factories that fail to disclose environmental information, or fail to conduct CP audit, or report any false results.<br>➢ Reducing environmental pollution by enforcing CP Promotion Law i.e. mandatory CP implementation for certain factories and organizations.<br>➢ Promoting CP implementation through mandatory CP audits in all factories and organizations.<br>➢ Promoting energy efficiency by closing down factories having inefficient plant and processes.<br>➢ Enforcing energy efficiency policies by working closely with provincial and municipal authorities and strictly monitoring industrial energy consumption<br>➢ Accelerating CP implementation by making regular amendments or revisions in respective regulations. |
| | Economic Instrument or MBI | ➢ Encouraging CP implementation by providing financial incentives such as deducting training costs, CP audit tax and awarding CP achievements.<br>➢ Supporting SMEs to integrate CP into practice by providing special funds.<br>➢ Supporting key CP projects through special funds and guiding capital opportunities.<br>➢ Encouraging factories that produce products from waste by exempting their value-added tax.<br>➢ Encouraging factories having cleaner production by giving priority to their products in the market.<br>➢ Promoting energy efficiency investments by giving grants and low-interest loans to factories. |
| | Information and Other Instruments | ➢ Promoting CP by guiding CP methodology, training of personnel, and demonstrating CP projects.<br>➢ Promoting CP technologies and practices by incorporating CP into the curriculums of higher education, vocational education and technical training.<br>➢ Accelerating CP and energy efficiency implementation by guiding factories about advanced environmental protection technologies, advanced energy technologies, and advanced operations technologies.<br>➢ Promoting energy efficiency and conservation by establishing huge information network at national, provincial and local levels i.e. over two hundred energy conservation service centers.<br>➢ Research & Development at modest funding levels and demonstrating projects at significant levels.<br>➢ Raising awareness of CP and energy efficiency through education, training, and a propaganda e.g. annual energy conservation week in November. |

Table 5.6: Summary of Relevant Measures Adopted by India and Bangladesh

| Name of Country | Type of Instrument | Measures to promote CP and Energy Efficiency |
|---|---|---|
| India | Regulatory Instrument | ➢ Minimizing pollution by enforcing strict environmental regulations, imposing fines on old factories, and establishing CETPs & CHWTSFs for waste treatment.<br>➢ Discouraging energy wastage by strictly monitoring factories' particulars on energy efficiency.<br>➢ Enforcing energy efficiency and relevant policies by establishing energy management centers. |
| | Economic Instrument or MBI | ➢ Encouraging SMEs to install pollution control equipment by providing 100% depreciation allowance.<br>➢ Supporting CP technologies in medium and large-scale industries through loans from World Bank and ADB.<br>➢ Facilitating investment for CP related technologies through TEST scheme (i.e. loans at 12.5%) from ICICI.<br>➢ Facilitating factories to adopt CP technologies in order to control pollution through the Integrated Technology Up-gradation and Management Programme (UPTECH)<br>➢ Promoting energy saving through Perform Achieve and Trade (PAT) scheme and energy conservation awards. |
| | Information and Other Instruments | ➢ Promoting CP by providing cost-effective training to industrial staff on CP assessment and implementation.<br>➢ Promoting energy efficiency through network building and capacity building of SMEs.<br>➢ Raising energy efficiency awareness through seminars, conferences, training, and demonstrative projects under the PACER program funded by USAID.<br>➢ Facilitating technology transfer through initiatives e.g. European Business and Technology Centre (EBTC)<br>➢ Enabling CP investments by raising awareness of SMEs about available funding options through advertising campaigns and discussion at various forums |
| Bangladesh | Regulatory Instrument | ➢ Promoting CP through the 3R Strategy.<br>➢ Ensuring reduction of environmental pollution by enforcing a penalty for violating regulations. |
| | Economic Instrument or MBI | ➢ Encouraging SMEs and large scale industries to adopt environmentally sound manufacturing processes and practices by providing proactive incentives.<br>➢ Encouraging factories to implement zero discharge or zero emissions system by providing fiscal incentives.<br>➢ Facilitating investments for energy efficiency projects through Industrial Energy Efficiency Finance Program (BIEEFP) as loans from ADB.<br>➢ Promoting renewable energy technology by exempting 15% value-added tax.<br>➢ Promoting investment in renewable energy technology by exempting corporate income tax for 5 years.<br>➢ Discouraging fossil fuels by providing 10% higher incentive tariff for generating electricity from renewable energy technologies. |
| | Information Instruments | ➢ Promoting CP and energy efficiency by raising awareness, capacity development, research & development, and network building.<br>➢ Promoting CP by facilitating climate-friendly technology transfer from developed countries.<br>➢ Facilitating the import of energy efficient technologies. |

### 5.5. Analysis of Other Regional Countries and Pakistan

The above-mentioned discussion (see sections 5.1, 5.2, and 5.3) explains how other regional countries (China, India, and Bangladesh) have promoted CP and energy efficiency in their industrial sector. However, Pakistan can also promote CP and energy efficiency in its industrial sector by learning from the experiences of other regional countries.

#### 5.5.1. Lessons from Other Regional Countries

The following lessons show some successful measures as adopted by the other regional countries.

Lessons from China:

- China has been using a balanced mix of policy instruments i.e. equally utilizing regulatory, economic, and informative instruments.
- China has been enforcing CP as mandatory instead of voluntary.
- China has developed very strong legislation e.g. CP Promotion Law.
- China has been imposing heavy fines on the violations of regulations.
- China has been conducting mandatory CP audits.
- China has been working closely with provincial and municipal authorities.
- China has been providing special funds, loans, incentives.
- China has been exempting value-added tax.
- China has established a huge network of information centers throughout the country.
- China has been incorporating CP into the curriculums of higher education, vocational education and technical training.

Lessons from India:

- India has been also focusing on a mix of policy instruments.
- India has been banning old factories to reduce environmental pollution and establishing CETPs and CHWTSFs for waste water treatment.
- India has been accessing international funding e.g. World Bank and ADB.
- India has created many financing options for SMEs and other industries.
- India has been mandating powers to institutions, raising awareness, and developing capacity at all levels.

Lessons from Bangladesh:

- Bangladesh has been implementing 3R (Reduce, Reuse, Recycle) strategy.
- Bangladesh has been facilitating technology transfer from developed countries and accessing investments for energy efficiency projects from ADB.
- Bangladesh has been promoting CP and energy efficiency by raising awareness, capacity development, research & development, and network building.

### 5.5.2. Suggestive Measures for Pakistan (What and Why)

The above-mentioned lessons provide an insight into various measures to promote CP and energy efficiency. This section specifically analyzes, why and what measures, Pakistan should adopt from the experiences of other regional countries. In addition, chapter seven explains how to adopt those measures. The majority of textile factories in Pakistan do not have the capacity (i.e. funding and technical expertise) to initiate CP and energy efficiency projects. Moreover, the owners of the textile factories (particularly in small and medium-sized factories) do not realize the impacts associated with industrial pollution nor they feel ownership to environmental protection. Also, environmental awareness among the public is generally low as well as the regulatory enforcement system is weak. Therefore, it can be assumed that either there is no pressure or weak pressure on textile factories to protect environmental degradation. In this situation, CP as voluntary cannot be expected from the textile factories in Pakistan. It is very rare that a textile factory adopts CP as voluntary without any regulatory pressure or other factors (i.e. competition in the international market, rising energy costs, and higher production costs). Also, there is a lack of incentives that can motivate textile factories to adopt CP as voluntary.

It is very difficult to promote CP as voluntary in the above-mentioned situation. Therefore, Pakistan should enforce CP as mandatory like China. However, the government should facilitate funding. In parallel, strict punishments or heavy fines must be enforced on the violations of regulations. If there is no punishment then the owner of textile factories may neglect CP implementation despite having sufficient funding. So, proper check and balance system is also required. Also, there is a weak regulatory enforcement system hence the institutional infrastructure must be strengthened in Pakistan like China. There is also a communication gap and lack of cooperation among the institutions in Pakistan. Therefore, the federal government should work closely with provincial government, municipal authorities, and relevant institutions. The biggest challenge for textile factories in Pakistan is a lack of funding to invest in CP and energy efficiency. Therefore, Pakistan must develop cooperation with international organizations like India and Bangladesh who facilitated funding through World Bank and ADB. Pakistan should also adopt other measures including facilitating technology transfer, establishing a huge network of information centers, and in incorporating CP into the curriculums of higher education, vocational education and technical training.

## 5.6. Conclusion

The aforementioned summary of measures adopted by other regional countries (China, India, and Bangladesh) concisely answers the second sub-research question i.e. how have other regional countries promoted CP and energy efficiency in their industrial sector. In addition, the lessons from other regional countries explain which measures successfully promoted CP and energy efficiency in their respective industrial sectors. Notably, it also provides an insight for why and what steps or measures Pakistan can adopt in order to promote CP and energy efficiency in its industrial sector and particularly in the textile sector.

In conclusion, Pakistan should enforce CP as mandatory in the industrial sector by establishing a CP audit system, strengthening infrastructure, and improving cooperation among provincial and municipal authorities. However, the government should also provide funding, facilitate technology transfer, and disseminate information by establishing a huge network of information centers. Moreover, Pakistan should also incorporate CP into the curriculums of higher education, vocational education and technical training. Chapter seven provides more recommendations in detail.

# CHAPTER SIX: CASE STUDY OF TEXTILE SECTOR OF PAKISTAN

This chapter illustrates the case study results in order to answer sub-research questions. The first two sections specifically answer the third sub-research question: what is the present level of CP practices and energy efficiency measures adopted by the textile factories in Pakistan? And last two sections specifically answer the fourth sub-research question: what are the barriers and drivers to the implementation of CP and energy efficiency in the textile factories of Pakistan?

## 6.1. Stance of Textile Factories on Environmental and Energy Management

An environmental and energy policy shows the values and stance of a factory on environmental and energy issues. Also, the implementation of respective management systems i.e. EMS and EnMS indicate the motivation of a factory for continuous improvement. This case study evaluated that the majority of textile factories have an explicit environmental policy. However, they do not have an explicit energy policy. In addition, the role of top management is very important to fully operationalize the environmental and energy policy. The majority of textile factories showed a good response regarding top management commitment. However, the commitment level varies factory to factory. Hence, the environmental and energy policies are not fully integrated into the operations of all textile factories. Notably, the majority of textile factories never appointed anyone for the energy management though they appointed someone responsible for the environmental management. However, the majority of textile factories did not implement EMS and EnMS. The following charts (figures 6.1 to 6.5) statistically represents the above-stated results.

Figure 6.1 shows the percentage of textile factories having an explicit environmental and / or energy policy. It shows that 92.3% textile factories have an explicit environmental policy whereas only 12.8% have an explicit energy policy.

Figure 6.1: Textile Factories with respect to Environmental and Energy Policy.

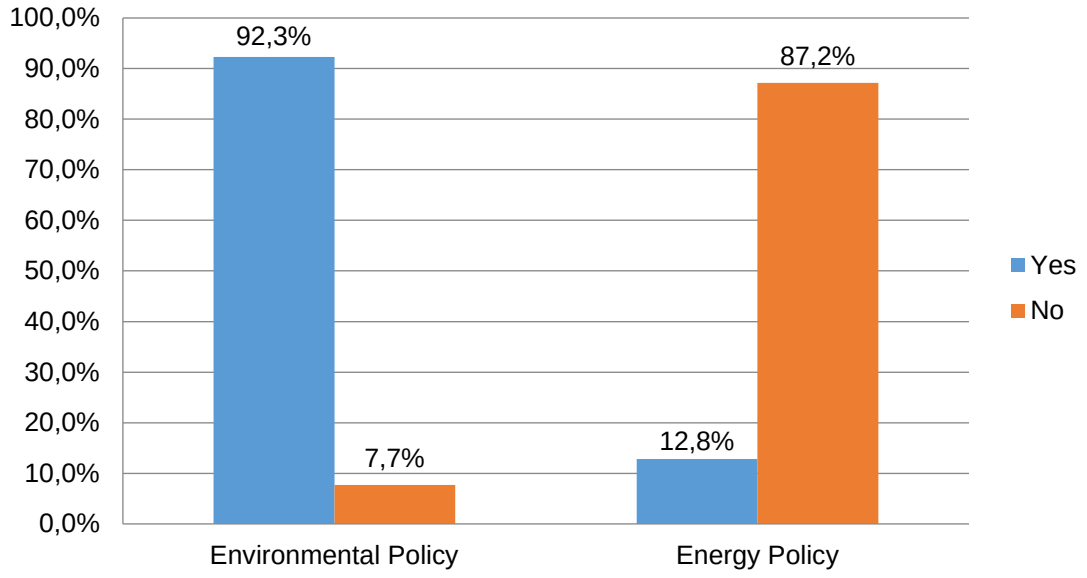



Figure 6.2 shows the percentage of textile factories wherein the top management is fully committed to environmental and / or energy policy.

Figure 6.2: Top Management Commitment to Environmental and / or Energy Policy

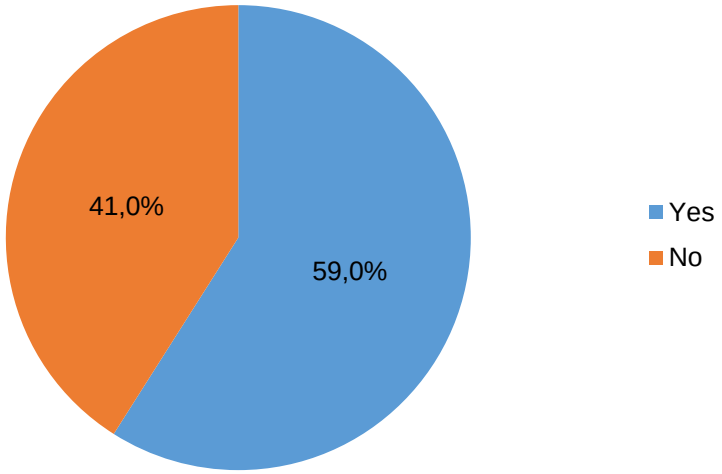



Figure 6.3 shows the percentage of textile factories wherein environmental and / or energy policy is fully integrated into the operations of the factory.

Figure 6.3: Operationalization of Environmental and / or Energy Policy

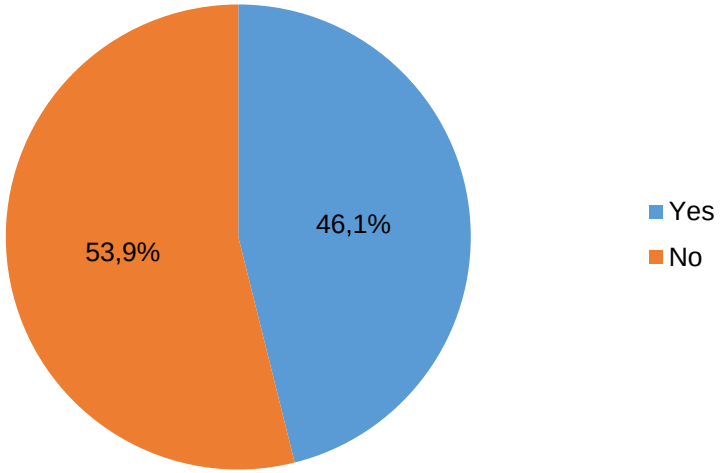



Figure 6.4 shows the percentage of textile factories having an Environmental Management System (EMS) and / or Energy Management System (EnMS).

Figure 6.4: Textile Factories with respect to Implementation of EMS or EnMS

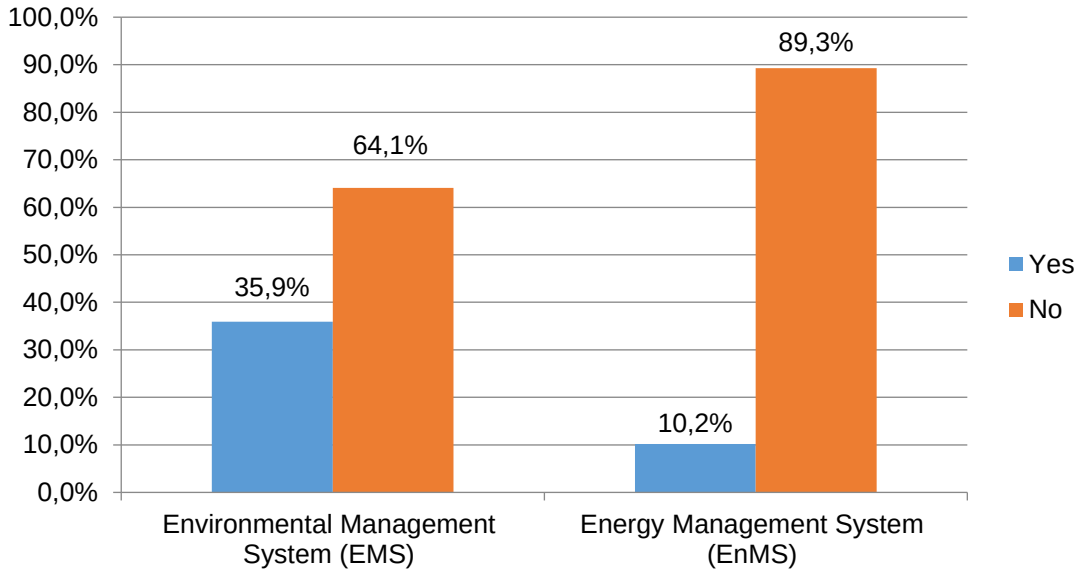
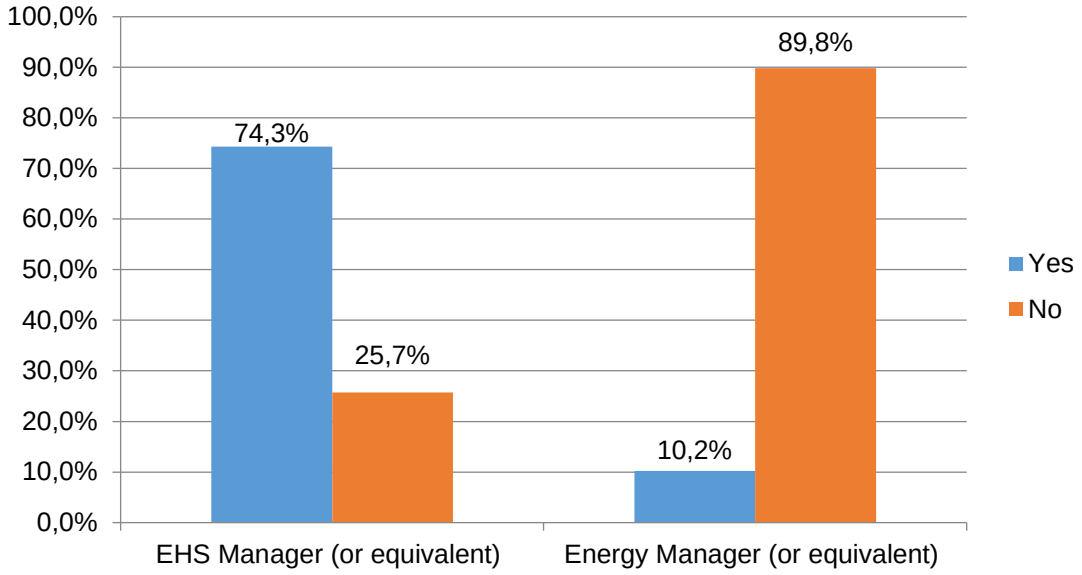


Figure 6.5 shows the percentage of textile factories appointed EHS manager (or equivalent) and Energy Manager (or equivalent).

Figure 6.5: Textile Factories with respect to EHS Manager and / or Energy Manager




## 6.2. Level of Awareness, Capacity, and Measures Adopted by Textiles Factories

Awareness with other conditions usually creates a momentum necessary to implement CP and energy efficiency in a factory. However, the capacity of a factory sets the actions of a factory. For instance, a factory having adequate environmental awareness and capacity is more likely to adopt CP practices and energy efficiency measures. Hence, this case study also evaluated the level of awareness, capacity, and common measures adopted by the textile factories.

This case study concluded that generally, the overall awareness of environmental and / or energy-related issues among textile factories is just an average or moderate[27]. However, the majority of textile factories showed a positive interest to implement energy efficiency measures. Moreover, they responded that the energy efficiency measures were proved to be profitable as per their investment criteria. In contrast, CP implementation remained slow due to some barriers. Notably, lack of expertise or technical staff is one of the major reasons for not implementing CP practices in textile factories. In addition, the majority of textile factories are aware of the initiatives introduced by the CPI and ENERCON. However, they are moderately[28] satisfied with the initiatives such as CTP-Textile, PISD, SCI-Pak, and REEE-Pakistan. The following charts (figures 6.6 to 6.16) statistically represent the above-stated results.

[27] The analysis of the data of each questionnaire submitted by a textile factory shows a pattern that overall awareness of environmental and / or energy-related issues among textile factories is just an average or moderate. A closer look at all charts i.e. statistical representation of the responses of each question in the questionnaire (see Appendix-A) also reveals same. This statement does not mean to rule out the textile factories who have successfully implemented CP and energy efficiency or have showed exceptional environmental performances. However, this statement is based on the average of sample size.

[28] The textile factories were asked to rate each initiative on a scale of 0 - 4 (i.e. none, low, average, above-average, high). However, the weighted average of the responses to each initiative shows an average i.e. moderate (see figure 4.1 and question 16 in Appendix-A)

Figure 6.6 shows the weighted average of the level of awareness about environmental and / or energy-related issues among laborers or non-management workers in the textile factories[29].

Figure 6.6: Weighted Average of Level of Awareness among Laborers or Workers

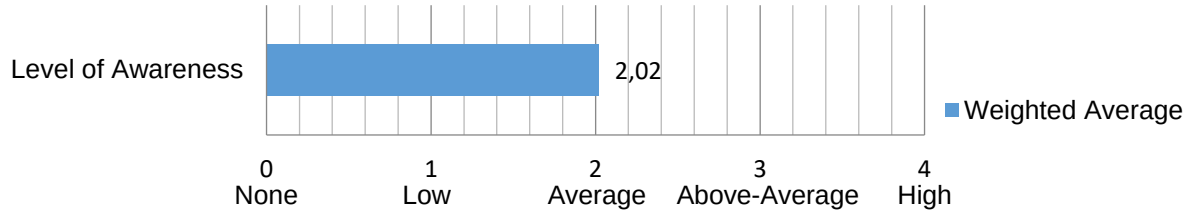



Figure 6.7 shows the percentage of textile factories that either implemented or never implemented any energy efficiency measures.

Figure 6.7: Textile Factories with respect to Energy Efficiency Measures

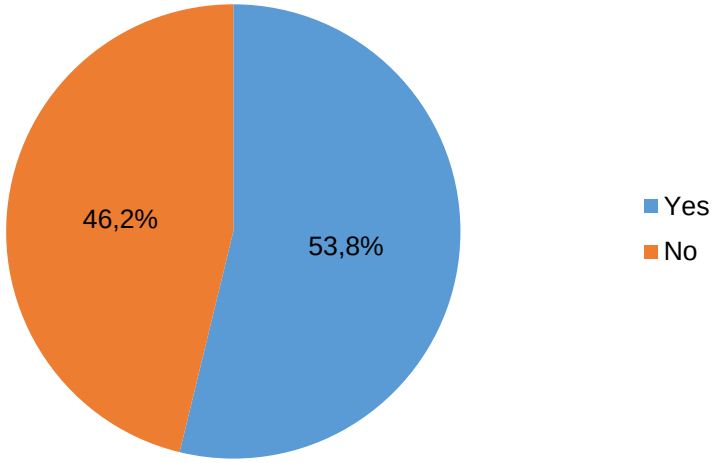
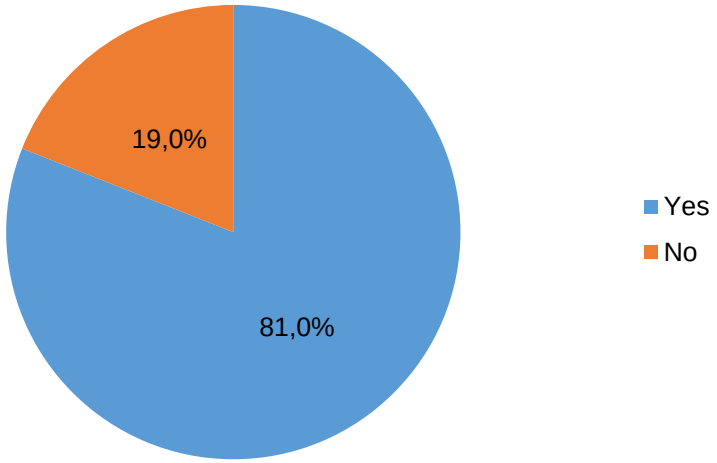



Figure 6.8 shows that the implementation of energy efficiency measure was profitable in the majority of the textile factories.

Figure 6.8: Energy Efficiency Measures with respect to Profitability

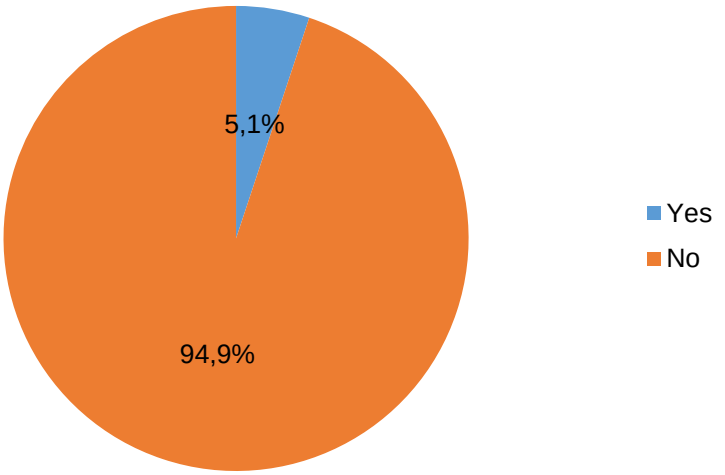



[29] The textile factories were asked to rate the level of awareness about environmental and / or energy-related issues among their laborers or non-management workers on a scale of 0 - 4 (i.e. none, low, average, above-average, high). The weighted average of the responses shows 2.0 (i.e. average) on a scale of 0 - 4 (see question 6 in Appendix-A). However, this result is purely based on the perspective of the textile factories or how the respondent (i.e. representative of a textile factory) rates the level of awareness. In general, the textile factories who conduct regular training for its laborer will certainly have a good level of environmental awareness among its laborer as compared to the textile factories having illiterate laborers or manpower.

Pakistan is endowed with the potential renewable energy resources such wind, hydro, solar, and biomass. Notably, a huge potential of biomass sources including bagasse, wheat straw, rice husk, and cotton stalks is available in abundance throughout the country. The textile factories can utilize biomass as a sustainable energy source for boilers and power generation.

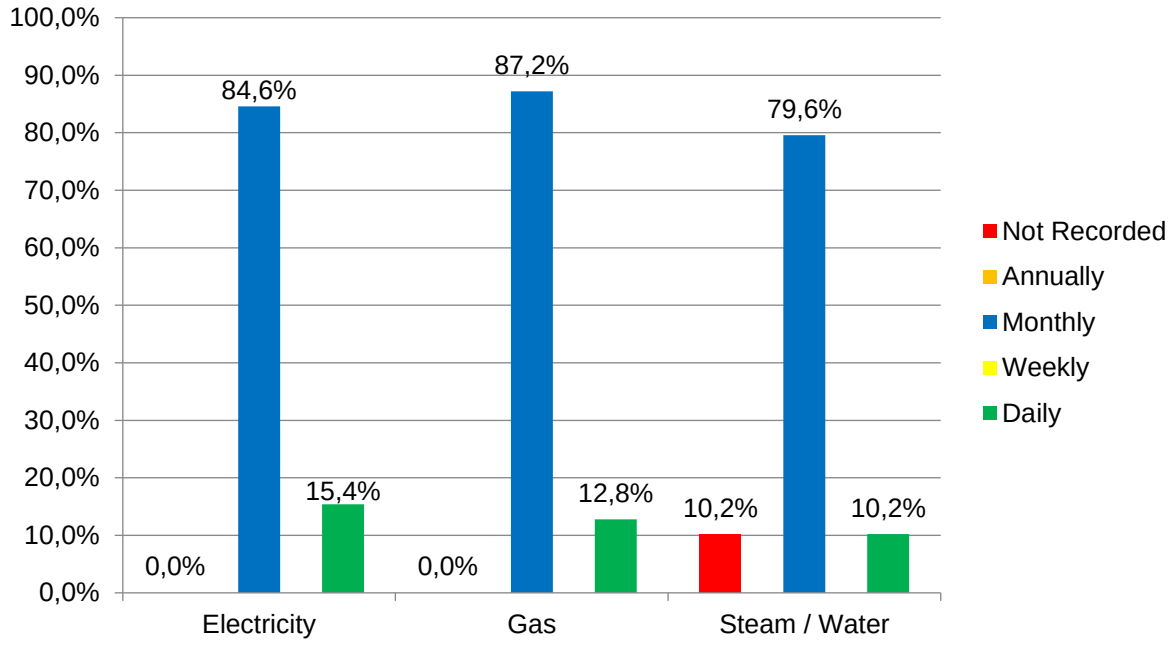
Figure 6.9 shows that majority of textile factories never utilize renewable energy[30]. However, one of the main reasons for this situation is the lack of capital and limited capacity of textile factories.

Figure 6.9: Textile Factories with respect to Use of Renewable Energy




Monitoring and recording energy consumption is very important in order to properly implement Energy Management System (EnMS). This case study found that majority of the textile factories records their energy consumption monthly. However, some factories record their energy consumption daily. Figure 6.10 shows the percentage of textile factories with respect to the frequency of energy consumption recording.

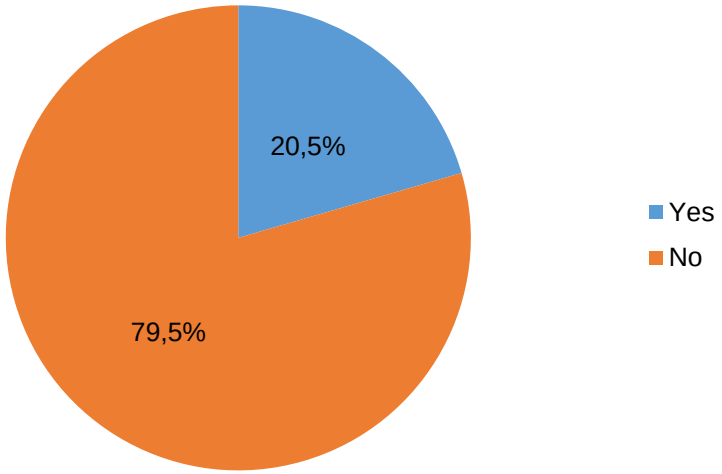
Figure 6.10: Textile Factories with respect to Energy Consumption Recording




[30] Figure 6.9 is based on the findings of the case study. This does not mean to rule out the fact that some textile processing mills have already started utilizing biomass for heat energy for boilers according to APTMA. However, the percentage of textile factories using biomass is still low. Retrieved 12 August 2016, from http://www.dawn.com/news/1128024

Similarly, a regular energy audit is regarded as vital for energy efficiency implementation. Energy audits provide key information such as energy losses within a factory and it also identifies opportunities to improve energy efficiency. Figure 6.11 shows that majority of textile factories do not regularly conduct energy audits.

Figure 6.11: Textile Factories with respect to Energy Audits




This case study also found that textile factories understand the benefits of CP and energy efficiency. However, the majority of textile factories do not give importance or priority to CP and energy efficiency over other priorities thus they never implemented any CP practice. In fact, there are many reasons behind this situation such as limited budget, higher production priorities, lack of motivation, and lack of commitment from the top management. Figure 6.12 shows the weighted average of the level of importance given to the implementation of CP and energy efficiency by the textile factories.

Figure 6.12: Weighted Average of Level of Importance to CP and EE

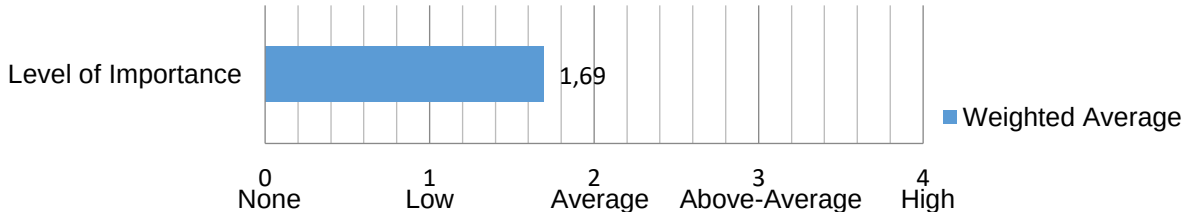
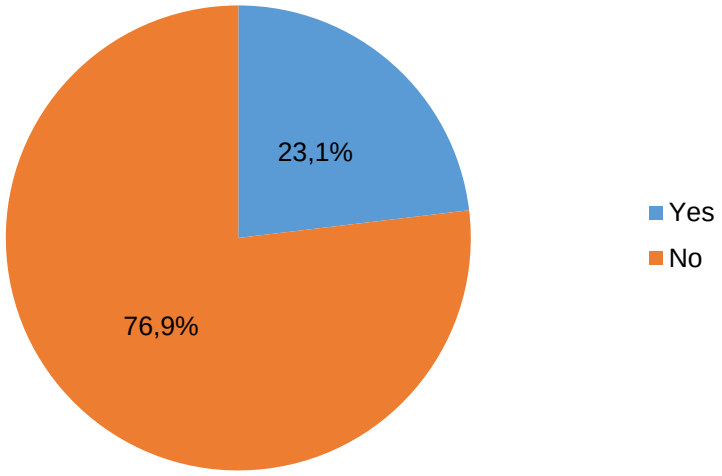



Figure 6.13 shows that majority of textile factories never implemented any CP practice. It also indicates that textile factories gave less than average importance or priority to CP implementation.

Figure 6.13: Textile Factories with respect to CP Implementation



Figures 6.12 and 6.13 also indicate that CP is still in the development phase in Pakistan. For instance, this case study found that majority of textile factories never implemented CP. In contrast, the majority of textile factories showed a positive interest in energy efficiency. There are many reasons why textile factories never implemented CP. Notably, the investors or the owner of textile factories prefer to invest in higher production or in other activities of the business. However, another major reason behind low CP implementation is the lack of CP expertise or technical staff.

Figure 6.14 clearly shows that majority of textile factories do not have the expertise or technical staff to implement CP or energy efficiency.

Figure 6.14: Textile Factories with respect to CP Expertise or Technical Staff

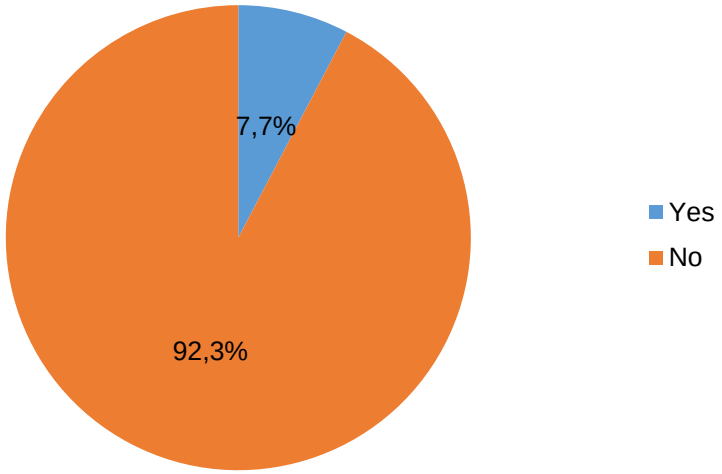
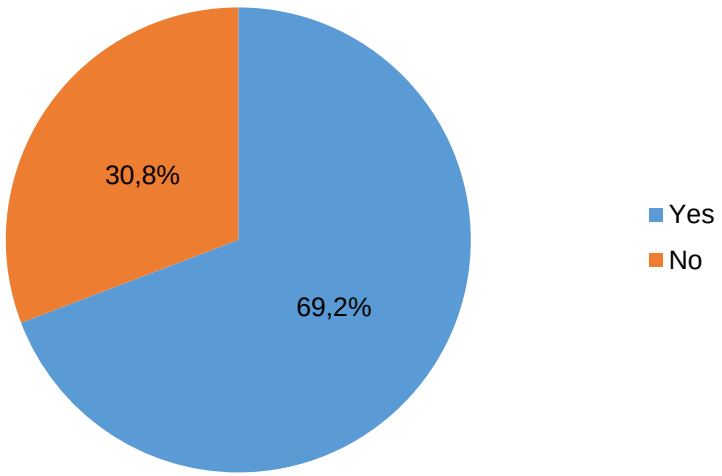



Figure 6.15 shows that majority of textile factories are aware of the initiatives introduced by the CPI and ENERCON. However, they are moderately[31] satisfied with the initiatives such as CTP-Textile, PISD, SCI-Pak, and REEE-Pakistan. Therefore, CPI and ENERCON still need to disseminate information throughout the country by using modern means of communication. In addition, they need to take more effective steps in order to promote CP and energy efficiency.

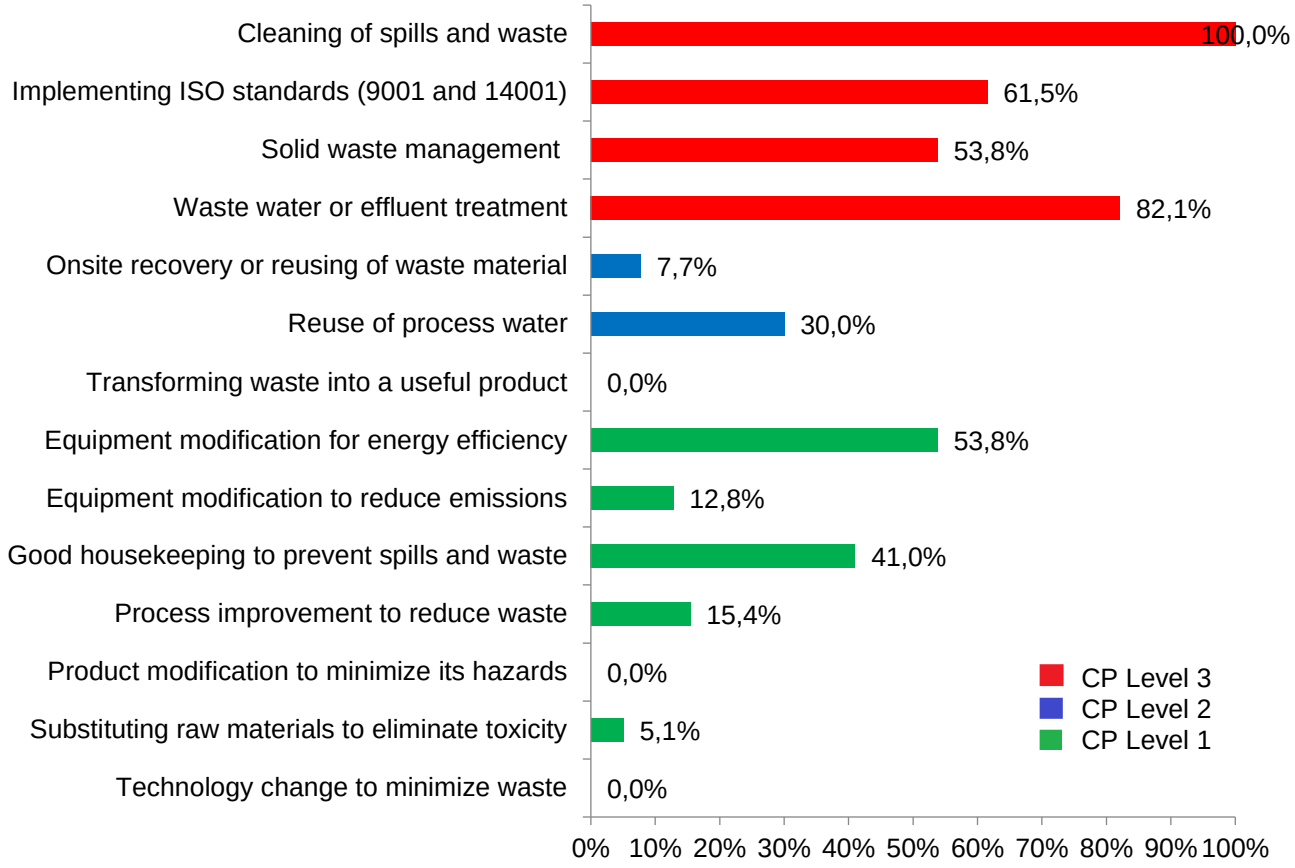
Figure 6.15: Textile Factories with respect to Awareness of Relevant Initiatives




[31] The textile factories were asked to rate each initiative on a scale of 0 - 4 (i.e. none, low, average, above-average, high). However, the weighted average of the responses to each initiative shows an average i.e. moderate (see figure 4.1 and question 16 in Appendix-A)

Figure 6.16 shows that the overall CP Level is generally low i.e. majority of textile factories adopted CP Level 3 practices. It also illustrates that effective CP practices commonly adopted by textile factories include: wastewater treatment, equipment modification for energy efficiency, solid waste management, reuse of process water, and good housekeeping to prevent waste. Notably, it shows that the majority of textile factories missing CP Level 1 practices except energy efficiency measures.

Figure 6.16: Level of CP Implementation[32] in Textile Factories of Pakistan




## 6.3. Barriers and Drivers to CP in Textile Sector of Pakistan

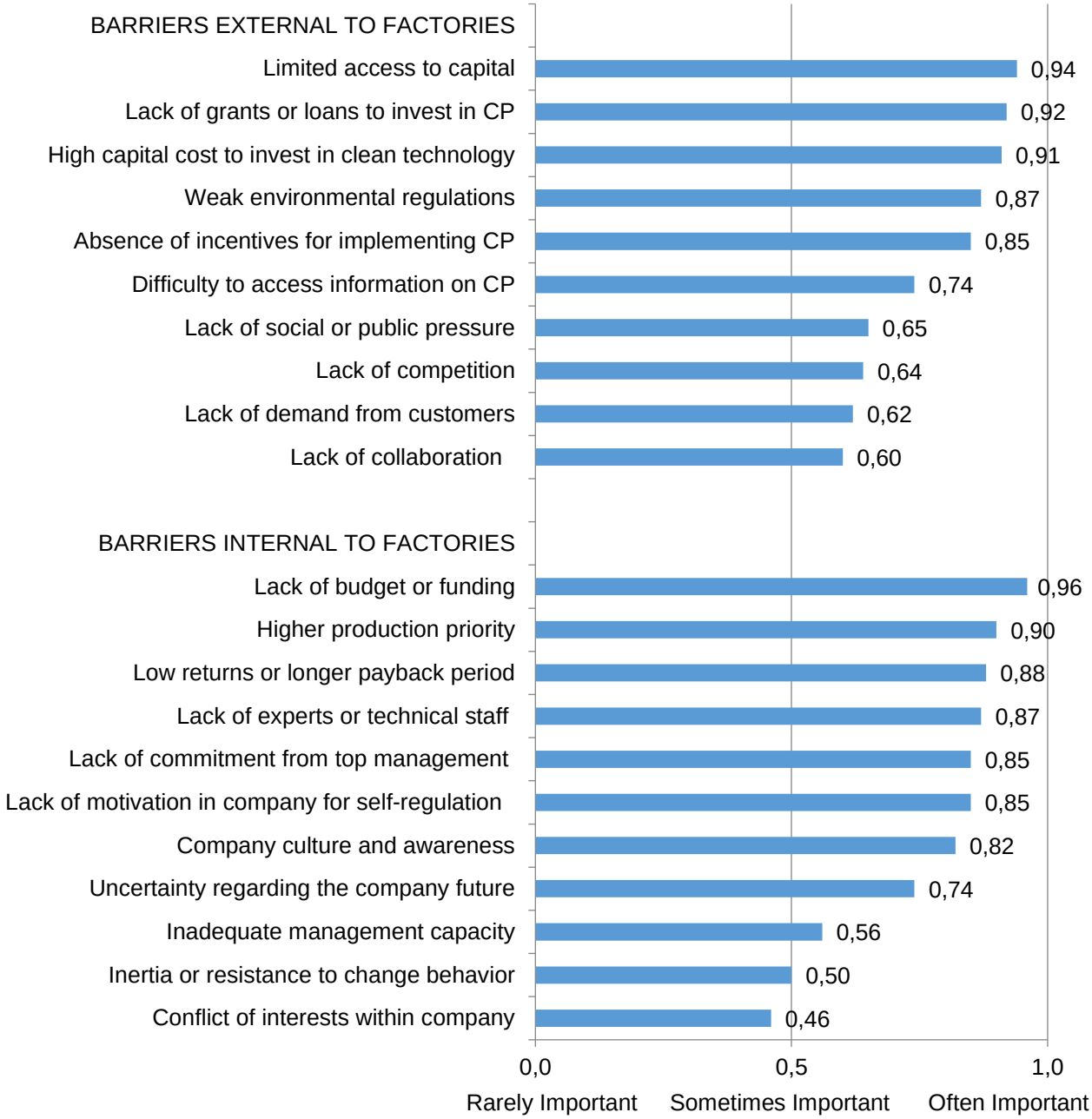
There are many factors that usually hinder the CP implementation. In contrast, there are also some factors that motivate factories to implement CP. However, it makes sense to first identify the most significant barriers and drivers in order to develop recommendations for promoting CP. Hence, this case study also questioned to textile factories regarding barriers and drivers to CP implementation.

The majority of textile factories responded that the most impacting factors include lack of budget, limited access to capital, lack of grants, higher production priority, weak environmental regulations, lack of CP expertise or technical staff, and absence of incentives for CP. In contrast, the most significant drivers for CP include rising energy prices, competition in the international market, governmental regulations, company recognition, and higher production costs. The following charts (figures 6.17 and 6.18) statistically represent the above-stated results.

[32] The Level of CP Implementation is derived from the Level of CP Strategies (see figure 2.6, Q17 in Appendix-A, and Appendix-C). CP practices with red, blue, and green color bars represent CP Level 3, CP Level 2, and CP Level 1 respectively.
Also, note that implementing ISO standards simply refers here as CP Level 3. It means if a textile factory has implemented either ISO 9001 or ISO 14001 then this action is considered here as a CP Level 3 practice. Furthermore, ISO 50001 is not included here since the majority of textile factories have not yet implemented it.

Figure 6.17 shows the weighted average of barriers to CP implementation. These barriers to CP are divided as external and internal to factories and ranked as per their weighted average.

Figure 6.17: Weighted Average of Barriers to CP Implementation in Textile Factories of Pakistan



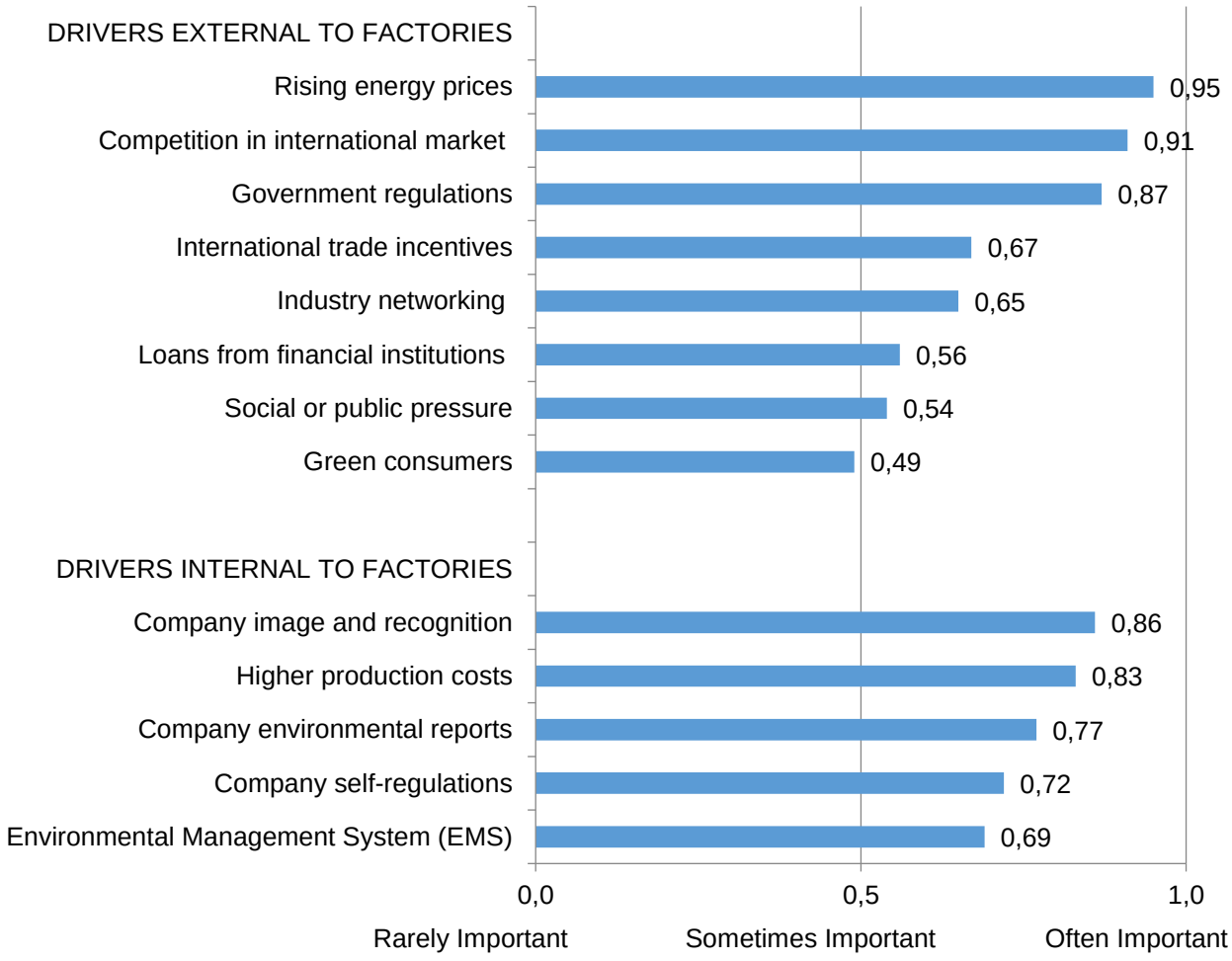

It is clearly evident that the major barriers to CP are at both sides i.e. external as well as internal to the factories. However, financing is the most dominant impacting factor on both sides. It means that textile factories lacking the budget or capital cannot access funding from financial institutions due to the limited access to capital and lack of grants or loans. In addition, owner of textile factories refrains from investing in cleaner technology due to its high capital costs. However, this high capital cost to invest in cleaner technology can be lowered if it is developed locally instead of importing. Furthermore, other external factors such as weak environmental regulations and lack of public pressure[33] significantly hinder CP implementation. Notably, the absence of incentives (from the government) to invest in CP strongly demotivate owner of the textile factories. Hence, they refrain from implementing CP.

[33] Lack of public pressure is not rated as a major barrier to CP implementation by the textile factories (i.e. weighted average: 0.65). However, undoubtedly public pressure can accelerate CP implementation.

The most impacting factors internal to factories that hinder CP implementation includes: higher production priority, lack of CP expertise or technical staff, lack of commitment from the top management, and longer payback period. In addition, company culture and awareness and lack of motivation are the fundamental barriers hindering CP implementation in the textile factories of Pakistan. For instance, the owners of the textile factories principally focus on higher production rather than long-term financial returns i.e. no commitment to invest in cleaner technology due to its longer payback period. This often leads to a culture where everyone focuses on higher production and neglects eco-friendly production due to lack of awareness. In contrast, the textile factories having culture and awareness facing the biggest drawback i.e. lack of CP or expertise or technical staff. This situation can be improved by the incorporating CP into the curriculums of higher education, vocational education, and technical training.

This case study found that the most significant drivers to CP implementation in textile factories of Pakistan include rising energy prices, competition in the international market, government regulations, company recognition, and higher production costs. Figure 6.18 shows the weighted average of drivers to CP implementation. These drivers to CP are divided as external and internal to factories and ranked as per their weighted average.

Figure 6.18: Weighted Average of Drivers to CP Implementation in Textile Factories of Pakistan



It is clearly evident that most significant drivers for CP external to the textile factories include rising energy prices and competition in the international market. Also, the requirement of environmental regulations is a major driver for CP. In contrast, the influence of green consumers or public pressure on textile factories is very limited. However, public pressure can be developed by raising environmental awareness. Similarly, other external factors such as international trade incentives and industry networking can positively promote CP. Notably, the loans from financial institutions can be a significant driver for CP implementation. However, financing needs to be improved by introducing new loans schemes or accessing funding from international organizations. On the other hand, the most significant drivers for CP internal to the textile factories include higher production costs and company recognition. Also, the requirements of environmental reports and Environmental Management System (EMS) are the major drivers for CP implementation in the textile factories.

### 6.4. Barriers and Drivers to Energy Efficiency in Textile Sector of Pakistan

There are also many factors that usually hinder the energy efficiency implementation. However, there are also some factors that motivate factories to implement energy efficiency. It is important to identify the most significant barriers and drivers in order to develop recommendations for promoting energy efficiency. Hence, this case study also questioned to textile factories regarding barriers and drivers to energy efficiency implementation.

The majority of textile factories responded that the most significant barriers to energy efficiency implementation include lack of budget, limited access to capital, lack of grants or loans, higher production priorities, costs of production disruptions, lack of expertise or technical staff, and low priority to energy management. In contrast, the most significant drivers to energy efficiency implementation in textile factories include cost reductions from lowered energy use, rising energy prices, energy consumption or energy bills, competition in the international market, energy audits, and government regulations. The following charts (figures 6.19 and 6.20) statistically represent the above-stated results.

Figure 6.19 shows the weighted average of barriers to the energy efficiency (EE) implementation. These barriers to energy efficiency are divided as external and internal to factories and ranked as per their weighted average. Surprisingly, it shows that the most of the significant barriers to energy efficiency are internal to the factories except financial barriers (i.e. limited access to capital and lack of grants or loans) which are external to factories. However, financing is the most dominant impacting factor on both sides i.e. external and internal to the factories. Similar to CP barrier, textile factories lacking the budget or capital to invest in energy efficiency cannot access funding from financial institutions due to the limited access to capital and lack of grants.

The owner of textile factories usually reluctant to invest in energy efficient technologies due to lack of information to make a cost-effective decision. In particular, the owner of small and medium-sized textile factories usually avoid risks hence unavailability of information to make a cost-effective decision becomes a significant barrier to the energy efficiency implementation. In addition, energy efficient technologies are usually imported from other countries thus difficulties in getting information about equipment often hinders energy efficiency implementation. However, this situation can be improved if CP technology is locally developed or equipment is directly supplied by the local vendors.

Figure 6.19: Weighted Average of Barriers to EE Implementation[34] in Textile Factories of Pakistan

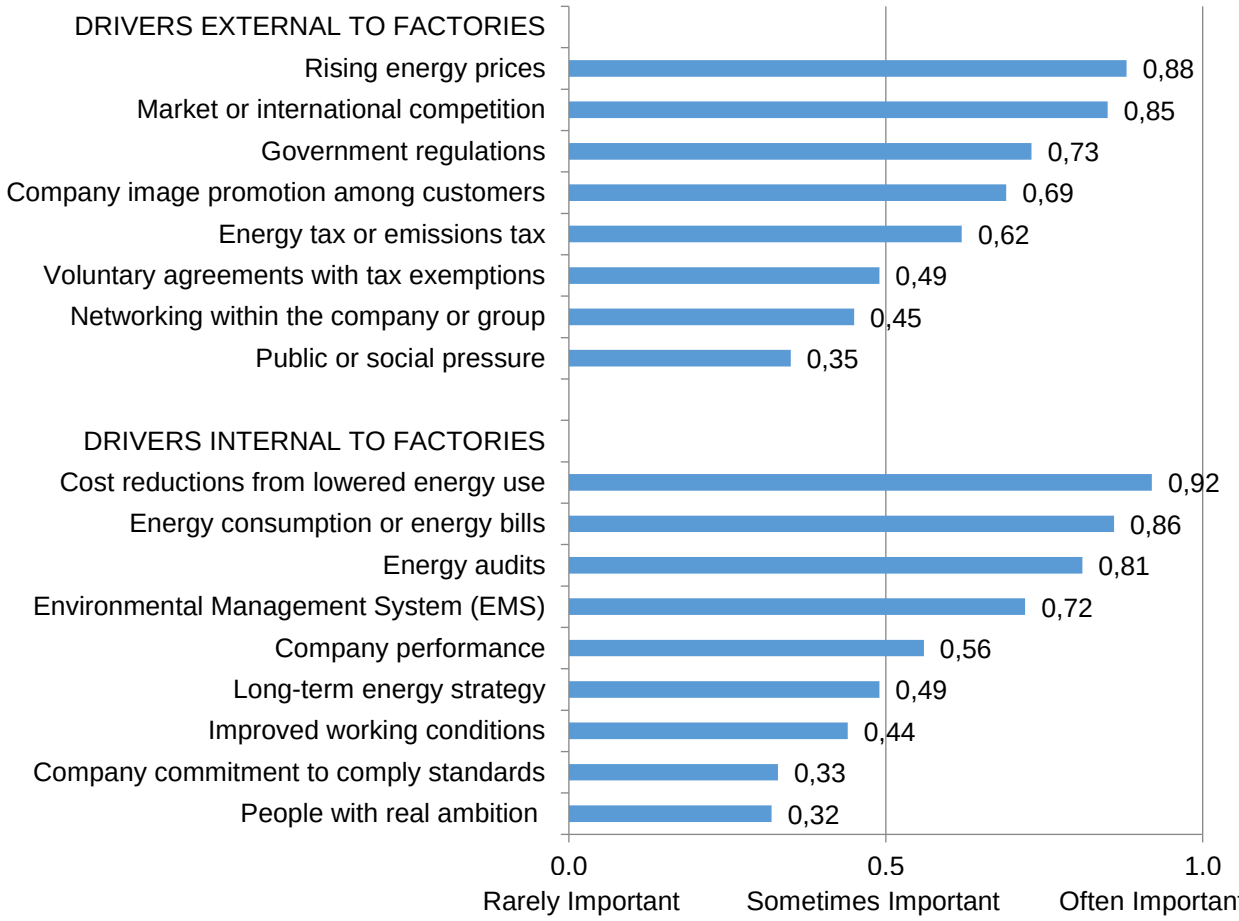

The most impacting factors internal to factories that hinder energy efficiency implementation includes: lack of budget or funding, higher production priority, the cost of production disruptions, lack of expertise or technical staff, low priority to energy management, lack of commitment from top management, and hidden costs of new equipment. The reasons for the barriers such as lack of budget, higher production priority, lack of technical staff, and lack of commitment are almost same

[34] Classification of barriers to energy efficiency is derived from the literature review (see section 2.3.2). However, the terminologies are simplified for better comprehension so the textile factories can easily respond to the questionnaire (see Q-20 in Appendix-A)

as in the case of CP[35]. The implementation of energy efficiency often needs equipment replacement which may disrupt production. In contrast, higher production is the prime goal, therefore, the owner or top management of textile factories usually never compromise with production disruptions and its associated costs. In fact, energy management is not regarded as a priority in the textile factories of Pakistan. This situation can be improved by raising awareness among laborers and top management. Furthermore, awareness can also improve commitment from the top management. In addition, the other factors that often significantly hinder energy efficiency implementation include additional or hidden costs of new equipment, energy manager lack sufficient power, company hierarchy or long chain decisions, and company culture and awareness.

This case study found that the most significant drivers to energy efficiency implementation in textile factories of Pakistan include cost reductions from lowered energy use, rising energy prices, energy consumption or energy bills, competition in the international market, energy audits, and government regulations. Figure 6.20 shows the weighted average of drivers to energy efficiency (EE) implementation. These drivers to energy efficiency (EE) are divided as external and internal to factories and ranked as per their weighted average.

Figure 6.20: Weighted Average of Drivers to EE Implementation in Textile Factories of Pakistan




It is clearly evident that most significant drivers for energy efficiency external to the textile factories include rising energy prices and competition in the international market. Also, the requirements of government regulations, energy tax or emissions tax, and company recognition are the important

[35] The reasons for the barriers such as lack of budget, higher production priority, lack of technical staff, and lack of commitment from the top management are almost similar in both cases i.e. CP and energy efficiency implementation (see section 6.3).

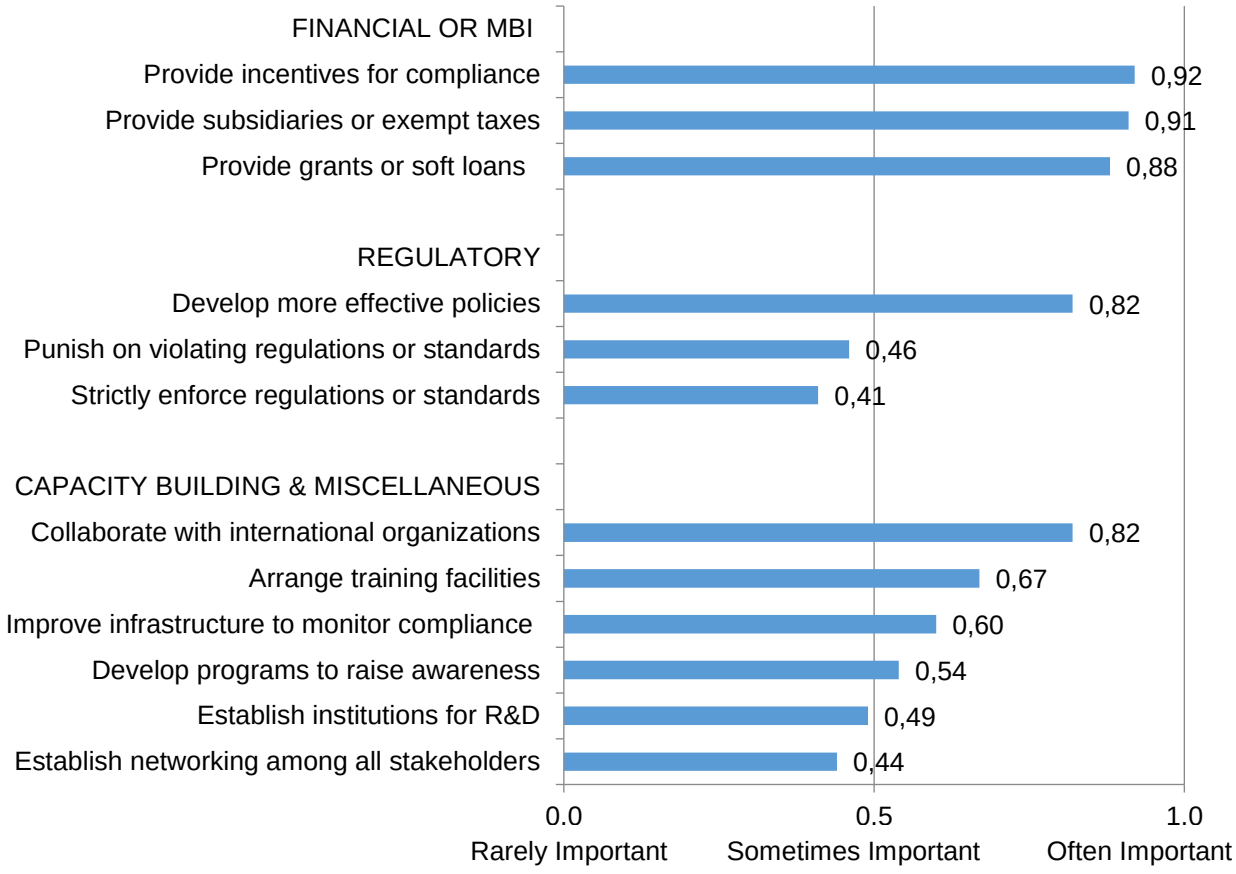
drivers for energy efficiency implementation. On the other hand, the most significant drivers for energy efficiency internal to the textile factories include benefits such as production costs reduction due to lowered energy use, reduction in energy bills, and meeting the requirements of energy audit in order to gain ISO certifications. Similarly, long-term energy strategy[36] is an important driver for energy efficiency implementation.

### 6.5. Conclusion

The above-mentioned discussion (see sections 6.1 and 6.2) answers the third sub-research question i.e. what is the present level of CP practices and energy efficiency measures adopted by the textile factories in Pakistan. Similarly, the above-mentioned discussion (see sections 6.3 and 6.4) answers the fourth sub-research question i.e. what are the barriers and drivers to the implementation of CP and energy efficiency in the textile factories of Pakistan.

In addition, this case study also questioned to the textile factories about various options or tools that government should opt in order to overcome above-mentioned barriers and to promote CP and energy efficiency. Figure 6.21 shows the weighted average of tools to promote CP and energy efficiency. These tools are categorized as financial, regulatory, and capacity building and miscellaneous. Also, they are ranked as per their weighted average.

Figure 6.21: Weighted Average of Tools to Promote CP and EE in Textile Factories of Pakistan




[36] Surprisingly, long-term energy strategy is not rated as high as other significant drivers for energy efficiency by the textile factories (i.e. weighted average 0.49). It indicates that most of the textile factories particularly small and medium-sized textile factories are not focusing on long-term energy strategy. However, long-term energy strategy is very important thus this situation should be improved.

This case study concluded that the textile factories are struggling with financing since most of the textile factories indicated financial barriers as the most dominant barriers to CP and energy efficiency implementation. In addition, the textile factories rated financial tools as the most liked option. In contrast, textile factories rated regulatory tools as the least liked option among all options. It shows that financial incentives are highly attractive for textile factories. It includes financial incentives for compliance, subsidiaries or tax exemption, and grants or soft loans. In short, such financial incentives or MBIs are the most effective and vital instrument to promote CP and energy efficiency in textile sector of Pakistan.

It is really important to develop more effective policies. Also, the majority of the textile factories are in favor of more effective policies as they rated it among top options. Notably, it is the only most liked option among regulatory options. In contrast, tools or options such as punishment and strict enforcement are rated as the most unattractive option among all options. However, this does not mean to exclude these options since a balanced system is a must requirement in order to successfully promote CP and energy efficiency in the textile sector of Pakistan. In short, financial incentives must be provided for implementing CP and energy efficiency. However, there should also be a strong regulatory system that strictly enforces regulations and punish on violation of regulations.

Capacity building is also very important for promoting CP and energy efficiency. Textile factories rated collaboration with the international organizations as one of the most preferred options. Similarly, they showed a positive response to the options such as arranging training facilities, improving infrastructure, raising awareness, establishing institutions for R&D, and networking among all stakeholders. Undoubtedly, all of these options are essential for capacity building leading to successful promotion of CP and energy efficiency. Chapter seven further provides recommendations in order to promote CP and energy efficiency in the industrial sector particularly the textile sector of Pakistan.

# CHAPTER SEVEN: RECOMMENDATIONS

Pakistan has established relevant institutions as well as introduced various legislations and initiatives. However, Pakistan still needs much effort to promote cleaner production (CP) and energy efficiency (EE) in the industrial sector. Therefore, this chapter provides recommendations in order to answer the main research question: How can cleaner production (CP) and energy efficiency (EE) be promoted in the textile sector of Pakistan.

## 7.1. Overview of Recommendations

Table 7.1 provides an overview of recommendations against each significant barrier to cleaner production (CP) and energy efficiency (EE) external to factories. It also shows specific measures which can overcome each significant barrier respectively, and ultimately promoting CP and energy efficiency in the industrial sector, and particularly in the textile sector of Pakistan.

Table 7.1: Overview of Recommendations for Barriers External to Factories

| Significant Barriers to CP and EE in the Textile Sector of Pakistan | | Recommendation (Category) | Specific Measures |
|---|---|---|---|
| **Barriers External to Factories** | Limited access to capital | • Financing<br>• Collaboration & Networking<br>• Raising Awareness | • Facilitating available funding options<br>• International collaboration<br>• Training of financial institutions |
| | Lack of grants or loans | • Financing | • Launching industry specific schemes |
| | High capital cost to invest in CT/CP | • Capacity Building<br>• Regulatory Framework | • Facilitating R&D i.e. local manufacturing instead of imports<br>• Supporting technology innovation |
| | Weak environmental regulations | • Regulatory Framework<br>• Institutional Structure | • Formulating a national policy for CP and establishing a mandatory CP audit system<br>• Revising and improving NEQS<br>• Strengthening institutions & enforcement system |
| | Absence of incentives for CP and EE | • Financing | • Providing subsidy for training of workers<br>• Provide incentives for CP & ISO certifications |
| | Difficulty to access information | • Raising Awareness<br>• Miscellaneous | • Establishing CP information centers<br>• Disseminating information<br>• Demonstrating CP projects<br>• Compiling up-to-date information |
| | Lack of social or public pressure | • Raising Awareness | • Raising public awareness |
| | Lack of competition | • Regulatory Framework<br>• Collaboration & Networking | • Formulating appropriate policies for SMEs<br>• International collaboration<br>• Establishing network among stakeholders |
| | Lack of demand from customers | • Miscellaneous<br>• Raising Awareness | • Green consumers<br>• Raising public awareness |
| | Lack of collaboration | • Collaboration & Networking | • International collaboration<br>• Establishing network among stakeholders<br>• Supporting reuse of waste<br>• Establishing combined facilities |

Table 7.2 provides an overview of recommendations against each significant barrier to cleaner production (CP) and energy efficiency (EE) internal to factories[37].

Table 7.2: Overview of Recommendations for Barriers Internal to Factories

| Significant Barriers to CP and EE in the Textile Sector of Pakistan | | Recommendation (Category) | Specific Measures |
|---|---|---|---|
| **Barriers Internal to Factories** | Lack of budget or funding | • Financing | • Decreasing interest rates of soft loans<br>• Launching industry specific schemes |
| | Higher production priority | • Raising Awareness | • Disseminating information<br>• Training of workers |
| | Low returns or longer payback period | • Financing | • Decreasing interest rates of soft loans |
| | Lack of expertise or technical staff | • Capacity Building | • Incorporating CP into the curriculum of education and establishing training institutes |
| | Lack of commitment and motivation | • Miscellaneous | • Introducing awards to encourage factories |
| | Company culture and awareness | • Raising Awareness<br>• Capacity Building | • Disseminating information<br>• Demonstrating CP projects<br>• Training of workers<br>• Training of experts |
| | Inertia or residence to change | • Raising Awareness | • Disseminating information |
| | Low priority to energy management | • Regulatory<br>• Raising Awareness | • Formulating appropriate policies for SMEs<br>• Disseminating information |
| | Workers not accountable | • Raising Awareness | • Training of workers |
| | Conflict of interests | • Raising Awareness | • Disseminating information |

## 7.2. Description of Recommendations

This section elaborates recommendations (with respect to following categories) in order to promote CP and energy efficiency in the industrial sector and particularly in the textile sector of Pakistan[38].

- Raising Awareness
- Capacity Building
- Regulatory Framework
- Institutional Structure
- Financing
- Collaboration and Networking
- Miscellaneous

[37] This research found that the significant barriers are mostly similar for both CP and energy efficiency (e.g. limited access to capital and lack of grants or loans) thus table 7.1 and table 7.2 represent an overview of recommendations for both CP and energy efficiency. In addition, these barriers are somehow interlinked to each other (e.g. absence of incentives causes demotivation thus factories refrain from investing in CP or EE). It means that a recommendation for one barrier can also assist in overcoming another barrier (e.g. lack of public pressure, company culture, and difficulty in accessing information can be overcome by raising awareness.

[38] These recommendations are not limited to the above-mentioned significant barriers nor limited to the textile sector. In other words, it also represents some general recommendations for the industrial sector.

### 7.2.1. Raising Awareness

- **Raising Public Awareness:** The public should be informed about the impacts of industrial pollution on human health and the benefits of CP. The involvement of the public can create a huge pressure on factories to adopt CP practices. Therefore, a national strategic plan for raising public awareness should be developed. Most importantly, public awareness must be raised through all channels (e.g. advertisement in newspapers, propaganda on TV channels, campaigns through NGOs and social media, and information through educational institutions). Similarly, energy efficiency can also be promoted by raising public awareness.

- **Training of Workers:** The environmental performance of a factory is significantly affected by the attitude of workers. However, the main reason for such attitude is generally the lack of education and awareness regarding the importance of resource conversation. They are unaware of the fact that their working practices can save substantial resources of the factory with no cost. Therefore, training should be organized to educate workers particularly on following topics:

    - CP and energy efficiency measures specific to the factory
    - Resources conservation measures (water, energy, and chemicals)

- **Training of Financial Institutions:** Factories usually approach to financial institutions for the loans to invest in CP technologies or energy efficiency measures. However, financial institutions do not have the necessary knowledge to evaluate CP or energy efficiency related projects thus they often turn down the loan applications. Therefore, selective personnel from the financial institutions should also be trained on CP and energy efficiency specificities.

- **Establishing Information Centers:** A huge network of information centers should be established throughout the country within industrial areas in order to provide all necessary information related to CP and energy efficiency.

- **Disseminating Information:** SMEs usually do not access internet or web resources extensively thus CP information though the internet is not likely to be accessed by them. However, SMEs trust information from respective industrial associations. Therefore, preferably a direct contact should be made with SMEs in order to disseminate CP information. In addition, printed materials (brochures, fact sheets, manuals, case studies) written in native language should be distributed to SMEs through organizations such as industry associations, trade associations, the local chamber of commerce, and regional offices of relevant institutions.

- **Demonstrating CP Projects:** CP and energy efficiency should be marketed as providing financial benefits in addition to environmental benefits. However, SMEs are unlikely to adopt CP practices or energy efficiency measures unless they are clearly shown how those practices or measures can affect their bottom line. Therefore, pilot CP projects should be demonstrated in order to attract factories.

### 7.2.2. Capacity Building

- **Incorporating CP into the Curriculum of Education:** Several universities throughout the world have developed M.Sc. and Ph.D. programs to provide students an opportunity to expand and deepen their knowledge and skills on Cleaner Production, Cleaner Products, Industrial Ecology, Sustainable Development and related concepts. As a result, a growing number of young graduates are now actively working within academic, industrial, governmental, NGOs, and consultative organizations throughout the world. Therefore, CP must be incorporated into the curriculum of higher education (e.g. colleges and universities) and vocational education (e.g. technical training centers) in Pakistan in order to create professionals and technical staff capable of meeting industry demands in the future.

- **Establishing Training Institutes:** Training institutes should be established to provide industry specific training. These institutions should also provide technical training on environmental and energy management such as cleaner production (CP) and energy efficiency. However, these institutions should be located near to the relevant industries. Moreover, a regular feedback should be taken from industries to ensure that the training is addressing the actual needs of the industry.

- **Training of Experts:** Special training programs should be developed to prepare a group of experts who will be expected to:

    - Provide training for raising awareness and to encourage factories to undertake CP and energy efficiency measures.
    - Conduct assessment in factories in order to identify system optimization opportunities.
    - Work with factories to develop projects based on the findings of the assessment.
    - Prepare case studies of successful projects.

- **Facilitating Research & Development (R&D):** Research and Development (R&D) must be focused and facilitated in order to encourage national self-reliance i.e. creating own technology rather than relying on imports. Moreover, state-of-the-art laboratories should be established to serve R&D needs of the industry. Such laboratories can also be established in universities with the collaboration of industry.

### 7.2.3. Regulatory Framework

- **Formulating a National Policy for CP:** A National Policy for Cleaner Production (CP) should be developed. Notably, a CP policy does not refer to simply making a few provisions (e.g. tax rebates and permitting provisions) in the existing system nor does it mean enacting a brand new stand-alone Cleaner Production Act. In fact, it requires interweaving the concept of preventive strategies in all facets of the policy framework to make it uniformly supportive and favorable to CP concept. In short, this policy should address the environmental issues from an integral perspective rather than an isolated perspective. However, a strong collaboration among relevant authorities and stakeholders must also be developed for proper implementation of policy at all levels.

- **Establishing Mandatory CP Audit System:** A mandatory CP audit system must be established in order to strictly enforce CP in factories. A system similar to the Chinese CP audit system can be introduced with appropriate modifications in Pakistan. The relevant Chinese authority should be contacted in order to understand their infrastructure and to develop an action plan.

- **Mainstreaming Sustainable Production into all Policies:** Sustainable Production consists of many different aspects that fall under the responsibilities of different ministries e.g. Ministry of Climate Change, Ministry of Industries and Production, Ministry of Textiles, Ministry of Finance, Environmental Protection Agencies (EPAs), ENERCON, SMEDA, and AEDB. However, a strong cooperation among institutions is mandatory required in order to coordinate regulations, building capacity, allocating funding, setting technical requirements, and to make coherent efforts. Therefore, a national sustainable production action plan should be developed and sustainable production must be mainstreamed in all relevant policies of the country.

- **Revising and Improving NEQS:** NEQS should be revised in consultation with all stakeholders. Moreover, NEQS should be industry specific. However, it must be strictly enforced and monitored by strengthening regulatory system (see section 7.4).

- **Strengthening Enforcement System:** The policies related to environment or energy efficiency do not have the impact that they were envisioned to have. The reason behind is the weak enforcement system. Therefore, the regulatory enforcement system must be strengthened by strengthening institutional structure (see section 7.4).

- **Assuring the Health and Safety of Factory Workers:** The factory owners usually avoid to fulfill the requirements of health and safety by:

    - Hiring factory workers on daily wages instead of hiring on the permanent or contract basis.
    - Misusing the human resource department for the short term benefits of a factory e.g. hiring home based workers who are not entitled to any benefit.
    - Not allowing workers to form unions in a factory.
    - Bribing the government officer responsible for implementing health and safety rules in the industry.

  Therefore, the health and safety rules should be revised and must be strictly enforced. Also, a transparent monitoring system or an online reporting system should be initiated so that the local community or factory workers can confidentially report any disparity or violation of rules. The relevant authority should also do unplanned visits to factories without the consent of factory owners in order to verify either the health and safety rules properly implemented or not. If the violation of rules is found then factories should be closed down until the health and safety of workers are assured and a heavy fine is paid to the concerned authority. In addition, incentives should be given to encourage factories that are strongly committed to improving working conditions.

- **Formulating Appropriate Policies for SMEs:** SMEs are difficult to reach and often they do not respond to either regulations or assistance programs. Therefore, industrial and environmental policies should pay special attention to this sector in order to formulate appropriate policies. Moreover, information about regulations in SMEs should be channeled through local governments or organizations working closely with them.

- **Regulating Inefficient Machinery Imports:** SMEs mostly from textile processing and tannery sector tend to use second-hand inefficient machinery. Therefore, policies should be developed to restrict the import of these inefficient machines. However, there is an opportunity of transferring better technology machinery from China thus it should be facilitated.

- **Supporting Technology Innovation:** Technology innovation and the use of energy efficient technology should be supported by setting minimum rules and exempting taxes on the import of relevant technologies.

- **Revising Boiler Code:** The boiler code of Pakistan covers only safety parameters. It does not address environmental impacts or energy efficiency. Therefore, boiler code should be revised in order to provision environmental impacts or energy efficiency.

### 7.2.4. Institutional Structure

- **Strengthening Institutions:** In order to enforce energy efficiency and CP or environmental regulations, a strong institutional structure is mandatory required. However, the institutions are weak to operate and enforce regulations in Pakistan.

    - Institutions having weakness due to deficits in autonomy and transparency
    - Institutions having weak capacity to enforce regulations due to corruption and a system based on seniority not based on performance
    - Institutions lacking skilled manpower due to the recruitment of manpower through a quota system and political affiliations.
    - Institutions lacking training and resources necessarily required for monitoring and enforcing compliance.
    - Institutions lacking industry-specific benchmarks and necessary instruments to measure quantifiable violations.

  Therefore, the relevant institutions must be strengthened by resolving above-mentioned weaknesses. Most importantly, the recruitment of manpower must be on the basis of merit.

### 7.2.5. Financing

- **Facilitating Available Funding Options:** Factories usually face difficulties in accessing funding due to the information asymmetries. In addition, complicated documentation procedure for funding application (e.g. loans application) also discourages factories to avail funding from financial institutions. Therefore, the information should be disseminated through all channels (e.g. advertisement in newspapers, TV channels, and social media). Furthermore, the application procedure must be facilitated (e.g. an online application system to expedite application procedure).

- **Launching Industry Specific Schemes:** Some groundbreaking schemes or new financial mechanism should be launched for factories undertaking CP or energy efficiency measures. Alternatively, industry specific loan schemes should be initiated to cover the requirements of the industry. In addition, these schemes should also focus on SMEs.

- **Decreasing Interest Rates of Soft Loans:** Financial institutions offering so-called soft loans at interest rate of around 17% is highly unattractive for factories. Therefore, the high-interest rate of soft loans should be decreased and its payback period should also be eased.

- **Provide Incentives for EMS, EnMS, and ISO certifications:** Financial incentives or tax incentives, tax rebates should be provided to support factories that want to implement EMS or EnMS and to obtain ISO certifications. In addition, there should also be some financial incentives for implementing CP and energy efficiency.

- **Providing Subsidy for Training of Workers:** A subsidy should be provided to factories for the training of workers. However, the percentage of subsidy can be decided in consultation with all stakeholders. For example, factories should bear seventy percent training costs whereas the remaining costs i.e. thirty percent should bear by the government. Most importantly, workers must be trained on CP or energy efficiency related machines or technology as per standards.

### 7.2.6. Collaboration and Networking

- **International Collaboration:** International collaboration must be made in order to facilitate technology transfer and attracting investments from international donor agencies for projects related to CP and energy efficiency.

- **Establishing Network Among Stakeholders:** A strong network must be established among all stakeholders including relevant authorities, academia, R&D organizations, financial institutions, industry associations, and factories.

- **Supporting Reuse of Waste**: Cooperation between different industry sectors should be supported in order to reuse waste of one industry for other industries.

- **Establishing Combined Facilities:** Combined Effluent Treatment Plants (CETPs) and Common Hazardous Waste Treatment and Storage Facilities (CHWTSFs) must be established on the urgent basis in all industrial estates or in the areas where clusters of industry are located. So, the factories can cooperate and share facilities to treat wastewater in order to decrease the costs of environment compliance. Also, Combined Effluent Treatment Plants (CETPs) can be used for disintegrated power generation.

### 7.2.7. Miscellaneous

- **Correcting Subsidies:** Pre-existing subsidies or economic incentives that might artificially lower the prices of certain resources and stimulate pollution due to unsustainable use must be reviewed and corrected.

- **Initiating Internship Programs:** Internship programs should be initiated in order to combine professional training for graduates with low-cost CP services delivery to SMEs. However, such internship programs must be structured to give graduates ample background to engage in worthwhile projects.

- **Introducing Awards to Encourage Factories:** A Sector-specific award scheme must be introduced in order to recognize high-level achievements of factories on CP and resource efficiency. Moreover, the factories will receive marketing advantage because of media and institutional recognition.

- **Green Consumers:** Undoubtedly, there is a considerable untapped potential of green consumers to influence factories to provide environmentally sound products. Therefore, a momentum must be launched through NGOs in order to create widespread awareness among consumers.

- **Compiling Up-to-date Information:** Up-to-date information on CP practices and technologies should be compiled and disseminated in a user-friendly manner addressing specifically regional or national needs.

## 7.3. Closing Remarks

In addition to the answers of the four sub-research questions, the above-mentioned description of recommendations particularly answers the main research question i.e. how can cleaner production (CP) and energy efficiency be promoted in the industrial sector and particularly in the textile sector Pakistan. In short, this research concludes that CP and energy efficiency can be successfully promoted by raising awareness, building capacity, strengthening regulatory framework and institutional structure, facilitating finance, and establishing collaboration and networking among stakeholders.

# REFERENCES


ADB,. (2011). Sector Overview: Industrial Energy Efficiency Finance Program. Asian Development Bank. Retrieved 12 August 2016, from http://www.adb.org/sites/default/files/linked-documents/45916-01-ban-oth-01.pdf

ADB,. (2014). Bangladesh: Industrial Energy Efficiency Finance Program. Asian Development Bank. Retrieved 12 August 2016, from http://www.adb.org/sites/default/files/project-document/80742/45916-014-tacr-01.pdf

Agnello, X., Naveen, J., Ravichandran, M., and Balamurugan, J. (2015). Clean Technology and its Efficacy: Strategies of Environmental Management. Journal of Environmental and Social Sciences, 2(2), 110

Bai, Y., Yin, J., Yuan, Y., Guo, Y., and Song, D. (2015). An innovative system for promoting cleaner production: mandatory cleaner production audits in China. Journal of Cleaner Production, 108, 883-890

Christian Aid,. (2014). Low-carbon South Asia: Pakistan. Christian Aid. Retrieved 10 May 2016, from http://www.christianaid.org.uk/Images/low-carbon-south-asia-pakistan-november-2014.pdf

CIA,. (2016). the World Factbook. Central Intelligence Agency. Retrieved 10 May 2016, from https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html

CPI,. (2015a). Complete Profile. Cleaner Production Institute. Retrieved 10 May 2016, from http://www.cpi.org.pk/PROFILE_HOME.ASPX

CPI,. (2015b). Environmental Improvement and Energy Efficiency in Pakistan Industry. Cleaner Production Institute. Retrieved 18 July 2016, from http://www.cpi.org.pk/CPIAboutUS.aspx

CPI,. (2015c). CTP-Textile Environmental Engineering. Cleaner Production Institute. Retrieved 18 July 2016, from http://www.cpi.org.pk/ProjectCtpTextileEnvEngineering.aspx

Dawn,. (2012a). Textile industry saves Rs 400 million through energy efficiency program. Retrieved 12 August 2016, from http://www.dawn.com/news/760949/textile-industry-saves-rs-400-million-through-energy-efficiency-program

Dawn,. (2012b). Industrial Policy. Retrieved 12 August 2016, from http://www.dawn.com/news/705502/industrial-policy

ENVIS,. (2014). BAT in Textile Sector. ENVIS Gujrat Cleaner Production Centre. Retrieved 12 August 2016, from http://gcpcenvis.nic.in/Poster/TEXTILE_HOME_POSTER.PDF

EPA,. (2014). Global Greenhouse Gas Emissions Data. United States Environmental Protection Agency. Retrieved 10 May 2016, from https://www3.epa.gov/climatechange/ghgemissions/global.html

European Commission (EC),. (2015). International Labour and Environmental Standards Application in Pakistan's SMEs. European Commission. Retrieved 10 May 2016, from https://ec.europa.eu/europeaid/sites/devco/files/aap-financing-asia-part3-annex4-20151209_en.pdf

Francisco L., (2002), Enforcement of Cleaner Production practices in shrimp farming through economic and regulatory measures: a case study in Thailand, AIT Thesis No. EV-02-14

Germanwatch,. (2015). Global Climate Risk Index 2016. Germanwatch. Retrieved 12 August 2016, from https://germanwatch.org/fr/download/13503.pdf

GCPC,. (2016). ENVIS Centre On: Cleaner Production. Gujrat Cleaner Production Centre. Retrieved 12 August 2016, from http://gcpcenvis.nic.in/default.aspx

Gielen, D. and Taylor, P. (2009). Indicators for industrial energy efficiency in India. Energy, 34(8), 962-969

Grant, T. (2011). On 10th birthday, BRICs poised for more growth. The Globe and Mail. Retrieved 10 May 2016, from http://www.theglobeandmail.com/report-on-business/economy/economy-lab/daily-mix/on-10th-birthday-brics-poised-for-more-growth/article2264208/

Hansen, A., Cottle, S., Negrine, R., and Newbold, C. (1998). Mass communication Research Methods. Hampshire: Macmillan.

Hicks, C. and Dietmar, R. (2007). Improving cleaner production through the application of environmental management tools in China. Journal of Cleaner Production, 15(5), 395-408.

Hilson, G. (2000). Barriers to implementing cleaner technologies and cleaner production (CP) practices in the mining industry: A case study of the Americas. Minerals Engineering, 13(7), 699-717.

Hossain, T. (2015). Application of Resource Efficient and Cleaner Production (RECP) in the Energy Intensive Industry to Promote Low Carbon Industrial Development in Bangladesh. Low Carbon Economy, 06(03), 73-85

HSE,. (2015). Health and safety in the textiles industries. Health and Safety Executive. Retrieved 10 May 2016, from http://www.hse.gov.uk/textiles/

Hydrocarbon Development Institute of Pakistan (HDIP),. (2013). Pakistan Energy Year Book 2012. Ministry of Petroleum & Natural Resources Government of Pakistan.

IEA,. (2007). International Energy Agency. Tracking Industrial Energy Efficiency and CO2 Emissions. Retrieved 10 May 2016, from https://www.iea.org/publications/freepublications/publication/tracking_emissions.pdf

IEA,. (2008). Worldwide Trends in Energy Use and Efficiency Key Insights from IEA Indicator Analysis. International Energy Agency. Retrieved 10 May 2016, from http://www.iea.org/publications/freepublications/publication/Indicators_2008.pdf

IEA,. (2010). Key World Energy Statistics 2010. International Energy Agency. Retrieved 10 May 2016, from http://www.iea.org/textbase/nppdf/free/2010/key_stats_ 2010.pdf

IEP,. (2013). Energy Situation in Pakistan. The Institution of Engineers Pakistan. Retrieved 10 May 2016, from http://www.iepkarachi.org.pk/IEP%20Energy%20Presentation%2030%20Jan%2013-Hasan%20Nawab.pdf

IFC,. (2012). Industry Specific Study on Sustainable Energy Finance Potential for Financial Institution in Bangladesh under the South Asia Enterprise Development Facility Project. International Finance Corporation (IFC) of World Bank Group.

IIP,. (2015). Perform Achieve Trade Scheme (PAT Scheme). Institute for Industrial Productivity. Retrieved 12 August 2016, from http://iepd.iipnetwork.org/policy/perform-achieve-trade-scheme-pat-scheme

IPCC,. (2007). Climate Change 2007: Mitigation of Climate Change, Chapter 7 Industry (pp. 447-496). Cambridge, United Kingdom and New York, NY, USA.: Cambridge University Press. Retrieved 10 May 2016, from https://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg3_report_mitigation_of_climate_change.htm

Jeswani, H., Wehrmeyer, W., and Mulugetta, Y. (2008). How warm is the corporate response to climate change? Evidence from Pakistan and the UK. Business Strategy and the Environment, 17(1), 46-60.

Jie, Y. (2013). CP Promotion Law in China. ENVIS - Gujrat Cleaner Production Centre. Retrieved 12 August 2016, from http://gcpcenvis.nic.in/PDF/China.ppt

Kong, G. and White, R. (2010). Toward cleaner production of hot dip galvanizing industry in China. Journal of Cleaner Production, 18(10-11), 1092-1099

Maheshwari, J. (2015). Pakistan economy vulnerable to climate change. The Nature News. Retrieved 10 May 2016, from http://thenaturenews.com/2015/07/pakistan-economy-vulnerable-to-climate-change/

Ministry of Finance,. (2013). Population, Labour Force and Employment. Ministry of Finance. Retrieved 10 May 2016, from http://www.finance.gov.pk/survey/chapters_13/12-Population.pdf

Ministry of Finance,. (2014). Chapter 14 Energy - Pakistan Economic Survey. Ministry of Finance. Retrieved 12 August 2016, from http://www.finance.gov.pk/survey/chapters_14/14_Energy.pdf

Ministry of Petroleum,. (2013). Pakistan's Energy Yearbook 2012. Islamabad: Ministry of Petroleum and Natural Resources Government of Pakistan.

MINTEX,. (2013). Year Book 2010-11 and 2011-12. Islamabad: Ministry of Textile Industry Government of Pakistan.

MOCC,. (2013). Framework for Implementation of Climate Change Policy. Islamabad: Climate Change Division, Government of Pakistan.

Mol, A. and Liu, Y. (2005). Institutionalising cleaner production in China: the Cleaner Production Promotion Law. International Journal of Environment and Sustainable Development, 4(3), 227.

Muneer, T., Maubleu, S., and Asif, M. (2006). Prospects of solar water heating for textile industry in Pakistan. Renewable and Sustainable Energy Reviews, 10(1), 1-23.

NEC,. (2010). Programme for Industrial Sustainable Development. NEC Consultants. Retrieved 18 July 2016, from http://www.nec.com.pk/PISD.aspx

Nilsson, L., Persson, P., Rydén, L., Darozhka, S., and Zaliauskiene, A. (2007). Cleaner Production Technologies and Tools for Resource Efficient Production (p. 17). Uppsala: Baltic University Press.

Patterson, M. (1996). What is energy efficiency: Concepts, indicators and methodological issues. Energy Policy, 24(5), 377-390.

Peng, H. and Liu, Y. (2016). A comprehensive analysis of cleaner production policies in China. Journal of Cleaner Production, 135, 1138-1149

Pimenta, H. and Gouvinhas, R. (2011). Cleaner Production as a Corporate Sustainability Tool: An Exploratory Discussion. In 3rd International Workshop Cleaner Production Initiatives and Challenges for a Sustainable World. São Paulo: Advances in Cleaner Production Network. Retrieved 18 July 2016, from http://www.advancesincleanerproduction.net/third/files/sessoes/4B/6/Pimenta_HCD%20-%20Paper%20-%204B6.pdf

PISD,. (2013a). Generic Sustainability Framework for Industrial Estates of Pakistan. Programme for Industrial Sustainable Development. Retrieved 10 May 2016, from http://www.pisd.org.pk/SustainabilityFramework.aspx

PISD,. (2013b). Textile Processing. Programme for Industrial Sustainable Development. Retrieved 10 May 2016, from http://www.pisd.org.pk/PisdBrochure.aspx

Radford, T. (2005). Two-thirds of world's resources 'used up'. The Guardian. Retrieved 10 May 2016, from https://www.theguardian.com/science/2005/mar/30/environment.research

Rafiq, M. (2015). The Cleaner Production and Institutional Development in Pakistan. LEAD Pakistan. Retrieved 18 July 2016, from http://www.lead.org.pk/attachments/mtd/mtd50/attachments/fellow_case_study.pdf

Rao, K. (2004). Financing of energy efficiency investment: principal options for industrial investors. Promotion of Energy Efficiency in Industry and Financing of Investment.

Rathi, A. (2003). Promotion of cleaner production for industrial pollution abatement in Gujarat (India). Journal of Cleaner Production, 11(5), 583-590

Reddy, B. (2013). Barriers and drivers to energy efficiency – A new taxonomical approach. Energy Conversion and Management, 74, 403-416.

Sahoo, S., Varma, P., Lall, K., and Talwar, C. (2016). Energy efficiency in India: Achievements, challenges and legality. Energy Policy, 88, 495-503

Sardianou, E. (2008). Barriers to industrial energy efficiency investments in Greece. Journal of Cleaner Production, 16(13), 1416–1423.

SCI-Pak,. (2007). Project Information. Sustainable and Cleaner Production in the Manufacturing Industries of Pakistan. Retrieved 10 May 2016, from http://sci-pak.org/LinkClick.aspx?fileticket=yllyjdfMOaQ=&tabid=72

SCI-Pak,. (2009). Opportunity Analysis of the Policy Framework. SCI-Pak. Retrieved 12 August 2016, from http://www.sci-pak.org/LinkClick.aspx?fileticket=OeMWy%2F9ztz4%3D&tabid=7

SCI-Pak,. (2010). Clean Development Mechanism for Textile Processing and Tannery Sector of Pakistan. Sustainable and Cleaner production in the manufacturing Industries of Pakistan. Retrieved 10 May 2016, from http://sci-pak.org/LinkClick.aspx?fileticket=%2FAIyNi7HZ9A%3D&tabid=75

SDPI,. (2012). Experiments with Industrial Policy: The Case of Pakistan. Sustainable Development Policy Institute. Retrieved 12 August 2016, from https://sdpi.org/publications/files/Experiments-with-Industrial-Policy.pdf

Shahid, K. (2014). A tale of two Energy Policies. MIT Technology Review Pakistan. Retrieved 12 August 2016, from http://www.technologyreview.pk/a-tale-of-two-energy-policies/

Shi, H., Pen, S., Liu, Y., and Zhong, P. (2008). Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders' perspectives. Journal of Cleaner Production, 16(7), 842–852.

SMEDA,. (2008). Best Practices Reports on Energy Conservation Measures. SMEDA. Retrieved 12 August 2016, from http://www.smeda.org/index.php?option=com_content&view=article&catid=20&id=135

SPRU,. (2000a). Barriers to Energy Efficiency in Public and Private Organisations. University of Sussex. Retrieved 10 May 2016, from http://www.sussex.ac.uk/Units/spru/publications/reports/barriers/final.html

SPRU,. (2000b). Understanding barriers to energy efficiency. University of Sussex. Retrieved 10 May 2016, from http://www.sussex.ac.uk/Units/spru/publications/reports/barriers/finalsection3.pdf

Steinfeld, J. (2001). Climate change and energy options: decision making in the midst of uncertainty. Fuel Processing Technology, 71(1-3), 121-129.

Stevenson, R.S. (2002), Guidelines for Policy Integration and Strategic and Action Planning for the Promotion of Cleaner Production, Published by the Asian Development Bank, Manila, Philippines, ISBN 971-561-442-6, Stock No. 040102

Terefe, H., Gashaw, T., and Warkineh, B. (2015). Evolution of waste management strategies in industries: from passive to proactive. Journal of Environment and Waste Management. Retrieved 12 August 2016, from https://premierpublishers.org/jewm/280820152917

UNCRD,. (2013). Country Analysis Paper (Bangladesh). United Nations Centre for Regional Development. Retrieved 12 August 2016, from http://www.uncrd.or.jp/content/documents/Country%20Analysis%20Paper_Bangladesh.pdf

UNEP,. (2002). Sustainable Consumption and Cleaner Production Global Status 2002. United Nations Environment Programme. Retrieved 10 May 2016, from http://www.unep.fr/shared/publications/pdf/3211-GlobalStatus02.pdf

UNEP,. (2003). RECP Policies. United Nations Environment Programme. Retrieved 10 May 2016, from http://www.unep.org/resourceefficiency/Business/CleanerSaferProduction/ResourceEfficientCleaner Production/UnderstandingRECP/RECPPolicies/tabid/78841/Default.aspx

UNEP,. (2004). Guidance Manual How to Establish and Operate a Cleaner Production Centre. United Nations Environment Programme. Retrieved 10 May 2016, from http://www.unep.fr/shared/publications/pdf/WEBx0072xPA-CPcentre.pdf

UNEP,. (2007). Energizing Cleaner Production. United Nations Environment Programme. Retrieved 10 May 2016, from http://www.unep.org/pdf/DTIE_PDFS/DTIx0922xBA-EnergizingCP.pdf

UNEP,. (2015a). Introduction to Cleaner Production (CP) Concepts and Practice. United Nations. Retrieved 10 May 2016, from http://www.un.org/esa/sustdev/sdissues/technology/cleanerproduction.pdf

UNEP,. (2015b). Detailed assessment: Energy efficiency. United Nations Environment Programme. Retrieved 10 May 2016, from http://www.unep.org/resourceefficiency/Portals/24147/scp/presme/pdfs/UNEP_PRE_SME_I

UNESCO,. (2015). Water for a Sustainable World. Paris: United Nations Educational, Scientific and Cultural Organization. Retrieved 10 May 2016, from http://unesdoc.unesco.org/images/0023/002318/231823E.pdf

UNFCCC,. (2003). Pakistan's Initial National Communication on Climate Change. United Nations Framework Convention on Climate Change. Retrieved 10 May 2016, from http://unfccc.int/resource/docs/natc/paknc1.pdf

UNFCCC,. (2011). National Economic & Environmental Development Study (NEEDS) Pakistan. United Nations Framework Convention on Climate Change. Retrieved 10 May 2016, from https://unfccc.int/files/adaptation/application/pdf/pakistanneeds.pdf

UNIDO,. (2000). Industrial Policy and the Environment in Pakistan. UNIDO. Retrieved 12 August 2016, from http://www.unido.org/fileadmin/import/userfiles/timminsk/rio10-ind-pakistan-eng.pdf

UNIDO,. (2009). Funding Options for Small and Medium Size Enterprises to Finance Cleaner Production Projects and Environmentally Sound Technology Investments. Institute for Environmental Management and Economics. Retrieved 12 August 2016, from http://www.ioew.at/ioew/download/09-80065_Ebook-UNIDOFundingoptions.pdf

UNIDO,. (2011). Barriers to industrial energy efficiency: A literature review. United Nations Industrial Development Organization. Retrieved 10 May 2016, from https://www.unido.org/fileadmin/user_media/Services/Research_and_Statistics/WP102011_Ebook.pdf

UNIDO,. (2014a). Inclusive and Sustainable Industrial Development. United Nations Industrial Development Organization. Retrieved 10 May 2016, from https://www.unido.org/fileadmin/user_media_upgrade/Who_we_are/Mission/ISID-Brochure-LowRes1_EN.pdf

UNIDO,. (2014b). Resource Efficient Greening of Industry Initiative for Pakistan. Green Industry Platform. Retrieved 10 May 2016, from http://www.greenindustryplatform.org/wp-content/uploads/2015/03/Final-REGI-Initiative-for-Pakistan-28.-01.-14a.pdf

UNIDO,. (2015). Cleaner Production (CP). United Nations Industrial Development Organization. Retrieved 10 May 2016, from http://www.unido.org/en/what-we-do/environment/resource-efficient-and-low-carbon-industrial-production/cp/cleaner-production.html

United Nations,. (2015). World Population Prospects. United Nations. Retrieved 10 May 2016, from http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf

Unnikrishnan, S. and Hegde, D. (2007). Environmental training and cleaner production in Indian industry-A micro-level study. Resources, Conservation and Recycling, 50(4), 427-441

World Bank,. (2009). Energizing climate-friendly development: World Bank Group progress on renewable energy and energy efficiency in fiscal 2008. Washington DC: The World Bank Group.

World Bank,. (2016). Gross Domestic Product 2015. The World Bank Group. Retrieved 10 May 2016, from http://databank.worldbank.org/data/download/GDP.pdf

Willers, C., Ferraz, S., Carvalho, L., & Rodrigues, L. (2014). Determination of indirect water consumption and suggestions for cleaner production initiatives for the milk-producing sector in a Brazilian middle-sized dairy farming. Journal of Cleaner Production, 72, 146–152.

Worrell, E., Bernstein, L., Roy, J., Price, L., and Harnisch, J. (2009). Industrial energy efficiency and climate change mitigation. Energy Efficiency, 2(1), 109-123.

Yang, M. (2006). Energy efficiency policy impact in India: case study of investment in industrial energy efficiency. Energy Policy, 34(17), 3104-3114

Zhang, B., Yang, S., and Bi, J. (2013). Enterprises' willingness to adopt/develop cleaner production technologies: an empirical study in Changshu, China. Journal of Cleaner Production, 40, 62-70

Zhou, N., Levine, M., and Price, L. (2010). Overview of current energy-efficiency policies in China. Energy Policy, 38(11), 6439-645

# APPENDIX-A

# UNIVERSITY OF TWENTE.

## Questionnaire: Energy Efficiency & Cleaner Production in Textile Sector of Pakistan

This questionnaire is a part of a research (thesis) "*Promoting Energy Efficiency and Cleaner Production in Industries of Pakistan: A Case Study of Textile Manufacturing Sector*" conducted by *Owais Ur Reman Khan*, a student of Environmental & Energy Management at the University of Twente in Netherlands.
The purpose of this research is contributing to improving the present situation by providing recommendations on how energy efficiency and cleaner production be promoted in the textile sector of Pakistan. You are kindly requested to respond the following questions. This questionnaire filling might take 15-20 minutes. Thank you for your valuable time and important contribution.
**Note: The information will be kept as confidential and will be used only for research purpose. I will be happy to share a draft with you if you would like to check that my thesis complies with this statement.**

Name of Company: …… Company Address (City) ……..……...

Number of Employees (approx.) ……..…… Customers (Domestic / International) ……....

Name of Person: ……..... Designation: ……..……

1. Does your company have an explicit environmental and / or energy policy?
   - An explicit environmental policy ☐ Yes ☐ No
   - An explicit energy policy ☐ Yes ☐ No
2. Is the top management of your company fully committed to environmental and / or energy policy? ☐ Yes ☐ No
3. Are the environmental and / or energy policy fully integrated into the operations of your company? ☐ Yes ☐ No
4. Does your company have an Environmental Management System (EMS) and / or Energy Management System (EnMS)?
   - Environmental Management System (EMS) ☐ Yes ☐ No
   - Energy Management System (EnMS) ☐ Yes ☐ No
5. Does your company have appointed someone who is responsible for environmental and / or energy management?
   - EHS Manager (or equivalent) for environmental management ☐ Yes ☐ No
   - Energy Manager (or equivalent) for energy management ☐ Yes ☐ No
6. How do you rate the level of awareness about environmental and / or energy-related issues among your company laborers or non-management workers?
   ☐ None (0) ☐ Low (1) ☐ Average (2) ☐ Above average (3) ☐ High (4)
7. Did your company implement any energy efficiency measures in the past? ☐ Yes ☐ No
8. Was it profitable to implement any energy efficiency measure in your company as per investment criteria of your company (if applicable i.e. question 7 is Yes)? ☐ Yes ☐ No
9. How frequent is energy use generally recorded in your company (please tick the appropriate box)?
   - Electricity ☐ Not Recorded ☐ Annually ☐ Monthly ☐ Weekly ☐ Daily
   - Gas ☐ Not Recorded ☐ Annually ☐ Monthly ☐ Weekly ☐ Daily
   - Steam / Water ☐ Not Recorded ☐ Annually ☐ Monthly ☐ Weekly ☐ Daily
10. Does your company conduct energy audits? ☐ Yes ☐ No
11. Does your company use any kind of renewable energy? ☐ Yes ☐ No
12. Did your company implement any cleaner production practices in the past? ☐ Yes ☐ No
13. How much your company gives importance to implement energy efficiency and cleaner production?
    ☐ None (0) ☐ Low (1) ☐ Average (2) ☐ Above average (3) ☐ High (4)
14. Have your company expertise or technical staff to implement energy efficiency and / or cleaner production? ☐ Yes ☐ No
15. Are you aware of the initiatives introduced by the Cleaner Production Institute (CPI) and National Energy Conservation Centre (ENERCON) in the textile sector of Pakistan? ☐ Yes ☐ No

16. How much your company is satisfied with the following initiatives of CPI and / or ENERCON?

| | None (0) | Low (1) | Average (2) | Above Average (3) | High (4) |
|---|---|---|---|---|---|
| Cleaner Technology Program for Textile Sector (CTP-Textile) | | | | | |
| Program for Industrial Sustainable Development (PISD) | | | | | |
| Sustainable and Cleaner Production in Manufacturing Industries (SCI-Pak) | | | | | |
| Renewable Energy and Energy Efficiency by GIZ-Germany (REEE-Pakistan) | | | | | |

17. Which of the following CP practices are adopted in your company (please tick the appropriate box)?

| CP Level | | Yes | No |
|---|---|---|---|
| 3 | Cleaning of spills and waste | | |
| | Implementing ISO standards | | |
| | Solid waste management | | |
| | Waste water or effluent treatment | | |
| 2 | Onsite recovery or reusing of waste material | | |
| | Reuse of process water | | |
| | Transforming waste into a useful product to be sold | | |
| 1 | Equipment modification for energy efficiency | | |
| | Equipment modification to reduce waste and emissions | | |
| | Good housekeeping to prevent leaks, spills and waste | | |
| | Process improvement to reduce waste and emissions | | |
| | Product modification to minimize its environmental impacts | | |
| | Substituting raw materials to eliminate toxicity, waste, and emissions | | |
| | Technology change to minimize waste and emissions during production | | |

18. How do you value the impact the following factors have on the implementation of cleaner production practices at your company?

| | Rarely Important (0) | Sometimes Important (0.5) | Often Important (1) |
|---|---|---|---|
| Absence of incentives to implement cleaner production | | | |
| Company culture and awareness | | | |
| Conflict of interests within company | | | |
| Difficulty to access information on cleaner production | | | |
| High capital cost to invest in clean technology | | | |
| Higher production priority | | | |
| Inadequate management capacity | | | |
| Inertia or resistance to change behavior | | | |
| Lack of budget or funding | | | |
| Lack of collaboration | | | |
| Lack of commitment from top management | | | |
| Lack of competition | | | |
| Lack of demand from customers | | | |
| Lack of experts or technical staff | | | |
| Lack of grants or loans to invest in clean technology | | | |
| Lack of motivation in company for self-regulation | | | |
| Lack of social or public pressure | | | |
| Limited access to capital | | | |
| Low returns or longer payback period | | | |
| Uncertainty regarding the company future | | | |
| Weak environmental regulations from government | | | |
| Others (please describe) | | | |

19. How do you value the following factors impact to drive the implementation of cleaner production practices at your company?

| | Rarely Important (0) | Sometimes Important (0.5) | Often Important (1) |
|---|---|---|---|
| Company environmental reports | | | |
| Company image and recognition | | | |
| Company self-regulations | | | |
| Competition in international market | | | |
| Environmental Management System and continuous improvement | | | |
| Government regulations | | | |
| Green consumers | | | |
| Higher production costs | | | |
| Industry networking | | | |
| International trade incentives | | | |
| Loans from financial institutions | | | |
| Rising energy prices | | | |
| Social or public pressure | | | |
| Others (please describe) | | | |

20. How do you value the impact the following factors have on the implementation of energy efficiency measures at your company?

| | Rarely Important (0) | Sometimes Important (0.5) | Often Important (1) |
|---|---|---|---|
| Additional or hidden costs of new equipment | | | |
| Company culture and awareness | | | |
| Company hierarchy or long decision chains | | | |
| Conflict of interests within company | | | |
| Cost of identifying energy efficiency opportunities | | | |
| Cost of production disruption / inconvenience | | | |
| Difficulties in obtaining information about the energy consumption of purchased equipment | | | |
| Energy manager lacks sufficient power or influence | | | |
| Energy objectives not integrated into operating, maintenance or purchasing procedures | | | |
| Higher production priority | | | |
| Inertia or resistance to change behavior | | | |
| Lack of budget or funding | | | |
| Lack of collaboration | | | |
| Lack of commitment from top management | | | |
| Lack of competition | | | |
| Lack of experts or technical staff | | | |
| Lack of grants or loans to invest in energy efficiency | | | |
| Lack of sub-meters | | | |
| Lack of information to make energy efficient decisions | | | |
| Lack of time or other priorities | | | |
| Limited access to capital | | | |
| Low priority to energy management | | | |
| Possible poor performance of new equipment | | | |
| Technical risks such as risk of production disruptions | | | |
| Technology is not appropriate or cost effective | | | |
| Uncertainty regarding the company future | | | |
| Workers not accountable for energy costs | | | |
| Others (please describe) | | | |

21. How do you value the following factors impact to drive the implementation of energy efficiency measures at your company?

| | Rarely Important (0) | Sometimes Important (0.5) | Often Important (1) |
|---|---|---|---|
| Company commitment to comply standards | | | |
| Company image promotion among customers | | | |
| Company performance | | | |
| Cost reductions resulting from lowered energy use | | | |
| Energy audits | | | |
| Energy consumption or energy bills | | | |
| Energy tax or emissions tax ($CO_2$, $NO_X$, & Sulfur) | | | |
| Environmental Management System (EMS) | | | |
| Government regulations | | | |
| Improved working conditions | | | |
| Long-term energy strategy | | | |
| Market or international competition | | | |
| Networking within the company or group | | | |
| People with real ambition | | | |
| Public or social pressure | | | |
| Rising energy prices | | | |
| Voluntary agreements with tax exemptions | | | |
| Others (please describe) | | | |

22. How do you value the following tools that government should adopt to promote energy efficiency and cleaner production in the textile sector of Pakistan?

| | Rarely Important (0) | Sometimes Important (0.5) | Often Important (1) |
|---|---|---|---|
| Arrange training facilities | | | |
| Collaborate with international organizations | | | |
| Develop more effective policies | | | |
| Develop programs to raise awareness | | | |
| Establish institutions for R&D | | | |
| Establish networks among companies, financial institutions, academia, NGOs and government | | | |
| Improve infrastructure to monitor compliance | | | |
| Provide grants or soft loans | | | |
| Provide incentives for compliance | | | |
| Provide subsidiaries or exempt taxes | | | |
| Punish on violating regulations or standards | | | |
| Strictly enforce regulations or standards | | | |

23. Do you have any further suggestions that government should opt?

……
……
……

**Thank you very much for completing this questionnaire**

# APPENDIX-B

# UNIVERSITY OF TWENTE.

**Introduction:**

I am a student of Master of Environmental & Energy Management at the University of Twente in Netherlands. I am interviewing textile factories in Pakistan for my research (thesis) "*Promoting Energy Efficiency and Cleaner Production in Industries of Pakistan: A Case Study of Textile Manufacturing Sector*". The purpose of this research is contributing to improving the present situation by providing recommendations on how energy efficiency and cleaner production be promoted in the textile sector of Pakistan. You are kindly requested to share your experiences. The interview will take approximately 30 minutes. I highly appreciate your contribution as your opinions are highly valuable for this research.
**Note: Your information will be kept confidential and will be used only for research purpose.**

As a start, could you please give some general information about your company and yourself?

Name of Company: …… Company Address (City) ……..……...

Number of Employees (approx.) ……..…… Customers (Domestic / International) ……....

Name of Person: ……..... Designation: ……..……

## Interview Questions

1. Do you think that the textile sector of Pakistan, particularly small textile factories are facing serious challenges in complying with environmental standards?
    a. Does it also impact on the business of your company?
    b. If yes, how your company cope with these challenges?
    c. How can small textile factories cope with these challenges?

2. What is your opinion about implementing cleaner production in the industrial sector particularly in the textile sector of Pakistan?

3. Have your company adopted any energy efficiency measures and/or cleaner production practices?
    a. If yes, what are these measures and/or practices?
    b. If yes, was it profitable according to the investment criteria of your company?
    c. If not, why? Any particular reasons? And do you plan to adopt them in future?
    d. What are the most common energy efficiency measures or cleaner production practices adopted by other textile factories, if you know?

4. What is your opinion about the present level of energy efficiency measures and cleaner production practices adopted by textile factories in Pakistan?
    a. Do you know any statistics i.e. how many textile factories have already implemented energy efficiency and/or cleaner production?
    b. Or can you roughly guess the percentage of those textile factories?

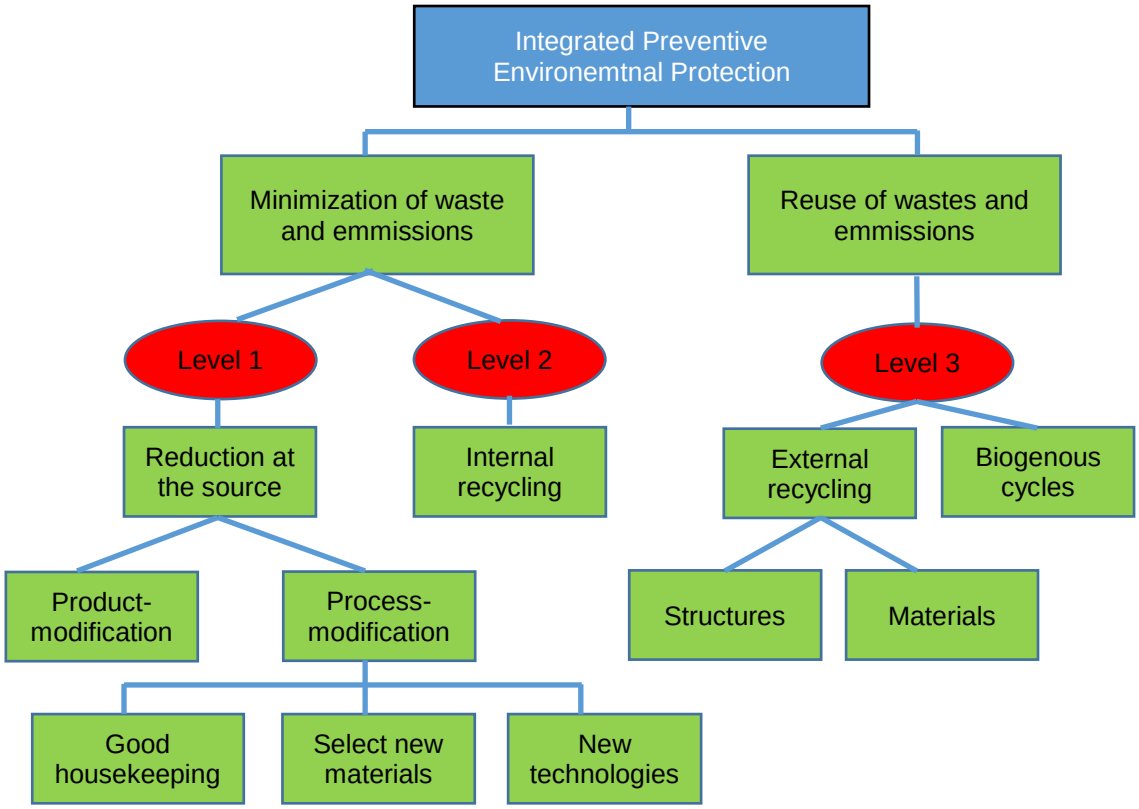
5. What are the major barriers and drivers to the implementation of energy efficiency and cleaner production in the textile sector of Pakistan?

6. What is your opinion about government policies and initiatives introduced in Pakistan to promote energy efficiency and cleaner production?
    a. Are these policies and initiatives effective? If not, what are their weaknesses?
    b. Are you satisfied with the activities and programs introduced by the Cleaner Production Institute (CPI) in the textile sector of Pakistan?
    c. Do you have suggestions for the government to promote energy efficiency and cleaner production in the textile sector?

# APPENDIX-C

## Level of CP Strategies

Figure 2.6: Levels of CP Strategies (Sources: Nilsson et al, 2007; Willers et al, 2014)




## CP Practices

| | |
|---|---|
| • Cleaning of spills and waste | Level 3 |
| • Implementing ISO standards | Level 3 |
| • Solid waste management | Level 3 |
| • Waste water or effluent treatment | Level 3 |
| • Onsite recovery or reusing of waste material | Level 2 |
| • Reuse of process water | Level 2 |
| • Transforming waste into a useful product to be sold | Level 2 |
| • Equipment modification for energy efficiency | Level 1 |
| • Equipment modification to reduce waste and emissions | Level 1 |
| • Good housekeeping to prevent leaks, spills, and waste | Level 1 |
| • Process improvement to reduce waste and emissions | Level 1 |
| • Product modification to minimize its environmental impacts | Level 1 |
| • Substituting raw materials to eliminate toxicity, waste, and emissions | Level 1 |
| • Technology change to minimize waste and emissions during production | Level 1 |

Note: Level 3, Level 2, and Level 1 respectively represent the lowest, medium, and a good level of CP implementation.

## What is not CP?

- Offsite recycling
- Transferring hazardous waste
- Waste treatment
- Concentrating hazardous or toxic constituents to reduce volume
- Diluting constituents to reduce hazard or toxicity

# APPENDIX-D

## All Pakistan Textile Mills Association (APTMA)

All Pakistan Textile Mills Association (APTMA) is the premier national trade association of the textile spinning, weaving, and composite mills representing the organized sector in Pakistan. APTMA emerges as the largest association of the country as it represents 396 textile mills out of which 315 are spinning, 44 weaving and 37 composite units. These spinning mills have production facilities of texturing, mercerizing and dyeing of yarns; weaving mills have a sizeable number of air-jet looms, and the composite mills have manufacturing facilities from spinning to finished textile products under one roof. APTMA principal office is located at Karachi, and regional offices are in Karachi, Lahore, and Peshawar. APTMA works in close coordination with other national textile trade association and groups to safeguard the interest of its members in particular and textile industry as a whole.

The aims and objectives of the Association as per charter and by-laws are as follows:

1. To encourage friendly feeling and unanimity amongst textile mill owners on all subjects connected with their common good. To secure good relations between members of the Association.
2. To promote and protect the trade commerce and manufactures of Pakistan in general and of the cotton trade in particular. To consider questions connected with the trade commerce and manufactures of its members. To collect and circulate statistics and information classify relating to the trade, commerce, and manufactures of its members.
3. To take all steps which may be necessary for promoting, supporting or opposing legislative and other measures affecting the trade, commerce or manufactures of its members.
4. To make representation to local, provincial and federal authorities on any matter connected with the trade, commerce, and manufactures of its members.
5. To arbitrate in the settlement of disputes arising out of transactions, piece goods, yarn and other manufactured goods between parties willing or agreeing to submit to arbitration in accordance with the Arbitration Rules of the Association.
6. To advance and promote commercial and technical education connected with the trade and commerce of its members. To undertake special inquiries and initiate or support any action for securing the redress of legitimate grievances connected with the trade or commerce of its members.
7. To take any action that may be conducive to the extension of the trade and commerce of its members or incidental to the attainment of this object.
8. To subscribe, to become a member of and cooperate with any other Association whether incorporated or not whose objects are altogether or in part similar to those of the Association and to procure from or communicate to any such Association such information as may be likely to forward the objects of this Association
9. To establish or aid in the establishment of funds to benefit employees of the Association or the depending of such persons and to subscribe, donate or guarantee money for charitable or benevolent purposes at the discretion of the Association.
10. To regulate conditions of employment in the industry conducted or carried on by its members. And generally to do all that may be necessary for the interest of the realization of the above objects of the Association directly or indirectly.

## All Pakistan Textile Processing Mills Association (APTMA)

All Pakistan Textile Processing Mills Association (APTPMA) is a body organizing all textile processing and composite units. APTPMA has collaborated with Cleaner Production Institute (CPI) and the Embassy of Kingdom of the Netherlands (EKN) in implementation of various environmental and cleaner technology initiatives such as Environmental Technology Program for Industry (ETPI 1996-2000), Cleaner Production Program (CPP 2000-2002), and Cleaner Technology Program for Textile Industry (CTP-Textile I & II:2000-2007). APTPMA is now going to start phase III of Programme for Industrial Sustainable Development (PISD).

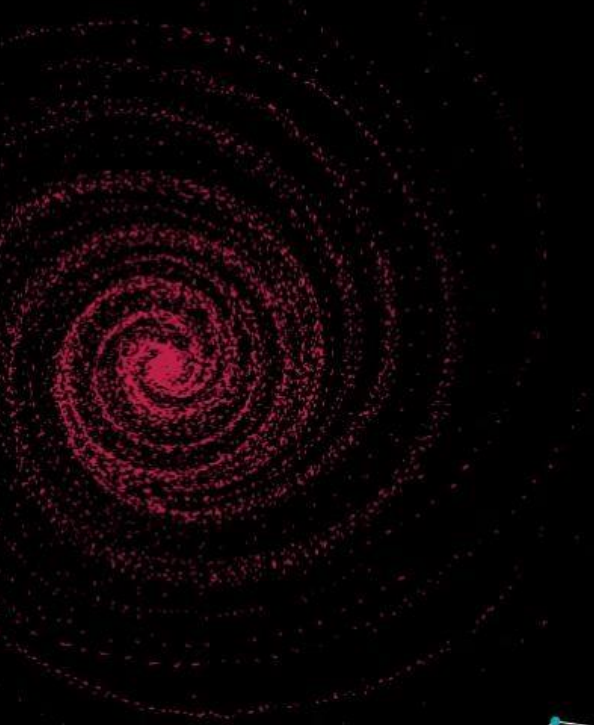
Academic Year 2015 / 2016

Master of Environmental and Energy Management (MEEM)

Department of Governance and Technology for Sustainability (CSTM)

Faculty of Behavioural, Management and Social Sciences (BMS)

**UNIVERSITY OF TWENTE**



UNIVERSITY OF TWENTE.